Cambridge Assessment International Education

Grade thresholds – November 2017

Cambridge IGCSE Chemistry (0620)

Grade thresholds taken for Syllabus 0620 (Chemistry) in the November 2017 examination.

		minimum raw mark required for grade:						
	maximum raw mark available	A	B	C	D	E	F	G
Component 11	40	–	–	25	21	18	15	12
Component 12	40	–	–	24	21	19	15	11
Component 13	40	–	–	24	21	18	14	10
Component 21	40	29	25	22	18	15	12	9
Component 22	40	31	27	24	21	18	14	10
Component 23	40	29	25	22	18	15	12	10
Component 31	80	–	–	50	43	34	27	20
Component 32	80	–	–	50	42	33	27	21
Component 33	80	–	–	50	41	33	27	22
Component 41	80	44	34	24	21	16	13	10
Component 42	80	46	36	26	21	17	13	9
Component 43	80	46	37	27	24	19	14	9
Component 51	40	31	26	21	18	16	12	8
Component 52	40	31	27	23	20	17	14	11
Component 53	40	31	26	21	18	16	12	8
Component 61	40	31	26	21	18	16	12	8
Component 62	40	32	27	23	20	17	14	11
Component 63	40	30	25	21	18	16	12	8

Grade A* does not exist at the level of an individual component.

The maximum total mark for this syllabus, after weighting has been applied, is **200**.

The overall thresholds for the different grades were set as follows.

Option	Combination of Components	A*	A	B	C	D	E	F	G
BX	21, 41, 51	152	129	106	84	71	59	46	33
BY	22, 42, 52	155	134	113	92	78	65	51	37
BZ	23, 43, 53	153	131	109	88	75	62	48	34
CX	21, 41, 61	152	129	106	84	71	59	46	33

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Grade thresholds continued

Cambridge IGCSE Chemistry (0620)

Option	Combination of Components	A*	A	B	C	D	E	F	G
CY	22, 42, 62	157	135	113	92	78	65	51	37
CZ	23, 43, 63	151	130	109	88	75	62	48	34
FY	12, 32, 52	–	–	–	121	104	87	70	53
FZ	13, 33, 53	–	–	–	119	101	84	67	50
GX	11, 31, 61	–	–	–	120	103	86	68	50
GY	12, 32, 62	–	–	–	121	104	87	70	53
GZ	13, 33, 63	–	–	–	119	101	84	67	50

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/51**

Paper 5 Practical Test **October/November 2017**

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Supervisors are advised to remind candidates that **all** substances in the examination should be treated with caution. Suitable eye protection should be provided.

In accordance with COSHH (Control of Substances Hazardous to Health) Regulations, operative in the UK, a hazard appraisal of the examination has been carried out.

Attention is drawn, in particular, to certain materials used in the examination. The following codes are used where relevant.

C	corrosive	**MH**	moderate hazard
HH	health hazard	**T**	acutely toxic
F	flammable	**O**	oxidising
N	hazardous to the aquatic environment		

Hazard data sheets should be available from your suppliers.

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Question 1

Each candidate will require the following apparatus and chemicals.

(a) 50 cm^3 measuring cylinder

(b) stirring thermometer, –10 °C to +110 °C at 1 °C graduations

(c) polystyrene cup

(d) 250 cm^3 beaker

[MH] (e) 6 g of ammonium chloride in a stoppered test-tube, labelled **solid W**

[MH] (f) 3 g of anhydrous calcium chloride in a stoppered test-tube, labelled **solid X**

The anhydrous calcium chloride should be newly purchased.

(g) stopclock or timer which can measure to an accuracy of 1 s

(h) access to water and distilled water

Question 2

Each candidate will require the following apparatus and chemicals. Labels do **not** need to include concentrations.

(a) 10 cm^3 of aqueous chromium(III) nitrate, $Cr(NO_3)_3.9H_2O$, of concentration 0.1 mol / dm^3, in a stoppered test-tube, labelled **solution Y**

[MH][N] **(b)** 10 cm^3 of aqueous ammonia of concentration 1 mol / dm^3, in a stoppered test-tube, labelled **solution Z**

(c) distilled water

(d) red and blue litmus paper

(e) Universal Indicator paper and chart

(f) rack of six test-tubes

(g) stopper to fit test-tubes

(h) boiling tube

[C] **(i)** aqueous sodium hydroxide of concentration 1 mol / dm^3

(j) aluminium foil

[N] **(k)** aqueous copper(II) sulfate of concentration 0.5 mol / dm^3

(l) 10 cm^3 measuring cylinder

(m) Bunsen burner and matches

(n) teat pipettes

(o) test-tube holder

The Supervisor's Report is on pages 7 and 8.

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The Supervisor's Report is on pages 7 and 8.

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Supervisor's Report

1 **(a)** Supervisor's Results

It is recommended that the Supervisor should be a chemistry teacher.

The Supervisor is asked to carry out the experiments in Questions 1 and 2 and to record the results on a spare copy of the Question Paper clearly labelled 'Supervisor's Results'. Failure to enclose these results and this report form may lead to candidates being unavoidably penalised.

(b) The candidate numbers of candidates in each session were:

First session	*Second session*

2 The Supervisor is invited to report details of any difficulties experienced by candidates, giving names and candidate numbers. The report should include reference to:

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Declaration (to be signed by the Supervisor)

The preparation of this practical examination has been carried out so as to maintain fully the security of the examination.

Name of Centre .....

Centre number .....

Signed .....

Name (in block capitals) ..... (Supervisor)

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CHEMISTRY **0620/52**

Paper 5 Practical Test **October/November 2017**

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C	corrosive	**MH**	moderate hazard
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Question 1

Each candidate will require the following apparatus and chemicals.

(a) 50 cm^3 measuring cylinder

(b) stirring thermometer, –10 °C to +110 °C at 1 °C graduations

(c) polystyrene cup

(d) 250 cm^3 beaker

(e) samples in stoppered test-tubes of

[MH] 2 g of anhydrous calcium chloride, labelled **2.0 g of solid S**,

[MH] 3 g of anhydrous calcium chloride, labelled **3.0 g of solid S**,

[MH] 5 g of anhydrous calcium chloride, labelled **5.0 g of solid S**.

The anhydrous calcium chloride should be newly purchased.

(f) samples in stoppered test-tubes of

[MH] 2 g of ammonium chloride, labelled **2.0 g of solid T**,

[MH] 3 g of ammonium chloride, labelled **3.0 g of solid T**,

[MH] 4 g of ammonium chloride, labelled **4.0 g of solid T**,

[MH] 6 g of ammonium chloride, labelled **6.0 g of solid T**.

(g) access to water and distilled water

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Question 2

Each candidate will require the following apparatus and chemicals. Labels do **not** need to include concentrations.

[MH] **(a)** 0.5 g of anhydrous sodium carbonate, Na_2CO_3, in a stoppered test-tube, labelled **solid U**

[T] **(b)** 0.5 g of barium chloride, $BaCl_2.2H_2O$, in a stoppered test-tube, labelled **solid W**

(c) distilled water

(d) apparatus for a flame test

(e) rack of six test-tubes

(f) stopper to fit test-tubes

[C] **(g)** dilute nitric acid of concentration 1 mol / dm^3

[MH] **(h)** limewater and apparatus used to test for carbon dioxide

(i) red and blue litmus paper

[MH][N] **(j)** aqueous silver nitrate of sufficient concentration to give a positive halide test

(k) dilute hydrochloric acid of concentration 1 mol / dm^3

(l) 10 cm^3 measuring cylinder

(m) Bunsen burner and matches

(n) teat pipettes

(o) splints

(p) spatula

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Name of Centre .....

Centre number .....

Signed .....

Name (in block capitals) ..... (Supervisor)

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CHEMISTRY **0620/53**

Paper 5 Practical Test **October/November 2017**

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(g) stopper to fit test-tubes

(h) boiling tube

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(j) aluminium foil

[N] **(k)** aqueous copper(II) sulfate of concentration 0.5 mol / dm^3

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CHEMISTRY **0620/11**

Paper 1 Multiple Choice (Core) **October/November 2017**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1	D	**1**
2	B	**1**
3	C	**1**
4	D	**1**
5	C	**1**
6	A	**1**
7	C	**1**
8	B	**1**
9	C	**1**
10	B	**1**
11	B	**1**
12	C	**1**
13	B	**1**
14	C	**1**
15	B	**1**
16	B	**1**
17	B	**1**
18	C	**1**
19	A	**1**
20	B	**1**
21	C	**1**
22	A	**1**
23	B	**1**
24	D	**1**
25	A	**1**
26	A	**1**
27	A	**1**
28	A	**1**
29	C	**1**

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Question	Answer	Marks
30	C	**1**
31	B	**1**
32	A	**1**
33	C	**1**
34	C	**1**
35	C	**1**
36	B	**1**
37	B	**1**
38	A	**1**
39	B	**1**
40	C	**1**

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CHEMISTRY **0620/12**

Paper 1 Multiple Choice (Core) **October/November 2017**

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Question	Answer	Marks
1	D	**1**
2	B	**1**
3	B	**1**
4	C	**1**
5	D	**1**
6	C	**1**
7	D	**1**
8	D	**1**
9	D	**1**
10	C	**1**
11	B	**1**
12	C	**1**
13	B	**1**
14	C	**1**
15	B	**1**
16	B	**1**
17	B	**1**
18	D	**1**
19	B	**1**
20	A	**1**
21	B	**1**
22	B	**1**
23	A	**1**
24	D	**1**
25	A	**1**
26	B	**1**
27	C	**1**
28	A	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	B	**1**
32	D	**1**
33	C	**1**
34	D	**1**
35	B	**1**
36	C	**1**
37	B	**1**
38	A	**1**
39	B	**1**
40	C	**1**

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CHEMISTRY **0620/13**

Paper 1 Multiple Choice (Core) **October/November 2017**

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Question	Answer	Marks
1	B	**1**
2	C	**1**
3	C	**1**
4	B	**1**
5	B	**1**
6	A	**1**
7	C	**1**
8	B	**1**
9	D	**1**
10	C	**1**
11	B	**1**
12	D	**1**
13	B	**1**
14	C	**1**
15	D	**1**
16	B	**1**
17	B	**1**
18	B	**1**
19	C	**1**
20	B	**1**
21	B	**1**
22	A	**1**
23	A	**1**
24	D	**1**
25	A	**1**
26	B	**1**
27	A	**1**
28	D	**1**

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Question	Answer	Marks
29	C	**1**
30	A	**1**
31	B	**1**
32	A	**1**
33	C	**1**
34	C	**1**
35	C	**1**
36	D	**1**
37	B	**1**
38	A	**1**
39	B	**1**
40	C	**1**

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CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2017**

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Question	Answer	Marks
1	D	**1**
2	C	**1**
3	B	**1**
4	A	**1**
5	C	**1**
6	B	**1**
7	A	**1**
8	B	**1**
9	A	**1**
10	D	**1**
11	B	**1**
12	B	**1**
13	B	**1**
14	B	**1**
15	C	**1**
16	C	**1**
17	B	**1**
18	B	**1**
19	A	**1**
20	B	**1**
21	C	**1**
22	A	**1**
23	B	**1**
24	D	**1**
25	A	**1**
26	A	**1**
27	D	**1**
28	D	**1**

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Question	Answer	Marks
29	C	**1**
30	B	**1**
31	C	**1**
32	B	**1**
33	D	**1**
34	C	**1**
35	C	**1**
36	C	**1**
37	B	**1**
38	B	**1**
39	C	**1**
40	B	**1**

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2017**

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2	B	**1**
3	B	**1**
4	B	**1**
5	B	**1**
6	C	**1**
7	A	**1**
8	B	**1**
9	A	**1**
10	D	**1**
11	B	**1**
12	B	**1**
13	B	**1**
14	D	**1**
15	C	**1**
16	B	**1**
17	B	**1**
18	B	**1**
19	B	**1**
20	A	**1**
21	B	**1**
22	B	**1**
23	A	**1**
24	D	**1**
25	A	**1**
26	B	**1**
27	B	**1**
28	A	**1**

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Question	Answer	Marks
29	C	**1**
30	D	**1**
31	A	**1**
32	C	**1**
33	D	**1**
34	C	**1**
35	D	**1**
36	B	**1**
37	B	**1**
38	B	**1**
39	B	**1**
40	D	**1**

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2017**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1	C	**1**
2	C	**1**
3	C	**1**
4	D	**1**
5	B	**1**
6	A	**1**
7	A	**1**
8	B	**1**
9	A	**1**
10	D	**1**
11	C	**1**
12	B	**1**
13	B	**1**
14	D	**1**
15	A	**1**
16	A	**1**
17	B	**1**
18	B	**1**
19	C	**1**
20	B	**1**
21	B	**1**
22	A	**1**
23	A	**1**
24	D	**1**
25	A	**1**
26	C	**1**
27	D	**1**
28	C	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	A	**1**
32	B	**1**
33	D	**1**
34	C	**1**
35	C	**1**
36	C	**1**
37	B	**1**
38	B	**1**
39	D	**1**
40	C	**1**

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CHEMISTRY **0620/31**

Paper 3 Core Theory **October/November 2017**

MARK SCHEME

Maximum Mark: 80

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Question	Answer	Marks
1(a)(i)	**A**	**1**
1(a)(ii)	**B**	**1**
1(a)(iii)	**D**	**1**
1(a)(iv)	**B**	**1**
1(a)(v)	**C**	**1**
1(b)	substance containing only one type of atom / substance containing atoms (each) with the same number of protons / substance which cannot be broken down further by chemical means	**1**
1(c)	solid	**1**
	–15 °C is below the melting point	**1**

Question	Answer	Marks
2(a)	1.5 (%)	**1**
2(b)	any 3 from: • greater percentage of helium (on Neptune) / more helium on Neptune / less helium on Earth • greater percentage of hydrogen (on Neptune) / more hydrogen on Neptune / no hydrogen on Earth / (very) little hydrogen on Earth • no oxygen on Neptune / little oxygen on Neptune (but Earth has 21% oxygen) • greater percentage of methane (on Neptune) / more methane on Neptune / less methane on Earth / more methane on Neptune • more argon on Earth / less argon on Neptune • no nitrogen on Neptune / little nitrogen on Neptune	**3**
2(c)	labels ‘C’ and ‘H’ in the correct circles and no non-bonding electrons or extra bonding electrons	**1**
	one pair of electrons in each overlap area	**1**

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Question	Answer	Marks
2(d)(i)	atoms of the same element with the same number of protons but a different number of neutrons	**1**
2(d)(ii)	number of protons: 1	**1**
	number of neutrons: 2	**1**
2(e)(i)	30 IF full credit is not awarded, allow 1 mark for (C =) 12 and (H =) 1	**2**
2(e)(ii)	anhydrous / white copper(II) sulfate **OR** anhydrous / blue cobalt(II) chloride	**1**
	(anhydrous copper(II) sulfate) turns blue **OR** (anhydrous cobalt(II) chloride) turns pink	**1**

Question	Answer	Marks
3(a)(i)	2 (CO_2)	**1**
	3 (H_2O)	**1**
3(a)(ii)	correct structure showing all of the atoms and all of the bonds including O–H IF full credit is not awarded, allow 1 mark for structure with OH	**2**
3(b)(i)	pH 10	**1**
3(b)(ii)	red / pink	**1**
	to yellow	**1**
3(b)(iii)	sodium carbonate + sulfuric acid → sodium sulfate + carbon dioxide + water IF full credit is not awarded, allow 1 mark for either sodium sulfate **OR** carbon dioxide + water	**2**

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Question	Answer	Marks
3(c)	sulfur dioxide	**1**
3(d)(i)	**P**: chromatography paper / filter paper	**1**
	Q: solvent	**1**
3(d)(ii)	chromatography	**1**
3(d)(iii)	**X** drawn on the baseline	**1**

Question	Answer	Marks
4(a)	graphite: conducts	**1**
	potassium: conducts	**1**
4(b)	low boiling point	**1**
4(c)	does not conduct when solid but conducts when molten IF full credit is not awarded, allow 1 mark for conducts when molten	**2**
4(d)	positive electrode (anode): chlorine / Cl_2	**1**
	negative electrode (cathode): zinc / Zn	**1**
4(e)	chlorine is more reactive than iodine	**1**

Question	Answer	Marks
5(a)(i)	2 (C)	**1**
	2 (Cl_2)	**1**
5(a)(ii)	carbon gains oxygen / oxidation number of carbon increases / carbon loses electrons	**1**

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Question	Answer	Marks
5(b)	any 2 from: • titanium has a high melting / boiling point **ORA** • titanium has a high density **ORA** • titanium is hard / strong **ORA**	**2**
5(c)(i)	relative reactivity with water: forms bubbles slowly / slower than sodium	**1**
	melting point of potassium: any value between 45–90 (°C) inclusive	**1**
5(c)(ii)	increases down the group / decreases up the group	**1**
5(d)	basic because it is a metal (oxide)	**1**

Question	Answer	Marks
6(a)	any 4 from: • petroleum vaporised / heated • petroleum enters the fractionating column at the bottom • vapours move up the fractionating column • column is hotter at the bottom / cooler at the top • idea of vapours condensing in different parts of the fractionating column • idea of different fractions having different boiling ranges • fractions (condensing) higher up have lower boiling points **ORA**	**4**
6(b)(i)	breaking down / decomposing / splitting hydrocarbons	**1**
	into smaller hydrocarbons / into alkanes and alkenes / by heating / using a high temperature	**1**
6(b)(ii)	hydrogen	**1**
6(c)	covalent	**1**
6(d)	polymer	**1**

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Question	Answer	Marks
7(a)	any 3 from: • diffusion • molecules move (from place to place) • (molecules move) randomly • molecules collide • molecules spread out / mix up • (bulk) movement of molecules from areas of where they are at higher concentration to where they are at lower concentration	**3**
7(b)(i)	$C_4H_6O_2Br_2$	**1**
7(b)(ii)	carboxylic acid	**1**
7(c)	average	**1**
	an element	**1**
	an atom	**1**
	12	**1**
7(d)(i)	increasing the concentration of the acid	**1**
	increasing the temperature	**1**
	using magnesium powder / using smaller pieces of magnesium	**1**
7(d)(ii)	4 (HBr)	**1**

Question	Answer	Marks
8(a)(i)	reversible reaction	**1**
8(a)(ii)	speed up the reaction / increase the rate of reaction / speed of reaction faster	**1**

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Question	Answer	Marks
8(b)(i)	decreases as the temperature increases **ORA**	**1**
8(b)(ii)	28%	**1**
8(c)	112 (g)	**1**
8(d)	clothing / named clothing / fishing lines	**1**

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CHEMISTRY **0620/32**

Paper 3 Core Theory **October/November 2017**

MARK SCHEME

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Question	Answer	Marks
1(a)(i)	**A**	**1**
1(a)(ii)	**C**	**1**
1(a)(iii)	**D**	**1**
1(a)(iv)	**D**	**1**
1(a)(v)	**E**	**1**
1(b)	any 3 from: • metals conduct electricity / heat **ORA** • metals are malleable **ORA** • metals are ductile **ORA** • metals are sonorous / ring when hit **ORA** • metals are shiny / lustrous **ORA**	**3**
1(c)	substance contain two (or more different) elements which are bonded together / which are chemically combined	**1**

Question	Answer	Marks
2(a)	any 3 from: • greater percentage of helium (on Saturn) / less helium on Earth • greater percentage of hydrogen (on Saturn) / little hydrogen on Earth • no oxygen on Saturn / oxygen on Earth / Earth has 1/5 oxygen • lower percentage of other gases (on Saturn) / more of other gases on Earth • greater percentage of argon on Earth / less argon on Saturn • no **OR** very little nitrogen on Saturn / Earth has about 80% nitrogen / Earth has a lot of nitrogen	**3**
2(b)(i)	hydrogen is less dense than helium	**1**
2(b)(ii)	gas	**1**
	–250 °C is above the boiling point	**1**

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Question	Answer	Marks
2(c)(i)	(damp) red litmus	1
	turns blue	1
2(c)(ii)	labels 'N' and 'H' in the correct circles	1
	one pair of electrons in each overlap area and no non-bonding electrons or extra bonding electrons added	1
2(d)	51 IF full credit is not awarded, allow 1 mark for (S =) 32, (N =) 14 and (H =) 1	2
2(e)(i)	carbon dioxide / CO_2	1
2(e)(ii)	global warming / effect of global warming, e.g. melting ice caps / desertification / more extreme weather / death of corals / more risk of flooding	1

Question	Answer	Marks
3(a)(i)	functional group shown as –COOH / $–CO_2H$ or displayed formula	1
3(a)(ii)	pH 4	1
3(a)(iii)	neutralisation	1
3(a)(iv)	releases heat / heat given out	1
3(b)	$C_3H_8O_3$	1
3(c)	2 (CO)	1
	3 (H_2O)	1

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Question	Answer	Marks
3(d)(i)	distillation	1
	water is the distillate / water collects in the condenser / sodium chloride remains in the flask	1
	idea of different boiling points (of water and sodium chloride)	1
3(d)(ii)	boiling point / melting point	1
3(d)(iii)	(aqueous) silver nitrate (acidified with nitric acid)	1
	white precipitate	1

Question	Answer	Marks
4(a)	electrical conductivity of zinc: conducts	1
	solubility in water of sodium chloride: soluble	1
4(b)	low boiling point / does not conduct when solid or molten	1
4(c)	does not conduct when solid but conducts when molten IF full credit is not awarded, allow 1 mark for conducts when molten	2
4(d)	positive electrode (anode): iodine	1
	negative electrode (cathode): calcium	1
4(e)	number of protons: 15	1
	number of neutrons: 16	1
4(f)	acidic because phosphorus is a non-metal	1
4(g)	goes (directly) from solid to vapour / gas (without liquid state being formed)	1

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Question	Answer	Marks
5(a)	nickel(II) oxide loses oxygen / oxidation number of nickel decreases / nickel gains electrons	**1**
5(b)	reversible reaction	**1**
5(c)(i)	carbon monoxide is a gas / carbon monoxide escapes from the mixture	**1**
5(c)(ii)	toxic / poisonous	**1**
5(d)(i)	any 2 from: • nickel has a high melting / boiling point **ORA** • nickel has a high density **ORA** • nickel is hard / strong **ORA**	**2**
5(d)(ii)	nickel(II) chloride is coloured **ORA** / nickel(II) chloride can be a catalyst **ORA**	**1**
5(e)(i)	boiling point: any value between 680–750 °C inclusive	**1**
	relative reactivity of rubidium with water: reacts explosively / bigger flame (than potassium) / forms bubbles extremely rapidly / faster that potassium but slower than caesium / rapidly bursts into flame	**1**
5(e)(ii)	density increases down the group **ORA**	**1**

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Question	Answer	Marks
6(a)	any 5 from: *from ethene*: • steam • high temperature • catalyst *by fermentation*: • yeast / zymase / enzymes • absence of oxygen / anaerobic • water / aqueous (suspension) • suitable temperature quoted (10–40 °C)	**5**
6(b)(i)	saturated hydrocarbon: no change / aqueous bromine remains orange	**1**
	unsaturated hydrocarbon: aqueous bromine decolourised	**1**
6(b)(ii)	a large molecule formed from many monomers	**1**
6(b)(iii)	clothing / named article of clothing	**1**

Question	Answer	Marks
7(a)	any 3 from: • diffusion • molecules move (from place to place) • (molecules move) randomly • molecules collide • molecules spread out / mix up • (bulk) movement of molecules from areas of where they are at higher concentration to where they are at lower concentration	**3**

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Question	Answer	Marks
7(b)	Cl_2	1
	2 (SCl_2)	1
7(c)	**P**: freezing	1
	Q: condensing / condensation	1

Question	Answer	Marks
8(a)	89.6 (g)	1
8(b)(i)	220 (cm^3)	1
8(b)(ii)	49 (min)	1
8(b)(iii)	goes faster / increases (rate)	1
8(c)(i)	16%	1
8(c)(ii)	any 2 from: • neutralise soil • reduce acidity of soils • so plants grow properly / so plants grow well	2

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CHEMISTRY **0620/33**

Paper 3 Core Theory **October/November 2017**

MARK SCHEME

Maximum Mark: 80

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Question	Answer	Marks
1(a)(i)	**B**	**1**
1(a)(ii)	**C**	**1**
1(a)(iii)	**B**	**1**
1(a)(iv)	**D**	**1**
1(a)(v)	**C**	**1**
1(b)(i)	burning fossil fuels / volcanoes / high temperature furnaces / burning named fossil fuel	**1**
1(b)(ii)	breathing difficulties / irritates nose / irritates eyes / irritates throat	**1**
1(c)	number of protons: 7	**1**
	number of neutrons: 8	**1**
	number of electrons: 7	**1**

Question	Answer	Marks
2(a)	any 3 from: • no oxygen on Venus / (very) little oxygen on Venus / Earth has oxygen / Earth has 21% oxygen • greater per cent carbon dioxide on Venus / more carbon dioxide on Venus **ORA** • smaller per cent of nitrogen on Venus / (very) little nitrogen on Venus / less nitrogen on Venus / Earth has 79% nitrogen	**3**
2(b)	limewater	**1**
	turns milky / cloudy / white precipitate	**1**
2(c)(i)	labels ‘O’ and ‘H’ in the correct circles and no extra non-bonding electrons or bonding electrons	**1**
	one pair of electrons in each overlap area	**1**

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Question	Answer	Marks
2(c)(ii)	solid	**1**
	–200 °C is lower than melting point	**1**
2(c)(iii)	it has 8 electrons in its outer shell	**1**
2(d)(i)	sulfuric acid + magnesium carbonate → magnesium sulfate + carbon dioxide + water IF full credit is not awarded, award 1 mark for either magnesium sulfate **OR** carbon dioxide + water	**2**
2(d)(ii)	98 IF full credit is not awarded, award 1 mark for (S =) 32 , (O = 16) and (H =1)	**2**
2(e)(i)	bleach / treating wood pulp / preservative	**1**
2(e)(ii)	pH 2	**1**

Question	Answer	Marks
3(a)	calcium carbonate	**1**
3(b)(i)	condensation (at mouth of tube)	**1**
3(b)(ii)	add (aqueous) sodium hydroxide / (aqueous) ammonia	**1**
	green precipitate	**1**
3(c)(i)	H_2	**1**
3(c)(ii)	filtration / filter	**1**
3(d)(i)	structure completed correctly with all of the atoms and all of the bonds IF full credit is not awarded, award 1 mark for OH instead of O–H	**2**
3(d)(ii)	bubbles **OR** effervesces / magnesium decreases in size **OR** magnesium disappears	**1**

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Question	Answer	Marks
3(e)	any 3 from: • beaker with chromatography paper inside **OR** chromatography paper with spot on baseline • solvent in bottom of beaker • solvent and chromatography paper correctly labelled • spot (of dye) above level of solvent	**3**
3(f)	any 3 from: • diffusion • molecules move (from place to place) • (molecules move) randomly • molecules collide • molecules spread out / mix up • (bulk) movement of molecules from areas of where they are at higher concentration to where they are at lower concentration	**3**

Question	Answer	Marks
4(a)	electrical conductivity of solid diamond: does not conduct	**1**
	electrical conductivity of molten sulfur: does not conduct	**1**
4(b)	low boiling point	**1**
4(c)	does not conduct when solid but conducts when molten IF full credit is not awarded, award 1 mark for does not conduct when molten	**2**
4(d)(i)	low density	**1**
4(d)(ii)	electrolysis	**1**
4(e)	positive electrode (anode): bromine / Br_2	**1**
	negative electrode (cathode): potassium / K	**1**
4(f)(i)	diamond has a giant structure **AND** diamond has covalent bonds	**1**

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Question	Answer	Marks
4(f)(ii)	drill (bits) / jewellery	**1**

Question	Answer	Marks
5(a)	3 (O_2)	**1**
	2 (SO_2)	**1**
5(b)(i)	lead oxide loses oxygen / oxidation number of lead decreases / lead gains electrons	**1**
5(b)(ii)	any 2 from: • high melting points / high boiling points • high densities • conduct heat **OR** conduct electricity • shiny / lustrous • sonorous / rings when hit • malleable • ductile	**2**
5(c)	air / oxygen	**1**
	water	**1**
5(d)(i)	to oxidise impurities / to oxidise named impurities (restricted to phosphorus / sulfur / carbon / silicon)	**1**
5(d)(ii)	potassium oxide	**1**
	it is the oxide of a metal / metal oxides are basic	**1**
5(e)	mixture	**1**
	of metals / of metal with non-metal / of metals with other elements	**1**
5(f)(i)	car bodies / bridges / railings	**1**

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Question	Answer	Marks
5(f)(ii)	cutlery / chemical plant	**1**

Question	Answer	Marks
6(a)	**X** in bottom compartment of fractionating column	**1**
	B in bottom right tube or shown to the right of the arrow	**1**
6(b)	naphtha	**1**
6(c)(i)	correct structure of ethane showing all of the atoms and all of the bonds	**1**
6(c)(ii)	3 (H_2)	**1**
6(c)(iii)	takes in heat (from surroundings) / absorbs heat / absorbs thermal energy	**1**
6(d)	any 4 from: • idea of breaking down / splitting / decomposing (long-chained) hydrocarbons • example of fraction broken down, e.g. kerosene or fuel oil • shorter / smaller hydrocarbons formed • and alkenes • heat / high temperature • catalysts	**4**
6(e)(i)	(boiling point) increases	**1**
6(e)(ii)	any value between –8 and –80 (°C) inclusive of these values	**1**
6(e)(iii)	arrangement: irregular / random / no particular arrangement	**1**
	separation: close together / touching	**1**

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CHEMISTRY **0620/41**

Paper 4 Extended Theory **October/November 2017**

MARK SCHEME

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Question	Answer	Marks
1(a)(i)	**B**	**1**
1(a)(ii)	**A**	**1**
1(a)(iii)	**C**	**1**
1(a)(iv)	**E**	**1**
1(b)	O^{2-} **M1** O **M2** $^{2-}$	**2**

Question	Answer	Marks
2(a)(i)	**S**	**1**
2(a)(ii)	**S**	**1**
2(a)(iii)	**V**	**1**
2(b)	any value in the range 130–145 °C	**1**
2(c)	sublimation	**1**
2(d)(i)	Brownian motion	**1**
2(d)(ii)	nitrogen / oxygen / carbon dioxide / air molecules hit / bombard the smoke particles	**1**
	(the bombarding particles) move randomly	**1**

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Question	Answer	Marks
3(a)(i)	brown / orange solid (forms / is made) **OR** solution becomes paler / colourless	**1**
3(a)(ii)	magnesium is oxidised **AND** copper ions are reduced **OR** magnesium loses electrons **AND** copper ions gain electrons **OR** magnesium increases in oxidation number **AND** copper decreases in oxidation number	**1**
3(a)(iii)	Cu^{2+} **OR** copper(II) ions **OR** copper ions	**1**
	gains electrons	**1**
3(a)(iv)	$3Mg + Fe_2O_3 \rightarrow 3MgO + 2Fe$ **M1** Fe_2O_3 **AND** MgO **M2** fully correct	**2**
3(b)(i)	prevents air / oxygen **AND** water from reaching the steel	**1**
3(b)(ii)	magnesium is more reactive than iron / steel	**1**
	the magnesium corrodes (before the iron / steel) **OR** the magnesium corrodes preferentially	**1**
3(b)(iii)	copper is less reactive than iron / steel	**1**

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Question	Answer	Marks
4(a)(i)	→ $2(C_2H_5OH)$ + $2CO_2$ **M1** carbon dioxide made as product **M2** balanced	**2**
4(a)(ii)	any 2 from: • 37 °C • anaerobic • glucose is aqueous • yeast	**2**
4(b)(i)	(concentrated) phosphoric acid	**1**
4(b)(ii)	92 If full credit is not awarded, allow 1 mark for M_r of ethene = 28	**2**
4(c)(i)	(acidified) potassium manganate(VII) **OR** potassium (di)chromate(VI)	**1**
4(c)(ii)	 **M1** all shared pairs of electrons correct for single bonds **M2** 2 shared pairs of electrons for the C=O bond **M3** total of 8 electrons on each O including 4 non-bonding electrons and no additional non-bonding electrons	**3**
4(d)(i)	partially ionised / dissociated	**1**

Question	Answer	Marks
4(d)(ii)	**M1** (acids) have same concentration	**1**
	M2: measure pH **OR** describe how to measure pH (such as use Universal Indicator) **M3**: lower pH corresponds to the stronger acid / hydrochloric acid **OR** **M2**: add calcium / magnesium / zinc / iron **M3**: faster rate of forming bubbles corresponds to the stronger acid / hydrochloric acid **OR** **M2**: rate of reaction with (metal) carbonate **M3**: faster rate of forming bubbles corresponds to the stronger acid / hydrochloric acid **OR** **M2**: rate of reaction with (named) metal oxide **M3**: dissolves faster means that reaction is with the stronger acid / hydrochloric acid **OR** **M2**: electrical conductivity **M3**: greater conductivity corresponds to the stronger acid / hydrochloric acid **OR** **M2**: add sodium hydroxide (or other named alkali) **M3**: greater temperature change corresponds to the stronger acid / hydrochloric acid	**2**
4(e)	structure of propanoic acid	**1**
	propanoic acid	**1**
	structure of butan-1-ol	**1**
	butan-1-ol	**1**

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Question	Answer	Marks
5(a)(i)	*start colour:* green *end colour:* black	**1**
5(a)(ii)	$CuCO_3 \rightarrow CuO + CO_2$	**1**
5(b)(i)	(*copper(II) ions)* add sodium hydroxide (solution)	**1**
	(*copper(II) ions)* blue ppt.	**1**
	(*nitrate ions*) add aluminium **AND** aqueous sodium hydroxide **AND** warm	**1**
	ammonia given off / gas turns damp (red) litmus blue	**1**
5(b)(ii)	2 / 2 / 4 / 1	**1**
5(c)(i)	becomes paler	**1**
	equilibrium moves right	**1**
	(because) fewer moles (of gas) on right	**1**
5(c)(ii)	equilibrium moved right / more N_2O_4 / less NO_2	**1**
	(forward) reaction exothermic	**1**

Question	Answer	Marks
6(a)	aluminium is more reactive than carbon	**1**
6(b)(i)	oxide ion has an outer shell with six <u>dots</u> and two <u>crosses</u>	**1**
	oxide ion has a charge of 2^-	**1**

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Question	Answer	Marks
6(b)(ii)	(electrostatic) forces of attraction between ions	**1**
	(are) strong **OR** require lots of energy to overcome	**1**
6(c)(i)	*the wires:* electrons	**1**
	the electrolyte: ions	**1**
6(c)(ii)	any 2 from: • increases conductivity • as a solvent • lowers the operating temperature	**2**
6(c)(iii)	$Al^{3+} + 3e^- \rightarrow Al$	**1**
6(c)(iv)	oxygen is made at the anode	**1**
	the anodes are made of carbon	**1**
	oxygen (made) reacts with carbon	**1**
6(d)	aluminium coated with layer of (unreactive) aluminium oxide	**1**

Question	Answer	Marks
7(a)(i)	more particles (of acid) in a given volume / dm^3 / cm^3	**1**
	more collisions per second / unit time **OR** greater collision rate	**1**

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Question	Answer	Marks
7(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	**1**
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	**1**
7(b)(i)	0.075 If full credit is not awarded, allow 1 mark for M_r of CuO = 80	**2**
7(b)(ii)	0.05	**1**
7(b)(iii)	4 (g) **M1** moles copper(II) oxide that reacted = (0.05 / 2) = 0.025 mol **M2** mass copper(II) oxide = ((0.075 – 0.025) × 80) = 4 g	**2**
7(c)	$Cl_2CuH_4O_2$ **M1** 41.52 / 35.5; 37.43 / 64; 2.34 / 1; 18.71 / 16 **OR** 1.17 : 0.58 : 2.34 : 1.17 **M2** appropriate scaling to give whole number ratios	**2**

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CHEMISTRY **0620/42**

Paper 4 Extended Theory **October/November 2017**

MARK SCHEME

Maximum Mark: 80

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Question	Answer	Marks
1(a)(i)	Brownian (motion)	**1**
1(a)(ii)	molecules	**1**
	nitrogen / N_2 / N **OR** oxygen / O_2 / O	**1**
1(a)(iii)	nitrogen **OR** oxygen (particles) collide with / bombard / hit the dust (particles)	**1**
	(the bombarding particles) move **randomly**	**1**
1(b)(i)	diffusion	**1**
1(b)(ii)	Br_2 has an M_r of 160 **AND** Cl_2 has an M_r of 71 / bromine has an A_r of 80 **AND** chlorine has an A_r of 35.5	**1**
	(heavier) bromine (molecules / particles) diffuses more slowly	**1**
1(b)(iii)	particles have more energy / move faster	**1**

Question	Answer	Marks
2(a)	*Si:* 2: 8 : 4	**1**
	Ca^{2+}: 2 : 8: 8	**1**
	N^{3-}: 2 : 8	**1**
2(b)	Ca_3N_2	**1**
2(c)	Li shown as having one shell with 2 electrons **OR** no electrons **OR** no outer shell	**1**
	Cl shown as having an outer shell of 7 electrons of one type, plus one different electron which matches Li electrons	**1**
	'+' charge on Li **AND** '–' charge on *Cl*	**1**

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Question	Answer	Marks
2(d)	two shared pairs of electrons	**1**
	both C*l* with complete outer shells	**1**
	S with complete outer shell	**1**
2(e)	SCl_2 has intermolecular forces (of attraction)	**1**
	LiC*l* has (electrostatic) forces (of attraction) between ions	**1**
	intermolecular forces are weaker / less energy is needed to break intermolecular forces	**1**
2(f)	silicon(IV) oxide	**1**

Question	Answer	Marks
3(a)	*exothermic mark*: horizontal line representing the energy of the products below the energy of the reactants	**1**
	label of products mark: product line labelled with $2CO_2$ + $3H_2O$	**1**
	correct direction of vertical heat of reaction arrow: arrow starts level with reactant energy and finishes level with product energy **AND** has (only) **one** arrow head	**1**
3(b)	activation energy / E_a	**1**

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Question	Answer	Marks
3(c)	–650 kJ / mol **M1** bonds broken 2 × ((3 × 410) + 360 + 460) + (3 × 500) 2 × (1230 + 360 + 460) + 1500 2 × 2050 + 1500 4100 + 1500 = 5600 **M2** bonds formed (2 × (2 × 805)) + (4 × (2 × 460)) 2 × 1610 + 4 × 920 3220 + 3680 = 6900 **M3** = **M1** – **M2** energy change of reaction = 5600 – 6900 = –1300 **M4** = **M3** / 2	**4**
3(d)(i)	cracking	**1**
3(d)(ii)	$C_{12}H_{26} \rightarrow 3C_2H_4 + C_6H_{14}$ **M1** $C_{12}H_{26}$ **M2** rest of equation	**2**
3(d)(iii)	phosphoric acid	**1**
	heat	**1**
3(d)(iv)	addition / hydration	**1**
3(d)(v)	measure its boiling temperature	**1**
	compare to (known) data	**1**
3(e)(i)	any 2 from: • 37 °C • anaerobic • glucose is aqueous • yeast	**2**

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Question	Answer	Marks
3(e)(ii)	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ **M1** CO_2 as a product **M2** Rest of equation	**2**
3(e)(iii)	yeast is killed by the ethanol	**1**
3(e)(v)	slow rate of reaction	**1**
3(e)(v)	uses renewable resources / does not use a finite resource	**1**
3(e)(vi)	fractional distillation	**1**
3(f)(i)	CH_3O	**1**
3(f)(ii)	no (C=C) double bonds	**1**
3(f)(iii)	at least two alternating rectangles with attempted linking	**1**
	one displayed ester link (all atoms and all bonds)	**1**
	fully correct structure with at least one repeat unit including continuation bonds from correct atom or rectangle	**1**
3(f)(iv)	polyester	**1**

Question	Answer	Marks
4(a)	the breakdown (into elements)	**1**
	of an (ionic) compound by (the passage of) electricity	**1**
4(b)(i)	oxygen	**1**
4(b)(ii)	**glowing** splint	**1**
	relights	**1**

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Question	Answer	Marks
4(b)(iii)	$2H^+ + 2e^- \rightarrow H_2$ **M1** gain of electrons by H^+ **M2** rest of equation	**2**
4(c)	*the wires:* electrons	**1**
	the electrolyte: ions	**1**
4(d)	any 2 from: • green gas at positive electrode • bulb is brighter • rate of bubbles increases	**2**
4(e)(i)	*anode made of:* impure copper	**1**
	cathode made of: (pure) copper	**1**
	electrolyte of: (aqueous) copper sulfate	**1**
4(e)(ii)	silver (impurities) fall to the bottom of the cell	**1**
	zinc (impurities) (dissolve) into solution (as ions)	**1**
	because zinc is more reactive than copper **AND** silver is less reactive than copper	**1**

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Question	Answer	Marks
5(a)	both colours referred to correctly as observations in both parts of the answer	**1**
	(if sulfuric acid is added to solution **Y**,) equilibrium moves to the right-hand side	**1**
	because the concentration of acid has increased	**1**
	(if sodium hydroxide is added to solution **Y**,) equilibrium moves to the left-hand side	**1**
	because sodium hydroxide reacts with / neutralises sulfuric acid	**1**
5(b)(i)	210 cm^3 **M1** expected volume of hydrogen = 300 cm^3 **M2** 70% of **M1**	**2**
5(b)(ii)	fewer moles / molecules / particles (of gas) on the left-hand side	**1**
5(b)(iii)	endothermic	**1**
5(b)(iv)	increases rate (of reaction)	**1**

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CHEMISTRY **0620/43**

Paper 4 Extended Theory **October/November 2017**

MARK SCHEME

Maximum Mark: 80

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Question	Answer	Marks
1(a)	mixture	**1**
1(b)	element	**1**
1(c)	compound	**1**
1(d)	mixture	**1**

Question	Answer	Marks
2(a)(i)	(two or more) **atoms**	**1**
	combined / joined / sharing electrons (by a covalent bond) / bonded	**1**
2(a)(ii)	substance that cannot be split up / broken down / decomposed (into anything simpler) **OR** (substance) made of **atoms** with the same atomic number / number of protons / proton number	**1**
2(b)(i)	10	**1**
2(b)(ii)	22	**1**
2(b)(iii)	A **AND** B	**1**
2(b)(iv)	A **AND** B	**1**
2(b)(v)	C **AND** D	**1**
2(c)		**3**

	number of protons	number of electrons
Na	11	11
S^{2-}	16	18
Cl_2	34	34

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Question	Answer	Marks
3(a)	hematite	**1**
3(b)	(coke reacts with oxygen / air) to produce heat / increase temperature / exothermically	**1**
	coke is reducing agent / produces reducing agent / produces carbon monoxide **OR** **coke reduces** Fe_2O_3 / (iron) ore / hematite (producing iron)	**1**
	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ **OR** $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ **OR** $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ **M1** species correct **M2** balanced	**2**
	limestone (decomposes to calcium oxide which) reacts with / removes **acidic impurities** / SiO_2 / sand / silica / silicon(IV) oxide / silicon dioxide	**1**
	limestone / calcium oxide / lime is involved in the production of slag / calcium silicate	**1**
3(c)(i)	positive ions / cations	**1**
	sea of electrons / mobile electrons / delocalised electrons / moving electrons / flowing electrons	**1**
	attraction between positive ions and electrons	**1**
3(c)(ii)	layers / rows / sheets of ions	**1**
	slide / slip / shift (over each other or past each other)	**1**
3(c)(iii)	particles have different sizes / radii	**1**
	layers cannot slide / slip / shift	**1**
3(d)(i)	$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$	**1**

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Question	Answer	Marks
3(d)(ii)	$Fe_2O_3 + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2O$ **M1** formula of $Fe_2(SO_4)_3$ **M2** all formulae correct (no additional species) **M3** balanced	**3**
3(e)		**4**

	observation with aqueous iron(II) sulfate	observation with aqueous iron(III) sulfate
aqueous sodium hydroxide		**M3** brown precipitate
aqueous potassium iodide	**M1** no change	**M4** brown solution / black solid
aqueous acidified potassium manganate(VII)	**M2** (pink / purple to) colourless / decolourised	

Question	Answer	Marks
4(a)	fractional distillation	**1**
4(b)(i)	oxidation	**1**
4(b)(ii)	acid(ic)	**1**
4(c)	$2H_2 + O_2 \rightarrow 2H_2O$	**1**
4(d)(i)	no carbon dioxide produced / more efficient	**1**
4(d)(ii)	storage of hydrogen is difficult / takes more space to store (hydrogen) / high likelihood of (hydrogen) leaks / lack of availability of hydrogen	**1**
4(e)(i)	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ **M1** species correct **M2** balanced	**2**
4(e)(ii)	climate change / greenhouse effect / consequence of climate change	**1**

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Question	Answer	Marks
4(e)(iii)	fermentation	**1**
4(f)	electrolysis	**1**

Question	Answer	Marks
5(a)(i)	oxygen / O_2	**1**
	sodium nitrite / sodium nitrate(III) / $NaNO_2$	**1**
5(a)(ii)	$2Cu(NO_3)_2 \rightarrow 2CuO + O_2 + 4NO_2$ **M1** CuO **M2** rest of equation fully correct	**2**
5(b)(i)	reversible reaction in which the **rate** of the forward reaction **equals** the **rate** of the backward reaction	**1**
	concentration of all reactants and products becomes constant / does not change	**1**
5(b)(ii)	forward reaction is endothermic	**1**
	(increased temperature) causes equilibrium to shift to the right / to shift in the endothermic direction / to form more nitrogen dioxide / to form more product(s)	**1**
5(b)(iii)	less brown / light**er** / paler / colour fades	**1**
	more molecules / moles / volume on the right **ORA** **OR** equilibrium shifts in the direction of **fewer** molecules / moles / lower volume	**1**

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Question	Answer	Marks
6(a)(i)	compounds containing carbon and hydrogen **only**	**1**
6(a)(ii)	*alkanes:* C_nH_{2n+2}	**1**
	alkenes: C_nH_{2n}	**1**
6(a)(iii)	any 2 from: • same or similar chemical properties • (consecutive members) differ by CH_2 • same functional group • common (allow similar) methods of preparation • physical properties vary in predictable manner / show trends / gradually change **OR** example of a physical property variation	**2**
6(a)(iv)	 **OR** 	**1**
6(a)(v)	structural isomers	**1**

Question	Answer	Marks
6(b)(i)	**more than** enough oxygen to react with **all** of the hydrocarbon	**1**
6(b)(ii)	125 (cm^3)	**1**
6(b)(iii)	1:5:3	**1**
6(b)(iv)	C_3H_8 If full credit is not awarded, allow 1 mark for $C_xH_y(g)$ + **5**$O_2(g)$ → **3**$CO_2(g)$ + **4**$H_2O(l)$	**2**

Question	Answer	Marks
7(a)(i)	diffusion	**1**
7(a)(ii)	silicon(IV) oxide is a solid, whereas carbon dioxide is a gas	**1**
7(a)(iii)	photosynthesis	**1**
	chlorophyll / chloroplasts	**1**
	M2 sunlight / UV (light)	**1**
	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ **M1** species correct **M2** balanced	**2**
7(b)(i)	condensation	**1**
7(b)(ii)	hydrolysis	**1**
7(b)(ii)	HO–□–OH **OR** H–O–□–O–H	**1**

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CHEMISTRY **0620/51**

Paper 5 Practical **October/November 2017**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1(a)	temperature boxes completed correctly with decreasing trend shown	**1**
	results comparable to the supervisor's	**1**
1(b)	temperature boxes completed correctly with increasing trend shown	**1**
	results comparable to the supervisor's	**1**
1(c)	all points plotted	**2**
	two smooth line graphs	**1**
	both graphs appropriately labelled	**1**
1(d)(i)	value from graph	**1**
	shown clearly	**1**
1(d)(ii)	value from graph	**1**
	shown clearly	**1**
1(e)	exothermic	**1**
1(f)	room temperature / initial temperature from table **AND** reaction has finished / all the solid has dissolved	**1**

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<tr><td>1(h)</td><td>fewer data / less detail / fewer readings / graph not as good / not enough readings taken whilst the solid is reacting</td><td>1</td></tr>
</table>

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Question	Answer	Marks
2(a)	blue (liquid)	1
2(b)(i)	green	1
	precipitate	1
2(b)(ii)	green solution / precipitate dissolves	1
2(b)(iii)	(red) litmus paper / Universal Indicator paper	1
	(red litmus paper) turns blue / (Universal Indicator paper) turns purple	1
2(c)	pH 8–11	1
2(d)(i)	dark / deep blue (solution)	1
2(d)(ii)	blue	1
	precipitate	1
2(e)	grey-green	1
	precipitate	1
2(f)	chromium	1
	nitrate	1
2(g)	ammonia / NH_3	1

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Question	Answer	Marks
3	*heating to dryness method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat (to remove water of crystallisation) **M3** in named container **M4** cool **M5** reweigh **M6** repeat heating **M7** to constant mass **M8** appropriate calculation suggested for the percentage of water *mass of water method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat to remove water of crystallisation **M3** in named container **M4** using apparatus capable of collecting water (vapour) **M5** cool / condense (water vapour) **M6** continue until no more collects **M7** weigh water **M8** appropriate calculation suggested for the percentage of water	**6**

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CHEMISTRY **0620/52**

Paper 5 Practical **October/November 2017**

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Question	Answer	Marks
1(a)	initial and final temperature boxes completed AND results ascending in magnitude with more solid **S** added	**1**
	results comparable to the supervisor's	**1**
1(b)	initial and final temperature boxes completed AND results ascending in magnitude with more solid **T** added	**1**
	results comparable to the supervisor's	**1**
1(c)	all points plotted	**2**
	two straight lines of best fit drawn with a ruler	**1**
	both graphs appropriately labelled	**1**
1(d)(i)	value from graph	**1**
	shown clearly	**1**
1(d)ii	value from graph	**1**
	shown clearly	**1**
1(e)	exothermic	**1**
1(f)	*change to the experiments* use burette/pipette use insulation/lid use a new cup / dry the cup	**1**
	explanation (to match change) more accurate (than measuring cylinder) reduce heat losses remove water left from the previous experiment	**1**
1(g)	repeat experiments	**1**

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Question	Answer	Marks
1(h)	lower temperatures measured / smaller temperature changes	**1**
	changed is halved / more water (to heat)	**1**

Question	Answer	Marks
2(a)	white (crystals)	**1**
2(b)	bubbles / fizz	**1**
	limewater	**1**
	(turns) milky	**1**
2(c)	carbon dioxide	**1**
2(d)	yellow	**1**
2(e)	sodium	**1**
	carbonate	**1**
2(f)	white	**1**
	precipitate	**1**
2(g)(i)	white	**1**
	precipitate	**1**

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Question	Answer	Marks
2(g)(ii)	dissolves / clears / soluble	**1**
	bubbles / fizz / effervescence	**1**
2(h)	non-transition metal / Group II metal / barium / calcium / magnesium	**1**
	chloride	**1**

Question	Answer	Marks
3	*max [6]:* **M1** weigh specified number of nail(s) / specified number of nails **M2** immerse in same volume **M3** samples of tap water and distilled water (in two test-tubes) **M4** for suitable time **M5** dry (in oven) **M6** reweigh nails **M7** compare / conclusion	**6**

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CHEMISTRY **0620/53**

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<tr><td>1(h)</td><td>fewer data / less detail / fewer readings / graph not as good / not enough readings taken whilst the solid is reacting</td><td>1</td></tr>
</table>

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Question	Answer	Marks
2(a)	blue (liquid)	1
2(b)(i)	green	1
	precipitate	1
2(b)(ii)	green solution / precipitate dissolves	1
2(b)(iii)	(red) litmus paper / Universal Indicator paper	1
	(red litmus paper) turns blue / (Universal Indicator paper) turns purple	1
2(c)	pH 8–11	1
2(d)(i)	dark / deep blue (solution)	1
2(d)(ii)	blue	1
	precipitate	1
2(e)	grey-green	1
	precipitate	1
2(f)	chromium	1
	nitrate	1
2(g)	ammonia / NH_3	1

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Question	Answer	Marks
3	*heating to dryness method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat (to remove water of crystallisation) **M3** in named container **M4** cool **M5** reweigh **M6** repeat heating **M7** to constant mass **M8** appropriate calculation suggested for the percentage of water *mass of water method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat to remove water of crystallisation **M3** in named container **M4** using apparatus capable of collecting water (vapour) **M5** cool / condense (water vapour) **M6** continue until no more collects **M7** weigh water **M8** appropriate calculation suggested for the percentage of water	**6**

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CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2017**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	evaporating basin / dish	**1**
1(b)	zinc oxide	**1**
1(c)(i)	filtration	**1**
1(c)(ii)	no filter paper	**1**
1(d)	heat / boil / evaporate	**1**
	to crystallising point	**1**
	cool / leave to stand	**1**

Question	Answer	Marks
2(a)	average temperatures completed for all five experiments: 18, 31, 41, 53, 63	**1**
	times completed for all five experiments: 210, 111, 84, 66, 54	**1**
	all times in seconds	**1**
2(b)	all five points plotted	**3**
	smooth line graph	**1**
2(c)	value from graph for average temperature 72 °C	**1**
	unit (s)	**1**
	shown clearly	**1**
2(d)	line above experimental line	**1**
2(e)(i)	Experiment 5	**1**

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Question	Answer	Marks
2(e)(ii)	particles move faster / particles have more energy	1
	more (frequent) collisions / greater chance of collisions	1
2(f)(i)	more accurate	1
	comparison to measuring cylinder	1
2(f)(ii)	time shorter / cross disappears faster	1
	depth greater	1

Question	Answer	Marks
3(a)(i)	red-brown	1
	precipitate	1
3(a)(ii)	insoluble / no change	1
3(b)	red-brown precipitate	1
3(c)	(red) litmus paper	1
	turns blue	1
3(d)	ammonia	1
3(e)	lithium	1
	carbonate	1

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Question	Answer	Marks
4	*reaction with acid method* max [6]: **M1** fixed volume of acid **M2** to fixed mass of metal **M3** measure volume of gas / temperature change **M4** named apparatus for the measurement **M5** after time **M6** repeat with other metals **M7** compare / conclude *displacement method* **M1** add each metal to named tin salt solution **M2** observe if deposit is formed **M3** results, e.g. Zn and Fe positive **M4** repeat with named iron salt **M5** results, e.g. Zn positive **M6** conclude	**6**

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Question	Answer	Marks
1(a)	water	**1**
1(b)(i)	arrow under mineral wool **AND** arrow under magnesium ribbon	**1**
1(b)(ii)	boiling tube	**1**
1(c)	use sandpaper / glass paper / steel wool	**1**
1(d)(i)	gas syringe / measuring cylinder over a trough of water	**1**
	labelled	**1**
1(d)(ii)	'pops'	**1**
1(e)	**large** amount of energy released / **high** temperature reached	**1**

Question	Answer	Marks
2(a)	initial and final temperature boxes completed: 21, 21, 21, 32, 37, 48 all readings correct = [2] 4 or 5 readings correct = [1]	**2**
2(b)	initial and final temperature boxes completed: 23, 23, 23, 23, 20, 18, 16, 12 all readings correct = [2] 6 or 7 readings correct = [1]	**2**
2(c)	all points plotted	**2**
	two straight lines of best fit drawn with a ruler	**1**
	both graphs appropriately labelled	**1**
2(d)(i)	value from graph	**1**
	shown clearly	**1**

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Question	Answer	Marks
2(d)(ii)	value from graph	**1**
	shown clearly	**1**
2(e)	exothermic	**1**
2(f)	*change to the experiments* use burette / pipette use insulation / lid use a new cup / dry the cup	**1**
	explanation (to match change) more accurate (than measuring cylinder) reduce heat losses remove water left from the previous experiment	**1**
2(g)	repeat experiments	**1**
2(h)	lower temperatures measured / smaller temperature changes	**1**
	changed is halved / more water (to heat)	**1**

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Question	Answer	Marks
3(a)	white (crystals)	**1**
3(b)	bubbles / fizz	**1**
	limewater	**1**
	(turns) milky	**1**
3(c)	carbon dioxide	**1**
3(d)	yellow	**1**
3(e)	non-transition metal / Group II metal / barium / calcium / magnesium	**1**
3(e)	chloride	**1**

Question	Answer	Marks
4	*max [6]:* **M1** weigh specified number of nail(s) / specified number of nails **M2** immerse in same volume **M3** samples of tap water and distilled water (in two test-tubes) **M4** for suitable time **M5** dry (in oven) **M6** reweigh nails **M7** compare / conclusion	**6**

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Question	Answer	Marks
1(a)	pestle	**1**
	(teat) pipette	**1**
1(b)	to increase surface area / make it dissolve faster	**1**
1(c)	nitric (acid)	**1**
1(d)	residue	**1**
1(e)	**M1** add a more reactive metal (e.g. zinc / magnesium)	**1**
	M2 displaces lead / filter out lead	**1**

Question	Answer	Marks
2(a)	temperature boxes completed: 23, 16, 14, 13, 12, 11, 11, 11, 11, 11 all readings correct = [2] 8 or 9 readings correct = [1]	**2**
2(b)	temperature boxes completed correctly: 22, 26, 29, 31, 32, 33, 34, 35, 35, 35 all readings correct = [2] 8 or 9 readings correct = [1]	**2**
2(c)	all points plotted	**1**
	two smooth line graphs (one line graph correct = [1])	**2**
	both graphs appropriately labelled	**1**
2(d)(i)	value from graph	**1**
	shown clearly	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="2">2(d)(ii)</td><td>value from graph</td><td>1</td></tr>
<tr><td>shown clearly</td><td>1</td></tr>
<tr><td>2(e)</td><td>exothermic</td><td>1</td></tr>
<tr><td>2(f)</td><td>room temperature / 22 °C
AND
reaction has finished / all the solid has dissolved</td><td>1</td></tr>
<tr><td>2(g)</td><td><table>
<tr><th>source of error</th><th>improvement</th></tr>
<tr><td>heat losses</td><td>use a lid / lag the apparatus</td></tr>
<tr><td>use of a measuring cylinder</td><td>use a pipette/burette</td></tr>
<tr><td>wet cup in the second experiment</td><td>use new/another cup **OR** dry the cup</td></tr>
<tr><td>the solid absorbs water from the air</td><td>store in a sealed container / airtight container / desiccator</td></tr>
<tr><td>only done once</td><td>repeat **and** average</td></tr>
<tr><td>different masses of solids used / masses of solids not measured</td><td>use same mass of solid / weigh the solids</td></tr>
</table></td><td>4</td></tr>
<tr><td>2(h)</td><td>fewer data / less detail / fewer readings / graph not as good / not enough readings whilst the solid is reacting</td><td>1</td></tr>
</table>

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Question	Answer	Marks
3(a)(i)	green	**1**
	precipitate	**1**
3(a)(ii)	green solution / precipitate dissolves	**1**
3(a)(iii)	bubbles / fizzing / effervescence	**1**
	(red) litmus paper / Universal Indicator paper	**1**
	(red litmus paper) turns blue / (Universal Indicator paper) turns purple	**1**
3(b)	ammonia / NH_3	**1**
3(c)	(aqueous) ammonia / NH_3	**1**

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Question	Answer	Marks
4	*heating to dryness method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat (to remove water of crystallisation) **M3** in named container **M4** cool **M5** reweigh **M6** repeat heating **M7** to constant mass **M8** appropriate calculation suggested for the percentage of water *mass of water method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat to remove water of crystallisation **M3** in named container **M4** using apparatus capable of collecting water (vapour) **M5** cool / condense (water vapour) **M6** continue until no more collects **M7** weigh water **M8** appropriate calculation suggested for the percentage of water	**6**

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CHEMISTRY **0620/11**

Paper 1 Multiple Choice (Core) **October/November 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

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1 The diagram shows how the arrangement of particles changes when a substance changes state.

Which change of state is shown?

A boiling

B condensation

C evaporation

D sublimation

2 Which method can be used to separate a mixture of salt and water to obtain **both** parts of the mixture?

A crystallisation

B distillation

C evaporation

D filtration

3 A student put 25.0 cm^3 of dilute hydrochloric acid into a conical flask.

The student added 2.5 g of solid sodium carbonate and measured the change in temperature of the mixture.

Which apparatus does the student need to use to obtain the most accurate results?

A balance, measuring cylinder, thermometer

B balance, pipette, stopwatch

C balance, pipette, thermometer

D burette, pipette, thermometer

4 Propanone, C_3H_6O, is a liquid at room temperature.

What is the boiling point of pure propanone?

A –61 °C to –51 °C

B –56 °C

C 51 °C to 61 °C

D 56 °C

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5 Which statement about the boxes P, Q and R is correct?

A Box P contains two compounds and box R contains two elements.

B Box P contains two elements and box Q contains a mixture.

C Box P contains two elements and box Q contains one compound.

D Box Q contains two compounds and box R contains a mixture.

6 The number of particles in atoms W, X, Y and Z are shown.

	protons	electrons	neutrons
W	6	6	6
X	6	6	7
Y	7	7	7
Z	7	7	8

Which statement is correct?

A W and X are isotopes of carbon.

B X and Y are isotopes of nitrogen.

C X has a mass number of 12.

D Z has an atomic number of 8.

7 Which row describes the type of bonding present in substances 1 and 2?

	substance 1	substance 2
A	methane has ionic bonding	graphite has covalent bonding
B	graphite has ionic bonding	potassium chloride has covalent bonding
C	potassium chloride has ionic bonding	methane has covalent bonding
D	potassium chloride has ionic bonding	graphite has ionic bonding

8 Substances with giant covalent structures can be used as lubricants and as cutting tools for hard materials.

The diagram shows how the atoms are arranged in two giant covalent substances, X and Y.

Which statement is correct?

A Only X is used as a cutting tool and only Y is used as a lubricant.

B Only X is used as a lubricant and only Y is used as a cutting tool.

C X and Y are both used as cutting tools.

D X and Y are both used as lubricants.

9 The equation shows the thermal decomposition of magnesium carbonate (M_r = 84).

$$MgCO_3 \rightarrow MgO + CO_2$$

Which mass of magnesium oxide is formed when 21.0 g of magnesium carbonate are completely decomposed?

A 1.9 g **B** 4.0 g **C** 10.0 g **D** 40.0 g

10 Electricity is passed through concentrated aqueous sodium chloride. Inert electrodes are used.

What is formed at the negative electrode?

A chlorine

B hydrogen

C oxygen

D sodium

11 Two chemical processes are described.

- During the combustion of gasoline, energy is .....1..... .
- During the electrolysis of sulfuric acid, energy is .....2..... .

Which words complete gaps 1 and 2?

	1	2
A	given out	given out
B	given out	taken in
C	taken in	given out
D	taken in	taken in

12 When dilute sulfuric acid reacts with aqueous sodium hydroxide, the temperature of the solution increases.

Which words describe this reaction?

A endothermic and neutralisation

B endothermic and redox

C exothermic and neutralisation

D exothermic and redox

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

14 When blue copper(II) sulfate is heated, a white solid and water are formed.

The white solid turns blue and gives out heat when water is added to it.

Which terms describe the blue copper(II) sulfate and the reactions?

	the blue copper(II) sulfate is	reactions
A	a mixture	can be reversed
B	a mixture	cannot be reversed
C	hydrated	can be reversed
D	hydrated	cannot be reversed

15 Which changes increase the rate of reaction between calcium carbonate and dilute hydrochloric acid?

1 increasing the concentration of the acid

2 increasing the temperature

3 increasing the size of the pieces of calcium carbonate

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

16 The equations for two reactions P and Q are given.

P $2\underline{NaNO_2} + O_2 \rightarrow 2NaNO_3$

Q $2\underline{Hg}O \rightarrow 2Hg + O_2$

In which of these reactions does oxidation of the underlined substance occur?

	P	Q
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

17 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

18 Magnesium, phosphorus and chlorine are elements in the same period of the Periodic Table.

Which row describes the type of oxide formed by each of these elements?

	magnesium	phosphorus	chlorine
A	acidic	acidic	basic
B	acidic	basic	basic
C	basic	acidic	acidic
D	basic	basic	acidic

19 Zinc sulfate is made by reacting an excess of zinc oxide with dilute sulfuric acid.

The excess zinc oxide is then removed from the solution.

Which process is used to obtain solid zinc sulfate from the solution?

A crystallisation

B dissolving

C filtration

D fractional distillation

20 What is used to test for chlorine?

A a glowing splint

B damp litmus paper

C limewater

D potassium manganate(VII) solution

21 Which statements about the trends across a period of the Periodic Table are correct?

1 Aluminium is more metallic than sodium.

2 Beryllium is more metallic than carbon.

3 Boron is more metallic than lithium.

4 Magnesium is more metallic than silicon.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

22 Astatine is an element in Group VII of the Periodic Table.

Astatine is .....1..... reactive than iodine.

The melting point of astatine is .....2..... than the melting point of iodine.

Astatine is .....3..... in colour than bromine.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	less	higher	darker
B	less	lower	lighter
C	more	higher	darker
D	more	lower	lighter

23 Which row describes the properties of a typical transition element?

	melting point	forms coloured compounds	can act as a catalyst
A	high	no	no
B	high	yes	yes
C	low	no	yes
D	low	yes	no

24 Why is argon gas used to fill electric lamps?

A It conducts electricity.

B It glows when heated.

C It is less dense than air.

D It is not reactive.

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 Which material is **not** involved in the large-scale extraction of iron from iron ore?

A bauxite

B calcium carbonate (limestone)

C carbon (coke)

D hematite

27 Some reactions of three metals are listed in the table.

metal	metal reacts with dilute hydrochloric acid	metal oxide is reduced by carbon
P	yes	no
Q	no	yes
R	yes	yes

What is the order of reactivity of the metals?

	most reactive →		least reactive
A	P	R	Q
B	Q	P	R
C	R	P	Q
D	R	Q	P

28 Which uses of the metals shown are both correct?

	aluminium	stainless steel
A	aircraft bodies	cutlery
B	car bodies	aircraft bodies
C	chemical plant	food containers
D	food containers	car bodies

29 The flow chart shows stages in the treatment of river water to produce drinking water.

What occurs at stages X and Y?

	X	Y
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

30 Which gas is over 30% of air?

A argon

B carbon dioxide

C nitrogen

D oxygen

31 Iron is a metal that rusts in the presence of oxygen and water.

Mild steel is used for .....1..... and is prevented from rusting by .....2..... .

Stainless steel does not rust. It is produced by .....3..... iron with another metal.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	car bodies	greasing	covering
B	car bodies	painting	mixing
C	cutlery	greasing	covering
D	cutlery	painting	mixing

32 A mixture produces a gas both when it reacts with an acid and when it reacts with an alkali.

Which ions are present in the mixture?

A ammonium ions and carbonate ions

B ammonium ions and oxide ions

C hydrogen ions and carbonate ions

D hydrogen ions and oxide ions

33 Some marble chips (calcium carbonate) are heated strongly and substances X and Y are formed.

Substance X is a white solid that reacts with water, giving out heat. Substance Y is a colourless gas.

What are substances X and Y?

	X	Y
A	calcium chloride	oxygen
B	calcium hydroxide	carbon dioxide
C	calcium oxide	carbon dioxide
D	calcium sulfate	oxygen

34 The structures of some organic molecules are shown.

1

2

3

4

Which structures represent an alkane with four carbon atoms?

A 1 only **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

35 Some of the fractions obtained from the fractional distillation of petroleum are used as fuels for vehicles.

Which two fractions are used as fuels for vehicles?

A bitumen fraction and gasoline fraction

B bitumen fraction and naphtha fraction

C gasoline fraction and kerosene fraction

D kerosene fraction and lubricating fraction

36 Burning fossil fuels releases heat energy.

Which substance is **not** a fossil fuel?

A coal

B hydrogen

C natural gas

D petroleum

37 X, Y and Z are three hydrocarbons.

X $CH_2{=}CH_2$ Y $CH_3{-}CH{=}CH_2$ Z $CH_3{-}CH_2{-}CH{=}CH_2$

What do compounds X, Y and Z have in common?

1 They are all alkenes.

2 They are all part of the same homologous series.

3 They all have the same boiling point.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

38 The table shows bonds that are present and bonds that are not present in compound X.

bond	
C–C	✓
C=C	✗
C–H	✓
C–O	✓
C=O	✓
O–H	✓

What type of compound is X?

A a carboxylic acid

B an alcohol

C an alkane

D an alkene

39 The diagram shows a reaction sequence.

Which row names the processes X, Y and Z?

	X	Y	Z
A	cracking	fermentation	respiration
B	cracking	hydration	combustion
C	distillation	fermentation	respiration
D	distillation	hydration	combustion

40 Molecules of a substance react together as shown.

Which type of reaction has taken place?

A cracking

B oxidation

C polymerisation

D reduction

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/12**

Paper 1 Multiple Choice (Core) **October/November 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level1/Level 2 Certificate.

This document consists of **15** printed pages and **1** blank page.

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1 The melting points and boiling points of four elements are shown.

element	melting point / °C	boiling point / °C
W	–7	60
X	–101	–34
Y	114	184
Z	39	688

In which elements do the particles vibrate about fixed positions at 0 °C?

A W and X **B** W and Z **C** X and Y **D** Y and Z

2 The apparatus used to separate a mixture is shown.

What is the mixture?

A aqueous calcium chloride and aqueous calcium nitrate

B calcium carbonate and aqueous calcium chloride

C ethanol and water

D sand and calcium carbonate

3 During an experiment a measurement is recorded in cm^3.

Which apparatus is used?

A balance

B measuring cylinder

C stopclock

D thermometer

4 Substance Q boils at 445 °C and is a yellow solid at room temperature.

Which temperature could be the melting point of pure Q?

A –9 °C

B 72 °C to 78 °C

C 116 °C

D 116 °C to 126 °C

5 Which diagram shows a mixture of an element and a compound?

6 Which pair of atoms contains the same number of neutrons?

A $^{59}_{27}Co$ and $^{59}_{28}Ni$

B $^{64}_{29}Cu$ and $^{65}_{29}Cu$

C $^{64}_{29}Cu$ and $^{65}_{30}Zn$

D $^{65}_{29}Cu$ and $^{65}_{30}Zn$

7 In which row do the properties described match the type of bonding?

	melting point	electrical conductivity when liquid	type of bonding
A	high	does not conduct	ionic
B	low	conducts	covalent
C	low	conducts	ionic
D	low	does not conduct	covalent

8 Which statement explains why graphite is used a lubricant?

A All bonds between the atoms are weak.

B It conducts electricity.

C It has a low melting point.

D Layers in the structure can slide over each other.

9 What is the relative formula mass of magnesium nitrate, $Mg(NO_3)_2$?

A 74 **B** 86 **C** 134 **D** 148

10 The diagram shows the electrolysis of two solutions using inert electrodes.

Which substance is made at each electrode?

	P	Q	R	S
A	hydrogen	oxygen	chlorine	sodium
B	hydrogen	oxygen	sodium	chlorine
C	oxygen	hydrogen	chlorine	hydrogen
D	oxygen	hydrogen	hydrogen	chlorine

11 Two chemical processes are described.

- During the combustion of ethanol, energy is .....1..... .
- During the electrolysis of aqueous sodium chloride, energy is .....2..... .

Which words complete gaps 1 and 2?

	1	2
A	given out	given out
B	given out	taken in
C	taken in	given out
D	taken in	taken in

12 Water is added to anhydrous copper(II) sulfate in a test-tube.

The mixture becomes hot.

Which type of reaction and energy level diagram apply to this reaction?

	type of reaction	energy level diagram
A	endothermic	
B	endothermic	
C	exothermic	
D	exothermic	

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

14 When blue copper(II) sulfate is heated, a white solid and water are formed.

The white solid turns blue and gives out heat when water is added to it.

Which terms describe the blue copper(II) sulfate and the reactions?

	the blue copper(II) sulfate is	reactions
A	a mixture	can be reversed
B	a mixture	cannot be reversed
C	hydrated	can be reversed
D	hydrated	cannot be reversed

15 An experiment was carried out to find the rate of reaction when 1 g of solid X reacts with 100 cm^3 of solution Y.

The experiment took place too quickly for measurements to be made.

Which change could be made to slow down the reaction?

A add a catalyst

B decrease the concentration of solution Y

C decrease the particle size of solid X

D increase the temperature

16 The equations for two reactions P and Q are given.

P $2\underline{NaNO_2} + O_2 \rightarrow 2NaNO_3$

Q $2\underline{Hg}O \rightarrow 2Hg + O_2$

In which of these reactions does oxidation of the underlined substance occur?

	P	Q
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

17 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

18 Elements Q and R both burn in air.

The oxides formed both dissolve in water.

The solution of the oxide formed from element Q turns Universal Indicator red.

The solution of the oxide formed from element R turns Universal Indicator blue.

What are Q and R?

	Q	R
A	carbon	sulfur
B	sodium	magnesium
C	sodium	sulfur
D	sulfur	sodium

19 Copper(II) sulfate can be prepared by adding excess copper(II) carbonate to sulfuric acid.

Why is an **excess** of copper(II) carbonate added?

A to ensure all the copper(II) carbonate has reacted

B to ensure all the sulfuric acid has reacted

C to increase the rate of reaction

D to increase the yield of copper(II) sulfate

20 Compound P reacts with hydrochloric acid to produce a gas that turns limewater milky.

What is P?

A sodium carbonate

B sodium chloride

C sodium hydroxide

D sodium sulfate

21 Which statement about nitrogen and phosphorus is **not** correct?

A Both are in the same group of the Periodic Table.

B Both are in the same period of the Periodic Table.

C Both are non-metals.

D Both have the same number of electrons in their outer shell.

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22 Sodium and rubidium are elements in Group I of the Periodic Table.

Which statement is correct?

A Sodium atoms have more electrons than rubidium atoms.

B Sodium has a lower density than rubidium.

C Sodium has a lower melting point than rubidium.

D Sodium is more reactive than rubidium.

23 Which properties do the elements chromium, iron and vanadium have in common?

1 They all conduct electricity.

2 They, or their compounds, can act as catalysts.

3 They all form coloured compounds.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

24 Why is argon gas used to fill electric lamps?

A It conducts electricity.

B It glows when heated.

C It is less dense than air.

D It is not reactive.

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 Which process is used to extract iron from hematite in the blast furnace?

A electrolysis

B reduction with carbon monoxide

C reduction with lime

D thermal decomposition

27 Some reactions of three metals are listed in the table.

metal	metal reacts with dilute hydrochloric acid	metal oxide is reduced by carbon
P	yes	yes
Q	yes	no
R	no	yes

What is the order of reactivity of the metals?

	most reactive →		least reactive
A	P	Q	R
B	P	R	Q
C	Q	P	R
D	R	P	Q

28 Which uses of the metals shown are both correct?

	aluminium	copper
A	aircraft bodies	electrical wiring
B	car bodies	aircraft bodies
C	chemical plant	cooking utensils
D	food containers	chemical plant

29 The flow chart shows stages in the treatment of river water to produce drinking water.

What occurs at stages X and Y?

	X	Y
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

30 Which element in Group VI is a component of air?

A argon

B nitrogen

C oxygen

D sulfur

31 Iron is a metal that rusts in the presence of oxygen and water.

Mild steel is used for .....1..... and is prevented from rusting by .....2..... .

Stainless steel does not rust. It is produced by .....3..... iron with another metal.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	car bodies	greasing	covering
B	car bodies	painting	mixing
C	cutlery	greasing	covering
D	cutlery	painting	mixing

32 A chemical reaction is carried out on substance X.

A gas is produced that turns red litmus paper blue.

What is this reaction?

A the reaction of an acid with a metal carbonate

B the reaction of an acid with an ammonium salt

C the reaction of an alkali with a metal carbonate

D the reaction of an alkali with an ammonium salt

33 Some marble chips (calcium carbonate) are heated strongly and substances X and Y are formed.

Substance X is a white solid that reacts with water, giving out heat. Substance Y is a colourless gas.

What are substances X and Y?

	X	Y
A	calcium chloride	oxygen
B	calcium hydroxide	carbon dioxide
C	calcium oxide	carbon dioxide
D	calcium sulfate	oxygen

34 The structures of four organic compounds are shown.

Which compounds are unsaturated?

A S only **B** T and U **C** U only **D** V only

35 Which statement is **not** correct?

A Petroleum is a mixture of hydrocarbons.

B The main constituent of natural gas is ethane.

C The naphtha fraction of petroleum is used for making chemicals.

D When natural gas burns in air, carbon dioxide and water are formed.

36 Which equation represents the complete combustion of butane, C_4H_{10}?

A $2C_4H_{10} + 5O_2 \rightarrow 8C + 10H_2O$

B $2C_4H_{10} + 9O_2 \rightarrow 8CO + 10H_2O$

C $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

D $C_4H_{10} + 4O_2 \rightarrow 4CO_2 + 5H_2$

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37 X, Y and Z are three hydrocarbons.

X $CH_2=CH_2$ Y $CH_3–CH=CH_2$ Z $CH_3–CH_2–CH=CH_2$

What do compounds X, Y and Z have in common?

1 They are all alkenes.

2 They are all part of the same homologous series.

3 They all have the same boiling point.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

38 The table shows bonds that are present and bonds that are not present in compound X.

bond	
C–C	✓
C=C	✗
C–H	✓
C–O	✓
C=O	✓
O–H	✓

What type of compound is X?

A a carboxylic acid

B an alcohol

C an alkane

D an alkene

39 The diagram shows a reaction sequence.

Which row names the processes X, Y and Z?

	X	Y	Z
A	cracking	fermentation	respiration
B	cracking	hydration	combustion
C	distillation	fermentation	respiration
D	distillation	hydration	combustion

40 Molecules of a substance react together as shown.

Which type of reaction has taken place?

A cracking

B oxidation

C polymerisation

D reduction

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/13**

Paper 1 Multiple Choice (Core) **October/November 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
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There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
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A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

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This document consists of **16** printed pages.

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1 Which statement about liquids and gases is correct?

A 1 cm^3 of gas contains more particles than 1 cm^3 of liquid.

B A given mass of liquid has a fixed volume at room temperature.

C Particles in a liquid can easily be forced closer together.

D Particles in a liquid have fixed positions.

2 Which method is used to obtain copper(II) sulfate crystals from an aqueous solution of copper(II) sulfate?

A chromatography

B condensation

C evaporation

D filtration

3 25 cm^3 of an alkali are added to 20 cm^3 of an acid. The temperature change is measured.

Which apparatus is **not** needed in the experiment?

A 25 cm^3 measuring cylinder

B 100 cm^3 beaker

C balance

D thermometer

4 A sample of liquid X turns blue cobalt(II) chloride paper pink. The sample boils at 102 °C.

Which statements are correct?

1 X contains water.

2 X is impure water.

3 X freezes above 0 °C.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

5 Substance Y is added to an excess of hot water.

A blue solution forms and a brown solid remains.

The brown solid is filtered off and dried.

The brown solid conducts electricity.

What is Y?

A a compound which contains a metal

B a mixture which contains a metal

C a pure substance which is a metal

D a pure substance which is a non-metal

6 Which row gives the number of protons, electrons and neutrons found in an atom of zinc?

	protons	electrons	neutrons
A	30	30	35
B	30	35	35
C	35	30	30
D	35	35	30

7 Four statements about atoms and ions are shown.

1 F^- has more electrons than Na^+.

2 Mg^{2+} has the same number of electrons as Na^+.

3 Na^+ has more electrons than Li^+.

4 An atom of P has more outer shell electrons than an atom of N.

Which statements are correct?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

8 The diagrams, X, Y and Z, show part of a polymer and two giant covalent structures.

X

Y

Z

Which of X, Y or Z could be used as a cutting tool and which of X, Y or Z could be used to reduce friction?

	cutting tool	reduce friction
A	X	Y
B	Y	Z
C	Z	X
D	Z	Y

9 A compound with the formula XO_2 has a relative formula mass of 64.

What is X?

A cadmium

B copper

C gadolinium

D sulfur

10 The electrolysis of concentrated hydrochloric acid using platinum electrodes is shown.

What is observed at each electrode at the start of the electrolysis?

	positive electrode	negative electrode
A	colourless gas	colourless gas
B	colourless gas	green gas
C	green gas	colourless gas
D	green gas	green gas

11 Two chemical processes are described.

- During the combustion of kerosene, energy is .....1..... .
- During the electrolysis of hydrochloric acid, energy is .....2..... .

Which words complete gaps 1 and 2?

	1	2
A	given out	given out
B	given out	taken in
C	taken in	given out
D	taken in	taken in

12 Which reaction is endothermic?

A neutralisation of an acid by an alkali

B reaction of hydrogen with oxygen

C reaction of sodium with water

D thermal decomposition of limestone

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

14 When blue copper(II) sulfate is heated, a white solid and water are formed.

The white solid turns blue and gives out heat when water is added to it.

Which terms describe the blue copper(II) sulfate and the reactions?

	the blue copper(II) sulfate is	reactions
A	a mixture	can be reversed
B	a mixture	cannot be reversed
C	hydrated	can be reversed
D	hydrated	cannot be reversed

15 The equation for the reaction between magnesium and hydrochloric acid is shown.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

The rate of this reaction is studied using the apparatus shown.

Which change increases the rate of reaction?

A lowering the temperature of the acid

B using a larger volume of the same hydrochloric acid

C using less concentrated hydrochloric acid

D using the same mass of magnesium powder

16 The equations for two reactions P and Q are given.

P $2\underline{NaNO_2} + O_2 \rightarrow 2NaNO_3$

Q $2\underline{Hg}O \rightarrow 2Hg + O_2$

In which of these reactions does oxidation of the underlined substance occur?

	P	Q
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

17 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

18 Which oxide produces a solution with a pH between pH 1 and pH 7 when reacted with water?

A calcium oxide

B carbon dioxide

C potassium oxide

D sodium oxide

19 Three solids, P, Q and R, all react with dilute sulfuric acid to produce zinc sulfate.

P and R produce gases during the reaction.

The gas produced when P reacts will not burn. The gas produced when R reacts will burn.

What are P, Q and R?

	P	Q	R
A	zinc	zinc hydroxide	zinc carbonate
B	zinc carbonate	zinc	zinc oxide
C	zinc carbonate	zinc hydroxide	zinc
D	zinc oxide	zinc carbonate	zinc

20 Which ion forms a green precipitate with aqueous sodium hydroxide that dissolves in an excess of aqueous sodium hydroxide?

A Ca^{2+} **B** Cr^{3+} **C** Cu^{2+} **D** Fe^{2+}

21 A period of the Periodic Table is shown.

group	I	II	III	IV	V	VI	VII	VIII
element	R	S	T	V	W	X	Y	Z

The letters are not their chemical symbols.

Which statement is correct?

A Element R does not conduct electricity.

B Elements R and Y react together to form an ionic compound.

C Element Z exists as a diatomic molecule.

D Element Z reacts with element T.

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22 Some properties of element X are shown.

melting point in °C	98
boiling point in °C	883
reaction with cold water	gives off H_2 gas
reaction when heated with oxygen	burns to give a white solid

In which part of the Periodic Table is X found?

A Group I

B Group VII

C Group VIII

D transition elements

23 The table gives some properties of an element.

melting point in °C	3422
appearance of the element	grey
appearance of the chloride of the element	dark blue
density in g/cm^3	19.2
electrical conductivity when solid	good

Which other property would you expect this element to have?

A acts as a catalyst

B brittle

C forms an acidic oxide

D highly reactive with water

24 Why is argon gas used to fill electric lamps?

A It conducts electricity.

B It glows when heated.

C It is less dense than air.

D It is not reactive.

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 What is the reducing agent in the large-scale extraction of iron from iron ore?

A air

B carbon monoxide

C hematite

D limestone

27 Some reactions of three metals are listed in the table.

metal	metal reacts with dilute hydrochloric acid	metal oxide is reduced by carbon
P	yes	no
Q	yes	yes
R	no	yes

What is the order of reactivity of the metals?

	most reactive →		least reactive
A	P	Q	R
B	P	R	Q
C	Q	P	R
D	R	P	Q

28 Which uses of the metals shown are both correct?

	aluminium	stainless steel
A	aircraft bodies	car bodies
B	car bodies	aircraft bodies
C	chemical plant	food containers
D	food containers	cutlery

29 The flow chart shows stages in the treatment of river water to produce drinking water.

What occurs at stages X and Y?

	X	Y
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

30 What is produced by the incomplete combustion of methane?

A carbon monoxide

B hydrogen

C lead compounds

D sulfur dioxide

31 Iron is a metal that rusts in the presence of oxygen and water.

Mild steel is used for .....1..... and is prevented from rusting by .....2..... .

Stainless steel does not rust. It is produced by .....3..... iron with another metal.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	car bodies	greasing	covering
B	car bodies	painting	mixing
C	cutlery	greasing	covering
D	cutlery	painting	mixing

32 Compound Q is heated with aqueous sodium hydroxide.

The damp red litmus paper turns blue.

What is Q?

A ammonium chloride

B copper(II) chloride

C iron(III) chloride

D sodium chloride

33 Some marble chips (calcium carbonate) are heated strongly and substances X and Y are formed.

Substance X is a white solid that reacts with water, giving out heat. Substance Y is a colourless gas.

What are substances X and Y?

	X	Y
A	calcium chloride	oxygen
B	calcium hydroxide	carbon dioxide
C	calcium oxide	carbon dioxide
D	calcium sulfate	oxygen

34 The structure of compound R is shown.

What is R?

A propane

B propanoic acid

C propanol

D propene

35 Fuel oil and naphtha are two fractions obtained from petroleum.

What are the major uses of these fractions?

	fuel oil	naphtha
A	jet fuel	making chemicals
B	jet fuel	making roads
C	ship fuel	making chemicals
D	ship fuel	making roads

36 What are the products of the complete combustion of ethanol?

A $CO + H_2$

B $CO + H_2O$

C $CO_2 + H_2$

D $CO_2 + H_2O$

37 X, Y and Z are three hydrocarbons.

X $CH_2{=}CH_2$ Y $CH_3{-}CH{=}CH_2$ Z $CH_3{-}CH_2{-}CH{=}CH_2$

What do compounds X, Y and Z have in common?

1 They are all alkenes.

2 They are all part of the same homologous series.

3 They all have the same boiling point.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

38 The table shows bonds that are present and bonds that are not present in compound X.

bond	
C–C	✓
C=C	✗
C–H	✓
C–O	✓
C=O	✓
O–H	✓

What type of compound is X?

A a carboxylic acid

B an alcohol

C an alkane

D an alkene

39 The diagram shows a reaction sequence.

Which row names the processes X, Y and Z?

	X	Y	Z
A	cracking	fermentation	respiration
B	cracking	hydration	combustion
C	distillation	fermentation	respiration
D	distillation	hydration	combustion

40 Molecules of a substance react together as shown.

Which type of reaction has taken place?

A cracking

B oxidation

C polymerisation

D reduction

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group	I	II											III	IV	V	VI	VII	VIII
								1 H hydrogen 1										2 He helium 4
	3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
	87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **15** printed pages and **1** blank page.

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1 Which process causes the greatest increase in the distance between particles?

A condensation

B freezing

C melting

D sublimation

2 A student put 25.0 cm^3 of dilute hydrochloric acid into a conical flask.

The student added 2.5 g of solid sodium carbonate and measured the change in temperature of the mixture.

Which apparatus does the student need to use to obtain the most accurate results?

A balance, measuring cylinder, thermometer

B balance, pipette, stopwatch

C balance, pipette, thermometer

D burette, pipette, thermometer

3 The results obtained from a chromatogram are shown.

	distance travelled / cm
solvent	5.0
substance X	3.0
substance Y	2.5

Which row gives the R_f values of substance X and substance Y?

	R_f (X)	R_f (Y)
A	0.5	0.6
B	0.6	0.5
C	1.6	2.0
D	2.0	1.6

4 Two statements about silicon(IV) oxide are given.

1 It is a hard substance.

2 It has a macromolecular structure with strong covalent bonds.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is not correct.

D Statement 2 is correct but statement 1 is not correct.

5 Which statement explains why isotopes of the same element have the same chemical properties?

A They have a different number of neutrons in the nucleus.

B They have the same number of neutrons in the nucleus.

C They have the same number of outer shell electrons.

D They have the same number of protons as neutrons.

6 Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of nitrogen?

A

B

C

D

7 The equation for the reaction between barium chloride solution and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

8 A compound is analysed and found to contain 85.7% carbon and 14.3% hydrogen.

What is its empirical formula?

A CH **B** CH_2 **C** C_2H_4 **D** C_6H

9 Which statements about the electrolysis of concentrated copper(II) chloride are correct?

1 Electrons are transferred from the cathode to the copper(II) ions.

2 Electrons move round the external circuit from the cathode to the anode.

3 Chloride ions are attracted to the anode.

4 Hydroxide ions transfer electrons to the cathode.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

10 Which metal combination produces the highest voltage reading in the cells shown?

11 The compound hydrazine is used as a rocket fuel. It has the structural formula shown.

One of the reactions of hydrazine is shown. This reaction is exothermic.

$$N_2H_4 \rightarrow N_2 + 2H_2$$

The bond energies are shown in the table.

	bond energy in kJ / mol
H–H	+436
N–H	+390
N–N	+160
N≡N	+945

What is the energy change for this reaction?

A –339 kJ / mol **B** –97 kJ / mol **C** +97 kJ / mol **D** +339 kJ / mol

12 Which statement describes an exothermic reaction?

A The energy absorbed for bond breaking is greater than the energy released by bond formation.

B The energy absorbed for bond breaking is less than the energy released by bond formation.

C The energy released by bond breaking is greater than the energy absorbed for bond formation.

D The energy released by bond breaking is less than the energy absorbed for bond formation.

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

14 Copper(II) oxide reacts with hydrogen.

$$CuO + H_2 \rightarrow Cu + H_2O$$

Which row is correct?

	oxidising agent	reducing agent
A	H_2	CuO
B	CuO	H_2
C	H_2O	Cu
D	Cu	H_2O

15 Ethanoic acid reacts slowly with calcium carbonate.

Which statements explain why an increase in temperature increases the rate of the reaction?

1 The activation energy of the reaction is decreased.

2 There is an increase in collision rate.

3 The particles have more energy.

4 There will be fewer successful collisions.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

16 Methane reacts with steam to produce hydrogen and carbon monoxide.

The equation for the reaction is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$$

The reaction is reversible. The forward reaction is endothermic.

Which changes in temperature and pressure increase the equilibrium yield of carbon monoxide?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

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17 Some properties of four oxides are listed.

Oxide 1 reacts with both acids and alkalis to form salts.

Oxide 2 reacts with acids to form salts but does not react with alkalis.

Oxide 3 reacts with alkalis to form salts but does not react with acids.

Oxide 4 does not react with acids or alkalis.

Which row describes the oxides?

	oxide 1	oxide 2	oxide 3	oxide 4
A	amphoteric	acidic	basic	neutral
B	amphoteric	basic	acidic	neutral
C	neutral	acidic	basic	amphoteric
D	neutral	basic	acidic	amphoteric

18 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

19 Zinc sulfate is made by reacting an excess of zinc oxide with dilute sulfuric acid.

The excess zinc oxide is then removed from the solution.

Which process is used to obtain solid zinc sulfate from the solution?

A crystallisation

B dissolving

C filtration

D fractional distillation

20 What is used to test for chlorine?

A a glowing splint

B damp litmus paper

C limewater

D potassium manganate(VII) solution

21 Which statements about the trends across a period of the Periodic Table are correct?

1 Aluminium is more metallic than sodium.

2 Beryllium is more metallic than carbon.

3 Boron is more metallic than lithium.

4 Magnesium is more metallic than silicon.

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

22 Astatine is an element in Group VII of the Periodic Table.

Astatine is .....1..... reactive than iodine.

The melting point of astatine is .....2..... than the melting point of iodine.

Astatine is .....3..... in colour than bromine.

Which words complete gaps 1, 2 and 3?

	1	2	3
A	less	higher	darker
B	less	lower	lighter
C	more	higher	darker
D	more	lower	lighter

23 Which row describes the properties of a typical transition element?

	melting point	forms coloured compounds	can act as a catalyst
A	high	no	no
B	high	yes	yes
C	low	no	yes
D	low	yes	no

24 Why is argon gas used to fill electric lamps?

A It conducts electricity.

B It glows when heated.

C It is less dense than air.

D It is not reactive.

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 Aluminium is extracted by the electrolysis of aluminium oxide.

Which statement is **not** correct?

A Aluminium ions are oxidised at the cathode.

B Carbon dioxide is made at the anode.

C Cryolite is added to lower the melting point of the aluminium oxide.

D The electrodes are made from graphite.

27 Which row describes how the metals are used?

	mixed with zinc to form brass	used to galvanise iron
A	aluminium	tin
B	aluminium	zinc
C	copper	tin
D	copper	zinc

28 Information about the nitrates and carbonates of two metals, Q and R, is shown.

	appearance	solubility in water	effect of heat
nitrate of Q	white solid	soluble	colourless gas evolved which relights a glowing splint
carbonate of Q	white solid	soluble	no reaction
nitrate of R	white solid	soluble	brown gas evolved
carbonate of R	white solid	insoluble	colourless gas evolved which turns limewater milky

Which statement is correct?

A Q is calcium and R is magnesium.

B Q is magnesium and R is sodium.

C Q is potassium and R is copper.

D Q is sodium and R is calcium.

29 The flow chart shows stages in the treatment of river water to produce drinking water.

What occurs at stages X and Y?

	X	Y
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

30 Four iron nails had different metals wrapped around them.

The nails were placed in an open dish filled with water and left for a week.

Which iron nail has no protection against rusting?

31 Ammonia is made by the Haber process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

What are the sources of the nitrogen and hydrogen used in the Haber process?

	nitrogen	hydrogen
A	fertilisers	reacting methane with steam
B	fertilisers	the air
C	the air	reacting methane with steam
D	the air	the air

32 Which process does **not** produce carbon dioxide?

A combustion of alkanes

B photosynthesis

C respiration

D thermal decomposition of limestone

33 Which row shows the conditions used in the manufacture of sulfuric acid by the Contact process?

	temperature / °C	pressure / atm	catalyst
A	40	200	Fe
B	40	200	V_2O_5
C	400	2	Fe
D	400	2	V_2O_5

34 Some marble chips (calcium carbonate) are heated strongly and substances X and Y are formed.

Substance X is a white solid that reacts with water, giving out heat. Substance Y is a colourless gas.

What are substances X and Y?

	X	Y
A	calcium chloride	oxygen
B	calcium hydroxide	carbon dioxide
C	calcium oxide	carbon dioxide
D	calcium sulfate	oxygen

35 The structures of some organic molecules are shown.

1

2

3

4

Which structures represent an alkane with four carbon atoms?

A 1 only **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

36 Some of the fractions obtained from the fractional distillation of petroleum are used as fuels for vehicles.

Which two fractions are used as fuels for vehicles?

A bitumen fraction and gasoline fraction

B bitumen fraction and naphtha fraction

C gasoline fraction and kerosene fraction

D kerosene fraction and lubricating fraction

37 X, Y and Z are three hydrocarbons.

X $CH_2{=}CH_2$ Y $CH_3{-}CH{=}CH_2$ Z $CH_3{-}CH_2{-}CH{=}CH_2$

What do compounds X, Y and Z have in common?

1 They are all alkenes.

2 They are all part of the same homologous series.

3 They all have the same boiling point.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

38 The diagram shows a reaction sequence.

Which row names the processes X, Y and Z?

	X	Y	Z
A	cracking	fermentation	respiration
B	cracking	hydration	combustion
C	distillation	fermentation	respiration
D	distillation	hydration	combustion

39 Which pair of compounds can be used to prepare $CH_3CH_2COOCH_2CH_3$?

A ethanoic acid and ethanol

B ethanoic acid and propanol

C propanoic acid and ethanol

D propanoic acid and propanol

40 The structure of a synthetic polymer is shown.

The structure shows that it is a .....1..... . It is formed by .....2..... polymerisation.

Which words complete gaps 1 and 2?

	1	2
A	polyamide	addition
B	polyamide	condensation
C	polyester	addition
D	polyester	condensation

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group	I	II											III	IV	V	VI	VII	VIII
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	3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
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actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **October/November 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

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1 The diagram shows the arrangement of particles in the three states of matter.

Solid carbon dioxide (dry ice) sublimes to gaseous carbon dioxide.

Which row describes the initial and final states?

	initial state	final state
A	P	R
B	Q	P
C	R	P
D	R	Q

2 During an experiment a measurement is recorded in cm^3.

Which apparatus is used?

A balance

B measuring cylinder

C stopclock

D thermometer

3 A student carried out paper chromatography on a mixture of amino acids.

The student sprayed the dried chromatogram with a locating agent.

What is the function of the locating agent?

A to dissolve the amino acids

B to form coloured spots with the amino acids

C to preserve the amino acids

D to stop the amino acids reacting

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4 Which row describes silicon(IV) oxide?

	has a giant structure	is an acidic oxide	conducts electricity
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✗
D	✗	✓	✓

5 Why do isotopes of the same element have the same chemical properties?

A They have the same nucleon number.

B They have the same number of electrons in the outer shell.

C They have the same number of neutrons in the nucleus.

D They have the same number of protons as neutrons.

6 Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of carbon dioxide?

A

B

C

D

7 The equation for the reaction between phosphorus and oxygen is shown.

$$xP_4 + yO_2 \rightarrow zP_2O_5$$

Which values of *x*, *y* and *z* balance the equation?

	x	*y*	*z*
A	1	5	2
B	1	10	2
C	2	5	2
D	2	10	1

8 The relative molecular mass of an alcohol is 88.

Its percentage composition by mass is: C, 54.5%; H, 9.1%; O, 36.4%.

Which row shows the empirical formula and molecular formula for this alcohol?

	empirical formula	molecular formula
A	C_2H_4O	C_2H_4O
B	C_2H_4O	$C_4H_8O_2$
C	$C_4H_8O_2$	$C_4H_8O_2$
D	$C_4H_8O_2$	C_2H_4O

9 Which statements about the electrolysis of concentrated copper(II) chloride are correct?

1 Electrons are transferred from the cathode to the copper(II) ions.

2 Electrons move round the external circuit from the cathode to the anode.

3 Chloride ions are attracted to the anode.

4 Hydroxide ions transfer electrons to the cathode.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

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10 Which metal combination produces the highest voltage reading in the cells shown?

11 The equation for the combustion of methane is shown.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The energy change for the combustion of methane is –890 kJ / mol.

The bond energies are shown in the table.

bond	bond energy in kJ / mol
C–H	+410
O=O	+496
H–O	+460

What is the bond energy of the C=O bond?

A +49 kJ / mol **B** +841 kJ / mol **C** +1301 kJ / mol **D** +1335 kJ / mol

12 Which statement describes an exothermic reaction?

A The energy absorbed for bond breaking is greater than the energy released by bond formation.

B The energy absorbed for bond breaking is less than the energy released by bond formation.

C The energy released by bond breaking is greater than the energy absorbed for bond formation.

D The energy released by bond breaking is less than the energy absorbed for bond formation.

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

14 Copper metal donates electrons to silver ions.

Zinc metal donates electrons to copper ions.

What is the strongest reducing agent?

A copper ions

B copper metal

C silver ions

D zinc metal

15 Four statements about the effect of increasing temperature on a reaction are shown.

1 The activation energy becomes lower.

2 The particles move faster.

3 There are more collisions between reacting particles.

4 There are more collisions which have energy greater than the activation energy.

Which statements are correct?

A 1, 2 and 3 **B** 1, 3 and 4 **C** 2, 3 and 4 **D** 2 and 3 only

16 The formation of sulfur trioxide from sulfur dioxide is a reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which changes would increase the equilibrium yield of SO_3?

1 increasing the pressure

2 lowering the temperature

3 decreasing the concentration of oxygen

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

17 Some properties of four oxides are listed.

Oxide 1 reacts with both acids and alkalis to form salts.

Oxide 2 reacts with acids to form salts but does not react with alkalis.

Oxide 3 reacts with alkalis to form salts but does not react with acids.

Oxide 4 does not react with acids or alkalis.

Which row describes the oxides?

	oxide 1	oxide 2	oxide 3	oxide 4
A	amphoteric	acidic	basic	neutral
B	amphoteric	basic	acidic	neutral
C	neutral	acidic	basic	amphoteric
D	neutral	basic	acidic	amphoteric

18 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

19 Copper(II) sulfate can be prepared by adding excess copper(II) carbonate to sulfuric acid.

Why is an **excess** of copper(II) carbonate added?

A to ensure all the copper(II) carbonate has reacted

B to ensure all the sulfuric acid has reacted

C to increase the rate of reaction

D to increase the yield of copper(II) sulfate

20 Compound P reacts with hydrochloric acid to produce a gas that turns limewater milky.

What is P?

A sodium carbonate

B sodium chloride

C sodium hydroxide

D sodium sulfate

21 Which statement about nitrogen and phosphorus is **not** correct?

A Both are in the same group of the Periodic Table.

B Both are in the same period of the Periodic Table.

C Both are non-metals.

D Both have the same number of electrons in their outer shell.

22 Sodium and rubidium are elements in Group I of the Periodic Table.

Which statement is correct?

A Sodium atoms have more electrons than rubidium atoms.

B Sodium has a lower density than rubidium.

C Sodium has a lower melting point than rubidium.

D Sodium is more reactive than rubidium.

23 Which properties do the elements chromium, iron and vanadium have in common?

1 They all conduct electricity.

2 They, or their compounds, can act as catalysts.

3 They all form coloured compounds.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

24 Why is argon gas used to fill electric lamps?

A It conducts electricity.

B It glows when heated.

C It is less dense than air.

D It is not reactive.

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 Aluminium is extracted from bauxite by electrolysis.

Which row shows the anode material and the anode reaction?

	anode material	anode reaction
A	carbon	$Al^{3+} + 3e^- \rightarrow Al$
B	carbon	$2O^{2-} \rightarrow O_2 + 4e^-$
C	steel	$Al^{3+} + 3e^- \rightarrow Al$
D	steel	$2O^{2-} \rightarrow O_2 + 4e^-$

27 Which statement about the metal zinc is **not** correct?

A It forms an oxide more readily than iron.

B It is manufactured by the electrolysis of zinc blende.

C It is used to make brass.

D It is used to prevent iron from rusting.

28 Calcium nitrate decomposes when it is heated.

What is the equation for the thermal decomposition of calcium nitrate?

A $2Ca(NO_3)_2 \rightarrow 2CaO + O_2 + 4NO_2$

B $Ca(NO_3)_2 \rightarrow Ca(NO_2)_2 + O_2$

C $Ca(NO_3)_2 \rightarrow Ca + O_2 + 2NO_2$

D $Ca(NO_3)_2 \rightarrow Ca + 3O_2 + N_2$

29 The flow chart shows stages in the treatment of river water to produce drinking water.

What occurs at stages X and Y?

	X	Y
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

30 An experiment to investigate the effect of galvanising iron is shown.

The experiment is left for seven days.

What happens to the water level in tubes X and Y?

	tube X	tube Y
A	falls	rises
B	no change	no change
C	rises	falls
D	rises	no change

31 Which metal is used as a catalyst in the Haber process for the manufacture of ammonia?

A iron

B nickel

C platinum

D vanadium

32 Which process removes carbon dioxide from the atmosphere?

A combustion of fossil fuels

B decomposition of carbonates

C photosynthesis

D respiration

33 Which row shows the conditions used in the manufacture of sulfuric acid by the Contact process?

	temperature / °C	pressure / atm	catalyst
A	40	200	Fe
B	40	200	V_2O_5
C	400	2	Fe
D	400	2	V_2O_5

34 Some marble chips (calcium carbonate) are heated strongly and substances X and Y are formed.

Substance X is a white solid that reacts with water, giving out heat. Substance Y is a colourless gas.

What are substances X and Y?

	X	Y
A	calcium chloride	oxygen
B	calcium hydroxide	carbon dioxide
C	calcium oxide	carbon dioxide
D	calcium sulfate	oxygen

35 The structures of four organic compounds are shown.

S

T

U

V

Which compounds are unsaturated?

A S only **B** T and U **C** U only **D** V only

36 Which statement is **not** correct?

A Petroleum is a mixture of hydrocarbons.

B The main constituent of natural gas is ethane.

C The naphtha fraction of petroleum is used for making chemicals.

D When natural gas burns in air, carbon dioxide and water are formed.

37 X, Y and Z are three hydrocarbons.

X $CH_2=CH_2$ Y $CH_3–CH=CH_2$ Z $CH_3–CH_2–CH=CH_2$

What do compounds X, Y and Z have in common?

1 They are all alkenes.

2 They are all part of the same homologous series.

3 They all have the same boiling point.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

38 The diagram shows a reaction sequence.

Which row names the processes X, Y and Z?

	X	Y	Z
A	cracking	fermentation	respiration
B	cracking	hydration	combustion
C	distillation	fermentation	respiration
D	distillation	hydration	combustion

39 The structure of an ester is shown.

Which substances react to form this ester?

A ethanol and ethanoic acid

B ethanol and propanoic acid

C propanol and ethanoic acid

D propanol and propanoic acid

40 A polymer can be made from methyl propene.

Which diagram shows the structure of the polymer?

A

B

C

D

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **October/November 2017**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **15** printed pages and **1** blank page.

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1 Which statement describes sublimation?

A Particles moving slowly past each other speed up and move further apart.

B Particles vibrating next to each other become mobile and move slowly past each other.

C Particles vibrating next to each other start to move rapidly and move further apart.

D Rapidly moving particles slow down and move closer together.

2 25 cm^3 of an alkali are added to 20 cm^3 of an acid. The temperature change is measured.

Which apparatus is **not** needed in the experiment?

A 25 cm^3 measuring cylinder

B 100 cm^3 beaker

C balance

D thermometer

3 The painkiller paracetamol is synthesised from 4-aminophenol.

Chromatography was carried out on an impure sample of paracetamol. The results are shown (not drawn to scale).

The sample of paracetamol was contaminated with 4-aminophenol only.

What is the R_f value of 4-aminophenol?

A 0.49 **B** 0.65 **C** 0.74 **D** 1.35

4 Which compound is silicon(IV) oxide?

	melting point / °C	good electrical conductor when solid	good electrical conductor when molten
A	–73	no	no
B	801	no	yes
C	1495	yes	yes
D	1710	no	no

5 Carbon has three naturally occurring isotopes, ^{12}C, ^{13}C and ^{14}C.

Which statement explains why the isotopes have the same chemical properties?

A They have the same number of electrons in the first shell.

B They have the same number of electrons in the outer shell.

C They have the same number of neutrons in the nucleus.

D They have the same number of protons as neutrons.

6 Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of carbon dioxide?

A

B

C

D

7 The equation represents the reaction between solid magnesium oxide and dilute hydrochloric acid to form magnesium chloride and water.

$$MgO + 2HCl \rightarrow MgCl_2 + H_2O$$

Which row shows the state symbols for hydrochloric acid, magnesium chloride and water?

	HCl	$MgCl_2$	H_2O
A	(aq)	(aq)	(l)
B	(aq)	(l)	(l)
C	(l)	(aq)	(aq)
D	(l)	(l)	(aq)

8 A compound contains 34.5% calcium, 24.1% silicon and 41.4% oxygen by mass.

What is its empirical formula?

A Ca_2SiO_3 **B** $CaSiO_3$ **C** $CaSi_2O_3$ **D** $CaSiO_6$

9 Which statements about the electrolysis of concentrated copper(II) chloride are correct?

1 Electrons are transferred from the cathode to the copper(II) ions.

2 Electrons move round the external circuit from the cathode to the anode.

3 Chloride ions are attracted to the anode.

4 Hydroxide ions transfer electrons to the cathode.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

10 Which metal combination produces the highest voltage reading in the cells shown?

11 Some bond energies are shown in the table.

bond	bond energy in kJ / mol
H–H	+436
O=O	+496
H–O	+460

Hydrogen reacts with oxygen. The reaction is exothermic.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

What is the energy change for the reaction?

A –3208 kJ / mol

B –908 kJ / mol

C –472 kJ / mol

D –448 kJ / mol

12 Which statement describes an exothermic reaction?

A The energy absorbed for bond breaking is greater than the energy released by bond formation.

B The energy absorbed for bond breaking is less than the energy released by bond formation.

C The energy released by bond breaking is greater than the energy absorbed for bond formation.

D The energy released by bond breaking is less than the energy absorbed for bond formation.

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?

14 Silver chloride reacts when it is exposed to light.

Which row shows what happens to the silver in this process?

	half-equation	type of reaction
A	$Ag \rightarrow Ag^+ + e^-$	oxidation
B	$Ag \rightarrow Ag^+ + e^-$	reduction
C	$Ag^+ + e^- \rightarrow Ag$	oxidation
D	$Ag^+ + e^- \rightarrow Ag$	reduction

15 Which statement about the effect of concentration and temperature on the rate of a reaction is **not** correct?

A If the concentration of a reactant is increased, the rate of reaction increases because more particles have sufficient energy to react.

B If the concentration of a reactant is increased, the rate of reaction increases because there are more collisions between particles per second.

C If the temperature is increased, the rate of reaction increases because there are more collisions between particles per second.

D If the temperature is increased, the rate of reaction increases because more particles have sufficient energy to react.

16 The following reaction has reached equilibrium in a closed system.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which row shows the effect of increasing the pressure on the equilibrium mixture?

	reaction rate	amount of SO_2	amount of SO_3
A	increases	decreases	increases
B	increases	increases	decreases
C	unchanged	decreases	increases
D	unchanged	increases	decreases

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17 Some properties of four oxides are listed.

Oxide 1 reacts with both acids and alkalis to form salts.

Oxide 2 reacts with acids to form salts but does not react with alkalis.

Oxide 3 reacts with alkalis to form salts but does not react with acids.

Oxide 4 does not react with acids or alkalis.

Which row describes the oxides?

	oxide 1	oxide 2	oxide 3	oxide 4
A	amphoteric	acidic	basic	neutral
B	amphoteric	basic	acidic	neutral
C	neutral	acidic	basic	amphoteric
D	neutral	basic	acidic	amphoteric

18 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

19 Three solids, P, Q and R, all react with dilute sulfuric acid to produce zinc sulfate.

P and R produce gases during the reaction.

The gas produced when P reacts will not burn. The gas produced when R reacts will burn.

What are P, Q and R?

	P	Q	R
A	zinc	zinc hydroxide	zinc carbonate
B	zinc carbonate	zinc	zinc oxide
C	zinc carbonate	zinc hydroxide	zinc
D	zinc oxide	zinc carbonate	zinc

20 Which ion forms a green precipitate with aqueous sodium hydroxide that dissolves in an excess of aqueous sodium hydroxide?

A Ca^{2+} **B** Cr^{3+} **C** Cu^{2+} **D** Fe^{2+}

21 A period of the Periodic Table is shown.

group	I	II	III	IV	V	VI	VII	VIII
element	R	S	T	V	W	X	Y	Z

The letters are not their chemical symbols.

Which statement is correct?

A Element R does not conduct electricity.

B Elements R and Y react together to form an ionic compound.

C Element Z exists as a diatomic molecule.

D Element Z reacts with element T.

22 Some properties of element X are shown.

melting point in °C	98
boiling point in °C	883
reaction with cold water	gives off H_2 gas
reaction when heated with oxygen	burns to give a white solid

In which part of the Periodic Table is X found?

A Group I

B Group VII

C Group VIII

D transition elements

23 The table gives some properties of an element.

melting point in °C	3422
appearance of the element	grey
appearance of the chloride of the element	dark blue
density in g/cm^3	19.2
electrical conductivity when solid	good

Which other property would you expect this element to have?

A acts as a catalyst

B brittle

C forms an acidic oxide

D highly reactive with water

24 Why is argon gas used to fill electric lamps?

A It conducts electricity.

B It glows when heated.

C It is less dense than air.

D It is not reactive.

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 Aluminium is obtained by the electrolysis of a mixture of aluminium oxide and cryolite.

Why is cryolite used?

A as a catalyst to speed up the process

B as a coolant to prevent the process getting too hot

C as a solvent for aluminium oxide

D as the main source of aluminium ions

27 Metal M is mixed with copper to produce brass.

What is M?

A chromium

B nickel

C vanadium

D zinc

28 Some metal nitrates and carbonates decompose when heated strongly.

Metal Q has a nitrate that decomposes to give a salt and a colourless gas only.

The carbonate of metal Q does not decompose when heated with a Bunsen burner.

What is metal Q?

A calcium

B copper

C sodium

D zinc

29 The flow chart shows stages in the treatment of river water to produce drinking water.

What occurs at stages X and Y?

	X	Y
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

30 A piece of zinc is attached to the hull of a steel boat. Steel is an alloy of iron.

Which statement explains why the zinc prevents the iron from rusting?

A Zinc is less reactive than iron, and iron is less likely to lose electrons than zinc.

B Zinc is less reactive than iron, and iron is more likely to lose electrons than zinc.

C Zinc is more reactive than iron, and iron is less likely to lose electrons than zinc.

D Zinc is more reactive than iron, and iron is more likely to lose electrons than zinc.

31 The Haber process for making ammonia is carried out at a temperature of 450 °C and a pressure of 200 atmospheres in the presence of a catalyst.

Which statement is **not** correct?

A Lowering the pressure increases the rate at which ammonia is produced.

B Lowering the temperature slows down the rate at which ammonia is produced.

C Maintaining a very high pressure is very difficult and needs expensive equipment.

D The reaction is a reversible reaction which can proceed forwards and backwards.

32 Which process does **not** produce carbon dioxide?

A combustion of methane

B photosynthesis

C respiration

D thermal decomposition of calcium carbonate

33 Which row shows the conditions used in the manufacture of sulfuric acid by the Contact process?

	temperature / °C	pressure / atm	catalyst
A	40	200	Fe
B	40	200	V_2O_5
C	400	2	Fe
D	400	2	V_2O_5

34 Some marble chips (calcium carbonate) are heated strongly and substances X and Y are formed.

Substance X is a white solid that reacts with water, giving out heat. Substance Y is a colourless gas.

What are substances X and Y?

	X	Y
A	calcium chloride	oxygen
B	calcium hydroxide	carbon dioxide
C	calcium oxide	carbon dioxide
D	calcium sulfate	oxygen

35 The structure of compound R is shown.

What is R?

A propane

B propanoic acid

C propanol

D propene

36 Fuel oil and naphtha are two fractions obtained from petroleum.

What are the major uses of these fractions?

	fuel oil	naphtha
A	jet fuel	making chemicals
B	jet fuel	making roads
C	ship fuel	making chemicals
D	ship fuel	making roads

37 X, Y and Z are three hydrocarbons.

X $CH_2=CH_2$ Y $CH_3–CH=CH_2$ Z $CH_3–CH_2–CH=CH_2$

What do compounds X, Y and Z have in common?

1 They are all alkenes.

2 They are all part of the same homologous series.

3 They all have the same boiling point.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

38 The diagram shows a reaction sequence.

Which row names the processes X, Y and Z?

	X	Y	Z
A	cracking	fermentation	respiration
B	cracking	hydration	combustion
C	distillation	fermentation	respiration
D	distillation	hydration	combustion

39 The structure of an ester is shown.

Which combination of carboxylic acid and alcohol produces this ester?

	carboxylic acid	alcohol
A	butanoic acid	ethanol
B	butanoic acid	propanol
C	ethanoic acid	butanol
D	propanoic acid	butanol

40 The equation shows the formation of a polymer called *Kevlar*.

Which row describes *Kevlar*?

	how the polymer is formed	type of polymer
A	addition polymerisation	polyamide
B	addition polymerisation	polyester
C	condensation polymerisation	polyamide
D	condensation polymerisation	polyester

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

8786129582

CHEMISTRY **0620/31**

Paper 3 Theory (Core) **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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1 The diagram shows the structures of five substances, **A**, **B**, **C**, **D** and **E**.

Answer the following questions using only the structures in the diagram.
Each structure may be used once, more than once or not at all.

(a) Which structure, **A**, **B**, **C**, **D** or **E**,

(i) is a diatomic molecule, ... [1]

(ii) contains ions, ... [1]

(iii) decolourises aqueous bromine, ... [1]

(iv) conducts electricity when molten, ... [1]

(v) contains atoms of **two** different halogens? ..... [1]

(b) Bromine is an element.

What is meant by the term *element*?

.....

..... [1]

(c) Bromine melts at –7 °C and boils at 59 °C.

What is the physical state of bromine at –15 °C?
Explain your answer.

.....

..... [2]

[Total: 8]

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2 The table shows the composition of the atmosphere of the planet Neptune.

gas present	percentage of gas in Neptune's atmosphere
helium	19.5
hydrogen	78.8
methane	
other gases	0.2

(a) Complete the table to calculate the percentage of methane in Neptune's atmosphere. [1]

(b) Describe how Neptune's atmosphere differs from the Earth's atmosphere.
Give **three** differences.

1 .....

.....

2 .....

.....

3 .....

.....
[3]

(c) Methane is a covalent compound.

Complete the diagram to show
- the arrangement of electrons in a molecule of methane,
- the symbols of the atoms present.

Show outer shell electrons only.

[2]

(d) Isotopes of hydrogen are present in Neptune's atmosphere.

(i) What is meant by the term *isotopes*?

.....

..... [1]

(ii) An atom of hydrogen has three nucleons.

Deduce the number of protons and neutrons present in **one** atom of this isotope of hydrogen.
Use your Periodic Table to help you.

number of protons .....

number of neutrons .....
[2]

(e) Other gases present in Neptune's atmosphere include ethane and water vapour.

(i) Calculate the relative molecular mass of ethane, C_2H_6.
Use your Periodic Table to help you.

relative molecular mass = ... [2]

(ii) Describe a chemical test for water.

test .....

result .....
[2]

[Total: 13]

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3 The following substances are present in a liquid floor cleaner.

coloured dyes
ethanol
preservatives
sodium carbonate

(a) **(i)** Balance the chemical equation for the complete combustion of ethanol.

$$C_2H_5OH + 3O_2 \rightarrow .....CO_2 + ...H_2O$$

[2]

(ii) Draw the structure of an ethanol molecule showing all of the atoms and all of the bonds.

[2]

(b) Aqueous sodium carbonate is alkaline.

(i) Which **one** of the following pH values is alkaline?
Put a circle around the correct answer.

pH 3 pH 6 pH 7 pH 10

[1]

(ii) Aqueous sodium carbonate is colourless.

An excess of aqueous sodium carbonate is added to a solution of dilute sulfuric acid and methyl orange.

Describe the colour change.

from ..... to ..... [2]

(iii) The chemical equation for the reaction between sodium carbonate and dilute sulfuric acid is shown.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

Write the word equation for this reaction.

..... [2]

(c) Preservatives stop the growth of bacteria and fungi.

State the name of an acidic gas used to preserve food.

..... [1]

(d) The coloured dyes in the liquid floor cleaner can be separated using the apparatus shown.

(i) Complete the boxes to label **P** and **Q**. [2]

(ii) State the name of this method of separation.

..... [1]

(iii) On the diagram, put an **X** to show where the mixture of coloured dyes is placed at the start of the experiment. [1]

[Total: 14]

4 The table shows the properties of four substances.

substance	boiling point	electrical conductivity of solid	electrical conductivity when molten	density in g/cm^3
graphite				2.25
iodine	low	does not conduct	does not conduct	4.93
potassium	high		conducts	0.86
zinc chloride	high	does not conduct	conducts	2.91

(a) Complete the table to show the electrical conductivity of solid graphite and solid potassium. [2]

(b) Give **one** piece of evidence from the table that shows that iodine is a simple covalent substance.

..... [1]

(c) What information in the table shows that zinc chloride is an ionic compound?

.....

..... [2]

(d) Molten zinc chloride can be electrolysed.

Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). ..... [2]

(e) Aqueous iodine is formed when aqueous chlorine is added to aqueous potassium iodide.

Use ideas about reactivity to explain why this reaction occurs.

.....

..... [1]

[Total: 8]

5 Titanium is extracted from an ore which contains titanium(IV) oxide, TiO_2.

(a) **(i)** Balance the chemical equation for the first step in this extraction.

$$TiO_2 + ...C + ...Cl_2 \rightarrow TiCl_4 + 2CO$$

[2]

(ii) Explain why the conversion of carbon to carbon monoxide is an oxidation reaction.

..... [1]

(b) Titanium is a transition element.
Sodium is a Group I element.

Describe **two** differences in the physical properties of titanium and sodium.

1 .....

.....

2 .....

.....
[2]

(c) The properties and relative reactivity with water of some Group I elements are shown in the table.

element	density in g / cm³	melting point in °C	relative reactivity with water
lithium	0.53	181	
sodium		98	forms bubbles rapidly but does not burst into flames
potassium	0.86		forms bubbles very rapidly and bursts into flames
rubidium	1.53	39	reacts explosively

(i) Complete the table
- for the relative reactivity of lithium with water,
- to predict the melting point of potassium.

[2]

(ii) Describe the general trend in the density of the Group I elements.

..... [1]

(d) Is lithium oxide an acidic oxide or a basic oxide?
Explain your answer.

.....

..... [1]

[Total: 9]

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6 The diagram shows a fractionating column used for the fractional distillation of petroleum.

(a) Describe the fractional distillation of petroleum.

In your answer, include
- where the petroleum enters the fractionating column,
- the relative temperatures in the fractionating column (higher or lower),
- the relative boiling points of the fractions (higher or lower),
- the changes in physical state which occur.

.....

.....

.....

.....

.....

.....

..... [4]

(b) Alkenes can be made by cracking the kerosene fraction.

(i) What is meant by the term *cracking*?

.....

..... [2]

(ii) When butane is cracked, ethene and gas **X** are produced.

$$C_4H_{10} \rightarrow 2C_2H_4 + \mathbf{X}$$

State the name of gas **X**.

..... [1]

(c) Complete the sentence about the bonding in butane.

All the bonds in butane are single ..... chemical bonds. [1]

(d) Ethene is used to make poly(ethene).

Which **one** of the following words describes poly(ethene)?
Put a circle around the correct answer.

gas **monomer** **polymer** **solvent**

[1]

[Total: 9]

7 Bromine is a red-brown liquid which is soluble in cyclohexane.

(a) A few drops of liquid bromine were placed at the bottom of a beaker containing cyclohexane. After 3 days, a red-brown colour had spread throughout the beaker.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(b) The structure of a compound containing bromine is shown.

(i) Deduce the molecular formula of this compound showing the number of carbon, hydrogen, oxygen and bromine atoms.

..... [1]

(ii) State the name of the

functional group.

..... [1]

(c) The relative atomic mass of bromine is 80.

Complete the definition of relative atomic mass using terms from the list.

6
12
an atom
an element
a molecule
average
carbon
hydrogen
total

Relative atomic mass is the ..... mass of naturally occurring atoms

of ..... on a scale where ..... of the ^{12}C isotope has

a mass of exactly ..... units. [4]

(d) Dilute hydrobromic acid reacts with magnesium ribbon.

(i) Suggest **three** ways of increasing the rate of this reaction.

1 .....

2 .....

3 .....
[3]

(ii) Hydrobromic acid reacts with oxygen. The products are water and bromine.

Balance the chemical equation for this reaction.

$$.....HBr + O_2 \rightarrow 2H_2O + 2Br_2$$

[1]

[Total: 13]

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8 Ammonia is manufactured by combining nitrogen and hydrogen at high temperature and pressure.

$$\text{nitrogen} + \text{hydrogen} \overset{\text{catalyst}}{\rightleftharpoons} \text{ammonia}$$

(a) **(i)** What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(ii) What is the purpose of the catalyst?

..... [1]

(b) The graph shows the percentage yield of ammonia at different temperatures.

(i) Describe how the percentage yield of ammonia changes with temperature.

..... [1]

(ii) Deduce the percentage yield of ammonia at 400 °C.

..... [1]

(c) Copper(II) oxide reacts with ammonia.

copper(II) oxide + ammonia → copper + nitrogen + water

When 20 g of copper(II) oxide react with an excess of ammonia, 16 g of copper are formed.

Calculate the mass of copper formed when 140 g of copper(II) oxide react with an excess of ammonia.

..... g [1]

(d) Ammonia is used in the manufacture of nylon.

Give **one** use of nylon.

..... [1]

[Total: 6]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/32**

Paper 3 Theory (Core) **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 The diagram shows the structures of five substances, **A**, **B**, **C**, **D** and **E**.

Answer the following questions using only the structures in the diagram.
Each structure may be used once, more than once or not at all.

(a) Which structure, **A**, **B**, **C**, **D** or **E**,

(i) is an element, ... [1]

(ii) has a structure similar to ethanol, ... [1]

(iii) is a compound which contributes to acid rain, ... [1]

(iv) has double covalent bonds, ... [1]

(v) contains halogen atoms? ..... [1]

(b) Structure **A** is a non-metal.

State **three** typical differences between metals and non-metals.

1 .....

2 .....

3 ..... [3]

(c) Structure **B** is hydrogen sulfide.
Hydrogen sulfide is a compound.

What is meant by the term *compound*?

.....

..... [1]

[Total: 9]

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2 The diagram shows the composition of the planet Saturn.

(a) Describe how Saturn's atmosphere differs from the Earth's atmosphere.
Give **three** differences.

1 .....

.....

2 .....

.....

3 .....

.....
[3]

(b) Some properties of hydrogen and helium are given in the table.

element	density of the liquid in g / cm^3	melting point in °C	boiling point in °C
hydrogen	0.07	–259	–253
helium	0.15	–272	–269

(i) Use the information to suggest why the layer of liquid hydrogen in Saturn floats on top of the liquid helium.

..... [1]

(ii) What is the physical state of hydrogen at –250 °C?
Explain your answer.

.....

..... [2]

(c) The atmosphere of Saturn contains small amounts of ammonia.

(i) Describe a test for ammonia.

test .....

result .....
[2]

(ii) Ammonia is a covalent compound.

Complete the diagram to show
- the arrangement of electrons in a molecule of ammonia,
- the symbols of the atoms present.

Show outer electrons only.

[2]

(d) Saturn's atmosphere also contains small amounts of ammonium hydrosulfide.

Calculate the relative molecular mass of ammonium hydrosulfide, NH_4SH.
Use your Periodic Table to help you.

relative molecular mass = ... [2]

(e) Saturn's atmosphere also contains small amounts of methane.
Small amounts of methane are present in the Earth's atmosphere.
Methane is a greenhouse gas.

(i) Name another greenhouse gas present in the Earth's atmosphere.

..... [1]

(ii) Scientists are concerned about the increase in the amount of greenhouse gases in the Earth's atmosphere.

Explain why.

..... [1]

[Total: 14]

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3 The following compounds are present in a liquid used for cleaning metal.

ethanoic acid

ethanol

glycerol

sodium chloride

water

(a) **(i)** Draw the structure of the functional group present in ethanoic acid.

[1]

(ii) Which **one** of the following pH values is acidic?
Put a circle around the correct answer.

pH 4 pH 7 pH 9 pH 13

[1]

(iii) Ethanoic acid reacts with sodium hydroxide.

What type of reaction is this?
Put a circle around the correct answer.

neutralisation **oxidation** **polymerisation** **reduction**

[1]

(iv) The reaction of ethanoic acid with sodium hydroxide is exothermic.

What is meant by the term *exothermic*?

..... [1]

(b) The structure of glycerol is shown.

Deduce the molecular formula of glycerol showing the number of carbon, hydrogen and oxygen atoms.

..... [1]

(c) Balance the chemical equation for the incomplete combustion of ethanol.

$$C_2H_5OH + 2O_2 \rightarrow .....CO + ...H_2O$$

[2]

(d) **(i)** Describe a method of obtaining pure samples of **both** sodium chloride and water from aqueous sodium chloride. Explain why this method works.

.....

.....

.....

.....

..... [3]

(ii) Which physical property could you measure to find out if a sample of water is pure?

..... [1]

(iii) Sodium chloride contains chloride ions.

Describe a test for chloride ions.

test .....

result .....

[2]

[Total: 13]

4 The table shows the properties of four substances.

substance	boiling point	electrical conductivity of solid	electrical conductivity when molten	solubility in water
calcium iodide	very high	does not conduct	conducts	
phosphorus	low	does not conduct	does not conduct	insoluble
sodium chloride	very high	does not conduct	conducts	soluble
zinc	high		conducts	insoluble

(a) Complete the table to show the solubility in water of calcium iodide and the electrical conductivity of solid zinc. [2]

(b) Give **one** piece of evidence from the table that shows that phosphorus is a simple covalent substance.

..... [1]

(c) What information in the table shows that sodium chloride is an ionic compound?

.....

..... [2]

(d) Molten calcium iodide can be electrolysed.

Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). .....
[2]

(e) An atom of phosphorus has 31 nucleons.

Deduce the number of protons and neutrons present in **one** atom of phosphorus.
Use your Periodic Table to help you.

number of protons .....

number of neutrons .....
[2]

(f) Phosphorus burns in an excess of air to form phosphorus(V) oxide.

Is phosphorus(V) oxide an acidic oxide or a basic oxide?
Explain your answer.

.....

..... [1]

(g) Arsenic is in the same group of the Periodic Table as phosphorus.
Arsenic sublimes at 613 °C.

What is meant by the term *sublimation*?

.....

..... [1]

[Total: 11]

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5 Nickel can be obtained from nickel(II) oxide by heating it with a mixture of carbon monoxide and hydrogen.

$$2NiO + CO + H_2 \rightarrow 2Ni + CO_2 + H_2O$$

(a) How does this equation show that the nickel(II) oxide is reduced?

..... [1]

(b) Nickel can be purified by reacting impure nickel with carbon monoxide.
A compound called tetracarbonylnickel, $Ni(CO)_4$, is formed.

$$Ni + 4CO \rightleftharpoons Ni(CO)_4$$

What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(c) The tetracarbonylnickel is heated to obtain pure nickel.

$$Ni(CO)_4 \rightarrow Ni + 4CO$$

(i) Suggest why the nickel obtained can be separated easily from the carbon monoxide.

..... [1]

(ii) State **one** adverse effect of carbon monoxide on health.

..... [1]

(d) Nickel is a transition element.
Potassium is a Group I element.

(i) Describe **two** differences in the physical properties of nickel and potassium.

1 .....

.....

2 .....

.....
[2]

(ii) Describe **one** difference in the properties of nickel(II) chloride and potassium chloride.

..... [1]

(e) The properties and relative reactivity with water of some Group I elements are shown in the table.

element	density in g / cm^3	boiling point in °C	relative reactivity with water
sodium		883	forms bubbles rapidly but does not burst into flames
potassium	0.86	760	forms bubbles very rapidly and bursts into flames
rubidium	1.53		
caesium	1.88	669	reacts explosively

(i) Complete the table
- to predict the boiling point of rubidium,
- for the relative reactivity of rubidium with water.

[2]

(ii) Describe the general trend in the density of the Group I elements.

..... [1]

[Total: 10]

6 Ethanol can be manufactured from ethene or by the fermentation of glucose.

(a) Describe these **two** methods of manufacturing ethanol.

In your answer, include
- the names of any additional substances needed,
- the reaction conditions.

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) Ethene is an unsaturated hydrocarbon.

(i) Describe how you could distinguish between an unsaturated hydrocarbon and a saturated hydrocarbon using aqueous bromine.

.....

.....

..... [2]

(ii) Ethene molecules can form polymers.

Which phrase describes a polymer?
Tick **one** box.

a giant structure containing one type of atom	☐
a large molecule formed by cracking monomers	☐
a large molecule formed by the addition of many ions	☐
a large molecule formed from many monomers	☐

[1]

(iii) *Terylene* is a polymer.

Give **one** use of *Terylene*.

..... [1]

[Total: 9]

7 Sulfur dichloride, SCl_2, is a red liquid which vaporises easily at room temperature and pressure.

(a) A drop of sulfur dichloride was placed in the corner of a glass box.
The glass box was closed and left for 12 hours.
After 12 hours a red vapour had spread to fill the whole box.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(b) Sulfur dichloride can be made by passing chlorine through liquid disulfur dichloride, S_2Cl_2.

Complete the chemical equation for this reaction.

$$S_2Cl_2 + \text{.....} \rightarrow \text{.....}SCl_2$$

[2]

(c) Some changes of state of sulfur dichloride are shown.

$$\underset{\text{solid}}{SCl_2} \underset{\mathbf{P}}{\overset{\text{melting}}{\rightleftharpoons}} \underset{\text{liquid}}{SCl_2} \underset{\mathbf{Q}}{\overset{\text{evaporating}}{\rightleftharpoons}} \underset{\text{gas}}{SCl_2}$$

Name the changes of state represented by **P** and **Q**.

P .....

Q .....

[2]

[Total: 7]

8 Calcium carbonate (limestone) decomposes when heated.

$$CaCO_3 \rightarrow CaO + CO_2$$

(a) When 20.0 g of calcium carbonate are decomposed, 11.2 g of calcium oxide (lime), CaO, are formed.

Calculate the mass of calcium oxide formed when 160.0 g of calcium carbonate are decomposed.

..... g [1]

(b) The graph shows the volume of carbon dioxide produced when some small pieces of calcium carbonate are heated and decompose.

(i) Deduce the volume of carbon dioxide produced during the first 20 minutes of the decomposition.

..... [1]

(ii) At what time was the reaction complete?

..... [1]

(iii) What would be the effect, if any, on the rate of reaction if the same mass of powdered calcium carbonate were used?

..... [1]

(c) The table shows how limestone is used.

use of limestone	percentage of limestone used for this purpose
agriculture	
cement manufacture	37
chemical industries	14
iron and steel manufacture	11
road building	20
other uses	2
total	100

(i) What percentage of limestone is used in agriculture?

..... [1]

(ii) Limestone and lime are used in agriculture.

Why is lime used in agriculture?

.....

..... [2]

[Total: 7]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/33**

Paper 3 Theory (Core) **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Answer **all** questions.
Electronic calculators may be used.
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1 The diagram shows the structures of five substances, **A**, **B**, **C**, **D** and **E**.

Answer the following questions using only the structures in the diagram.
Each structure may be used once, more than once or not at all.

(a) Which structure, **A**, **B**, **C**, **D** or **E**,

(i) is a compound which is used as a fertiliser, ... [1]

(ii) is a diatomic molecule, ... [1]

(iii) contains chloride ions, ... [1]

(iv) is a gas which turns damp red litmus paper blue, ... [1]

(v) is an element? ..... [1]

(b) Structure **A** is sulfur dioxide.
Sulfur dioxide is an atmospheric pollutant.

(i) State **one** source of sulfur dioxide.

..... [1]

(ii) Give **one** adverse effect of sulfur dioxide on health.

..... [1]

(c) An isotope of nitrogen is represented by the symbol $^{15}_{7}N$.

Deduce the number of protons, neutrons and electrons in this isotope of nitrogen.

number of protons .....

number of neutrons .....

number of electrons .....
[3]

[Total: 10]

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2 The atmosphere of the planet Venus contains 96.4% carbon dioxide, 3.5% nitrogen and small amounts of other gases.

(a) Describe how Venus' atmosphere differs from the Earth's atmosphere.
Give **three** differences.

1 .....

.....

2 .....

.....

3 .....

.....
[3]

(b) Describe a test for carbon dioxide.

test .....

result .....
[2]

(c) Venus' atmosphere also contains small amounts of water and argon.

(i) Water is a covalent compound.

Complete the diagram to show
- the arrangement of electrons in a molecule of water,
- the symbols of the atoms present.

Show outer shell electrons only.

[2]

(ii) The melting point of argon is –189 °C.
The boiling point of argon is –186 °C.

What is the physical state of argon at –200 °C?
Explain your answer.

.....

..... [2]

(iii) Argon is unreactive.

Explain why argon is unreactive in terms of its electronic structure.

.....

..... [1]

(d) Clouds of sulfuric acid are present in Venus' atmosphere.
Sulfuric acid reacts with magnesium carbonate.

$$H_2SO_4 + MgCO_3 \rightarrow MgSO_4 + CO_2 + H_2O$$

(i) Write the word equation for this reaction.

..... [2]

(ii) Calculate the relative molecular mass of sulfuric acid, H_2SO_4.
Use your Periodic Table to help you.

relative molecular mass = ... [2]

(e) Sulfur dioxide is found in the atmospheres of both Venus and the Earth.

(i) State **one** use of sulfur dioxide.

..... [1]

(ii) Sulfur dioxide dissolves in water to form an acidic solution.

Which **one** of the following pH values is acidic?
Put a circle around the correct answer.

pH 2 pH 7 pH 9 pH 14

[1]

[Total: 16]

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3 The list shows some of the compounds used to manufacture ink.

calcium carbonate

ethanoic acid

iron(II) sulfate

potassium dichromate(VI)

sodium sulfate

sulfuric acid

(a) Which compound is present in limestone?

..... [1]

(b) Hydrated iron(II) sulfate is heated gently.

$$FeSO_4.7H_2O \rightarrow FeSO_4 + 7H_2O$$

(i) Describe what you would see when a test-tube containing a small amount of hydrated iron(II) sulfate is heated gently.

..... [1]

(ii) Describe a test for aqueous iron(II) ions.

test .....

result .....
[2]

(c) Iron(II) sulfate can be prepared by reacting an excess of iron with dilute sulfuric acid.

(i) Complete the chemical equation for this reaction.

$$Fe + H_2SO_4 \rightarrow FeSO_4 + ...$$

[1]

(ii) Describe how you could remove the excess iron from the mixture formed.

..... [1]

(d) **(i)** Complete the structure of ethanoic acid to show all of the atoms and all of the bonds.

[2]

(ii) Give **one** observation when aqueous ethanoic acid reacts with magnesium.

..... [1]

(e) Black ink contains a mixture of different coloured dyes.

Draw a labelled diagram of the apparatus used to separate these different coloured dyes by chromatography.

[3]

(f) Blue ink was placed at the bottom of a beaker containing water.
After 2 days, a blue colour had spread throughout the beaker.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

[Total: 15]

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4 The table shows the properties of four substances.

substance	boiling point	electrical conductivity of solid	electrical conductivity when molten	density in g/cm^3
aluminium	high	conducts	conducts	2.70
diamond				3.51
potassium bromide	high	does not conduct	conducts	2.75
sulfur	low	does not conduct		2.07

(a) Complete the table to show the electrical conductivity of solid diamond and molten sulfur. [2]

(b) Give **one** piece of evidence from the table that shows that sulfur is a simple covalent substance.

..... [1]

(c) What information in the table shows that potassium bromide is an ionic compound?

.....

..... [2]

(d) **(i)** State **one** property of aluminium given in the table which makes it suitable for making aircraft.

..... [1]

(ii) Aluminium oxide is obtained from the ore bauxite.

What method is used to extract aluminium from aluminium oxide?

..... [1]

(e) Molten potassium bromide can be electrolysed.

Predict the products of this electrolysis at

the positive electrode (anode), ...

the negative electrode (cathode). .....
[2]

(f) **(i)** Which **two** statements describe the structure and bonding in diamond?
Tick **two** boxes.

Diamond has ionic bonds.	☐
Diamond has a giant structure.	☐
Diamond is a simple molecule.	☐
Diamond has covalent bonds.	☐

[1]

(ii) Give **one** use of diamond.

..... [1]

[Total: 11]

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5 Lead is extracted from an ore which contains lead(II) sulfide.

(a) The ore is first heated in air.

Balance the chemical equation for this reaction.

$$2PbS + ...O_2 \rightarrow 2PbO + ...SO_2$$

[2]

(b) The lead(II) oxide produced is then reduced with carbon.

$$PbO + C \rightarrow Pb + CO$$

(i) How does this equation show that the lead(II) oxide is reduced?

..... [1]

(ii) Lead is a metal in Group IV.
Iron is a transition element.

Give **two** physical properties that are typical of transition elements.

1 .....

2 .....
[2]

(c) State the conditions needed for iron to rust.

..... [2]

(d) Iron from the blast furnace is converted into steel using oxygen and basic oxides.

(i) What is the purpose of the oxygen?

..... [1]

(ii) Which **one** of these oxides is a basic oxide?
Put a circle around the correct answer.

carbon dioxide **nitrogen dioxide** **potassium oxide** **sulfur trioxide**

Explain your answer.

.....
[2]

(e) Steel is an alloy.

What is meant by the term *alloy*?

.....

..... [2]

(f) **(i)** Give **one** common use of mild steel.

..... [1]

(ii) Give **one** common use of stainless steel.

..... [1]

[Total: 14]

6 The diagram shows a fractionating column used for the fractional distillation of petroleum.

(a) On the diagram, write
- the letter **X** to show where the temperature in the fractionating column is highest,
- the letter **B** to show where bitumen is removed from the fractionating column.

[2]

(b) Give the name of the fraction labelled **F** in the diagram.

..... [1]

(c) Refinery gas contains methane, ethane and propane.

(i) Draw the structure of a molecule of ethane showing all of the atoms and all of the bonds.

[1]

(ii) Methane can be converted to hydrogen by reaction with steam.

Balance the chemical equation for this reaction.

$$CH_4 + H_2O \rightarrow CO + ...H_2$$

[1]

(iii) This reaction is endothermic.

What is meant by the term *endothermic*?

..... [1]

(d) Some petroleum fractions are cracked to form different hydrocarbons.

Describe the process of cracking.

In your answer
- explain what is meant by the term *cracking*,
- state the conditions needed to crack hydrocarbons.

.....

.....

.....

.....

.....

.....

..... [4]

(e) The table shows some properties of four alkanes.

alkane	number of carbon atoms in one molecule	boiling point / °C
methane	1	–164
ethane	2	–88
propane	3	
butane	4	0

(i) How does the boiling point change as the number of carbon atoms in one molecule increases?

..... [1]

(ii) Predict the boiling point of propane.

..... [1]

(iii) Describe the arrangement and separation of the molecules in liquid butane.

arrangement .....

separation .....
[2]

[Total: 14]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 The table gives information about five particles. The particles are all atoms or ions.

particle	number of protons	number of neutrons	number of electrons
A	6	8	6
B	12	12	12
C	13	14	10
D	8	8	10
E	11	12	11

Answer the following questions using the information in the table.
Each particle may be used once, more than once or not at all.

(a) Which particle, **A**, **B**, **C**, **D** or **E**,

(i) is an atom with atomic number 12,

..... [1]

(ii) is an atom with nucleon number 14,

..... [1]

(iii) is an ion with a positive charge,

..... [1]

(iv) has only **one** electron in its outer shell?

..... [1]

(b) **D** is an ion of an element.

Identify the element and write the formula of **D**.

..... [2]

[Total: 6]

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2 The graph shows how the temperature of a substance changes as it is cooled over a period of 30 minutes. The substance is a gas at the start.

Each letter on the graph may be used once, more than once or not at all.

(a) Which letter, **S**, **T**, **V**, **W**, **X**, **Y** or **Z**, shows when

(i) the particles in the substance have the most kinetic energy,

..... [1]

(ii) the particles in the substance are furthest apart,

..... [1]

(iii) the substance exists as both a gas and a liquid?

..... [1]

(b) Use the graph to estimate the freezing point of the substance.

..... °C [1]

(c) Name the change of state directly from a solid to a gas.

..... [1]

(d) When smoke is viewed through a microscope, the smoke particles in the air appear to jump around.

(i) What term describes this movement of the smoke particles?

..... [1]

(ii) Explain why the smoke particles move in this way.

.....

.....

..... [2]

[Total: 8]

3 **(a)** When magnesium is added to aqueous copper(II) sulfate a reaction occurs.
The ionic equation for the reaction is shown.

$$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$$

(i) Give **one** change you would observe during this reaction.

..... [1]

(ii) Explain why this is a redox reaction.

.....

..... [1]

(iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

.....

..... [2]

(iv) A redox reaction occurs when magnesium is heated with iron(III) oxide.

Write a chemical equation for the reaction between magnesium and iron(III) oxide.

..... [2]

(b) The metal iron and the alloy steel are commonly used materials. A problem with them is that they rust.

(i) How does painting iron and steel prevent rusting?

.....

..... [1]

(ii) Magnesium blocks can be attached to the bottom of steel boats.

Explain how the magnesium blocks prevent the whole of the bottom of the boat from rusting.

.....

.....

.....

..... [2]

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(iii) Replacing the magnesium blocks with copper blocks does not prevent rusting.

Explain why the copper blocks do **not** prevent rusting.

.....

..... [1]

[Total: 10]

4 **(a)** Ethanol, C_2H_5OH, can be made by fermentation.

(i) Complete the chemical equation for the formation of ethanol by fermentation.

$$C_6H_{12}O_6 \rightarrow \text{.....}C_2H_5OH + \text{.....}$$

[2]

(ii) State **two** conditions required for fermentation.

1 .....

2 .....

[2]

(b) Ethanol can also be made by the catalytic hydration of ethene. The equation for the reaction is shown.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(i) Name a suitable catalyst for this reaction.

..... [1]

(ii) Calculate the maximum mass of ethanol that can be made from 56 g of ethene.

maximum mass of ethanol = ... g [2]

(c) Ethanol can be oxidised to form ethanoic acid.

(i) Name a suitable oxidising agent for this reaction.

..... [1]

(ii) A molecule of ethanoic acid has the structure shown.

Complete the dot-and-cross diagram to show the electron arrangement in ethanoic acid. Show outer shell electrons only.

[3]

(d) Ethanoic acid is a weak acid.

(i) When referring to an acid, what is meant by the term *weak*?

.....

..... [1]

(ii) Describe how you could show that ethanoic acid is a weaker acid than hydrochloric acid.

.....

.....

.....

..... [3]

(e) Carboxylic acids react with alcohols to make esters.

The structure of an ester is shown.

Draw the structures of the carboxylic acid and alcohol from which this ester can be made.
Give the names of the carboxylic acid and alcohol.

structure of the carboxylic acid

name of the carboxylic acid .....

structure of the alcohol

name of the alcohol .....
[4]

[Total: 19]

5 **(a)** Solid copper(II) carbonate undergoes thermal decomposition. One of the products of the thermal decomposition is copper(II) oxide.

(i) State the colour change of the solid seen during the reaction.

start colour .....

end colour .....
[1]

(ii) Write a chemical equation for the thermal decomposition of copper(II) carbonate.

..... [1]

(b) Copper(II) carbonate reacts with dilute nitric acid. One of the products of the reaction is a solution of copper(II) nitrate.

(i) Describe tests for copper(II) ions and nitrate ions. Include the results of the tests.

copper(II) ions .....

.....

.....

nitrate ions .....

.....

.....
[4]

(ii) Copper(II) nitrate undergoes thermal decomposition.

Balance the chemical equation for the thermal decomposition of copper(II) nitrate.

$$.....Cu(NO_3)_2 \rightarrow .....CuO + ...NO_2 + ...O_2$$

[1]

(c) Nitrogen dioxide, NO_2, exists in equilibrium with dinitrogen tetroxide, N_2O_4.
Nitrogen dioxide is brown and dinitrogen tetroxide is colourless.

$$\underset{\text{brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{N_2O_4(g)}$$

(i) A sample of nitrogen dioxide and dinitrogen tetroxide at equilibrium was placed in a closed gas syringe.
The syringe plunger was pushed in. This increased the pressure in the gas syringe. The temperature was kept constant.

State how the colour of the gas in the syringe changed. Explain your answer in terms of the position of the equilibrium.

.....

.....

.....

..... [3]

(ii) A sealed tube containing nitrogen dioxide and dinitrogen tetroxide at equilibrium was cooled in an ice bath at constant pressure. The contents of the tube became paler.

Suggest an explanation for this observation in terms of the position of the equilibrium.

.....

.....

..... [2]

[Total: 12]

6 Aluminium is extracted from aluminium oxide by electrolysis.

(a) Why is aluminium **not** extracted by heating aluminium oxide with carbon?

.....

..... [1]

(b) Aluminium oxide is an ionic compound with a high melting point.

(i) Complete the dot-and-cross diagram to show the electron arrangement in **one** of the oxide ions present in aluminium oxide. Include the charge on the oxide ion.
One of the aluminium ions is shown.

[2]

(ii) The melting point of aluminium oxide is above 2000 °C.

Explain why aluminium oxide has a high melting point.

.....

.....

..... [2]

(c) Aluminium can be extracted by electrolysis using the apparatus shown.

(i) Name the type of particle responsible for the transfer of charge in

the wires, ...

the electrolyte. .....
[2]

(ii) Give **two** reasons why cryolite is used.

1 .....

2 .....
[2]

(iii) Write the ionic half-equation for the formation of aluminium during the electrolysis.

..... [1]

(iv) Explain how carbon dioxide gas is formed at the anodes.

.....

.....

..... [3]

(d) When a piece of aluminium is placed in dilute hydrochloric acid, there is no immediate visible reaction.
If the aluminium is left in the dilute hydrochloric acid for several hours, bubbles start to form.

Explain why aluminium does **not** react immediately with dilute hydrochloric acid.

.....

..... [1]

[Total: 14]

Question 7 starts on the next page.

7 Copper(II) oxide reacts with dilute hydrochloric acid.

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

6.00 g of copper(II) oxide were added to 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid. This was an excess of copper(II) oxide.

(a) The rate of the reaction can be increased by increasing the concentration of the hydrochloric acid or by heating it.

(i) In terms of collisions, explain why increasing the concentration of the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

..... [2]

(ii) In terms of collisions, explain why heating the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

..... [2]

(b) **(i)** Calculate the number of moles of copper(II) oxide added to the hydrochloric acid.

moles of copper(II) oxide = ... mol [2]

(ii) Calculate the number of moles of hydrochloric acid used.

moles of hydrochloric acid = ... mol [1]

(iii) Calculate the mass of copper(II) oxide that did **not** react.

mass of copper(II) oxide that did **not** react = ... g [2]

(c) Crystals of hydrated copper(II) chloride were obtained from the solution at the end of the reaction.

The crystals had the following composition by mass: C*l*, 41.52%; Cu, 37.43%; H, 2.34%; O, 18.71%.

Calculate the empirical formula of the crystals.

empirical formula = ... [2]

[Total: 11]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 **H** hydrogen 1										2 **He** helium 4
3 **Li** lithium 7	4 **Be** beryllium 9											5 **B** boron 11	6 **C** carbon 12	7 **N** nitrogen 14	8 **O** oxygen 16	9 **F** fluorine 19	10 **Ne** neon 20
11 **Na** sodium 23	12 **Mg** magnesium 24											13 **Al** aluminium 27	14 **Si** silicon 28	15 **P** phosphorus 31	16 **S** sulfur 32	17 **Cl** chlorine 35.5	18 **Ar** argon 40
19 **K** potassium 39	20 **Ca** calcium 40	21 **Sc** scandium 45	22 **Ti** titanium 48	23 **V** vanadium 51	24 **Cr** chromium 52	25 **Mn** manganese 55	26 **Fe** iron 56	27 **Co** cobalt 59	28 **Ni** nickel 59	29 **Cu** copper 64	30 **Zn** zinc 65	31 **Ga** gallium 70	32 **Ge** germanium 73	33 **As** arsenic 75	34 **Se** selenium 79	35 **Br** bromine 80	36 **Kr** krypton 84
37 **Rb** rubidium 85	38 **Sr** strontium 88	39 **Y** yttrium 89	40 **Zr** zirconium 91	41 **Nb** niobium 93	42 **Mo** molybdenum 96	43 **Tc** technetium –	44 **Ru** ruthenium 101	45 **Rh** rhodium 103	46 **Pd** palladium 106	47 **Ag** silver 108	48 **Cd** cadmium 112	49 **In** indium 115	50 **Sn** tin 119	51 **Sb** antimony 122	52 **Te** tellurium 128	53 **I** iodine 127	54 **Xe** xenon 131
55 **Cs** caesium 133	56 **Ba** barium 137	57–71 lanthanoids	72 **Hf** hafnium 178	73 **Ta** tantalum 181	74 **W** tungsten 184	75 **Re** rhenium 186	76 **Os** osmium 190	77 **Ir** iridium 192	78 **Pt** platinum 195	79 **Au** gold 197	80 **Hg** mercury 201	81 **Tl** thallium 204	82 **Pb** lead 207	83 **Bi** bismuth 209	84 **Po** polonium –	85 **At** astatine –	86 **Rn** radon –
87 **Fr** francium –	88 **Ra** radium –	89–103 actinoids	104 **Rf** rutherfordium –	105 **Db** dubnium –	106 **Sg** seaborgium –	107 **Bh** bohrium –	108 **Hs** hassium –	109 **Mt** meitnerium –	110 **Ds** darmstadtium –	111 **Rg** roentgenium –	112 **Cn** copernicium –		114 **Fl** flerovium –		116 **Lv** livermorium –		

lanthanoids	57 **La** lanthanum 139	58 **Ce** cerium 140	59 **Pr** praseodymium 141	60 **Nd** neodymium 144	61 **Pm** promethium –	62 **Sm** samarium 150	63 **Eu** europium 152	64 **Gd** gadolinium 157	65 **Tb** terbium 159	66 **Dy** dysprosium 163	67 **Ho** holmium 165	68 **Er** erbium 167	69 **Tm** thulium 169	70 **Yb** ytterbium 173	71 **Lu** lutetium 175
actinoids	89 **Ac** actinium –	90 **Th** thorium 232	91 **Pa** protactinium 231	92 **U** uranium 238	93 **Np** neptunium –	94 **Pu** plutonium –	95 **Am** americium –	96 **Cm** curium –	97 **Bk** berkelium –	98 **Cf** californium –	99 **Es** einsteinium –	100 **Fm** fermium –	101 **Md** mendelevium –	102 **No** nobelium –	103 **Lr** lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CENTRE NUMBER						CANDIDATE NUMBER				

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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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1 **(a)** Dust particles in the air move around in a random way.

(i) What term describes the random movement of the dust particles?

..... [1]

(ii) Identify the particles in the air which cause the random movement of the dust particles.

..... [2]

(iii) Explain why the dust particles move in this way.

.....

.....

..... [2]

(b) When chlorine gas, Cl_2, is put into a gas jar, it spreads out to fill the gas jar.

When bromine gas, Br_2, is put into a gas jar, it also spreads out to fill the gas jar.

The process takes longer for bromine gas than for chlorine gas.

(i) What term describes the way that the gas particles spread out?

..... [1]

(ii) Use **data** from the Periodic Table to explain why bromine gas takes longer to fill a gas jar than chlorine gas.

.....

.....

..... [2]

(iii) Explain why increasing the temperature increases the rate at which the gas particles spread out.

.....

..... [1]

[Total: 9]

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2 **(a)** Complete the table to show the electronic structure of the atoms and ions.

	electronic structure
F	2,7
Si	
Ca^{2+}	
N^{3-}	

[3]

(b) Predict the formula of the compound formed between Ca^{2+} and N^{3-}.

..... [1]

(c) Draw a dot-and-cross diagram to show the electron arrangements in the **two** ions present in lithium chloride, LiC*l*.
Show outer shell electrons only. Include the charges on the ions.

[3]

(d) Sulfur dichloride, SCl_2, is a covalent compound. It has the structure C*l*–S–C*l*.

Draw a dot-and-cross diagram to show the electron arrangement in a molecule of sulfur dichloride.
Show outer shell electrons only.

[3]

(e) In terms of attractive forces, explain why $LiCl$ has a higher melting point than SCl_2.

.....

.....

.....

.....

..... [3]

(f) Suggest the identity of a **covalent compound** with a higher melting point than $LiCl$.

..... [1]

[Total: 14]

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3 The chemical equation for the complete combustion of ethanol, C_2H_5OH, is shown.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

The energy released when one mole of ethanol undergoes complete combustion is 1280 kJ.

Part of the energy level diagram for this reaction is shown.

(a) Complete the energy level diagram to show
- the products of the reaction,
- the overall energy change of the reaction.

[3]

(b) What does **X** represent?

..... [1]

(c) The chemical equation for the complete combustion of methanol, CH_3OH, is shown.

$$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$$

The equation can be represented as shown.

Use the bond energies in the table to determine the energy change, ΔH, for the complete combustion of **one** mole of methanol.

bond	bond energy in kJ / mol
C–H	410
C–O	360
O–H	460
O=O	500
C=O	805

- energy needed to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

- energy change, ΔH, for the complete combustion of **one** mole of methanol

..... kJ / mol
[4]

(d) Dodecane is an alkane containing 12 carbon atoms. Ethanol can be manufactured from dodecane in a two-stage process.

In **stage 1**, each molecule of dodecane is converted into three molecules of ethene and one molecule of another hydrocarbon.

(i) Name the process which occurs in **stage 1**.

..... [1]

(ii) Write a chemical equation for the reaction which occurs in **stage 1**.

..... [2]

In **stage 2**, ethene reacts with steam to produce ethanol.

(iii) State **two** conditions needed for **stage 2**.

1 .....

2 .....
[2]

(iv) Name the type of reaction which occurs in **stage 2**.

..... [1]

(v) Suggest how to test the purity of the ethanol produced.

.....

..... [2]

(e) Ethanol can also be manufactured by the fermentation of glucose, $C_6H_{12}O_6$.

(i) State **two** conditions needed for the fermentation of glucose.

1 .....

2 .....
[2]

(ii) Complete the chemical equation for the fermentation of glucose.

$$C_6H_{12}O_6 \rightarrow \text{.....}C_2H_5OH + \text{.....}$$
[2]

(iii) One disadvantage of fermentation is that the maximum concentration of ethanol produced is about 15%.

Suggest why the concentration of ethanol produced by fermentation does **not** exceed 15%.

.....

..... [1]

(iv) Give **one** other disadvantage of manufacturing ethanol by fermentation.

..... [1]

(v) Give **one** advantage, other than cost, of manufacturing ethanol by fermentation.

..... [1]

(vi) Suggest the name of a process to obtain ethanol from a mixture of ethanol and water.

..... [1]

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(f) Ethane-1,2-diol has the following structure.

(i) Write the empirical formula of ethane-1,2-diol.

..... [1]

(ii) Ethane-1,2-diol can undergo condensation polymerisation but cannot undergo addition polymerisation.

Explain why ethane-1,2-diol **cannot** undergo addition polymerisation.

.....

..... [1]

(iii) Ethane-1,2-diol undergoes condensation polymerisation with molecule **Y**.

The diagrams represent the structures of ethane-1,2-diol and molecule **Y**.

ethane-1,2-diol

molecule **Y**

Draw the condensation polymer formed between ethane-1,2-diol and molecule **Y**.
Show **one** repeat unit. Show all of the atoms and all of the bonds in the linkage.

[3]

(iv) Name the type of condensation polymer formed between ethane-1,2-diol and molecule **Y**.

..... [1]

[Total: 30]

4 A student sets up the following electrolysis experiment.

(a) Define the term *electrolysis*.

.....

..... [2]

(b) The student observes bubbles of colourless gas forming at each electrode.

(i) Name the main gas produced at the positive electrode (anode).

..... [1]

(ii) Describe a test for the gas produced in **(b)(i)**.

test .....

result .....
[2]

(iii) Write the ionic half-equation for the reaction taking place at the negative electrode (cathode).

..... [2]

(c) Charge is transferred during electrolysis.

Name the type of particle responsible for the transfer of charge in

the wires, ...

the electrolyte. .....
[2]

(d) The student replaces the dilute aqueous sodium chloride with **concentrated** aqueous sodium chloride.

Suggest **two** differences that the student observes.

1 .....

2 .....
[2]

(e) The student has a small piece of impure copper. The main impurities in the copper are small quantities of silver and zinc.

The student uses electrolysis to extract pure copper from the small piece of impure copper.

(i) Complete the labels on the diagram of the student's electrolysis experiment.

[3]

(ii) Use your knowledge of the reactivity series to suggest what happens to the silver and zinc impurities. Explain your answers.

silver impurities .....

.....

.....

zinc impurities .....

.....

.....
[3]

[Total: 17]

5 Some chemical reactions are reversible.

(a) Aqueous potassium chromate(VI), K_2CrO_4, is a yellow solution.

Aqueous potassium dichromate(VI), $K_2Cr_2O_7$, is an orange solution.

The two compounds interconvert when the pH of the solution changes.

$$\underset{\text{yellow}}{2K_2CrO_4} + H_2SO_4 \rightleftharpoons \underset{\text{orange}}{K_2Cr_2O_7} + K_2SO_4 + H_2O$$

Solution **Y** is a mixture of aqueous potassium chromate(VI) and aqueous potassium dichromate(VI) at equilibrium.

- Explain, in terms of the position of the equilibrium, what you would **see** if sulfuric acid were added to solution **Y**.

  .....

  .....

  .....

- Explain, in terms of the position of the equilibrium, what you would **see** if sodium hydroxide were added to solution **Y**.

  .....

  .....

  .....

  .....

[5]

(b) Hydrogen can be manufactured using a reversible reaction between methane and steam.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

At 900 °C, in the presence of a nickel catalyst, the yield of hydrogen is 70%.

(i) What volume of hydrogen is produced from 100 cm^3 of methane under these conditions?

..... cm^3 [2]

Under different conditions, different yields of hydrogen are obtained.

(ii) If the pressure is increased, the yield of hydrogen becomes less than 70%.

Explain why, in terms of the position of the equilibrium.

.....

..... [1]

(iii) If the temperature is decreased, the yield of hydrogen decreases.

What does this information indicate about the reaction between methane and steam?

..... [1]

(iv) Why is a catalyst used in this reaction?

..... [1]

[Total: 10]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group

I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 12.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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1 Substances can be classified as elements, compounds or mixtures.

State whether each of the following is an element, a compound or a mixture.

(a) brass ..... [1]

(b) gold ..... [1]

(c) butane ..... [1]

(d) air ..... [1]

[Total: 4]

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2 **(a)** **(i)** Define the term *molecule*.

.....

..... [2]

(ii) Define the term *element*.

.....

..... [1]

(b) The table shows the composition of four atoms or ions, **A**, **B**, **C** and **D**.

	number of protons	number of neutrons	number of electrons
A	10	10	10
B	10	12	10
C	12	10	10
D	13	14	10

(i) What is the atomic number of **A**?

..... [1]

(ii) What is the nucleon number of **B**?

..... [1]

(iii) Which of **A**, **B**, **C** and **D** are isotopes of each other?

..... [1]

(iv) Which of **A**, **B**, **C** and **D** are atoms?

..... [1]

(v) Which of **A**, **B**, **C** and **D** are positive ions?

..... [1]

(c) Complete the table.

	number of protons	number of electrons
Na		
S^{2-}		
Cl_2		

[3]

[Total: 11]

3 Iron is extracted from its ore using coke in a blast furnace.

(a) Name the ore of iron which is mainly iron(III) oxide.

..... [1]

(b) Describe the reactions occurring in the blast furnace.

In your answer, include
- **two** reasons for using coke in the blast furnace,
- a chemical equation for the reduction of iron(III) oxide,
- an explanation for using limestone in the blast furnace.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(c) (i) Describe the bonding in iron. Include a diagram in your answer.

.....

..... [3]

(ii) Use your diagram in **(c)(i)** to explain why iron is malleable.

.....

..... [2]

(iii) Iron containing a small amount of carbon is known as steel.

Explain why steel is less malleable than iron.

.....

..... [2]

(d) (i) When iron is added to dilute sulfuric acid, an aqueous solution of iron(II) sulfate is formed as one of the products.

Write a chemical equation for the reaction.

..... [1]

(ii) When iron(III) oxide is added to dilute sulfuric acid, an aqueous solution of iron(III) sulfate is formed as one of the products.

Write a chemical equation for the reaction.

..... [3]

(e) Aqueous sodium hydroxide, aqueous potassium iodide and aqueous acidified potassium manganate(VII) are added to aqueous solutions of iron(II) sulfate and iron(III) sulfate.

- Iron(II) ions, Fe^{2+}, are reducing agents in aqueous solution.
- Iron(III) ions, Fe^{3+}, are oxidising agents in aqueous solution.

Complete the table.

reagent	observations with aqueous iron(II) sulfate	observations with aqueous iron(III) sulfate
aqueous sodium hydroxide	green precipitate	
aqueous potassium iodide		
aqueous acidified potassium manganate(VII)		no change

[4]

[Total: 22]

4 Hydrogen and oxygen react together in a hydrogen fuel cell. A hydrogen fuel cell is shown in the diagram.

(a) Name the process by which oxygen is obtained from air.

..... [1]

(b) **(i)** In a hydrogen fuel cell, the hydrogen molecules are converted into hydrogen ions, H^+, according to the ionic half-equation shown.

$$H_2 \rightarrow 2H^+ + 2e^-$$

What type of reaction does this ionic half-equation represent?

..... [1]

(ii) What **type** of substance reacts by donating hydrogen ions, H^+?

..... [1]

(c) Write a chemical equation for the overall reaction that occurs in a hydrogen fuel cell.

..... [1]

(d) Hydrogen fuel cells are being developed as alternatives to petrol engines in cars.

(i) Give **one** advantage of hydrogen fuel cells compared to petrol engines.

..... [1]

(ii) Give **one** disadvantage of hydrogen fuel cells compared to petrol engines.

..... [1]

(e) Some fuel cells use ethanol, C_2H_5OH, instead of hydrogen. Carbon dioxide and water are products of the reaction in an ethanol fuel cell.

(i) Write a chemical equation for the overall reaction occurring in an ethanol fuel cell.

..... [2]

(ii) State an environmental problem caused by the release of carbon dioxide into the atmosphere.

..... [1]

(iii) Name the process by which ethanol can be manufactured from a renewable resource.

..... [1]

(f) Name the process occurring when electrical energy is used to break down an ionic compound.

..... [1]

[Total: 11]

5 **(a)** **(i)** Name the products formed when sodium nitrate is heated.

..... [2]

(ii) When copper(II) nitrate, $Cu(NO_3)_2$, undergoes thermal decomposition, three products are formed. One of the products is nitrogen dioxide, NO_2.

Write a chemical equation for the thermal decomposition of copper(II) nitrate.

..... [2]

(b) The chemical equation shows the equilibrium between dinitrogen tetroxide (N_2O_4, a colourless gas) and nitrogen dioxide (NO_2, a brown gas).

$$\underset{\text{colourless}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown}}{2NO_2(g)}$$

A mixture of dinitrogen tetroxide and nitrogen dioxide is allowed to reach equilibrium in a closed gas syringe.

(i) In chemistry, what is meant by the term *equilibrium*?

.....

.....

..... [2]

(ii) If the equilibrium mixture is heated at constant pressure, a darker brown colour is seen inside the gas syringe.

What does this information indicate about the decomposition of dinitrogen tetroxide?
Explain your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

(iii) Suggest what you would see if the pressure on the equilibrium mixture were increased at constant temperature.
Explain your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

[Total: 10]

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6 **(a)** Alkanes and alkenes are two homologous series of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

..... [1]

(ii) What is the general formula of the homologous series of

alkanes, ...

alkenes? .....
[2]

(iii) Other than having a general formula, state **two** characteristics of a homologous series.

1 .....

2 .....
[2]

(iv) The structure of an alkene molecule with the molecular formula C_4H_8 is shown.

Draw the structure of a different alkene molecule with the molecular formula C_4H_8. Show all of the atoms and all of the bonds.

[1]

(v) What term describes molecules with the same molecular formula but different structural formulae?

..... [1]

(b) 25 cm^3 of a gaseous hydrocarbon, C_xH_y, were burnt in 150 cm^3 of oxygen. This was an excess of oxygen.

After cooling, the volume of the gases remaining was 100 cm^3. This consisted of 75 cm^3 of carbon dioxide and 25 cm^3 of unreacted oxygen. The water that was produced in the reaction was liquid.

All volumes were measured at the same temperature and pressure.

(i) What is meant by an *excess* of oxygen?

..... [1]

(ii) What was the volume of oxygen that reacted with the hydrocarbon?

..... cm^3 [1]

(iii) Complete the table to show the smallest whole number ratio of volumes.

	volume of hydrocarbon reacted	:	volume of oxygen reacted	:	volume of carbon dioxide produced
smallest whole number ratio of volumes		:		:	

[1]

(iv) Use your answer to **(b)(iii)** to balance the chemical equation. Deduce the formula of the hydrocarbon.

$$C_xH_y(g) + ...O_2(g) \rightarrow .....CO_2(g) + ...H_2O(l)$$

formula of the hydrocarbon = ... [2]

[Total: 12]

7 **(a)** Carbon and silicon are elements in Group IV of the Periodic Table.
Carbon dioxide from the air moves into green plants and is converted into carbohydrates.

(i) Name the process by which carbon dioxide molecules move through the air into green plants.

..... [1]

(ii) Explain why silicon(IV) oxide **cannot** move through the air in the same way that carbon dioxide can.

..... [1]

(iii) Name the process by which carbon dioxide is converted into glucose, $C_6H_{12}O_6$, in green plants. Give **two** conditions required for this process to occur. Write a chemical equation for the reaction which occurs.

name of process .....

condition 1 .....

condition 2 .....

chemical equation .....
[5]

(b) Starch is a natural polymer made from glucose.

(i) What type of polymerisation occurs when glucose is converted into starch?

..... [1]

(ii) What type of reaction occurs when starch is converted into glucose?

..... [1]

(iii) Starch can be represented as shown.

Complete the diagram below to represent the structure of the glucose monomer.

[1]

[Total: 10]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

8318292337

CHEMISTRY **0620/51**

Paper 5 Practical Test **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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Total	

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1 You are going to investigate what happens to the temperature when two different solids, **W** and **X**, dissolve in water.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to carry out two experiments.

(a) *Experiment 1*

- Put the polystyrene cup into the 250 cm^3 beaker for support.
- Use the measuring cylinder to pour 30 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the water and record it in the table at time = 0 seconds.
- Add all of solid **W** to the water, start the timer and stir the solution continuously with the thermometer.
- Measure the temperature of the solution every 10 seconds for 90 seconds.
- Record your results in the table.

time / s	0	10	20	30	40	50	60	70	80	90
temperature of the solution / °C										

[2]

(b) *Experiment 2*

- Empty the polystyrene cup and rinse it with water. Put the polystyrene cup back into the 250 cm^3 beaker.
- Use a measuring cylinder to pour 30 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the water and record it in the table at time = 0 seconds.
- Add all of solid **X** to the water, start the timer and stir the solution continuously with the thermometer.
- Measure the temperature of the solution every 10 seconds for 90 seconds.
- Record your results in the table.

time / s	0	10	20	30	40	50	60	70	80	90
temperature of the solution / °C										

[2]

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(c) Plot your results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your lines.

[4]

(d) **(i)** **From your graph**, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the time taken for the temperature of the solution in Experiment 2 to change by 6 °C from the initial temperature.
Show clearly **on the grid** how you worked out your answer.

..... s [2]

(e) Use your results to identify the type of energy change that occurs when solid **X** dissolves in water.

..... [1]

(f) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

.....

..... [1]

(g) State **two** sources of error in these experiments. Give **one** improvement to reduce each of these sources of error.

source of error 1 .....

improvement 1 .....

source of error 2 .....

improvement 2 .....
[4]

(h) When carrying out the experiments, what would be a disadvantage of taking the temperature readings only every 30 seconds?

.....

..... [1]

[Total: 19]

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Question 2 starts on the next page.

2 You are provided with two solutions, **Y** and **Z**.
Carry out the following tests on the solutions, recording all of your observations at each stage.

tests on solution Y

Divide the solution into two equal portions in two test-tubes.

(a) Describe the appearance of solution **Y**.

..... [1]

(b) (i) Add a few drops of aqueous sodium hydroxide to the first portion of solution **Y** and shake the test-tube to mix the solutions.
Record your observations.

..... [2]

(ii) Now add an excess of aqueous sodium hydroxide to the mixture.
Record your observations.

..... [1]

(iii) Pour the mixture from **(b)(ii)** into a boiling tube and add a small piece of aluminium foil. Heat the mixture carefully. Test the gas produced with indicator paper.
Record your observations.

.....

..... [2]

Keep the second portion of solution **Y** for the test in **(e)**.

tests on solution Z

Divide the solution into three equal portions in three test-tubes.

(c) Test the pH of the first portion of solution **Z**.
Record your observations.

..... [1]

(d) **(i)** Add a few drops of aqueous copper(II) sulfate to the second portion of solution **Z**.
Record your observations.

..... [1]

(ii) Now add an excess of aqueous copper(II) sulfate to the mixture.
Record your observations.

..... [2]

(e) To the third portion of solution **Z**, add the second portion of solution **Y**.
Record your observations.

..... [2]

(f) Identify solution **Y**.

..... [2]

(g) Identify solution **Z**.

..... [1]

[Total: 15]

3 Washing soda crystals are crystals of hydrated sodium carbonate, $Na_2CO_3.10H_2O$. When exposed to the air, some of the water is lost from the crystals and a new substance is formed. This process occurs faster in hotter climates.

Plan an experiment to determine the percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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* 2 9 0 8 8 4 5 9 8 4 *

CHEMISTRY **0620/52**

Paper 5 Practical Test **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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CAMBRIDGE International Examinations

1 You are going to investigate what happens when two different solids, **S** and **T**, dissolve in water.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to carry out two experiments.

(a) *Experiment 1*

- Put the polystyrene cup into the 250 cm^3 beaker for support.
- Use the measuring cylinder to pour 30 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the water and record it in the first row of the table.
- Add the 2.0 g sample of solid **S** to the polystyrene cup and stir the solution with the thermometer.
- Measure and record the **maximum** temperature of the solution.
- Pour the solution away and rinse out the polystyrene cup with distilled water.

- Repeat the procedure using the 3.0 g sample of solid **S**. Record your results in the appropriate row of the table.
- Repeat the procedure using the 5.0 g sample of solid **S**. Record your results in the appropriate row of the table.

mass of solid **S** / g	initial temperature of the water / °C	maximum temperature of the solution / °C
2.0		
3.0		
5.0		

[2]

(b) *Experiment 2*

- Put the polystyrene cup into the 250 cm^3 beaker for support.
- Use the measuring cylinder to pour 30 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the water and record it in the first row of the table.
- Add the 2.0 g sample of solid **T** to the polystyrene cup and stir the solution with the thermometer.
- Measure and record the **minimum** temperature of the solution.
- Pour the solution away and rinse out the polystyrene cup with distilled water.

- Repeat the procedure using the 3.0 g sample of solid **T**.
- Repeat the procedure using the 4.0 g sample of solid **T**.
- Repeat the procedure using the 6.0 g sample of solid **T**.
- Record your results in the appropriate rows of the table.

mass of solid **T** / g	initial temperature of the water / °C	minimum temperature of the solution / °C
2.0		
3.0		
4.0		
6.0		

[2]

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(c) Plot your results for Experiment 1 (maximum temperature) and Experiment 2 (minimum temperature) on the grid. Draw **two** straight lines of best fit.
Clearly label your lines.

[4]

(d) (i) **From your graph**, deduce the maximum temperature of the solution if 6.0 g of solid **S** were added to 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the minimum temperature of the solution if 4.5 g of solid **T** were added to 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) Use your results to identify the type of energy change that occurs when solid **S** dissolves in water.

..... [1]

(f) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change .....

explanation .....

.....
[2]

(g) Suggest how the reliability of the results could be checked.

..... [1]

(h) Explain how the temperatures measured would be different if Experiment 1 were repeated using 60 cm^3 of distilled water in each case.

.....

..... [2]

[Total: 18]

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Question 2 starts on the next page.

2 You are provided with two solid salts, **U** and **W**.
Carry out the following tests on solid **U** and solid **W**, recording all of your observations at each stage.

tests on solid U

(a) Describe the appearance of solid **U**.

..... [1]

Add about half of solid **U** to about 5 cm^3 of distilled water in a test-tube. Stopper the test-tube and shake it to dissolve solid **U** and form solution **U**.

Divide solution **U** into two equal portions in two test-tubes and carry out the following tests.

(b) To the first portion of solution **U**, add about 1 cm^3 of dilute hydrochloric acid.
Test the gas produced.
Record your observations.

.....

..... [3]

Keep the second portion of solution **U** for the test in **(g)(i)**.

(c) Identify the gas produced in **(b)**.

..... [1]

(d) Carry out a flame test on solid **U**.
Record your observations.

..... [1]

(e) Identify solid **U**.

..... [2]

tests on solid W

Add about half of solid **W** to about 5 cm^3 of distilled water in a test-tube. Stopper the test-tube and shake it to dissolve solid **W** and form solution **W**.

Divide solution **W** into two equal portions in two test-tubes and carry out the following tests.

(f) To the first portion of solution **W**, add a few drops of dilute nitric acid and about 1 cm^3 of aqueous silver nitrate.
Record your observations.

..... [2]

(g) **(i)** To the second portion of solution **W**, add the second portion of solution **U**.
Record your observations.

..... [2]

(ii) Now add an excess of dilute hydrochloric acid to the mixture from **(g)(i)**.
Record your observations.

..... [2]

(h) What conclusions can you draw about solid **W**?

.....

..... [2]

[Total: 16]

3 When iron nails rust, the mass of the nails increases.
Plan an experiment to investigate if iron nails rust more quickly in tap water or in distilled water.
You are provided with new iron nails and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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CENTRE NUMBER						CANDIDATE NUMBER				

4303035995

CHEMISTRY **0620/53**

Paper 5 Practical Test **October/November 2017**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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CAMBRIDGE International Examinations

1 You are going to investigate what happens to the temperature when two different solids, **W** and **X**, dissolve in water.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to carry out two experiments.

(a) *Experiment 1*

- Put the polystyrene cup into the 250 cm^3 beaker for support.
- Use the measuring cylinder to pour 30 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the water and record it in the table at time = 0 seconds.
- Add all of solid **W** to the water, start the timer and stir the solution continuously with the thermometer.
- Measure the temperature of the solution every 10 seconds for 90 seconds.
- Record your results in the table.

time / s	0	10	20	30	40	50	60	70	80	90
temperature of the solution / °C										

[2]

(b) *Experiment 2*

- Empty the polystyrene cup and rinse it with water. Put the polystyrene cup back into the 250 cm^3 beaker.
- Use a measuring cylinder to pour 30 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the water and record it in the table at time = 0 seconds.
- Add all of solid **X** to the water, start the timer and stir the solution continuously with the thermometer.
- Measure the temperature of the solution every 10 seconds for 90 seconds.
- Record your results in the table.

time / s	0	10	20	30	40	50	60	70	80	90
temperature of the solution / °C										

[2]

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(c) Plot your results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your lines.

[4]

(d) **(i)** **From your graph**, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the time taken for the temperature of the solution in Experiment 2 to change by 6 °C from the initial temperature.
Show clearly **on the grid** how you worked out your answer.

..... s [2]

(e) Use your results to identify the type of energy change that occurs when solid **X** dissolves in water.

..... [1]

(f) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

.....

..... [1]

(g) State **two** sources of error in these experiments. Give **one** improvement to reduce each of these sources of error.

source of error 1 .....

improvement 1 .....

source of error 2 .....

improvement 2 .....
[4]

(h) When carrying out the experiments, what would be a disadvantage of taking the temperature readings only every 30 seconds?

.....

..... [1]

[Total: 19]

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Question 2 starts on the next page.

2 You are provided with two solutions, **Y** and **Z**.
Carry out the following tests on the solutions, recording all of your observations at each stage.

tests on solution Y

Divide the solution into two equal portions in two test-tubes.

(a) Describe the appearance of solution **Y**.

..... [1]

(b) (i) Add a few drops of aqueous sodium hydroxide to the first portion of solution **Y** and shake the test-tube to mix the solutions.
Record your observations.

..... [2]

(ii) Now add an excess of aqueous sodium hydroxide to the mixture.
Record your observations.

..... [1]

(iii) Pour the mixture from **(b)(ii)** into a boiling tube and add a small piece of aluminium foil. Heat the mixture carefully. Test the gas produced with indicator paper.
Record your observations.

.....

..... [2]

Keep the second portion of solution **Y** for the test in **(e)**.

tests on solution Z

Divide the solution into three equal portions in three test-tubes.

(c) Test the pH of the first portion of solution **Z**.
Record your observations.

..... [1]

(d) **(i)** Add a few drops of aqueous copper(II) sulfate to the second portion of solution **Z**.
Record your observations.

..... [1]

(ii) Now add an excess of aqueous copper(II) sulfate to the mixture.
Record your observations.

..... [2]

(e) To the third portion of solution **Z**, add the second portion of solution **Y**.
Record your observations.

..... [2]

(f) Identify solution **Y**.

..... [2]

(g) Identify solution **Z**.

..... [1]

[Total: 15]

3 Washing soda crystals are crystals of hydrated sodium carbonate, $Na_2CO_3.10H_2O$. When exposed to the air, some of the water is lost from the crystals and a new substance is formed. This process occurs faster in hotter climates.

Plan an experiment to determine the percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2017**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 A student reacted dilute hydrochloric acid with zinc oxide to prepare zinc chloride solution. The diagram shows part of the procedure.

(a) Complete the box to name the apparatus. [1]

(b) Which of the reactants was in excess?

..... [1]

(c) **(i)** Name the separation process this apparatus is used for.

..... [1]

(ii) Suggest why this apparatus would **not** work.

.....

..... [1]

(d) Describe how crystals of zinc chloride could be obtained from the zinc chloride solution.

.....

.....

..... [3]

[Total: 7]

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2 A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were carried out using the apparatus shown.

Experiment 1

- Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate were poured into a conical flask. The initial temperature of the solution was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm^3 of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 2

- Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate were poured into a conical flask. The solution was heated to about **30 °C** and the temperature was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm^3 of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 3

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **40 °C** before adding the dilute hydrochloric acid.

Experiment 4

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **50 °C** before adding the dilute hydrochloric acid.

Experiment 5

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **60 °C** before adding the dilute hydrochloric acid.

(a) Calculate the average temperatures and record them in the table.
Use the stopclock diagrams to record the times in the table.

experiment number	initial temperature of the solution / °C	final temperature of the mixture / °C	average temperature / °C	stopclock diagram	time taken for the printed words to disappear from view / s
1	19	17			
2	32	30			
3	42	40			
4	54	52			
5	65	61			

[3]

(b) Plot the results of Experiments 1–5 on the grid. Draw a smooth line graph.

[4]

(c) **From your graph**, deduce the time taken for the printed words to disappear from view when Experiment 2 was repeated at an initial temperature of 73 °C. The final temperature of the mixture was 71 °C.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) Sketch **on the grid** the graph you would expect if all of the experiments were repeated using a more dilute solution of aqueous sodium thiosulfate. [1]

(e) **(i)** In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

.....

..... [2]

(f) Suggest and explain the effect on the results of using

(i) a burette to measure the volumes,

.....

.....

..... [2]

(ii) a 100 cm^3 conical flask instead of a 250 cm^3 conical flask.

.....

.....

..... [2]

[Total: 18]

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3 Two solid salts, **F** and **G**, were analysed. Solid **F** was iron(III) nitrate.
Tests were carried out on each solid.

tests on solid F

Complete the expected observations.

Solid **F** was dissolved in distilled water to produce solution **F**. Solution **F** was divided into three equal portions in three test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution **F** until a change was seen.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture from **(a)(i)**.

observations ..... [1]

(b) An excess of aqueous ammonia was added to the second portion of solution **F** until a change was seen.

observations ..... [1]

(c) Aluminium foil and aqueous sodium hydroxide were added to the third portion of solution **F**. The mixture was heated and the gas which was produced was tested.

test for gas .....

test result .....
[2]

(d) Identify the gas produced in **(c)**.

..... [1]

tests on solid G

Tests were carried out and the following observations made.

tests on solid **G**	observations
test 1 A flame test was carried out on solid **G**.	red colour
test 2 Dilute nitric acid was added to solid **G**. The gas produced was passed through limewater.	rapid effervescence limewater turned milky

(e) Identify solid **G**.

..... [2]

[Total: 9]

4 Iron, tin and zinc all react with dilute hydrochloric acid to produce hydrogen.
Plan an experiment to determine the order of reactivity of iron, tin and zinc.
You are provided with powdered samples of the metals and common laboratory apparatus.

.....

.....

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.....

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.....

.....

.....

.....

..... [6]

[Total: 6]

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **October/November 2017**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

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Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 Some magnesium ribbon was cleaned.
Steam was then passed over the magnesium ribbon as it was heated, using the apparatus shown.

(a) What liquid is absorbed on the mineral wool?

..... [1]

(b) **(i)** Use **two** arrows to show **two** places where heat is applied. [1]

(ii) Complete the box to name the apparatus. [1]

(c) Suggest how the magnesium ribbon was cleaned.

..... [1]

(d) **(i)** Complete the diagram to show how the hydrogen produced could be collected and its volume measured. Label your diagram. [2]

(ii) State the effect of a lighted splint on the hydrogen produced.

..... [1]

(e) Suggest why the tube containing the magnesium cracks after the reaction.

.....

..... [1]

[Total: 8]

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2 A student investigated what happened when two different solids, **S** and **T**, dissolved in water.

Two experiments were carried out.

Experiment 1

- Using a measuring cylinder, 30 cm^3 of distilled water were poured into a polystyrene cup. The initial temperature of the water was measured.
- 2.0 g of solid **S** were added to the polystyrene cup and the solution was stirred with a thermometer.
- The **maximum** temperature of the solution was measured.
- The solution was poured away and the polystyrene cup was rinsed out with distilled water.

- The procedure was repeated using 3.0 g of solid **S**.
- The procedure was repeated using 5.0 g of solid **S**.

(a) Use the thermometer diagrams to record the temperatures in the table.

mass of solid **S** / g	thermometer diagram	initial temperature of the water / °C	thermometer diagram	maximum temperature of the solution / °C
2.0				
3.0				
5.0				

[2]

Experiment 2

- Experiment 1 was repeated using 2.0 g, 3.0 g, 4.0 g and 6.0 g of solid **T**. The **minimum** temperature of the solution was measured in each case.

(b) Use the thermometer diagrams to record the temperatures in the table.

mass of solid **T** / g	thermometer diagram	initial temperature of the water / °C	thermometer diagram	minimum temperature of the solution / °C
2.0				
3.0				
4.0				
6.0				

[2]

(c) Plot the results of Experiment 1 (maximum temperature) and Experiment 2 (minimum temperature) on the grid. Draw **two** straight lines of best fit.
Clearly label your lines.

[4]

(d) (i) **From your graph**, deduce the maximum temperature of the solution if 6.0 g of solid **S** were added to 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the minimum temperature of the solution if 4.5 g of solid **T** were added to 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) Use the results to identify the type of energy change that occurs when solid **S** dissolves in water.

..... [1]

(f) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change .....

explanation .....

.....
[2]

(g) Suggest how the reliability of the results could be checked.

..... [1]

(h) Explain how the temperatures measured would be different if Experiment 1 were repeated using 60 cm^3 of distilled water in each case.

.....

..... [2]

[Total: 18]

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3 Two solid salts, **U** and **W**, were analysed. Solid **U** was sodium carbonate.
Tests were carried out on each solid.

tests on solid U

Complete the expected observations.

(a) Describe the appearance of solid **U**.

..... [1]

About half of solid **U** was dissolved in distilled water to produce solution **U**. Solution **U** was divided into two equal portions in two test-tubes.

(b) Dilute hydrochloric acid was added to the first portion of solution **U**.
The gas produced was tested.

observations .....

..... [3]

(c) Name the gas produced in **(b)**.

..... [1]

(d) A flame test was carried out on solid **U**.

observations ..... [1]

tests on solid W

Tests were carried out and the following observations made.

tests on solid **W**	observations
Appearance of solid **W**.	white crystals
Solid **W** was dissolved in distilled water to produce solution **W**. The solution was divided into two equal portions in two test-tubes. **test 1** Dilute nitric acid and aqueous silver nitrate were added to the first portion of solution **W**.	white precipitate formed
test 2 The second portion of solution **U** was added to the second portion of solution **W**. An excess of dilute hydrochloric acid was then added to the mixture.	white precipitate formed rapid effervescence white precipitate dissolved

(e) What conclusions can you draw about solid **W**?

..... [2]

[Total: 8]

4 When iron nails rust, the mass of the nails increases.
Plan an experiment to investigate if iron nails rust more quickly in tap water or in distilled water.
You are provided with new iron nails and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **October/November 2017**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

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1 Cerussite is a lead ore which contains lead(II) carbonate. A student obtained a solution of lead(II) nitrate from cerussite using the apparatus shown.

(a) Complete the boxes to name the apparatus. [2]

(b) Why was the cerussite crushed in **step 1**?

..... [1]

(c) Name the dilute acid used in **step 2**.

..... [1]

(d) What is the general name given to an insoluble solid left on a filter paper after filtration?

..... [1]

(e) Suggest how a sample of lead could be obtained from the solution of lead(II) nitrate.

.....

.....

.....

..... [2]

[Total: 7]

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Question 2 starts on the next page.

2 A student investigated what happened to the temperature when two different solids, **W** and **X**, dissolved in water.

Two experiments were carried out.

Experiment 1

- Using a measuring cylinder, 30 cm^3 of distilled water were poured into a polystyrene cup. The initial temperature of the water was measured at time = 0 seconds.
- Solid **W** was added to the water, a timer was started and the solution was stirred with a thermometer.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(a) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	10	20	30	40	50	60	70	80	90
thermometer diagram										
temperature of the solution / °C										

[2]

Experiment 2

- The polystyrene cup was emptied and rinsed with water.
- Experiment 1 was repeated using solid **X**.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(b) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	10	20	30	40	50	60	70	80	90
thermometer diagram										
temperature of the solution / °C										

[2]

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(c) Plot the results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your lines.

[4]

(d) (i) **From your graph**, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the time taken for the temperature of the solution in Experiment 2 to change by 6 °C from the initial temperature.
Show clearly **on the grid** how you worked out your answer.

..... s [2]

(e) Use the results to identify the type of energy change that occurs when solid **X** dissolves in water.

..... [1]

(f) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

.....

..... [1]

(g) State **two** sources of error in these experiments. Give **one** improvement to reduce each of these sources of error.

source of error 1 .....

improvement 1 .....

source of error 2 .....

improvement 2 .....
[4]

(h) When carrying out the experiments, what would be a disadvantage of taking the temperature readings only every 30 seconds?

.....

..... [1]

[Total: 19]

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3 Two solutions, **Y** and **Z**, were analysed.
Solution **Y** was aqueous chromium(III) nitrate.
Tests were carried out on both solutions.

tests on solution Y

Complete the expected observations.

The solution was divided into two equal portions in two test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution **Y** and the test-tube shaken to mix the solutions.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture.

observations ..... [1]

(iii) The mixture from **(a)(ii)** was poured into a boiling tube and a small piece of aluminium foil was added.
The mixture was heated and the gas produced was tested.

observations .....

..... [3]

(b) Identify the gas produced in **(a)(iii)**.

..... [1]

tests on solution Z

Tests were carried out and the following observations made.

tests on solution **Z**	observations
Solution **Z** was divided into three equal portions in three test-tubes. **test 1** The pH of the first portion of solution **Z** was tested.	pH 10
test 2 A few drops of aqueous copper(II) sulfate were added to the second portion of solution **Z**. An excess of aqueous copper(II) sulfate was then added to the mixture.	dark blue solution formed light blue precipitate formed
test 3 The second portion of solution **Y** was added to the third portion of solution **Z**.	grey-green precipitate formed

(c) Identify solution **Z**.

..... [1]

[Total: 8]

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4 Washing soda crystals are crystals of hydrated sodium carbonate, $Na_2CO_3.10H_2O$. When exposed to the air, some of the water is lost from the crystals and a new substance is formed. This process occurs faster in hotter climates.

Plan an experiment to determine the percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Paper 0620/12
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**A**
2	**B**	22	**A**
3	**C**	23	**B**
4	**D**	24	**A**
5	**B**	25	**A**
6	**C**	26	**B**
7	**C**	27	**C**
8	**A**	28	**B**
9	**C**	29	**C**
10	**A**	30	**C**
11	**C**	31	**A**
12	**A**	32	**B**
13	**B**	33	**C**
14	**B**	34	**D**
15	**B**	35	**D**
16	**A**	36	**B**
17	**B**	37	**C**
18	**B**	38	**A**
19	**C**	39	**B**
20	**D**	40	**B**

General comments

Performance on the paper was generally good; some candidates found parts of the paper more difficult.

Candidates found **Questions 26** and **29** straightforward. **Questions 8**, **18** and **24** were more challenging for many candidates.

Comments on specific questions

The following responses were common wrong answers to the questions listed.

Question 1

Response **A** – Candidates were unsure of the meaning of condensation and sublimation.

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Question 12

Response **C** – Candidates knew that the reaction would speed up but did not realise that the loss of carbon dioxide results in mass decrease.

Question 18

Response **C** – This response was far more popular than the correct response. Candidates did not realise that copper metal does not react with dilute sulfuric acid.

Question 19

Response **B** – Candidates knew that the proton number was used to order elements but were unclear about the trends in each group.

Question 24

Response **B** – This response was much more popular than the correct one. Candidates correctly used the reaction with acid but did not know the effect of reactivity on the stability of metal oxides when heated with carbon.

Question 30

Response **A** – Candidates did not know that argon was present in the air and many did not recognise the significance of the word ‘clean’.

Question 31

Response **D** – Candidates recognised two compounds that are fertilisers but did not realise that phosphorus was necessary.

Question 34

Response **C** – Candidates correctly ignored the neutral plot but did not always understand the relationship between pH and acidity.

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CHEMISTRY

Paper 0620/22
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**C**
2	**C**	22	**A**
3	**B**	23	**D**
4	**C**	24	**B**
5	**A**	25	**C**
6	**A**	26	**B**
7	**A**	27	**C**
8	**C**	28	**C**
9	**C**	29	**C**
10	**B**	30	**D**
11	**C**	31	**A**
12	**A**	32	**B**
13	**B**	33	**B**
14	**C**	34	**D**
15	**B**	35	**A**
16	**A**	36	**D**
17	**C**	37	**C**
18	**A**	38	**A**
19	**B**	39	**D**
20	**B**	40	**B**

General comments

Candidates performed well on this paper.

Most candidates found **Questions 3**, **4**, **18**, **24**, **27**, **29**, **32** and **36** straightforward. **Question 20** was challenging for many candidates.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 9

Response **B** – Candidates did not realise that when copper electrodes are used the anode dissolves away and no gas is released. This reaction is the basis of copper refining.

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Question 15

Response **D** – Many candidates were not familiar with the reactions of silver halides in light.

Question 16

Response **C** – Candidates knew that the energy of molecules increases but did not realise that this also means they move faster and so collide more frequently.

Question 20

Response **C** – This response was more popular than the correct one. Candidates did not realise that copper metal does not react with dilute sulfuric acid.

Question 21

Response **D** – Candidates knew that the proton number was used to order the elements but were unclear about the trends of melting points in the two groups.

Question 23

Response **C** – Candidates knew the trend in reactivity in Group I but not in Group VII.

Question 25

Response **B** – Candidates were looking for a reaction which showed the extraction of aluminium and many did not realise that the answer chosen does not occur in the extraction of aluminium.

Question 28

Response **B** – Many candidates chose –153 as the lowest boiling point when in fact, it is the highest.

Question 34

Response **C** – Candidates correctly ignored the neutral plot but did not always understand the relationship between pH and acidity.

Question 40

Response **A** – This response was more popular than the correct one. Many candidates did not check that the correct groups were opposite each other.

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CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

- Many candidates need more practice in memorising qualitative tests for specific ions and molecules.
- Some candidates would benefit from improving their knowledge of specific chemical terms. The terms mixture, compound, elements and molecule were often used interchangeably.
- Some candidates need more practice in answering questions requiring free response and in organising their work. Candidates should take note of each bullet point in a question to ensure that all relevant points have been answered.
- A few candidates selected more than one answer for a question and so could not gain credit.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. The standard of English was generally good. A few of the questions were left unanswered by a minority of candidates.

Some candidates need more practice in writing answers with the correct amount of detail for core level. Some candidates disadvantaged themselves by including material from the supplement. For example, in **Questions 2(c)(i)** and **6(b)(iii)** answering the questions about oxidation and reduction in terms of either electron loss/gain or change in oxidation number often led to incorrect answers. In contrast, some candidates wrote too much and repeated themselves, sometimes resulting in writing contradictory statements. For example, in **Question 7(a)** some candidates first wrote that water is a product of the reaction of calcium oxide with acid and then wrote in another place that the product was hydrogen.

Many candidates needed to show a better understanding of qualitative tests for specific ions and molecules. The answers to the questions about the tests for oxygen (**1(c)**), chloride ions (**2(a)(iv)**) and carbonate ions (**8(b)(ii)**) were often incorrect.

Many candidates were able to extract information from tables and balance symbol equations.

Questions involving general Chemistry including, electrolysis, atomic structure and many aspects of simple organic chemistry were answered well by many candidates.

Comments on specific questions

Question 1

(a) (i) Many candidates identified oxygen as a diatomic molecule. The most common error was to suggest the interhalogen compound (compound **D**). Compound **C** (carbon dioxide), was also a common error.

(ii) A majority of the candidates correctly identified sodium bromide. The most common error was to suggest compound **B** (dibromoethane).

(iii) A majority of the candidates recognised that oxygen is an element. The most common errors were to suggest either compound **A** (sodium bromide) or compound **B** (dibromoethane).

(iv) Nearly all the candidates recognised that carbon dioxide is a product of respiration. The most common incorrect answer was substance **E** (oxygen).

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(v) This was the least well answered question in **(a)**. The most common incorrect answers were to suggest either compound **B** (dibromoethane) or the interhalogen compound (compound **D**).

(b) Most candidates gained at least partial credit. The most common errors were: 17 protons; 8 or 17 neutrons; 9 electrons. A few candidates added the atomic number to the mass number when calculating the number of neutrons.

(c) Stronger responses described the correct test for oxygen involving the relighting of a glowing splint. However, many just mentioned the use of either a splint (unqualified) or a lighted splint. Others reversed the test and suggested that a lighted splint glows. Many suggested the use of a flame test or litmus.

Question 2

(a) (i) A majority of candidates calculated the relative molecular mass of ethanol correctly. The most common errors related to the use of atomic numbers rather than atomic masses or to some type of mole calculation involving the relative atomic mass of calcium. The most common of these incorrect answers was 6.4 mg obtained by $(20 \times 40) \div 125$.

(ii) Many candidates correctly identified potassium ions. The most common error was to suggest calcium ions. A significant number of candidates suggested substances that did not appear in the table, e.g. lithium ions, water.

(iii) Some candidates gave the correct name (magnesium sulfate). Others either gave the formula or gave incorrect names. The most common of these was magnesium sulfur oxide. A small number of candidates ignored the sulfur and incorrectly suggested that the compound was magnesium oxide.

(iv) A minority of candidates gave a completely correct description of a test for chloride ions. Some confused this test with the test for chlorine and suggested the use of litmus paper. Others suggested that a flame test be used. Many did not mention the use of nitric acid or gave the wrong acid, often hydrochloric acid. Another incorrect test reagent often given was sodium hydroxide.

(b) (i) A majority of the candidates identified the carboxylic acid group correctly. The most common error was to circle only the C=O group.

(ii) Some candidates deduced the correct formula of lactic acid. A significant number of candidates did not count the atoms correctly. The most common errors were either to reduce the number of carbon or hydrogen atoms by one, e.g. $C_2H_6O_3$ or to write a partial molecular formula, e.g. $C_3H_5O_2OH$.

(c) (i) Some candidates gave a good explanation of reduction in terms of removal of oxygen. Others gave a correct explanation in terms of gain of electrons. A significant number of candidates who chose the electron route incorrectly suggested that electrons are lost. Many candidates gave answers which were too vague or confusing, e.g. ‘to decrease the number of something’ or ‘reduction of oxygen’.

(ii) Many candidates calculated the relative molecular mass of ethanol correctly. The most common errors involved either incorrect addition or the use of atomic number instead of atomic mass.

Question 3

(a) Many candidates gained at least partial credit for this question. Some candidates gave well-written answers mentioning diffusion and including the (overall) movement of particles from a higher concentration to a lower concentration. However, others made vague statements about the colour spreading out or the iodine dissolving without mentioning particles. Some candidates only wrote about the process of dissolving and did not mention the spreading of the particles throughout the liquid.

(b) (i) This was answered well by many candidates and most gained at least partial credit. The most common error was to give an incorrect value for the melting point, usually above –7°C. A few candidates did not respond to this question.

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(ii) Many candidates suggested that fluorine is lighter in colour intensity than chlorine but few gave the correct trend in colour of the halogens. The most common errors were either trying to relate the colour intensity to the melting point or trying to relate colour intensity to reactivity.

(iii) Many candidates realised that bromine is liquid at 40°C. Fewer gave a complete explanation for this in terms of both melting point and boiling point. Many just repeated the values of the melting point and boiling point without referring to 40°C. Others referred to room temperature instead of 40°C. A significant minority thought that the bromine should be in the solid state.

(c) Nearly all candidates gained at least partial credit for balancing the equation. The most common error was to suggest 2Br or Br instead of Br_2.

Question 4

(a) A minority of candidates selected both correct statements about a homologous series but nearly all the candidates selected one correct statement. The most common error was to tick the second box from the top (similar physical properties). A few candidates ticked only one box.

(b) Most candidates gave the correct answer 'alkane'. The most common errors were either 'anes' or 'alkene'. A few candidates just repeated the word 'hydrocarbon' which was in the stem of the question.

(c) Stronger responses gave a suitable definition of a hydrocarbon including the words 'compound' and 'only' in their answers. However, most candidates gave vague or incorrect answers such as 'it contains hydrogen and carbon molecules'. A significant number of candidates suggested that hydrocarbons are mixtures or elements. Many forgot the important words 'only' or 'no other substance'.

(d) Many candidates drew the correct structure of ethane. The most common errors were either leaving off one or more hydrogen atoms or drawing the structure of methane or the addition of a C=C bond. Some candidates drew a dot-and-cross diagram but these were not always correct.

(e) (i) Most candidates gave at least one correct condition for cracking. 'High temperature' or 'heat' was the most common correct answer. A few candidates did not gain credit because they suggested 'temperature' or 'pressure' unqualified. Some candidates gave values but either did not put a unit such as °C, or gave a unit which did not fit, e.g. '5 Pascal's instead of '5 atmospheres' and so could not be credited.

(ii) Most candidates gave the correct molecular formula. Common errors included $C_{11}H_{26}$, C_2H_6 and C_6H_{12}.

(f) A wide variety of incorrect answers was seen, suggesting that many candidates were unfamiliar with this reaction. The most common incorrect answers were carbon dioxide and alcohol. Ethane, oxygen, acid and glucose were other common incorrect answers.

(g) Most candidates gained partial credit and many gained full credit for 'monomers' and 'addition' in the correct places. The most common incorrect answer was to give 'polymers' instead of 'monomers'. Only a few candidates suggested 'condensation' instead of 'addition'.

Question 5

(a) (i) Many candidates answered well and referred to the fact that the magnesium floated (on top of the magnesium chloride). The most common errors were to refer to the intensity of the grey colour in the diagram, to refer to reactivity or to refer to the cathode.

(ii) Many candidates correctly identified chlorine. The most common error was to suggest 'chloride'. Other common errors were oxygen or hydrogen.

(iii) Many candidates wrote imprecise or incorrect answers as to why air is not blown over the molten magnesium such as 'the air can combine with the atmosphere' or 'air can react with the magnesium chloride'.

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(iv) Many candidates identified a suitable unreactive gas and argon was the most common correct answer. The most common incorrect answers were hydrogen, oxygen or carbon dioxide. A few candidates gave chlorine or bromine.

(b) (i) Most candidates identified aluminium and most of these referred to its low density. The most common incorrect answer was to refer to the strength of aluminium. A minority of candidates gave cobalt instead of aluminium. A few candidates disadvantaged themselves by suggesting that aluminium is less dense than air.

(ii) Some candidates correctly identified aluminium but a significant number gave 'cobalt' and referred to its strength or high melting point.

(iii) Many candidates realised that cobalt and nickel are transition elements. The most common incorrect answer was gallium.

(c) Most candidates gave at least one correct property associated with transition elements and many gave two correct properties. The most common error was to suggest general metallic properties such as lustre and electrical conductivity.

(d) (i) Some candidates gave a good definition of an alloy. Others made no mention of a mixture or used incorrect terminology such as 'a compound of two different metals'. A significant number of candidates either suggested that 'an alloy is a mixture of elements' or 'a mixture of non-metals'. A few just gave the name of an alloy.

(ii) A minority of the candidates referred to the alloy being stronger or harder than the corresponding metals. Many did not use the comparative, e.g. 'alloys are strong', 'alloys are light' and so could not be credited. Others gave answers which were too vague, e.g. 'shows the properties of both metals'.

Question 6

(a) (i) Some candidates identify methane as the main component of natural gas. Others gave incorrect answers such as carbon dioxide or carbon monoxide. Water, ethene and nitrogen were other incorrect answers which were occasionally given.

(ii) This was generally well answered and most candidates referred to 'making the reaction faster'. The most common error was reference to 'slows down the reaction'. A few candidates did not refer to rate.

(b) (i) Many candidates were able to name sulfuric acid. The most common error was sulfur dioxide. A significant number of candidates wrote the formula (often incorrectly as H_2SO_3) instead of the name.

(ii) A minority of the candidates gave a suitable effect of acid rain on buildings. Many referred to changing the colour or damaging paintwork. Others gave answers which were too vague or too drastic, e.g. 'reacts with them', 'damages them', 'destroys them', 'makes them weak'.

(iii) Some candidates explained oxidation by referring to the addition of oxygen to sulfur dioxide. Others either gave a generalised definition of oxidation or referred to the nitrogen dioxide rather than sulfur dioxide. A few candidates gave answers which were too vague, e.g. 'the sulfur dioxide goes to sulfur trioxide'. A significant number of candidates tried to answer in terms of electron transfer or changes in oxidation number. Many of these answers were incorrect because they referred to sulfur dioxide as a whole rather than the sulfur.

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Question 7

(a) Many candidates answered this question well. Some candidates did not write about the effect of acids on a named indicator or only wrote about the effect of acids on either calcium oxide or magnesium. Many candidates repeated themselves and sometimes wrote conflicting statements. Common errors included: carbon dioxide, hydrogen or hydroxide being formed when calcium oxide reacts with hydrochloric acid; water being formed when magnesium reacts with hydrochloric acid; red litmus being used as an indicator. Some candidates attempted to write symbol equations for the reactions rather than word equations. The products of these symbol equations were accepted if they were correct but the formulae of the chlorides were often incorrectly written as $CaCl$ and $MgCl$.

(b) (i) Some candidates correctly identified the reaction as 'neutralisation'. Other answers were either vague, e.g. 'acid-base' or incorrect, e.g. 'endothermic'. A few candidates wrote an equation instead of naming the type of reaction.

(ii) Most candidates suggested the correct pH of 13. The most common error was to suggest pH 2. A significant number of candidates chose pH 7.

(iii) Some candidates correctly identified ammonia. A few candidates incorrectly suggested ammonium or ammonium hydroxide. The most frequently seen error was to suggest hydrogen.

(iv) Many candidates selected the correct statement about sodium hydroxide. A common incorrect answer was to select the third box down from the top (sodium boils between 319°C and 1 390°C).

(v) A minority of candidates explained why the ingredients used in medicines have to be pure. The best answers referred to side-effects or stated 'harms the body'. Many answers were vague, e.g. 'doesn't react in the body' or made reference to melting or boiling points. Some candidates thought that the question was about sodium hydroxide rather than medicines in general and wrote about acid-base reactions of sodium hydroxide.

Question 8

(a) (i) Many candidates realised that the rate of reaction decreases when the concentration of hydrochloric acid decreases. The most common errors were to write about time instead of rate or to give answers which were not comparative, e.g. 'the rate would be slow'.

(ii) Many candidates gave a reason for their answer although this was not required. Some candidates incorrectly thought that the rate of reaction would increase because the surface area was greater. A common error was to suggest that the rate of reaction does not change because there is the same amount of iron present.

(iii) A majority of the candidates predicted that the rate would increase. The most common errors were to write about time instead of rate or to give answers which were not comparative, e.g. 'the rate would be fast'.

(b) (i) Many candidates gave the correct name of an ore of iron other than siderite. The most common errors were to suggest 'bauxite' or 'limestone'.

(ii) Only the strongest responses gained full credit here. Many candidates referred to reactions in the blast furnace. Some obtained partial credit for mentioning that carbon dioxide is released or for the use of limewater. Others suggested that a white precipitate is formed when hydrochloric acid is added. A significant number of candidates did not answer this question.

(c) Many candidates gave the correct order of reactivity. The most common error was to completely reverse the order.

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Paper 0620/42
Theory (Extended)

Key messages

- Candidates need to be reminded that if **one** property is asked for, as in **Question 1(c)(iv)**, then no more than one should be given in answers as any incorrect properties given will be viewed as a contradiction to correct ones.
- If observations about a substance are asked for, such as silver chloride in **Question 2(c)(i)**, candidates should be made aware that substances should be described by (at least) two words. The first word should be a colour (or colourless if applicable) and the second word should be the state.
- In calculation work, such as in **Questions 2(c)(iv)** and **4(b)(i)**, candidates should show their working to allow credit for 'error carried forward' where this is relevant. Candidates should be advised to include words indicating what they are attempting to do within their working, such as 'number of moles of …'.
- Candidates need to be reminded that a word equation, unless specifically asked for, will receive no credit in place of a correct symbol chemical equation.

General comments

Candidates generally answered well and there was no evidence that there was insufficient time for candidates to complete the paper.

Comments on specific questions

Question 1

(a) (i)–(vi)
Most candidates could identify the majority of the gases asked for. It was noticeable that the term 'diatomic molecule' was not always known.

(b) (i) Nearly all candidates knew a covalent bond involved sharing electrons; only a very small minority knew it involved sharing a pair of electrons.

(ii) The dot-and-cross diagram of NF_3 was well known, with all but a few candidates showing three shared pairs of electrons. Weaker responses tended not to show non-bonding electrons as pairs and consequently some of the three F atoms had five or seven non-bonding electrons. These candidates may have found it easier to count three pairs.

(c) (i) Many candidates tried to explain the meaning of mixture by using the words 'mix', 'mixing' or even 'mixture' in phrases such as 'a mixture of substances'.

(ii) Most candidates knew that 21% of air was oxygen.

(iii) Many candidates wrote very detailed descriptions describing the fractional distillation of liquid air including the extraction of carbon dioxide, water vapour and noble gases which were not asked for.

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(iv) The idea of different boiling points being the key property which allows N_2 and O_2 to be separated was well known. Some candidates include a second, incorrect property, such as differing densities, and could not be credited.

Question 2

(a) (i) This was answered well by candidates.

(ii) A number of candidates answered this question incorrectly, possibly because they misread the question, as many incorrect responses included '17' (the number of electrons in an atom), '7' (the number of electrons in an outer shell of an atom) and '8' (the number of electrons in an outer shell of an ion).

(iii) Argon, the correct response, was the most common answer seen, although neon was also a popular response.

(b) (i) The definition of electrolysis was well known and some well learnt responses were seen. Candidates need to be reminded that it is a breakdown (or decomposition) of a compound rather than a separation process involving the formation of ions.

(ii) The three products of electrolysis of concentrated aqueous sodium chloride were well known, although frequent incorrect responses included oxygen and occasionally, sodium.

(iii) The ionic half equation was known by many candidates; state symbols were frequently omitted or were incorrect due to H^+ ions being given as gaseous.

(c) (i) Candidates knew that solid silver chloride would form but often vague descriptions of observations or even names of the solid product received no credit. In this case 'white' was usually omitted from answers.

(ii) Candidates often focused on the collection of a pure residue, and the vague comment, 'to remove (soluble) impurities' was frequently seen.

(iii) Candidates generally answered this question well.

(iv) Some well set out and fully correct answers were seen. A common error was to miss out the final 90% step. In weaker responses, working out was poorly set out so that it could not be clearly followed. Candidates should be advised to include words within their working.

(v) The equation for the thermal decomposition of sodium nitrate was not well known and $NaNO_2$ was rarely seen as the product. Instead, many unusual sodium-based products were seen. Many candidates started with hydrated crystals and simply dehydrated them.

Question 3

(a) (i)–(vi)
This series of questions based upon the limestone cycle were answered well. Candidates found the equation in **(v)** more challenging due to water either being omitted as a product or being substituted by hydrogen.

(b) A minority of candidates could determine the formula of magnesium nitrate correctly with $MgNO_3$ being a very common error. As there is effervescence between an acid and a carbonate, candidates were expected to show the other two products as H_2O and CO_2 rather than H_2CO_3.

(c) Many candidates knew the method to follow and gained credit for division of the mass of the element by its relative atomic mass. Some excessive rounding after the first step saw a significant number of candidates end up with the wrong answer.

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Question 4

(a) (i) Many candidates gave the correct definition; there were a number of vague and irrelevant comments about properties of bases.

(ii) Many candidates opted to include water as a product. Partial credit was frequently awarded for identifying the correct ammonium compound relative to the acid used in the reaction. Candidates who chose to provide a chemical equation were rarely successful.

If candidates write word equations over two lines, they should avoid writing the word equation in such a way as to introduce ambiguity.

e.g.	ammonia	+	hydrochloric acid	→	ammonium chloride

This would be the expected way to write a word equation with the second word of a substance appearing below the first word.

If written in a more linear manner, the words may look like:

ammonia + hydrochloric acid → ammonium chloride

This introduces a substance which may be taken as having the name 'ammonia chloride'.

(b) (i) Candidates needed to determine the number of moles of NH_3 used and then use the stoichiometric ratio seen in the equation to determine the number of moles of Cl_2 needed and finally convert this value to a gas volume (in cm^3) by multiplying by 24 000.

Some candidates tried a non-mole method based upon reacting masses and were usually unsuccessful.

(ii)–(iii)
Many candidates successfully gained full credit in the calculation sections and went on to explain why this reaction was exothermic, (i.e. more energy was released in bond formation than used in bond breaking). Occasionally in **(iii)**, candidates had the direction of energy change incorrect, (i.e. more energy was used in bond formation than used in bond breaking or more energy was released in bond formation than released in bond breaking).

(c) (i) Most candidates realised that NH_3 was a reducing agent because it underwent oxidation. Stronger responses were able to explain what the oxidation was in terms of electron loss or change in oxidation state.

(ii) Platinum was probably the most often suggested metal as a catalyst from the list of five, but few candidates gave the reason that platinum was the only transition element in the list. Many candidates thought it was because platinum was (relatively) inert.

Question 5

(a) 'Homologous series' was almost always seen, although the occasional 'functional group' or just 'homologous' was seen.

(b) The general formula for alcohols is $C_nH_{2n+2}O$, although $C_nH_{2n+1}OH$ was accepted.

(c) (i) Stronger responses stated that steam was the reagent needed under conditions of a catalyst, and some even named the catalyst. Water, if seen with a temperature above 100°C as a condition, was allowed as the reagent.

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(ii) The equation for the combustion of propan-1-ol was often not done well. Many candidates wrote an incorrect formula for propan-1-ol; oxygen was not always seen as a reactant and there were many incorrect products such as alkanes. For those with the correct species, $5O_2$ instead of $4\frac{1}{2}\ O_2$ was occasionally seen, possibly as a result of the oxygen atoms in the alcohol being ignored when balancing.

(d) (i) The structure of the linkages tended to be correct but often continuation bonds were missing at the end of the structure.

(ii) Although most candidates knew that the breakdown of carbohydrate polymers was an example of hydrolysis, many opted for hydration. Catalytic cracking was another frequently seen error.

(iii) The conditions needed for the breakdown of carbohydrate polymers were known by only a small number of candidates. If acid was used, heat would frequently be omitted and enzymes (if seen) was frequently accompanied with impossible temperatures.

(e) (i)–(iv)

The responses to this series of questions showed candidates had a good understanding of chromatography involving colourless solutes.

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Paper 0620/52
Practical Test

Key messages

- Candidates should be familiar with the technique of carrying out a flame test.
- In qualitative analysis exercises, candidates must follow the instructions given and record all observations.
- Candidates should be aware that the mark allocation reflects the number of valid points to be made for parts of questions.

General comments

The majority of candidates successfully completed all questions and there was no evidence that candidates were short of time. A range of marks was seen, with some candidates answering very well.

Supervisors' results were submitted by the majority of Centres with the candidates' scripts. Very few comments were submitted by supervisors after carrying out the experiments. The results obtained by some supervisors and candidates for **Question 1** suggested that some Centres did not use reagents that were close to the concentrations specified in the Confidential Instructions.

Comments on specific questions

Question 1

(a), (b) and (c)

Almost all candidates completed the tables of results. Credit could sometimes not be awarded due to candidates:

- not recording all readings to one decimal place,
- incorrectly recording initial burette readings in **(a)** at values other than 0.0 cm^3,
- incorrectly recording final burette readings as values less than initial burette readings or values greater than 50 cm^3,
- giving a large difference between the titres in **(a)** and **(b)**.

(d) (i) Many candidates described the initial colour as orange instead of yellow and so could not be awarded credit. Some candidates described the final colour as green or colourless.

(ii) A minority of candidates correctly answered with the observation that bubbles were formed. There were a significant number who stated that the volume increased.

(e) This was generally answered well with Experiment 3 being the expected response.

(f) The majority of candidates answered the question correctly and named a burette or pipette. A significant number thought a (graduated) beaker or a measuring cylinder, which they had just used, would be more accurate.

(g) Many candidates mistakenly thought that changing the temperature would change the volumes of dilute hydrochloric acid used. Stronger responses gained full credit for stating that there would be no effect on the volume as warming the solution of sodium hydroxide would only affect the rate and not change the volume or concentrations of the reactants.

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(h) (i) This question was answered correctly by most candidates. Some candidates got the ratio the wrong way round or did not follow the instruction 'Determine the simplest whole number ratio' and gave fractions or ratios to one or two decimal places.

(ii) Many candidates gave incorrect references to solutions of different concentrations being used in Experiments 1 and 3 and showed a lack of knowledge and understanding. Stronger responses realised that the use of different indicators resulted in different volumes of dilute hydrochloric acid being used.

(i) Many candidates thought that universal indicator was only a test paper and that testing would be necessary after each addition of hydrochloric acid. References to pH were ignored. Other candidates thought that universal indicator was colourless, or would not change colour or that it would react with the mixture. However, stronger responses understood that there would be more than one colour change and it would be difficult to find the end point.

(j) The idea that the reliability of the results could be checked by repeating the experiments was well understood and scored partial credit. The mark allocation indicated that reference to comparing or averaging the results obtained was also expected.

Some candidates wanted to repeat the experiments with different volumes or concentrations of solutions and showed a lack of understanding, as did those who wanted to repeat them without using an indicator.

Question 2

Solution **M** was aqueous iron(III) chloride.
Solid **N** was basic copper(II) carbonate.

Tests on solution **M**

(a) (i) Most candidates correctly stated that the solution was yellow or brown. References to red/orange, green or precipitate could not be credited.

(ii) This question was generally well answered but a few candidates gave pH values of 7 or more. Solution **M** was acidic.

(b) The majority of candidates reported the formation of a yellow precipitate instead of a white precipitate. This showed a lack of practical expertise and experience when carrying out the halide test.

In coloured solutions, candidates needed to let the precipitate settle out to see the colour more clearly. Some candidates gave two colours and could not be credited.

(c) Some candidates reported the formation of a white precipitate. A significant number of candidates implied some sort of colour change or effervescence. This test for a sulfate should be negative and responses such as no change, no reaction or no precipitate scored credit.

(d) The formation of a brown precipitate was often described. Yellow and red were common answers. References to cloudy or solid formation instead of the term precipitate were ignored.

(e) Most candidates identified the presence of iron(III) ions but a number stated that iron(II) or just iron ions were present. Most candidates identified the correct halide ion based on their observation in **(d)**.

Tests on solid **N**

(f) Most candidates correctly stated that the solid was green. References to a blue solid could not be credited.

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(g) At least four points were expected in answers to this question as indicated by the mark allocation. The solid turning black and testing the gas with limewater, which turned milky, were common creditworthy answers. A small number of candidates successfully noted the formation of liquid drops or condensation on the walls of the test-tube; answers such as gas, vapour or smoke formed were considered too vague for credit. Some impossible test results with splints were seen, e.g. lighted splints popping and glowing splints relighting. A number of candidates reported that the gas bleached litmus paper and that it was chlorine.

Some candidates reported fizzing on adding hydrochloric acid which indicated that they were not following instructions.

(h) Many candidates successfully carried out a flame test and recorded a green or green-blue colour as expected. Some red, lilac and yellow observations were inexplicably recorded. A minority of candidates were clearly unfamiliar with a flame test.

(i) Credit was awarded for recording the formation of a brown colouration or effervescence. A significant number of candidates described the formation of a green precipitate and could not be credited.

(j) Many candidates correctly identified copper carbonate. There were some references to chloride and sulfate.

Question 3

Despite the fact that they were measuring the rate of reaction between magnesium ribbon and dilute sulfuric acid, a number of candidates used hydrochloric acid and tried to grind the ribbon into a powder. A significant number of candidates heated the reactants with a Bunsen burner and carried out a series of experiments at different temperatures which showed a lack of understanding.

Most candidates described a method involving collecting and measuring the volume of hydrogen and timing. Timing at set intervals was well described but timing until the reaction stopped often lacked detail as to how they would know when the reaction stopped. Timing when the reaction started was a flawed method as the reaction is instantaneous. Using a gas syringe was a common correct method but those candidates who used collection over water, often used a test-tube instead of a measuring cylinder but still claimed they would be able to measure the volume. Stronger responses measured the loss in mass of the reactants using a balance and were able to score full credit. Weaker responses chose less appropriate methods, such as counting bubbles or vaguely timing how long it took for the gas produced to give a pop with a lighted splint.

A minority of candidates could describe how the results could be used to find the rate of the reaction and vague references to the rate being the same as the time of the reaction were common. Good answers gave experimental details. Credit was awarded for the following points:

- adding magnesium and sulfuric acid
- using a suitable container with the ability to have a bung
- giving a method of measuring the volume of gas
- starting the timing/using of a stopwatch
- measuring volume of gas
- measuring and recording results at a set time/at known intervals/at end of reaction
- showing that rate = volume ÷ time.

A significant number of candidates did not include a diagram as requested.

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Paper 0620/62
Alternative to Practical

Key messages

- Before answering a question, candidates should read it carefully and ensure that they know and understand what the point of the question is. A good example of this guidance not being followed was **Question 1(f)** where many candidates did not use the information provided to answer the question.
- Candidates should be prepared to answer questions requiring the planning of an investigation.

General comments

The vast majority of candidates successfully attempted all of the questions. The full range of marks was seen and the paper was accessible to all candidates. Candidates found **Questions 1(c)**, **2(j)** and **4** more demanding than the others.

The majority of candidates were able to correctly complete tables of results from readings on diagrams in **Question 2**.

Comments on specific questions

Question 1

(a) (i) A lot of candidates drew the solvent front. Credit for the level of the solvent was awarded for drawing a line between the base line and the bottom of the paper, which did not touch the dot showing the mixtures of dyes.

(ii) This question was well answered with water or an organic solvent a common correct response. A small number of candidates used acids or marker pens and gained no credit.

(b) This question was generally well answered. However, responses such as ninhydrin or locating agent showed a lack of understanding.

(c) There was a lack of detail in many of the answers given. Stronger answers referred to keeping the base line above the solvent level or stated that the paper should not fall into the solvent as the dyes would mix.

(d) Many responses showed an understanding that dye **B** was a mixture of two substances and/or one of these was dye **D**.

(e) A large number of incorrect responses referred to dye **C** being colourless, pure, only one substance or too dense to move. Stronger responses realised that dye **C** was insoluble in the solvent.

(f) Despite the instructions given, many candidates were unable to measure the distances required to score full credit. A range of R_f values was accepted from 0.56 to 0.64. Many candidates got the fraction the wrong way up.

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Question 2

(a), (b) and (c)
Almost all candidates completed the tables of results successfully.

(d) Many candidates described the initial colour as orange instead of yellow and could not be credited. Some candidates described the final colour as green, blue or colourless.

(e) The majority of candidates realised that the flask was rinsed with distilled water to clean it and remove impurities from the previous experiment. Vague comments about removing traces of indicators were ignored.

(f) Answers to this question were generally correct with Experiment 3 being the expected response.

(g) The majority of candidates answered the question correctly and named a burette or pipette. A significant number thought a (graduated) beaker or a measuring cylinder, which was used originally, would be more accurate.

(h) Many candidates mistakenly thought that changing the temperature would change the volumes of dilute hydrochloric acid used because the reaction would be faster. Stronger responses gained full credit for answers stating that there would be no effect on the volume of acid as warming the solution of sodium hydroxide would only affect the rate and not change the volume or concentrations of the reactants.

(i) (i) This question was answered correctly by most candidates. Some candidates got the ratio the wrong way round or failed to follow the instruction 'Determine the simplest whole number ratio' and gave fractions or ratios to one or two decimal places.

(ii) Many candidates gave incorrect references to solutions of different concentrations being used in Experiments 1 and 3 and showed a lack of knowledge and understanding. Stronger responses realised that the use of different indicators resulted in different volumes of dilute hydrochloric acid being used.

(j) Many candidates thought that universal indicator was only a test paper and that testing would be necessary after each addition of hydrochloric acid. References to pH were ignored. Other candidates thought that universal indicator was colourless, or would not change colour or that it would react with the mixture. However, stronger responses understood that there would be more than one colour change and it would be difficult to find the end point.

(k) The idea that the reliability of the results could be checked by repeating the experiments was well understood and scored partial credit. The mark allocation indicated that reference to comparing or averaging the results obtained was also expected.

Some candidates wanted to repeat the experiments with different volumes or concentrations of solutions and showed a lack of understanding as did those who wanted to repeat them without using an indicator.

Question 3

(a) This was generally well answered with brown or yellow scoring credit. A number of candidates followed their chosen colour with the description of solid or crystals, not realising that solution **M** was being tested.

(b) This question was generally well answered with the recognition of the formation of a white precipitate. Additional incorrect observations, e.g. effervescence, meant that credit could not be awarded.

(c) Some candidates reported the formation of a white precipitate. A significant number of candidates implied some sort of colour change or effervescence. This test for a sulfate should be negative and responses such as no change, no reaction or no precipitate scored credit.

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(d) (i) This question was well answered. The formation of a brown precipitate was often described correctly. Some confusion with the test for iron(II) ions was seen.

(ii) Most candidates knew that the precipitate was insoluble in excess sodium hydroxide.

(e) The gas produced in **test 1** was identified correctly by some candidates.

(f) Copper carbonate was identified correctly by nearly all candidates.

Question 4

There were some excellent answers for this question.

Despite the fact that they were measuring the rate of reaction between magnesium ribbon and dilute sulfuric acid, a number of candidates used hydrochloric acid and tried to grind the ribbon into a powder. A significant number of candidates heated the reactants with a Bunsen burner and carried out a series of experiments at different temperatures which showed a lack of understanding.

Almost all candidates scored some credit for adding magnesium to sulfuric acid in a suitable container.

Most candidates described a method involving collecting and measuring the volume of hydrogen and timing. Timing at set intervals was well described but timing until the reaction stopped often lacked detail as to how they would know when the reaction stopped. Timing when the reaction started was a flawed method as the reaction is instantaneous. Using a gas syringe was a common correct method but those candidates who used collection over water, often used a test-tube instead of a measuring cylinder but still claimed they would be able to measure the volume. Stronger responses measured the loss in mass of the reactants using a balance and were able to score full credit. Weaker responses chose less appropriate methods such as counting bubbles or vaguely timing how long it took for the gas produced to give a pop with a lighted splint.

A minority of candidates could describe how the results could be used to find the rate of the reaction and vague references to the rate being the same as the time of the reaction were common.

Good answers gave experimental details. Credit was awarded for the following points:

- adding magnesium and sulfuric acid
- using a suitable container with the ability to have a bung
- giving a method of measuring the volume of gas
- starting the timing/using of a stopwatch
- measuring volume of gas
- measuring and recording results at a set time/at known intervals/at end of reaction
- showing that rate = volume ÷ time.

A number of candidates did not include a diagram as requested.

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Cambridge Assessment International Education

Grade thresholds – March 2018

Cambridge IGCSE Chemistry (0620)

Grade thresholds taken for Syllabus 0620 (Chemistry) in the March 2018 examination.

		minimum raw mark required for grade:						
	maximum raw mark available	A	B	C	D	E	F	G
Component 12	40	–	–	25	21	18	15	12
Component 22	40	30	25	21	18	15	12	9
Component 32	80	–	–	55	45	35	25	15
Component 42	80	54	45	35	29	23	17	11
Component 52	40	29	26	23	19	16	13	10
Component 62	40	31	27	24	21	18	15	12

Grade A* does not exist at the level of an individual component.

The maximum total mark for this syllabus, after weighting has been applied, is **200**.

The overall thresholds for the different grades were set as follows.

Option	Combination of Components	A*	A	B	C	D	E	F	G
BY	22, 42, 52	163	141	119	98	82	67	52	37
CY	22, 42, 62	165	143	121	99	84	69	54	39
FY	12, 32, 52	–	–	–	128	107	87	67	47
GY	12, 32, 62	–	–	–	129	109	89	69	49

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CHEMISTRY **0620/12**

Paper 1 Multiple Choice (Core) **March 2018**

MARK SCHEME

Maximum Mark: 40

Published

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This document consists of **3** printed pages.

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Question	Answer	Marks
1	C	**1**
2	B	**1**
3	C	**1**
4	D	**1**
5	B	**1**
6	C	**1**
7	C	**1**
8	A	**1**
9	C	**1**
10	A	**1**
11	C	**1**
12	A	**1**
13	B	**1**
14	B	**1**
15	B	**1**
16	A	**1**
17	B	**1**
18	B	**1**
19	C	**1**
20	D	**1**
21	A	**1**
22	A	**1**
23	B	**1**
24	A	**1**
25	A	**1**
26	B	**1**
27	C	**1**
28	B	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	A	**1**
32	B	**1**
33	C	**1**
34	D	**1**
35	D	**1**
36	B	**1**
37	C	**1**
38	A	**1**
39	B	**1**
40	B	**1**

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Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/12**

Paper 1 Multiple Choice (Core) **February/March 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
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There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
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Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level1/Level 2 Certificate.

This document consists of **13** printed pages and **3** blank pages.

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1 Four physical changes are listed.

1 condensation

2 evaporation

3 freezing

4 sublimation

In which changes do the particles move further apart?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

2 The diagram shows liquid in a burette and in a measuring cylinder.

burette measuring cylinder

Which row shows the readings for the burette and the measuring cylinder?

	burette	measuring cylinder
A	27.8	42
B	27.8	44
C	28.2	42
D	28.2	44

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3 Substance L melts at –7 °C and is a brown liquid at room temperature.

Which temperature is the boiling point of pure L?

A –77 °C

B –7 °C to +7 °C

C 59 °C

D 107 °C to 117 °C

4 A student is given a mixture of barium sulfate, copper(II) sulfate and water.

The table shows information about barium sulfate and copper(II) sulfate.

substance	solubility in water	state at room temperature
barium sulfate	insoluble	solid
copper(II) sulfate	soluble	solid

How does the student obtain copper(II) sulfate crystals from the mixture?

A crystallisation followed by distillation

B crystallisation followed by filtration

C distillation followed by crystallisation

D filtration followed by crystallisation

5 What is the nucleon number of an atom?

A the number of electrons, neutrons and protons in the nucleus

B the number of neutrons and protons in the nucleus

C the number of neutrons in the nucleus

D the number of protons in the nucleus

6 Caesium, Cs, is an element in Group I of the Periodic Table.

When caesium reacts it forms a positive ion, Cs^+.

How is a caesium ion formed?

A A caesium atom gains a proton.

B A caesium atom gains an electron.

C A caesium atom loses an electron.

D A caesium atom shares an electron.

7 Which statement about graphite and diamond is correct?

A Diamond has a high melting point but graphite does not.

B Graphite and diamond both conduct electricity.

C Graphite and diamond both have giant structures.

D Graphite is ionic and diamond is covalent.

8 What is the definition of relative atomic mass, A_r?

A $\left(\dfrac{\text{average mass of naturally occurring atoms of an element}}{\text{mass of one atom of } ^{12}\text{C}}\right) \times 12$

B $\left(\dfrac{\text{average mass of naturally occurring atoms of an element}}{\text{mass of one atom of } ^{12}\text{C} \times 12}\right)$

C $\left(\dfrac{\text{average mass of naturally occurring atoms of an element}}{\text{mass of one atom of } ^{12}\text{C}}\right)$

D $\left(\dfrac{\text{mass of one atom of } ^{12}\text{C}}{\text{average mass of naturally occurring atoms of an element}}\right)$

9 Which statement about electrolysis reactions is correct?

A When concentrated aqueous sodium chloride is electrolysed, sodium forms at the cathode.

B When concentrated hydrochloric acid is electrolysed, a green gas forms at the cathode.

C When dilute sulfuric acid is electrolysed, a colourless gas forms at both electrodes.

D When molten lead(II) bromide is electrolysed, lead forms at the anode.

10 Statement 1 Hydrogen is used as a fuel.

Statement 2 When hydrogen burns in the air to form water, heat energy is produced.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 2 is correct but statement 1 is incorrect.

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11 The diagram shows a match.

By striking the match, a chemical reaction takes place.

Which row describes the chemical reaction?

	type of reaction	reason
A	endothermic	because energy is given out as the match burns
B	endothermic	because energy is used to strike the match
C	exothermic	because energy is given out as the match burns
D	exothermic	because energy is used to strike the match

12 Magnesium carbonate was reacted with dilute hydrochloric acid in a conical flask.

The conical flask was placed on a balance and the mass of the conical flask and contents was recorded as the reaction proceeded.

During the reaction, carbon dioxide gas was produced.

The reaction was done at two different temperatures.

Which row is correct?

	change in mass	temperature at which the mass changed more quickly
A	decrease	higher temperature
B	decrease	lower temperature
C	increase	higher temperature
D	increase	lower temperature

13 Separate samples of anhydrous copper(II) sulfate and hydrated copper(II) sulfate are heated.

Which row shows the correct colour changes?

	anhydrous copper(II) sulfate	hydrated copper(II) sulfate
A	blue to white	white to blue
B	no change	blue to white
C	white to blue	blue to white
D	white to blue	no change

14 In which equation does oxidation of the underlined substance occur?

A $2CuO + C \rightarrow CO_2 + \underline{2Cu}$

B $Fe_2O_3 + \underline{3CO} \rightarrow 2Fe + 3CO_2$

C $2Mg + O_2 \rightarrow \underline{2MgO}$

D $\underline{MnO_2} + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

15 Which property is shown by the alkali sodium hydroxide?

A It has a pH less than pH 7.

B It produces a gas when it is warmed with ammonium chloride.

C It turns blue litmus red.

D It turns Universal Indicator green.

16 A solution of compound Z gives a light blue precipitate with aqueous ammonia. The precipitate dissolves in an excess of ammonia.

A flame test is done on compound Z.

What is the colour of the flame?

A blue-green

B lilac

C red

D yellow

17 Carbon, copper, magnesium, sodium and sulfur can all form oxides.

How many of these elements form acidic oxides?

A 1 **B** 2 **C** 3 **D** 4

18 Which method is used to make the salt copper(II) sulfate?

A dilute acid + alkali

B dilute acid + carbonate

C dilute acid + metal

D dilute acid + non-metal oxide

19 The Periodic Table lists all the known elements.

Elements are arranged in order of .....1..... number.

The melting points of Group I elements .....2..... down the group.

The melting points of Group VII elements .....3..... down the group.

Which words correctly complete gaps 1, 2 and 3?

	1	2	3
A	nucleon	decrease	increase
B	nucleon	increase	decrease
C	proton	decrease	increase
D	proton	increase	decrease

20 Which statements about Group I and Group VII elements are correct?

1 In Group I, lithium is more reactive than potassium.

2 In Group VII, chlorine is more reactive than fluorine.

	statement 1	statement 2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

21 Which statement describes transition elements?

A They have high densities and high melting points.

B They have high densities and low melting points.

C They have low densities and high melting points.

D They have low densities and low melting points.

22 Which trend occurs across the period from sodium to argon?

A a change from metal to non-metal

B an increase in melting point

C a more violent reaction with water

D an increase in electrical conductivity

23 Why is argon used in lamps?

A Argon forms molecules when electricity is passed through it.

B Argon is inert and so does not react with the hot filament.

C Argon is less dense than air.

D Argon produces light when it burns.

24 Metals W, X, Y and Z are reacted with dilute hydrochloric acid.

The oxides of metals W, X, Y and Z are heated with carbon.

The results are shown.

reaction	W	X	Y	Z
metal + dilute hydrochloric acid	fizzing	fizzing	violent fizzing	no reaction
metal oxide + carbon + heat	no reaction	metal produced	no reaction	metal produced

What is the order of reactivity of the metals?

	most reactive →			least reactive
A	Y	W	X	Z
B	Y	X	W	Z
C	Z	W	X	Y
D	Z	X	W	Y

25 Iron is extracted from Fe_2O_3 by reduction with carbon.

Aluminium is difficult to extract from Al_2O_3. The process requires electrolysis.

Starting with the most reactive, which order of reactivity is correct?

A $Al \rightarrow C \rightarrow Fe$

B $Al \rightarrow Fe \rightarrow C$

C $Fe \rightarrow Al \rightarrow C$

D $Fe \rightarrow C \rightarrow Al$

26 Which two properties are physical properties of **all** pure metals?

	property 1	property 2
A	brittle	poor conductor of heat
B	good conductor of electricity	malleable
C	good conductor of heat	low melting point
D	malleable	low density

27 Which statement about the uses of aluminium, copper and iron is correct?

A Aluminium is used for aircraft manufacture because it has a high density.

B Aluminium is used for food containers because it is a good conductor of electricity.

C Copper is used for cooking utensils because it is a good conductor of heat.

D Stainless steel is used for car bodies because it corrodes easily.

28 The list gives four experiments done with calcium carbonate.

1 acid added

2 alkali added

3 heated strongly

4 water added

Which experiments produced carbon dioxide?

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

29 Water must be purified before it is suitable for use in the home.

Which processes are used to remove solid impurities and to kill bacteria?

	to remove solid impurities	to kill bacteria
A	chlorination	chlorination
B	chlorination	filtration
C	filtration	chlorination
D	filtration	filtration

30 Which gas is **not** present in clean air?

A argon

B carbon dioxide

C carbon monoxide

D water vapour

31 Which pair of compounds would make an NPK fertiliser?

A ammonium sulfate and potassium phosphate

B calcium hydroxide and ammonium nitrate

C calcium phosphate and potassium chloride

D potassium nitrate and ammonium sulfate

32 Which pollutant gas is produced by the decomposition of vegetation?

A carbon monoxide

B methane

C nitrogen dioxide

D sulfur dioxide

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33 Sulfur burns to make sulfur dioxide.

Which row describes a source of sulfur and a use of sulfur dioxide?

	source of sulfur	use of sulfur dioxide
A	the air	food preservative
B	the air	water treatment
C	underground deposits	food preservative
D	underground deposits	water treatment

34 The diagram shows the pH values of the soil in two parts of a garden, X and Y.

Lime is used to neutralise the soil in one part of the garden.

To which part of the garden should the lime be added and why?

	part of the garden	because lime is
A	X	acidic
B	X	basic
C	Y	acidic
D	Y	basic

35 Which substance is **not** used as a fuel?

A ethanol

B hydrogen

C methane

D oxygen

36 Which formula represents an alkene?

A CH_4 **B** C_2H_4 **C** C_2H_6 **D** C_2H_5OH

37 Three chemical reactions are shown.

1 catalytic addition of steam to ethene

2 combustion of ethanol

3 fermentation of glucose

In which of the reactions does the relative molecular mass of the carbon-containing compound decrease?

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

38 How is ethanol produced by fermentation?

A using anaerobic conditions at 30 °C

B using anaerobic conditions at 450 °C

C using steam at 30 °C

D using steam at 450 °C

39 A compound has the formula CH_3COOH.

What is **not** a property of this compound?

A It has a smell like vinegar.

B It reacts with acids to form salts.

C It reacts with magnesium to produce hydrogen.

D It turns blue litmus red.

40 Which statement about polymers is correct?

A Polymers are formed by breaking down monomers.

B Polymers can be natural or synthetic.

C Polymers contain atoms of only one element.

D Polymers have a giant ionic structure.

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **March 2018**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1	A	**1**
2	C	**1**
3	B	**1**
4	C	**1**
5	A	**1**
6	A	**1**
7	A	**1**
8	C	**1**
9	C	**1**
10	B	**1**
11	C	**1**
12	A	**1**
13	B	**1**
14	C	**1**
15	B	**1**
16	A	**1**
17	C	**1**
18	A	**1**
19	B	**1**
20	B	**1**
21	C	**1**
22	A	**1**
23	D	**1**
24	B	**1**
25	C	**1**
26	B	**1**
27	C	**1**
28	C	**1**

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Question	Answer	Marks
29	C	**1**
30	D	**1**
31	A	**1**
32	B	**1**
33	B	**1**
34	D	**1**
35	A	**1**
36	D	**1**
37	C	**1**
38	A	**1**
39	D	**1**
40	B	**1**

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **February/March 2018**

45 minutes

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1 Hydrogen chloride gas, HCl, reacts with ammonia gas, NH_3, to form solid ammonium chloride.

The apparatus is set up as shown.

After a few minutes, solid ammonium chloride forms where the two gases meet.

The experiment is repeated using hydrogen bromide, HBr, in place of hydrogen chloride.

How far along the tube does the solid ammonium bromide form?

2 Substance L melts at –7 °C and is a brown liquid at room temperature.

Which temperature is the boiling point of pure L?

A –77 °C

B –7 °C to +7 °C

C 59 °C

D 107 °C to 117 °C

3 Chromatography is done on a mixture containing a drug. The drug has an R_f value of 0.66.

The diagram is **not** drawn to scale.

Which spot on the chromatogram represents the drug?

4 Caesium, Cs, is an element in Group I of the Periodic Table.

When caesium reacts it forms a positive ion, Cs^+.

How is a caesium ion formed?

A A caesium atom gains a proton.

B A caesium atom gains an electron.

C A caesium atom loses an electron.

D A caesium atom shares an electron.

5 The structure of copper is described as a lattice of positive ions in a ‘sea of electrons’.

Which statements are correct?

1 Copper has a high melting point because of the strong electrostatic attraction between the positive ions and the ‘sea of electrons’.

2 Copper is malleable because the layers of atoms in the lattice can slide over each other.

3 Copper atoms can be oxidised to form copper ions by losing electrons.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

6 Three statements about diamond, graphite and silicon(IV) oxide are listed.

1 Diamond and graphite both have giant covalent structures.

2 In silicon(IV) oxide, silicon and oxygen atoms are joined together by covalent bonds throughout the whole structure.

3 Diamond and silicon(IV) oxide have similar structures.

Which statements are correct?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

7 The concentration of a hydrochloric acid solution is 0.5 mol / dm^3.

How many moles of hydrochloric acid are present in 25 cm^3 of this solution?

A 0.0125 **B** 0.0200 **C** 12.5 **D** 20.0

8 A sample of an iron oxide contains 50.4 g of iron and 21.6 g of oxygen.

What is the empirical formula of the iron oxide?

A FeO **B** FeO_3 **C** Fe_2O_3 **D** Fe_3O_2

9 A solution of copper(II) sulfate can be electrolysed using copper electrodes or carbon electrodes.

Which statements are correct?

1 Using copper electrodes, oxygen gas forms at the anode.

2 Using copper electrodes, copper atoms lose electrons at the anode.

3 Using carbon electrodes, copper metal forms at the cathode.

4 Using carbon electrodes, copper ions gain electrons at the cathode.

A 1 and 2 **B** 1 and 3 **C** 2, 3 and 4 **D** 4 only

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10 Pairs of metals are connected together to make a simple cell, as shown.

The table shows the reading on the voltmeter when different metals are used.

		metal 2			
		beryllium	cerium	cobalt	manganese
metal 1	beryllium	0.00 V	+0.64 V	–1.57 V	–0.67 V
	cerium		0.00 V	–2.21 V	–1.30 V
	cobalt			0.00 V	+0.90 V
	manganese				0.00 V

If metal 2 is more reactive than metal 1, the voltage measured is positive.

The greater the difference in reactivity of the metals, the larger the reading on the voltmeter.

What is the order of reactivity?

	most reactive →			least reactive
A	cerium	beryllium	cobalt	manganese
B	cerium	beryllium	manganese	cobalt
C	cobalt	manganese	beryllium	cerium
D	cobalt	manganese	cerium	beryllium

11 The energy level diagram for the reaction between X_2 and Y_2 to form XY gas is shown.

Which statement is correct?

A Energy is released when X_2 and Y_2 bonds are broken.

B Energy is needed to form XY bonds.

C The energy change, ΔH, for the reaction is negative.

D The reaction is endothermic.

12 Methane burns in oxygen to form carbon dioxide and water.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The bond energies are shown in the table.

bond	bond energy in kJ / mol
C–H	+410
C=O	+805
O–H	+460
O=O	+496

What is the energy change for the reaction?

A –818 kJ / mol

B –323 kJ / mol

C +323 kJ / mol

D +818 kJ / mol

13 Methanol is made by reacting carbon monoxide with hydrogen. The reaction is reversible.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

Which combination of temperature and pressure gives the highest equilibrium yield of methanol?

	temperature / °C	pressure / atmospheres
A	200	10
B	200	200
C	600	10
D	600	200

14 The ionic equation for the reaction between zinc and aqueous copper ions is shown.

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Which statement about this reaction is correct?

A Copper ions are oxidised and their oxidation state changes.

B Copper ions are reduced because they lose electrons.

C Zinc atoms are oxidised and their oxidation state changes.

D Zinc atoms are reduced because they gain electrons.

15 In which reaction is the rate of reaction **not** affected by light?

A the conversion of carbon dioxide and water to glucose and oxygen in green plants

B the reaction of bromine with ethene

C the reaction of chlorine with methane

D the reduction of silver ions to silver

16 Calcium carbonate reacts with dilute hydrochloric acid to form bubbles of carbon dioxide.

At a higher temperature, the same reaction is faster.

Which row explains this observation?

	collision rate	number of molecules with sufficient energy to react
A	increases	more
B	increases	the same
C	stays the same	more
D	stays the same	the same

17 Ethanoic acid reacts with water to produce an acidic solution.

Which row describes the roles of ethanoic acid and water in this reaction?

	ethanoic acid	water
A	accepts a proton	donates a proton
B	accepts an electron	donates an electron
C	donates a proton	accepts a proton
D	donates an electron	accepts an electron

18 A solution of compound Z gives a light blue precipitate with aqueous ammonia. The precipitate dissolves in an excess of ammonia.

A flame test is done on compound Z.

What is the colour of the flame?

A blue-green

B lilac

C red

D yellow

19 Carbon, copper, magnesium, sodium and sulfur can all form oxides.

How many of these elements form acidic oxides?

A 1 **B** 2 **C** 3 **D** 4

20 Which method is used to make the salt copper(II) sulfate?

A dilute acid + alkali

B dilute acid + carbonate

C dilute acid + metal

D dilute acid + non-metal oxide

21 The Periodic Table lists all the known elements.

Elements are arranged in order of .....1..... number.

The melting points of Group I elements .....2..... down the group.

The melting points of Group VII elements .....3..... down the group.

Which words correctly complete gaps 1, 2 and 3?

	1	2	3
A	nucleon	decrease	increase
B	nucleon	increase	decrease
C	proton	decrease	increase
D	proton	increase	decrease

22 Metal X reacts with non-metal Y to form an ionic compound with the formula X_2Y.

Which statements are correct?

1 X is in Group I of the Periodic Table.

2 X is in Group II of the Periodic Table.

3 Y is in Group VI of the Periodic Table.

4 Y is in Group VII of the Periodic Table.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

23 Which statements about Group I and Group VII elements are correct?

1 In Group I, lithium is more reactive than potassium.

2 In Group VII, chlorine is more reactive than fluorine.

	statement 1	statement 2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

24 Which two properties are physical properties of **all** pure metals?

	property 1	property 2
A	brittle	poor conductor of heat
B	good conductor of electricity	malleable
C	good conductor of heat	low melting point
D	malleable	low density

25 Aluminium is extracted from aluminium oxide using electrolysis.

Carbon dioxide is formed in this process.

Which equation shows the formation of carbon dioxide during the extraction of aluminium from aluminium oxide by electrolysis?

A $Al_2(CO_3)_3 \rightarrow Al_2O_3 + 3CO_2$

B $Al_2O_3 + 3CO \rightarrow 2Al + 3CO_2$

C $C + O_2 \rightarrow CO_2$

D $C^{4+} + 2O^{2-} \rightarrow CO_2$

26 A sample of solid X was added to three different solutions to predict the position of X in the reactivity series.

$$X(s) + FeSO_4(aq) \rightarrow \text{no reaction}$$

$$X(s) + 2HCl(aq) \rightarrow XCl_2(aq) + H_2(g)$$

$$X(s) + Zn(NO_3)_2(aq) \rightarrow \text{no reaction}$$

Which other solution would react with solid X?

A $CaSO_4(aq)$ **B** $CuSO_4(aq)$ **C** $MgSO_4(aq)$ **D** $Na_2SO_4(aq)$

27 Which statement about the uses of aluminium, copper and iron is correct?

A Aluminium is used for aircraft manufacture because it has a high density.

B Aluminium is used for food containers because it is a good conductor of electricity.

C Copper is used for cooking utensils because it is a good conductor of heat.

D Stainless steel is used for car bodies because it corrodes easily.

28 Air is a mixture of gases.

The melting and boiling points of some gases present in clean, dry air are shown.

In the fractional distillation of liquid air, which gas boils first?

	gas	melting point / °C	boiling point / °C
A	argon	–189	–186
B	krypton	–157	–153
C	nitrogen	–210	–196
D	oxygen	–219	–183

29 Water must be purified before it is suitable for use in the home.

Which processes are used to remove solid impurities and to kill bacteria?

	to remove solid impurities	to kill bacteria
A	chlorination	chlorination
B	chlorination	filtration
C	filtration	chlorination
D	filtration	filtration

30 Which processes do **not** produce carbon dioxide?

1 heating limestone

2 burning gasoline in car engines

3 photosynthesis

4 production of nylon

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

31 Which pair of compounds would make an NPK fertiliser?

A ammonium sulfate and potassium phosphate

B calcium hydroxide and ammonium nitrate

C calcium phosphate and potassium chloride

D potassium nitrate and ammonium sulfate

32 Which pollutant gas is produced by the decomposition of vegetation?

A carbon monoxide

B methane

C nitrogen dioxide

D sulfur dioxide

33 The equation for the formation of sulfur trioxide from sulfur dioxide is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which combination of pressure and temperature gives the highest equilibrium yield of sulfur trioxide?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

34 The diagram shows the pH values of the soil in two parts of a garden, X and Y.

Lime is used to neutralise the soil in one part of the garden.

To which part of the garden should the lime be added and why?

	part of the garden	because lime is
A	X	acidic
B	X	basic
C	Y	acidic
D	Y	basic

35 Statement 1 Hydrogen is used as a fuel.

Statement 2 When hydrogen burns in the air to form water, heat energy is produced.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 2 is correct but statement 1 is incorrect.

36 Which row identifies compounds in the same homologous series?

	chemical properties	functional group
A	different	different
B	different	same
C	similar	different
D	similar	same

37 Three chemical reactions are shown.

1 catalytic addition of steam to ethene

2 combustion of ethanol

3 fermentation of glucose

In which of the reactions does the relative molecular mass of the carbon-containing compound decrease?

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

38 How is ethanol produced by fermentation?

A using anaerobic conditions at 30 °C

B using anaerobic conditions at 450 °C

C using steam at 30 °C

D using steam at 450 °C

39 Which substances react together to form ethyl propanoate?

A ethanoic acid and propanol

B ethanol and propene

C ethene and propanol

D propanoic acid and ethanol

40 The structure of a chlorofluorocarbon polymer is shown.

Which monomer is used to make this polymer?

A

B

C

D

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **March 2018**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)(i)	E / oxygen / O_2	1
1(a)(ii)	A / sodium bromide / NaBr	1
1(a)(iii)	E / oxygen / O_2	1
1(a)(iv)	C / carbon dioxide / CO_2	1
1(a)(v)	A / sodium bromide / NaBr	1
1(b)	protons: 8	1
	neutrons: 9	1
	electrons: 8	1
1(c)	glowing splint	1
	relights	1

Question	Answer	Marks
2(a)(i)	25 (mg)	1
2(a)(ii)	potassium / K^+	1
2(a)(iii)	magnesium sulfate	1
2(a)(iv)	add nitric acid	1
	add (aqueous) silver nitrate and white precipitate (1 mark if silver nitrate alone)	2
2(b)(i)	circle around COOH group	1
2(b)(ii)	$C_3H_6O_3$	1

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Question	Answer	Marks
2(c)(i)	removal of oxygen (from a compound)	**1**
2(c)(ii)	46 If 2 marks not obtained: 1 mark for 1 row all correct e.g. hydrogen 6 × 1 = 6 oxygen 1 × 16 = 16	**2**

Question	Answer	Marks
3(a)	one mark each for any 3 of: • (iodine) particles go from solid to solution • diffusion • particles move / particles collide • random (movement of) particles / particles (move) anywhere / particles (move) in all directions • spreading out of particles / intermingling of particles / mixing of particles • (bulk) movement (of particles) from higher to lower concentration	**max 3**
3(b)(i)	density of fluorine: ALLOW: values lower than 1.56 (but not 0 or negative numbers)	**1**
	melting point of chlorine: ALLOW values between –220 and –7 °C (excluding these two values)	**1**
3(b)(ii)	<u>lighter</u> because the trend of colour down (the Group) is towards dark(er) colours / <u>lighter</u> because the trend of colour up (the Group) is towards light(er) colours	**1**
3(b)(iii)	liquid	**1**
	40 °C is between the melting and boiling points / 40 °C is between –7 °C and 59 °C / 40 °C is higher than the melting point **AND** lower than the boiling point	**1**
3(c)	Br_2	**1**
	2 (KBr)	**1**

Question	Answer	Marks
4(a)	1st and 3rd boxes down ticked (1 mark each)	**2**
4(b)	alkane(s)	**1**
4(c)	**compound** of carbon and hydrogen only / **compound** of hydrogen and carbon with no other elements If 2 marks not scored: 1 mark for : contains carbon and hydrogen only / compound of hydrogen and carbon	**2**
4(d)	structure of ethane correct with all atoms and all bonds H H | | H – C – C – H | | H H	**1**
4(e)(i)	one mark each for any two of: • high temperature • catalyst • high pressure	**max 2**
4(e)(ii)	$C_{11}H_{24}$	**1**
4(f)	steam	**1**
4(g)	monomers	**1**
	addition	**1**

Question	Answer	Marks
5(a)(i)	magnesium floats (on the molten magnesium chloride)	**1**
5(a)(ii)	chlorine	**1**

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Question	Answer	Marks
5(a)(iii)	to stop the magnesium oxidising / to stop the magnesium reacting with the air / to stop it oxidising / to stop it reacting with the air	1
5(a)(iv)	argon / krypton / xenon	1
5(b)(i)	aluminium	1
	has the lowest density / has a low density	1
5(b)(ii)	aluminium	1
	has the best (electrical) conductivity	1
5(b)(iii)	cobalt **AND** nickel	1
5(c)	one mark each for any two of: • high melting points / high boiling points • high density • hard / strong • compounds are coloured • form ions with different oxidation states • act as catalysts	max 2
5(d)(i)	mixture of metals / mixture of metal and non-metal / mixture of a metal with another element(1)	1
5(d)(ii)	alloy is stronger (than pure metal) / alloy is more resistant to corrosion (than pure metal) / alloy is harder	1

Question	Answer	Marks
6(a)(i)	methane	1
6(a)(ii)	speeds up the reaction / increases the rate of reaction	1
6(b)(i)	sulfuric acid	1

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Question	Answer	Marks
6(b)(ii)	(chemical) erosion (of buildings) / pitting (of buildings) / corrosion (of metalwork) / weathering	**1**
6(b)(iii)	sulfur dioxide gains oxygen / it gains oxygen	**1**

Question	Answer	Marks
7(a)	one mark each for any 5 points maximum 2 marks for each of the reactions (with calcium oxide, magnesium, indicator) *with calcium oxide:* • forms calcium chloride • forms water • neutralises (calcium oxide) • reaction is exothermic / (reaction mixture) gets hot *with magnesium* • forms magnesium chloride • forms hydrogen • reaction is exothermic / (reaction mixture) gets hot • bubbles / effervesce / fizzes (seen in **one** of the above reactions) • calcium oxide / magnesium disappears (or gets smaller) (seen in **one** of the above reactions) *with indicator* • named acid-base indicator • correct colour of indicator in acidic solution	**max 5**
7(b)(i)	neutralisation	**1**
7(b)(ii)	pH 13	**1**
7(b)(iii)	ammonia	**1**

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Question	Answer	Marks
7(b)(iv)	4th box down ticked	**1**
7(b)(v)	so they do not harm you / no side effects	**1**

Question	Answer	Marks
8(a)(i)	decreases (rate) / slower (rate)	**1**
8(a)(ii)	decreases (rate) / slower (rate)	**1**
8(a)(iii)	increases (rate) / faster (rate)	**1**
8(b)(i)	hematite	**1**
8(b)(ii)	one mark each for any 3 of: • add (hydrochloric) acid • test gas given off with limewater • turns milky / cloudy / white precipitate (this mark dependent on limewater) • carbon dioxide produced	**max 3**
8(c)	bismuth < tin < iron < titanium 1 mark if all reversed / one consecutive pair reversed	**2**

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 6 5 7 2 7 8 2 5 0 6 *

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **February/March 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 **(a)** The structures of five substances, **A**, **B**, **C**, **D** and **E**, are shown.

A **B** **C** **D** **E**

Answer the following questions using only the substances in the diagram.
Each substance may be used once, more than once or not at all.

State which substance, **A**, **B**, **C**, **D** or **E**:

(i) is a diatomic molecule ..... [1]

(ii) contains bromide ions ..... [1]

(iii) is an element ..... [1]

(iv) is a gas which is a product of respiration ..... [1]

(v) gives a yellow colour in a flame test. ..... [1]

(b) An isotope of oxygen is represented by the symbol shown.

$^{17}_{8}O$

Deduce the number of protons, neutrons and electrons in this isotope of oxygen.

number of protons .....

number of neutrons .....

number of electrons .....
[3]

(c) Describe a test for oxygen.

test .....

result .....
[2]

[Total: 10]

2 **(a)** The table shows the mass of each type of ion present in a 100 cm^3 sample of milk.

name of ion	formula of ion	mass of ion present in 100 cm^3 milk / mg
calcium	Ca^{2+}	125
chloride	Cl^-	120
	Mg^{2+}	12
phosphate	PO_4^{3-}	95
potassium	K^+	140
sodium	Na^+	58
	SO_4^{2-}	30
negative ions of organic acids		160

(i) Calculate the mass of calcium ions present in a 20 cm^3 sample of this milk.

mass of calcium ions = ... mg [1]

(ii) Which positive ion is present in the highest concentration in this sample of milk?

..... [1]

(iii) Name the compound formed from Mg^{2+} and SO_4^{2-} ions.

..... [1]

(iv) Describe a test for chloride ions.

test .....

.....

result .....
[3]

(b) One of the organic acids present in milk is lactic acid.
The structure of lactic acid is shown.

(i) On the structure shown draw a circle around the carboxylic acid functional group. [1]

(ii) Deduce the molecular formula of lactic acid showing the number of carbon, hydrogen and oxygen atoms.

..... [1]

(c) Ethanoic acid is another organic acid.

(i) The reduction of ethanoic acid produces ethanol.

What is meant by the term *reduction*?

..... [1]

(ii) The molecular formula of ethanol is C_2H_6O.

Complete the table to calculate the relative molecular mass of ethanol.

	number of atoms	relative atomic mass	
carbon	2	12	2 × 12 = 24
hydrogen			
oxygen			

relative molecular mass = ... [2]

[Total: 11]

3 This question is about halogens.

(a) A crystal of iodine was placed at the bottom of a beaker containing the solvent cyclohexane. After 2 days, a purple colour had spread throughout the cyclohexane.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

Question 3 continues on the next page.

(b) The table shows the properties of some halogens.

halogen	melting point in °C	boiling point in °C	density when liquid in g / cm^3	colour
fluorine	–220	–188		
chlorine		–29	1.56	light green
bromine	–7	59	3.12	red-brown
iodine	114	184	3.96	grey-black

(i) Complete the table to estimate:
- the density of liquid fluorine
- the melting point of chlorine.

[2]

(ii) Is fluorine lighter or darker in colour than chlorine?
Explain your answer.

.....

..... [1]

(iii) What is the physical state of bromine at 40 °C?
Give a reason for your answer.

.....

..... [2]

(c) Complete the chemical equation for the reaction of aqueous bromine with aqueous potassium iodide.

..... + 2KI → I_2 + ...KBr [2]

[Total: 10]

4 This question is about organic compounds.

(a) Which **two** statements about members of a homologous series are correct?
Tick **two** boxes.

- They have similar chemical properties. ☐
- They have similar physical properties. ☐
- They have the same functional group. ☐
- They have the same relative molecular mass. ☐
- They have the same number of carbon atoms. ☐

[2]

(b) To which homologous series do methane and ethane belong?

..... [1]

(c) Methane and ethane are both hydrocarbons.

What is meant by the term *hydrocarbon*?

.....

..... [2]

(d) Draw the structure of ethane showing all of the atoms and all of the bonds.

[1]

(e) The hydrocarbon tetradecane, $C_{14}H_{30}$, can be cracked to form a mixture of alkanes and alkenes.

(i) State **two** conditions needed for cracking.

1 .....

2 .....
[2]

(ii) Complete the chemical equation for the cracking of tetradecane to form **two** different hydrocarbons.

$$C_{14}H_{30} \rightarrow C_3H_6 + \text{.....}$$ [1]

(f) Ethanol can be manufactured from ethene.

Complete the word equation for this reaction.

ethene + ... → ethanol [1]

(g) Ethene can be polymerised to form poly(ethene).

Complete the sentence about this reaction using words from the list.

addition **condensation** **ions** **monomers** **oxidation** **polymers**

Ethene ..... combine to form poly(ethene) by ..... polymerisation.
[2]

[Total: 12]

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5 This question is about metals.

(a) Magnesium is manufactured by the electrolysis of molten magnesium chloride.

(i) What information in the diagram shows that molten magnesium is less dense than molten magnesium chloride?

..... [1]

(ii) One of the products of this electrolysis is magnesium.

State the name of the other product.

..... [1]

An unreactive gas is blown over the surface of the molten magnesium.

(iii) Suggest why an unreactive gas and **not** air is blown over the surface of the molten magnesium.

..... [1]

(iv) Suggest the name of an unreactive gas which could be used.

..... [1]

(b) The table shows some properties of four metals.

metal	density in g/cm^3	melting point in °C	relative strength	relative electrical conductivity
aluminium	2.7	660	7	9
cobalt	8.9	1495	21	4
gallium	5.9	30	1	1
nickel	8.9	1455	20	3

Answer these questions using **only** the information shown in the table.

(i) Which metal is most suitable to make the body of an aircraft?
Give a reason for your answer.

.....

..... [2]

(ii) Which metal is most suitable to use for overhead power cables?
Give a reason for your answer.

.....

..... [2]

(iii) Which **two** metals in the table are transition elements?

..... and ..... [1]

(c) Give **two** properties of transition elements which are **not** shown by Group I elements.

1 .....

2 .....
[2]

(d) Cobalt is added to iron to make steel alloys.

(i) What is meant by the term *alloy*?

.....

..... [1]

(ii) Give **one** reason why alloys are used instead of pure metals.

..... [1]

[Total: 13]

6 This question is about sulfur and its compounds.

(a) Natural gas contains hydrocarbons and hydrogen sulfide.

(i) Give the name of the hydrocarbon which is present in the greatest concentration in natural gas.

..... [1]

(ii) Hydrogen sulfide is removed from natural gas by reaction with oxygen in the presence of a catalyst.

What is the purpose of a catalyst?

..... [1]

(b) (i) Name the acid manufactured from sulfur.

..... [1]

(ii) When fossil fuels containing sulfur are burned, sulfur dioxide is formed.
Sulfur dioxide contributes to acid rain.

Give **one** harmful effect of acid rain on buildings.

..... [1]

(iii) Sulfur dioxide is oxidised by nitrogen dioxide in the atmosphere to form sulfur trioxide.

$$SO_2 + NO_2 \rightarrow SO_3 + NO$$

How does this equation show that sulfur dioxide is oxidised?

.....

..... [1]

[Total: 5]

7 Acids have characteristic chemical properties.

(a) Describe the reactions of hydrochloric acid with:
- calcium oxide
- magnesium
- a named indicator of your choice.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Acids react with alkalis such as sodium hydroxide.

(i) What type of chemical reaction is this?

..... [1]

(ii) Which **one** of the following pH values is the pH of an aqueous solution of sodium hydroxide? Draw a circle around the correct answer.

pH 2 pH 5 pH 7 pH 13

[1]

(iii) A mixture of sodium hydroxide and ammonium sulfate is warmed gently.

State the name of the gas produced.

..... [1]

(iv) The melting point of sodium hydroxide is 319 °C.
The boiling point of sodium hydroxide is 1390 °C.

Which **one** of the following statements about sodium hydroxide is correct?
Tick **one** box.

- Pure sodium hydroxide melts over a range of temperatures. ☐
- Impure sodium hydroxide has a sharp melting point. ☐
- Pure sodium hydroxide boils between 319 °C and 1390 °C. ☐
- Pure sodium hydroxide has a sharp boiling point. ☐

[1]

(v) Sodium hydroxide is used in the manufacture of some medicines.

Why is it important that the ingredients used in medicines are pure?

..... [1]

[Total: 10]

8 This question is about iron and its compounds.

(a) A student investigates the rate of reaction of 1 g of iron powder with 25 cm^3 of hydrochloric acid of concentration 2.0 mol / dm^3. The temperature is 20 °C.

What effect do the following have on the initial rate of this reaction?

(i) Using hydrochloric acid of concentration 1.2 mol / dm^3.
All other conditions are kept the same.

..... [1]

(ii) Using a piece of iron of mass 1 g.
All other conditions are kept the same.

..... [1]

(iii) Carrying out the experiment at 25 °C.
All other conditions are kept the same.

..... [1]

(b) Siderite is an ore of iron.

(i) State the name of **one** other ore of iron.

..... [1]

(ii) Siderite contains mainly iron(II) carbonate.

Describe how to show that siderite contains a carbonate.

.....

.....

..... [3]

(c) Iron can be extracted from its oxide by reduction with carbon.
The table shows how easy it is to reduce four metal oxides by heating with carbon.

metal oxide	ease of reduction with carbon
bismuth(III) oxide	only reduced above 250 °C
iron(III) oxide	only reduced above 650 °C
tin(II) oxide	only reduced above 500 °C
titanium(IV) oxide	**not** reduced at 700 °C

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive ⟶ most reactive

[2]

[Total: 9]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **March 2018**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the March 2018 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)(i)	**A**	**1**
1(a)(ii)	M1 **C** M2 **D**	**2**
1(a)(iii)	**D**	**1**
1(a)(iv)	**B**	**1**
1(a)(v)	M1 **F** M2 **B**	**2**
1(a)(vi)	M1 **G** M2 **H**	**2**
1(b)(i)	a shared **pair** of electrons (between two atoms) M1 shared electrons M2 pair of / two electrons	**2**
1(b)(ii)	M1 three correct bonding pairs from one N atom to each of three F atoms M2 (3 pairs of) non-bonding electrons on each of three F atoms to complete an octet M3 (1 pair of) non-bonding electrons on N atom to complete an octet	**3**
1(c)(i)	two (or more) substances not chemically combined	**1**
1(c)(ii)	21(%)	**1**
1(c)(iii)	fractional distillation of liquid air M1 air is made into a liquid M2 (allow air to) boil or evaporate M3 condense the vapours / collect the vapours in order (of evaporation) fractional distillation gets M2 and M3	**3**

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Question	Answer	Marks
1(c)(iv)	boiling points	1

Question	Answer	Marks
2(a)(i)	M1 correct orientation of '+' and '–' on front four ions M2 rest of structure	2
2(a)(ii)	18	1
2(a)(iii)	Ne or Neon	1
2(b)(i)	M1 breakdown of an ionic compound when molten or in aqueous solution M2 (by the passage of) electricity / electric current / electrical energy	2
2(b)(ii)	hydrogen chlorine sodium hydroxide	3
2(b)(iii)	$2H^+(aq) + 2e^- \rightarrow H_2(g)$ M1 H^+ on left hand side with e^- added M2 fully correct equation	2
2(c)(i)	white precipitate	1
2(c)(ii)	to ensure all sodium nitrate / $NaNO_3$ was collected	1
2(c)(iii)	M1 evaporation M2 crystallisation	2

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Question	Answer	Marks
2(c)(iv)	M1 (moles of NaC*l* = 0.20 × 20 ÷ 1000 =) 4(.00) × 10^{-3} or 0.004(00) M2 (M_r of $NaNO_3$ =) 85 M3 (85 × 4(.00) × 10^{-3} =) 0.34 (g) M4 (0.34 × 90 / 100 =) 0.306 (g) OR 0.31 (g)	**4**
2(c)(v)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ M1 = $NaNO_2$ M2 = rest of equation	**2**

Question	Answer	Marks
3(a)(i)	M1 calcium oxide M2 CaO	**2**
3(a)(ii)	(step) **3**	**1**
3(a)(iii)	thermal decomposition	**1**
3(a)(iv)	heating	**1**
3(a)(v)	$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$	**1**
3(a)(vi)	M1 CO_2 is acidic M2 $Ca(OH)_2$ is a base / alkali	**2**
3(b)	$MgCO_3 + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$ M1 $Mg(NO_3)_2$ M2 rest of equation	**2**

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Question	Answer	Marks
3(c)	Mg Si O M1 2.73 / 24 1.58 / 28 3.60 / 16 OR 0.11375 0.0564 0.23(0) M2 0.0.11375 / .0564 0.0564 / .0564 0.230 / .0564 leading to Mg_2SiO_4	**2**

Question	Answer	Marks
4(a)(i)	proton acceptor	**1**
4(a)(ii)	ammonia + named acid → correct ammon**ium** salt M1 ammon**ium** product (from ammonia / ammonium hydroxide + acid) M2 fully correct equation	**2**
4(b)(i)	M1 (moles of NH_3 = 0.68 / 17 =) 0.04(00) M2 (M1 × 3 / 2 =) 0.06(00) M3 (volume of Cl_2 = 0.06(00) × 24000 =) 1440 (cm^3)	**3**
4(b)(ii)	M1 (reactants 2 × 3 × 390 (= 2340) + 3 × 240 (= 720) =) 3060 M2 (products 945 + 6 × 430 (= 2580) =) 3525 M3 M1 – M2	**3**
4(b)(iii)	(**(b)(ii)** is exothermic then) exothermic **and** more energy released than used OR (**(b)(ii)** is endothermic then) endothermic **and** less energy released than used	**1**
4(c)(i)	ammonia / it is oxidised / oxygen is reduced	**1**

Question	Answer	Marks
4(c)(ii)	M1 platinum M2 transition metal / element	2

Question	Answer	Marks
5(a)	homologous series	1
5(b)	$C_nH_{2n+2}O$ OR $C_nH_{2n+1}OH$	1
5(c)(i)	M1 steam M2 catalyst	2
5(c)(ii)	$2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$ M1 species M2 fully correct equation	2
5(d)(i)	M1 at least one –O– link between two blocks M2 correct structure including continuation bonds	2
5(d)(ii)	hydrolysis	1
5(d)(iii)	enzyme OR heat + acid	1
5(e)(i)	locating ((re)agent)	1
5(e)(ii)	<u>distance travelled by substance</u> distance travelled by solvent	1
5(e)(iii)	compare to known data	1
5(e)(iv)	similar R_f values	1

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

2199140551

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **February/March 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **13** printed pages and **3** blank pages.

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1 This question is about gases.

(a) The following substances are gases at room temperature.

letter	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
substance	SO_2	Ar	CO	Cl_2	NH_3	CO_2	CH_4	C_3H_8

Identify, by letter:

(i) a gas which combines with water to form acid rain ..... [1]

(ii) **two** gases which exist as diatomic molecules ..... [2]

(iii) a gas which bleaches damp litmus paper ..... [1]

(iv) a gas which is used as an inert atmosphere in lamps ..... [1]

(v) **two** gases which are found in clean dry air ..... [2]

(vi) **two** gases which are found in refinery gas. ..... [2]

(b) NF_3 has covalent bonds.

(i) What is a covalent bond?

.....

..... [2]

(ii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.
Show outer shell electrons only.

[3]

(c) Air is a mixture. Nitrogen and oxygen are the two most common gases in air.

(i) What is meant by the term *mixture*?

.....

..... [1]

(ii) State the percentage of oxygen, to the nearest whole number, in clean dry air.

..... [1]

(iii) Describe the steps in the industrial process which enables nitrogen and oxygen to be separated from clean dry air.

Use scientific terms in your answer.

.....

.....

.....

.....

.....

.....

..... [3]

(iv) Which physical property of nitrogen and oxygen allows them to be separated?

..... [1]

[Total: 20]

2 Sodium chloride is a typical ionic compound.

(a) The diagram shows part of a lattice of sodium chloride.

(i) Complete the diagram to show the ions present. Use '+' for Na^+ ions and '–' for Cl^- ions. One ion has been completed for you.

[2]

(ii) How many electrons does a chloride ion have?

..... [1]

(iii) Identify an element which has atoms with the same number of electrons as a sodium ion.

..... [1]

(b) Electrolysis of concentrated aqueous sodium chloride is an important industrial process.

(i) What is meant by the term *electrolysis*?

.....

..... [2]

(ii) Name the products of the electrolysis of concentrated aqueous sodium chloride.

1 .....

2 .....

3 .....

[3]

(iii) Write an ionic half-equation for the reaction at the cathode.
Include state symbols.

..... [2]

(c) Silver chloride can be made by reacting aqueous sodium chloride with aqueous silver nitrate. The other product of the reaction is sodium nitrate. The chemical equation for the reaction is shown.

$$NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

A student attempted to make the maximum amount of **sodium nitrate** crystals. The process involved three steps.

step 1 The student added aqueous sodium chloride to aqueous silver nitrate and stirred. Neither reagent was in excess.

step 2 The student filtered the mixture. The student then washed the residue and added the washings to the filtrate.

step 3 The student obtained sodium nitrate crystals from the filtrate.

(i) Describe what the student observed in **step 1**.

..... [1]

(ii) Why was the residue washed in **step 2**?

.....

..... [1]

(iii) Give the names of the **two** processes which occurred in **step 3**.

1 .....

2 .....
[2]

(iv) The student started with 20 cm^3 of 0.20 mol / dm^3 $NaCl(aq)$.

- Determine the amount of $NaCl(aq)$ used.

amount of $NaCl(aq)$ used = ... mol

The yield of $NaNO_3$ crystals was 90%.

- Calculate the mass of $NaNO_3$ crystals made.

mass of $NaNO_3$ crystals = ... g
[4]

(v) Write a chemical equation for the action of heat on sodium nitrate crystals.

..... [2]

[Total: 21]

3 Limestone rock is mainly calcium carbonate, $CaCO_3$.

(a) The 'limestone cycle' is shown. Each step is numbered.

(i) Complete the box to give the chemical name and formula of lime. [2]

(ii) Which step involves a physical change?

..... [1]

(iii) What type of reaction is **step 1**?

..... [1]

(iv) Suggest how **step 2** could be reversed.

..... [1]

(v) Write a chemical equation for **step 4**.

..... [1]

(vi) Explain why **step 4** is a neutralisation reaction. Refer to the substances reacting in your answer.

.....

..... [2]

(b) Dolomite is a similar rock to limestone. Dolomite contains magnesium carbonate, $MgCO_3$.

Write a chemical equation for the reaction between magnesium carbonate and dilute nitric acid.

..... [2]

(c) Forsterite is another rock which contains a magnesium compound.

A sample of forsterite has the following composition by mass: Mg, 2.73 g; Si, 1.58 g; O, 3.60 g.

Calculate the empirical formula of forsterite.

empirical formula = ... [2]

[Total: 12]

4 Ammonia is an important chemical.

(a) Ammonia is a base.

(i) In chemistry, what is meant by the term *base*?

.....

..... [1]

(ii) Write a word equation to show ammonia behaving as a base.

.....

..... [2]

(b) Ammonia reacts with chlorine. The chemical equation is shown.

$$2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$$

(i) Calculate the volume of chlorine, measured at room temperature and pressure, needed to react completely with 0.68 g of ammonia.

volume of chlorine = ... cm^3 [3]

(ii) The chemical equation can be represented as shown.

Use the bond energies in the table to determine the energy change, ΔH, for the reaction between ammonia and chlorine.

bond	bond energy in kJ / mol
N–H	390
C*l*–C*l*	240
N≡N	945
H–C*l*	430

- energy needed to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

- energy change, ΔH, for the reaction between ammonia and chlorine

..... kJ
[3]

(iii) Is the reaction endothermic or exothermic? Explain your answer.

.....

..... [1]

(c) Ammonia reacts with oxygen at high temperatures in the presence of a suitable catalyst to form nitric oxide, NO.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

(i) Explain how this chemical equation shows ammonia acting as a reducing agent.

.....

..... [1]

(ii) Suggest a suitable catalyst for the reaction from the list of metals. Give a reason for your answer.

aluminium **calcium** **platinum** **potassium** **sodium**

suitable catalyst .....

reason .....
[2]

[Total: 13]

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5 Alcohols are a ‘family’ of organic molecules which have the same general formula.

(a) What is the name given to any ‘family’ of organic molecules which have the same general formula and similar chemical properties?

..... [1]

(b) Give the general formula of alcohols.

..... [1]

(c) Propan-1-ol can be made from propene.

(i) Name the reagent and give the conditions needed to convert propene into propan-1-ol.

reagent .....

conditions .....
[2]

(ii) Write a chemical equation for the complete combustion of propan-1-ol.

..... [2]

(d) A simple sugar can be represented as shown.

Simple sugars can be polymerised to make more complex carbohydrates.

(i) Complete the diagram to show part of a carbohydrate **polymer** made from the simple sugar shown.

[2]

(ii) Name the chemical process which occurs when a carbohydrate polymer is broken down into simple sugars.

..... [1]

(iii) What conditions are needed for this process to occur?

..... [1]

(e) Chromatography can be used to identify simple sugars in a mixture.

A student analysed a mixture of simple sugars by chromatography. All the simple sugars in the mixture were colourless.

(i) What is the name given to the type of substance used to identify the positions of the simple sugars on the chromatogram?

..... [1]

(ii) The student calculated the R_f value of a spot on the chromatogram.

Complete the expression for the R_f value of the spot.

R_f =

[1]

(iii) How could a student identify a simple sugar from its R_f value?

.....

..... [1]

(iv) Sometimes not all the substances in a mixture can be identified from the chromatogram produced.

Explain why this may happen.

..... [1]

[Total: 14]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
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actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/52**

Paper 5 Practical Test **February/March 2018**

CONFIDENTIAL INSTRUCTIONS

Great care should be taken to ensure that any confidential information given does not reach the candidates either directly or indirectly.

READ THESE INSTRUCTIONS FIRST

The teacher responsible for preparing the examination is **not** allowed to consult the Question Paper before the examination. Teachers should, as part of the preparation of the examination requirements, carry out any tests indicated on pages 2 and 3 in order to satisfy themselves that the supplied materials are satisfactory.

The Supervisor's Report to be included with the scripts is given on pages 7 and 8. Please detach and enclose it with the scripts. If scripts are despatched in more than one envelope, it is essential that a copy of the Supervisor's Results and of the Supervisor's Report are sent inside **each** envelope.

More material may be issued if required, without penalty, but this should **not** be necessary.

Supervisors are advised to remind candidates that **all** substances in the examination should be treated with caution. Suitable eye protection should be provided.

In accordance with COSHH (Control of Substances Hazardous to Health) Regulations, operative in the UK, a hazard appraisal of the examination has been carried out.

Attention is drawn, in particular, to certain materials used in the examination. The following codes are used where relevant.

C	corrosive	**MH**	moderate hazard
HH	health hazard	**T**	acutely toxic
F	flammable	**O**	oxidising
N	hazardous to the aquatic environment		

Hazard data sheets should be available from your suppliers.

If you have any queries regarding these Confidential Instructions, please contact Cambridge stating the Centre number, the nature of the query and the syllabus number quoted above.

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This document consists of **8** printed pages.

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Question 1

Each candidate will require the following chemicals and apparatus. Labels must **not** include concentrations.

(a) 100 cm^3 of aqueous sodium carbonate, Na_2CO_3, of concentration 0.1 mol / dm^3 labelled **solution L**

(b) 100 cm^3 of dilute hydrochloric acid of concentration 0.2 mol / dm^3 labelled **dilute hydrochloric acid for Question 1**

[F][HH] [MH] **(c)** methyl orange indicator

[F][HH] [MH] **(d)** thymolphthalein indicator

(e) access to water and distilled water

(f) 25 cm^3 or 50 cm^3 measuring cylinder

(g) 50 cm^3 burette with stand and clamp

(h) 250 cm^3 conical flask

(i) white tile

(j) funnel for filling burette

(k) teat pipette

Question 2

Each candidate will require the following chemicals and apparatus. Labels do **not** need to include concentrations.

[C] **(a)** 15 cm^3 of aqueous iron(III) chloride, $FeCl_3.6H_2O$, of concentration 0.25 mol/dm^3 labelled **solution M**

[MH][N] **(b)** 1 g of basic copper(II) carbonate, for example $CuCO_3.Cu(OH)_2$, labelled **solid N**

(c) dilute hydrochloric acid of concentration 1 mol/dm^3

(d) aqueous barium nitrate of sufficient concentration to give a positive sulfate test

[MH][N] **(e)** aqueous silver nitrate of sufficient concentration to give a positive halide test

[C] **(f)** aqueous nitric acid of concentration 1 mol/dm^3

[C] **(g)** aqueous sodium hydroxide of concentration 1 mol/dm^3

[MH] **(h)** limewater and apparatus used to test for carbon dioxide

(i) distilled water

(j) pH indicator papers and chart

(k) splints

(l) apparatus for a flame test

(m) Bunsen burner and matches

(n) rack of test-tubes

(o) hard glass test-tube

(p) test-tube holder

(q) teat pipettes

(r) spatula

The Supervisor's Report is on pages 7 and 8.

The Supervisor's Report is on pages 7 and 8.

The Supervisor's Report is on pages 7 and 8.

This form must be completed and returned in the envelope with the scripts.

Supervisor's Report

1 **(a)** Supervisor's Results

It is recommended that the Supervisor should be a chemistry teacher.

The Supervisor is asked to carry out the experiments in Questions 1 and 2 and to record the results on a spare copy of the Question Paper clearly labelled 'Supervisor's Results'. Failure to enclose these results and this report form may lead to candidates being unavoidably penalised.

(b) The candidate numbers of candidates in each session were:

First session	*Second session*

2 The Supervisor is invited to report details of any difficulties experienced by candidates giving names and candidate numbers. The report should include reference to:

(a) any general difficulties encountered in making preparations for the examination

(b) difficulties due to faulty apparatus or materials

(c) accidents to apparatus or materials.

Other cases of individual hardship, e.g. illness, temporary disability, should be reported directly to Cambridge on the Special Consideration form.

Declaration (to be signed by the Supervisor)

The preparation of this practical examination has been carried out so as to maintain fully the security of the examination.

Name of Centre .....

Centre number .....

Signed .....

Name (in block capitals) ..... (Supervisor)

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CHEMISTRY **0620/52**

Paper 5 Practical Test **March 2018**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)	*table of results* initial, final readings and differences completed correctly	**1**
	all readings to 1 decimal places	**1**
1(b)	*table of results* initial, final readings and differences completed correctly	**1**
	comparable to supervisor's	**1**
1(c)	initial, final readings and differences completed correctly	**1**
1(d)(i)	yellow **and** to orange	**1**
1(d)(ii)	effervescence	**1**
1(e)	Experiment 3	**1**
1(f)	pipette / burette	**1**
1(g)	*effect* no effect	**1**
	reason no change in reactant concentrations/owtte	**1**
1(h)(i)	1:2	**1**
1(h)(ii)	different indicators used / owtte	**1**
1(i)	more than one colour change / cannot find end point	**1**
1(j)	repeat (experiments)	**1**
	compare / average / check spread of results	**1**

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Question	Answer	Marks
2	tests on solution **M**	
2(a)(i)	yellow / brown	**1**
2(a)(ii)	<7	**1**
2(b)	white precipitate	**1**
2(c)	no reaction / change / precipitate	**1**
2(d)	brown	**1**
	precipitate	**1**
2(e)	iron	**1**
	III / 3 / three	**1**
	chloride	**1**
2	tests on solid **N**	
2(f)	green	**1**
2(g)	turns black	**1**
	condensation	**1**
	limewater	**1**
	white precipitate / milky	**1**
2(h)	blue-green	**1**
2(i)	turns darker / turns brown / effervescence	**1**

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Question	Answer	Marks
2(j)	*any two from:* copper / transition element	**1**
	carbonate hydrated / water	**1**

Question	Answer	Marks
3		**max 6**

	gas volume	*mass loss*
M1	Mg added to sulfuric acid	Mg added to sulfuric acid
M2	in a suitable container with ability to have a bung	in a suitable container
M3	methods of measuring gas volume (gas syringe, downward displacement of water using a measuring cylinder)	on a balance
M4	start timer / timing (when added together)	start timer / timing (when added together)
M5	measure volume of gas	measure mass loss
M6	at set time / at end of experiment / at (regular) known intervals	at set time / time to end of experiment / at (regular) known intervals
M7	rate = volume ÷ time	rate = mass loss ÷ time

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

7059295991

CHEMISTRY **0620/52**

Paper 5 Practical Test **February/March 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Total	

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1 You are going to investigate the reaction between dilute hydrochloric acid and an aqueous solution of sodium carbonate labelled solution **L**.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to do three experiments.

(a) *Experiment 1*

- Use the measuring cylinder to pour 25 cm^3 of solution **L** into the conical flask.
- Add ten drops of thymolphthalein indicator to the conical flask.
- Fill the burette up to the 0.0 cm^3 mark with the dilute hydrochloric acid.
- Add dilute hydrochloric acid from the burette to the conical flask, 1.0 cm^3 at a time, while swirling the conical flask, until the solution just changes to colourless.
- Record the burette readings in the table and complete the table.

Keep your solution from Experiment 1 to use in Experiment 2.

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(b) *Experiment 2*

- Now add ten drops of methyl orange indicator to the solution in the conical flask from Experiment 1.
- Record the initial burette reading in the table.
- Add dilute hydrochloric acid from the burette to the conical flask, 1.0 cm^3 at a time, while swirling the conical flask, until the solution just changes colour.
- Record the final burette reading in the table and complete the table.

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

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(c) *Experiment 3*

- Empty the conical flask and rinse it with distilled water.
- Repeat Experiment 1, using methyl orange indicator instead of thymolphthalein indicator and adding dilute hydrochloric acid from the burette to the conical flask until the solution just changes colour.
- Record the burette readings in the table and complete the table.

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[1]

(d) **(i)** What colour change was observed in the conical flask in Experiment 3?

from ..... to .....
[1]

(ii) Apart from the colour change, what was observed in the conical flask in Experiment 3?

..... [1]

(e) Complete the sentence.

Experiment ..... needed the largest volume of dilute hydrochloric acid to change the colour of the indicator. [1]

(f) Give the name of a more accurate piece of apparatus for measuring the volume of solution **L**.

..... [1]

(g) What would be the effect on the results if solution **L** were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on the results .....

reason .....
[2]

(h) **(i)** Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 3.

..... [1]

(ii) Suggest why the volumes of dilute hydrochloric acid used in Experiments 1 and 3 are different.

..... [1]

(i) Suggest why Universal Indicator **cannot** be used in these experiments.

.....

..... [1]

(j) Suggest how the reliability of the results could be checked.

.....

..... [2]

[Total:16]

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2 You are provided with two substances, solution **M** and solid **N**.
Do the following tests on the substances, recording all of your observations at each stage.

tests on solution M

Divide solution **M** into five approximately equal portions in five test-tubes.

(a) **(i)** Describe the appearance of solution **M**.

..... [1]

(ii) Test the pH of the first portion of solution **M**.

pH = ... [1]

(b) Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous silver nitrate to the second portion of solution **M**.
Record your observations.

..... [1]

(c) Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous barium nitrate to the third portion of solution **M**.
Record your observations.

..... [1]

(d) Add an excess of aqueous sodium hydroxide to the fourth portion of solution **M**.
Record your observations.

..... [2]

Keep the fifth portion of solution M for the test on solid N in (i).

(e) Identify solution **M**.

..... [3]

tests on solid N

Divide solid **N** into three approximately equal portions in one hard glass test-tube and two test-tubes.

(f) Describe the appearance of solid **N**.

..... [1]

(g) Heat the first portion of solid **N** in the hard glass test-tube. Heat gently and then more strongly.
Test the gas produced.
Record your observations.

.....

.....

.....

..... [4]

(h) Add about 1 cm^3 of dilute hydrochloric acid to the second portion of solid **N** in a test-tube.
Carry out a flame test on the mixture.
Record the colour of the flame.

..... [1]

(i) Add the fifth portion of solution **M** to the third portion of solid **N** in a test-tube. Leave the solution to stand for about 5 minutes.
Record your observations.

..... [1]

(j) What conclusions can you draw about solid **N**?

.....

..... [2]

[Total:18]

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3 Magnesium reacts with dilute sulfuric acid at room temperature to form hydrogen gas.

Plan an experiment to find the rate of reaction between magnesium ribbon and dilute sulfuric acid.

In your answer:
- include a diagram
- indicate how you could use the results obtained to find the rate of reaction.

You are provided with common laboratory apparatus, magnesium ribbon and dilute sulfuric acid.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **March 2018**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Generic Marking Principles

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GENERIC MARKING PRINCIPLE 1:

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- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

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- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

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Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)(i)	line drawn on diagram between base line and bottom of paper and below dot	**1**
1(a)(ii)	water	**1**
1(b)	dropper / teat pipette	**1**
1(c)	so mixture is above / not in contact/does not run/dissolve in solvent	**1**
1(d)	is two substances / contains **D**	**1**
1(e)	insoluble	**1**
1(f)	2.8 to 3.2 / 5	**1**
	0.56–0.64	**1**

Question	Answer	Marks
2(a)	*table of results final reading and difference completed correctly* 11.6	**1**
2(b)	*table of results with final reading and difference completed* correctly 23.6 **and** 11.6	**1**
2(c)	*final reading completed correctly* 24.1	**1**
	initial reading completed correctly 0.9	**1**
	difference correct 23.2	**1**
2(d)	yellow to orange	**1**
2(e)	to remove impurities / chemicals / residue / solution / owtte	**1**
2(f)	3	**1**

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Question	Answer	Marks
2(g)	pipette / burette	1
2(h)	*effect* no effect	1
	reason no change in reactant concentrations / owtte	1
2(i)(i)	1:2	1
2(i)(ii)	different indicators used / owtte	1
2(j)	more than one colour change / cannot find end point	1
2(k)	repeat (experiments)	1
	compare / average / check spread of results	1

Question	Answer	Marks
3	tests on solution **M**	
3(a)	yellow / brown	1
3(b)	white	1
	precipitate	1
3(c)	no reaction / change / precipitate	1
3(d)(i)	<u>brown</u>	1
	precipitate	1
3(d)(ii)	no change / precipitate remains / insoluble	1

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Question	Answer	Marks
3	tests on solid **N**	
3(e)	carbon dioxide	**1**
3(f)	copper / transition element	**1**
	carbonate	**1**

Question	Answer	Marks
4		**max 6**

	gas volume	*mass loss*
M1	Mg added to sulfuric acid	Mg added to sulfuric acid
M2	in a suitable container with ability to have a bung	in a suitable container
M3	methods of measuring gas volume (gas syringe, downward displacement of water using a measuring cylinder)	on a balance
M4	start timer / timing (when added together)	start timer / timing (when added together)
M5	measure volume of gas	measure mass loss
M6	at set time / at end of experiment / at (regular) known intervals	at set time / time to end of experiment / at (regular) known intervals
M7	rate = volume ÷ time	rate = mass loss ÷ time

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **February/March 2018**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 A student used paper chromatography to separate a mixture of coloured dyes. The diagram shows the apparatus used.

(a) **(i)** Draw a line on the diagram to show the level of the solvent. [1]

(ii) Suggest a suitable solvent that could be used.

..... [1]

(b) What could be used to put the mixture of coloured dyes onto the paper?

..... [1]

(c) The clips hold the paper in position.

Why is this important for the chromatography experiment?

..... [1]

The diagram shows the chromatogram obtained from four dyes, **A**, **B**, **C** and **D**.

(d) Give **one** conclusion that can be drawn about dye **B**.

..... [1]

(e) Suggest why dye **C** remained on the baseline.

.....

..... [1]

(f) R_f values are used to identify compounds.

$$R_f = \frac{\text{distance travelled by the compound}}{\text{distance travelled by the solvent}}$$

Calculate the R_f value of dye **A**.

R_f = ... [2]

[Total: 8]

2 A student investigated the reaction between dilute hydrochloric acid and an aqueous solution of sodium carbonate labelled solution **L**.

Three experiments were done.

Experiment 1

- A measuring cylinder was used to pour 25 cm^3 of solution **L** into a conical flask.
- Ten drops of thymolphthalein indicator were added to the conical flask.
- A burette was filled up to the 0.0 cm^3 mark with dilute hydrochloric acid.
- Dilute hydrochloric acid was added from the burette to the conical flask until the solution just changed to colourless at the end-point of the titration.

(a) Use the burette diagram to record the final burette reading in the table and complete the table.

final burette reading

	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	0.0
difference / cm^3	

[1]

Experiment 2

- Ten drops of methyl orange indicator were added to the solution in the conical flask from Experiment 1.
- Dilute hydrochloric acid was added from the burette to the conical flask until the solution just changed colour.

(b) Use the burette diagram to record the final burette reading in the table and complete the table.

final burette reading

	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	12.0
difference / cm^3	

[1]

Experiment 3

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein indicator and adding dilute hydrochloric acid from the burette to the conical flask until the solution just changed colour.

(c) Use the burette diagrams to record the burette readings in the table and complete the table.

initial burette reading

final burette reading

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[3]

(d) What colour change was observed in the conical flask in Experiment 3?

from ..... to .....
[1]

(e) Why was the conical flask emptied and rinsed with distilled water at the start of Experiment 3?

..... [1]

(f) Complete the sentence.

Experiment ..... needed the largest volume of dilute hydrochloric acid to change the colour of the indicator. [1]

(g) Give the name of a more accurate piece of apparatus for measuring the volume of solution **L**.

..... [1]

(h) What would be the effect on the results if solution **L** were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on the results .....

reason .....
[2]

(i) **(i)** Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 3.

..... [1]

(ii) Suggest why the volumes of dilute hydrochloric acid used in Experiments 1 and 3 are different.

..... [1]

(j) Suggest why Universal Indicator **cannot** be used in these experiments.

.....

..... [1]

(k) Suggest how the reliability of the results could be checked.

.....

..... [2]

[Total: 16]

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3 Two substances, solution **M** and solid **N**, were analysed. Solution **M** was aqueous iron(III) chloride. Tests were done on the substances.

Complete the expected observations.

tests on solution M

(a) Describe the appearance of solution **M**.

..... [1]

Solution **M** was divided into three equal portions in three test-tubes.

(b) Dilute nitric acid and aqueous silver nitrate were added to the first portion of solution **M**.

observations ..... [2]

(c) Dilute nitric acid and aqueous barium nitrate were added to the second portion of solution **M**.

observations ..... [1]

(d) **(i)** Drops of aqueous sodium hydroxide were added to the third portion of solution **M** until a change was seen.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture.

observations ..... [1]

tests on solid N

Some of the tests and observations are shown.

tests on solid **N**	observations
The appearance of solid **N** was studied.	green powder
test 1 Solid **N** was heated. The gas produced was tested.	solid turned black limewater turned milky
test 2 A flame test was done on solid **N**.	blue-green colour

(e) Name the gas produced in **test 1**.

..... [1]

(f) Identify solid **N**.

..... [2]

[Total: 10]

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4 Magnesium reacts with dilute sulfuric acid at room temperature to form hydrogen gas.

Plan an experiment to find the rate of reaction between magnesium ribbon and dilute sulfuric acid.

In your answer:
- include a diagram
- indicate how you could use the results obtained to find the rate of reaction.

You are provided with common laboratory apparatus, magnesium ribbon and dilute sulfuric acid.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Paper 0620/11
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**A**
2	**A**	22	**A**
3	**B**	23	**C**
4	**D**	24	**D**
5	**B**	25	**B**
6	**A**	26	**B**
7	**C**	27	**B**
8	**C**	28	**C**
9	**C**	29	**C**
10	**B**	30	**C**
11	**B**	31	**D**
12	**D**	32	**C**
13	**B**	33	**D**
14	**A**	34	**A**
15	**B**	35	**A**
16	**C**	36	**B**
17	**C**	37	**C**
18	**A**	38	**C**
19	**C**	39	**A**
20	**B**	40	**D**

General comments

Questions 11 and **26** proved to be of lower demand.

Questions 17, **25**, **27** and **32** proved to be more challenging.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 2

Response **D** was slightly more popular than the correct one. Candidates did not appreciate that a burette is necessary to measure 0.1 cm^3 accurately.

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Questions 3

This had an approximately equal number of candidates choosing each alternative. This indicates that a high proportion of candidates were guessing the answer.

Question 8

Response **B**. This was slightly more popular that the correct one. Candidates simply divided 120 by 12 rather than correctly using the information given.

Question 10

Response **C**. Nitrogen was a popular incorrect choice.

Question 13

Response **A**. More candidates chose this response than chose the correct one. They recognised the correct colour change and read no further.

Questions 17

This had an approximately equal number of candidates choosing each alternative.

Question 19

Response **A**. Candidates did not read the question properly and opted for an element in the same group.

Question 25

Response **C**. The chemistry of the blast furnace was poorly understood. Few candidates selected the correct response.

Question 27

Response **C**. This was more popular than the correct response. Candidates found the mathematics challenging and may have been unfamiliar with the experiment.

Question 29

Response **D**. This response was much more popular than the correct one. Candidates did not know that tap water contains dissolved substances and missed the term *soluble* in option 2.

Question 32

Response **A**. This was more popular than the correct response. Candidates were not familiar with sulfur dioxide and its uses.

Questions 38

This had an approximately equal number of candidates choosing each alternative.

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Paper 0620/12
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**D**	21	**C**
2	**D**	22	**D**
3	**B**	23	**A**
4	**D**	24	**C**
5	**A**	25	**B**
6	**B**	26	**B**
7	**C**	27	**B**
8	**C**	28	**C**
9	**D**	29	**C**
10	**D**	30	**A**
11	**A**	31	**B**
12	**D**	32	**C**
13	**D**	33	**A**
14	**A**	34	**A**
15	**B**	35	**A**
16	**C**	36	**B**
17	**C**	37	**A**
18	**B**	38	**C**
19	**B**	39	**B**
20	**C**	40	**C**

General comments

Questions 9, **15**, **17**, **22**, **25** and **29** proved to be the most challenging.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 1

Response **A**. Candidates did not know the meaning of the term *sublimation*.

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Question 4

Response **B**. This response was more popular than the correct response. Candidates did not appreciate that hydrogen has no neutrons.

Question 8

Response **B**. Candidates did not understand the mathematical process involved and simply divided 120 by 12.

Question 9

Response **C**. This response was more popular than the correct response. Candidates knew that lead moves to the negative electrode but selected the wrong option.

Question 11

Response **D**. It was a common misconception that because the reaction loses energy candidates assumed that temperature goes down whereas the energy released by the reaction causes it to increase.

Question 13

Response **C**. Candidates may not have read the second column of the table.

Question 15

Responses **A** and **D** were both more popular than the correct answer. Candidates did not know the tests for the different gases listed in the syllabus.

Question 18

This had an approximately equal number of candidates choosing each alternative. This indicates that a high proportion of candidates were guessing the answer.

Question 22

Response **B** was more popular than the correct one. Candidates often forget that helium, a noble gas, has only two electrons.

Question 24

This had an approximately equal number of candidates choosing each alternative.

Question 25

Response **C** was more popular than the correct response. Candidates did not know all the chemical reactions that take place in the blast furnace.

Question 26

This had an approximately equal number of candidates choosing each alternative.

Question 30

This had an approximately equal number of candidates choosing each alternative.

Question 34

Response **C**. Candidates realised that the result was ‘neutral’ but were unsure of the initial nature of the waste.

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Paper 0620/13
Multiple Choice (Core)

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**D**
2	**A**	22	**D**
3	**D**	23	**B**
4	**B**	24	**C**
5	**B**	25	**A**
6	**A**	26	**A**
7	**C**	27	**B**
8	**C**	28	**C**
9	**B**	29	**C**
10	**B**	30	**C**
11	**C**	31	**A**
12	**D**	32	**D**
13	**B**	33	**B**
14	**A**	34	**A**
15	**B**	35	**A**
16	**C**	36	**B**
17	**C**	37	**B**
18	**C**	38	**C**
19	**B**	39	**A**
20	**A**	40	**C**

General comments

Questions 2, **15**, **32** and **37** proved to be of lower demand.

Questions 10, **16**, **18**, **22**, **23**, **24**, **30** and **31** proved to be particularly challenging.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 6

Response **B**. Candidates realised that Q was a metal but did not know the bonding in hydrogen.

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Question 7

Response **B**. Candidates elected an option which, whilst true, does not answer the question.

Question 8

Response **B**. Candidates did not understand the mathematical process involved and simply divided 120 by 12.

Question 9

Response **A**. Candidates missed the term *molten* in the stem of the question.

Question 10

Response **A**. This response was more popular than the correct response. Hydrogen, a fuel, does not release carbon dioxide whereas all fuels release heat.

Question 11

Response **D**. This response was more popular than the correct response. Candidates were confused by the two prefixes ‘exo’ and ‘endo’.

Question 16

This had an approximately equal number of candidates choosing each alternative. This indicates that a high proportion of candidates were guessing the answer.

Question 18

Response **D**. This was more popular than the correct response. Candidates rejected the three previous options, not realising that a carbonate would have fizzed producing carbon dioxide.

Question 22

Response **A**. This response was more popular than the correct one. Candidates did not consult their Periodic Table and assumed all noble gases have eight electrons in their outer shell.

Question 23

Response **A**. This was more popular than the correct response. Candidates did not know that an alloy shows a random distribution of the atoms of the second metal.

Question 24

Response **D**. This response was more popular than the correct response. The least reactive metals have oxides which react with carbon.

Question 31

Response **B**. This response was more popular than the correct response. Candidates knew that greenhouse gases absorb heat but did not think their answer through.

Question 39

Response **B**. Candidates knew about fermentation but did not remember the ethene process as an addition reaction.

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Paper 0620/21
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**A**	21	**C**
2	**D**	22	**B**
3	**A**	23	**A**
4	**C**	24	**C**
5	**B**	25	**C**
6	**D**	26	**D**
7	**D**	27	**B**
8	**B**	28	**B**
9	**B**	29	**C**
10	**D**	30	**C**
11	**C**	31	**D**
12	**A**	32	**A**
13	**B**	33	**C**
14	**C**	34	**D**
15	**B**	35	**A**
16	**B**	36	**D**
17	**C**	37	**C**
18	**D**	38	**A**
19	**C**	39	**A**
20	**C**	40	**B**

General comments

Questions 4, **5**, **6**, **25**, **29**, **32**, **34** and **40** proved to be of lower demand.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 8

Response **C**. Candidates realised from the equation that there was a difference with a factor of two. However, they applied it in the wrong direction.

Question 16

Response **C**. Candidates confused oxidising agent with the substance being oxidised.

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Question 23

Response **B**. Candidates did not realise that both the elements and the compounds show catalytic activity.

Question 24

Response **D**. Candidates did not realise that copper does not react with dilute acids and missed the electrical conduction.

Question 30

Response **D**. Candidates did not realise that tap water is not pure as it contains dissolved solids, and missed the term *soluble* in option 2.

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Paper 0620/22
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**C**	22	**C**
3	**D**	23	**C**
4	**C**	24	**A**
5	**B**	25	**B**
6	**B**	26	**C**
7	**D**	27	**B**
8	**B**	28	**B**
9	**B**	29	**C**
10	**D**	30	**C**
11	**C**	31	**D**
12	**A**	32	**A**
13	**A**	33	**C**
14	**C**	34	**A**
15	**D**	35	**A**
16	**D**	36	**D**
17	**C**	37	**C**
18	**C**	38	**A**
19	**C**	39	**A**
20	**C**	40	**D**

General comments

Questions 4, **7**, **9**, **17**, **21**, **25**, **29** and **32** proved to be of lower demand.

Question 2 proved to be particularly challenging.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 1

Response **A**. Candidates chose the lightest gas but omitted to take into account the indicator colour change.

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Question 2

Response **D**. This response was more popular than the correct response. Candidates did not realise that two substances with the same R_f value would not separate at all.

Question 30

Response **D**. Candidates did not realise that tap water contains dissolved solids. They also missed the term *soluble* in option 2.

Question 35

Response **B**. Candidates were not familiar with the names for the fractions given in the syllabus.

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Paper 0620/23
Multiple Choice (Extended)

Question Number	*Key*	*Question Number*	*Key*
1	**C**	21	**B**
2	**D**	22	**A**
3	**A**	23	**D**
4	**C**	24	**B**
5	**B**	25	**C**
6	**B**	26	**A**
7	**D**	27	**A**
8	**C**	28	**B**
9	**C**	29	**C**
10	**C**	30	**C**
11	**C**	31	**D**
12	**B**	32	**A**
13	**B**	33	**D**
14	**C**	34	**B**
15	**D**	35	**A**
16	**C**	36	**D**
17	**C**	37	**C**
18	**D**	38	**A**
19	**B**	39	**A**
20	**C**	40	**B**

General comments

Questions 2, **3**, **4**, **7**, **21**, **22**, **27**, **29**, **32** and **33** proved to be of lower demand.

Questions 9, **20** and **30** proved to be particularly challenging.

Comments on specific questions

The following responses were popular wrong answers to the questions listed.

Question 1

Response **B**. Candidates knew that the answer involved diffusion but did not understand the reason for this.

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Question 5

Response **D** is true but does not answer the question. It is electrons which determine chemical properties.

Question 6

Response **D**. Candidates did not fully understand the structure of solid silicon dioxide, only knowing that it was similar to diamond.

Question 9

Response **B**. This response was more popular than the correct response. Candidates got part of the way with the calculation but added less water instead of more.

Question 10

Response **A**. Candidates did not take into account the copper electrodes.

Question 15

Response **C**. Candidates may have been thinking of rate of production rather than yield.

Question 18

This had an approximately equal number of candidates choosing each alternative. This indicates that a high proportion of candidates were guessing the answer.

Question 24

Response **A**. Candidates should realise that the second metal atoms are randomly distributed through the metallic structure.

Question 28

Response **C**. Candidates knew it must be higher but selected wrongly, possibly without doing the maths.

Question 30

Responses **A** and **D** were both more popular than the correct response. Candidates missed the term *solubl*e in option 2 and then found the question challenging.

Question 34

Response **D**. Candidates confused lime with slaked lime.

Question 35

Response **B**. Candidates did not know the names of the fractions that are given in the syllabus.

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Paper 0620/31
Theory (Core)

Key messages

- Many candidates needed more practice in questions involving qualitative analysis.
- It is important that candidates read questions carefully in order to understand what is exactly being asked.
- Many candidates needed more practice in memorising the meaning of chemical terms such as *compound* or *hydrocarbon*.
- The balancing of simple equations and extraction of data from tables was generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. The standard of English was generally good. Most candidates attempted all parts of each question. The exceptions were **Questions 4(e)(i)**, **5(b)**, **5(e)**, **7(a)(i)**, **8(c)** and **8(d)** where a significant number of candidates did not respond.

Many candidates needed more practice in questions involving qualitative analysis. For example, very few candidates knew the test for an unsaturated hydrocarbon (**Question 3(c)(ii)**) or iron(II) ions (**Question 4(e)(i)**).

Some candidates needed more practice in reading and interpreting questions. The rubric was misinterpreted or ignored by some candidates. In **Question 2(b)(ii)** the words 'on health' were ignored. In **Question 4(d)**, many candidates did not refer to the equation as instructed in the stem of the question whilst in **Question 5(a)** some candidates did not choose words from the list. In **Question 6(a)** a considerable number of candidates did not write about the position of the sub-atomic particles in the atom. In **Question 6(c)** some candidates ignored the words 'medical use'.

Many candidates needed more practice in answering questions involving chemical terms without contradicting themselves. For example, in **Question 1(c)**, many candidates wrote about mixtures and in **Question 2(b)(i)** some candidates suggested that hydrocarbons were elements.

Some candidates needed more practice in answering extended questions such as **Questions 3(c)** (diffusion) and **6(a)** (position and number of sub-atomic particles).

Questions involving general chemistry, including organic chemistry, were generally tackled well by many candidates. Many candidates were able to balance simple equations and extract relevant information from tables of data. Others needed more practice in naming salts and understanding the reactions of halogens with halide ions.

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Comments on specific questions

Question 1

Parts **(a)** and **(d)** were generally well answered. Many candidates identified at least three of the gases correctly in part **(a)** and gained at least one mark for the electron arrangement in **part (d)**. Fewer gave a suitable explanation for the use of helium in party balloons (**part (b)(i)**). A greater number gave a correct use of argon in **part (b)(ii)**. The definition of the term *compound* (**part (c)**) was not well known.

(a) (i) Many candidates realised that ammonia turns red litmus blue. The commonest error was to suggest sulfur dioxide.

(ii) A majority of the candidates suggested that sulfur dioxide contributes to acid rain. A wide range of incorrect answers was seen, hydrogen or methane being the commonest.

(iii) A considerable number of candidates appeared not to take account of the term *hydrocarbon* in the stem of the question and gave the incorrect answer 'carbon dioxide'. Another common error was to suggest 'argon'.

(iv) A minority of the candidates identified carbon dioxide correctly. The commonest errors were to suggest either 'hydrogen' or 'ammonia'.

(v) Many candidates identified argon as the noble gas with electronic structure 2.8.8. A wide variety of incorrect answers was seen, the commonest being carbon dioxide, hydrogen or helium.

(b) (i) A minority of the candidates gave correct answers involving the reactivity or flammability of hydrogen or the inert nature of argon. Others did not gain the mark because they implied that helium is reactive, e.g. 'helium is only slightly reactive'. Many gave answers relating to density; the majority of these suggesting that helium is less dense than hydrogen.

(ii) Many candidates suggested lights, lamps or similar correct answers. Others thought that argon was an oil, perhaps by mixing up with argan oil, or a fuel. A minority of candidates either referred to the filament in the lamp rather than the surrounding gas or gave vague statements about argon in the atmosphere.

(c) Few candidates were able to define the term *compound* with the exactitude required. Many described mixtures or unqualified combinations of atoms or sometimes just substances. Many candidates confused atoms, molecules and substances. A large number of candidates, despite referring to bonds or 'joining of different atoms', disadvantaged themselves by starting their explanation with 'a mixture of'.

(d) Many candidates scored at least one mark, most commonly for the three bonding pairs of electrons. Common errors included: extra non-bonding electrons on one or more hydrogen atoms; extra electrons on the nitrogen atom; three bonding electrons or a single non-bonding electron on the nitrogen. A small number of candidates drew a large number of electrons on a single atom, e.g. up to 12, either on each atom.

Question 2

This question was well answered in parts. In part **(a)** many candidates answered parts **(i)** to **(iv)** correctly. Few candidates worked out that the nitrogen came from the air in part **(a)(v)**. Part **(b)** was less well done with a minority of the candidates being able to give a satisfactory definition of a hydrocarbon or a suitable effect of carbon monoxide on health. Many candidates were able to balance the equation in part **(b)(iii)**.

(a) (i) A majority of the candidates gave the correct answer. The commonest errors were to give either 85.5 (the total of the other gases) or a near miss in the calculation, e.g. 15.4.

(ii) Most candidates identified hydrogen as the gas present in the lowest concentration. The commonest error was to suggest hydrocarbons.

(iii) Many candidates gave the correct elements. The commonest errors were to suggest nitrogen and carbon dioxide or carbon dioxide and water.

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(iv) A significant number of candidates who gave CO_2 in part **(a)(iii)** gave the formula of nitrogen dioxide as NCO_2. Other common errors were N_2O_3 and N_2O.

(v) A minority of the candidates realised that the nitrogen came from the air / atmosphere. Many suggested that the nitrogen comes from the exhaust, the engine or from the incomplete combustion of the fuel. Others suggested that it comes from reactions involving hydrogen, carbon dioxide or water. A significant number of candidates gave answers which bore no relationship to the question, e.g. 'from industry' or 'from limestone'.

(b) (i) A minority of the candidates defined a hydrocarbon correctly. Many described mixtures of elements or combinations with other elements. Others omitted the essential idea that there were no other elements present. A significant number of candidates either suggested that hydrocarbons are elements rather than compounds.

(ii) A minority of candidates gave an answer that referred to the poisonous nature of carbon monoxide. Many suggested that it causes cancer or lung diseases or gave biological descriptions involving haemoglobin (rather than giving the effect on the body). Others gave answers that were too vague, e.g. 'effects breathing'.

(iii) Many candidates scored at least one mark for balancing the equation, usually for balancing the carbon in the carbon dioxide. The commonest examples of incorrect balancing for the water molecules were $10(H_2O)$ and $8(H_2O)$. A small number of candidates gave the incorrect balance of $2CO_2 + 2H_2O$.

Question 3

Few candidates scored well in parts **(a)(i)** (diffusion) and **(a)(ii)** (explaining why limonene is a solid at –80°C). Many candidates could define a catalyst in part **(b)(i)** and oxidation in part **(b)(ii)** but fewer were able to describe the colour change when bromine is added to an unsaturated compound in part **(c)(ii)**.

(a) (i) Many candidates recognised that diffusion was occurring. Fewer explained diffusion in terms of the particles moving randomly from areas of higher concentration to areas of lower concentration. Many just described the smell moving or the limonene moving. A minority of the candidates did not recognise the physical process of diffusion and described chemical reactions with the air. Very few candidates wrote about the particles escaping from the liquid to form a vapour.

(ii) A minority of the candidates gained both marks. Those who scored one mark either did not give an explanation or gave the state as being liquid. Some responses just referred to the melting or boiling points as changing, which was insufficient. A significant number of candidates misunderstood the negative signs and wrote statements such as 'because –80°C is higher than –74°C'.

(b) (i) A majority of the candidates could describe the purpose of a catalyst. Many seemed to think that all catalysts are enzymes. Common errors were to suggest that a catalyst changes the rate of reaction and this was not a specific enough answer, or to refer to other properties of catalysts, e.g. 'they are not used up in the reaction'. Some candidates suggested incorrectly that catalysts do not take part in the reaction.

(ii) Many candidates gave a suitable definition of oxidation. Others gave more than one definition and sometimes contradicted themselves by writing incorrect statements such as 'gain of electrons' or 'when you take the oxygen away'. Some candidates referred to the oxygen alone without reference to any other element or gave vague answers such as 'when you oxidise something'.

(c) (i) Many candidates identified the double bond. The commonest errors were to either refer to the CH_3 group or to the OH group.

(ii) Some candidates knew the correct colour change when aqueous bromine reacts with an unsaturated compound. Others either reversed the colours (colourless to orange) or guessed the colour of the product, green, purple or blue being commonly seen. Common incorrect colours for aqueous bromine were red or pink. A few candidates suggested white or clear for the colour of the product, which was not accurate enough.

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Question 4

Many candidates gave good answers to part **(a)**, **(c)** and **(e)(ii)**. Fewer were able to describe three ways in which the properties of iron differ from those of potassium in part **(b)** and many did not use the equation provided in part **(d)** to explain how the iron(III) oxide is reduced by hydrogen. The test for iron(II) ions in part **(e)(i)** was not well known and in part **(f)** many candidates did not use all the information in the diagram.

(a) Some candidates gave the correct order of reactivity but many reversed the order completely. Others seemed to rely on their existing knowledge of the reactivity series rather than using the information in the table. This was obvious from the large number of candidates who wrote down lists of relative reactivity either next to the question or on one of the blank pages.

(b) Many candidates gained one or two marks for correct comparisons of the properties of iron and potassium but few gained all three marks. Many described properties which were common to both metals e.g. conductivity. Some thought that one was a metal and the other was a non-metal or described their relative positions in the Periodic Table. A significant number of candidates did not mention which metal they were writing about. Many candidates did not score because they wrote about electronic structure, valency or physical state or did not compare properties sufficiently well, e.g. iron is malleable, rather than less malleable than potassium.

(c) Most candidates balanced the equation successfully. The 3(Fe) was the mark most often scored. Common errors were 4(Fe) + 2(O_2); 2(Fe) + 2(O_2) and 2(Fe) + 3(O_2).

(d) Many candidates gave a definition of reduction but did not apply the concept of reduction to the equation. Others described the equation without explaining how it was a reduction. Many candidates described the iron as losing oxygen rather than the iron oxide losing oxygen.

(e) (i) Very few candidates knew the test for iron(II) ions. A wide variety of incorrect test reagents were seen including indicators (mainly litmus), flame tests, barium nitrate and hydrochloric acid. Many described how iron chloride might be formed. A few suggested that a green precipitate would be formed but used the incorrect test reagent. Of those who gave the correct test reagent, about half suggested a red-brown precipitate.

(ii) Some candidates gave the correct molecular formula. The commonest error was to suggest $FeCl_3$. Other common errors included $FeCl_6$, 2Fe6C*l* or 2Fe + 6C*l*. Some candidates disadvantaged themselves by writing two formulae, one correct and one incorrect.

(f) Few scored more than one mark for this question. Many candidates only chose one bottle. Some candidates realised that calcium chloride dries the air but then assumed that it removed oxygen as well. Many candidates wrote conflicting statements. Some realised that air and water were necessary for rusting but were unable to identify which of the bottles contained only air, only water or both air and water.

Question 5

Most candidates gave a good answer to part **(a)** and many answered parts **(b)** and **(c)** correctly. Fewer candidates predicted the correct electrode products in part **(d)**. Even fewer identified the brown solution or gave a correct explanation in part **(e)**.

(a) Most candidates performed well. The commonest errors were: electroplating or heat, instead of break down; element, instead of compound; gaseous or electroplating, instead of molten and electroplating, instead of electricity. A few candidates did not select words from the list.

(b) Most candidates gained at least one mark. Some confused the anode with the cathode; others labelled the electrolyte incorrectly. The commonest errors being to label the electrodes or the cell.

(c) Many candidates gave a suitable reason for using a graphite electrode. Others just stated that it was a non-metal or gave irrelevant properties such as density, hardness or catalysis. A considerable minority referred to cheapness.

(d) Some candidates realised that zinc is formed at the negative electrode. Fewer identified iodine being formed at the positive electrode. Many reversed the products, having the zinc at the positive

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electrode. Common errors, applying indiscriminately to each electrode, included hydrogen, oxygen or zinc iodide. A significant number of candidates gave irrelevant answers such as 'electrons' and 'neutrons'.

(e) A minority of candidates gained one mark and very few gained both marks. The commonest error was to suggest that the brown colour was caused by the formation of bromine even though there was no bromine or bromide in the equation. A considerable number of candidates suggested that zinc chloride is the brown-coloured product. A few candidates recognised that chlorine is more reactive than iodine, but most made the comparison with bromine, zinc bromide or zinc. Others tried to give reasons unrelated to the reactivity series.

Question 6

Candidates responded well to some parts of this question, especially parts **(b)** and **(d).** The question about the structure of the atom (part **(a)**) was less well answered with many candidates ignoring the position of the sub-atomic particles. In part **(c)**, some candidates knew about the medical uses of radioactive isotopes; others did not take note of the word 'medical' in the stem of the question and wrote about other uses.

(a) The location of electrons was not made clear by many candidates. Statements such as 'in energy levels' or 'in shells' were not sufficient to gain the mark. Many candidates suggested that 'the electrons are outside the atom', rather than outside or surrounding the nucleus. Many gained only three marks because they identified the correct number of number of electrons, protons and neutrons but did not describe their position. Others described the position by trying to relate it to the isotopic symbol, e.g. 'the proton number is lower' or 'the neutrons plus protons are up'.

(b) Many candidates performed well. Element was nearly always seen.

Some candidates wrote 'molecular' or 'nucleon' in place of 'atomic' or 'ions' in place of 'atoms'. Others did not use words from the list as instructed.

(c) Some candidates ignored the word 'medical' in the stem of the question and described energy production or testing for leakages in pipelines. Others wrote vague statements such as 'in medicines' or incorrect statements such as 'chemotherapy'.

(d) A majority of the candidates recognised the isotope of uranium. The commonest error was to suggest the isotope of iodine. The isotope of xenon was also selected by a minority of candidates.

Question 7

Parts **(a)(i)**, **(a)(iii)**, **(b)** and **(d)** of this question were answered well by a majority of the candidates. In part **(a)(ii)** the direction of the trend was not always made clear whilst in part **(c)**, the correlation between the basic nature of sodium oxide and the position of sodium in the Periodic Table was often missing or the answers were too vague. In part **(e)** some candidates were able to complete the word equation correctly. Others gave names which appeared to be a random arrangement of elements and compounds.

(a) (i) Most candidates gave suitable figures within the ranges so that a trend was followed. More candidates made errors with the values for atomic radius than with the values for thermal conductivity.

(ii) Some candidates did not make clear whether the direction of the trend in boiling point was decreasing up or down the group. Others tried to link the trend in boiling point to the trend in atomic radius or reactivity, often unsuccessfully.

(iii) Some candidates gave answers that were identical to the observations about the extent of bubbling for potassium, e.g. 'very rapid bubbling'. Others just suggested 'bubbling' without any further qualification or suggested that there was 'no reaction'. A significant number of candidates gave a description that was not an observation such as 'reacts rapidly'.

(b) Many candidates realised that an electron is lost when a sodium atom forms a sodium ion. The commonest error was to suggest electron gain. A few candidates suggested that the sodium atom gains a proton.

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(c) Many candidates realised that sodium oxide is a basic oxide but a considerable number thought that sodium oxide is an acidic oxide. The best answers focussed on the position of sodium in the Periodic Table or the fact that sodium is a metal. Common errors included: 'it is a less reactive oxide'; 'sodium gains protons' or 'sodium gains oxygen'.

(d) Many candidates calculated the relative formula mass correctly. The commonest errors were: to use atomic numbers rather than atomic masses; to use a relative atomic mass of carbon of 16, thus giving an answer of 92, or to not take the number of each atom into account, thus giving an answer of 36.

(e) A minority of the candidates gained full credit for the word equation. A common error was to suggest that hydrogen is formed instead of water. The salt was sometimes named as an incorrect combination of elements and compounds, e.g. 'sodium sulfuric oxide', 'sodium sulfuric acid'. Other common errors were 'sodium hydroxide', 'sodium sulfite' or 'sodium sulfide'.

Question 8

Some candidates gave good answers to most parts of this question but a considerable minority did not attempt parts **(c)** and **(d)**. Most candidates were able to read the volume of gas from the graph in part **(b)**. Fewer gave a convincing explanation of why the volume of hydrogen remains the same in part **(a)** or could name the salt in part **(d)**.

(a) Some candidates just paraphrased the stem of the question and wrote answers such as 'the hydrogen produced stays the same'. Others described a limit to the maximum amount of hydrogen released without further explanation. A few candidates described correctly that hydrogen chloride was the limiting reagent. Others did not take note of the term *excess zinc* in the stem of the question and suggested that all the zinc had been used up.

(b) A majority of the candidates deduced the volume of gas correctly. The commonest error was to misread the scale of the graph and give a value of 48 cm^3 instead of 38 cm^3.

(c) Many candidates gained credit for drawing a shallower gradient. Fewer gained credit for estimating the final volume of hydrogen produced when the concentration of hydrochloric acid is halved. Many drew curves which ended with the same overall volume and a significant number drew curves that ended up higher than the 54 cm^3 on the *y*-axis.

(d) Some candidates gave the correct name of the salt. Others either made up names such as zinc hydrochloric acid or added elements that were not present in either reactant, e.g. oxygen (incorrect answer: zinc oxide) or iodine (incorrect answer: zinc iodide).

(e) A majority of the candidates realised that the pH value of an acid is below pH 7. A significant number suggested pH 7. Fewer suggested values of pH 9 or pH 13.

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Paper 0620/32
Theory (Core)

Key messages

- Questions requiring simple answers to calculations were usually answered well, as were questions involving balancing equations and organic definitions.
- Questions on more detailed aspects of kinetic particle theory needed to contain a more focused explanation and attention to detail. Candidates needed to think more carefully when constructing their answers.
- Some candidates needed more practice on answering questions requiring extended answers, e.g. **Questions 4(a)** and **6(a)**. Questions involving extended writing need to contain the same number of relevant points as the number of marks available. This should also be applied to any other question that has more than one mark available.
- It is very important that candidates read the question carefully in order to understand what exactly is being asked. This was particularly the case in **Question 8(b)**. Practice of reading and interpreting data based questions should also be prioritised.
- Many candidates needed more practice at answering questions involving the organic parts of the syllabus. The questions that related to practical techniques, namely electrolysis, need to be concentrated on and practised. More specific revision of the chemical tests specified in the syllabus would also be an advantage to many candidates.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. Good answers were shown throughout the paper to a number of different questions. Most candidates found parts of every question challenging with the longer questions, in particular, being poorly answered. Nearly all candidates were entered at the appropriate level but there were a few candidates who did not attempt several parts of the question paper. It was evident that many candidates are now using past paper practice as part of their revision program, but more revision is needed on some aspects of the syllabus.

Misinterpretation of the rubric did happen in some cases. The most common was in the question that asked for ‘the greatest temperature rise per gram’. However, not reading the question properly was a key factor of some making slight mistakes in their answers. The use of ‘chlorine’ instead of ‘chloride’ and ‘chloride’ instead of ‘chlorine’ was seen and needs to be practiced. For example, in halogen displacement questions most candidates thought the answer was ‘chlorine’ not ‘chloride’. The balancing of equations indicated that candidates had practiced these as part of their revision from past papers. Definitions from across the syllabus were poorly done and candidates need to concentrate on them both when being taught for the first time and during the revision period.

The vast majority of candidates were able to ‘calculate the relative molecular mass’. However, a few candidates used atomic numbers instead of mass numbers in this question. Most candidates could give at least one answer to the comparison of manganese with sodium. Data handling type questions could have been answered better. Candidates were much better at estimating melting points and densities.

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Dot-and-cross diagrams were drawn very well as in the 'dot-and-cross diagram for chlorine'. Candidates needed to be more explicit when talking about certain concepts and not use the words 'it' and 'they' to answer questions as this can lead to unclear responses. Some candidates wrote their answers as short phrases or bullet points. Candidates are less likely to write vague statements or contradict themselves if this is done.

Comments on specific questions

Question 1

Candidates tackled this question reasonably well; some struggled with parts **(a)(i)** and **(ii)**.

(a) (i) A very small proportion of candidates answered this question correctly. Candidates did not seem to know that chlorine was the correct answer, with many thinking the answer was ammonia.

(ii) This question proved challenging. Candidates would have benefitted from revising the chemical tests.

(iii) This was a well answered question – only a few candidates thought it was helium.

(iv) The products of incomplete combustion had not been revised enough and lots of different answers were seen here.

(v) Candidates did not seem to know the correct answer here and ethane was seen quite a few times.

(b) (i) This was a well answered question with most candidates realising that diatomic meant two atoms but two atomic was not allowed. Two or more atoms was also seen in a few instances.

(ii) This was one of the least well answered questions on the paper. Only a very small proportion of candidates knew the definition for this, with it being something that needs to be concentrated on when teaching this part of the syllabus.

(c) This was a very well answered question. Dot-and-cross diagrams have obviously been worked on. Candidates needed to make sure that they counted how many electrons were in the outer shell when they finished this question.

Question 2

Candidates answered this question well. The part question that most struggled with was **(c)(i).**

(a) (i) Calculators are a must for this type of question. Where candidates did not quite get the correct answer, calculator error was probably the cause so candidates need to be encouraged to check their keying in of numbers more than once on the calculator.

(ii) Only a very small minority of candidates did not achieve this mark.

(b) (i) This was a poorly answered question where some candidates thought they 'caused cancer' or were 'poisonous/toxic'. Candidates need to learn at least one adverse effect for any of these gases that are mentioned in the syllabus.

(ii) This was a very well answered question. Most of the candidates that were entered for this paper can now balance equations with a degree of confidence.

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(iii) More practice is needed on naming salts from formula. NO_3^- is nitrate not nitrite, as some candidates thought. Some candidates thought that NO was nobelium and had obviously wasted time looking through the Periodic Table to find it. Candidates need to know that capital letters are new elements. NO is nitrogen and oxygen in this case. Sodium nitroxide was also seen in quite a few different instances.

(c) (i) This question was not answered well. Some candidates thought that the answer was to do with having enough solid dissolved in water, which showed that they had not read the first part of the question which said that the 'petrol contains saturated hydrocarbons'. Some candidates wrote about single bonds but forgot to mention the word 'only'.

(ii) Many candidates achieved at least one mark on this question. Candidates needed to realise the word 'only' must be used again and that a hydrocarbon is a 'compound'. Some candidates thought that oxygen was present.

(d) This part question was well answered in many cases. The alkanes needed to be added together, which most candidates could do. Not making slight mistakes on calculators and repeating a calculation needs to be practiced.

Question 3

This proved to be a challenging question for most candidates. The structure of the alcohol group in **(a)(ii)** was a problem to most candidates as well as **(a)(iv)** the polymer definition.

(a) (i) Many candidates did get five types of element but some missed out one element and got four – probably not spotting the sulfur. More practice is needed in answering this type of question.

(ii) This question was not answered very well by most candidates, with many candidates circling carbons as well as the 'OH' group. Many candidates also circled the 'OH' on the carboxylic acid which was wrong. Some candidates did not attempt this question at all.

(iii) This was a well answered question. Candidates had obviously been taught this well and had revised it in readiness for the examination.

(iv) Most candidates did not know this polymer definition and more practice is needed here.

(b) (i) This was a poorly answered question. Typical properties of acids were looked for, which candidates did not know. 'Reacts with sodium hydroxide' or 'reacts with a carbonate' were correct answers. Candidates did not put these down and instead talked about melting and boiling points. Some candidates did get 'pH below 7'.

(ii) Not many candidates achieved the mark here. Other groups were seen like alcohols and alkenes. Candidates needed to practice the drawing of molecules. Some candidates did get the correct answer but then others were nearly there but forgot the bond between the oxygen and hydrogen.

(c) (i) Many candidates worked out it was a solid. Some candidates realised that –120°C was below –114°C as the justification for the solid answer. However, some candidates got mixed up with negative numbers and how they work for temperatures and thought the temperature was above the melting point. Many candidates had obviously practiced this type of question as part of their preparation for the examination.

(ii) The second blank proved to be the hardest with not many candidates writing down 'ethene' here. Candidates need to be reminded not to over write the 'e' and the 'a' in an alkene and alkene, as answers must be unambiguous. It is better for a candidate to cross the work out and rewrite it. Candidates must be encouraged to do this as part of their examination technique. More revision on the manufacture of ethanol needs to be done.

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Question 4

Most candidates did well on this question, especially on **(c)(ii),** the balancing of the equation. Candidates struggled on **(c)(i)**, showing that chemical tests needed to be revised more. There was an improvement on answering the 'kinetic particle model' question but candidates needed to mention the term *molecules* or *particles* in their answer.

(a) There was some improvement in the answering of this 'kinetic particle model' question. However, some forgot to mention the term *particles* or *molecules* in their answers. Further practice on this type of question would be very helpful.

(b) Candidates answered this question well. Some got mixed up with the definition for oxidation and put the definition for reduction instead. The gain and loss of electrons was also occasionally mixed up.

(c) (i) Candidates found this part challenging. The chemical tests proved hard for candidates to recall. More revision time should be used learning these tests and frequent revisiting in class would be very advantageous. This part of the syllabus needs more time given to it.

(ii) The balancing of the equation was answered very well by most candidates.

(d) Most candidates could get the metals in the correct order. A few candidates used the term *metal* in one of the boxes, which showed that they had not processed the boxes correctly.

(e) Not many candidates gained full credit here. Some candidates did not read the question properly and talked about 'going down the group'. In this sort of question, it is better for the candidates to think about transition metal properties rather than just ordinary metal properties. It is also better for candidates to be taught as part of exam technique to name the metals they are talking about rather than calling them 'it' as sometimes it is hard to decide which metal is being talked about. All responses must be unambiguous.

Question 5

Candidates struggled with part **(a)(i)** and did not know how to collect the gas from the electrodes. They also struggled with **(a)(iii)**, as they forgot the fact that it was an aqueous solution.

(a) (i) Only very few candidates got this question correct. This was probably the most challenging question on the paper and lots of candidates did not answer it. Candidates did not realise that two test-tubes placed over the two electrodes was sufficient. Candidates who did attempt the question tried to cover the two electrodes with the same vessel (for example a beaker) and therefore were not awarded the mark. Candidates who were experienced with the practical aspects of this course were more likely to perform well here.

(ii) The vast majority of candidates were able to access and answer this question. A common incorrect response was 'canode'.

(iii) This was a poorly answered question, with candidates not reading the question properly and not noticing the term *aqueous*. This meant that 'sodium' was given as the main product at the negative electrode, which was incorrect. Some candidates gave 'chloride' instead of 'chlorine'.

(iv) Some candidates did get the correct element here. Other candidates thought that other reactive elements like copper could be used. Candidates would have benefited from more revision of electrolysis experiments.

(b) (i) Most candidates got the correct answer here. Candidates must always ensure that they write down the correct units, as '150 cm^3' was an incorrect answer.

(ii) Very few candidates achieved the correct answer here – most of them thinking that the melting point 'increased'.

(c) This practical based question was poorly answered. 'Crystallisation' or 'evaporation' are the main answers that were seen in some cases but many candidates did not use those words successfully.

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Question 6

Part **(a)** was answered well by most candidates. Many candidates did not know the in-depth definition of the term *isotopes* in part **(b).**

(a) This was a very well answered question, especially by the candidates who went on to gain the higher marks on this paper. These candidates were able to easily answer about the numbers of protons, neutrons and electrons in the stated isotope and also to say where the sub-atomic particles were in the atom. Some candidates did misinterpret this question by thinking the position meant where the sub-atomic particles were in terms of how the symbol is written; for example 'protons are found at the bottom of the symbol'.

(b) Candidates did not seem to know the in-depth definition of the term *isotope*. Some could say that there are the 'same numbers of protons but different numbers of neutrons' but forgot to use the fact that they are 'atoms'. More revision of definitions was needed here.

(c) Candidates needed to read the question carefully, as it was asking for 'one industrial use' – many candidates put a 'medical' use of radioactive isotopes.

Question 7

Parts of this question were answered well including **(a)(i)** and **(c)**. Candidates struggled with the 'density of chlorine' in part **(a)(ii)** and they had not mastered the displacement word equations from the halogens part of this course in part **(b)**.

(a) (i) Most candidates could identify the trends in melting points and densities of the halogens and they put the correct figures into the table. Candidates need to be discouraged from using ranges of numbers because these usually fall outside the allowed parameters. It is not always a good idea for candidates to use numbers too near to the lower or upper parameter. It is best to use numbers in the middle. Not many candidates realised that the colours got darker down the group.

(ii) This was a poorly answered question by most candidates, as they did not realise that chlorine is a 'gas' at room temperature and that is why its density is lower than that of bromine and astatine.

(iii) Some candidates needed to expand their answer. 'Increases' was not enough, as the trend was not wholly identified. 'Increases down the group' was the appropriate answer and candidates must be encouraged to practice these questions more.

(b) This question was poorly answered. Candidates struggled with the products of a halogens displacement reaction. 'Potassium bromine' was seen, as well as 'bromine iodide'. More practice is needed when studying this part of the course. Not many completely correct answers were seen here.

(c) Candidates were well practiced at this relative molecular mass question, showing much practice and revision. Not many wrong answers were seen here. Some candidates did use atomic numbers instead of masses.

Question 8

Candidates answered parts **(e)(i)** and **(iii)** well but struggled with parts **(a)** and **(b)**.

(a) Some candidates got both answers correct. Candidates struggled with the practical aspects and this is something that needs to be concentrated on. Typical wrong answers were 'same amount of fuel' and 'same starting temperature'. Candidates were better to 'keep the distance of the flame to the can the same' and the 'same volume of water'.

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(b) This question was very poorly answered by all candidates. Most candidates used the answer '**C**' which was wrong – they did not spend enough time on the question and read it carefully enough. Candidates needed to give the 'greatest temperature rise per gram'. It was evident that candidates did not spend enough time reading the question properly.

(c) It is a good idea for candidates to know at least two uses of the substances mentioned for uses in the syllabus. It was evident that some candidates only knew that ethanol was used as a 'fuel', as they used this in their answer even though it was mentioned at the start of the question. This is a good reason to know at least two uses.

(d) (i) Candidates did get mixed up with this question and lots of different answers were seen. If a straight forward word equation for complete combustion had been asked for, then most candidates would have achieved the two marks but in this question a little bit more reading and thinking was needed.

(ii) Using the information in the diagram to explain the answer was a challenge for most candidates. Explaining energy profile diagrams needs to be practiced more. Pointing out which has the most energy, reactants or products, is a good starting point here.

(e) (i) The definition of the term *alloy* was generally good. Candidates had learned the definition and obviously practiced it. Some candidates thought it was a 'combination' of metals and a few thought that an alloy just had non-metals in it.

(ii) Not many candidates could answer the 'arrangement' part of this question correctly and talked 'tightly packed' instead of a 'lattice' or 'regular' arrangement. More candidates could get the 'type of motion' part with the correct answer of 'vibration'.

(iii) This last question was very well answered with candidates able to talk about the fact that stainless steel does not corrode or iron does. Candidates must guard against talking about iron being 'corrosive'.

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Paper 0620/33
Theory (Core)

Key messages

- Many candidates needed more practice in questions involving qualitative analysis.
- It is important that candidates read questions carefully in order to understand what is exactly being asked.
- Many candidates needed more practice in memorising the meaning of chemical terms such as *compound* or *hydrocarbon*.
- The balancing of simple equations and extraction of data from tables was generally well done.

General comments

Many candidates tackled this paper well, showing a good knowledge of core Chemistry. Nearly all candidates were entered at the appropriate level. Most candidates attempted all parts of each question. The exceptions were **Questions 4(a)(ii)**, **5(d)**, **7(a)(i)**, **7(a)(i)**, **7(b)**, **7(c)** and **(8)(e)** where a significant number of candidates did not respond.

Many candidates needed more practice in questions involving qualitative analysis. For example, very few candidates knew the test for water using cobalt chloride (**Question 3(b)(ii)**), the test for an unsaturated hydrocarbon (**Question 4(a)(ii)**) or the test for bromide ions (**Question 5(f)**).

Some candidates needed more practice in reading and interpreting questions. The rubric was misinterpreted or ignored by some candidates. In **Question 2(a)(i)** the words 'on health' were ignored. In **Question 3(g)**, many candidates did not refer to the equation as instructed in the stem of the question, whilst in **Question 4(b)(iii)** some candidates did not choose a 'use in industry' as asked for by the question. In **Question 6(a)** a considerable number of candidates did not write about the position of the sub-atomic particles in the atom.

Many candidates needed more practice in answering questions involving chemical terms without contradicting themselves. For example, in **Question 1(b)(ii)**, many candidates wrote about single atoms or compounds rather than elements and in **Question 6(c)** some candidates suggested that nucleons were only protons or the mass of the element.

Some candidates needed more practice in answering extended questions such as **3(a)** (diffusion) and **6(a)** (position and number of sub-atomic particles).

Questions involving general chemistry, including organic chemistry, were generally tackled well by many candidates. Many candidates were able to balance simple equations and extract relevant information from tables of data. Others needed more practice in naming salts, describing how a soluble salt can be separated from an insoluble salt and in understanding the reactions of halogens with halide ions.

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Comments on specific questions

Question 1

Most candidates identified two of the gases correctly in part **(a)** but only a minority of the candidates identified the gas that forms an acidic solution in part **(i)** or identified the monatomic gas in part **(ii)**. In part **(b)** most candidates identified two elements in **(b)(i)**; fewer gave a convincing explanation of the term *element* in **(b)(ii)**. The dot-and-cross diagram in part **(c)** was generally well answered.

(a) (i) A minority of the candidates identified hydrogen chloride. The commonest error was to suggest ammonia. The next most common error was to suggest ethene.

(ii) A minority of the candidates correctly identified helium as being monatomic. The commonest error was to suggest hydrogen. Other common errors were ammonia or methane.

(iii) Some candidates correctly identified nitrogen as forming 78% of dry air. Hydrogen was the commonest incorrect answer. The next most common error was methane.

(iv) Some candidates correctly identified methane as the main constituent of natural gas. Hydrogen was the commonest incorrect answer. Hydrogen chloride or ammonia were other errors seen.

(v) Many candidates were able to identify the molecule containing 14 protons. The commonest error was to suggest hydrogen chloride.

(b) (i) Nearly all the candidates were able to identify two elements from the list.

(ii) A minority of the candidates gave a good definition of the term *element*. Many answers were too vague to give credit, e.g. 'a set of one atom', 'two or more atoms together', 'a product in the Periodic Table'. Better performing candidates wrote about substance containing only one sort of atom. A significant number of candidates wrote 'the same type of molecule', which could apply to ammonia or hydrogen chloride'.

(c) Many candidates drew a correct dot-and-cross diagram for hydrogen chloride. Some only gave a bonding pair of electrons. Common errors included: too many electrons on the chlorine atom; one or no bonding electrons or addition of extra non-bonding electrons on the hydrogen atom.

Question 2

This question was generally the best-answered on the paper. Many candidates gained full credit for parts **(a)(i)**, **(b)** and **(c).** Fewer gained full credit for comparing the composition of the exhaust gases in part **(a)(ii)** or for giving one adverse effect of sulfur dioxide on health in part **(a)(ii)**.

(a) (i) Most candidates gave the correct answer. The commonest errors arose from not including all the figures in the addition.

(ii) Many candidates gave at least two differences in the composition of the exhaust gases. Others wrote statements that were too vague, e.g. 'there is a greater volume of gases, which are not harmful in petrol' or 'there is more volume of gases in the petrol engine than the diesel'.

(iii) Some candidates gave a correct effect of sulfur dioxide on health. Others did not focus on the word 'health' in the stem of the question and gave answers such as 'hazardous for the environment' or 'acid rain'. Some answers were incorrect because they either referred to disease or cancer. A significant number of candidates appeared to muddle the effect of sulfur dioxide with that of carbon monoxide.

(b) Nearly all the candidates filled in the gaps in the sentences correctly. The commonest errors were 'density' or 'crystallisation' (instead of distillation), 'poly(ethene)' (instead of kerosene) and 'poly(ethene)' (instead of boiling).

(c) Most candidates were able to balance the equation. The commonest errors were $3(H_2O)$ and $2(CO_2)$. Those who made errors, generally gave an incorrect balance for the carbon dioxide. A significant number of candidates gave a balance of $2(H_2O)$ and $2(CO_2)$.

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Question 3

Parts **(b)(i)**, **(d)** and **(f)** were answered well by many candidates. Many did not give detailed enough answers to part **(a)** (diffusion) and **(g)** (reduction). Few knew the test for water using anhydrous cobalt chloride (part **(b)(ii)**). Some candidates were able to give three differences between cobalt and lithium in part **(e)**. Others wrote answers that were too vague.

(a) Some candidates recognised that diffusion was occurring. Few explained diffusion in terms of the particles moving randomly from areas of higher concentration to areas of lower concentration. Many just described the cobalt chloride moving or the colour moving. A minority of the candidates did not recognise the physical process of diffusion and described chemical reactions in the solution.

(b) (i) Many candidates recognised the symbol for a reversible reaction. Common errors included: 'balanced equation'; 'same reactants and products' or 'turns into products'.

(ii) Few candidates knew the test for water using anhydrous cobalt chloride. Many confused it with the test for water using anhydrous copper sulfate, often giving the colours the wrong way round. Others confused it with the bromine water test for unsaturation. Common incorrect colours for the anhydrous cobalt chloride included orange, red and white. Common incorrect colours for the hydrated cobalt chloride included brown, blue and colourless.

(c) Some candidates wrote the correct molecular formula. Others disadvantaged themselves by writing the formula as $CO_2C_8O_8$. Other common errors were: $2CoC_8O_8$, CO28CO or 2Co8C8O.

(d) Some candidates gave the correct order of reactivity but many reversed the order completely. Others seemed to rely on their existing knowledge of the reactivity series rather than using the information in the table. This was obvious from those candidates who wrote down lists of relative reactivity either next to the question or on one of the blank pages.

(e) Some candidates gained credit for correct comparisons of the properties of cobalt and lithium but few gained full credit. Many described properties that were common to both metals, e.g. conductivity. Some thought that one was a metal and the other was a non-metal or described their relative positions in the Periodic Table. A significant number of candidates did not mention which metal they were writing about. It was assumed that if no name was mentioned, that the answer referred to cobalt. Many candidates did not score because they wrote about electronic structure, number of protons or physical state or did not compare properties sufficiently well, e.g. cobalt is malleable (rather than less malleable than lithium). Others wrote statements that were too vague, e.g. cobalt is heavier than lithium.

(f) Many candidates balanced the equation correctly. The commonest incorrect answer was to suggest 2(CoO).

(g) Many candidates gave a definition of reduction but did not apply the concept of reduction to the equation. Others described the equation without explaining how it was a reduction. Many candidates described the cobalt losing oxygen rather than the cobalt oxide losing oxygen. Others wrote answers that were too vague, e.g. 'the oxygen and cobalt split apart'.

Question 4

Parts **(a)(i)**, and **(b)(ii)** were answered well by many candidates. Many did not know the test for an unsaturated compound in part **(a)(ii)** and many candidates did not respond to this part. Better performing candidates were able to draw the structure of ethanol in part **(b)**. A minority of the candidates gave a suitable use of ethanol in industry in part **(b)(iii)** and few could explain the energy level diagram in part **(b)(iv)** or state the name of two products formed when ethanol burns in a limited supply of air in part **(b)(v)**.

(a) (i) Many candidates identified the C=C bond as being responsible for unsaturation. The commonest errors were to refer to either the OH or CH_2 group or to suggest that there were 'missing bonds'.

(ii) A minority of the candidates knew the correct colour change when aqueous bromine reacts with an unsaturated compound. Others either reversed the colours (colourless to orange) or guessed the colour of the product, green, white, orange or blue being commonly seen. Common incorrect colours for aqueous bromine were red or blue. A few candidates suggested white or transparent for the colour of the product, which was not accurate enough.

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(iii) Some candidates gave good answers relating the temperature of –120°C to its position between the melting point and the boiling point. Most candidates who chose the correct state (liquid) only wrote about one of the fixed points, e.g. 'liquid because it is above the melting point'. Others gave vague answers such as: 'the melting point is 9 degrees away' or 'it's about to reach its boiling point'.

(b) (i) A minority of the candidates drew the correct structure of ethanol. The commonest errors were to show the presence of a double bond, to draw the structure of ethane or to draw the carbon attached to the OH group with five bonds.

(ii) Most candidates gained at least two marks. The commonest errors were salt (instead of sugar), 300°C (instead of 30°C), sugar (instead of enzymes) and electrolysis (instead of distillation).

(iii) Very few candidates gave a suitable use of ethanol in industry. Many suggested its use as a fuel or oil despite the word 'fuel' being in the stem of the question. Others gave non-industrial uses such as 'rubbing alcohol', 'for drinking' or 'preservatives'. A significant number of candidates thought that ethanol is used in fertilisers.

(iv) Many candidates did not gain credit because they did not refer to the diagram and only gave a definition of an endothermic reaction. Others gave vague answers such as 'energy goes from top to bottom' or just referred to the equation.

(v) Many candidates gained only one mark because one of the products suggested was water, which is in the stem of the question. Other common errors included hydrogen or oxygen. A few suggested methane.

Question 5

Some candidates responded well to this question, especially in parts **(a)** and **(f)**. Others suggested that gases were given off during the electrolysis in part **(b)** or that elements other than those present in the electrolyte were formed. Few gave correct descriptions of the salt preparation in part **(c)** or identified the orange-brown substance in part **(d)**. The colour of silver bromide in part **(e)** was known by very few.

(a) Many candidates were able to give the name of the positive electrode. Common incorrect answers included 'cnathode, pathode, anion and graphite'.

(b) Some candidates gained one mark but few gained both marks. Some wrote lead(II) (equivalent to Pb^{2+}) instead of lead. Others suggested that gases such as hydrogen and oxygen were produced, perhaps thinking that the electrolyte was an aqueous solution. A significant number of candidates either gave electrode products that did not relate to the electrolyte, e.g. copper, or gave the names of compounds, e.g. lead bromide.

(c) A minority of the candidates gave a suitable method for getting crystals of lead bromide from the mixture. Many either did not add water or added acids instead of water. The process of filtration was absent from many answers. Many suggested evaporating the solids formed. Others did not explain the process of crystallisation sufficiently and wrote vague answers such as 'let the solution rest'.

(d) Some candidates identified bromine as the element responsible for the orange-brown colour. Others suggested sodium bromide, sodium, an inter-halogen compound or sodium chloride plus bromine.

Very few candidates gave a suitable reason and some referred to chlorine being reactive instead of comparing the reactivity with bromine. The most common error was to compare the reactivity of chlorine with sodium or bromide ions. A significant number of candidates wrote vague statements about electrons or the balance of the equation.

(e) Few candidates knew the colour of silver bromide. The commonest incorrect answers were white or yellow.

(f) A majority of the candidates recognised that an electron is gained when a chloride ion is formed from a chlorine atom. The commonest incorrect answer was to suggest a proton.

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Question 6

Some candidates gave good answers to part **(a)** (atomic structure). Others did not respond to the part of the question asking about the position of the subatomic particles. Many candidates gained at least one of the two marks available in part (**b**). Fewer could describe the term *nucleon number* satisfactorily in part **(c)**.

(a) The location of electrons was not made clear by many candidates. Statements such as 'they are in energy levels' or 'in shells' were not sufficient to gain the mark. Many candidates suggested that 'the electrons are outside the atom', rather than outside or surrounding the nucleus. Many gained only three marks because they identified the correct number of electrons, protons and neutrons but did not describe their position. Others described the position by trying to relate it to the isotopic symbol, e.g. 'the proton number is lower' or 'the neutrons plus protons are up'.

(b) Many candidates gained at least one mark for a correct statement about isotopes. The commonest error was to tick the top box (isotopes of the same element have different numbers of protons).

(c) A minority of the candidates realised that the term *nucleon* refers to both neutrons and protons. The commonest errors were: 'the number of neutrons', 'the mass of the atom', 'the number that the element has' or 'the number in the nucleon'.

Question 7

Many candidates performed reasonably well in this question, especially in parts **(a)(i)** and **(d)**. In part **(b)** some candidates could write the electronic structure of sodium correctly. Others did not appear to understand the meaning of this term. Part **(c)** was least well answered, with many candidates writing vague answers for the explanation of alkalinity and the use of indicators to show that a solution is alkaline.

(a) (i) Most candidates gave suitable figures within the ranges so that a trend was followed. More candidates made errors with the values for melting point than with the values for relative hardness.

(ii) Many candidates gave suitable observations mentioning slow bubbling. The commonest incorrect answer was 'no reaction'. Others wrote 'bubbling' (unqualified) or wrote general comments about reactivity instead of giving observations.

(b) Few candidates were able to deduce the electronic structure of sodium. Many just wrote Na or gave the total number of electrons. A few candidates wrote structures in the form $1s^2 2s^2$, etc. These candidates almost invariably gave the incorrect electronic structure.

(c) (i) Some candidates focussed on the sodium hydroxide or hydroxide ions being responsible for the alkalinity. The commonest error was to suggest that the hydrogen is alkaline in nature. Many candidates wrote answers about neutralisation or the loss of atoms or electrons.

(ii) Many candidates were able to select a suitable indicator, Universal Indicator generally being the indicator of choice. Fewer were able to give a correct colour in alkaline solution, yellow, green or red being the colours most often suggested.

(d) Most candidates calculated the relative formula mass correctly. The commonest incorrect answers were 20 (using atomic numbers) or 35 (not multiplying the number of hydrogen atoms by 4).

Question 8

Many candidates gave good answers to part **(a)** and **(c)**. Fewer were able to describe fully how the apparatus was used in part **(b)** or to relate the size of the pieces of calcium carbonate to the rate of reaction in part **(d)**. In part **(e)** many candidates either named the salt incorrectly or gave products other than carbon dioxide and water.

(a) Many candidates identified the measuring cylinder. The commonest incorrect answer was 'test-tube'. References to beakers or flasks were not uncommon.

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(b) Few candidates gave convincing descriptions about how the apparatus could be used to measure the rate of reaction. A common error was to state 'measure the volume of the substance' without referring to which volume was to be measured. A significant minority thought that it was the volume of the acid and zinc that should be measured. Many just referred to liquid levels without reference to the volume of gas. Others suggested counting bubbles or gave answers that were irrelevant to the question, e.g. 'the more the gas, the higher the rate of reaction'. Most candidates that gained a mark did so for a reference to time rather than measuring the volume of gas.

(c) Many candidates recognised that the reaction rate would be less or the reaction would be slower. Others did not gain the mark because their answers were not comparative, e.g. the reaction is slow. A significant number of candidates wrote about the reaction decreasing, rather than the reaction <u>rate</u> decreasing.

(d) Some candidates were able to relate the size of the pieces of calcium carbonate to the rate of reaction. The commonest error was to suggest small pieces (medium rate of reaction), powder (slowest reaction) and large pieces (fastest reaction). Some candidates wrote numbers in the left hand column instead of sizes.

(e) Very few candidates gained two marks for this question. The commonest errors were to write 'calcium hydroxide' or 'salt' instead of calcium chloride. Hydrogen was often written instead of carbon dioxide or water. A few candidates wrote sulfur instead of sodium. Others suggested organic compounds.

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Paper 0620/41
Theory (Extended)

Key messages

- Candidates should be reminded to use precise terms and words where applicable. For example, there was frequent incorrect use of terms in **Question 1(a)** where it was frequently written that two atoms make a compound or in **6(b)** where it was frequently written that one element replaces a molecule.
- Candidates should be reminded that if a specified number of characteristics of a substance is asked for, such as **Questions 2(e)**, **3(a)**, **5(a)(ii)**, **5(b)** and **5(e)(iii)**, then no more than this number should appear in the answer; any incorrect characteristics given may be viewed as a contradiction to the correct responses.
- Better performing candidates had good examination techniques, such as underlining of command words in the questions. Candidates should be encouraged to read questions carefully.
- Candidates should look to make answers concise and keep to the space available. Better performing candidates made use of simple bullet points rather than long paragraphs; this was seen frequently in **Question 3(b)**.

General comments

Working should be shown in calculations and this working should be set out so that it can be followed. This will allow method marks to be awarded in calculations even if the final answer is incorrect.

When a question asks for a *chemical equation* a word equation will not be accepted. Where a *word equation* is asked for, candidates should refrain from writing a chemical equation as these are more difficult and increase the likelihood that an error will be made.

Comments on specific questions

Question 1

(a) Most candidates were able to explain the term *compound*. Candidates who performed less well showed a lack of understanding of the linking of basic terms such as *atoms*, *molecules* and *elements*.

(b) Most candidates knew this straight forward method of separation. Many omitted to attempt the dissolving stage and it was evident that a significant number of candidates assumed that evaporation and crystallisation were separate stages.

(c) (i) The name of the condenser was well known; a minority realised that cooling water needs to enter at the lower aperture only.

(ii) Most candidates included a bung in the diagram accompanied with the logical response that it prevented alcohol vapours escaping. Some candidates opted to draw a thermometer but often left substantial gaps either sides of it. The need for a thermometer was less well understood.

(iii) A minority of candidates knew that the flammability of alcohols was the reason to avoid using a Bunsen burner. Several common misconceptions, such as a lack of temperature control of the mixture or possible cracking of the flask, were seen.

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(iv) Some excellent answers were seen; there were also some imprecise answers with much confusion between evaporation, boiling and melting. Such responses indicated that the candidate was not familiar with the use of a water bath and did not realise that a water bath could not be heated to the temperatures needed to boil the alcohols. A common error was to assume that the boiling points of alcohols **C** and **D** were too close together.

Question 2

(a) Most candidates were able to determine that element Z must be calcium; neon was a commonly seen error.

(b) Nearly all candidates indicated knowledge of what periods are in the Periodic Table; many mis-counted and assumed F*l* was in Period 6.

(c) Most candidates were able to use the copy of the Periodic Table provided to spot that F*l* was a Group 4 element and would have four outer shell electrons.

(d) (i) The term *radioisotopes* was not well known. The most common error was to attempt a definition of isotopes.

(ii) Most candidates answered this correctly.

(e) (i) Most candidates were able to give two physical properties that are typical of metals. Many candidates opted to give more than two properties. This was not asked for and some candidates contradicted previously correct responses.

(ii) Many candidates did not understand the difference between physical and chemical properties and gave physical properties as the answer. Better performing candidates knew that the oxide of a metal would be basic.

Question 3

(a) The correct answer, hot air, was seldom seen. Oxygen was the popular wrong answer. Many other incorrect answers were seen, ranging from iron ore to zinc blende.

(b) There were some well written, well-structured and suitably detailed answers. Many candidates clearly worked hard to learn this industrial process thoroughly. Candidates who performed less well found this process difficult to recall or difficult to sequence correctly. Candidates are advised to use a bullet point approach and to use short sentences.

(c) Carbon was well known as the main impurity of iron extracted from the blast furnace; very few stated that oxygen needs to be blown **through** molten iron and also did not realise the significance that carbon dioxide was able to escape as a gas.

Question 4

(a) Relatively few candidates realised that the definition was in fact that of relative atomic mass. 'Mole', 'Avogadro's constant' and 'relative molecular mass' were popular alternatives.

(b) The origin of the different terms was not well known with most candidates not appreciating the ionic and covalent nature of the two substances. A common mistake was to focus on butane being organic and KF being a compound.

(c) Many candidates were able to calculate the correct answer to this demanding question but having arrived at a relative molecular mass value of 38, did not realise that this gas must be fluorine (F_2). Common incorrect identities included strontium and potassium.

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(d) Candidates were not confident in the mathematical method to find an empirical formula. A significant proportion of candidates rounded calculated values too soon in the calculation, leading to incorrect whole number ratios of moles. Many candidates did not calculate the mass of oxygen in the compound as an initial step of the calculation, but credit could still be earned for the rest of the work provided clear working out was shown.

(e) Candidates found this question challenging. Having determined the molecular formula of the oxide or the relative formula mass of P_2O_3 or even P_4O_6, they went on to do irrelevant calculations instead of determining the relative molecular mass.

Question 5

(a) (i) The term *catalyst* was familiar to candidates as something which increased the rate of a reaction but remained unchanged at the end of the reaction. It is not strictly true that catalysts do not take any part in the reaction, the key point is that they remain unchanged at the end of the reaction. Some candidates assumed catalysts had to be enzymes.

(ii) Many candidates repeated properties given in the question such as 'forms coloured ions' or gave physical properties instead of a chemical property which was asked for.

(b) The physical properties given were usually correct; some candidates did not appreciate that this question referred to physical properties of transition metals, which were not shared with Group 1 metals and gave the same general physical properties of metals as already seen in **2(e)(i)**.

(c) (i) The products of this reaction were often correct but a significant number of candidates omitted state symbols or erroneously assumed $ZnSO_4$ to be (s).

(ii) This part was not well-attempted. Where candidates did realise where the activation energy arrow should go, many arrows were of the wrong length or were double-headed.

(iii) The vast majority identified the reaction as being exothermic but the reason was often inadequately stated or was flawed. One common flaw was to include comments about the energy needed for bond formation or the energy released when bonds are broken.

(d) Very few correct energy profiles for a catalysed reaction were seen.

(e) The electrolysis of aqueous copper sulfate was well known.

(i) Most candidates attempted an ionic half-equation and copper was frequently seen as the product. State symbols were often omitted.

(ii) Non-observational responses such as 'copper is formed' were frequently given. Candidates should be aware that observations need two parts: firstly, the colour, secondly the state of the substance. In this case, 'pink solid' was expected.

(iii) Better performing candidates knew that the blue colour of the solution would fade and that effervescence would also take place. Candidates should remember that a colourless gas cannot be seen so is not an observation.

(iv) Better performing candidates realised that a green gas would be seen. Non-creditworthy responses included 'chlorine is made', which missed out the key details of what would actually be seen.

Question 6

(a) The meaning of the term *hydrocarbon* was well known.

(b) Better performing candidates knew that *saturated* referred to all bonds being single. To say 'it has single C–C bonds' is not correct as alkenes (apart from ethene and propene) have at least 2 C–C bonds. Some candidates incorrectly wrote about saturated solutions.

(c) (i) Many candidates understood the principle of substitution but did not adequately describe the process in terms of one atom taking the place of another atom.

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(ii) The need for ultraviolet light (or sunlight) was known by many candidates

(iii) It was expected that candidates would give the products of mono-substitution (C_2H_5Cl + HCl) but frequently di-substituted $C_2H_4Cl_2$ was given along with H_2, which indicated some understanding of the idea of substitution.

(d) (i) Candidates were aware of the concept of an addition reaction but did not state the key point that only one product is formed. As an alternative, the idea of the C=C double bond being broken was accepted. Imprecise answers included simple statements such as 'because bromine is added to the molecule' and these could not be credited.

(ii) Candidates found this a challenging question. A large number of the candidates who gave a dibromo- product attached the bromines each to C_1 and C_3 whereas others attached both bromines to the same C atom. Some drew dibromoethene.

(e) Most candidates realised that but-2-ene was the unbranched isomer required and could successfully draw and name the isomer. Some correct structures were shown which were not fully displayed.

(f) (i) Poly(ethene) was known by most of the candidates.

(ii) The completion of the equation was reasonably well attempted. Better performing candidates included continuation bonds bisecting brackets and the use of a subscript 'n'.

(g) Most candidates were able to draw at least one amide link but very few were able to orientate both amide links in the correct alignment for the part of the protein shown.

(h) Better performing candidates recognised the ester as ethyl butanoate and consequently gave the names of the reactants as ethanol and butanoic acid. Only a small minority of candidates realised that water is also a product. Some candidates did not notice that a **word** equation was asked for.

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Paper 0620/42
Theory (Extended)

Key messages

- Candidates are advised to write equations on one line as opposed to starting on one line and carrying on the next line. In such cases, it is often unclear what the products are and what the reactants are.
- Candidates should be aware of the precise meaning of the terms *electrolysis*, *electrolyte* and *electrode*. Although they all start with the same letters, they have very different meanings.
- Candidates should understand the meanings of the terms *filter*, *filtrate* and *residue* as applied to the process of filtration.

General comments

Working should be shown in calculations and this working should be set out so that it can be followed. This will allow method marks to be awarded in calculations even if the final answer is incorrect.

When a question asks for a *chemical equation* a word equation will not be accepted. Where a *word equation* is asked for, candidates should refrain from writing a chemical equation as these are more difficult and increase the likelihood that an error will be made.

Comments on specific questions

Question 1

Candidates generally answered this question well.

(a) Evaporation was occasionally seen, rather than distillation.

(b) & (c) Candidates performed well on these questions.

(d) Incorrect answers included cracking and fermentation.

(e) Spelling occasionally proved to be a problem but phonetic answers were credited.

Question 2

Candidates generally answered this question well and were familiar with the Period 3 elements.

(a) & (b) There were no common incorrect answers.

(c) Magnesium was seen occasionally but was incorrect as it does not need to be stored in oil.

(d) Argon was seen occasionally.

(e) Argon was well known as a gas that provides an inert atmosphere in lamps.

(f) Some candidates were under the impression that they had to identify **two** elements rather than one element that can form two oxides.

(g) Sulfur was seen occasionally rather than phosphorus in phosphate fertilisers.

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Question 3

This was answered extremely well by the majority of candidates. The charge on the iron(II) ion was a common omission. The number of electrons was occasionally given as 16 or 17. Ba was occasionally given as an alternative to Fe.

Question 4

(a) Br was often seen as the formula of bromine. K_2 was occasionally seen as potassium (the $_2$ being used to balance the equation). The formulae of both elements were occasionally shown with charges. State symbols were often incorrect and candidates need to take care when choosing state symbols. It was often stated that bromine was a gas at room temperature and that potassium bromide was formed in aqueous solution.

(b) (i) Attempts to explain the term *ionic lattice* required candidates to state that positive and negative ions are arranged in a regular pattern rather than simply using the terms ionic and/or lattice that were given in the question.

(ii) Incorrect use of the term *free* instead of moving / mobile was seen frequently. It is unnecessary to use the word free to answer this question because it contributes nothing to the answer. Free and moving are different things.

(c) (i) Answers to this question were often confused. Candidates are advised to start an answer to similar questions with 'An electrolyte is a **substance**...'

The important things associated with electrolytes are:
- they are aqueous solutions or molten substances containing ions
- they conduct electricity
- they are chemically changed by electricity.

(ii) Potassium, rather than hydrogen, was occasionally given as the product at the cathode. Hydrogen and bromine were occasionally given as products at the wrong electrodes (oppositely charged). Potassium oxide and occasionally potassium bromide were given as the name of the potassium compound formed.

(iii) Even though potassium bromide is a compound containing potassium and bromine only, it was not uncommon to see elements other than potassium and bromine given in answer to this question. Hydrogen was sometimes seen as the answer, particularly by those who gave potassium as the cathode product in **(c)(ii)**.

(d) (i) I and Cl were regularly seen instead of I_2 and Cl_2. Some equations that used correct formulae were unbalanced. Species with charges were occasionally seen.

(ii) The majority of candidates answered this question very well.

Some candidates unsuccessfully attempted to work out the electron configuration of an iodine atom using the atomic number of 53. This often led to iodine atoms with 17 (or sometimes 3) electrons in the outer shell. Candidates who answered this question successfully realised that because iodine is in Group VII, an iodine atom has seven electrons in its outer shell.

(e) Some correct references to intermolecular forces were seen.

Better performing candidates gave the following response to achieve all three marks:

- When potassium bromide melts, its strong ionic bonds break. When iodine monochloride melts, its weak intermolecular forces break.

The presence of ionic bonds in potassium bromide was often qualified as meaning forces of attraction between atoms or molecules.

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References to covalency in iodine monochloride are irrelevant in answering the question as covalent bonds are unaffected when iodine monochloride melts.

Bonds should be described as strong or weak as opposed to high or low or even large or small.

(f) (i) The most common errors were using Cl instead of Cl_2 and showing electrons on the wrong side.

(ii) Statements such as 'bromide oxidises' should be avoided. It is not clear whether the meaning is that bromide becomes oxidised itself or bromide oxidises something else. 'They oxidise themselves' is similarly ambiguous. Bromide ion is oxidised is preferable.

Question 5

(a) The forward reaction is equal to the backward reaction was frequently seen. Very few candidates referred to concentrations of all reactants and products being constant (unchanging) when equilibrium was established. If there was reference to concentration, it was usually to say concentrations become equal rather than constant.

(b) (i) 'The gas syringe was blocked' was seen quite often. Responses should have stated that there were the same number of moles of gas on both sides of the equilibrium.

(ii) Candidates found this challenging. Despite being told that 'the position of the equilibrium did not change', many candidates suggested that the mixture turned darker purple because more iodine had been produced. Some candidates attempted an explanation in terms of increase in temperature or in terms of kinetics. Those who said 'the gas was compressed' were merely rewriting the question instead of suggesting why there was a change in colour intensity.

(c) (i) Candidates should be aware that if temperature increases, equilibrium will shift in the direction of endothermic change. In this case, the equilibrium shifts to the left.

(ii) It was very common to see answers of both increase and decrease. This is because candidates confuse rate with equilibrium. All chemical reactions (with the exception of enzyme catalysed reactions) occur at increased rates if temperature is increased. Thus, in an equilibrium such as the one referred to in this question both forward and reverse reactions occur at increased rates if the temperature is increased.

Question 6

(a) Many candidates gave formulae of reactants, even though names were requested. Many candidates started with barium carbonate. Others started with insoluble or otherwise inappropriate reactants. Many candidates omitted to mention that a precipitation reaction requires the mixing of two aqueous solutions. Candidates should be careful with terminology, the filtrate is the liquid which passes through the filter paper in filtration. The term *filtrate* has a different meaning to filter. Washing the residue was often omitted.

The equation often contained incorrect formulae such as $BaNO_3$ and/or $NaCO_3$. It was not uncommon to see Br as symbol for barium in the equation. Those with correct formulae were often unbalanced.

(b) (i) O_2 was the product most likely to be identified. NaO and NO_2 were commonly seen as incorrect products. Other incorrect products included NO_3, Na_2O and Na. The thermal decomposition of the nitrates referred to on the syllabus continues to be an area that is neglected by candidates.

(ii) Most candidates had 2CuO and $4NO_2$ as correct answers but balanced the H_2O with a 3 rather than a 6.

(iii) There was confusion with colour change of anhydrous cobalt(II) chloride, blue to pink being correct.

(iv) Those who mentioned that melting point or boiling point should be measured often did not state the values or did not state that the data book value should be used or that melting point or boiling point should be sharp. 'It boils at 100°C' is not the same as stating that the boiling point is 100°C.

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Question 7

(a) It is essential to show full working out for all calculations. A common error was to divide all three percentages by 13.33. Over approximation often lead to an incorrect final answer, sometimes resulting in $C_5H_{13}O_2$ in this case.

(b) This was answered very well and candidates successfully calculated the molecular formula. $2(C_2H_4O)$ was occasionally seen.

(c) (i) Candidates were able to name structural isomers from the definition. Isotope was a common incorrect answer.

(ii) Candidates found this challenging. Some candidates drew the same compound twice to represent both **T** and **V**.

Some candidates incorrectly thought that when asked to 'show all of the atoms and all of the bonds', the O–H bond did not need to be included; this is not the case and the O–H should be shown.

The rules that carbon atoms have four bonds, oxygen atoms two bonds and hydrogen atoms one bond should always be applied.

(iii) Those that used correct formulae often had problems with balancing, largely concerning the oxygen atoms. Some were unaware that fractions can be used in balancing equations. It was perfectly acceptable to put a two in front of $C_3H_6O_2$, which meant that fractions did not have to be used.

(d) (i) Ester was an occasional answer from those candidates who may not have read the question carefully enough. Ethanol was also seen occasionally.

(ii) The O–H bond was not always included. This was sometimes the only error in the answer.

(e)(i) The definition for hydrocarbon was well known and candidates clearly stated that it was a substance formed from only carbon and hydrogen atoms.

(ii) This was answered very well by the majority of candidates.

(f) Equations that did not contain ethene were occasionally seen and octane did not always appear as the reactant in cracking. Fermentation and hydrolysis were frequent incorrect names for the conversion of ethene to ethanol.

The temperature of hydration was frequently incorrect. The reaction is generally conducted at 300°C but a range was accepted. Temperatures much higher than 350°C were often seen for hydration. Catalysts of iron and nickel appeared occasionally for both processes.

Candidates were expected to give more specific reaction conditions rather than high temperature / high pressure / catalyst.

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Paper 0620/43
Theory (Extended)

Key messages

- Candidates need to take care when using technical terms, such as *filtrate* or *residue* and ensure they are using them in the correct context.
- Electrolysis and the chemistry of esters proved to be weaker areas. These topic areas do contain some demanding content and additional time should be spent covering these areas with students.

General comments

Working should be shown in calculations and this working should be set out so that it can be followed. This will allow method marks to be awarded in calculations even if the final answer is incorrect.

When a question asks for a *chemical equation* a word equation will not be accepted. Where a *word equation* is asked for, candidates should refrain from writing a chemical equation as these are more difficult and increase the likelihood that an error will be made.

Comments on specific questions

Question 1

(a) The majority of candidates could identify chlorine as the substance used to kill bacteria in drinking water.

(b) Most candidates gave the correct answer of sulfur dioxide; a number suggested argon or calcium hydroxide or chlorine could be used.

(c) Almost all candidates correctly identified copper as the electrical conductor used in cables.

(d) Most answers seen were correct; an appreciable number of candidates suggested substances that were not gases.

(e) Carbon dioxide and sulfur dioxide were common errors.

(f) A very common answer was iron, showing some confusion between the contact process and the Haber process.

Question 2

(a) (i) Despite the question asking for a description in terms of protons, neutrons and electrons, an appreciable number of candidates ignored this and tried to answer the question in terms of only two of the three particles. Candidates need to read questions with care – some candidates ignored the instruction regarding the three subatomic particles and answered in terms of atomic number and mass number.

(ii) Some candidates missed the fact that the species in the question was an aluminium ion rather than an atom and so stated there were 13 electrons.

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(b) (i) The name of the main ore of aluminium proved was not well known. A common error was to give 'aluminium oxide' or 'alumina' as the ore – these are not correct, they are both Al_2O_3 and are obtained from the ore.

(ii) An answer comparing the reactivity of aluminium with that of carbon was required. Vague answers such as 'aluminium is reactive' were not sufficient to be awarded the mark.

(iii) Cryolite is used in the extraction of aluminium oxide since it is a solvent for aluminium oxide. The solution has a far lower melting point than aluminium oxide alone and is a better conductor of electricity. Many candidates claimed that the cryolite changed the boiling (rather than melting) point or that it was the melting point of aluminium that was very high. It should be noted that cryolite is not a catalyst.

(iv) Some candidates thought that because there was a '+ $4e^-$' that electrons had been gained and so this was reduction. Of those who realised this was electron loss and so oxidation often then went on to say that oxygen had been oxidised; this is incorrect, oxygen is formed in this reaction, the species being oxidised is oxide ions.

(v) Better performing candidates gave clear explanations of how oxygen formed at the anode reacted with the graphite from which the anode was made to form carbon dioxide. Common weaker answers referred to the carbon coming from the electrolyte or the oxygen from the air.

(c) (i) The answer needed to include a comparison of the reactivity of zinc and copper. While 'zinc is more reactive than copper' was an acceptable answer, 'zinc is more reactive' was not, since we are not told what zinc is more reactive than; given the wording of the question 'zinc is more reactive' actually means zinc is more reactive than copper(II) sulfate.

(ii) Most candidates were able to identify this correctly as a redox or displacement reaction.

(iii) The existence of an inert coating of aluminium oxide on the surface of aluminium was not well known. A common error was for candidates to claim that aluminium was unreactive.

Question 3

(a) Better performing candidates generally had no difficulty in selecting a property that was common to all metals – such as the ability to conduct electricity.

(b) (i) Better performing candidates generally had no difficulty in selecting a property that was different for the two metals. A common error was to identify a property common to all metals, which should have been given as the answer to **(a)**.

(ii) A number of candidates gave the answer to this part in **(b)(i)**.

(c) Most candidates gave two correct observations. Some candidates repeated the observations given in the question and so did not gain credit, or gave the same observation twice, such as 'fizzes' and 'bubbles' thinking they were two different observations. In this reaction, it is the hydrogen gas that is made that catches fire, not the potassium.

(d) (i) The test for hydrogen should be known by almost all candidates and while most had some idea about the test there was also some confusion – a burning and not a glowing splint is required in order to ignite the hydrogen.

(ii) Some candidates did not read the question and stated that increasing the temperature would increase the rate, which, while true, did not gain credit since that information was in the question. The most common correct answer was to increase the concentration. A few candidates stated that the pressure should be increased – this will not work as the substances involved were a solid and an aqueous solution, neither of which are compressible.

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(iii) Better performing candidates included the following key points:

1. Increasing the temperature gives the particles more energy, this results in them moving faster.
2. As a result of moving faster the particles have more collisions per second. (Note: the reference to time or frequency is essential).
3. As the particles have more energy, a bigger proportion of particles have energy greater than the activation energy and so a greater percentage of collisions are successful.

(e) (i) Candidates were expected to realise that the equilibrium would move right and so become (more) pink. However, many candidates did not refer to the equilibrium and just gave a colour. Some candidates confused themselves and having worked out the equilibrium moved right and formed more $(Co(H_2O)_6)^{2+}$ they then thought that this would shift the equilibrium left to make the blue species.

(ii) This was well answered.

(f) Some excellent answers were seen, although some candidates incorrectly chose to give the charge shown on a species other than Co, such as $Co(OH)_3^{3+}$.

Question 4

(a) The characteristics of a homologous series were well known. Common errors were to mix up chemical and physical properties (giving incorrect answers such as 'a trend in chemical properties') and confusion between general and molecular formulae (giving answers such as 'have the same molecular formula').

(b) Many fully correct answers were seen. The two most common errors were to omit the non-bonding electrons on the oxygen or to omit the bonding pair between the two carbon atoms.

(c) (i) This was not well answered; equations often had incorrect formulae for ethanol and ethene or additional incorrect products.

(ii) Very few candidates could recall the equation for fermentation, a number of candidates tried to write an equation for aerobic respiration.

(iii) Both the greater speed and greater purity of the product were well known advantages. Some candidates mixed up the advantages of each method and stated that catalytic hydration used renewable materials.

(iv) The most common answer given was based on the renewable nature of the raw materials used. Those who mixed the two methods up often incorrectly stated the product was purer.

(d) Very few candidates could identify the reagent used to oxidise ethanol.

(e) (i) Few fully correct structures were seen. Only a minority of candidates could draw an ester group. Structures showing trivalent or pentavalent carbon atoms were common.

(ii) Better performing candidates could correctly name the ester formed.

(iii) The name of the homologous series was known by some but polyester was a common incorrect answer.

(f) (i) This was not well answered. The difference between a strong and weak acid is not based on pH; a very dilute strong acid can have a pH higher than a more concentrated weak acid. Candidates are expected to refer to the fact that weak acids ionise only partially in aqueous solution.

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(ii) Candidates are expected to be familiar with the preparation of soluble salts from acids. There are three steps to the process:

1. Add excess copper carbonate to the acid. Most candidates did not state the copper carbonate should be in excess.
2. Filter the solution to remove unreacted copper carbonate. The copper ethanoate solution is the filtrate. There was some confusion between the terms 'filtrate' and 'residue'.
3. The filtrate should be heated to the point of crystallisation and then allowed to cool so that crystals form. It should not be evaporated to dryness.

(iii) Correct word equations were not common; often carbon dioxide or water were omitted as products. Some candidates decided to attempt a chemical equation rather than a word equation. This made the question much more difficult.

Question 5

(a) Many fully correct answers to the empirical formula calculation were seen. A common error was to divide the percentages given in the question by the smallest percentage, so missing out the first step of calculating a number of moles of each element. Some candidates mixed up Ni and N, and so divided by the relative atomic mass of nitrogen. A significant number of candidates attempted to guess a formula and made no attempt at showing any working; in these cases, the answer given was invariably incorrect.

(b) (i) The movement of electrons in the wires was well known.

(ii) Both anions and cations transfer charge through the solution. It was a common error to specify just one of these two as the answer.

(iii) Many candidates were able to correctly identify the electrolysis products. Some candidates thought a solution was being electrolysed and so stated hydrogen would be made; this is despite the nickel(II) iodide being identified as molten in both the diagram and the stem to **(b)**. It was expected that candidates would write the equation for the formation of nickel (since ionic half-equations for the cathode reactions are on the syllabus) but many attempted the equation for anodic reaction and were often successful.

(c) (i) While many candidates were able to correctly state that copper was deposited on the negative electrodes, a number of candidates simply stated that copper ions go the negative electrode without any mention of copper being formed and coating the electrode.

(ii) This was often correct with hydrogen as the most common incorrect gas formed.

(iii) The fact that copper atoms lose electrons and form copper ions which pass into the solution was not well known. Some answers put the mass loss down to just the loss of electrons.

(iv) Some fully correct answers were seen with clear explanations of the colour changes seen in both sets of apparatus. Other candidates clearly did not understand the difference in electrolysis products when using an inert cathode compared to using a reactive cathode.

Question 6

(a) (i) This part involved two stages; the calculation of the relative formula mass of calcium hydroxide and using this value to calculate the number of moles of calcium hydroxide. There were some common errors in the calculation of the relative formula mass – having just one hydroxide ion being the most common. Where candidates set their work out so that it could be followed, the error could be carried forward and credit given for the correct use of the incorrect relative formula mass. Consequential marks can only be awarded if candidates set out their working in a clear and logical manner.

(ii) A common error was to use the value as 24 dm^3 rather than 24 000 cm^3. Candidates needed to consider the units used for volume in the question.

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(iii) Better performing candidates were able to use the 6:1 ratio in the equation to obtain a correct value. A common error was to not use the limiting reagent identified from the values in **(a)(i)** and **(a)(ii)**.

(iv) This two-step calculation firstly required the relative formula mass to be determined and then using that figure to work out the mass of the number of moles stated in **(a)(iii)**. An error in the calculation of the relative formula mass could be carried forward, but only if the working was presented in a clear and logical manner by the candidate.

(v) The percentage yield calculation was often correct.

(b) (i) Most candidates were able to state that heating was required to bring about thermal decomposition.

(ii) This question part was generally very well answered. Many candidates identified oxygen as the colourless gas and were able to construct a fully correct equation.

(c) (i) The colour of methyl orange in an acid was well known.

(ii) There were many errors in the definition of an acid; many candidates incorrectly stated it was a proton receiver.

(iii) Candidates found this part challenging and few were able to complete the equation to show the transfer of a proton from $HClO_3$ (the acid) to H_2O (the base).

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Paper 0620/51
Practical Test

Key messages

- In the planning question (**Question 3**) there is no need to write a list of apparatus at the start of the answer, any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.
- Plotted points on a grid should be clearly visible, e.g. crosses. Smooth line graphs should be curves with no straight-line sections drawn with a ruler
- Observations are those which you can see. For example, 'fizzing, bubbles or effervescence' is an observation; 'a gas or carbon dioxide was given off' is not an observation.
- Candidates should avoid giving lists of answers, as an incorrect response can contradict a correct one. For example, if the correct answer is 'precipitate dissolves' and a candidate writes 'precipitate dissolves and a white solid forms', no mark can be awarded.

General comments

The vast majority of candidates successfully attempted all of the questions. Almost all centres were able to gain the expected results in **Question 1**, with *Experiment 5* showing a large increase in time compared to *Experiments 1–4*.

Candidates found the last question, **Question 3**, challenging.

Comments on specific questions

Question 1

(a) The table of results was often completed correctly. A common error was completing the time for *Experiment 5*, leaving the time in minutes and seconds.

(b) Most candidates plotted the points correctly but often not clearly. Poorly drawn line graphs were evident, without a smooth curve. The section between 10 cm^3 and 30 cm^3 proved challenging with some candidates drawing a straight line with a ruler. Others drew a best-fit straight line through all of the points.

(c) The formation of a yellow precipitate was the expected description of the appearance of the mixture in the flask. Vague references to milky and white were ignored.

(d) (i) Candidates should be encouraged to show clear construction lines and ensure that these lines are parallel to the axes. A significant number of candidates did not show clearly on the grid how they worked out their answer.

(ii) The question asked for a calculation and marks were lost for leaving the answer as a fraction. Incorrectly rounded numbers could not be awarded credit.

(e) (i) A few candidates confused rate and time and so incorrectly stated *Experiment 5,* as it had the longest time.

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(ii) Good responses referred to the presence of more particles and hence more frequent collisions between the particles. A lack of understanding was seen with many candidates suggesting that at higher concentration the particles had more energy or that more collisions released more energy.

(f) Many candidates gave a burette or pipette. Some candidates did not read the question and stated that a measuring cylinder is more accurate than a measuring cylinder.

(g) The difference to the results caused by using a smaller conical flask was only realised by better performing candidates. Many candidates thought the concentration or pressure of the reactants would increase and the rate of reaction would increase. Candidates who have done this sort of experiment should be familiar with how changing the reaction vessel will change the results obtained. In this case, a greater depth of reacting mixture would lead to the cross disappearing from view in shorter times.

(h) A common mistake was to join their sketch line to their plotted line so having decided the reaction would be slower they then showed the reaction slower most of the time but having the same rate at the highest or lowest concentration. A significant number of candidates did not follow the instruction to draw their sketch on the grid and filled the space at **(h)** with a sketch of a graph which was not comparable with the original on the previous page.

Question 2

Solution **A** was dilute nitric acid.
Solid **B** was zinc carbonate.

(a) A number of candidates recorded unexpected pH numbers greater than 7.

(b) This was generally well answered with candidates observing bubbles or effervescence.

(c) Only a minority recorded that a blue solution was formed, The formation of a black colouration/precipitate showed a lack of understanding, having just added copper(II) oxide to the solution. The mention of green solutions and blue precipitates being formed scored no credit.

(d) Marks were awarded for noticing that the solid turned yellow on heating. A significant number of candidates did not describe that the solid returned to a white colour after standing for a minute. Credit was given for recording the formation of water droplets/condensation.

(e) Candidates were required to realise that the gas produced was carbon dioxide and then give the test for carbon dioxide. Blue litmus is not an appropriate test since candidates should know that there are other acidic gases. Similarly, the use of a lighted splint is not appropriate. The fact that the splint goes out tells us that the gas does not support combustion and is not flammable – the same result is obtained with nitrogen and ammonia.

(f) (i) The expected observation was that a white precipitate formed.

(ii) The precipitate dissolving was missed by many candidates.

(g) (i) The expected observation was that a white precipitate formed.

(ii) The precipitate dissolving was missed by many candidates.

(h) The majority of candidates tested the gas with litmus paper, which turned blue. Many did not record the bubbles in the mixture. Credit was awarded for reference to a pungent smell but identifying ammonia was ignored as the name of a gas is not an observation.

(i) Only the better performing candidates realised that a positive nitrate test showed the solution was nitric acid. Some candidates realised that **A** was an acid.

(j) Candidates found identifying solid **B** challenging. Calcium and ammonium compounds were frequently named. Despite the correct observations to the tests some candidates did not use the notes given on pages 11 and 12 to help identify the solid **B**.

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Question 3

A significant number of candidates did not attempt the question.

There were a number of acceptable methods for determining the solubility of a salt in water. Many candidates scored credit for specifying a measured volume of water and heating it to 40°C. The commonest method was to add potassium chloride to the water until no more dissolved, filtering off the excess salt, drying the solid and weighing the residue. This mass was then subtracted from the initial mass taken. Many candidates using this method did not mention 'add the potassium chloride to the water until no more dissolves/until in excess' and could not be awarded that mark.

Variants involved heating the filtrate to dryness or weighing the beaker of water initially and then reweighing when the solution was saturated.

Credit was given for naming the apparatus used to measure the volume of water and indicating that the mixture of the potassium chloride and water should be stirred to facilitate the dissolving.

A common error was to produce a plan based on the time it took the salt to dissolve or the speed of the process rather than the mass that would dissolve. Candidates should read the question carefully as this clearly related the solubility of the salt to the mass of the salt.

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Paper 0620/52
Practical Test

Key messages

- If, when two solutions are added to together, the product is cloudy this will be because a precipitate has formed. The solid formed should be called a *precipitate*.
- When reporting the result of a qualitative test, if there has been no change then candidates should say this, or state that the solution remains colourless; saying the solution becomes colourless is saying that a change took place and so is incorrect.
- In the planning question (**Question 3**) there is no need to write a list of apparatus at the start of the answer, any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.

General comments

Almost all Centres were able to gain the expected results in **Question 1**, with *Experiment 1* showing a decrease in temperature and *Experiment 2* an increase.

If glassware is washed in a dishwasher then it would be wise to rinse items such as test-tubes (which do not always get rinsed very well in a dishwasher) with water; the substance used as a cleaner in dishwashers is often strongly alkaline and can leave a residue in test-tubes.

Candidates should complete graph work in pencil so that errors can be erased.

Solutions should be made up using distilled or deionised water to avoid false positive tests for ions such as chloride.

Comments on specific questions

Question 1

(a) The vast majority of candidates obtained three sets of results with an increasing magnitude of temperature change as the mass of solid **C** increased. Almost all candidates correctly included the sign of the temperature change in their table. Most candidates gained results that were comparable to the Supervisor's result.

(b) The vast majority of candidates gained the expected results. A small percentage of candidates did not record all temperatures and temperature changes to the same degree of accuracy, i.e. a consistent number of decimal places, and so did not gain full credit.

(c) Few errors in plotting were noted, although the most common error was to plot the points for 6 g of solid **C** or solid **D** at 5 g on the *x*-axis. A minority of candidates did not read the instruction regarding drawing two straight lines but a much larger number did not have their lines meeting at (0,0). If no solid has been added, then there cannot be a temperature change and so both lines had to pass through the pre-plotted point at (0,0). Some candidates plotted points or drew graph lines in ink – this means that if an error is made the point/line that is wrong cannot be erased.

(d) Most candidates successfully extrapolated their graph line to 8 g, but there were then some errors in reading from the scale.

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(e) A number of candidates suggested the reaction was endothermic. It is suspected that some of these candidates had not read the question carefully and so had not noticed this question part was about solid **D** while the previous question part had been about solid **C**.

(f) Most candidates realised the reaction would be over after two hours, but not all of these suggested the solution would return to room temperature. Incorrect answers included that the solution would remain at its highest temperature indefinitely or that the temperature would continue to increase at the same rate – so giving temperature changes 120 times the ones reported in the experiments.

(g) The majority of candidates realised that if the quantity of water was increased, the temperature change would be smaller; many did not give the expected quantitative answer – namely that with twice the volume of water the temperature changes would be halved. A few candidates considered water as the limiting reactant and so incorrectly stated the temperature change would double.

(h) This question asked for a change to the experiment. Repeating the experiment is not a change to the experiment, it is simply doing the same experiment again. Of those who did suggest a suitable change the split between adding extra insulation or a lid as opposed to changing the way in which the water is measured was approximately equal. Some candidates forgot about the practical they had just completed and suggested using a polystyrene cup – despite the fact they had just used one.

(i) The reliability of an experiment can be checked by repeating it and comparing results. Unfortunately, some candidates suggested repeating it with different volumes of water; this would produce different results and would not allow you to check comparability.

Question 2

(a) Solid **E** was hydrated iron(II) sulfate. This is a pale green solid. Old samples may have had some brown tint to the solid due to oxidation to iron(III). However, a number of candidates reported that the solid was blue-green.

(b) Most candidates correctly noted the colour change to yellow or brown, but relatively few noticed the steam being given off or the condensation forming at the top of the test-tube.

(c) As iron(II) sulfate does not contain a halide ion, there should not have been a precipitate formed. A precipitate is only obtained with sulfates if the concentrations used are much too high. A wide variety of observations were reported, ranging from ‘no change’ to ‘black precipitate’.

(d) Most candidates correctly reported the formation of a white precipitate. It should be noted that the term *precipitate* is required.

(e) Iron(II) salt solutions normally give a deep green precipitate under laboratory conditions, these will then slowly become brown as the iron(II) is oxidised to iron(III). Despite this, some candidates reported a blue precipitate (signifying copper(II) ions) or a grey-green precipitate (the colour obtained for chromium(III) with aqueous ammonia but not sodium hydroxide), some candidates reported that the precipitate re-dissolved – this does not happen with iron(II) ions.

(f) Solid **E** was often identified correctly, although it was a common error to omit the oxidation state of iron despite the fact that the *Notes for use in qualitative analysis* makes it clear that the test results for iron(II) and iron(III) are not the same. Candidates are advised to write the name rather than the formula when giving identities of compounds.

(g) Solid **F** was calcium chloride. Solutions of calcium chloride should show a weakly acidic pH (around pH 6). However, a wide range of pH values were reported, ranging from strongly acidic to strongly alkaline. One possible explanation is that the glassware/stopper used was not clean. Glassware should be rinsed before use.

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(h) (i) Most candidates correctly reported the formation of a white precipitate. However, some candidates also reported additional impossible observations such as 'fizzing'. It should be noted that a solution cannot be 'white'; solutions are clear. If a solution looks white in these qualitative ion tests, it will be due to the formation of a white precipitate.

(ii) Most candidates correctly reported that the precipitate did not dissolve.

(i) Most candidates report that no change occurred. However, some candidates stated that the solution became colourless – suggesting that it was not colourless before, which is incorrect.

(j) Most candidates identified the calcium ion as being present.

Question 3

Candidates who opted to carry out a titration generally performed well on this question. The most common errors encountered in this method were:

1. Using Universal Indicator, which is not suitable for using in a titration as it shows a series of gradual colour changes rather than having a sharp end point.

2. Not adding the reagent in the burette slowly or dropwise to the other reagent. Rapid addition will lead to the end point being overshot.

Candidates would be well advised to plan their answers out before starting to write, this would avoid the need to try and insert missing parts at a later stage. There is no need to write a list of apparatus at the start, if a mark is available for selecting suitable apparatus then it must be clear what that apparatus is being used for and so it must be mentioned in the method.

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Paper 0620/53
Practical Test

Key messages

- If, when two solutions are added together, the product is cloudy this will be because a solid has formed. The solid formed should be called a *precipitate*.
- In the planning question (**Question 3**) there is no need to write a list of apparatus at the start of the answer. Any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.
- Candidates should be familiar with the technique of a flame test. A flame test involves placing a small amount of an ionic solid (normally on a wire) into a roaring Bunsen flame. The colour of the Bunsen flame then changes. Flame tests do not involve using a lighted splint and the result cannot be 'squeaky pop' or 'flame goes out'.

General comments

Almost all centres were able to gain the expected results in **Question 1**, with *Experiment 1* and *Experiment 2* showing an increase in temperature followed by a decrease.

Candidates should complete graph work in pencil so that errors can be erased.

Comments on specific questions

Question 1

(a) Almost all candidates were able to obtain the expected results showing an increase in temperature followed by a decrease.

(b) A number of errors in plotting were noted. Most candidates followed the instruction to draw two intersecting straight lines. Some candidates did 'dot to dot' lines or curves. Some candidates are plotted points or drew graph lines in ink – this means that if an error is made the point/line that is wrong cannot be erased.

(c) Almost all candidates were able to obtain the expected results showing an increase in temperature followed by a decrease.

(d) A number of errors in plotting were found and some candidates ignored the instruction to draw two intersecting straight lines.

(e) (i) A number of candidates misread their graph scales despite having just successfully plotted the graph. A small number of answers stated the temperature rather than the volume.

(ii) Most candidates worked out that a smaller volume would be required; they did not go on to give a quantitative answer and reason.

(f) Candidates need to ensure that when writing *exothermic* that the 'x' does not look like an 'n' as the intended answer must be unambiguous.

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(g) (i) Almost all candidates realised that the burette needed to be cleaned, with most candidates focussing on the acid left from the previous experiment.

(ii) Many candidates focused on removing the acid from the previous experiment despite having already removed it with water. Only the better performing candidates realised the water would dilute the acid used in the second experiment and so had to be removed.

(h) Many candidates did not realise that a source of error is not removed by repeating an experiment – if the same method and apparatus is used then that source of error in still there. Better responses identified heat loss or using a measuring cylinder as a source of error.

Question 2

(a) (i) A number of candidates confused flame test with testing a gas with a lighted splint. The result of a flame test should be a colour, not 'the flame went out'.

(ii) Most candidates gave an acceptable pH value.

(b) By this stage candidates could have identified solution **T** as aqueous sodium hydroxide. The results given by some candidates suggested that having worked out this was the reaction between an aqueous zinc salt and aqueous sodium hydroxide all that they needed to do was give observations similar to those in the *Notes for use in qualitative analysis*. However, in this instance the tests were reversed, with the zinc salt being added to the sodium hydroxide. Almost all candidates missed the initial formation of a white precipitate, which then quickly dissolves before any more of the zinc salt is added.

(c) The gas given off should have been ammonia. Some candidates reported positive tests for chlorine, presumably thinking that because ammonium chloride was used that chlorine would be made, it is not possible for chlorine to be made in this way. The expected test and result was that for ammonia.

(d) Many candidates missed the initial green precipitate, which rapidly dissolves giving a green solution. The final green precipitate that should have been formed when excess was added was often reported as being a green solution.

(e) Most candidates could correctly identify solution **T**.

(f) Most candidates stated that liquid **U** was colourless. It should be noted that 'clear' is not accepted as an alternative to colourless; coloured solutions, such as aqueous copper(II) sulfate, are coloured and clear.

(g) Many candidates noted the formation of a yellow precipitate.

(h) Most candidates reported that liquid **U** caught fire, some incorrectly stated that it extinguished the lighted splint.

(i) A common error was to state that liquid **U** contained iodide ions; this was presumably because of the yellow precipitate seen in **Question 2(g)**, despite the fact that silver nitrate had not been used.

Question 3

This question required candidates to extract the mixture of pigments from the leaves and then to analyse the pigments. Unfortunately, most answers seen concentrated on either extracting the pigment from the leaves or on conducting chromatography rather than addressing both aspects; relatively few answers described how to obtain the pigment from the leaves and then conduct chromatography. It was not uncommon for candidates who missed out the pigment extraction stage to place the leaf directly on chromatography paper. Some candidates were not sure what to do with the sand and so used it as a filtration medium or even the stationary phase in chromatography.

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Paper 0620/61
Alternative to Practical

Key messages

- Plotted points on a grid should be clearly visible, e.g. crosses. Smooth line graphs should be curves with no straight-line sections drawn with a ruler.
- Observations are those which you can see. For example, 'fizzing, bubbles or effervescence' is an observation; 'a gas or carbon dioxide was given off' is not.
- Candidates should avoid giving lists of answers, as an incorrect response can contradict a correct one. For example, if the correct answer is 'precipitate dissolves' and a candidate writes 'precipitate dissolves and a white solid forms', no mark can be awarded.
- In the planning question, **Question 4**, there is no need to write a list of apparatus at the start of the answer, any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.

General comments

The vast majority of candidates successfully attempted all of the questions. Candidates found the last question, **Question 4**, challenging.

The majority of candidates were able to complete tables of results from readings on diagrams, as in **Question 2**.

Comments on specific questions

Question 1

(a) Some candidates had difficulty identifying the burette. Pipette, funnel and measuring tube were common incorrect answers.

(b) Methyl orange, phenolphthalein and litmus gained credit. Universal Indicator is not suitable for use in titrations.

(c) (i) This was generally well-answered with most candidates identifying the anomalous point.

(ii) Many answers were vague referring to human error, misreading the burette or parallax errors. Credit was awarded for difficulties in judging the end point and consequent overshooting. Using too much sodium hydroxide was a high-level response.

(iii) Some candidates were able to calculate the average volume of nitric acid and give their answer to an appropriate number of decimal places.

(d) Marks were awarded for realising that less acid was used and therefore the acid was more concentrated. Confused answers were common. Descriptions of a displacement reaction showed a lack of knowledge and understanding. Some candidates stated that the nitric acid must be less concentrated as it was called 'dilute nitric acid'.

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Question 2

(a) The table of results was often completed correctly. A common error was completing the volume for *Experiment 1*, suggesting candidates may not have read through the experiment details carefully. Errors were also seen recording the times for *Experiments 4* and *5* leaving the time in minutes and seconds or just recording the seconds and ignoring the minutes.

(b) Most candidates plotted the points correctly but often not clearly. Poorly drawn line graphs were evident, without a smooth curve. The section between 10 cm^3 and 30 cm^3 proved challenging, with some candidates drawing a straight line with a ruler. Others drew a curve with a point of inflection and so had the curve becoming less steep to the left rather than steeper.

(c) (i) Candidates should be encouraged to show clear construction lines on the graph and ensure that these lines are parallel to the axes. A significant number of candidates did not show clearly on the grid how they worked out their answer.

(ii) The question asked for a calculation and marks were lost for leaving the answer as a fraction. Incorrectly rounded numbers could not be awarded credit.

(d) (i) A few candidates confused rate and time and so incorrectly stated *Experiment 5* as it had the longest time.

(ii) Good responses referred to the presence of more particles and hence more frequent collisions between the particles. A lack of understanding was seen with many candidates suggesting that at higher concentration the particles had more energy or that more collisions released more energy.

(e) Many candidates gave a burette or pipette. Some candidates did not read the question and stated that a measuring cylinder is more accurate than a measuring cylinder.

(f) The difference to the results caused by using a smaller conical flask was only realised by better performing candidates. Many candidates thought the concentration or pressure of the reactants would increase and the rate of reaction would increase. Candidates who have done this sort of experiment should be familiar with how changing the reaction vessel will change the results obtained. In this case a greater depth of reacting mixture would lead to the cross disappearing from view in shorter times.

(g) A common mistake was to join their sketch line to their plotted line so having decided the reaction would be slower they then showed the reaction slower most of the time but having the same rate at the highest or lowest concentration.

Question 3

(a) The majority correctly identified hydrogen as the gas given off in **test 2**. Responses indicated that some candidates found this challenging.

(b) Solution **A** was often identified as an acid but many did not use the result of **test 3** to identify sulfate ions.

(c) Candidates were required to realise that the gas produced was carbon dioxide and then give the test for carbon dioxide. Blue litmus is not an appropriate test since candidates should know that there are other acidic gases. Similarly the use of a lighted splint is not appropriate. The fact that the splint goes out tells us that the gas does not support combustion and is not flammable – the same result is obtained with nitrogen and ammonia.

(d) (i) The expected observation was white precipitate formed. Many responses mixed up this test with the nitrate ion test and produced ammonia despite no aluminium being added and the mixture not being heated.

(ii) The precipitate dissolving was known by most candidates.

(e) (i) The expected observation was that a white precipitate formed.

(ii) The precipitate dissolving was known by most candidates.

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Question 4

There were a number of acceptable methods of determining the solubility of a salt in water. Many candidates scored credit for specifying a measured volume of water and heating it to 40°C. The commonest method was to add potassium chloride to the water until no more dissolved, filtering off the excess salt, drying the solid and weighing the residue. This mass was then subtracted from the initial mass taken.

Variants involved heating the filtrate to dryness or weighing the beaker of water initially and then reweighing when the solution was saturated.

Credit was given for naming the apparatus used to measure the volume of water and indicating that the mixture of the potassium chloride and water should be stirred to facilitate the dissolving.

A common error was to produce a plan based on the time it took the salt to dissolve or the speed of the process rather than the mass that would dissolve. Candidates should read the question carefully as this clearly related the solubility of the salt to the mass of the salt.

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Paper 0620/62
Alternative to Practical

Key messages

- Observations are those which you can see. For example, 'fizzing' is an observation, whereas 'a gas was given off' is not. Smells, such as the pungent smell of ammonia, or the bleach or swimming pool smell of chlorine, are acceptable as observations.

- When a question asks for the name of a chemical, a correct formula is acceptable. However, if a candidate answers with an incorrect formula, then the mark cannot be awarded.

General comments

This session, **Question 4** was a planning task based on the determination of the concentration of an alkaline solution. The most common method was by titration, although other methods could gain credit

The vast majority of candidates were able to complete tables of results from readings on diagrams in **Question 2**.

Comments on specific questions

Question 1

(a) Most candidates correctly labelled the (gas) syringe.

(b) The label on the *y*-axis proved challenging. Candidates had to say 'volume' or give the units as cm^3, whilst referring to the gas or carbon dioxide.

Most realised that the graph was horizontal because the reaction had finished, but fewer mentioned that calcium carbonate was the limiting factor.

(c) The graph for lumps of calcium carbonate was well drawn by the majority of candidates. However, a significant number of candidates left this question blank.

(d) The test for carbon dioxide was well known.

Question 2

(a) Most candidates could read the thermometers correctly, although a minority omitted the minus sign.

(b) Most candidates could read the scales correctly.

(c) The points were usually plotted correctly and the lines were generally well drawn; many did not go through the origin. Many candidates did not label the lines.

(d) Most candidates successfully extrapolated their graph line to 8 g; some errors in reading from the scale were seen.

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(e) A number of candidates suggested the reaction was endothermic. It is suspected that some of these candidates had not read the question carefully and so had not noticed this question part was about solid **D** while the previous question part had been about solid **C**.

(f) Most candidates realised the reaction would be over after two hours, but not all of these suggested the solution would return to room temperature. Incorrect answers included that the solution would remain at its highest temperature indefinitely or that the temperature would continue to increase at the same rate – so giving temperature changes 120 times the ones reported in the experiments.

(g) The majority of candidates realised that if the quantity of water was increased, the temperature changed would be smaller; many did not give the expected quantitative answer – namely, that with twice the volume of water the temperature changes would be halved. A few candidates considered water as the limiting reactant and so incorrectly stated that the temperature change would double.

(h) This question asked for a change to the experiment. Repeating the experiment is not a change to the experiment, it is simply doing the same experiment again. Of those who did suggest a suitable change the split between adding extra insulation or a lid as opposed to changing the way in which the water is measured was approximately equal.

(i) The reliability of an experiment can be checked by repeating it and comparing results. Unfortunately, some candidates suggested repeating it with different volumes of water; this would produce different results and would not allow you to check comparability.

Question 3

(a) Some candidates realised that iron(II) sulfate is green. Despite the fact that the question referred to the solid, a significant minority incorrectly called it a solution.

(b) The qualitative analysis tests were generally well known. Most candidates realised that there would be no change or no precipitate with silver nitrate solution.

(c) ‘White precipitate ‘was by far the most common answer.

(d) Most answers referred to the green precipitate.

(e) Green precipitate was the most common answer.

(f) Most candidates correctly identified calcium as the cation; a few could not be awarded the mark as they wrote Ca^{+}.

Question 4

Candidates who opted to carry out a titration normally scored highly on this question. The most common errors encountered in this method were:

1 Using Universal Indicator, which is not suitable for using in a titration as it shows a series of gradual colour changes rather than having a sharp end point.

2 Not adding the reagent in the burette slowly or dropwise to the other reagent. Rapid addition will lead to the end point being overshot.

Candidates would be well advised to plan their answers out before starting to write, this would avoid the need to try and insert missing parts at a later stage. There is no need to write a list of apparatus at the start, if a mark is available for selecting suitable apparatus then it must be clear what that apparatus is being used for and so it must be mentioned in the method.

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Paper 0620/63
Alternative to Practical

Key messages

- If, when two solutions are added together, the product is a solid, the solid formed should be called a *precipitate*.
- In the planning question, **Question 4**, there is no need to write a list of apparatus at the start of the answer. Any apparatus used should be referred to in the description of the experiment so that it is clear for what purpose that apparatus has been used.
- Plotted points on a grid should be clearly visible, e.g. crosses. Straight line graphs should be drawn with a ruler.

General comments

Candidates found **Questions 3** and **4** to be the most demanding.

The majority of candidates were able to complete the tables of results from readings on diagrams and plot points successfully on a grid as in **Question 2**.

Comments on specific questions

Question 1

(a) (i) Common incorrect answers were scales or weighing machine.

(ii) Only a minority of candidates identified the crucible. This suggests that most candidates have not heated solids strongly over a Bunsen burner. Beaker and flask were common responses.

(b) Many candidates did not know what the 'air hole' was. Contradictory answers such as closed and blue flame were common. This suggests that many candidates had not used a Bunsen burner on a regular basis.

(c) Very few candidates understood the idea of heating the solid to constant mass. Common incorrect answers heated the crystals and looked for steam or tested with anhydrous copper sulfate.

(d) Lots of physical tests were seen. Candidates who understood what a chemical test was scored credit; some got the colour changes reversed or mixed up copper sulfate and cobalt chloride.

Question 2

(a) Almost all candidates were able to complete the temperatures from the thermometer diagrams.

(b) A number of errors in plotting were noted. Most candidates followed the instruction to draw two intersecting straight lines. The vast majority used a ruler to draw the straight lines.

(c) Almost all candidates were able to complete the temperatures from the thermometer diagrams.

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(d) A number of errors in plotting were found and some candidates ignored the instruction to draw two intersecting straight lines. Some drew a straight line from point 1 to point 4 instead of point 3, so the lines crossed at 15 cm^3.

(e) (i) A number of candidates misread their graph scales despite having just successfully plotted the graph. A small number of answers stated the temperature rather than the volume. Many did not show any working on the grid.

(ii) Most candidates worked out that a smaller volume would be required; others did not give a quantitative answer and explanation.

(f) Candidates need to ensure that when writing *exothermic* that the 'x' does not look like an 'n' as the intended answer must be unambiguous.

(g) (i) Almost all candidates realised that the burette needed to be cleaned, with most candidates focussing on the acid left from the previous experiment.

(ii) Many candidates still focussed on removing the acid from the previous experiment despite having already removed it with water. Only the better performing candidates realised the water would dilute the acid used in the second experiment and so had to be removed.

(h) Many candidates did not realise that a source of error is not removed by repeating an experiment – if the same method and apparatus is used then that source of error is still there. Better responses identified heat loss or using a measuring cylinder as a source of error.

Question 3

(a) (i) There was a number of candidates that confused a flame test with testing a gas with a lighted splint. The result of a flame test should be a colour, not 'the flame went out'. Many candidates showed confusion and gave answers based on bubbling, precipitates or squeaky pops.

(ii) Many candidates thought that sodium hydroxide was either an acid or a weak alkali. A minority realised that it was strongly alkaline and so gave a pH from 11–14.

(b) Most candidates gave the observations you would expect for adding sodium hydroxide to an aqueous solution of a zinc salt, hence thinking that the sodium hydroxide was in excess in the second step rather than the first. Therefore, the correct response was a white precipitate that is soluble and then reappears.

(c) The expected test and result was that for ammonia and was that red litmus turns blue. Blue litmus is not a suitable test for ammonia. Some performed tests with lighted splints or thought that chlorine would be produced and would bleach litmus.

(d) Many candidates missed the final green precipitate that should have been formed when excess chromium(III) chloride solution was added. This was often reported as being soluble, forming a green solution.

(e) Many candidates could correctly conclude that solution **T** was a fuel, an alcohol or an organic substance. A common answer was to say it was a copper compound due to the blue flame in the second test, not understanding that touching something with a lighted splint is not a flame test.

Question 4

This investigation has two stages; extraction of the pigment and then separation by chromatography.
The question required candidates to describe the extraction of the pigments from the leaves and then to analyse the pigments. Unfortunately, most answers concentrated on either extracting the pigment or on conducting chromatography rather than addressing both aspects.
Relatively few answers described how to obtain the pigment from the leaves and then conduct chromatography. Good answers gave descriptions of the formation of coloured spots up the paper and the calculation of R_f values. It was not uncommon for candidates who missed out the pigment extraction stage to place the leaf directly on chromatography paper.

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CHEMISTRY **0620/51**

Paper 5 Practical Test **May/June 2018**

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HH	health hazard	**T**	acutely toxic
F	flammable	**O**	oxidising
N	hazardous to the aquatic environment		

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Question 1

Each candidate will require the following chemicals and apparatus. Labels do **not** need to include concentrations.

(a) 250 cm^3 of aqueous sodium thiosulfate, $Na_2S_2O_3.5H_2O$, containing 40 g / dm^3 labelled **aqueous sodium thiosulfate**.
The aqueous sodium thiosulfate must be freshly prepared.

(b) 100 cm^3 of hydrochloric acid of concentration 2.0 mol / dm^3 labelled **dilute hydrochloric acid**

(c) access to water and distilled water

(d) 50 cm^3 measuring cylinder

(e) 10 cm^3 measuring cylinder

(f) 250 cm^3 conical flask

(g) teat pipette

(h) stop-clock or timer which can measure to an accuracy of 1 s

Per five candidates

A bucket labelled **quenching bath** must be provided.

The bucket must contain 1 dm^3 of approximately 5% sodium carbonate solution (made up by dissolving 50 g of Na_2CO_3 **[MH]** or 135 g of $Na_2CO_3.10H_2O$ **[MH]** in 1 dm^3 of water) and Universal Indicator.

The Supervisor must monitor the colour of the Universal Indicator in each quenching bath to check that the solution has not become acidic. If the solution becomes acidic, the Supervisor must add more 5% sodium carbonate solution to the quenching bath.

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Question 2

Each candidate will require the following chemicals and apparatus. Labels do **not** need to include concentrations.

[C] **(a)** 12 cm^3 of dilute nitric acid of concentration 1 mol / dm^3 in a stoppered test-tube labelled **solution A**

(b) 0.3 g of basic zinc carbonate or zinc carbonate, $ZnCO_3$, in a stoppered test-tube labelled **solid B**

[MH][N] **(c)** aqueous ammonia of concentration 1 mol / dm^3

[C] **(d)** aqueous sodium hydroxide of concentration 1 mol / dm^3

[MH][N] **(e)** solid copper(II) oxide

[F] **(f)** 2 cm strip of magnesium ribbon

(g) small piece of aluminium foil, approximately 1 cm × 1 cm in size

[MH] **(h)** limewater and apparatus used to test for carbon dioxide

(i) distilled water

(j) pH indicator paper and chart

(k) red and blue litmus paper

(l) splints

(m) Bunsen burner and matches

(n) rack of test-tubes

(o) hard glass test-tube

(p) 2 × boiling tubes

(q) stopper to fit test-tubes

(r) test-tube holder

(s) teat pipettes

(t) spatula

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Supervisor's Report

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(b) The candidate numbers of candidates in each session were:

First session	*Second session*

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Other cases of individual hardship, e.g. illness, temporary disability, should be reported directly to Cambridge on the Special Consideration form.

Declaration (to be signed by the Supervisor)

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Name of Centre .....

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Signed .....

Name (in block capitals) ..... (Supervisor)

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CHEMISTRY **0620/52**

Paper 5 Practical Test **May/June 2018**

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Question 1

Each candidate will require the following chemicals and apparatus.

(a) samples in stoppered test-tubes of:

[MH] 3 g of hydrated sodium carbonate, $Na_2CO_3.10H_2O$, labelled **3 g of solid C**

[MH] 4 g of hydrated sodium carbonate, $Na_2CO_3.10H_2O$, labelled **4 g of solid C**

[MH] 6 g of hydrated sodium carbonate, $Na_2CO_3.10H_2O$, labelled **6 g of solid C**.

(b) samples in stoppered test-tubes of:

[MH] 3 g of anhydrous sodium carbonate, Na_2CO_3, labelled **3 g of solid D**

[MH] 4 g of anhydrous sodium carbonate, Na_2CO_3, labelled **4 g of solid D**

[MH] 6 g of anhydrous sodium carbonate, Na_2CO_3, labelled **6 g of solid D**

[MH] 8 g of anhydrous sodium carbonate, Na_2CO_3, labelled **8 g of solid D**.

The anhydrous sodium carbonate should be newly purchased.

(c) access to water and at least 300 cm^3 of distilled water

(d) 50 cm^3 measuring cylinder

(e) 250 cm^3 beaker

(f) stirring thermometer, –10 °C to +110 °C at 1 °C graduations

(g) polystyrene cup

(h) stop-clock or timer which can measure to an accuracy of 1 s

(i) spatula

(j) teat pipette

Note
Confirmatory tests to be performed before the examination.

- 4 g of hydrated sodium carbonate added to 40 cm^3 of distilled water should give a temperature decrease of about 4 °C.
- 4 g of anhydrous sodium carbonate added to 40 cm^3 of distilled water should give a temperature increase of about 5 °C.

If you do **not** observe these temperature changes, then you must replace your stocks of hydrated sodium carbonate and anhydrous sodium carbonate accordingly.

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Question 2

Each candidate will require the following chemicals and apparatus. Labels do **not** need to include concentrations.

[MH] **(a)** 0.5 g of hydrated iron(II) sulfate, $FeSO_4.7H_2O$, in a stoppered test-tube labelled **solid E**

[MH] **(b)** 0.4 g of calcium chloride in a stoppered test-tube labelled **solid F**

(c) aqueous barium nitrate of sufficient concentration to give a positive sulfate test

[MH][N] **(d)** aqueous silver nitrate of sufficient concentration to give a positive halide test

[MH][N] **(e)** aqueous ammonia of concentration 1 mol / dm^3

[C] **(f)** aqueous nitric acid of concentration 1 mol / dm^3

[C] **(g)** aqueous sodium hydroxide of concentration 1 mol / dm^3

(h) distilled water

(i) pH indicator paper and chart

(j) 10 cm^3 measuring cylinder

(k) Bunsen burner and matches

(l) rack of test-tubes

(m) hard glass test-tube

(n) 2 × boiling tube

(o) stopper to fit boiling tubes

(p) test-tube holder

(q) teat pipettes

(r) spatula

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Paper 5 Practical Test **May/June 2018**

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Question 1

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[C] **(a)** 150 cm^3 of aqueous sodium hydroxide of concentration 1.0 mol / dm^3 labelled **aqueous sodium hydroxide for Question 1**

(b) 100 cm^3 of dilute hydrochloric acid of concentration 2.0 mol / dm^3 labelled **acid R**

[C] **(c)** 100 cm^3 of dilute sulfuric acid of concentration 2.0 mol / dm^3 labelled **acid S**

(d) access to water and distilled water

(e) 50 cm^3 measuring cylinder

(f) 250 cm^3 beaker

(g) 50 cm^3 burette with stand and clamp

(h) funnel for filling burette

(i) stirring thermometer, –10 °C to +110 °C at 1 °C graduations

(j) polystyrene cup

(k) teat pipettes

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Question 2

Each candidate will require the following chemicals and apparatus. Labels do **not** need to include concentrations.

[C] **(a)** 8 cm^3 of aqueous sodium hydroxide of concentration 1 mol / dm^3 in a stoppered test-tube labelled **solution T**

[F][MH] **(b)** 3 cm^3 of propanone in a stoppered test-tube labelled **liquid U**

[MH] **(c)** access to solid ammonium chloride

(d) aqueous chromium(III) chloride of concentration 0.1 mol / dm^3

[N] **(e)** 10 cm^3 of aqueous iodine in potassium iodide
(0.25 g of iodine, I_2, and 0.8 g of potassium iodide, KI, dissolved in distilled water to give 10 cm^3 of solution)

[C] **(f)** aqueous sodium hydroxide of concentration 1 mol / dm^3

[MH][N] **(g)** aqueous zinc sulfate of concentration 0.1 mol / dm^3

(h) distilled water

(i) pH indicator papers and chart

(j) red and blue litmus paper

(k) 10 cm^3 measuring cylinder

(l) watch glass

(m) splints

(n) apparatus for a flame test

(o) Bunsen burner and matches

(p) rack of test-tubes

(q) 2 × boiling tubes

(r) stopper to fit test-tubes

(s) test-tube holder

(t) teat pipettes

(u) spatula

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Grade thresholds – June 2018

Cambridge IGCSE™ Chemistry (0620)

Grade thresholds taken for Syllabus 0620 (Chemistry) in the June 2018 examination.

		minimum raw mark required for grade:						
	maximum raw mark available	A	B	C	D	E	F	G
Component 11	40	–	–	23	19	16	13	10
Component 12	40	–	–	20	17	14	12	10
Component 13	40	–	–	23	19	16	13	10
Component 21	40	27	23	19	16	14	12	10
Component 22	40	27	22	18	16	14	12	10
Component 23	40	27	22	18	16	14	12	10
Component 31	80	–	–	49	41	33	24	16
Component 32	80	–	–	44	36	29	21	13
Component 33	80	–	–	48	40	32	23	14
Component 41	80	43	32	21	19	16	13	10
Component 42	80	51	39	26	22	17	12	7
Component 43	80	49	38	25	20	16	12	8
Component 51	40	26	22	19	17	15	12	9
Component 52	40	30	24	19	17	15	13	11
Component 53	40	28	23	18	16	14	12	10
Component 61	40	30	24	19	17	15	12	9
Component 62	40	32	25	19	17	15	12	9
Component 63	40	29	23	18	16	14	12	10

Grade A* does not exist at the level of an individual component.

The maximum total mark for this syllabus, after weighting has been applied, is **200**.

The overall thresholds for the different grades were set as follows.

Option	Combination of Components	A*	A	B	C	D	E	F	G
BX	21, 41, 51	142	119	96	74	65	56	46	36
BY	22, 42, 52	160	133	106	79	68	57	46	35
BZ	23, 43, 53	156	129	102	76	65	55	45	35
CX	21, 41, 61	148	123	98	74	65	56	46	36

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Grade thresholds continued

Cambridge IGCSE Chemistry (0620)

Option	Combination of Components	A*	A	B	C	D	E	F	G
CY	22, 42, 62	163	135	107	79	68	57	45	33
CZ	23, 43, 63	157	130	103	76	65	55	45	35
FX	11, 31, 51	–	–	–	115	97	80	62	44
FY	12, 32, 52	–	–	–	104	88	72	57	42
FZ	13, 33, 53	–	–	–	113	95	78	60	42
GX	11, 31, 61	–	–	–	115	97	80	62	44
GY	12, 32, 62	–	–	–	104	88	72	56	40
GZ	13, 33, 63	–	–	–	113	95	78	60	42

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CHEMISTRY **0620/51**

Paper 5 Practical Test **May/June 2018**

INSERT

1 hour 15 minutes

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CHEMISTRY **0620/11**

Paper 1 Multiple Choice (Core) **May/June 2018**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1	B	**1**
2	A	**1**
3	B	**1**
4	D	**1**
5	B	**1**
6	A	**1**
7	C	**1**
8	C	**1**
9	C	**1**
10	B	**1**
11	B	**1**
12	D	**1**
13	B	**1**
14	A	**1**
15	B	**1**
16	C	**1**
17	C	**1**
18	A	**1**
19	C	**1**
20	B	**1**
21	A	**1**
22	A	**1**
23	C	**1**
24	D	**1**
25	B	**1**
26	B	**1**
27	B	**1**
28	C	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	D	**1**
32	C	**1**
33	D	**1**
34	A	**1**
35	A	**1**
36	B	**1**
37	C	**1**
38	C	**1**
39	A	**1**
40	D	**1**

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CHEMISTRY **0620/12**

Paper 1 Multiple Choice (Core) **May/June 2018**

MARK SCHEME

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Question	Answer	Marks
1	D	**1**
2	D	**1**
3	B	**1**
4	D	**1**
5	A	**1**
6	B	**1**
7	C	**1**
8	C	**1**
9	D	**1**
10	D	**1**
11	A	**1**
12	D	**1**
13	D	**1**
14	A	**1**
15	B	**1**
16	C	**1**
17	C	**1**
18	B	**1**
19	B	**1**
20	C	**1**
21	C	**1**
22	D	**1**
23	A	**1**
24	C	**1**
25	B	**1**
26	B	**1**
27	B	**1**
28	C	**1**

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Question	Answer	Marks
29	C	**1**
30	A	**1**
31	B	**1**
32	C	**1**
33	A	**1**
34	A	**1**
35	A	**1**
36	B	**1**
37	A	**1**
38	C	**1**
39	B	**1**
40	C	**1**

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CHEMISTRY **0620/13**

Paper 1 Multiple Choice (Core) **May/June 2018**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1	B	**1**
2	A	**1**
3	D	**1**
4	B	**1**
5	B	**1**
6	A	**1**
7	C	**1**
8	C	**1**
9	B	**1**
10	B	**1**
11	C	**1**
12	D	**1**
13	B	**1**
14	A	**1**
15	B	**1**
16	C	**1**
17	C	**1**
18	C	**1**
19	B	**1**
20	A	**1**
21	D	**1**
22	D	**1**
23	B	**1**
24	C	**1**
25	A	**1**
26	A	**1**
27	B	**1**
28	C	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	A	**1**
32	D	**1**
33	B	**1**
34	A	**1**
35	A	**1**
36	B	**1**
37	B	**1**
38	C	**1**
39	A	**1**
40	C	**1**

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CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2018**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1	A	**1**
2	D	**1**
3	A	**1**
4	C	**1**
5	B	**1**
6	D	**1**
7	D	**1**
8	B	**1**
9	B	**1**
10	D	**1**
11	C	**1**
12	A	**1**
13	B	**1**
14	C	**1**
15	B	**1**
16	B	**1**
17	C	**1**
18	D	**1**
19	C	**1**
20	C	**1**
21	C	**1**
22	B	**1**
23	A	**1**
24	C	**1**
25	C	**1**
26	D	**1**
27	B	**1**
28	B	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	D	**1**
32	A	**1**
33	C	**1**
34	D	**1**
35	A	**1**
36	D	**1**
37	C	**1**
38	A	**1**
39	A	**1**
40	B	**1**

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CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2018**

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Question	Answer	Marks
1	C	**1**
2	C	**1**
3	D	**1**
4	C	**1**
5	B	**1**
6	B	**1**
7	D	**1**
8	B	**1**
9	B	**1**
10	D	**1**
11	C	**1**
12	A	**1**
13	A	**1**
14	C	**1**
15	D	**1**
16	D	**1**
17	C	**1**
18	C	**1**
19	C	**1**
20	C	**1**
21	B	**1**
22	C	**1**
23	C	**1**
24	A	**1**
25	B	**1**
26	C	**1**
27	B	**1**
28	B	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	D	**1**
32	A	**1**
33	C	**1**
34	A	**1**
35	A	**1**
36	D	**1**
37	C	**1**
38	A	**1**
39	A	**1**
40	D	**1**

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CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2018**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1	C	**1**
2	D	**1**
3	A	**1**
4	C	**1**
5	B	**1**
6	B	**1**
7	D	**1**
8	C	**1**
9	C	**1**
10	C	**1**
11	C	**1**
12	B	**1**
13	B	**1**
14	C	**1**
15	D	**1**
16	C	**1**
17	C	**1**
18	D	**1**
19	B	**1**
20	C	**1**
21	B	**1**
22	A	**1**
23	D	**1**
24	B	**1**
25	C	**1**
26	A	**1**
27	A	**1**
28	B	**1**

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Question	Answer	Marks
29	C	**1**
30	C	**1**
31	D	**1**
32	A	**1**
33	D	**1**
34	B	**1**
35	A	**1**
36	D	**1**
37	C	**1**
38	A	**1**
39	A	**1**
40	B	**1**

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CHEMISTRY **0620/31**

Paper 3 Theory (Core) **May/June 2018**

MARK SCHEME

Maximum Mark: 80

Published

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)(i)	ammonia / NH_3	1
1(a)(ii)	sulfur dioxide / SO_2	1
1(a)(iii)	methane / CH_4	1
1(a)(iv)	carbon dioxide / CO_2	1
1(a)(v)	argon / Ar	1
1(b)(i)	helium is inert / it is inert / helium is unreactive / hydrogen is flammable	1
1(b)(ii)	(old) light bulbs / welding / to protect reactive metals from oxidation / lasers	1
1(c)	(substance containing) two (or more) types of atom bonded / two (or more) types of atom joined / two (or more) types of atoms chemically combined	1
1(d)	pair of bonding electrons between **each** N and H	1
	two unpaired electrons on N **AND** no extra electrons on the H	1

Question	Answer	Marks
2(a)(i)	15.5(%)	1
2(a)(ii)	hydrogen / H_2	1
2(a)(iii)	nitrogen **AND** oxygen	1
2(a)(iv)	NO_2	1
2(a)(v)	the air / the atmosphere	1

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Question	Answer	Marks
2(b)(i)	compound of carbon and hydrogen only / compound of hydrogen and carbon with no other elements **IF** 2 marks not scored: 1 mark for it contains carbon and hydrogen only / **compound** of hydrogen and carbon / molecules containing carbon and hydrogen	**2**
2(b)(ii)	poisonous / toxic	**1**
2(b)(iii)	5 (CO_2)	**1**
	6 (H_2O)	**1**

Question	Answer	Marks
3(a)(i)	One mark each for any 3 of: • (limonene) particles go from liquid to vapour • diffusion • random movement of particles / particles move anywhere / particles move in all directions • spreading out of particles / intermingling of particles / mixing of particles / particles collide / particles bounce off each other / particles go all over • (bulk) movement of particles from higher to lower concentration / movement of particles **down** concentration gradient	**3**
3(a)(ii)	solid	**1**
	– 80 °C is below the melting point / it is below the melting point / it has not yet reached its melting point / melts above – 80 °C	**1**
3(b)(i)	(substance which) speeds up a reaction / substance which increases the rate of reaction	**1**
3(b)(ii)	addition of oxygen (to a substance) / loss of electrons / increase in oxidation number	**1**

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Question	Answer	Marks
3(c)(i)	C=C bond	1
3(c)(ii)	orange / red-brown / brown	1
	to colourless	1

Question	Answer	Marks
4(a)	nickel<iron<chromium<magnesium **IF** 2 marks not scored: 1 mark if all reversed / one consecutive pair reversed	2
4(b)	One mark each for any 3 of: • iron has high melting point / boiling point / ORA for K • iron has high density / ORA for K • iron has catalytic activity / ORA for K • iron forms coloured <u>compounds</u> / ORA for K • iron <u>compounds</u> have variable oxidation states / form ions with different charges / ORA for K • iron is hard / potassium is soft / iron is strong / potassium is weak • one suitable difference in chemical properties e.g. iron is less reactive than potassium ORA / potassium reacts with cold water / iron does not react with cold water / iron rusts / potassium does not rust • iron is magnetic / ORA for K	3

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Question	Answer	Marks
4(c)	3 (Fe)	1
	2 (O_2)	1
4(d)	it loses oxygen / oxygen is removed from the iron oxide / hydrogen gains the oxygen from the iron oxide	1
4(e)(i)	add (aqueous) sodium hydroxide / (aqueous) ammonia AND green precipitate (2) **IF** 2 marks not scored: 1 mark for add (aqueous) sodium hydroxide / (aqueous) ammonia	2
4(e)(ii)	Fe_2Cl_6	1
4(f)	**B** / boiled water **AND** because no air / no oxygen	1
	C / with calcium chloride **AND** because no water	1

Question	Answer	Marks
5(a)	breakdown	1
	compound	1
	molten	1
	electricity	1
5(b)	+ electrode labelled anode **and** – electrode labelled cathode	1
	liquid labelled electrolyte	1

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Question	Answer	Marks
5(c)	graphite / it conducts electricity	1
5(d)	negative electrode: zinc / Zn	1
	positive electrode: iodine / I_2	1
5(e)	iodine	1
	chlorine is more reactive than iodine ORA	1

Question	Answer	Marks
6(a)	One mark each for any 5 of: • protons in the nucleus / centre (of the atom) • neutrons in the nucleus / centre (of the atom) • electrons outside the nucleus / electrons surrounding the nucleus / electrons orbiting the nucleus • 9 protons • 9 electrons • 10 neutrons	5
6(b)	element	1
	atomic	1
	nucleons	1
6(c)	any suitable e.g. treating cancer / checking thyroid function / tracer (in the body)	1

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Question	Answer	Marks
6(d)	$^{235}_{92}U$	1

Question	Answer	Marks
7(a)(i)	atomic radius of Rb: any value between 228 and 264 (inclusive of these values)	1
	relative thermal conductivity of K: any value between 3.8 and 1.7 (inclusive of these values)	1
7(a)(ii)	decreases down (the Group) / increases up (the Group) / decreases from sodium to caesium ORA	1
7(a)(iii)	bursts into flame / extremely rapid bubbling / explodes	1
7(b)	second box down ticked (a sodium atom loses an electron)	1
7(c)	basic oxide because metallic oxides are basic	1
7(d)	76 **IF** 2 marks not scored: 1 mark for (C =) 12, (H =) 1 (Na =) 23	2
7(e)	sodium sulfate	1
	water	1

Question	Answer	Marks
8(a)	the reaction is complete / the reaction has finished	1
8(b)	any value between and including 37 (cm^3) to 38 (cm^3)	1

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Question	Answer	Marks
8(c)	line starts from 0 cm^3 **AND** initial gradient less steep	**1**
	final volume levels off between 24–30 cm^3 **OR** line below 27 cm^3 **AND** gradient becoming less steep at a later point	**1**
8(d)	zinc chloride	**1**
8(e)	pH 1	**1**

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CHEMISTRY **0620/32**

Paper 3 Theory (Core) **May/June 2018**

MARK SCHEME

Maximum Mark: 80

Published

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- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)(i)	chlorine / Cl_2	1
1(a)(ii)	ammonia / NH_3	1
1(a)(iii)	neon / Ne	1
1(a)(iv)	carbon monoxide / CO	1
1(a)(v)	ethene / C_2H_4	1
1(b)(i)	(molecules) made up of two atoms	1
1(b)(ii)	shared pair of electrons (between two atoms)	1
1(c)	bonding pair of electrons	1
	6 non-bonded electrons in each Cl atom	1

Question	Answer	Marks
2(a)(i)	72 (%)	1
2(a)(ii)	hydrogen / H_2	1
2(b)(i)	breathing difficulties / irritates nose / irritates eyes / asthma attacks	1
2(b)(ii)	2 (NO_2)	1
	2 (NaOH)	1
2(b)(iii)	sodium nitrate	1
2(c)(i)	compound with no double C=C bonds / <u>only</u> contains single bonds.	1

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Question	Answer	Marks
2(c)(ii)	**compound** of carbon and hydrogen only / **compound** of hydrogen and carbon with no other elements **IF** 2 marks not scored: 1 mark for carbon and hydrogen only / **compound** of hydrogen and carbon	**2**
2(d)	98.5 (%)	**1**

Question	Answer	Marks
3(a)(i)	5	**1**
3(a)(ii)	ring around the OH group	**1**
3(a)(iii)	(substance which) speeds up a reaction / increases the rate of reaction	**1**
3(a)(iv)	idea of very long chains of repeating units / idea of lots of monomers joined together	**1**
3(b)(i)	any typical property of an acid e.g. reacts with sodium hydroxide / reacts with hydroxides / reacts with carbonates / reacts with metals / has pH below 7 / colourless / turns litmus red	**1**
3(b)(ii)	structure of ethanoic acid correct	**1**
3(c)(i)	solid	**1**
	–120 °C is below the melting point / it is below the melting point / it has not yet reached its melting point / melts above –120 °C	**1**
3(c)(ii)	addition	**1**
	ethene	**1**
	high	**1**
	catalyst	**1**

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Question	Answer	Marks
4(a)	One mark each for any 3 of: • particles go from solid to liquid • diffusion • random movement of particles / particles move anywhere / particles move in all directions / particles move away • spreading out of particles / intermingling of particles / mixing of particles / particles collide / particles bounce (off each other) / particles slide over each other • (bulk) movement of particles from higher to lower concentration / movement of particles **down** concentration gradient	**3**
4(b)	addition of oxygen (to a substance) / loss of electrons / increase in oxidation number	**1**
4(c)(i)	glowing splint	**1**
	relights	**1**
4(c)(ii)	4 (HCl)	**1**
	2 (H_2O)	**1**
4(d)	lead<tin<manganese<magnesium **IF** 2 marks not scored: 1 mark if all reversed / one consecutive pair reversed	**2**

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Question	Answer	Marks
4(e)	One mark each for any 3 of: • Mn has high melting point / boiling point / ORA for Na • Mn has high density / ORA for Na • Mn has catalytic activity / ORA for Na • Mn forms coloured compounds / ORA for Na • Mn compounds have variable oxidation states / form ions with different charges / ORA for Na • Mn is hard / Na is soft / Mn is strong / Na is weak • one suitable difference in chemical properties e.g. Mn is less reactive than Na ORA / Na reacts with cold water / Mn does not react with cold water	3

Question	Answer	Marks
5(a)(i)	test tubes of solution covering each electrode	1
5(a)(ii)	cathode	1
5(a)(iii)	negative electrode: hydrogen / H_2	1
	positive electrode: chlorine / Cl_2	1
5(a)(iv)	carbon / platinum	1
5(b)(i)	150 (g)	1
5(b)(ii)	decreases the melting point / melting point is not sharp	1
5(c)	evaporation/ crystallisation	1

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Question	Answer	Marks
6(a)	One mark each for any 5 of: • protons in the nucleus / centre (of the atom) / middle • neutrons in the nucleus / centre (of the atom) / middle • electrons outside the nucleus / electrons surrounding the nucleus / electrons orbiting the nucleus • 7 protons • 7 electrons • 8 neutrons	**5**
6(b)	atoms (of an element) with the same number of protons but different number of neutrons **IF** 2 marks not scored: 1 mark for idea of same number of protons but different number of neutrons	**2**
6(c)	any suitable use e.g. measuring the thickness of paper / energy from nuclear reactors / finding leaks (in pipelines) / smoke alarms / energy production	**1**

Question	Answer	Marks
7(a)(i)	density of iodine: values between 3.10 and 6.35 (excluding these two values)	**1**
	melting point of At_2 values greater than 114 °C but less than 500 °C	**1**
	colour of At_2: black / grey-black	**1**
7(a)(ii)	it is a gas (at room temperature)	**1**
7(a)(iii)	(boiling point) increases down (the group) / (boiling point) decreases up (the group) / increases from chlorine to astatine ORA	**1**
7(b)	iodine	**1**

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Question	Answer	Marks
	potassium bromide	1
7(c)	171 **IF** 2 marks not scored: 1 mark for C = 12, F = 19 C*l* = 35.5	2

Question	Answer	Marks
8(a)	One mark each for any 2 of: • distance of flame from can • length of wick • same can • volume of water used / amount of water / mass of water • same amount of stirring of the water	2
8(b)	**B**	1
8(c)	solvent / for making named chemical (e.g. ethanoic acid)	1
8(d)(i)	oxygen (on left)	1
	water (on right)	1
8(d)(ii)	exothermic because energy level of reactants above energy level of products / exothermic because the arrow is going downwards	1
8(e)(i)	<u>mixture</u> of metals / <u>mixture</u> of metal and non-metal / mixture of metal with another element	1

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Question	Answer	Marks
8(e)(ii)	arrangement: in layers / regular / lattice	1
	motion: (only) vibrating	1
8(e)(iii)	(stainless steel / it) is more resistant to corrosion (than pure metal)	1

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CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 2018**

MARK SCHEME

Maximum Mark: 80

Published

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Question	Answer	Marks
1(a)(i)	hydrogen chloride / HC*l*	1
1(a)(ii)	helium / He	1
1(a)(iii)	nitrogen / N_2	1
1(a)(iv)	methane / CH_4	1
1(a)(v)	nitrogen / N_2	1
1(b)(i)	One mark each for any 2 of: • helium • hydrogen • nitrogen	1
1(b)(ii)	(substance) containing only one type of atom / (substance) which cannot be broken down chemically into any other substance	1
1(c)	bonding pair of electrons between H and C*l*	1
	6 non-bonding electrons on the C*l* and none on the H	1

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Question	Answer	Marks
2(a)(i)	12(%)	**1**
2(a)(ii)	One mark each for any 3 of: • more nitrogen in petrol engine / ORA for diesel • more carbon dioxide in petrol engine / ORA for diesel • more water vapour in petrol engine / ORA for diesel • more carbon monoxide in petrol engine / ORA for diesel • less oxides of nitrogen in petrol engine / ORA for diesel • more hydrocarbons in petrol engine / ORA for diesel • less sulfur dioxide in petrol engine / ORA for diesel • less / no oxygen in petrol engine / ORA for diesel	**3**
2(a)(iii)	breathing difficulties / irritates eyes / irritates nose / irritates throat / irritates lungs / (potentiates) asthma	**1**
2(b)	distillation	**1**
	kerosene	**1**
	boiling	**1**
2(c)	3 (CO_2)	**1**
	4 (H_2O)	**1**

Question	Answer	Marks
3(a)	One mark each for any 3 of: • (cobalt / chloride) particles go from close together to spread out / (cobalt / chloride) particles go into solution / (cobalt / chloride) particles go into the water • diffusion • random movement of particles / particles move anywhere (in the liquid) / particles move in all directions • spreading out of particles / intermingling of particles / mixing of particles / particles collide / particles bounce off each other / particles go all over • (bulk) movement of particles from higher to lower concentration / movement of particles **down** concentration gradient	**3**
3(b)(i)	reversible reaction	**1**
3(b)(ii)	blue	**1**
	to pink	**1**
3(c)	$Co_2C_8O_8$	**1**
3(d)	cobalt<zinc<magnesium<barium **IF** 2 marks not scored: 1 mark if all reversed / one consecutive pair reversed	**2**

Question	Answer	Marks
3(e)	3 of the following correct = 2 marks 1 or 2 of the following correct = 1 mark • Co has high melting point / boiling point ORA for lithium • Co has high density ORA for lithium • Co has catalytic activity ORA for lithium • Co forms coloured compounds ORA for lithium • Co compounds have variable oxidation states / form ions with different charges ORA • iron is hard / lithium is soft(er) / iron is strong / lithium is weak • one suitable difference in chemical properties e.g. cobalt is less reactive ORA / lithium reacts with cold water • cobalt is magnetic / ORA for lithium	**2**
3(f)	6 (CoO)	**1**
3(g)	Co_3O_4 loses oxygen / it loses oxygen / oxygen is removed from the cobalt oxide / the cobalt oxide loses oxygen	**1**

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Question	Answer	Marks
4(a)(i)	C=C double bond	1
4(a)(ii)	orange / red-brown / brown	1
	to colourless	1
4(a)(iii)	liquid	1
	–120 °C is in between the melting point and boiling point / –120 °C is higher than the melting point **AND** lower than the boiling point	1
4(b)(i)	correct structure of ethanol showing all atoms and all bonds	1
4(b)(ii)	sugar	1
	30 °C	1
	enzymes	1
	distillation	1
4(b)(iii)	any suitable use e.g. solvent / to make **named** chemical	1
4(b)(iv)	energy level of reactants above energy level of products / the arrow is going downwards / energy (level) goes down / product has less energy than reactants	1
4(b)(v)	carbon monoxide	1
	carbon	1

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Question	Answer	Marks
5(a)	anode	1
5(b)	negative electrode: lead	1
	positive electrode: bromine	1
5(c)	add (sufficient) water and stir (to dissolve) / add the mixture to water	1
	filter off the lead bromide / filter to obtain solution sodium bromide	1
	evaporate (some of the) water from the solution / warm solution to crystallisation point then leave (to crystallise)	1
5(d)	bromine	1
	chlorine is more reactive than bromine	1
5(e)	cream	1
5(f)	electron	1

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Question	Answer	Marks
6(a)	One mark each for any 5 of: • protons in the nucleus / centre (of the atom) • neutrons in the nucleus / centre of the atom • electrons outside the nucleus / electrons surrounding the nucleus / electrons orbiting the nucleus • 8 protons • 8 electrons • 9 neutrons	**5**
6(b)	2nd box down ticked	**1**
	4th box down ticked	**1**
6(c)	number of protons plus neutrons in an atom	**1**

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Question	Answer	Marks
7(a)(i)	relative hardness of potassium: between 1 and 3 (exclusive of these two values)	**1**
	melting point of rubidium: less than 63°C but not lower than 20°C	**1**
7(a)(ii)	slow bubbling / fewer bubbles than sodium	**1**
7(b)	2,8,1	**1**
7(c)(i)	Group I hydroxide is alkaline / sodium hydroxide is an alkali	**1**
7(c)(ii)	add (red) litmus **OR** add universal / full range indicator	**1**
	turns blue **OR** turns blue / purple	**1**
7(d)	38 **IF** two marks not scored: 1 mark for (B =) 11, (Na =) 23, (H =) 1	**2**

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Question	Answer	Marks
8(a)	measuring cylinder	**1**
8(b)	measure the volume of gas given off / measure volume of carbon dioxide produced **OR** measure time taken	**1**
	over a given time(s) **OR** to produce given volume(s) of gas	**1**
8(c)	decreases rate / decreases it / makes it slower	**1**
8(d)	small pieces **AND** large pieces **AND** powder	**1**
8(e)	calcium chloride	**1**
	carbon dioxide **AND** water	**1**

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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2018**

MARK SCHEME

Maximum Mark: 80

Published

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Question	Answer	Marks
1(a)	a substance made from two (or more) **elements**	**1**
	chemically combined	**1**
1(b)	dissolving	**1**
	filtration	**1**
	evaporation / crystallisation	**1**
	three correct stages in the correct order	**1**
1(c)(i)	condenser	**1**
	arrow pointing into lower aperture **only**	**1**
1(c)(ii)	stopper shown in diagram	**1**
	gases or vapours escape	**1**
1(c)(iii)	(mixture is) (in)flammable	**1**
1(c)(iv)	water bath cannot exceed 100 (°C)	**1**
	C AND D have a boiling point above 100 (°C)	**1**

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Question	Answer	Marks
2(a)	calcium / Ca	**1**
2(b)	7	**1**
2(c)	4	**1**
2(d)(i)	radioisotopes	**1**
2(d)(ii)	^{286}Fl 114p 172n 114e	**1**
	^{289}Fl 114p 175n 114e	**1**
2(e)(i)	any **two** from: high melting point / boiling point hard dense conduct electricity conduct heat ductile / malleable sonorous lustrous / shiny	**2**
2(e)(ii)	basic (oxide)	**1**

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Question	Answer	Marks
3(a)	(hot) air	**1**
3(b)	coke is burned (to form carbon dioxide) **OR** $C + O_2 \rightarrow CO_2$	**1**
	carbon dioxide is reduced by (more) coke to form **carbon monoxide** or **CO** **OR** $C + CO_2 \rightarrow 2CO$	**1**
	$3CO + Fe_2O_3 \rightarrow 2Fe + 3CO_2$	**1**
	limestone (decomposes to) form lime / CaO / calcium oxide (and carbon dioxide) **OR** $CaCO_3 \rightarrow CaO + CO_2$	**1**
	$CaO + SiO_2 \rightarrow CaSiO_3$	**1**
3(c)	the impurity is C	**1**
	blow **into** or pass oxygen **through** (molten) **iron**	**1**
	carbon dioxide escapes or carbon dioxide is a gas	**1**

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Question	Answer	Marks
4(a)	relative atomic mass	**1**
4(b)	C_4H_{10} is covalent	**1**
	KF is ionic	**1**
4(c)	mol of **Y** = 0.060 / 24.0 = 2.5×10^{-3} or 0.0025	**1**
	M_r = 0.095 / 2.5×10^{-3} = 38(.0)	**1**
	fluorine	**1**
4(d)	mass of O = 3.87 g – 1.68 g = 2.19 (g)	**1**
	mol of P and mol of O 1.68 / 31 OR 0.054.. 2.19 / 16 **OR** 0.13…	**1**
	ratio of P to O P = 0.054… / 0.054 O = 0.13… / 0.054… = 1 = 2.5	**1**
	whole number ratio and P_2O_5 = 2 = 5	**1**
4(e)	the formula is P_4O_6 or (one mole of) P_2O_3 = 110 (g)	**1**
	mass = 220 (g)	**1**

Question	Answer	Marks
5(a)(i)	(a substance which) increases the rate of a reaction	1
	without being used up (at the end) / remains unchanged or unaffected or without changing mass	1
5(a)(ii)	variable oxidation states	1
5(b)	any **two** from: high(er) melting point / boiling point (very) hard(er) (very) strong(er) dense(r)	2
5(c)(i)	$ZnSO_4$	1
	H_2 written on product line	1
	states (aq) **AND** (g)	1
5(c)(ii)	(labelled) arrow pointing upwards starting level with reactants and finishing level with top of the hump.	1
5(c)(iii)	exothermic **AND** products are at lower energy (than reactants)	1
5(d)	lower hump starting from reactants line	1
5(e)(i)	$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ 1 mark for any equation which has Cu as the product or Cu^{2+} ions on left 1 mark for correct species 1 mark for correct state symbols	3
5(e)(ii)	(a pink / brown) solid / deposit forms	1
5(e)(iii)	bubbles / fizzing (at the anode)	1
	solution becomes paler / less blue / colourless	1

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Question	Answer	Marks
5(e)(iv)	a green gas would be seen (on the anode)	1

Question	Answer	Marks
6(a)	(they contain) carbon and hydrogen (atoms)	1
	only	1
6(b)	(all) the (C–C) bonds are single	1
6(c)(i)	(one) atom or group is replaced by another (atom or group)	1
6(c)(ii)	ultra-violet light **OR** sunlight	1
6(c)(iii)	$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ 1 mark for C_2H_5Cl 1 mark for the rest of the equation	2
6(d)(i)	only one product (compound) forms	1
6(d)(ii)	fully displayed formula of 1,2-dibromopropane	1
6(e)	fully displayed formula of but-2-ene	1
	but-2-ene	1

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Question	Answer	Marks
6(f)(i)	poly(ethene)	**1**
6(f)(ii)	single bond between two C atoms	**1**
	fully correct answer	**1**
6(g)	any one correct amide link showing all bonds	**1**
	both amide links shown in the correct orientation for three amino acids	**1**
6(h)	ethanol + butanoic acid → ethyl butanoate + water 1 mark for the names of the reactants 1 mark for the name of the ester 1 mark for water as a product	**3**

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CHEMISTRY **0620/42**

Paper 2 Theory (Extended) **May/June 2018**

MARK SCHEME

Maximum Mark: 80

Published

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Question	Answer	Marks
1(a)	distillation	1
1(b)	electrolysis	1
1(c)	filtration	1
1(d)	fractional distillation / fractionation	1
1(e)	chromatography	1

Question	Answer	Marks
2(a)	silicon / Si	1
2(b)	aluminium / Al	1
2(c)	sodium / Na	1
2(d)	chlorine / Cl_2 / Cl	1
2(e)	argon / Ar	1
2(f)	sulfur / S	1
2(g)	phosphorus / P	1

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Question	Answer	Marks
3		**6**

particles	number of protons	number of electrons	number of neutrons	number of nucleons
			12 (1)	
	17 (1)	18 (1)		37 (1)
Fe (1) 2+ (1)				

Question	Answer	Marks
4(a)	$2K(s) + Br_2(l) \rightarrow 2KBr(s)$ 1 mark for formulae all correct 1 mark for balancing 1 mark for state symbols	**3**
4(b)(i)	(ionic): made of, positive and negative ions / anions and cations / oppositely charged ions / unlike charged ions / different charged ions	**1**
	(lattice): regular / sequence / pattern / alternating / repeated / framework / ordered / organised / network / uniform	**1**
4(b)(ii)	(in solid) ions don't move	**1**
	(when molten) ions move / ions mobile	**1**

Question	Answer	Marks
4(c)(i)	substance that conducts electricity / (undergoes) electrolysis	1
	decomposed / chemically changed **OR** molten or liquid or solution or aqueous **AND** containing ions/or ionic	1
4(c)(ii)	$2H^+ + 2e^- \rightarrow H_2$ 1 mark for $H^+ + e^-$ as the only species on the left 1 mark for equation fully correct 1 mark for bromine at the anode 1 mark for potassium hydroxide	4
4(c)(iii)	potassium	1
4(d)(i)	$I_2 + Cl_2 \rightarrow 2ICl$ 1 mark for formulae all correct 1 mark for correct balancing	2
4(d)(ii)	one bonding pair	1
	6 non-bonding electrons on each atom	1
4(e)	(potassium bromide): ionic bonds / attraction between ions	1
	(iodine monochloride): intermolecular forces / forces between molecules / named intermolecular forces, e.g. van der Waals / London forces / dispersion forces / dipole- dipole	1
	bonds in KBr are stronger / need more energy to break bonds / ORA	1

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Question	Answer	Marks
4(f)(i)	$Cl_2 + 2e^- \rightarrow 2Cl^-$	1
4(f)(ii)	(bromide ions) lose electrons / donate electrons / are oxidised	1

Question	Answer	Marks
5(a)	the rate of forward reaction equals (the rate of the) reverse reaction	1
	concentrations of reactants and products are constant	1
5(b)(i)	same number of gas moles on both sides of the equilibrium / same number of gas molecules on both sides of the equilibrium	1
5(b)(ii)	(increased pressure) particles or molecules (forced) closer together / same number of particles or molecules in a smaller volume	1
5(c)(i)	to left / towards reactants / in reverse direction	1
5(c)(ii)	increase / faster	1
	increase / faster	1

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Question	Answer	Marks
6(a)	(mix) sodium carbonate **AND** barium nitrate / barium chloride	**1**
	in solution / aqueous / dissolved (in water)	**1**
	filter / centrifuge (barium carbonate)	**1**
	wash (residue) **AND** dry / description of washing and drying	**1**
	$Ba(NO_3)_2 + Na_2CO_3 \rightarrow BaCO_3 + 2NaNO_3$ / $Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3$ **OR** $BaCl_2 + Na_2CO_3 \rightarrow BaCO_3 + 2NaCl$	**1**
6(b)(i)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ 1 mark for either $NaNO_2$ or O_2 on the right-hand side 1 mark for fully correct equation	**2**
6(b)(ii)	$2Cu(NO_3)_2.3H_2O(s) \rightarrow \mathbf{2}CuO(s) + \mathbf{4}NO_2(s) + O_2(g) + \mathbf{6}H_2O(g)$ all 3 numbers = 2 marks any 2 numbers = 1 mark	**2**
6(b)(iii)	blue	**1**
	pink	**1**
6(b)(iv)	boiling point sharp / melting point sharp / freezing point sharp / boiling point 100 (°)C / freezing point or melting point 0 (°)C	**1**

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Question	Answer	Marks
7(a)	60 / 12 :13.33 / 1 : 26.67 / 16 or evaluation 5 : 13.33 : 1.67 or 3:8:1	**1**
	C_3H_8O	**1**
7(b)	(C_2H_4O =) 44	**1**
	$C_4H_8O_2$	**1**
7(c)(i)	structural isomers	**1**
7(c)(ii)	**T** **V** **OR**	**2**
7(c)(iii)	$C_3H_6O_2 + 3½ O_2 \rightarrow 3CO_2 + 3H_2O$ 1 mark for all formulae correct 1 mark for correct balancing	**2**

Question	Answer	Marks
7(d)(i)	alcohol / alkanol	**1**
7(d)(ii)		**1**
7(e)(i)	(they contain) carbon and hydrogen (atoms)	**1**
	only	**1**
7(e)(ii)	alkane: C_nH_{2n+2}	**1**
	alkene: C_nH_{2n}	**1**
7(f)	(step 1) crack / cracking (of octane)	**1**
	(step 1) equation with only C_8H_{18} on left hand side and C_2H_4 + other correct product(s) on right hand side e.g. $C_8H_{18} \rightarrow C_2H_4 + C_6H_{14}$	**1**
	(step 2) hydration / addition	**1**
	(step 2) one correct condition for **either** process required (cracking): 450 (°) C to 800 (°) C / zeolites / aluminosilicates / silica / SiO_2 / aluminium oxide / Al_2O_3 / alumina / china / broken pot / chromium oxide / Cr_2O_3 / up to 70 atmospheres (hydration): phosphoric acid / H_3PO_4 / 300 (°)C / 60 atmospheres	**1**
	$C_2H_4 + H_2O \rightarrow C_2H_5OH$ / CH_3CH_2OH	**1**

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CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2018**

MARK SCHEME

Maximum Mark: 80

Published

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Question	Answer	Marks
1(a)	Cl_2 / chlorine	1
1(b)	SO_2 / sulfur dioxide	1
1(c)	Cu / copper	1
1(d)	Ar / argon	1
1(e)	$Ca(OH)_2$ / calcium hydroxide	1
1(f)	V_2O_5 / vanadium(V) oxide	1

Question	Answer	Marks
2(a)(i)	similarities: number of protons **and** electrons	1
	differences: number of neutrons	1
2(a)(ii)	nucleons: 27	1
	neutrons: 14	1
	electrons: 10	1
2(b)(i)	bauxite	1
2(b)(ii)	aluminium is more reactive than carbon	1
2(b)(iii)	to lower the operating temperature / the mixture has a lower melting point than aluminium oxide	1
	to increase the conductivity	1

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Question	Answer	Marks
2(b)(iv)	oxidation (because) (the O^{2-}ion OR 'oxide ions') electrons are lost **OR** (the O^{2-}ion OR 'oxide ions') oxidation number increases	**1**
2(b)(v)	electrodes/anodes are made from carbon/graphite	**1**
	oxygen (made) reacts with carbon/anode	**1**
2(c)(i)	zinc is more reactive than copper	**1**
2(c)(ii)	displacement / redox	**1**
2(c)(iii)	(aluminium) has (inert) coating of aluminium oxide	**1**

Question	Answer	Marks
3(a)	any **one** from: conduct electricity conduct heat malleable ductile shiny	**1**
3(b)(i)	any **one** from: melting point hardness strength density	**1**
3(b)(ii)	(cobalt) high(er) / (cobalt) strong(er)	**1**

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Question	Answer	Marks
3(c)	any **two** from: potassium melts / potassium forms a ball fizzes / bubbles potassium moves (lilac) flame	**2**
3(d)(i)	test: lighted splint / flame result: (squeaky) pop	**2**
3(d)(ii)	any **one** from: increase surface area (of cobalt) powder the metal add a catalyst	**1**
3(d)(iii)	(particles) have more energy / (particles) move faster	**1**
	more collisions per second / greater collision rate	**1**
	more of the colliding molecules have sufficient energy (activation energy) to react	**1**
3(e)(i)	becomes pink / becomes purple	**1**
	equilibrium moves right	**1**
3(e)(ii)	(forward reaction is) exothermic	**1**
3(f)	3+	**1**

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Question	Answer	Marks
4(a)	any **two** from: trend in physical properties same/similar chemical properties (same) general formula successive members differ by CH_2 same functional group	**2**
4(b)	all bonding pairs correct and no extra incorrect non-bonding electrons	**1**
	4 non-bonding electrons on O completing oxygen octet	**1**
4(c)(i)	$C_2H_4 + H_2O \rightarrow C_2H_5OH$	**1**
4(c)(ii)	$C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$	**1**
4(c)(iii)	any **one** from: pure(r) product fast(er) reaction continuous process	**1**
4(c)(iv)	any **one** from: renewable feedstock low**er** temperature low**er** pressure	**1**
4(d)	(acidified) potassium manganate(VII)	**1**

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Question	Answer	Marks
4(e)(i)	ester linkage correct	**1**
	fully correct molecule	**1**
4(e)(ii)	ethyl ethanoate	**1**
4(e)(iii)	ester	**1**
4(f)(i)	partially dissociated / partially ionised	**1**
4(f)(ii)	add excess copper(II) carbonate to ethanoic acid	**1**
	filter	**1**
	heat to point of crystallisation **AND** leave (to cool)	**1**
4(f)(iii)	ethanoic acid + copper carbonate → copper ethanoate + carbon dioxide + water	**1**

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Question	Answer	Marks
5(a)	14.01/59 : 60.33/127 : 2.85/1 : 22.81/16 **OR** 0.237 : 0.475 : 2.85 : 1.43	**1**
	$NiI_2H_{12}O_6$	**1**
5(b)(i)	electrons	**1**
5(b)(ii)	(positive and negative) ions	**1**
5(b)(iii)	nickel	**1**
	iodine	**1**
	$Ni^{2+} + 2e^- \rightarrow Ni$ **OR** $2I^- \rightarrow I_2 + 2e^-$	**1**
5(c)(i)	copper formed/copper deposited	**1**
5(c)(ii)	oxygen	**1**
5(c)(iii)	copper removed or copper lost **or** copper forms ions	**1**
5(c)(iv)	any **three** from: (apparatus **A**): solution becomes paler/fades in **A** (apparatus **B**): solution stays the same colour in **B** (explanation): copper ions removed (but not added) copper ions not replaced in **A** **OR** copper ions both removed and added (at the same rate) copper ions are being replaced (continually)	**3**

Question	Answer	Marks
6(a)(i)	74	1
	0.12	1
6(a)(ii)	0.3	1
6(a)(iii)	0.02	1
6(a)(iv)	207	1
	4.14	1
6(a)(v)	75%	1
6(b)(i)	heat it	1
6(b)(ii)	$Ca(ClO_3)_2 \rightarrow CaCl_2 + 3O_2$ 1 mark for O_2 as product 1 mark for the rest correct and balanced	2
6(c)(i)	red	1
6(c)(ii)	proton donor	1
6(c)(iii)	$\rightarrow ClO_3^- + H_3O^+$	1

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CHEMISTRY **0620/51**

Paper 5 Practical Test **May/June 2018**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	volumes of sodium thiosulfate, 50, 40, 35, 30, 10 **AND** volumes of water 0, 10, 15, 20, 40 completed correctly	**1**
	times completed in seconds	**1**
	comparable to supervisor's	**1**
1(b)	all points plotted correctly (± half a small square)	**2**
	smooth line graph	**1**
1(c)	pale yellow (precipitate) / cloudy	**1**
1(d)(i)	value from graph	**1**
	indication	**1**
1(d)(ii)	1 ÷ time in **(d)(i)**	**1**
1(e)(i)	experiment 1	**1**
1(e)(ii)	more particles of thiosulfate present (in a given volume)	**1**
	more (chance of) collisions	**1**
1(f)	pipette / burette	**1**
1(g)	times would be shorter	**1**
	idea of depth of solution	**1**
1(h)	sketch above original curve	**1**

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Question	Answer	Marks
2(a)	pH 1–3	1
2(b)	effervescence / fizz / bubbles / magnesium disappears	1
2(c)	turns blue	1
2(d)	turns yellow	1
	white on standing	1
2(e)	limewater	1
	milky / cloudy / white ppt.	1
2(f)(i)	white precipitate	1
2(f)(ii)	clears / dissolves / colourless / soluble	1
2(g)(i)	white precipitate	1
2(g)(ii)	clears / dissolves / colourless / soluble	1
2(h)	bubbles / fizz / effervescence	1
	pH>7 / indicator paper turns blue	1
2(i)	nitric	1
	acid	1
2(j)	zinc	1
	carbonate	1

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Question	Answer	Marks
3	any **6** from one method: evaporation • measured volume of water • using measuring cylinder / pipette / burette • heat to 40 °C / heat to >40 °C • add KC*l* until no more dissolves / add excess KC*l* • stir • filter mixture (if heated to >40 °C then need to cool and filter) • evaporate filtrate to <u>dryness</u> • weigh solid mass not used • measured volume of water • using measuring cylinder / pipette / burette • heat to 40 °C • add KC*l* until no more dissolves • stir • weigh KC*l* not added • weigh KC*l* before adding any to water – only awarded if weighed mass not used after • difference in mass of KC*l* is mass dissolved mass undissolved • measured volume of water • using measuring cylinder / pipette / burette • heat to 40 °C • stir • filter • weigh residue (do not award if residue washed) • add weighed (excess) KC*l* to water – only awarded if mass of residue measured • mass KC*l* dissolved = initial mass – final mass	**max 6**

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CHEMISTRY **0620/52**

Paper 5 Practical Test **May/June 2018**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	initial **AND** final **AND** temperature change boxes completed correctly	**1**
	values ascending in magnitude **AND** comparable to supervisor's	**1**
1(b)	initial **AND** final temperature **AND** temperature change boxes completed correctly **AND** all temperature **AND** temperature changes recorded to the same number of decimal places	**1**
	values ascending in magnitude	**1**
1(c)	all 7 points plotted correctly (± half a small square)	**2**
	best-fit straight-line graphs	**1**
	both lines labelled	**1**
1(d)	evidence of extrapolation on graph	**1**
	value from graph	**1**
1(e)	exothermic	**1**
1(f)	room temperature / initial value from table	**1**
	(all) solid dissolved / heat lost to the surroundings	**1**
1(g)	temperature change is halved	**2**
1(h)	change in apparatus or method e.g. use a pipette / burette or insulation / lid	**1**
	as more accurate than a measuring cylinder **OR** reduce heat losses / gain	**1**

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Question	Answer	Marks
1(i)	repeat experiments	1
	compare	1

Question	Answer	Marks
2(a)	(pale) green (solid / crystals)	1
2(b)	condensation / drops of liquid at top of tube	1
	turns white / brown / yellow	1
2(c)	no change / reaction / precipitate or no observation	1
2(d)	white precipitate	1
2(e)	green	1
	precipitate	1
2(f)	iron(II) / Fe^{2+}	1
	sulfate / SO_4^{2-} $FeSO_4$ **OR** iron(II) sulfate = 2 marks iron sulfate = 1 mark	1
2(g)	pH 4–9	1
2(h)(i)	white	1
	precipitate	1
2(h)(ii)	no change / remains	1

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Question	Answer	Marks
2(i)	no change / reaction / precipitate	**1**
2(j)	calcium / Ca^{2+}	**1**

Question	Answer	Marks
3	any **6** from: • hydrochloric acid in burette / measuring cylinder (solutions can be reversed) • measured volume of barium hydroxide solution (solutions can be reversed) • in named container e.g. beaker / (conical) flask • (named) indicator (ignore Universal Indicator) / pH meter • acid added gradually / slowly / dropwise / dripped • until colour changes / endpoint / neutral / pH 7 • note volume added / initial and final volumes • calculation (using volumes and concentration of the acid)	**max 6**

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CHEMISTRY **0620/53**

Paper 5 Practical Test **May/June 2018**

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	all temperature boxes completed with all temperatures completed to same number of decimal places	1
	temperature increases and then decreases	1
1(b)	all points plotted correctly	1
	best-fit intersecting straight-line graphs	1
1(c)	all temperature boxes completed with all temperatures completed to same number of decimal places	1
	temperature increases and then decreases	1
1(d)	all points plotted correctly (± half a small square)	1
	best-fit intersecting straight-line graphs	1
1(e)(i)	working shown on graph	1
	value from graph where lines cross	1
1(e)(ii)	half as much	1
	less / half as much / many moles of sodium hydroxide present	1
1(f)	exothermic	1
1(g)(i)	to remove traces of acid **A** / clean or to remove impurities / contamination	1
1(g)(ii)	to remove traces of water / avoid dilution	1

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Question	Answer	Marks
1(h)	source of error: using a measuring cylinder or heat losses	1
	improvement: use a pipette / burette or lag / insulation / lid	1

Question	Answer	Marks
2(a)(i)	yellow	1
2(a)(ii)	anything in range 11–14	1
2(b)	white precipitate	1
	clears / dissolves	1
	white precipitate	1
2(c)	pH / litmus paper	1
	turns blue	1
2(d)	green precipitate	1
	clears / dissolves	1
	green precipitate	1
2(e)	sodium / Na^+	1
	hydroxide / OH^-	1
2(f)	colourless	1

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Question	Answer	Marks
2(g)	(pale) yellow	**1**
	precipitate / suspension	**1**
2(h)	yellow / blue flame	**1**
2(i)	organic / fuel / flammable	**1**

Question	Answer	Marks
3	any **6** from: • cut leaves into small pieces • grind / crush with sand / ethanol • using pestle/mortar • decant / pour-off / filter liquid • chromatography • apply extract to paper (in correct location) • description of separating colours	**max 6**

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CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2018**

MARK SCHEME

Maximum Mark: 40

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Question	Answer	Marks
1(a)	burette	1
1(b)	methyl orange / thymolphthalein / litmus	1
1(c)(i)	number 2 / 18.9 cm^3	1
1(c)(ii)	overshot end point / more than 25 cm^3 KOH in flask	1
1(c)(iii)	18.2	1
	cm^3	1
1(d)	(wrong conclusion) nitric acid more concentrated / stronger	1
	smaller volume of acid needed	1

Question	Answer	Marks
2(a)	volume boxes completed correctly in seconds 0, 10, 15, 20, 40	1
	time boxes completed correctly 27, 33, 45, 66, 201	2
2(b)	all points plotted correctly (± half a small square)	2
	smooth line graph	1
2(c)(i)	value from graph	1
	with clear indication	1
2(c)(ii)	1 ÷ value from **(c)(i)**	1
2(d)(i)	experiment 1	1

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Question	Answer	Marks
2(d)(ii)	more particles of thiosulfate (in a given volume)	1
	more chance of collision	1
2(e)	use a pipette / burette	1
2(f)	times would be shorter	1
	idea of depth of solution is greater	1
2(g)	sketch curve roughly same shape and above original	1

Question	Answer	Marks
3(a)	hydrogen / H_2	1
3(b)	sulfuric	1
	acid	1
3(c)	limewater	1
	milky / cloudy / white ppt.	1
3(d)(i)	white	1
	precipitate	1
3(d)(ii)	dissolves / clears / goes colourless	1
3(e)(i)	white precipitate	1
3(e)(ii)	dissolves / clears / goes colourless	1

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Question	Answer	Marks
4	any **6** from one method: evaporation • measured volume of water • using measuring cylinder / pipette / burette • heat to 40 °C / heat to >40 °C • add KC*l* until no more dissolves / add excess KC*l* • stir • filter mixture (if heated to >40 °C then need to cool and filter) • evaporate filtrate to <u>dryness</u> • weigh solid mass not used • measured volume of water • using measuring cylinder / pipette / burette • heat to 40 °C • add KC*l* until no more dissolves • stir • weigh KC*l* not added • weigh KC*l* before adding any to water – only awarded if weighed mass not used after • difference in mass of KC*l* is mass dissolved mass undissolved • measured volume of water • using measuring cylinder / pipette / burette • heat to 40 °C • stir • filter • weigh residue (do not award if residue washed) • add weighed (excess) KC*l* to water – only awarded if mass of residue measured • mass KC*l* dissolved = initial mass – final mass	**max 6**

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CHEMISTRY **0620/62**

Paper 6 Alterative to Practical **May/June 2018**

MARK SCHEME

Maximum Mark: 40

Published

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- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)	(gas) syringe	1
1(b)(i)	volume of gas / volume of carbon dioxide	1
1(b)(ii)	reaction finished / no more gas given off	1
	calcium carbonate used up	1
1(c)	sketch less steep at beginning	1
	to same level / volume / final amount of gas	1
1(d)	limewater / calcium hydroxide solution	1
	milky / cloudy / white ppt.	1

Question	Answer	Marks
2(a)	initial temperatures all 21 **AND** final temperatures 18, 17, 15	1
	temperature changes –3, –4, –6	1
2(b)	initial temperatures 22, 22, 21, 22 **AND** final temperatures 26, 27, 29, 33	1
	temperature changes +4, +5, +8, +11	1
2(c)	all points plotted correctly (± half a small square)	2
	best-fit straight-line graphs	1
	labels **D** (upper) **and C** (lower) or (expt.) 2 and 1	1

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Question	Answer	Marks
2(d)	value from graph, –8 °C	1
	extrapolation	1
2(e)	exothermic	1
2(f)	room temperature / 21 °C / 22 °C	1
	heat lost to surroundings	1
2(g)	half as much	2
2(h)	change in apparatus or method e.g. use a pipette / burette or use insulation / lid	1
	explanation e.g. as more accurate / precise, than a measuring cylinder / reduce heat losses	1
2(i)	repeat experiments	1
	compare / average	1

Question	Answer	Marks
3(a)	(pale) green (solid / crystals)	1
3(b)	no change / no reaction / no precipitate / no observation	1
3(c)	white precipitate	1
3(d)	green	1
	precipitate	1
3(e)	green precipitate	1
3(f)	calcium	1

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Question	Answer	Marks
4	any **6** from: • hydrochloric acid in burette / measuring cylinder (solutions can be reversed) • measured volume of barium hydroxide solution (solutions can be reversed) • in named container e.g. beaker / (conical) flask • (named) indicator (ignore Universal Indicator) **OR** pH meter • acid added gradually / slowly / dropwise / dripped • until colour changes / endpoint / neutral / pH 7 • note volume added / initial and final volumes • calculation (using volumes and concentration of the acid)	**max 6**

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Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2018**

MARK SCHEME

Maximum Mark: 40

Published

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Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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This document consists of **6** printed pages.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

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- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)(i)	balance	1
1(a)(ii)	crucible	1
1(b)	open	1
1(c)	weigh the solid	1
	heat to constant mass	1
1(d)	anhydrous copper sulfate / cobalt chloride paper	1
	turns blue / turns pink	1

Question	Answer	Marks
2(a)	all temperature boxes completed correctly: 21, 23, 25, 27, 29, 31, 30, 29, 28	2
2(b)	all points plotted correctly (± half a small square)	1
	best-fit intersecting straight-line graphs	1
2(c)	temperature boxes completed correctly: 21, 26, 31, 32, 31, 30, 29, 28, 27	2
2(d)	all points plotted correctly	1
	best-fit intersecting straight-line graphs	1
2(e)(i)	value from graph where lines cross: 12 cm^3	1
	shown clearly at intersection	1

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Question	Answer	Marks
2(e)(ii)	half volume of acid	1
	less / half as many moles of sodium hydroxide present	1
2(f)	exothermic / heat given out	1
2(g)(i)	to remove traces of acid / clean / remove impurities	1
2(g)(ii)	to remove traces of water	1
2(h)	sources of error using a measuring cylinder or heat losses	1
	improvement use a pipette / use a burette / lag / insulation / lid	1

Question	Answer	Marks
3(a)(i)	yellow	1
3(a)(ii)	pH 11–14	1
3(b)	white precipitate	1
	clears / dissolves	1
	white precipitate	1
3(c)	pH / litmus paper	1
	turns pH >7 / turns blue	1
3(d)	grey-green	1
	precipitate	1

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Question	Answer	Marks
3(e)	organic / fuel / flammable	**1**

Question	Answer	Marks
4	any **6** from: • cut leaves into small pieces • grind / crush with sand / ethanol • using pestle/mortar • decant / pour-off / filter liquid • chromatography • apply extract to paper (in correct location) • description of separating colours	**Max 6**

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CHEMISTRY **0620/11**

Paper 1 Multiple Choice (Core) **May/June 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level1/Level 2 Certificate.

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1 The diagrams show particles in a container.

Which two diagrams show the process of evaporation?

A 1 → 2 **B** 1 → 3 **C** 2 → 3 **D** 3 → 1

2 Which piece of apparatus is used to measure exactly 26.3 cm^3 of a liquid?

3 The melting points and boiling points of pure substances W, X and Y are shown.

	W	X	Y
melting point / °C	–114	115	–101
boiling point / °C	78	445	–34

The substances are chlorine, ethanol and sulfur.

Which row identifies W, X and Y?

	W	X	Y
A	chlorine	ethanol	sulfur
B	ethanol	sulfur	chlorine
C	sulfur	chlorine	ethanol
D	sulfur	ethanol	chlorine

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4 In which atom is the number of protons equal to the number of neutrons?

A ^{40}Ar **B** ^{19}F **C** ^{23}Na **D** ^{16}O

5 Which row identifies an alloy, a pure metal and a non-metal?

	alloy	pure metal	non-metal
A	brass	carbon	copper
B	brass	copper	carbon
C	copper	brass	carbon
D	copper	carbon	brass

6 A covalent molecule Q contains exactly six shared electrons.

What is Q?

A ammonia, NH_3

B chlorine, Cl_2

C methane, CH_4

D water, H_2O

7 The 'lead' in a pencil is made of a mixture of graphite and clay.

When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

8 The equation for the reaction between magnesium and dilute sulfuric acid is shown.

The M_r of $MgSO_4$ is 120.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

Which mass of magnesium sulfate is formed when 12 g of magnesium completely reacts with dilute sulfuric acid?

A 5 g **B** 10 g **C** 60 g **D** 120 g

9 What is observed at each electrode when molten lead(II) bromide is electrolysed using platinum electrodes?

	negative electrode	positive electrode
A	bubbles of a colourless gas	bubbles of a brown gas
B	bubbles of a colourless gas	bubbles of a colourless gas
C	shiny grey liquid	bubbles of a brown gas
D	shiny grey liquid	bubbles of a colourless gas

10 Which gas is used as a fuel?

A argon

B hydrogen

C nitrogen

D oxygen

11 Burning fuels is an exothermic reaction.

What is meant by the term *exothermic*?

A A gas is produced.

B Energy is released.

C Heat is absorbed.

D The mass of the fuel decreases.

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12 The diagram shows a rate of reaction experiment.

Increasing the concentration of the acid and increasing the temperature both affect the rate of reaction.

Which row is correct?

	increase the concentration of acid	increase the temperature
A	decrease rate of reaction	decrease rate of reaction
B	decrease rate of reaction	increase rate of reaction
C	increase rate of reaction	decrease rate of reaction
D	increase rate of reaction	increase rate of reaction

13 Water is added to anhydrous copper(II) sulfate.

What happens during the reaction?

A The copper(II) sulfate turns blue and the solution formed gets colder.

B The copper(II) sulfate turns blue and the solution formed gets hotter.

C The copper(II) sulfate turns white and the solution formed gets colder.

D The copper(II) sulfate turns white and the solution formed gets hotter.

14 Which equation shows an oxidation reaction?

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

D $N_2O_4 \rightarrow 2NO_2$

15 Dilute nitric acid is added to a solid, F.

A gas, G, is produced which is denser than air and extinguishes a burning splint.

What are F and G?

	solid F	gas G
A	calcium	hydrogen
B	calcium carbonate	carbon dioxide
C	calcium hydroxide	hydrogen
D	calcium oxide	carbon dioxide

16 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

17 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

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18 Two salt solutions, X and Y, are tested.

The table shows the results.

test	X	Y
a few drops of aqueous sodium hydroxide are added	green precipitate formed	red-brown precipitate formed
a few drops of dilute nitric acid and a few drops of barium nitrate are added	no change seen	white precipitate formed
a few drops of dilute nitric acid and a few drops of silver nitrate are added	white precipitate formed	no change seen

What are X and Y?

	X	Y
A	iron(II) chloride	iron(III) sulfate
B	iron(III) chloride	iron(III) sulfate
C	iron(II) sulfate	iron(III) chloride
D	iron(III) sulfate	iron(III) chloride

19 Which element is in the same period of the Periodic Table as silicon?

A germanium

B scandium

C sodium

D strontium

20 Which statement about the halogens is correct?

A A sample of bromine reacts with potassium chloride solution.

B A sample of bromine reacts with potassium iodide solution.

C A sample of chlorine has a higher density than a sample of bromine.

D A sample of chlorine is a darker colour than a sample of bromine.

21 Which row shows the catalytic activity of transition elements and their compounds?

	catalytic activity of transition elements	catalytic activity of compounds of transition elements
A	good	good
B	good	poor
C	poor	good
D	poor	poor

22 Which statement about the noble gases is **not** correct?

A Noble gases are diatomic molecules.

B Noble gases are unreactive gases.

C Noble gases have full outer electron shells.

D The noble gas argon is used in lamps.

23 The following statements are made about the metals copper, iron, magnesium and zinc.

1 Their oxides are acidic.

2 They all conduct electricity in the solid state.

3 They all have high melting points.

4 They all react with dilute acids to form hydrogen.

Which statements are correct?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

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24 Three metals, X, Y and Z, were reacted with water.

The oxides of the same three metals were also heated strongly with carbon.

The results are shown.

metal	reaction of the metal with water	reaction of the metal oxide with carbon
X	vigorous reaction with cold water	no reaction
Y	no reaction	metal and carbon dioxide produced
Z	no reaction observed with cold water but reaction observed with steam	no reaction

What is a correct conclusion about X, Y and Z?

A X is sodium and Y is magnesium.

B X is the least reactive and Y is the most reactive.

C Z is less reactive than Y.

D Z is magnesium and Y is copper.

25 In a blast furnace, iron ore is mixed with coke and limestone, and heated in hot air.

Compound R is formed. Compound R then reduces the iron ore to iron.

Which equation shows the formation of compound R?

A $C + O_2 \rightarrow CO_2$

B $CO_2 + C \rightarrow 2CO$

C $CaCO_3 \rightarrow CaO + CO_2$

D $CaO + SiO_2 \rightarrow CaSiO_3$

26 Which statement explains why aluminium is used in the manufacture of aircraft?

A It conducts heat well.

B It has a low density.

C It is a good conductor of electricity.

D It is easy to recycle.

27 Dry air is passed over hot copper until all the oxygen has reacted.

The volume of gas at the end of the reaction is 120 cm^3.

What is the starting volume of dry air?

A 132 cm^3 **B** 152 cm^3 **C** 180 cm^3 **D** 570 cm^3

28 A steel bicycle which had been left outdoors for several months was starting to rust.

What would **not** reduce the rate of corrosion?

A Remove the rust and paint the bicycle.

B Remove the rust and store the bicycle in a dry shed.

C Remove the rust and wipe the bicycle with a clean, damp cloth.

D Remove the rust and wipe the bicycle with an oily cloth.

29 Which statements about water are correct?

1 Household water contains dissolved salts.

2 Water for household use is filtered to remove soluble impurities.

3 Water is treated with chlorine to kill bacteria.

4 Water is used in industry for cooling.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 3 and 4 only

D 2, 3 and 4 only

30 Farmers use fertilisers to replace minerals in the soil that have been removed by the crops they grow.

Which elements in the soil are replaced by adding fertilisers?

A Ca, P, O **B** K, O, S **C** N, K, P **D** N, O, S

31 Which statement is correct?

A Atmospheric carbon dioxide is not a cause of climate change.

B Atmospheric methane is produced by respiration.

C Burning natural gas decreases the level of carbon dioxide in the atmosphere.

D Decomposition of vegetation causes an increase in atmospheric methane.

32 Which statement about sulfur and its compounds is **not** correct?

A Sulfur dioxide is used as a food preservative.

B Sulfur dioxide turns acidified aqueous potassium manganate(VII) from purple to colourless.

C Sulfur forms a basic oxide.

D Sulfur is used in the manufacture of sulfuric acid.

33 Which process is used to convert limestone (calcium carbonate) into lime?

A electrolysis

B fractional distillation

C incomplete combustion

D thermal decomposition

34 Lime is used to treat an industrial waste.

Which change occurs in the treatment?

	untreated waste		treated waste
A	acidic	→	neutral
B	alkaline	→	acidic
C	alkaline	→	neutral
D	neutral	→	acidic

35 What is **not** the correct use of the fraction named?

	name of fraction	use
A	fuel oil	making waxes
B	gas oil	fuel in diesel engines
C	kerosene	jet fuel
D	naphtha	making chemicals

36 Four organic compounds are listed.

ethane

ethanoic acid

ethanol

ethene

Which bond do all four compounds contain?

A C–C **B** C–H **C** C–O **D** O–H

37 The first three members of a homologous series are shown.

Why do these molecules represent a homologous series?

A because they contain fluorine and carbon atoms

B because they have saturated bonds

C because they have the same functional group

D because they react differently from each other

38 Which substances can be obtained by cracking hydrocarbons?

A ethanol and ethene

B ethanol and hydrogen

C ethene and hydrogen

D ethene and poly(ethene)

39 Which reaction is used to make ethanol?

A adding steam to ethene

B addition polymerisation

C fractional distillation of petroleum

D reacting ethene with aqueous bromine

40 Polymers are long-chain molecules made from small molecules linked together.

Four polymers or types of polymer are listed.

1 carbohydrates

2 nylon

3 proteins

4 *Terylene*

Which of these polymers or types of polymer are synthetic?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group	I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1											2 He helium 4
	3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
	87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/12**

Paper 1 Multiple Choice (Core) **May/June 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
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Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

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1 When iodine is heated it turns from a solid to a gas.

When liquid ammonia is cooled it turns into a solid.

When ice is heated it turns into water.

Which terms describe these changes of state?

	when iodine is heated	when liquid ammonia is cooled	when ice is heated
A	boiling	freezing	melting
B	freezing	sublimation	boiling
C	sublimation	condensation	freezing
D	sublimation	freezing	melting

2 Which piece of apparatus **cannot** be used to collect and measure the volume of gas produced in an experiment?

A burette

B gas syringe

C measuring cylinder

D pipette

3 Pure ethanol has a melting point of –114 °C and a boiling point of 78 °C.

What are the melting and boiling points of a sample of ethanol with glucose dissolved in it?

	melting point / °C	boiling point / °C
A	–116	77
B	–116	79
C	–112	77
D	–112	79

4 Which atom has an equal number of protons, neutrons and electrons?

A ^{40}Ar **B** ^{1}H **C** ^{23}Na **D** ^{14}N

5 Which description of brass is correct?

A alloy

B compound

C element

D non-metal

6 The bonding between elements X and Y in compound XY_2 is shown.

$$Y = X = Y$$

Which row shows the type of bond in XY_2 and the type of element X?

	type of bond	type of element X
A	covalent	metal
B	covalent	non-metal
C	ionic	metal
D	ionic	non-metal

7 The 'lead' in a pencil is made of a mixture of graphite and clay.

When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

8 The equation for the reaction between magnesium and dilute sulfuric acid is shown.

The M_r of $MgSO_4$ is 120.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

Which mass of magnesium sulfate is formed when 12 g of magnesium completely reacts with dilute sulfuric acid?

A 5 g **B** 10 g **C** 60 g **D** 120 g

9 The electrolysis of molten lead(II) bromide is shown.

Which statement describes what happens at the negative electrode?

A Bromide ions gain electrons to form bromine molecules.

B Bromine molecules gain electrons to form bromide ions.

C Lead atoms lose electrons to form lead ions.

D Lead ions gain electrons to form lead atoms.

10 Which statement about the combustion of fuels is correct?

A It always produces carbon dioxide.

B It always produces carbon monoxide.

C It is always endothermic.

D It is always exothermic.

11 Which statement about chemical reactions is correct?

A Endothermic reactions show a temperature decrease because energy is absorbed from the surroundings.

B Endothermic reactions show a temperature increase because energy is released into the surroundings.

C Exothermic reactions show a temperature increase because energy is absorbed from the surroundings.

D Exothermic reactions show a temperature decrease because energy is released into the surroundings.

12 The diagram shows a rate of reaction experiment.

Increasing the concentration of the acid and increasing the temperature both affect the rate of reaction.

Which row is correct?

	increase the concentration of acid	increase the temperature
A	decrease rate of reaction	decrease rate of reaction
B	decrease rate of reaction	increase rate of reaction
C	increase rate of reaction	decrease rate of reaction
D	increase rate of reaction	increase rate of reaction

13 Reaction X shows a test for water. Reaction Y occurs in the blast furnace for extracting iron.

reaction X $CoCl_2 + 6H_2O \rightleftharpoons CoCl_2.6H_2O$

reaction Y $C + CO_2 \rightarrow 2CO$

Reaction X is .....1..... . In reaction Y, the oxide CO_2 is .....2..... .

Which words correctly complete gaps 1 and 2?

	1	2
A	irreversible	oxidised
B	irreversible	reduced
C	reversible	oxidised
D	reversible	reduced

14 Which equation shows an oxidation reaction?

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

D $N_2O_4 \rightarrow 2NO_2$

15 Which two gases each give the same result for the test shown?

	test	gas 1	gas 2
A	damp blue litmus paper	ammonia	chlorine
B	damp blue litmus paper	ammonia	oxygen
C	lighted splint	hydrogen	chlorine
D	lighted splint	hydrogen	oxygen

16 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

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17 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

18 Two separate tests are done on separate solutions of compound X.

1 Addition of aqueous sodium hydroxide forms a green precipitate that dissolves in an excess of aqueous sodium hydroxide.

2 Addition of dilute nitric acid and aqueous silver nitrate forms a white precipitate.

What is compound X?

A chromium(III) carbonate

B chromium(III) chloride

C iron(II) carbonate

D iron(II) chloride

19 Which statement about the Periodic Table is correct?

A Elements in the same group have the same number of electron shells.

B It contains elements arranged in order of increasing proton number.

C Metals are on the right and non-metals are on the left.

D The most reactive elements are at the bottom of every group.

20 Chlorine, bromine and iodine are elements in Group VII of the Periodic Table.

Which statement about these elements is **not** correct?

A The colour gets darker down the group.

B The density increases down the group.

C They are all gases at room temperature and pressure.

D They are all non-metals.

21 Which row describes the properties of a transition element?

	property 1	property 2
A	forms colourless compounds	acts as a catalyst
B	forms colourless compounds	low electrical conductivity
C	high density	acts as a catalyst
D	high density	low electrical conductivity

22 Which statement about the elements in Group VIII is correct?

A They all form diatomic molecules.

B They all have eight electrons in their outer shells.

C They all react with oxygen to form oxides.

D They are all gases at room temperature.

23 Stainless steel is an alloy of iron, carbon and other metals.

Which row is correct?

	stainless steel is harder than pure iron	stainless steel resists corrosion better than pure iron
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

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24 A student is given metal Z and its oxide.

The student does some experiments to find out the position of metal Z in the reactivity series.

The results are shown.

- Metal Z reacted slowly with dilute hydrochloric acid.
- Metal Z reacted slowly with steam but not with water.
- The oxide of metal Z reacted when heated with carbon.

Which statement about the position of metal Z in the reactivity series is correct?

A It is between calcium and sodium.

B It is between copper and hydrogen.

C It is between hydrogen and iron.

D It is between magnesium and calcium.

25 Iron is produced from iron ore in a blast furnace.

Which equation represents the main reaction that happens in zone 1?

A $C(s) + CO_2(g) \rightarrow 2CO(g)$

B $C(s) + O_2(g) \rightarrow CO_2(g)$

C $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$

D $Fe_3O_4(s) + CO(g) \rightarrow 3FeO(s) + CO_2(g)$

26 Which row describes the use of an alloy and the property upon which the use depends?

	alloy	use	property
A	mild steel	cutlery	resistant to corrosion
B	mild steel	machinery	strong
C	stainless steel	cutlery	low density
D	stainless steel	machinery	good conductor of electricity

27 Dry air is passed over hot copper until all the oxygen has reacted.

The volume of gas at the end of the reaction is 120 cm^3.

What is the starting volume of dry air?

A 132 cm^3 **B** 152 cm^3 **C** 180 cm^3 **D** 570 cm^3

28 A steel bicycle which had been left outdoors for several months was starting to rust.

What would **not** reduce the rate of corrosion?

A Remove the rust and paint the bicycle.

B Remove the rust and store the bicycle in a dry shed.

C Remove the rust and wipe the bicycle with a clean, damp cloth.

D Remove the rust and wipe the bicycle with an oily cloth.

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29 Which statements about water are correct?

1 Household water contains dissolved salts.

2 Water for household use is filtered to remove soluble impurities.

3 Water is treated with chlorine to kill bacteria.

4 Water is used in industry for cooling.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 3 and 4 only

D 2, 3 and 4 only

30 Ammonium nitrate is a common fertiliser used by farmers to increase the yield of their crops.

Which compound reacts with ammonium nitrate to form ammonia?

A calcium hydroxide

B potassium nitrate

C sodium chloride

D sodium phosphate

31 Which process does **not** release a greenhouse gas?

A digestion of food in cows

B reaction between zinc and hydrochloric acid

C respiration by animals

D thermal decomposition of calcium carbonate

32 Which row describes the uses of sulfur and sulfur dioxide?

	sulfur	sulfur dioxide
A	extraction of aluminium	food preservative
B	extraction of aluminium	water treatment
C	manufacture of sulfuric acid	food preservative
D	manufacture of sulfuric acid	water treatment

33 Limestone is used in many industrial processes.

In which process is it **not** used?

A manufacture of alkenes

B manufacture of cement

C manufacture of iron

D manufacture of lime

34 Lime is used to treat an industrial waste.

Which change occurs in the treatment?

	untreated waste		treated waste
A	acidic	→	neutral
B	alkaline	→	acidic
C	alkaline	→	neutral
D	neutral	→	acidic

35 What is **not** the correct use of the fraction named?

	name of fraction	use
A	fuel oil	making waxes
B	gas oil	fuel in diesel engines
C	kerosene	jet fuel
D	naphtha	making chemicals

36 Four organic compounds are listed.

ethane

ethanoic acid

ethanol

ethene

Which bond do all four compounds contain?

A C–C **B** C–H **C** C–O **D** O–H

37 Which compounds belong to the same homologous series?

A ethane and propane

B ethanoic acid and ethanol

C methane and ethene

D propene and ethanoic acid

38 Which substances can be obtained by cracking hydrocarbons?

A ethanol and ethene

B ethanol and hydrogen

C ethene and hydrogen

D ethene and poly(ethene)

39 The equations for two important processes used to manufacture ethanol are shown.

process 1 $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

process 2 $C_2H_4 + H_2O \rightarrow C_2H_5OH$

Which statement is **not** correct?

A Both processes require a catalyst.

B Both processes use a starting material obtained from petroleum.

C Process 1 shows the production of a renewable fuel.

D Process 2 is an addition reaction.

40 Part of the label on the packet of a potato product is shown.

This potato product contains: starch ethanoic acid sodium chloride sugar

Which constituent is a natural polymer?

A ethanoic acid

B sodium chloride

C starch

D sugar

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/13**

Paper 1 Multiple Choice (Core) **May/June 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level1/Level 2 Certificate.

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1 Mineral wool soaked in aqueous ammonia is placed in the apparatus shown.

After five minutes, the damp red litmus paper turned blue.

Which process led to this change?

A crystallisation

B diffusion

C distillation

D sublimation

2 Solid R reacted with dilute sulfuric acid.

The initial temperature of the dilute sulfuric acid and the final temperature of the solution are shown.

What was the change in temperature in °C?

A –6 **B** –4 **C** 4 **D** 6

3 The melting points of four impure samples of lead(II) bromide were measured. The results are shown.

Which sample is the most pure?

	temperature when the sample started to melt / °C	temperature when the sample finished melting / °C
A	342	355
B	353	360
C	365	371
D	372	373

4 Symbols representing four particles are shown.

$^{40}_{20}W$ $^{41}_{20}X^{2+}$ $^{37}_{18}Y$ $^{37}_{17}Z$

The letters are not the chemical symbols.

Which particles have the same number of neutrons?

A W and X^{2+} **B** W and Z **C** X^{2+} and Y **D** Y and Z

5 Which name is given to a pure substance made from more than one type of atom?

A alloy

B compound

C element

D mixture

6 The diagram shows solid element Q reacting with an acid to produce gas R.

Which row describes Q and R?

	Q	R
A	metal	element with covalent bonds
B	metal	element with ionic bonds
C	non-metal	compound with covalent bonds
D	non-metal	compound with ionic bonds

7 The 'lead' in a pencil is made of a mixture of graphite and clay.

When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

8 The equation for the reaction between magnesium and dilute sulfuric acid is shown.

The M_r of $MgSO_4$ is 120.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

Which mass of magnesium sulfate is formed when 12 g of magnesium completely reacts with dilute sulfuric acid?

A 5 g **B** 10 g **C** 60 g **D** 120 g

9 What is produced at each electrode when molten rubidium chloride is electrolysed using platinum electrodes?

	positive electrode	negative electrode
A	chlorine	hydrogen
B	chlorine	rubidium
C	hydrogen	chlorine
D	rubidium	chlorine

10 What is released when any fuel is burned?

A carbon dioxide

B heat energy

C smoke

D water

11 Group I metals react vigorously with water and release heat.

Which statement about this reaction is correct?

A The reaction is endothermic and the energy change is negative.

B The reaction is endothermic and the energy change is positive.

C The reaction is exothermic and the energy change is negative.

D The reaction is exothermic and the energy change is positive.

12 The diagram shows a rate of reaction experiment.

Increasing the concentration of the acid and increasing the temperature both affect the rate of reaction.

Which row is correct?

	increase the concentration of acid	increase the temperature
A	decrease rate of reaction	decrease rate of reaction
B	decrease rate of reaction	increase rate of reaction
C	increase rate of reaction	decrease rate of reaction
D	increase rate of reaction	increase rate of reaction

13 In a chemical reaction, blue compound X changed into white compound Y.

$$\underset{\text{blue}}{X} \rightarrow \underset{\text{white}}{Y}$$

Which statement describes this reaction?

A Hydrated cobalt(II) chloride is heated.

B Hydrated copper(II) sulfate is heated.

C Water is added to anhydrous cobalt(II) chloride.

D Water is added to anhydrous copper(II) sulfate.

14 Which equation shows an oxidation reaction?

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

D $N_2O_4 \rightarrow 2NO_2$

15 Pieces of damp red litmus paper and damp blue litmus paper are placed in three different gas jars.

In which gas jars does at least one piece of litmus paper change colour?

A 1, 2 and 3 **B** 1 and 2 **C** 1 and 3 **D** 2 and 3

16 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

17 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

18 A white crystalline solid is dissolved in distilled water.

A small amount of dilute nitric acid is added followed by aqueous silver nitrate.

No visible change occurs.

What can be deduced about the white crystalline solid?

A It contains chloride ions.

B It does not contain ammonium ions.

C It does not contain carbonate ions.

D It must contain either sulfate or nitrate ions.

19 Which element is classified as a non-metal in the Periodic Table?

A calcium

B chlorine

C chromium

D copper

20 Part of the Periodic Table is shown.

Element Q has a low boiling point, low density and does not conduct electricity.

Which element is Q?

21 Which row describes a typical transition element?

	density in g / cm^3	melting point in °C	boiling point in °C	colour of oxide
A	0.97	98	883	white
B	2.64	769	1382	white
C	3.10	–7	59	yellow
D	8.96	1085	2562	red

22 Helium is a noble gas.

Which statement is correct?

A A helium atom has eight electrons in its outer shell.

B Helium exists as diatomic molecules.

C Helium is used as an inert atmosphere in lamps.

D There are no naturally occurring chemical compounds of helium.

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23 Which diagram represents a solid alloy?

24 Some reactions of three metals and their oxides are shown.

metal	metal reacts with steam	metal oxide reacts with carbon
X	no	yes
Y	yes	no
Z	yes	yes

What is the order of reactivity of the metals?

	most reactive →		least reactive
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	Y	X

25 Which statement about the extraction of metals is correct?

A Aluminium is extracted from bauxite by electrolysis.

B Aluminium is extracted from hematite by heating with carbon.

C Iron is extracted from bauxite by heating with carbon.

D Iron is extracted from hematite by electrolysis.

26 Which statement explains why aluminium is used to manufacture aircraft?

A It has a low density.

B It is a good conductor of electricity.

C It is a good conductor of heat.

D It is ductile.

27 Dry air is passed over hot copper until all the oxygen has reacted.

The volume of gas at the end of the reaction is 120 cm^3.

What is the starting volume of dry air?

A 132 cm^3 **B** 152 cm^3 **C** 180 cm^3 **D** 570 cm^3

28 A steel bicycle which had been left outdoors for several months was starting to rust.

What would **not** reduce the rate of corrosion?

A Remove the rust and paint the bicycle.

B Remove the rust and store the bicycle in a dry shed.

C Remove the rust and wipe the bicycle with a clean, damp cloth.

D Remove the rust and wipe the bicycle with an oily cloth.

29 Which statements about water are correct?

1 Household water contains dissolved salts.

2 Water for household use is filtered to remove soluble impurities.

3 Water is treated with chlorine to kill bacteria.

4 Water is used in industry for cooling.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 3 and 4 only

D 2, 3 and 4 only

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30 Fertilisers are often mixtures of solid compounds.

Which compounds can be mixed to provide the three elements needed for healthy plant growth?

A ammonium nitrate and calcium phosphate

B ammonium nitrate and potassium chloride

C ammonium phosphate and potassium chloride

D potassium chloride and calcium phosphate

31 Carbon dioxide and methane are both greenhouse gases which contribute to climate change.

Which statement explains how greenhouse gases contribute to climate change?

A They absorb heat radiation from the Earth.

B They absorb heat radiation from the Sun.

C They absorb light radiation from the Sun.

D They cause acid rain.

32 Element Z forms an oxide, ZO_2. Three uses of ZO_2 are listed.

- bleaching agent
- killing bacteria
- manufacturing an important acid

What is Z?

A carbon

B lead

C nitrogen

D sulfur

33 Limestone is an important material with many uses.

Limestone is heated to produce .....1..... and carbon dioxide.

This reaction is called .....2..... .

Which words correctly complete gaps 1 and 2?

	1	2
A	lime	neutralisation
B	lime	thermal decomposition
C	slaked lime	neutralisation
D	slaked lime	thermal decomposition

34 Lime is used to treat an industrial waste.

Which change occurs in the treatment?

	untreated waste		treated waste
A	acidic	→	neutral
B	alkaline	→	acidic
C	alkaline	→	neutral
D	neutral	→	acidic

35 What is **not** the correct use of the fraction named?

	name of fraction	use
A	fuel oil	making waxes
B	gas oil	fuel in diesel engines
C	kerosene	jet fuel
D	naphtha	making chemicals

36 Four organic compounds are listed.

ethane

ethanoic acid

ethanol

ethene

Which bond do all four compounds contain?

A C–C **B** C–H **C** C–O **D** O–H

37 The structures of some organic compounds are shown.

1

2

3

4

Which compounds belong to the same homologous series?

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 and 4

38 Which substances can be obtained by cracking hydrocarbons?

A ethanol and ethene

B ethanol and hydrogen

C ethene and hydrogen

D ethene and poly(ethene)

39 Sugars and ethene can both be made into ethanol using different reactions.

Which type of reaction is used in each case?

	sugars to ethanol	ethene to ethanol
A	fermentation	addition
B	fermentation	cracking
C	incomplete combustion	addition
D	incomplete combustion	cracking

40 Which substances are natural polymers?

	ethanol	protein	starch	vinegar
A	✓	✓	✓	✓
B	✓	✗	✓	✗
C	✗	✓	✓	✗
D	✗	✗	✗	✓

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Key

atomic number
atomic symbol
name
relative atomic mass

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							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
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1 A student investigated the diffusion of ammonia gas, NH_3, and hydrogen chloride gas, HCl.

Two sets of apparatus were set up as shown at room temperature and pressure.

The damp red litmus paper in apparatus 1 changed colour after 30 seconds.

How long does it take for the damp blue litmus paper to change colour in apparatus 2?

A 64 seconds

B 30 seconds

C 21 seconds

D The blue litmus paper would not change colour.

2 Chromatography is a technique used to separate coloured dyes.

Which dye has an R_f value of 0.7?

3 Which piece of apparatus is used to measure exactly 26.3 cm^3 of a liquid?

4 The 'lead' in a pencil is made of a mixture of graphite and clay.

When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

5 Chlorine exists as two common isotopes, ^{35}Cl and ^{37}Cl.

Information about these two isotopes is shown.

	number of protons	number of neutrons	number of electron shells
^{35}Cl	17	18	3
^{37}Cl	17	20	3

Which statement explains why the two isotopes are of the same element?

A Both have the same number of electron shells.

B Both have the same number of protons.

C Both have 7 outer shell electrons.

D ^{37}Cl has 2 more neutrons than ^{35}Cl.

6 Which substance is **not** a macromolecule?

A diamond

B graphite

C silicon(IV) oxide

D sulfur

7 Copper is a metallic element.

Which statements about copper are correct?

1 Copper is malleable because layers of ions are in fixed positions and cannot move.

2 The structure of copper consists of negative ions in a lattice.

3 Copper conducts electricity because electrons can move through the metal.

4 Electrons hold copper ions together in a lattice by electrostatic attraction.

A 1 and 2 **B** 2, 3 and 4 **C** 2 and 3 only **D** 3 and 4 only

8 The equation for the combustion of ethane is shown.

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

Which volume of carbon dioxide, at room temperature and pressure, is formed when 0.5 moles of ethane burn?

A 48 dm^3 **B** 24 dm^3 **C** 12 dm^3 **D** 6 dm^3

9 A solution of ethanoic acid, CH_3COOH, has a concentration of 2 mol / dm^3.

Which statement about this solution is correct?

A 20 g of ethanoic acid is dissolved in 10 cm^3 of water.

B 30 g of ethanoic acid is dissolved in 250 cm^3 of water.

C 60 g of ethanoic acid is dissolved in 1 dm^3 of water.

D 120 g of ethanoic acid is dissolved in 2 dm^3 of water.

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement is correct?

A A reduction reaction occurs at the positive electrode.

B The blue colour of the solution becomes darker.

C The concentration of copper ions in the solution decreases.

D The mass of the negative electrode increases.

11 Dilute sulfuric acid is electrolysed using inert electrodes.

What are the ionic half-equations for the reactions that take place at each electrode?

	positive electrode	negative electrode
A	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
B	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- + 4H^+ \rightarrow 4H_2O$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H^+ + 2e^- \rightarrow H_2$
D	$4OH^- + 4H^+ \rightarrow 4H_2O$	$2H^+ + 2e^- \rightarrow H_2$

12 Plant cells use energy from sunlight for photosynthesis.

Which row describes and explains the energy change that occurs?

	type of energy change	explanation
A	endothermic	less energy is released making bonds than is absorbed to break bonds
B	endothermic	more energy is released making bonds than is absorbed to break bonds
C	exothermic	less energy is released making bonds than is absorbed to break bonds
D	exothermic	more energy is released making bonds than is absorbed to break bonds

13 Hydrogen bromide decomposes to form hydrogen and bromine. The equation is shown.

$$2HBr(g) \rightarrow H_2(g) + Br_2(g)$$

The bond energies are shown in the table. The reaction is endothermic.

bond	bond energy in kJ / mol
Br–Br	+193
H–Br	+366
H–H	+436

What is the energy change for the reaction?

A +263 kJ / mol **B** +103 kJ / mol **C** –103 kJ / mol **D** –263 kJ / mol

14 Which row describes the effects of increasing both concentration and temperature on the collisions between reacting particles?

	increasing concentration	increasing temperature
A	more collisions per second only	more collisions per second only
B	more collisions per second and more collisions with sufficient energy to react	more collisions per second only
C	more collisions per second only	more collisions per second and more collisions with sufficient energy to react
D	more collisions per second and more collisions with sufficient energy to react	more collisions per second and more collisions with sufficient energy to react

15 The formation of sulfur trioxide is a reversible reaction.

The equation is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of sulfur trioxide?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

16 Chlorine displaces iodide ions from potassium iodide.

$$Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$$

What is the oxidising agent?

A chloride ions

B chlorine

C iodide ions

D iodine

17 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

18 Which solution has the lowest pH?

A 0.1 mol / dm^3 ammonia solution

B 0.1 mol / dm^3 ethanoic acid

C 0.1 mol / dm^3 lithium hydroxide

D 0.1 mol / dm^3 nitric acid

19 A student mixes silver nitrate and barium chloride to form a white precipitate of silver chloride.

The equation is shown.

$$2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$$

Which row describes the solubility of the salts?

	soluble	insoluble
A	silver nitrate	barium chloride, barium nitrate and silver chloride
B	silver nitrate and barium chloride	barium nitrate and silver chloride
C	silver nitrate, barium chloride and barium nitrate	silver chloride
D	silver nitrate, barium chloride and silver chloride	barium nitrate

20 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

21 Which element is in the same period of the Periodic Table as silicon?

A germanium

B scandium

C sodium

D strontium

22 Which statement about the halogens is correct?

A A sample of bromine reacts with potassium chloride solution.

B A sample of bromine reacts with potassium iodide solution.

C A sample of chlorine has a higher density than a sample of bromine.

D A sample of chlorine is a darker colour than a sample of bromine.

23 Which row shows the catalytic activity of transition elements and their compounds?

	catalytic activity of transition elements	catalytic activity of compounds of transition elements
A	good	good
B	good	poor
C	poor	good
D	poor	poor

24 The following statements are made about the metals copper, iron, magnesium and zinc.

1 Their oxides are acidic.

2 They all conduct electricity in the solid state.

3 They all have high melting points.

4 They all react with dilute acids to form hydrogen.

Which statements are correct?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

25 Silver is a less reactive metal than cadmium.

Cadmium is a less reactive metal than barium.

Which statement is correct?

A Barium does not react when heated with silver oxide.

B Cadmium displaces barium from a solution of barium chloride.

C Cadmium displaces silver from a solution of silver nitrate.

D Cadmium reacts when heated with barium oxide.

26 Aluminium metal is extracted from aluminium oxide using electrolysis.

Which statement about the extraction process is **not** correct?

A A large amount of electricity is required.

B Molten cryolite is used to dissolve the aluminium oxide.

C Oxygen gas is released which reacts to form carbon dioxide.

D The negative electrodes burn away and have to be replaced.

27 Which statement explains why aluminium is used in the manufacture of aircraft?

A It conducts heat well.

B It has a low density.

C It is a good conductor of electricity.

D It is easy to recycle.

28 Dry air is passed over hot copper until all the oxygen has reacted.

The volume of gas at the end of the reaction is 120 cm^3.

What is the starting volume of dry air?

A 132 cm^3 **B** 152 cm^3 **C** 180 cm^3 **D** 570 cm^3

29 A steel bicycle which had been left outdoors for several months was starting to rust.

What would **not** reduce the rate of corrosion?

A Remove the rust and paint the bicycle.

B Remove the rust and store the bicycle in a dry shed.

C Remove the rust and wipe the bicycle with a clean, damp cloth.

D Remove the rust and wipe the bicycle with an oily cloth.

30 Which statements about water are correct?

1 Household water contains dissolved salts.

2 Water for household use is filtered to remove soluble impurities.

3 Water is treated with chlorine to kill bacteria.

4 Water is used in industry for cooling.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 3 and 4 only

D 2, 3 and 4 only

31 Ammonia is manufactured by reacting hydrogen with nitrogen in the Haber process.

Which row describes the sources of hydrogen and nitrogen and the conditions used in the manufacture of ammonia in the Haber process?

	source of hydrogen	source of nitrogen	temperature of reaction / °C	pressure of reaction / atm
A	air	natural gas	250	2
B	air	natural gas	250	200
C	natural gas	air	450	2
D	natural gas	air	450	200

32 Which statements about the carbon cycle are correct?

1 Carbon dioxide is added to the atmosphere by respiration.

2 Carbon dioxide is added to the atmosphere by combustion of coal.

3 Carbon dioxide is removed from the atmosphere by photosynthesis.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

33 Which statement about sulfur and its compounds is **not** correct?

A Sulfur dioxide is used as a food preservative.

B Sulfur dioxide turns acidified aqueous potassium manganate(VII) from purple to colourless.

C Sulfur forms a basic oxide.

D Sulfur is used in the manufacture of sulfuric acid.

34 Which process is used to convert limestone (calcium carbonate) into lime?

A electrolysis

B fractional distillation

C incomplete combustion

D thermal decomposition

35 What is **not** the correct use of the fraction named?

	name of fraction	use
A	fuel oil	making waxes
B	gas oil	fuel in diesel engines
C	kerosene	jet fuel
D	naphtha	making chemicals

36 Which reaction is **not** a reaction which alkenes undergo?

A bromination

B hydration

C hydrogenation

D hydrolysis

37 Which substances can be obtained by cracking hydrocarbons?

A ethanol and ethene

B ethanol and hydrogen

C ethene and hydrogen

D ethene and poly(ethene)

38 Ethanol is produced by fermentation or from ethene.

What is a disadvantage of producing ethanol by fermentation?

A Distillation is needed to purify the ethanol produced.

B Fermentation uses glucose from plants.

C Fermentation is catalysed by enzymes in yeast.

D Fermentation occurs at a low temperature and pressure.

39 Which structural formula represents methyl propanoate?

A $CH_3CH_2COOCH_3$

B $CH_3COOCH_2CH_2CH_3$

C $CH_3CH_2CH_2COOCH_3$

D $HCOOCH_2CH_2CH_3$

40 Which row describes addition polymerisation and condensation polymerisation?

	addition polymerisation	condensation polymerisation
A	monomers have a C=C double bond and the polymer is the only product	monomers have a C=C double bond and the polymer is the only product
B	monomers have a C=C double bond and the polymer is the only product	the monomers react to form the polymer and a small molecule
C	the monomers react to form the polymer and a small molecule	monomers have a C=C double bond and the polymer is the only product
D	the monomers react to form the polymer and a small molecule	the monomers react to form the polymer and a small molecule

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/22**

Paper 2 Multiple Choice (Extended) **May/June 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **13** printed pages and **3** blank pages.

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1 A gas is released at point X in the apparatus shown.

Which gas turns the damp Universal Indicator paper red most quickly?

A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

2 A chromatography experiment was done to separate a mixture of four substances.

The R_f values measured for these substances were 0.3, 0.5, 0.8 and 0.8.

Which diagram shows the chromatogram obtained?

3 Which piece of apparatus **cannot** be used to collect and measure the volume of gas produced in an experiment?

A burette

B gas syringe

C measuring cylinder

D pipette

4 The 'lead' in a pencil is made of a mixture of graphite and clay.

When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

5 Which pair shows particles with the same chemical properties?

A $^{23}_{11}M$ and $^{23}_{11}M^{+}$

B $^{23}_{11}M$ and $^{24}_{11}M$

C $^{23}_{11}M$ and $^{23}_{12}M$

D $^{24}_{11}M^{+}$ and $^{24}_{12}M^{+}$

6 Which substances have similar structures?

A diamond and graphite

B diamond and silicon(IV) oxide

C graphite and poly(ethene)

D graphite and silicon(IV) oxide

7 Which substance is **not** a macromolecule?

A diamond

B graphite

C silicon(IV) oxide

D sulfur

8 The equation for the reaction between potassium carbonate and nitric acid is shown.

$$K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2O + CO_2$$

Which volume of carbon dioxide is produced from 69 g of potassium carbonate?

A $6\,dm^3$ **B** $12\,dm^3$ **C** $24\,dm^3$ **D** $48\,dm^3$

9 A solution of sodium carbonate, Na_2CO_3, has a concentration of $0.03\,mol/dm^3$.

Which mass of sodium carbonate is dissolved in $1\,dm^3$ of this solution?

A 1.06 g **B** 3.18 g **C** 10.60 g **D** 31.80 g

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement about the electrolysis is **not** correct?

A An oxidation reaction occurs at the positive electrode.

B The current is carried through the electrolyte by ions.

C The negative electrode gains mass.

D The number of copper(II) ions in the electrolyte decreases.

11 Dilute sulfuric acid is electrolysed using inert electrodes.

What are the ionic half-equations for the reactions that take place at each electrode?

	positive electrode	negative electrode
A	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
B	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- + 4H^+ \rightarrow 4H_2O$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H^+ + 2e^- \rightarrow H_2$
D	$4OH^- + 4H^+ \rightarrow 4H_2O$	$2H^+ + 2e^- \rightarrow H_2$

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12 Which diagram is a correctly labelled energy level diagram for an endothermic reaction?

13 The equation for the complete combustion of methane is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

The bond energies are shown in the table.

bond	bond energy in kJ / mol
C–H	+410
C=O	+805
O–H	+460
O=O	+496

What is the energy change for the reaction?

A –818 kJ / mol **B** –359 kJ / mol **C** –323 kJ / mol **D** +102 kJ / mol

14 Which row describes the effects of increasing both concentration and temperature on the collisions between reacting particles?

	increasing concentration	increasing temperature
A	more collisions per second only	more collisions per second only
B	more collisions per second and more collisions with sufficient energy to react	more collisions per second only
C	more collisions per second only	more collisions per second and more collisions with sufficient energy to react
D	more collisions per second and more collisions with sufficient energy to react	more collisions per second and more collisions with sufficient energy to react

15 Sulfur dioxide reacts with oxygen at 2 atmospheres pressure. The forward reaction is exothermic.

The equation for the reaction is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The reaction reaches equilibrium. The pressure is then doubled.

How and why does the amount of sulfur trioxide formed change?

	amount of sulfur trioxide	reason
A	decreases	the forward reaction is exothermic
B	decreases	there are fewer molecules on the right
C	increases	the forward reaction is exothermic
D	increases	there are fewer molecules on the right

16 Iron(II) chloride solution reacts with chlorine gas.

The equation is shown.

$$2FeCl_2(aq) + Cl_2(g) \rightarrow 2FeCl_3(aq)$$

Which statements about this reaction are correct?

1 Fe^{2+} ions are reduced to Fe^{3+} ions.

2 Chlorine acts as a reducing agent.

3 Fe^{2+} ions each lose an electron.

4 Cl_2 molecules are reduced to Cl^- ions.

A 1 and 2 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

17 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

18 Which statement about acids and bases is correct?

A A base is a donor of hydrogen ions.

B An acid is an acceptor of protons.

C A strong acid is fully ionised in aqueous solution.

D A weak acid cannot be used to neutralise a strong base.

19 The solubility of some salts is shown.

	chloride	nitrate	sulfate	carbonate
barium	soluble	soluble	insoluble	insoluble
lead(II)	insoluble	soluble	insoluble	insoluble
potassium	soluble	soluble	soluble	soluble
zinc	soluble	soluble	soluble	insoluble

Which two aqueous solutions produce an insoluble salt when mixed together?

A barium chloride and zinc nitrate

B barium nitrate and lead(II) nitrate

C lead(II) nitrate and potassium carbonate

D potassium nitrate and zinc sulfate

20 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

21 Which statement about the Periodic Table is correct?

A Elements in the same group have the same number of electron shells.

B It contains elements arranged in order of increasing proton number.

C Metals are on the right and non-metals are on the left.

D The most reactive elements are at the bottom of every group.

22 Chlorine, bromine and iodine are elements in Group VII of the Periodic Table.

Which statement about these elements is **not** correct?

A The colour gets darker down the group.

B The density increases down the group.

C They are all gases at room temperature and pressure.

D They are all non-metals.

23 Which row describes the properties of a transition element?

	property 1	property 2
A	forms colourless compounds	acts as a catalyst
B	forms colourless compounds	low electrical conductivity
C	high density	acts as a catalyst
D	high density	low electrical conductivity

24 Stainless steel is an alloy of iron, carbon and other metals.

Which row is correct?

	stainless steel is harder than pure iron	stainless steel resists corrosion better than pure iron
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

25 Metal X is more reactive than metal Y. Metal Y is more reactive than metal Z.

Which statement is correct?

A When metal X is placed in a solution of Y sulfate, there is no reaction.

B When metal X is placed in a solution of Z sulfate, a reaction occurs.

C When metal Y is placed in a solution of Z sulfate, there is no reaction.

D When metal Z is placed in a solution of X sulfate, a reaction occurs.

26 Which statement about the industrial extraction of zinc is correct?

A Cryolite is added to lower the melting point.

B Molten zinc oxide is electrolysed.

C Zinc oxide is heated with coke.

D Zinc sulfide is heated with coke.

27 Which row describes the use of an alloy and the property upon which the use depends?

	alloy	use	property
A	mild steel	cutlery	resistant to corrosion
B	mild steel	machinery	strong
C	stainless steel	cutlery	low density
D	stainless steel	machinery	good conductor of electricity

28 Dry air is passed over hot copper until all the oxygen has reacted.

The volume of gas at the end of the reaction is 120 cm^3.

What is the starting volume of dry air?

A 132 cm^3 **B** 152 cm^3 **C** 180 cm^3 **D** 570 cm^3

29 A steel bicycle which had been left outdoors for several months was starting to rust.

What would **not** reduce the rate of corrosion?

A Remove the rust and paint the bicycle.

B Remove the rust and store the bicycle in a dry shed.

C Remove the rust and wipe the bicycle with a clean, damp cloth.

D Remove the rust and wipe the bicycle with an oily cloth.

30 Which statements about water are correct?

1 Household water contains dissolved salts.

2 Water for household use is filtered to remove soluble impurities.

3 Water is treated with chlorine to kill bacteria.

4 Water is used in industry for cooling.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 3 and 4 only

D 2, 3 and 4 only

31 Ammonia is manufactured by reacting hydrogen with nitrogen in the Haber process.

Which row describes the sources of hydrogen and nitrogen and the conditions used in the manufacture of ammonia in the Haber process?

	source of hydrogen	source of nitrogen	temperature of reaction / °C	pressure of reaction / atm
A	air	natural gas	250	2
B	air	natural gas	250	200
C	natural gas	air	450	2
D	natural gas	air	450	200

32 Which statements about the carbon cycle are correct?

1 Carbon dioxide is added to the atmosphere by respiration.

2 Carbon dioxide is added to the atmosphere by combustion of coal.

3 Carbon dioxide is removed from the atmosphere by photosynthesis.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

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33 Which row describes the uses of sulfur and sulfur dioxide?

	sulfur	sulfur dioxide
A	extraction of aluminium	food preservative
B	extraction of aluminium	water treatment
C	manufacture of sulfuric acid	food preservative
D	manufacture of sulfuric acid	water treatment

34 Limestone is used in many industrial processes.

In which process is it **not** used?

A manufacture of alkenes

B manufacture of cement

C manufacture of iron

D manufacture of lime

35 What is **not** the correct use of the fraction named?

	name of fraction	use
A	fuel oil	making waxes
B	gas oil	fuel in diesel engines
C	kerosene	jet fuel
D	naphtha	making chemicals

36 Which statement about alkenes is **not** correct?

A They decolourise aqueous bromine.

B They only contain the elements carbon and hydrogen.

C They react with hydrogen to form alkanes.

D They react with steam to produce carboxylic acids.

37 Which substances can be obtained by cracking hydrocarbons?

A ethanol and ethene

B ethanol and hydrogen

C ethene and hydrogen

D ethene and poly(ethene)

38 Two processes used for the large-scale production of ethanol are shown.

process 1 A compound containing carbon, hydrogen and oxygen is used to produce ethanol.

process 2 A compound containing carbon and hydrogen only is used to produce ethanol.

Which statement is correct?

A Process 1 uses a renewable starting material.

B Process 1 is done at a very high temperature.

C Process 2 involves fermentation.

D Process 2 is done at room temperature.

39 What is the name of the organic product of the reaction shown?

$$CH_3COOH + CH_3CH_2OH \rightarrow$$

A ethyl ethanoate

B ethyl methanoate

C methyl ethanoate

D methyl propanoate

40 Which two compounds react together to form a condensation polymer?

A $HOCH_2CH_2OH$ and CH_3COOH

B $HOCH_2CH_2OH$ and CH_3NH_2

C $HOCH_2CH_2OH$ and $H_2NCH_2CH_2NH_2$

D $HOCH_2CH_2OH$ and $HOOCCH_2CH_2COOH$

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CHEMISTRY **0620/23**

Paper 2 Multiple Choice (Extended) **May/June 2018**

45 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **14** printed pages and **2** blank pages.

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1 Ammonia gas is reacted with hydrogen chloride gas using the apparatus shown.

Solid ammonium chloride is produced.

Which statement explains why the solid ammonium chloride is formed nearer to the hydrogen chloride?

A Ammonia solution is a base and hydrogen chloride solution is an acid.

B Ammonia molecules diffuse more slowly than hydrogen chloride molecules.

C Hydrogen chloride has a greater molecular mass than ammonia.

D Hydrogen chloride moves by Brownian motion.

2 Paper chromatography is done in the same way with three different mixtures of dyes. Each mixture contains at least one of the dyes W, X, Y and Z.

The R_f values of the dyes in the three mixtures are shown.

dye	R_f values from mixture 1	R_f values from mixture 2	R_f values from mixture 3
W	0.15	0.15	0.15
X	0.00	0.00	0.00
Y	0.50	0.50	0.50
Z	0.00	0.91	0.91

Which conclusion is correct?

A Dye W is nearest the solvent front and is present only in mixture 1 and mixture 3.

B Dye X has travelled furthest up the chromatography paper.

C Dye Y is the only dye present in all three mixtures.

D Dye Z is nearest the solvent front and is found in only two of the mixtures.

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3 Solid R reacted with dilute sulfuric acid.

The initial temperature of the dilute sulfuric acid and the final temperature of the solution are shown.

initial temperature of the dilute sulfuric acid (°C)

final temperature of the solution (°C)

What was the change in temperature in °C?

A –6 **B** –4 **C** 4 **D** 6

4 The 'lead' in a pencil is made of a mixture of graphite and clay.

When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

5 Iron has an atomic number of 26. It occurs as the isotopes ^{54}Fe, ^{56}Fe, ^{57}Fe and ^{58}Fe.

Which statement explains why these isotopes have the same chemical properties?

A They have similar mass numbers.

B They have the same number of electrons in their outer shells.

C They have the same number of neutrons in their nuclei.

D They have the same number of protons in their nuclei.

6 How many silicon atoms are bonded to each oxygen atom in a crystal of silicon(IV) oxide?

A 1 **B** 2 **C** 3 **D** 4

7 Which substance is **not** a macromolecule?

A diamond

B graphite

C silicon(IV) oxide

D sulfur

8 An experiment was done to determine the formula of a hydrocarbon, C_xH_y.

10 cm^3 of the gaseous hydrocarbon, C_xH_y, was burned in an excess of oxygen to form 20 cm^3 of carbon dioxide and 30 cm^3 of water vapour.

What is C_xH_y?

A CH_4 **B** C_2H_4 **C** C_2H_6 **D** C_3H_8

9 4.00 g of solid sodium hydroxide is added to water to make a solution with a concentration of 0.200 mol / dm^3.

What is the volume of water used?

A 0.5 cm^3 **B** 20 cm^3 **C** 500 cm^3 **D** 2000 cm^3

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement is correct?

A Oxygen gas is produced at the positive electrode.

B The blue colour of the solution gradually fades.

C The concentration of copper ions in the solution stays the same.

D The mass of the negative electrode decreases.

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11 Dilute sulfuric acid is electrolysed using inert electrodes.

What are the ionic half-equations for the reactions that take place at each electrode?

	positive electrode	negative electrode
A	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
B	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- + 4H^+ \rightarrow 4H_2O$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H^+ + 2e^- \rightarrow H_2$
D	$4OH^- + 4H^+ \rightarrow 4H_2O$	$2H^+ + 2e^- \rightarrow H_2$

12 Information about two reactions is given.

- The neutralisation reaction between citric acid and sodium hydrogencarbonate is endothermic.
- The displacement reaction between magnesium and carbon dioxide is exothermic.

Which statements about the two reactions are correct?

1 The energy of the products formed in the neutralisation reaction is greater than the energy of the reactants.

2 The energy of magnesium and carbon dioxide is greater than the energy of magnesium oxide and carbon.

3 In an exothermic reaction, the energy required to break the bonds is greater than the energy released when the new bonds are formed.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 Ethene reacts with hydrogen. The equation is shown.

$$CH_2{=}CH_2 + H_2 \rightarrow C_2H_6$$

The bond energies are shown in the table. The reaction is exothermic.

bond	bond energy in kJ / mol
C–C	+350
C=C	+610
C–H	+410
H–H	+436

What is the energy change for the reaction?

A –560 kJ / mol **B** –124 kJ / mol **C** +486 kJ / mol **D** +5496 kJ / mol

14 Which row describes the effects of increasing both concentration and temperature on the collisions between reacting particles?

	increasing concentration	increasing temperature
A	more collisions per second only	more collisions per second only
B	more collisions per second and more collisions with sufficient energy to react	more collisions per second only
C	more collisions per second only	more collisions per second and more collisions with sufficient energy to react
D	more collisions per second and more collisions with sufficient energy to react	more collisions per second and more collisions with sufficient energy to react

15 In the Contact process, sulfur dioxide is converted into sulfur trioxide in a reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which conditions give the highest yield of sulfur trioxide at equilibrium?

	pressure / atmospheres	temperature
A	0.5	high
B	0.5	low
C	1.5	high
D	1.5	low

16 The equation for a redox reaction is shown.

$$2Fe^{3+} + Zn \rightarrow 2Fe^{2+} + Zn^{2+}$$

Which statements are correct?

1 Fe^{3+} is reduced to form Fe^{2+}.

2 Zn oxidises the Fe^{3+} ions.

3 Fe^{3+} is an oxidising agent.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

17 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

18 The equation represents an equilibrium in aqueous ammonia.

$$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

How does aqueous ammonia behave in this reaction?

A as a strong acid

B as a strong base

C as a weak acid

D as a weak base

19 An excess of aqueous sodium sulfate was added to aqueous barium chloride and the mixture was filtered.

Which row shows the identity of the residue and the substances present in the filtrate?

	residue	substances in filtrate
A	barium sulfate	barium chloride and sodium chloride
B	barium sulfate	sodium chloride and sodium sulfate
C	sodium chloride	barium chloride and sodium sulfate
D	sodium chloride	barium sulfate and sodium sulfate

20 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

21 Which element is classified as a non-metal in the Periodic Table?

A calcium

B chlorine

C chromium

D copper

22 Part of the Periodic Table is shown.

Element Q has a low boiling point, low density and does not conduct electricity.

Which element is Q?

23 Which row describes a typical transition element?

	density in g / cm^3	melting point in °C	boiling point in °C	colour of oxide
A	0.97	98	883	white
B	2.64	769	1382	white
C	3.10	–7	59	yellow
D	8.96	1085	2562	red

24 Which diagram represents a solid alloy?

A

B

C

D

25 The ionic equations for four reactions are shown.

$$Z + X^{2+} \rightarrow Z^{2+} + X$$

$$Z + 2W^{+} \rightarrow Z^{2+} + 2W$$

$$X + 2W^{+} \rightarrow X^{2+} + 2W$$

$$Y + Z^{2+} \rightarrow Y^{2+} + Z$$

What is the order of reactivity of the four metals, W, X, Y and Z?

	most reactive →			least reactive
A	W	X	Z	Y
B	X	W	Y	Z
C	Y	Z	X	W
D	Z	W	X	Y

26 Which equation represents the first stage in the extraction of zinc from zinc blende?

A $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

B $ZnS + H_2O \rightarrow ZnO + H_2S$

C $ZnO + CO \rightarrow Zn + CO_2$

D $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$

27 Which statement explains why aluminium is used to manufacture aircraft?

A It has a low density.

B It is a good conductor of electricity.

C It is a good conductor of heat.

D It is ductile.

28 Dry air is passed over hot copper until all the oxygen has reacted.

The volume of gas at the end of the reaction is 120 cm^3.

What is the starting volume of dry air?

A 132 cm^3 **B** 152 cm^3 **C** 180 cm^3 **D** 570 cm^3

29 A steel bicycle which had been left outdoors for several months was starting to rust.

What would **not** reduce the rate of corrosion?

A Remove the rust and paint the bicycle.

B Remove the rust and store the bicycle in a dry shed.

C Remove the rust and wipe the bicycle with a clean, damp cloth.

D Remove the rust and wipe the bicycle with an oily cloth.

30 Which statements about water are correct?

1 Household water contains dissolved salts.

2 Water for household use is filtered to remove soluble impurities.

3 Water is treated with chlorine to kill bacteria.

4 Water is used in industry for cooling.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1, 3 and 4 only

D 2, 3 and 4 only

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31 Ammonia is manufactured by reacting hydrogen with nitrogen in the Haber process.

Which row describes the sources of hydrogen and nitrogen and the conditions used in the manufacture of ammonia in the Haber process?

	source of hydrogen	source of nitrogen	temperature of reaction / °C	pressure of reaction / atm
A	air	natural gas	250	2
B	air	natural gas	250	200
C	natural gas	air	450	2
D	natural gas	air	450	200

32 Which statements about the carbon cycle are correct?

1 Carbon dioxide is added to the atmosphere by respiration.

2 Carbon dioxide is added to the atmosphere by combustion of coal.

3 Carbon dioxide is removed from the atmosphere by photosynthesis.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

33 Element Z forms an oxide, ZO_2. Three uses of ZO_2 are listed.

- bleaching agent
- killing bacteria
- manufacturing an important acid

What is Z?

A carbon

B lead

C nitrogen

D sulfur

34 Limestone is an important material with many uses.

Limestone is heated to produce .....1..... and carbon dioxide.

This reaction is called .....2..... .

Which words correctly complete gaps 1 and 2?

	1	2
A	lime	neutralisation
B	lime	thermal decomposition
C	slaked lime	neutralisation
D	slaked lime	thermal decomposition

35 What is **not** the correct use of the fraction named?

	name of fraction	use
A	fuel oil	making waxes
B	gas oil	fuel in diesel engines
C	kerosene	jet fuel
D	naphtha	making chemicals

36 Methane, ethane and propane belong to a family of hydrocarbons called alkanes.

What is the general formula of an alkane?

A C_nH_{2n} **B** C_nH_{2n+1} **C** C_nH_{2n-1} **D** C_nH_{2n+2}

37 Which substances can be obtained by cracking hydrocarbons?

A ethanol and ethene

B ethanol and hydrogen

C ethene and hydrogen

D ethene and poly(ethene)

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38 Which row describes an advantage and a disadvantage of making ethanol by fermentation?

	advantage	disadvantage
A	uses a renewable resource	occurs at a slow rate
B	needs a high temperature	produces impure ethanol as a product
C	produces pure ethanol as a product	needs a high temperature
D	occurs at a slow rate	uses a non-renewable resource

39 Which esters have the molecular formula $C_5H_{10}O_2$?

1 ethyl propanoate

2 propyl ethanoate

3 butyl methanoate

4 methyl butanoate

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1 and 2 only

D 3 and 4 only

40 A polymer linkage contains carbon, hydrogen, nitrogen and oxygen atoms.

Which row about the polymer is correct?

	type of polymer	formed by
A	polyamide	addition polymerisation
B	polyamide	condensation polymerisation
C	polyester	addition polymerisation
D	polyester	condensation polymerisation

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group	I	II											III	IV	V	VI	VII	VIII
								1 H hydrogen 1										2 He helium 4
	3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
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	87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

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actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/31**

Paper 3 Theory (Core) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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This document consists of **15** printed pages and **1** blank page.

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1 The names of eight gases are given.

ammonia
argon
carbon dioxide
helium
hydrogen
methane
neon
sulfur dioxide

(a) Answer the following questions about these gases.
Each gas may be used once, more than once or not at all.
State which gas:

(i) turns damp red litmus paper blue

..... [1]

(ii) contributes to the formation of acid rain

..... [1]

(iii) is a hydrocarbon which contributes to climate change

..... [1]

(iv) is a product of the reaction of copper(II) carbonate with hydrochloric acid

..... [1]

(v) is a monatomic gas which has atoms with the electronic structure 2,8,8.

..... [1]

(b) **(i)** Explain why helium and **not** hydrogen is used to fill party balloons.

..... [1]

(ii) Give **one** use of argon.

..... [1]

(c) Carbon dioxide is a compound.

What is meant by the term *compound*?

.....

..... [1]

(d) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ammonia. Show outer shell electrons only.

[2]

[Total: 10]

2 The table shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine.

name	percentage by volume
carbon monoxide	1.0
carbon dioxide	
hydrogen	0.2
nitrogen	77.0
nitrogen dioxide	0.3
oxygen	0.7
hydrocarbons	0.3
water vapour	5.0
	total 100.0

(a) **(i)** Calculate the percentage by volume of carbon dioxide in the exhaust gases.

.....% [1]

(ii) Which gas shown in the table is present in the lowest percentage by volume?

..... [1]

(iii) Which **two** elements in the table combine to form nitrogen dioxide?

..... and ..... [1]

(iv) Give the formula for nitrogen dioxide.

..... [1]

(v) Where does the nitrogen in the exhaust gases come from?

..... [1]

(b) The carbon monoxide in the exhaust gases comes from the incomplete combustion of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

.....

..... [2]

(ii) Give **one** adverse effect of carbon monoxide on health.

..... [1]

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(iii) Balance the chemical equation for the complete combustion of pentane.

$$C_5H_{12} + 8O_2 \rightarrow .....CO_2 + ...H_2O$$ [2]

[Total: 10]

3 Limonene is a volatile liquid which smells of oranges.

(a) A teacher placed a beaker of limonene at the front of a classroom.
At first, the students at the back of the classroom could not smell the limonene.
After two minutes, the smell of limonene had spread throughout the classroom.
The air in the classroom was still and calm.

(i) Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(ii) The melting point of limonene is –74 °C.
The boiling point of limonene is 176 °C.

What is the physical state of limonene at – 80 °C?
Explain your answer.

.....

..... [2]

(b) An enzyme present in peppermint plants is a catalyst for the oxidation of limonene.

State what is meant by the terms:

(i) *catalyst*

.....

..... [1]

(ii) *oxidation*

.....

..... [1]

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(c) Limonene can be made from a colourless compound called α-terpineol.
The structure of α-terpineol is shown.

(i) What feature of the structure of the α-terpineol molecule shows that it is an unsaturated compound?

..... [1]

(ii) Describe how the colour of aqueous bromine changes when an excess of α-terpineol is added to it.

from ..... to .....
[2]

[Total: 10]

4 This question is about iron and its compounds.

(a) The table shows how easy it is to reduce four metal oxides by heating with carbon.

metal oxide	ease of reduction with carbon
chromium(III) oxide	only reduced above 1700 °C
iron(III) oxide	only reduced above 650 °C
magnesium oxide	**not** reduced at 1750 °C
nickel(II) oxide	only reduced above 300 °C

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive ⟶ most reactive

[2]

(b) Iron is a transition element. Potassium is an element in Group I of the Periodic Table.

Describe **three** ways in which the properties of iron differ from those of potassium.

1 .....

2 .....

3 .....

[3]

(c) Iron wire burns in oxygen.

Balance the chemical equation for this reaction.

$$.....Fe + ...O_2 \rightarrow Fe_3O_4$$ [2]

(d) Pure iron can be made by reducing iron(III) oxide, Fe_2O_3, with hydrogen.

$$Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$$

How does this equation show that iron(III) oxide is reduced?

.....

..... [1]

(e) When iron reacts with dilute hydrochloric acid, iron(II) chloride is formed.

(i) Describe a test for iron(II) ions.

test .....

result .....
[2]

(ii) Another chloride of iron has the structure shown.

Deduce the molecular formula of this compound showing the number of iron and chlorine atoms.

..... [1]

(f) Some iron nails were placed in bottles under different conditions.

In which bottles will the iron nails **not** rust?
Give reasons for your answer.

.....

.....

..... [2]

[Total: 13]

5 **(a)** Complete the sentence about electrolysis using words from the list.

breakdown **compound** **electricity** **electroplating**

element **gaseous** **heat** **molten**

Electrolysis is the ..... of an ionic ..... when

..... or in aqueous solution by the passage of ..... .

[4]

(b) Molten zinc iodide can be electrolysed using the apparatus shown.

On the diagram, label:
- the anode
- the cathode
- the electrolyte [2]

(c) Why are the electrodes made of graphite?

..... [1]

(d) Predict the products of the electrolysis of molten zinc iodide at:

the negative electrode .....

the positive electrode. .....

[2]

(e) When chlorine is bubbled through a colourless aqueous solution of zinc iodide, the solution turns brown.

Name the brown substance. Suggest, using ideas about reactivity of the halogens, why this reaction occurs.

.....

..... [2]

[Total: 11]

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6 This question is about isotopes.

(a) An atom of an isotope of fluorine is represented by the symbol shown.

$^{19}_{9}F$

Describe the structure of an atom of this isotope of fluorine.
In your answer, include:
- the position of the protons, neutrons and electrons in the atom
- the number of protons, neutrons and electrons present in the atom.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Complete the sentence about isotopes using words from the list.

atomic **compound** **element** **ions** **molecular** **nucleons**

Isotopes are atoms of the same ..... which have the same

..... number but different numbers of ..... .

[3]

(c) Give **one** medical use of radioactive isotopes.

..... [1]

(d) Which **one** of the following isotopes is used as a source of energy?
Draw a circle around the correct answer.

$^{127}_{53}I$ $^{235}_{92}U$ $^{131}_{54}Xe$ $^{66}_{30}Zn$

[1]

[Total: 10]

7 This question is about Group I elements and their compounds.

(a) The properties of some Group I elements are shown in the table.

element	boiling point / °C	atomic radius / pm	relative thermal conductivity	observations when it reacts with cold water
sodium	883	186	3.9	rapid bubbling but does **not** burst into flame
potassium	759	227		very rapid bubbling and bursts into flame
rubidium	688		1.6	
caesium	671	265	1.0	explodes

(i) Complete the table to estimate:
- the relative thermal conductivity of potassium
- the atomic radius of rubidium.

[2]

(ii) Describe the trend in the boiling points of the Group I elements.

..... [1]

(iii) Use the information in the table to predict what you would observe when rubidium reacts with cold water.

..... [1]

(b) Which **one** of the statements about the formation of a sodium ion from a sodium atom is correct?
Tick **one** box.

A sodium atom gains an electron. ☐

A sodium atom loses an electron. ☐

A sodium atom loses a proton. ☐

A sodium atom gains a proton. ☐

[1]

(c) Is sodium oxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

..... [1]

(d) A compound of sodium has the formula C_4H_5Na.

Calculate the relative formula mass of C_4H_5Na.
Show all your working.
Use your Periodic Table to help you.

relative formula mass = ... [2]

(e) Complete the word equation for the reaction of sodium hydroxide with sulfuric acid.

sodium hydroxide	+	sulfuric acid	→	....	+	.....

[2]

[Total: 10]

8 When zinc reacts with hydrochloric acid, hydrogen gas is produced.
The graph shows how the volume of hydrogen gas produced changes with time when an excess of zinc is reacted with 0.2 mol / dm^3 hydrochloric acid.

(a) Explain why the volume of hydrogen gas remains constant after six minutes.

..... [1]

(b) What volume of hydrogen gas was released in the first **two** minutes of the reaction?

..... [1]

(c) The experiment is repeated using the same volume of 0.1 mol / dm^3 hydrochloric acid.
All other conditions are kept the same.

On the grid, draw the graph for the experiment using 0.1 mol / dm^3 hydrochloric acid. [2]

(d) Give the name of the salt formed when zinc reacts with hydrochloric acid.

..... [1]

(e) Which **one** of the following pH values could be the pH of dilute hydrochloric acid?
Draw a circle around the correct answer.

pH 1 pH 7 pH 9 pH 13 [1]

[Total: 6]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CENTRE NUMBER						CANDIDATE NUMBER				

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CHEMISTRY **0620/32**

Paper 3 Theory (Core) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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This document consists of **16** printed pages.

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1 The names of nine gases are given.

ammonia
carbon monoxide
chlorine
ethane
ethene
helium
hydrogen
neon
oxygen

(a) Answer the following questions about these gases.
Each gas may be used once, more than once or not at all.
State which gas:

(i) bleaches damp litmus paper

..... [1]

(ii) dissolves in water to form an alkali

..... [1]

(iii) is a monatomic gas with ten protons in its nucleus

..... [1]

(iv) is formed when hydrocarbons undergo incomplete combustion

..... [1]

(v) is an unsaturated hydrocarbon.

..... [1]

(b) Diatomic hydrogen molecules contain covalent bonds.

State what is meant by the terms:

(i) *diatomic* .....

..... [1]

(ii) *covalent bonds* .....

..... [1]

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(c) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of chlorine. Show outer shell electrons only.

[2]

[Total: 9]

2 The table shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine with a catalytic converter.

name	percentage by volume
carbon monoxide	0.20
carbon dioxide	15.00
hydrocarbons	0.02
hydrogen	0.01
nitrogen	
oxides of nitrogen	0.02
water vapour	12.75
	total 100.00

(a) (i) Calculate the percentage by volume of nitrogen in the exhaust gases.

.....% [1]

(ii) Which gas shown in the table is present in the lowest percentage by volume?

..... [1]

(b) (i) Give **one** adverse effect of oxides of nitrogen on health.

..... [1]

(ii) Balance the chemical equation for the reaction of nitrogen dioxide with sodium hydroxide.

$$.....NO_2 + ...NaOH \rightarrow NaNO_3 + NaNO_2 + H_2O$$ [2]

(iii) State the name of the salt with the formula $NaNO_3$.

..... [1]

(c) Petrol contains saturated hydrocarbons.

State what is meant by the terms:

(i) *saturated* .....

..... [1]

(ii) *hydrocarbon* .....

..... [2]

(d) The table shows the composition of a sample of dry natural gas.

name of gas	percentage by volume
methane	95.0
ethane	3.2
propane	0.2
butane	0.1
carbon dioxide	0.5
nitrogen	1.0
	total 100.0

Calculate the percentage by volume of hydrocarbons in the sample of dry natural gas.

.....% [1]

[Total: 10]

3 **(a)** The structures of two compounds, **A** and **B**, are shown.

compound **A**

compound **B**

(i) How many different types of atoms are present in compound **A**?

..... [1]

(ii) On structure **B** draw a circle around the alcohol functional group. [1]

(iii) Compounds **A** and **B** are formed in the body by enzyme-catalysed reactions.

What is the purpose of a catalyst?

..... [1]

(iv) Enzymes are polymers of compounds called amino acids.

What is meant by the term *polymer*?

.....

..... [1]

(b) Ethanoic acid is a carboxylic acid.

(i) Give **one** property of ethanoic acid.

..... [1]

(ii) Complete the structure of ethanoic acid showing all of the atoms and all of the bonds.

[1]

(c) Ethanoic acid can be made by the oxidation of ethanol.

(i) The melting point of ethanol is –114 °C.
The boiling point of ethanol is 78 °C.

What is the physical state of ethanol at –120 °C?
Explain your answer.

.....

..... [2]

(ii) Complete the sentences about the manufacture of ethanol using words from the list.

a catalyst **addition** **an enzyme** **cracking**

ethane **ethene** **high** **low**

Ethanol can be manufactured by the ..... of steam to ..... .

The reaction takes place at a ..... temperature in the presence of

..... . [4]

[Total: 12]

4 This question is about manganese and its compounds.

(a) Potassium manganate(VII) is soluble in water.
A purple crystal of potassium manganate(VII) was placed in the middle of a piece of damp filter paper.
After 1 hour, the purple colour had spread over most of the filter paper.

at the start after 1 hour

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(b) Potassium manganate(VII) is produced from manganese(IV) oxide by an oxidation reaction.

What is meant by the term *oxidation*?

.....

..... [1]

(c) Potassium manganate(VII) decomposes when heated. The products are oxygen and manganese(IV) oxide.

(i) Describe a test for oxygen.

test .....

result .....
[2]

(ii) Manganese(IV) oxide reacts with concentrated hydrochloric acid.

Balance the chemical equation for this reaction.

$$MnO_2 + ...HCl \rightarrow MnCl_2 + Cl_2 + ...H_2O$$

[2]

(d) The table compares the reactivity of four metals with hydrochloric acid of the same concentration.

metal	reactivity with hydrochloric acid
lead	No bubbles seen. Metal does **not** disappear.
magnesium	Rapid formation of bubbles. Metal disappears rapidly.
manganese	Steady formation of bubbles. Metal disappears slowly.
tin	Bubbles formed slowly. Metal disappears very slowly.

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive → most reactive

[2]

(e) Manganese is a transition element. Sodium is an element in Group I of the Periodic Table.

Describe **three** ways in which the properties of manganese differ from those of sodium.

1 .....

2 .....

3 .....

[3]

[Total: 13]

5 **(a)** Electrolysis of concentrated aqueous sodium chloride can be done using the apparatus shown.

(i) During electrolysis, a gas is produced at each electrode.

Complete the diagram to show how the gases can be collected. [1]

(ii) The positive electrode is called the anode.

State the name of the negative electrode.

..... [1]

(iii) Predict the main products of the electrolysis of concentrated aqueous sodium chloride at:

the negative electrode .....

the positive electrode. .....
[2]

(iv) Give the name of a suitable element to use as the electrodes in this electrolysis.

..... [1]

(b) Sodium hydroxide is manufactured by the electrolysis of sodium chloride.

(i) After electrolysis, 1000 cm^3 of solution contains 750 g of sodium hydroxide.

What mass of sodium hydroxide is present in 200 cm^3 of this solution?

..... [1]

(ii) What effect would impurities have on the melting point of sodium hydroxide?

..... [1]

(c) Describe how you could prepare a sample of solid sodium chloride from a solution of sodium chloride.

..... [1]

[Total: 8]

6 This question is about isotopes.

(a) An atom of an isotope of nitrogen is represented by the symbol shown.

$^{15}_{7}N$

Describe the structure of an atom of this isotope of nitrogen.
In your answer, include:
- the position of the protons, neutrons and electrons in the atom
- the number of protons, neutrons and electrons present in the atom.

.....

.....

.....

.....

.....

.....

..... [5]

(b) What is meant by the term *isotopes*?

.....

.....

..... [2]

(c) Give **one** industrial use of radioactive isotopes.

..... [1]

[Total: 8]

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7 **(a)** The properties of some Group VII elements are shown in the table.

element	melting point in °C	boiling point in °C	density at room temperature in g/cm^3	colour
chlorine	–101	–35	0.0032	green
bromine	–7	59	3.1	red-brown
iodine	114	184		grey-black
astatine		337	6.4	

(i) Complete the table to suggest:
- the density of iodine
- the melting point of astatine
- the colour of astatine.

[3]

(ii) Suggest why the density of chlorine at room temperature is much lower than the density of bromine and astatine at room temperature.

.....

..... [1]

(iii) Describe the trend in the boiling points of the halogens.

..... [1]

(b) Aqueous bromine reacts with aqueous potassium iodide.

Complete the word equation for this reaction.

bromine	+	potassium iodide	→	.....	+	....

[2]

(c) A compound has the formula $C_2F_4Cl_2$.

Calculate the relative molecular mass of $C_2F_4Cl_2$.
Show all your working.
Use your Periodic Table to help you.

relative molecular mass = ... [2]

[Total: 9]

8 The energy released by burning four different fuels is compared using the apparatus shown. A known mass of each fuel is burned and the temperature rise of the water is measured.

(a) Suggest **two** factors that should be kept constant in this experiment.

1 .....

2 .....
[2]

(b) The table shows the temperature changes when four different fuels, **A**, **B**, **C** and **D**, are burned.

fuel	mass of fuel burned / g	initial temperature of the water / °C	final temperature of the water / °C
A	2	20	30
B	1	18	24
C	4	21	37
D	2	20	28

Which fuel gave the greatest temperature rise per gram?

..... [1]

(c) Ethanol is a fuel.

Give **one** other use of ethanol.

..... [1]

(d) The energy level diagram for the complete combustion of ethanol is shown.

(i) Complete the diagram by filling in the missing reactant and the missing product. [2]

(ii) Is the complete combustion of ethanol exothermic or endothermic?
Use the information in the diagram to explain your answer.

.....

..... [1]

(e) A steel can is used in the experiment.

(i) Stainless steel is an alloy of iron.

What is meant by the term *alloy*?

.....

..... [1]

(ii) Describe the arrangement and type of motion of the particles in solid iron.

arrangement .....

type of motion .....
[2]

(iii) Suggest why stainless steel is used instead of pure iron for making cutlery.

.....

..... [1]

[Total: 11]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

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CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 20.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **17** printed pages and **3** blank pages.

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1 The names of seven gases are given.

ammonia
ethene
helium
hydrogen
hydrogen chloride
methane
nitrogen

(a) Answer the following questions about these gases.
Each gas may be used once, more than once or not at all.
State which gas:

(i) forms an acidic solution in water

..... [1]

(ii) is monatomic

..... [1]

(iii) forms 78% of clean dry air

..... [1]

(iv) is the main constituent of natural gas

..... [1]

(v) has molecules which each contain 14 protons.

..... [1]

(b) **(i)** Give the names of **two** elements in the list.

..... and .....
[1]

(ii) What is meant by the term *element*?

..... [1]

(c) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen chloride. Show outer electrons only.

[2]

[Total: 9]

2 **(a)** The table shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine and a diesel engine.

name	percentage by volume from a petrol engine	percentage by volume from a diesel engine
nitrogen	72.00	67.00
carbon dioxide	14.00	
water vapour	12.00	11.00
carbon monoxide	1.50	0.05
oxides of nitrogen	0.25	0.70
hydrocarbons	0.24	0.22
sulfur dioxide	0.01	0.03
oxygen	0.00	9.00
	total 100.00	total 100.00

(i) In the diesel engine, nitrogen, carbon dioxide and water vapour account for 90.00% of the exhaust gases by volume.

Calculate the percentage by volume of carbon dioxide in the exhaust gases from the diesel engine.

.....% [1]

(ii) Describe **three** ways in which the composition of the exhaust gases from the petrol engine differ from the composition of the exhaust gases from the diesel engine.

1 .....

2 .....

3 .....
[3]

(iii) Give **one** adverse effect of sulfur dioxide on health.

..... [1]

(b) Complete the sentences about the separation of petroleum into fractions using words from the list.

boiling crystallisation density distillation kerosene poly(ethene)

Fractional ..... of petroleum produces fractions such as gasoline, diesel oil and ..... . Within each fraction, the molecules have a particular range of ..... points.

[3]

(c) Balance the chemical equation for the complete combustion of propane.

$$C_3H_8 + 5O_2 \rightarrow .....CO_2 + ...H_2O$$

[2]

[Total: 10]

3 This question is about cobalt and its compounds.

(a) A coloured crystal of cobalt(II) chloride was placed at the bottom of a beaker containing water. After 2 days, the colour had spread throughout the water.

Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

(b) Cobalt(II) chloride can be used to test for the presence of water.

$$\underset{\text{anhydrous cobalt(II) chloride}}{CoCl_2} + 6H_2O \rightleftharpoons \underset{\text{hydrated cobalt(II) chloride}}{CoCl_2.6H_2O}$$

(i) What is meant by the symbol $\rightleftharpoons$?

..... [1]

(ii) Describe how the colour of anhydrous cobalt(II) chloride changes when water is added to it.

from ..... to .....
[2]

(c) A compound of cobalt can be represented by the structure shown.

Deduce the molecular formula of this compound showing the number of cobalt, carbon and oxygen atoms.

..... [1]

(d) The table compares the reactivity of cobalt with that of three other metals.

metal	reactivity with cold water	reactivity with steam
barium	reacts rapidly	
cobalt	no reaction	reacts slowly when heated
magnesium	reacts very slowly	reacts rapidly
zinc	no reaction	reacts easily when heated

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive → most reactive

[2]

(e) Cobalt is a transition element. Lithium is an element in Group I of the Periodic Table.

Describe **three** ways in which the properties of cobalt differ from those of lithium.

1 .....

2 .....

3 .....

[2]

(f) When cobalt(II) oxide, CoO, is heated in air, an oxide with the formula Co_3O_4 is formed.

Balance the chemical equation for this reaction.

$$.....CoO + O_2 \rightarrow 2Co_3O_4$$

[1]

(g) When Co_3O_4 is heated with hydrogen, cobalt metal can be formed.

$$Co_3O_4 + 4H_2 \rightarrow 3Co + 4H_2O$$

How does this equation show that Co_3O_4 is reduced?

.....

..... [1]

[Total: 13]

4 This question is about alcohols.

(a) The structure of compound **P** is shown.

(i) What feature of the structure of compound **P** shows that it is unsaturated?

..... [1]

(ii) Describe how the colour of aqueous bromine changes when an excess of compound **P** is added to it.

from ..... to .....
[2]

(iii) The melting point of compound **P** is –129 °C.
The boiling point of compound **P** is 97 °C.

What is the physical state of compound **P** at –120 °C?
Explain your answer.

.....

..... [2]

(b) Ethanol is an alcohol with two carbon atoms.

(i) Draw the structure of ethanol showing all of the atoms and all of the bonds.

[1]

(ii) Ethanol can be manufactured by fermentation.

Complete the sentences about fermentation using words from the list.

30 °C	**300 °C**	**distillation**	**electrolysis**
elements	**enzymes**	**salt**	**sugar**

A flask containing ..... solution and yeast is heated to ..... .

The yeast contains ..... which catalyse the reaction. The ethanol is separated by ..... . [4]

(iii) Ethanol can be used as a fuel.

Give **one** other use of ethanol in industry.

..... [1]

(iv) The energy level diagram for the complete combustion of ethanol is shown.

Explain how this diagram shows that the reaction is exothermic.

.....

..... [1]

(v) Carbon dioxide and water can be formed when ethanol burns in a limited supply of air.

State the name of **two** other products which can be formed when ethanol burns in a limited supply of air.

..... and .....
[2]

[Total: 14]

5 **(a)** Molten lead(II) bromide can be electrolysed using the apparatus shown.

The negative electrode is called the cathode.

State the name of the positive electrode.

..... [1]

(b) Predict the products of the electrolysis of molten lead(II) bromide at:

the negative electrode .....

the positive electrode. .....
[2]

(c) Lead(II) bromide is insoluble in cold water.
Sodium bromide is soluble in cold water.

Describe how you could obtain crystals of sodium bromide from a mixture of solid lead(II) bromide and solid sodium bromide.

.....

.....

.....

..... [3]

(d) When chlorine is bubbled through a colourless aqueous solution of sodium bromide, the solution turns orange-brown.

Name the orange-brown substance. Suggest, using ideas about reactivity of the halogens, why the reaction occurs.

orange-brown substance .....

why the reaction occurs .....

.....
[2]

(e) What is the colour of the precipitate formed when aqueous silver nitrate is added to aqueous sodium bromide?

..... [1]

(f) Complete the sentence about the formation of a chloride ion from a chlorine atom.

A chloride ion is formed when a chlorine atom gains one ..... . [1]

[Total: 10]

6 This question is about isotopes.

(a) An atom of an isotope of oxygen is represented by the symbol shown.

$^{17}_{8}O$

Describe the structure of an atom of this isotope of oxygen.
In your answer, include:
- the position of the protons, neutrons and electrons in the atom
- the number of protons, neutrons and electrons present in the atom.

.....

.....

.....

.....

.....

.....

..... [5]

(b) Which **two** statements about isotopes are correct?
Tick **two** boxes.

Isotopes of the same element have different numbers of protons.	☐
Isotopes of the same element have different numbers of neutrons.	☐
Isotopes are always radioactive.	☐
The isotope $^{235}_{92}U$ is a source of energy.	☐
$^{14}_{6}C$ and $^{14}_{7}N$ are isotopes of each other.	☐

[2]

(c) What is meant by the term *nucleon number*?

.....

..... [1]

[Total: 8]

7 This question is about Group I elements and their compounds.

(a) The properties of some Group I elements are shown in the table.

element	melting point / °C	relative hardness	observations when it reacts with cold water
lithium	181	23	
sodium	98	3	rapid bubbling but does **not** burst into flame
potassium	63		very rapid bubbling and bursts into flame
rubidium		1	bursts into flame and explodes

(i) Complete the table to estimate:
- the relative hardness of potassium
- the melting point of rubidium.

[2]

(ii) Use the information in the table to predict what you would observe when lithium reacts with cold water.

..... [1]

(b) Write the electronic structure of a sodium atom.

..... [1]

(c) When sodium reacts with water, an alkaline solution is formed.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

(i) Use the information in the equation to explain why the solution formed is alkaline.

..... [1]

(ii) Describe how you could use a named indicator solution to show that the solution is alkaline.

.....

..... [2]

(d) Sodium tetrahydridoborate, $NaBH_4$, is an ionic compound.

Calculate the relative formula mass of $NaBH_4$.
Show all your working.
Use your Periodic Table to help you.

relative formula mass = ... [2]

[Total: 9]

8 The apparatus shown is used to investigate the rate of reaction between calcium carbonate and hydrochloric acid at 30 °C.

(a) Name the piece of apparatus labelled **A** in the diagram.

..... [1]

(b) Describe how this apparatus can be used to find the rate of reaction.

.....

.....

..... [2]

(c) The experiment is repeated at 20 °C. All other conditions are kept the same.

How does the decrease in temperature affect the rate of reaction?

..... [1]

(d) The experiment is repeated using the same mass of different size pieces of calcium carbonate. All other conditions are kept the same.

The sizes of the pieces of calcium carbonate are:
- large pieces
- small pieces
- powder

Complete the table by writing the sizes of the pieces in the first column.

size of the pieces of calcium carbonate	initial rate of reaction in cm^3 gas / s
	5
	2
	12

[1]

(e) Give the names of the **three** products formed when calcium carbonate reacts with hydrochloric acid.

1 .....

2 .....

3 .....
[2]

[Total: 7]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/41**

Paper 4 Theory (Extended) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 12.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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1 Substances can be classified as elements, compounds or mixtures.

(a) What is meant by the term *compound*?

.....

.....

..... [2]

(b) Mixtures can be separated by physical processes.

A sequence of physical processes can be used to separate common salt (sodium chloride) from a mixture containing sand and common salt only.

Give the order and the correct scientific term for the physical processes used to separate the common salt from the mixture.

1 .....

2 .....

3 .....
[4]

The boiling points of four different alcohols, **A**, **B**, **C** and **D**, are shown.

alcohol	**A**	**B**	**C**	**D**
boiling point / °C	56	78	122	160

(c) A student suggested that the apparatus shown could be used to separate the mixture of alcohols.

(i) Apparatus **X** needs to have cold water flowing through it.

- Draw an arrow on the diagram to show where the cold water enters apparatus **X**.
- Name apparatus **X**.

.....
[2]

(ii) Part of the fractionating column is missing. This means that the experiment will not work.

- Draw on the diagram the part of the fractionating column which is missing.
- Explain why the experiment will **not** work with this part of the fractionating column missing.

.....

.....
[2]

(iii) Suggest why a Bunsen burner is **not** used to heat the flask.

..... [1]

(iv) A hot water bath cannot be used to separate alcohols **C** and **D**.

Explain why.

.....

.....

..... [2]

[Total: 13]

2 Flerovium, F*l*, atomic number 114, was first made in research laboratories in 1998.

(a) Flerovium was made by bombarding atoms of plutonium, Pu, atomic number 94, with atoms of element **Z**.

- The nucleus of **one** atom of plutonium combined with the nucleus of **one** atom of element **Z**.
- This formed the nucleus of **one** atom of flerovium.

Suggest the identity of element **Z**.

..... [1]

(b) In which period of the Periodic Table is flerovium?

..... [1]

(c) Predict the number of outer shell electrons in an atom of flerovium.

..... [1]

(d) Two isotopes of flerovium are ^{286}F*l* and ^{289}F*l*. The nuclei of both of these isotopes are unstable and emit energy when they split up.

(i) State the term used to describe isotopes with unstable nuclei.

..... [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in the atoms of the isotopes shown.

isotope	number of protons	number of neutrons	number of electrons
^{286}F*l*			
^{289}F*l*			

[2]

(e) Only a relatively small number of atoms of flerovium have been made in the laboratory and the properties of flerovium have not yet been investigated.

It has been suggested that flerovium is a typical metal.

(i) Suggest **two** physical properties of flerovium.

1 .....

2 .....

[2]

(ii) Suggest **one** chemical property of flerovium oxide.

..... [1]

[Total: 9]

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3 This question is about iron.

(a) Three of the raw materials added to a blast furnace used to extract iron from hematite are coke, hematite and limestone.

Name **one** other raw material added to the blast furnace.

..... [1]

(b) A series of reactions occurs in a blast furnace during the extraction of iron from hematite.

Describe these reactions.
Include:
- **one** chemical equation for the reduction of hematite
- **one** chemical equation for the formation of slag.

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) The iron extracted from hematite using a blast furnace is impure.

Identify the main impurity in this iron and explain how it is removed in the steel-making process.

main impurity .....

how it is removed .....

.....

.....
[3]

[Total: 9]

4 This question is about masses, volumes and moles.

(a) Which term is defined by the following statement?

The average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units.

..... [1]

(b) Butane, C_4H_{10}, has a relative **molecular** mass of 58.
Potassium fluoride, KF, has a relative **formula** mass of 58.

Explain why the term relative molecular mass can be used for butane but **cannot** be used for potassium fluoride.

.....

..... [2]

(c) A 0.095 g sample of gaseous element **Y** occupies 60.0 cm^3 at room temperature and pressure.

- Determine the number of moles of element **Y** in 60.0 cm^3.

moles of element **Y** = ... mol

- Calculate the relative molecular mass of element **Y** and hence suggest the identity of element **Y**.

relative molecular mass = ...

identity of element **Y** = ...
[3]

(d) A 1.68 g sample of phosphorus was burned and formed 3.87 g of an oxide of phosphorus.

Calculate the empirical formula of this oxide of phosphorus.

empirical formula = ... [4]

(e) Another oxide of phosphorus has the empirical formula P_2O_3.
One molecule of this oxide of phosphorus contains four atoms of phosphorus.

Calculate the mass of **one** mole of this oxide of phosphorus.

mass = ... g [2]

[Total: 12]

5 **(a)** The table gives some chemical properties of transition elements and their compounds, and of Group I elements and their compounds.

chemical property	transition elements	Group I elements
ability to act as catalysts	yes	no
exist as coloured compounds	yes	no

(i) What is meant by the term *catalyst*?

.....

.....

..... [2]

(ii) Give **one** other chemical property shown by transition elements which is **not** shown by Group I elements.

..... [1]

(b) Give **two** physical properties shown by transition elements which are **not** shown by Group I elements.

1 .....

2 .....
[2]

(c) The energy level diagram shows the energy profile for the reaction between zinc and dilute sulfuric acid.

(i) Complete the diagram by adding the formulae of the products. Include state symbols. [3]

(ii) Draw an arrow on the diagram to represent the activation energy. [1]

(iii) Is the reaction endothermic or exothermic? Explain your answer.

.....

..... [1]

(d) The reaction between zinc and dilute sulfuric acid can be catalysed by the addition of aqueous copper(II) sulfate.

On the diagram, add the energy profile for the catalysed reaction.

[1]

(e) A student electrolyses aqueous copper(II) sulfate using the apparatus shown.

Oxygen gas forms at the positive electrode (anode).

(i) Write an ionic half-equation for the reaction at the negative electrode (cathode). Include state symbols.

..... [3]

(ii) Describe what the student observes at the negative electrode.

..... [1]

(iii) Give **two other** observations which the student makes during the electrolysis.

1 .....

2 .....
[2]

(iv) What difference would the student observe at the positive electrode if the aqueous copper(II) sulfate were replaced by concentrated aqueous copper(II) chloride?

..... [1]

[Total: 18]

6 The table shows the structures of four hydrocarbons.

P	Q	R	S
$CH_3–CH_3$	$CH_2=CH_2$	$CH_2=CH–CH_3$	$CH_2=CH–CH_2–CH_3$

(a) Why are compounds **P**, **Q**, **R** and **S** known as hydrocarbons?

.....

..... [2]

(b) Compound **P** is saturated.

What is meant by the term *saturated*?

.....

..... [1]

(c) Compound **P** undergoes a substitution reaction with chlorine.

(i) What is meant by the term *substitution reaction*?

.....

..... [1]

(ii) State a condition required for this reaction to occur.

..... [1]

(iii) Write a chemical equation for this reaction.

..... [2]

(d) Compound **R** undergoes an addition reaction with bromine.

(i) Why is this reaction an addition reaction?

..... [1]

(ii) A compound containing bromine is formed in this reaction.

Draw the structure of this compound. Show all of the atoms and all of the bonds.

[1]

(e) Draw the structure of an unbranched isomer of compound **S**. Show all of the atoms and all of the bonds. Name this unbranched isomer of compound **S**.

structure

name .....
[2]

(f) Compound **Q** undergoes polymerisation.

(i) Name the polymer formed.

..... [1]

(ii) Complete the chemical equation to show the polymerisation of compound **Q**.

$n\ CH_2{=}CH_2 \rightarrow$

[2]

(g) Amino acids undergo polymerisation to form proteins. Part of a protein molecule with the linkages missing is shown.

Draw the linkages on the diagram. Show all of the atoms and all of the bonds.

[2]

(h) The structure shows an ester.

Write the word equation for a reaction which could be used to make this ester.

..... [3]

[Total: 19]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 **H** hydrogen 1										2 **He** helium 4
3 **Li** lithium 7	4 **Be** beryllium 9											5 **B** boron 11	6 **C** carbon 12	7 **N** nitrogen 14	8 **O** oxygen 16	9 **F** fluorine 19	10 **Ne** neon 20
11 **Na** sodium 23	12 **Mg** magnesium 24											13 **Al** aluminium 27	14 **Si** silicon 28	15 **P** phosphorus 31	16 **S** sulfur 32	17 **Cl** chlorine 35.5	18 **Ar** argon 40
19 **K** potassium 39	20 **Ca** calcium 40	21 **Sc** scandium 45	22 **Ti** titanium 48	23 **V** vanadium 51	24 **Cr** chromium 52	25 **Mn** manganese 55	26 **Fe** iron 56	27 **Co** cobalt 59	28 **Ni** nickel 59	29 **Cu** copper 64	30 **Zn** zinc 65	31 **Ga** gallium 70	32 **Ge** germanium 73	33 **As** arsenic 75	34 **Se** selenium 79	35 **Br** bromine 80	36 **Kr** krypton 84
37 **Rb** rubidium 85	38 **Sr** strontium 88	39 **Y** yttrium 89	40 **Zr** zirconium 91	41 **Nb** niobium 93	42 **Mo** molybdenum 96	43 **Tc** technetium –	44 **Ru** ruthenium 101	45 **Rh** rhodium 103	46 **Pd** palladium 106	47 **Ag** silver 108	48 **Cd** cadmium 112	49 **In** indium 115	50 **Sn** tin 119	51 **Sb** antimony 122	52 **Te** tellurium 128	53 **I** iodine 127	54 **Xe** xenon 131
55 **Cs** caesium 133	56 **Ba** barium 137	57–71 lanthanoids	72 **Hf** hafnium 178	73 **Ta** tantalum 181	74 **W** tungsten 184	75 **Re** rhenium 186	76 **Os** osmium 190	77 **Ir** iridium 192	78 **Pt** platinum 195	79 **Au** gold 197	80 **Hg** mercury 201	81 **Tl** thallium 204	82 **Pb** lead 207	83 **Bi** bismuth 209	84 **Po** polonium –	85 **At** astatine –	86 **Rn** radon –
87 **Fr** francium –	88 **Ra** radium –	89–103 actinoids	104 **Rf** rutherfordium –	105 **Db** dubnium –	106 **Sg** seaborgium –	107 **Bh** bohrium –	108 **Hs** hassium –	109 **Mt** meitnerium –	110 **Ds** darmstadtium –	111 **Rg** roentgenium –	112 **Cn** copernicium –		114 **Fl** flerovium –		116 **Lv** livermorium –		

lanthanoids	57 **La** lanthanum 139	58 **Ce** cerium 140	59 **Pr** praseodymium 141	60 **Nd** neodymium 144	61 **Pm** promethium –	62 **Sm** samarium 150	63 **Eu** europium 152	64 **Gd** gadolinium 157	65 **Tb** terbium 159	66 **Dy** dysprosium 163	67 **Ho** holmium 165	68 **Er** erbium 167	69 **Tm** thulium 169	70 **Yb** ytterbium 173	71 **Lu** lutetium 175
actinoids	89 **Ac** actinium –	90 **Th** thorium 232	91 **Pa** protactinium 231	92 **U** uranium 238	93 **Np** neptunium –	94 **Pu** plutonium –	95 **Am** americium –	96 **Cm** curium –	97 **Bk** berkelium –	98 **Cf** californium –	99 **Es** einsteinium –	100 **Fm** fermium –	101 **Md** mendelevium –	102 **No** nobelium –	103 **Lr** lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Answer **all** questions.
Electronic calculators may be used.
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1 Give the name of the process that is used:

(a) to obtain water from aqueous sodium chloride

..... [1]

(b) to produce lead from molten lead(II) bromide

..... [1]

(c) to separate an insoluble solid from a liquid

..... [1]

(d) to separate the components of petroleum

..... [1]

(e) to separate a mixture of coloured dyes.

..... [1]

[Total: 5]

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2 This question is about the elements in Period 3 of the Periodic Table.

Na	Mg	A*l*	Si	P	S	C*l*	Ar

For each of the following, identify a Period 3 element which matches the description. Each element may be used once, more than once or not at all.

State which Period 3 element:

(a) forms an oxide with a macromolecular structure

..... [1]

(b) is extracted from the ore bauxite

..... [1]

(c) is soft, metallic and stored in oil

..... [1]

(d) is a green gas at room temperature and pressure

..... [1]

(e) provides an inert atmosphere in lamps

..... [1]

(f) forms **two** different oxides during the Contact process

..... [1]

(g) is non-metallic and an important component of fertilisers.

..... [1]

[Total: 7]

3 Complete the following table.

particle	number of protons	number of electrons	number of neutrons	number of nucleons
$^{23}_{11}$Na	11	11	.....	23
$^{37}_{17}$C*l*$^{-}$	.....	.....	20	.....
$^{56}_{26}$.....	26	24	30	56

[6]

[Total: 6]

4 Potassium reacts with bromine at room temperature to form potassium bromide.

(a) Write a chemical equation for this reaction. Include state symbols.

..... [3]

(b) Potassium bromide exists as an ionic lattice.
Potassium bromide does **not** conduct electricity when solid but does conduct electricity when molten.

(i) What is meant by the term *ionic lattice*?

.....

..... [2]

(ii) Explain why potassium bromide does **not** conduct electricity when solid but does conduct electricity when molten.

.....

.....

..... [2]

(c) Concentrated aqueous potassium bromide is an electrolyte.

(i) What is meant by the term *electrolyte*?

.....

..... [2]

(ii) Describe the electrolysis of concentrated aqueous potassium bromide.

Include:
- an ionic half-equation for the reaction at the cathode
- the name of the product at the anode
- the name of the potassium compound formed.

.....

.....

.....

..... [4]

(iii) When molten potassium bromide is electrolysed, the product at the cathode is different.

Name the product at the cathode when molten potassium bromide is electrolysed.

..... [1]

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(d) Iodine reacts with chlorine to form iodine monochloride, ICl, as the only product.

(i) Write a chemical equation for this reaction.

..... [2]

(ii) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of iodine monochloride. Show outer shell electrons only.

[2]

(e) Potassium bromide has a melting point of 734 °C.
Iodine monochloride has a melting point of 27 °C.

In terms of attractive forces, explain why there is a large difference between these melting points.

.....

.....

.....

.....

..... [3]

(f) When chlorine gas is passed through aqueous potassium bromide, a redox reaction occurs. The ionic equation is shown.

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$

(i) Write an ionic half-equation showing what happens to the chlorine molecules, Cl_2, in this reaction.

..... [1]

(ii) Explain why the bromide ions, Br^-, act as reducing agents in this reaction.

..... [1]

[Total: 23]

5 Hydrogen and iodine react together in a reversible reaction. Hydrogen iodide is formed.

$$\underset{\text{colourless gas}}{H_2(g)} + \underset{\text{purple gas}}{I_2(g)} \rightleftharpoons \underset{\text{colourless gas}}{2HI(g)}$$

The forward reaction is exothermic.

A gas syringe containing an equilibrium mixture of hydrogen, iodine and hydrogen iodide gases was sealed and heated to 250 °C. The equilibrium mixture was a pale purple colour.

(a) What is meant by the term *equilibrium*?

.....

.....

..... [2]

(b) The plunger of the gas syringe was pressed in while the end of the gas syringe was blocked. This increased the pressure. The position of the equilibrium did **not** change. The colour of the gaseous mixture turned darker purple.

(i) Give a reason why the position of the equilibrium did **not** change.

..... [1]

(ii) Suggest why the gaseous mixture turned darker purple, even though the position of the equilibrium did **not** change.

..... [1]

(c) The temperature of the gas syringe was increased to 300 °C.

(i) What happened to the **position** of the equilibrium when the temperature of the gas syringe was increased from 250 °C to 300 °C?

..... [1]

(ii) What happened to the **rate** of the forward reaction and the **rate** of the backward reaction when the temperature of the gas syringe was increased from 250 °C to 300 °C?

rate of the forward reaction .....

rate of the backward reaction .....
[2]

[Total: 7]

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6 **(a)** All sodium salts are soluble in water. All nitrates are soluble in water. Barium carbonate is insoluble in water.

Describe how you would make a pure, dry sample of barium carbonate by precipitation.
Include:
- the names of the starting materials
- full practical details
- a chemical equation.

.....

.....

.....

.....

.....

..... [5]

(b) Nitrates decompose when heated.

(i) Write a chemical equation for the decomposition of sodium nitrate when it is heated.

..... [2]

(ii) The unbalanced chemical equation for the decomposition of hydrated copper(II) nitrate crystals is shown.

Balance the chemical equation for this reaction.

$$2Cu(NO_3)_2.3H_2O(s) \rightarrow .....CuO(s) + ...NO_2(g) + O_2(g) + ...H_2O(g)$$

[2]

(iii) When the hydrated copper(II) nitrate crystals are heated, steam is produced. When the steam condenses on a cool surface, it turns into a colourless liquid.

Anhydrous cobalt(II) chloride is used to show that the colourless liquid contains water.

How does the colour of the anhydrous cobalt(II) chloride change?

from ..... to .....

[2]

(iv) How would the student test to determine if the water produced in **(b)(iii)** is pure?

..... [1]

[Total: 12]

7 Many organic compounds, such as alcohols, carboxylic acids and esters, contain the elements carbon, hydrogen and oxygen only.

(a) Compound **R** has the following composition by mass: C, 60.00%; H, 13.33%; O, 26.67%.

Calculate the empirical formula of compound **R**.

empirical formula = ... [2]

(b) Compound **S** has the empirical formula C_2H_4O and a relative molecular mass of 88.

Calculate the molecular formula of compound **S**.

molecular formula = ... [2]

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(c) Compounds **T** and **V** both have the molecular formula $C_3H_6O_2$.

- Compound **T** produces bubbles of carbon dioxide gas when it is added to aqueous sodium carbonate.
- Compound **V** is an ester.

(i) What is the name given to compounds with the same molecular formula but different structures?

..... [1]

(ii) Draw the structures of compounds **T** and **V**. Show all of the atoms and all of the bonds.

compound **T**

compound **V**

[2]

(iii) All compounds with the molecular formula $C_3H_6O_2$ can undergo complete combustion in an excess of oxygen.

Complete the chemical equation for this reaction.

$C_3H_6O_2$ + ... → ..... + ...

[2]

(d) Compound **W** has the molecular formula C_2H_6O. Compound **W** reacts when heated with ethanoic acid and a catalyst to produce a sweet-smelling liquid.

(i) Give the name of the homologous series to which compound **W** belongs.

..... [1]

(ii) Draw the structure of compound **W**. Show all of the atoms and all of the bonds.

[1]

(e) Alkanes and alkenes are hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

.....

..... [2]

(ii) State the general formula of:

alkanes .....

alkenes .....
[2]

(f) Ethanol can be produced from long-chain alkanes as shown.

$$\text{long-chain alkane} \xrightarrow{\textbf{step 1}} \text{ethene} \xrightarrow{\textbf{step 2}} \text{ethanol}$$

Describe the **two-stage** manufacture of ethanol from the long-chain alkane octane, C_8H_{18}.
Include:
- the names of the types of chemical reactions that occur
- reaction equations
- reaction conditions.

step 1 .....

.....

.....

.....

step 2 .....

.....

.....

..... [5]

[Total: 20]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 **H** hydrogen 1										2 **He** helium 4
3 **Li** lithium 7	4 **Be** beryllium 9											5 **B** boron 11	6 **C** carbon 12	7 **N** nitrogen 14	8 **O** oxygen 16	9 **F** fluorine 19	10 **Ne** neon 20
11 **Na** sodium 23	12 **Mg** magnesium 24											13 **Al** aluminium 27	14 **Si** silicon 28	15 **P** phosphorus 31	16 **S** sulfur 32	17 **Cl** chlorine 35.5	18 **Ar** argon 40
19 **K** potassium 39	20 **Ca** calcium 40	21 **Sc** scandium 45	22 **Ti** titanium 48	23 **V** vanadium 51	24 **Cr** chromium 52	25 **Mn** manganese 55	26 **Fe** iron 56	27 **Co** cobalt 59	28 **Ni** nickel 59	29 **Cu** copper 64	30 **Zn** zinc 65	31 **Ga** gallium 70	32 **Ge** germanium 73	33 **As** arsenic 75	34 **Se** selenium 79	35 **Br** bromine 80	36 **Kr** krypton 84
37 **Rb** rubidium 85	38 **Sr** strontium 88	39 **Y** yttrium 89	40 **Zr** zirconium 91	41 **Nb** niobium 93	42 **Mo** molybdenum 96	43 **Tc** technetium –	44 **Ru** ruthenium 101	45 **Rh** rhodium 103	46 **Pd** palladium 106	47 **Ag** silver 108	48 **Cd** cadmium 112	49 **In** indium 115	50 **Sn** tin 119	51 **Sb** antimony 122	52 **Te** tellurium 128	53 **I** iodine 127	54 **Xe** xenon 131
55 **Cs** caesium 133	56 **Ba** barium 137	57–71 lanthanoids	72 **Hf** hafnium 178	73 **Ta** tantalum 181	74 **W** tungsten 184	75 **Re** rhenium 186	76 **Os** osmium 190	77 **Ir** iridium 192	78 **Pt** platinum 195	79 **Au** gold 197	80 **Hg** mercury 201	81 **Tl** thallium 204	82 **Pb** lead 207	83 **Bi** bismuth 209	84 **Po** polonium –	85 **At** astatine –	86 **Rn** radon –
87 **Fr** francium –	88 **Ra** radium –	89–103 actinoids	104 **Rf** rutherfordium –	105 **Db** dubnium –	106 **Sg** seaborgium –	107 **Bh** bohrium –	108 **Hs** hassium –	109 **Mt** meitnerium –	110 **Ds** darmstadtium –	111 **Rg** roentgenium –	112 **Cn** copernicium –		114 **Fl** flerovium –		116 **Lv** livermorium –		

lanthanoids	57 **La** lanthanum 139	58 **Ce** cerium 140	59 **Pr** praseodymium 141	60 **Nd** neodymium 144	61 **Pm** promethium –	62 **Sm** samarium 150	63 **Eu** europium 152	64 **Gd** gadolinium 157	65 **Tb** terbium 159	66 **Dy** dysprosium 163	67 **Ho** holmium 165	68 **Er** erbium 167	69 **Tm** thulium 169	70 **Yb** ytterbium 173	71 **Lu** lutetium 175
actinoids	89 **Ac** actinium –	90 **Th** thorium 232	91 **Pa** protactinium 231	92 **U** uranium 238	93 **Np** neptunium –	94 **Pu** plutonium –	95 **Am** americium –	96 **Cm** curium –	97 **Bk** berkelium –	98 **Cf** californium –	99 **Es** einsteinium –	100 **Fm** fermium –	101 **Md** mendelevium –	102 **No** nobelium –	103 **Lr** lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

6229193737

CHEMISTRY **0620/43**

Paper 4 Theory (Extended) **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **14** printed pages and **2** blank pages.

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1 The following are the symbols and formulae of some elements and compounds.

Ar $Ca(OH)_2$ Cl_2 CO_2 Cu Fe SO_2 V_2O_5

Answer the following questions using only the elements or compounds in the list.
Each element or compound may be used once, more than once or not at all.

State which element or compound is used:

(a) to kill bacteria in drinking water ..... [1]

(b) as a food preservative ..... [1]

(c) as an electrical conductor in cables ..... [1]

(d) as an inert atmosphere in lamps ..... [1]

(e) to neutralise excess acidity in soil ..... [1]

(f) as a catalyst in the Contact process. ..... [1]

[Total: 6]

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2 **(a)** ^{29}Al is a radioactive isotope of aluminium. The only non-radioactive isotope of aluminium is ^{27}Al.

(i) Describe, in terms of protons, neutrons and electrons, how the isotopes ^{29}Al and ^{27}Al are similar and how they are different.

how they are similar .....

how they are different .....
[2]

(ii) Complete the table to show the number of nucleons, neutrons and electrons in an $^{27}_{13}Al^{3+}$ ion.

	number in $^{27}_{13}Al^{3+}$
nucleons	
neutrons	
electrons	

[3]

(b) Aluminium is extracted from its ore by electrolysis.

(i) Name the main ore of aluminium.

..... [1]

(ii) Why is aluminium **not** extracted from its ore by reduction with carbon?

..... [1]

(iii) The main ore of aluminium contains aluminium oxide. Aluminium oxide is dissolved in molten cryolite before it is electrolysed.

Give **two** reasons, other than cost, why cryolite is used.

1 .....

2 .....
[2]

(iv) The reaction at the anode during the extraction of aluminium by electrolysis is shown.

$$2O^{2-} \rightarrow O_2 + 4e^-$$

Is this process oxidation or reduction?
Give a reason for your answer.

..... [1]

(v) During the extraction of aluminium by electrolysis, carbon dioxide is formed at the anode.

Explain how carbon dioxide is formed at the anode.

.....

..... [2]

(c) When a piece of zinc metal is added to copper(II) sulfate solution there is an immediate reaction.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

When a piece of aluminium metal is added to copper(II) sulfate solution the initial reaction is very slow.

(i) Explain why zinc metal reacts with copper(II) sulfate.

..... [1]

(ii) What type of reaction is this?

..... [1]

(iii) Explain why the initial reaction between aluminium metal and copper(II) sulfate is very slow.

..... [1]

[Total: 15]

3 Cobalt is a transition element. Potassium is in Group I of the Periodic Table.

(a) State **one** physical property that is similar for cobalt and potassium.

..... [1]

(b) **(i)** State **one** physical property that is different for cobalt and potassium.

..... [1]

(ii) Describe how the physical property given in **(b)(i)** is different for cobalt compared to potassium.

..... [1]

(c) When a small piece of potassium is added to cold water, the potassium floats and disappears as it reacts.

Give **two** other observations that would be made when a small piece of potassium is added to cold water.

1 .....

2 .....
[2]

(d) Cobalt reacts with dilute hydrochloric acid to make the salt cobalt(II) chloride. Bubbles of hydrogen gas are produced.

(i) Describe a test for hydrogen.

test .....

result .....
[2]

(ii) The rate of reaction of cobalt with dilute hydrochloric acid can be made faster by heating the acid or by increasing its concentration.

State **one** other way to make the rate of reaction faster.

..... [1]

(iii) Use collision theory to explain how heating the dilute hydrochloric acid makes the rate of reaction faster.

.....

.....

.....

.....

..... [3]

(e) When cobalt(II) chloride is added to water an equilibrium is established.

$$\underset{\text{blue}}{[CoCl_4]^{2-}} + 6H_2O \rightleftharpoons \underset{\text{pink}}{[Co(H_2O)_6]^{2+}} + 4Cl^-$$

(i) A student adds water to a blue solution containing $[CoCl_4]^{2-}$ ions.

Describe what the student observes. Give a reason for your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

(ii) Another student cools a blue solution containing $[CoCl_4]^{2-}$. The blue solution turns pink.

What does this information indicate about the forward reaction?

.....

..... [1]

(f) Another compound of cobalt is $Co(OH)_3$.

Deduce the charge on the cobalt ion in $Co(OH)_3$.

..... [1]

[Total: 15]

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4 Ethanol is a member of the homologous series of alcohols.

(a) Give **two** characteristics of members of a homologous series.

1 .....

2 .....
[2]

(b) The structure of ethanol is shown.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethanol. Show outer shell electrons only.

[2]

(c) Ethanol can be produced by the catalytic addition of steam to ethene or by the fermentation of glucose.

(i) Write a chemical equation for the production of ethanol by the catalytic addition of steam to ethene.

..... [1]

(ii) Write a chemical equation for the production of ethanol by the fermentation of glucose, $C_6H_{12}O_6$.

..... [1]

(iii) State **one** advantage of producing ethanol by the catalytic addition of steam to ethene. Your answer must **not** refer to cost.

..... [1]

(iv) State **one** advantage of producing ethanol by the fermentation of glucose. Your answer must **not** refer to cost.

..... [1]

(d) Ethanol can be oxidised to ethanoic acid.

State the chemical reagent needed to oxidise ethanol to ethanoic acid.

..... [1]

(e) Ethanoic acid reacts with ethanol in the presence of an acid catalyst. The products are an organic compound and water.

(i) Draw the structure of the organic compound formed. Show all of the atoms and all of the bonds.

[2]

(ii) State the name of the organic compound formed.

..... [1]

(iii) Which homologous series does the organic compound formed belong to?

..... [1]

(f) Ethanoic acid, CH_3COOH, is a weak acid. It reacts with copper(II) carbonate to form the salt copper(II) ethanoate, $Cu(CH_3COO)_2$.

(i) What is meant by the term *weak* when applied to acids?

..... [1]

(ii) Describe how a crystalline sample of copper(II) ethanoate can be prepared starting with ethanoic acid and copper(II) carbonate.

.....

.....

.....

.....

.....

..... [3]

(iii) Write the word equation for the reaction between ethanoic acid and copper(II) carbonate.

..... [1]

[Total: 18]

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5 **(a)** Nickel(II) iodide crystals are hydrated. A sample of hydrated nickel(II) iodide crystals has the following composition by mass: Ni, 14.01%; I, 60.33%; H, 2.85%; O, 22.81%.

Calculate the empirical formula of the hydrated nickel(II) iodide crystals.

empirical formula = ... [2]

(b) Molten nickel(II) iodide can be electrolysed using the apparatus shown.

During electrolysis, charge is transferred through the copper wires and through the molten nickel(II) iodide.

(i) Name the type of particles which transfer charge through the copper wires.

..... [1]

(ii) Name the type of particles which transfer charge through the molten nickel(II) iodide.

..... [1]

(iii) Predict the products of the electrolysis of molten nickel(II) iodide. Write an ionic half-equation for the formation of **one** of these products.

products .....

ionic half-equation .....
[3]

(c) A student electrolysed copper(II) sulfate solution using the two sets of apparatus shown.

In apparatus **A** the student used carbon electrodes.
In apparatus **B** the student used copper electrodes.

The student made the following observations.

apparatus **A**	apparatus **B**
The mass of the negative electrode increased.	The mass of the negative electrode increased.
The mass of the positive electrode stayed the same.	The mass of the positive electrode decreased.
Bubbles were seen at the positive electrode.	No bubbles were seen at the positive electrode.

(i) Explain why the mass of the negative electrode increased in **both** sets of apparatus.

.....

..... [1]

(ii) Name the gas that formed the bubbles seen in apparatus **A**.

..... [1]

(iii) Explain why the mass of the positive electrode decreased in apparatus **B**.

.....

..... [1]

(iv) Suggest what happens to the colour of the solution in apparatus **A** and apparatus **B** as the electrolysis progresses.
Explain your answer.

colour of the solution in apparatus **A** .....

colour of the solution in apparatus **B** .....

explanation .....

.....

.....
[3]

[Total: 13]

6 Calcium chlorate(V), $Ca(ClO_3)_2$, is made by reacting calcium hydroxide with chlorine gas.

$$6Ca(OH)_2 + 6Cl_2 \rightarrow Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O$$

(a) 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas are mixed together.

(i) How many moles is 8.88 g of calcium hydroxide?

..... mol [2]

(ii) How many moles of chlorine gas is 7200 cm^3?

..... mol [1]

(iii) What is the maximum **number of moles** of calcium chlorate(V) that can be made from 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas?

..... mol [1]

(iv) What is the maximum **mass** of calcium chlorate(V) that can be made from 8.88 g of calcium hydroxide and 7200 cm^3 of chlorine gas?

..... g [2]

The experiment is repeated using different amounts of calcium hydroxide and chlorine gas. The maximum mass of calcium chlorate(V) that can be made in the experiment is 4.84 g.

(v) The actual mass of calcium chlorate(V) made in the experiment is 3.63 g.

Calculate the percentage yield.

percentage yield = ... % [1]

(b) Calcium chlorate(V) undergoes thermal decomposition.

The only products are calcium chloride and a colourless gas.

(i) What must be done to calcium chlorate(V) to make it thermally decompose?

..... [1]

(ii) Write a chemical equation for the thermal decomposition of calcium chlorate(V).

..... [2]

(c) Chloric(V) acid, $HClO_3$, is a strong acid. It can be made from calcium chlorate(V).

(i) What colour is methyl orange indicator in chloric(V) acid?

..... [1]

(ii) Define the term *acid* in terms of proton transfer.

..... [1]

(iii) Complete the chemical equation to show $HClO_3$ behaving as an acid in water.

$$HClO_3 + H_2O \rightarrow \text{.....} + \text{.....}$$

[1]

[Total: 13]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group

I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 8 3 9 3 7 8 0 9 4 5 *

CHEMISTRY **0620/51**

Paper 5 Practical Test **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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CAMBRIDGE International Examinations

[Turn over

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1 You are going to investigate the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to do five experiments using the apparatus shown.

Experiment 1

- Use the large measuring cylinder to pour 50 cm^3 of aqueous sodium thiosulfate into the conical flask. Place the conical flask on the printed insert.
- Fill the small measuring cylinder with 10 cm^3 of dilute hydrochloric acid.
- Add the dilute hydrochloric acid to the solution in the conical flask. Start the timer immediately and swirl the mixture.
- View the conical flask from above and measure the time taken for the printed words to disappear from view. Record the time taken in the table on page 4.
- Immediately pour the contents of the conical flask into the quenching bath and rinse the conical flask with distilled water.

Experiment 2

- Use the large measuring cylinder to pour 40 cm^3 of aqueous sodium thiosulfate into the conical flask, followed by 10 cm^3 of distilled water. Place the conical flask on the printed insert.
- Fill the small measuring cylinder with 10 cm^3 of dilute hydrochloric acid.
- Add the dilute hydrochloric acid to the solution in the conical flask. Start the timer immediately and swirl the mixture.
- View the conical flask from above and measure the time taken for the printed words to disappear from view. Record the time taken in the table on page 4.
- Immediately pour the contents of the conical flask into the quenching bath and rinse the conical flask with distilled water.

Experiment 3

- Repeat Experiment 2 but use 35 cm^3 of aqueous sodium thiosulfate, 15 cm^3 of distilled water and 10 cm^3 of dilute hydrochloric acid.

Experiment 4

- Repeat Experiment 2 but use 30 cm^3 of aqueous sodium thiosulfate, 20 cm^3 of distilled water and 10 cm^3 of dilute hydrochloric acid.

Experiment 5

- Repeat Experiment 2 but use 10 cm^3 of aqueous sodium thiosulfate, 40 cm^3 of distilled water and 10 cm^3 of dilute hydrochloric acid.

(a) Complete the table.

experiment	volume of aqueous sodium thiosulfate / cm^3	volume of distilled water / cm^3	time taken for the printed words to disappear from view / s
1			
2			
3			
4			
5			

[3]

(b) Plot your results from Experiments 1–5 on the grid. Draw a smooth line graph.

[3]

(c) Describe the appearance of the mixture in the conical flask at the end of each experiment.

..... [1]

(d) (i) **From your graph**, deduce the time taken for the printed words to disappear from view if Experiment 2 were repeated using 20 cm^3 of aqueous sodium thiosulfate and 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... s [2]

(ii) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{1}{\text{time taken}}$$

Calculate the rate of reaction using your answer from **(d)(i)**.

..... [1]

(e) **(i)** In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(f) Give the name of a more accurate piece of apparatus for measuring volumes than a measuring cylinder.

..... [1]

(g) Suggest the effect on the results of using a 100 cm^3 conical flask instead of a 250 cm^3 conical flask. Explain your answer.

.....

..... [2]

(h) Sketch **on the grid** the graph you would expect if all of the experiments were repeated at a **lower** temperature. Clearly label your graph. [1]

[Total: 17]

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2 You are provided with two substances, solution **A** and solid **B**.
Do the following tests on the substances, recording all of your observations at each stage.

tests on solution A

Divide solution **A** into four approximately equal portions in three test-tubes and one boiling tube.

(a) Test the pH of the first portion of solution **A**.

pH = ... [1]

(b) Add a strip of magnesium ribbon to the second portion of solution **A** in a test-tube. Shake the mixture.
Record your observations.

.....

..... [1]

(c) Add a spatula measure of copper(II) oxide to the third portion of solution **A** in a boiling tube. Warm the mixture gently.
Record your observations.

..... [1]

Keep the fourth portion of solution A for the test in (e).

tests on solid B

(d) Use a spatula to place approximately half of solid **B** into a hard glass test-tube. Heat solid **B** gently then strongly. Leave the hard glass test-tube to stand for approximately 1 minute.
Record your observations.

..... [2]

(e) Add the rest of solid **B** to the fourth portion of solution **A** in a test-tube. Test the gas produced.
Record your observations.

test .....

result .....
[2]

Keep the solution from the test in (e) for the test in (f).

Add an approximately equal volume of distilled water to the solution from the test in **(e)**. Shake the solution and divide it into three approximately equal portions in two test-tubes and one boiling tube.

(f) **(i)** Add a few drops of aqueous sodium hydroxide to the first portion of the solution in a test-tube.
Record your observations.

..... [1]

(ii) Now add an excess of aqueous sodium hydroxide to the mixture.
Record your observations.

..... [1]

(g) **(i)** Add a few drops of aqueous ammonia to the second portion of the solution in a test-tube.
Record your observations.

..... [1]

(ii) Now add an excess of aqueous ammonia to the mixture.
Record your observations.

..... [1]

(h) Add a small piece of aluminium foil and about 2 cm^3 of aqueous sodium hydroxide to the third portion of the solution in a boiling tube. Gently warm the mixture. Test the gas produced with indicator paper.
Record your observations.

..... [2]

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(i) Identify solution **A**.

..... [2]

(j) Identify solid **B**.

..... [2]

[Total: 17]

3 Potassium chloride is a salt that dissolves in water.
The solubility of a salt is the mass in grams of the salt that dissolves in 100 cm^3 of water at a particular temperature.

Plan an investigation to determine the solubility of potassium chloride in water at 40 °C.

You are provided with potassium chloride and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

7645677451

CHEMISTRY **0620/52**

Paper 5 Practical Test **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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CAMBRIDGE International Examinations

1 You are going to investigate the temperature changes when two different solids, solid **C** and solid **D**, dissolve in water.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to do two experiments.

(a) *Experiment 1*

- Put the polystyrene cup into the 250 cm^3 beaker for support.
- Use the measuring cylinder to pour 40 cm^3 of distilled water into the polystyrene cup.
- Measure the initial temperature of the distilled water and record it in the first row of the table.
- Add the 3 g sample of solid **C** to the polystyrene cup and stir the solution with the thermometer.
- Measure and record the temperature of the solution after 1 minute.
- Calculate and record the temperature change, including whether the temperature increased (+) or decreased (–).
- Pour the solution away and rinse out the polystyrene cup with distilled water.

- Repeat the procedure using the 4 g sample of solid **C**. Record your results and the temperature change, including whether the temperature increased (+) or decreased (–), in the appropriate row of the table.
- Repeat the procedure using the 6 g sample of solid **C**. Record your results and the temperature change, including whether the temperature increased (+) or decreased (–), in the appropriate row of the table.

mass of solid **C** / g	initial temperature of the distilled water / °C	temperature of the solution after 1 min / °C	temperature change / °C
3			
4			
6			

[2]

(b) *Experiment 2*

- Repeat Experiment 1 but using the 3 g, 4 g, 6 g and 8 g samples of solid **D**.
- Record your results in the table.
- Calculate and record the temperature changes in each case, including whether the temperature increased (+) or decreased (–).

mass of solid **D** / g	initial temperature of the distilled water / °C	temperature of the solution after 1 min / °C	temperature change / °C
3			
4			
6			
8			

[2]

(c) Plot your results for Experiments 1 and 2 on the grid. The (0,0) point has been plotted for you.
Draw **two** straight lines of best fit.
Clearly label your graphs.

[4]

(d) **Use your graph** to estimate the temperature change after 1 minute if 8 g of solid **C** were added to 40 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) What type of energy change occurs when solid **D** dissolves in water?

..... [1]

(f) Suggest the temperature of the solution containing 8 g of solid **D**, if the solution were left for 2 hours.
Explain your answer.

.....

..... [2]

(g) How would the temperature changes measured after 1 minute differ if the experiments were repeated using 80 cm^3 instead of 40 cm^3 of distilled water in each case?

.....

..... [2]

(h) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change .....

explanation .....

.....
[2]

(i) Suggest how the reliability of the results could be checked.

.....

..... [2]

[Total: 19]

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2 You are provided with two solid salts, solid **E** and solid **F**.
Do the following tests on solid **E** and solid **F**, recording all of your observations at each stage.

tests on solid E

(a) Describe the appearance of solid **E**.

..... [1]

(b) Place about half of solid **E** in a hard glass test-tube. Heat the solid gently then strongly.
Record your observations.

.....

..... [2]

Add the rest of solid **E** to about 10 cm^3 of distilled water in a boiling tube. Stopper the boiling tube and shake it to dissolve solid **E** and form solution **E**.
Divide solution **E** into three approximately equal portions in three test-tubes.

(c) Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous silver nitrate to the first portion of solution **E**.
Record your observations.

..... [1]

(d) Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous barium nitrate to the second portion of solution **E**.
Record your observations.

..... [1]

(e) Add an excess of aqueous sodium hydroxide to the third portion of solution **E**.
Record your observations.

..... [2]

(f) Identify solid **E**.

..... [2]

tests on solid F

Add solid **F** to about 10 cm^3 of distilled water in a boiling tube. Stopper the boiling tube and shake it to dissolve solid **F** and form solution **F**.
Divide solution **F** into three approximately equal portions in three test-tubes.

(g) Test the pH of the first portion of solution **F**.

pH = ... [1]

(h) **(i)** Add a few drops of aqueous sodium hydroxide to the second portion of solution **F** and shake the mixture.
Record your observations.

..... [2]

(ii) Now add an excess of aqueous sodium hydroxide to the mixture.
Record your observations.

..... [1]

(i) Add an excess of aqueous ammonia to the third portion of solution **F**.
Record your observations.

..... [1]

(j) What conclusion can you draw about the cation present in solid **F**?

.....

..... [1]

[Total: 15]

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3 Aqueous solutions of barium hydroxide are alkaline.
Plan an investigation to find the concentration of an aqueous solution of barium hydroxide.

You are provided with an aqueous solution of barium hydroxide, dilute hydrochloric acid of known concentration and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

6726715019

CHEMISTRY **0620/53**

Paper 5 Practical Test **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

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Write in dark blue or black pen.
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DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Notes for use in qualitative analysis are provided on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 You are going to investigate how the temperature changes when aqueous sodium hydroxide reacts with solutions of two different acids, acid **R** and acid **S**.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to do two experiments.

(a) *Experiment 1*

- Put the polystyrene cup into the 250 cm^3 beaker for support.
- Use the measuring cylinder to pour 50 cm^3 of aqueous sodium hydroxide into the polystyrene cup.
- Measure the temperature of the solution and record it in the table.
- Fill the burette up to the 0.0 cm^3 mark with acid **R**.
- Add 5.0 cm^3 of acid **R** to the aqueous sodium hydroxide in the polystyrene cup and stir the solution with the thermometer.
- Measure and record the highest temperature of the solution in the table.
- Add a further 5.0 cm^3 of acid **R** to the polystyrene cup and stir the solution with the thermometer.
- Measure and record the highest temperature of the solution in the table.
- Continue to add 5.0 cm^3 portions of acid **R** to the polystyrene cup until a total volume of 40.0 cm^3 of acid **R** has been added. Stir after each addition and measure and record the highest temperature of the solution in the table in each case.
- Pour the solution away and rinse the polystyrene cup.

volume of acid **R** added / cm^3	highest temperature of the solution / °C
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	

[2]

(b) Plot your results for Experiment 1 on the grid and draw **two** intersecting straight line graphs.

[2]

(c) *Experiment 2*

- Empty the burette and rinse it with distilled water. Discard this liquid.
- Rinse the burette with some of acid **S**. Discard this acid.
- Repeat Experiment 1 but using acid **S** instead of acid **R**.
- Record your results in the table.

volume of acid **S** added / cm^3	highest temperature of the solution / °C
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	

[2]

(d) Plot your results for Experiment 2 on the grid and draw **two** intersecting straight line graphs.

[2]

(e) (i) **Use your graph** to estimate the volume of acid **S** which must be added to neutralise 50 cm^3 of aqueous sodium hydroxide.

Show clearly **on the grid** how you worked out your answer.

..... cm^3 [2]

(ii) Suggest how the volume in **(e)(i)** would differ if the experiment were repeated using 25 cm^3 instead of 50 cm^3 of aqueous sodium hydroxide.
Explain your answer.

.....

..... [2]

(f) What type of energy change occurs when acid **S** reacts with aqueous sodium hydroxide?

..... [1]

(g) **(i)** In Experiment 2, why was the burette rinsed with distilled water?

..... [1]

(ii) Why was the burette then rinsed with acid **S**?

..... [1]

(h) Describe **one** source of error in Experiment 2. Suggest an improvement to reduce this source of error.

source of error .....

improvement .....
[2]

[Total: 17]

2 You are provided with two substances, solution **T** and liquid **U**.
Do the following tests on the substances, recording all of your observations at each stage.

tests on solution T

Divide solution **T** into four approximately equal portions in three test-tubes and one boiling tube.

(a) **(i)** Do a flame test on the first portion of solution **T**.
Record your observations.

..... [1]

(ii) Test the pH of the first portion of solution **T**.

pH = ... [1]

(b) ● Add a few drops of aqueous zinc sulfate to the second portion of solution **T** in a test-tube.
Shake the test-tube to mix the solutions.
Record your observations.

.....

● Add an excess of aqueous zinc sulfate to the mixture.
Record your observations.

.....
[3]

(c) Add a small spatula measure of ammonium chloride to the third portion of solution **T** in a boiling tube. Warm the mixture carefully. Test the gas produced.
Record your observations.

.....

..... [2]

(d) ● Add a few drops of aqueous chromium(III) chloride to the fourth portion of solution **T** in a test-tube.
Record your observations.

.....

● Add an excess of aqueous chromium(III) chloride to the mixture.
Record your observations.

.....
[3]

(e) Identify solution **T**.

..... [2]

tests on liquid U

(f) Describe the appearance of liquid **U**.

..... [1]

(g) Add about 10 cm^3 of aqueous iodine to about 1 cm^3 of liquid **U** in a boiling tube. Add drops of aqueous sodium hydroxide until the brown colour of the aqueous iodine is removed.
Record your observations.

.....

..... [2]

(h) Use a teat pipette to place a few drops of liquid **U** on to a watch glass. Use a lighted splint to touch the surface of the liquid carefully.

..... [1]

(i) What conclusion can you draw about liquid **U**?

..... [1]

[Total: 17]

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3 Some trees have purple leaves. The purple colour is a mixture of coloured pigments.

Plan an experiment to extract and separate the coloured pigments present in the purple leaves.

You are provided with some purple leaves, sand, ethanol and common laboratory apparatus.
You may draw a diagram to help you answer the question.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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Notes for use in qualitative analysis
Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

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CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

* 3 9 8 3 9 5 5 4 2 7 *

CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **May/June 2018**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 The volume of dilute nitric acid that reacts with 25.0 cm^3 of aqueous potassium hydroxide can be found by titration using the apparatus shown.

(a) Complete the box to name the apparatus. [1]

(b) Name a suitable indicator that could be used.

..... [1]

A student did the titration four times and recorded the following results.

titration number	volume of dilute nitric acid / cm^3
1	18.1
2	18.9
3	18.3
4	18.2

(c) (i) Which **one** of the results is anomalous?

..... [1]

(ii) Suggest what might have caused this result to be anomalous.

..... [1]

(iii) Use the **other** results to calculate the average volume of dilute nitric acid that reacted with the aqueous potassium hydroxide.

..... [2]

(d) The equation for the reaction taking place in the titration is shown.

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

The student concluded that the aqueous potassium hydroxide was more concentrated than the dilute nitric acid.

Explain whether or not the student's conclusion was correct.

.....

.....

..... [2]

[Total: 8]

2 A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were done using the apparatus shown.

Experiment 1

- A large measuring cylinder was used to pour 50 cm^3 of aqueous sodium thiosulfate into a 250 cm^3 conical flask. The conical flask was placed on a printed sheet of paper.
- 10 cm^3 of dilute hydrochloric acid was added to the solution in the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 2

- The large measuring cylinder was used to pour 40 cm^3 of aqueous sodium thiosulfate into a conical flask, followed by 10 cm^3 of distilled water. The conical flask was placed on the printed sheet of paper.
- 10 cm^3 of dilute hydrochloric acid was added to the solution in the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 3

- Experiment 2 was repeated but using 35 cm^3 of aqueous sodium thiosulfate and 15 cm^3 of distilled water.

Experiment 4

- Experiment 2 was repeated but using 30 cm^3 of aqueous sodium thiosulfate and 20 cm^3 of distilled water.

Experiment 5

- Experiment 2 was repeated but using 10 cm^3 of aqueous sodium thiosulfate and 40 cm^3 of distilled water.

(a) Record the volumes of distilled water used in the table. Use the stop-clock diagrams to record the results in the table.

experiment	volume of aqueous sodium thiosulfate / cm^3	volume of distilled water / cm^3	stop-clock diagram	time taken for the printed words to disappear from view / s
1	50			
2	40			
3	35			
4	30			
5	10			

[3]

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(b) Plot the results from Experiments 1–5 on the grid. Draw a smooth line graph.

[3]

(c) (i) **From your graph**, deduce the time taken for the printed words to disappear from view if Experiment 2 were repeated using 20 cm^3 of aqueous sodium thiosulfate and 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... s [2]

(ii) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{1}{\text{time taken}}$$

Calculate the rate of reaction using your answer from **(c)(i)**.

..... [1]

(d) **(i)** In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) Give the name of a more accurate piece of apparatus for measuring volumes than a measuring cylinder.

..... [1]

(f) Suggest the effect on the results of using a 100 cm^3 conical flask instead of a 250 cm^3 conical flask. Explain your answer.

.....

..... [2]

(g) Sketch **on the grid** the graph you would expect if all of the experiments were repeated at a **lower** temperature. Clearly label your graph. [1]

[Total: 16]

3 Two substances, solution **A** and solid **B**, were analysed.

tests on solution A

Some of the tests and observations are shown.

tests on solution **A**	observations
Solution **A** was divided into three equal portions in three test-tubes. **test 1** The pH of the first portion of solution **A** was tested.	pH = 1
test 2 Magnesium ribbon was added to the second portion of solution **A**. The gas produced was tested.	effervescence gas 'popped' with a lighted splint
test 3 Dilute nitric acid and aqueous barium nitrate were added to the third portion of solution **A**.	white precipitate formed

(a) Identify the gas produced in **test 2**.

..... [1]

(b) Identify solution **A**.

..... [2]

tests on solid B

Solid **B** was zinc carbonate.

Complete the expected observations.

(c) Dilute nitric acid was added to solid **B**. The gas produced was tested.

observations .....

..... [2]

The zinc nitrate solution formed in the test in **(c)** was divided into two portions in two test-tubes.

(d) **(i)** Drops of aqueous sodium hydroxide were added to the first portion of the zinc nitrate solution.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture.

observations ..... [1]

(e) **(i)** Drops of aqueous ammonia were added to the second portion of the zinc nitrate solution.

observations ..... [1]

(ii) An excess of aqueous ammonia was then added to the mixture.

observations ..... [1]

[Total: 10]

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4 Potassium chloride is a salt that dissolves in water.
The solubility of a salt is the mass in grams of the salt that dissolves in 100 cm^3 of water at a particular temperature.

Plan an investigation to determine the solubility of potassium chloride in water at 40 °C.

You are provided with potassium chloride and common laboratory apparatus.

.....

.....

.....

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.....

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.....

.....

..... [6]

[Total: 6]

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CHEMISTRY **0620/62**

Paper 6 Alternative to Practical **May/June 2018**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 The rate of reaction between an excess of dilute nitric acid and powdered calcium carbonate was investigated. The carbon dioxide produced was collected. The apparatus used is shown.

(a) Complete the box to name the apparatus. [1]

A sketch graph of the results obtained is shown.

(b) **(i)** Label the *y*-axis. [1]

(ii) Explain why the sketch graph is horizontal at point **X**.

.....

..... [2]

(c) Draw **on the axes** the graph expected if the experiment were repeated using an equal mass of **lumps** of calcium carbonate. All other conditions were kept the same. [2]

(d) Describe a test for carbon dioxide.

test .....

result .....
[2]

[Total: 8]

2 A student investigated the temperature changes when two different solids, solid **C** and solid **D**, dissolved in water.

Two experiments were done.

Experiment 1

- Using a measuring cylinder, 40 cm^3 of distilled water was poured into a polystyrene cup. The initial temperature of the distilled water was measured.
- 3 g of solid **C** was added to the polystyrene cup and the mixture was stirred with a thermometer. The temperature of the solution was measured after 1 minute.

- The procedure was repeated using 4 g of solid **C**.
- The procedure was repeated using 6 g of solid **C**.

(a) Use the thermometer diagrams to record the results in the table.

Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

mass of solid **C** / g	thermometer diagram	initial temperature of the distilled water / °C	thermometer diagram	temperature of the solution after 1 min / °C	temperature change / °C
3					
4					
6					

[2]

Experiment 2

- Experiment 1 was repeated but using 3 g, 4 g, 6 g and 8 g of solid **D** .

(b) Use the thermometer diagrams to record the results in the table.

Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

mass of solid **D** / g	thermometer diagram	initial temperature of the distilled water / °C	thermometer diagram	temperature of the solution after 1 min / °C	temperature change / °C
3					
4					
6					
8					

[2]

(c) Plot the results for Experiments 1 and 2 on the grid. The (0,0) point has been plotted for you.
Draw **two** straight lines of best fit.
Clearly label your graphs.

[4]

(d) **Use your graph** to estimate the temperature change after 1 minute if 8 g of solid **C** were added to 40 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) What type of energy change occurs when solid **D** dissolves in water?

..... [1]

(f) Suggest the temperature of the solution containing 8 g of solid **D**, if the solution were left for 2 hours.
Explain your answer.

.....

..... [2]

(g) How would the temperature changes measured after 1 minute differ if the experiments were repeated using 80 cm^3 instead of 40 cm^3 of distilled water in each case?

.....

..... [2]

(h) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change .....

explanation .....

.....
[2]

(i) Suggest how the reliability of the results could be checked.

.....

..... [2]

[Total: 19]

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3 Two substances, solid **E** and solution **F**, were analysed. Solid **E** was iron(II) sulfate. Tests were done on solid **E** and solution **F**.

tests on solid E

Complete the expected observations.

(a) Describe the appearance of solid **E**.

..... [1]

Solid **E** was added to distilled water in a test-tube. The test-tube was shaken to dissolve solid **E** and form solution **E**. Solution **E** was divided into four equal portions in four test-tubes.

(b) Dilute nitric acid and aqueous silver nitrate were added to the first portion of solution **E**.

observations ..... [1]

(c) Dilute nitric acid and aqueous barium nitrate were added to the second portion of solution **E**.

observations ..... [1]

(d) An excess of aqueous sodium hydroxide was added to the third portion of solution **E**.

observations ..... [2]

(e) An excess of aqueous ammonia was added to the fourth portion of solution **E**.

observations ..... [1]

tests on solution F

Solution **F** was an aqueous salt solution.

Some of the tests and observations are shown.

tests on solution **F**	observations
Solution **F** was divided into two equal portions in two test-tubes. **test 1** Drops of aqueous sodium hydroxide were added to the first portion of solution **F**. An excess of aqueous sodium hydroxide was then added to the mixture.	 white precipitate formed white precipitate was insoluble
test 2 An excess of aqueous ammonia was added to the second portion of solution **F**.	no precipitate formed

(f) What conclusion can you draw about the cation present in solution **F**?

.....

..... [1]

[Total: 7]

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4 Aqueous solutions of barium hydroxide are alkaline.
Plan an investigation to find the concentration of an aqueous solution of barium hydroxide.

You are provided with an aqueous solution of barium hydroxide, dilute hydrochloric acid of known concentration and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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CHEMISTRY **0620/63**

Paper 6 Alternative to Practical **May/June 2018**

1 hour

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1 Zinc sulfate crystals are hydrated. They contain water of crystallisation. A student did an experiment to find the mass of water in hydrated zinc sulfate crystals.
The hydrated zinc sulfate crystals were weighed and then heated with a Bunsen burner to remove the water as shown.

(a) **(i)** Name the apparatus used to weigh the crystals in **A**.

..... [1]

(ii) Complete the box to name the apparatus. [1]

(b) What position should the air hole of the Bunsen burner be in when heating the hydrated zinc sulfate crystals in **B**?

..... [1]

(c) Describe how the student could find out if all of the water of crystallisation had been removed from the hydrated zinc sulfate crystals.

.....

.....

..... [2]

(d) Describe a **chemical** test for water.

test .....

result .....
[2]

[Total: 7]

2 A student investigated how the temperature changed when aqueous sodium hydroxide reacted with solutions of two different acids, acid **R** and acid **S**.

Two experiments were done.

Experiment 1

- A measuring cylinder was used to pour 50 cm^3 of aqueous sodium hydroxide into a polystyrene cup. The temperature of the solution was measured.
- A burette was filled up to the 0.0 cm^3 mark with acid **R**.
- 5.0 cm^3 of acid **R** was added to the aqueous sodium hydroxide in the polystyrene cup and the solution stirred.
- The highest temperature of the solution was measured.
- A further 5.0 cm^3 of acid **R** was added to the polystyrene cup and the solution was stirred.
- The highest temperature of the solution was measured.
- Further 5.0 cm^3 portions of acid **R** were added to the polystyrene cup until a total volume of 40.0 cm^3 of acid **R** had been added. The highest temperature of the solution was measured after each addition.

(a) Use the thermometer diagrams to record the results in the table.

volume of acid **R** added / cm^3	thermometer diagram	highest temperature of the solution / °C
0.0		
5.0		
10.0		
15.0		
20.0		
25.0		
30.0		
35.0		
40.0		

[2]

(b) Plot the results for Experiment 1 on the grid and draw **two** intersecting straight line graphs.

[2]

Experiment 2

- The burette was rinsed with distilled water and then with acid **S**.
- Experiment 1 was repeated but using acid **S** instead of acid **R**.

(c) Use the thermometer diagrams to record the results in the table.

volume of acid **S** added / cm^3	thermometer diagram	highest temperature of the solution / °C
0.0		
5.0		
10.0		
15.0		
20.0		
25.0		
30.0		
35.0		
40.0		

[2]

(d) Plot the results for Experiment 2 on the grid and draw **two** intersecting straight line graphs.

[2]

(e) (i) **Use your graph** to estimate the volume of acid **S** which must be added to neutralise 50 cm^3 of aqueous sodium hydroxide.

Show clearly **on the grid** how you worked out your answer.

..... cm^3 [2]

(ii) Suggest how the volume in **(e)(i)** would differ if the experiment were repeated using 25 cm^3 instead of 50 cm^3 of aqueous sodium hydroxide.
Explain your answer.

.....

..... [2]

(f) What type of energy change occurs when acid **S** reacts with aqueous sodium hydroxide?

..... [1]

(g) **(i)** In Experiment 2, why was the burette rinsed with distilled water?

..... [1]

(ii) Why was the burette then rinsed with acid **S**?

..... [1]

(h) Describe **one** source of error in Experiment 2. Suggest an improvement to reduce this source of error.

source of error .....

improvement .....
[2]

[Total: 17]

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3 Solution **T** and liquid **U** were analysed. Solution **T** was aqueous sodium hydroxide.
Tests were done on solution **T** and liquid **U**.

tests on solution T

Complete the expected observations.

Solution **T** was divided into four portions in three test-tubes and one boiling tube.

(a) **(i)** A flame test was done on the first portion of solution **T**.

observations ..... [1]

(ii) The pH of the first portion of solution **T** was tested.

pH = ... [1]

(b)
- A few drops of aqueous zinc sulfate were added to the second portion of solution **T** in a test-tube. The test-tube was shaken to mix the solutions.

  observations .....

- An excess of aqueous zinc sulfate was then added to the mixture.

  observations .....
  [3]

(c) Ammonium chloride was added to the third portion of solution **T** in a boiling tube. The mixture was heated and the gas produced was tested.

test .....

observations .....
[2]

(d) An excess of aqueous chromium(III) chloride was added to the fourth portion of solution **T** in a test-tube.

observations ..... [2]

tests on liquid U

Some of the tests and observations are shown.

tests on liquid **U**	observations
The appearance of liquid **U** was studied.	colourless, pleasant smelling
A few drops of liquid **U** were placed on to a watch glass. The surface of the liquid was touched with a lighted splint.	burned with a blue flame

(e) What conclusion can you draw about liquid **U**?

..... [1]

[Total: 10]

4 Some trees have purple leaves. The purple colour is a mixture of coloured pigments.

Plan an experiment to extract and separate the coloured pigments present in the purple leaves.

You are provided with some purple leaves, sand, ethanol and common laboratory apparatus.
You may draw a diagram to help you answer the question.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

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