Name		Register No.	Class
			4R1

BENDEMEER SECONDARY SCHOOL
2018 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 1
6092/01

DATE : 20 August 2018
DURATION : 1 hour

READ THESE INSTRUCTIONS FIRST

Write in 2B pencil.
Do not use paper clips, glue or correction fluid.
Write your name, class and register number on the question paper and OTAS sheet in the spaces provided.

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 **2B pencil** on the OTAS sheet.

Read the instructions on the OTAS 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.
The use of an approved scientific calculator is expected, where appropriate.

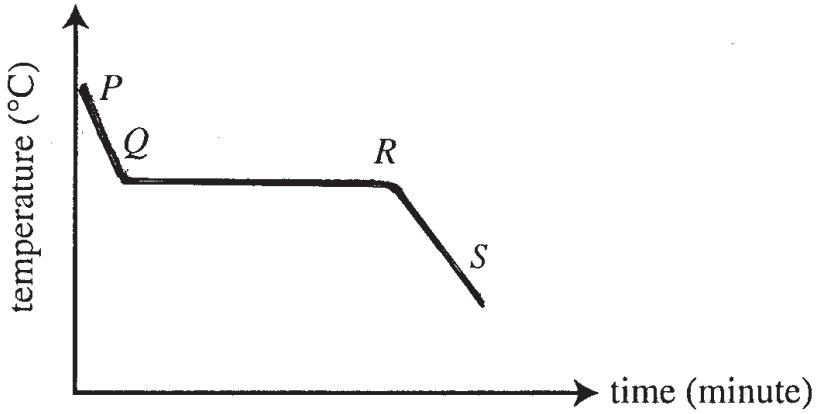
A copy of the Periodic Table can be found on page **18**.

40

This document consists of **18** printed pages.

[Turn over

1 A sample of solid X is heated until it is completely melted. The graph shows how its temperature varies with time as molten X is cooled.



Which of the following statements are true about the particles in X?

I They are closer to each other at stage RS than at stage PQ.
II The forces of attraction are stronger at stage P than at stage S.
III The arrangement is more orderly at stage RS than at stage PQ.
IV Their total energy content at stage QR is lower than at stage RS.

A I and II are correct
B I and III are correct
C II and III are correct
D II and IV are correct

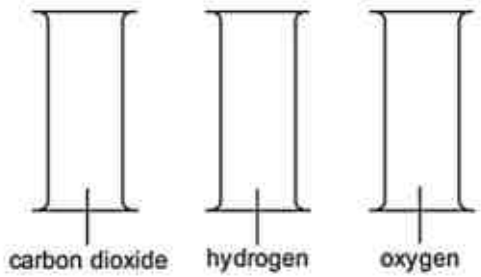
2 In a volumetric experiment involving the addition of dilute hydrochloric acid to 25.0 cm^3 of aqueous sodium hydroxide, it is necessary to determine when the reaction has just completed.

Which piece of apparatus could be used to determine the end-point of the reaction?

A electronic balance
B gas syringe
C stop watch
D thermometer

[Turn over

3 The gas jars shown below contain carbon dioxide, hydrogen and oxygen.



Which test could be used to identify the gases in each jar?

A a glowing splint
B a lighted splint
C damp blue litmus paper
D limewater

4 Which procedure shows the best method to obtain a pure sample of silver nitrate, from a mixture of silver nitrate and silver chloride salts?

	step 1	step 2	step 3	step 4
A	dissolution	filtration	evaporation	crystallisation
B	dissolution	crystallisation	filtration	evaporation
C	dissolution	evaporation	crystallisation	filtration
D	filtration	dissolution	crystallisation	evaporation

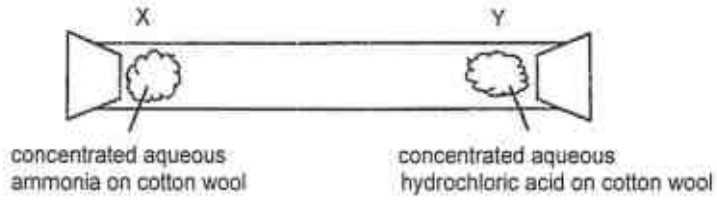
5 Argon is used to reduce the evaporation of the metal filament in electric light bulbs. There are three isotopes of argon: argon-36, argon-38 and argon-40.

Which of the following about these three isotopes is correct?

A They have different chemical properties.
B They have different rates of diffusion.
C They have different numbers of electrons.
D They have different numbers of protons.

[Turn over

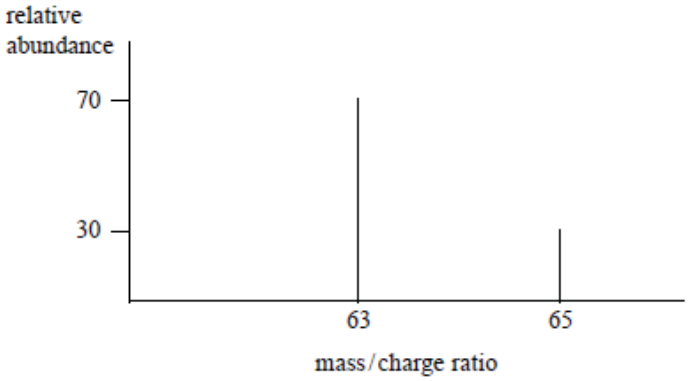
6 The apparatus was set up with two cotton wool plugs soaked in concentrated aqueous ammonia and concentrated aqueous hydrochloric acid respectively.
These plugs were placed at opposite ends of a long glass tube as shown. After some time, a white solid was formed within the tube. The experiment was then repeated at a higher temperature.



Which was true of the repeated experiment?

A The white solid was formed even closer to X as compared to the first experiment.
B The white solid was formed even closer to Y as compared to the first experiment.
C The white solid was formed at a much faster rate as compared to the first experiment.
D Yellow solid was formed instead.

7 A metal Y was analysed and found to contain only two isotopes, Y-63 and Y-65. The graph below shows the relative abundance of the two isotopes.



What is the relative atomic mass of Y?

A 63.2 **B** 63.4 **C** 63.6 **D** 64.0

[Turn over

8 The table below shows the proton number and nucleon number of elements M and N.

element	proton number	nucleon number
M	13	27
N	8	16

When M and N combine together to form a compound, what will be the mass of one mole of the compound?

A 43 **B** 70 **C** 102 **D** 113

9 Hexasulfur was prepared by M.R. Engel in 1891 by reacting concentrated hydrochloric acid with thiosulfate, $HS_2O_3^-$. It is orange-red and forms a rhombohedral crystal. It has a formula of S_6.

What can you deduce from the information given above?

A Hexasulfur contains only one element.
B Hexasulfur is a compound which contains 6 atoms.
C Hexasulfur is a compound which contains 6 elements.
D Hexasulfur is a mixture which contains 6 elements.

10 Since 1850, most books have been printed on acidic paper which eventually becomes brittle and disintegrates. These books can be preserved by treatment with diethylzinc vapour, $Zn(C_2H_5)_2$, which reacts with both acid and also with small amounts of water retained in paper.

The reaction below shows the reaction of diethylzinc with an acid.

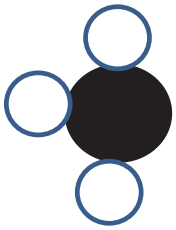
$$Zn(C_2H_5)_2 + 2H\mathbf{X} \rightarrow Zn\mathbf{X}_2 + 2C_2H_6$$

Which products are likely to result from the reaction of diethylzinc with water?

A $ZnH_2 + C_2H_5OH$
B $ZnH_2 + C_2H_6$
C $Zn(OH)_2 + C_2H_5OH$
D $Zn(OH)_2 + C_2H_6$

[Turn over

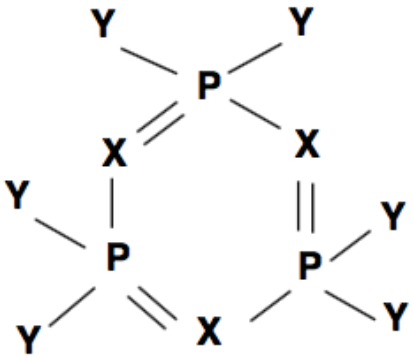
11 The following diagram shows the structure of one molecule of a substance.



What are the possible electronic configurations for the elements in the above substance?

		
A	1	2.3
B	2.6	2.5
C	2.7	2.3
D	2.8.7	2.5

12 A molecule consists of three types of elements, P, X and Y.



If P is phosphorus, what could X and Y be?

	X	Y
A	Al	H
B	N	Cl
C	O	H
D	Si	Cl

[Turn over

13 A student was given four bottles containing different solutions.
He mixed pairs of the solutions together and obtained the following results.

solutions	observations
1 and 2	effervescence
2 and 3	white ppt.
2 and 4	no visible reaction
1 and 3	white ppt.
1 and 4	white ppt.

Which of the following correctly identifies each solution?

	solution 1	solution 2	solution 3	solution 4
A	hydrochloric acid	sodium carbonate	barium nitrate	lead(II) nitrate
B	lead(II) nitrate	barium nitrate	sodium carbonate	hydrochloric acid
C	sodium carbonate	hydrochloric acid	lead(II) nitrate	barium nitrate
D	barium nitrate	lead(II) carbonate	hydrochloric acid	sodium carbonate

14 Which of the following pairs of solutions will show no visible change when mixed?

A barium nitrate and hydrochloric acid
B copper(II) sulfate and lead(II) nitrate
C magnesium chloride and sodium carbonate
D zinc and iron(II) sulfate

15 The following results are obtained from an experiment involving the reduction of an oxide of lead to lead metal.

Mass of test tube = 21.28 g
Mass of test tube + lead oxide = 27.26 g
Mass of test tube + lead = 26.46 g

What is the empirical formula of this oxide of lead?

A PbO **B** Pb_2O_3 **C** PbO_2 **D** Pb_3O_4

[Turn over

16 Which aqueous acid neutralizes the greatest volume of aqueous sodium hydroxide?

A 1 dm^3 of H_2SO_4 of concentration 4 mol/dm^3
B 2 dm^3 of H_3PO_4 of concentration 2 mol/dm^3
C 3 dm^3 of HNO_3 of concentration 2 mol/dm^3
D 4 dm^3 of CH_3COOH of concentration 1 mol/dm^3

17 5 g of barium sulfate is contaminated with barium carbonate. The mixture is added to excess nitric acid and filtered. The mass of the residue and filtrate is found to be 2.8 g and 9 g respectively.

What is the percentage purity of barium sulfate?

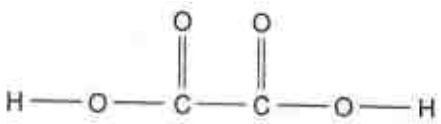
A $\frac{2.2}{5} \times 100\%$

B $\frac{2.8}{5} \times 100\%$

C $\frac{5}{9} \times 100\%$

D $\frac{9}{5} \times 100\%$

18 The structure of oxalic acid is shown below.



A 25.0 cm^3 solution of oxalic acid reacts completely with 15.0 cm^3 of 2.5 mol/dm^3 sodium hydroxide.

What is the concentration of the oxalic acid solution?

A 0.667 mol/dm^3
B 0.750 mol/dm^3
C 1.33 mol/dm^3
D 1.50 mol/dm^3

[Turn over

19 Nitrogenous fertilizer such as ammonium nitrate is used to increase crop yield.
Which substance can be added to increase pH of the acidic soil without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D magnesium sulfate

20 Which pair of elements would react together most vigorously?

A potassium and bromine
B potassium and iodine
C sodium and chlorine
D sodium and fluorine

21 Elements X and Y are in the same Group of the Periodic Table.

Which statement must be correct?

A Atoms X and Y have similar electronic structure.
B Atoms X and Y have the same physical properties.
C If X has a smaller proton number than Y, it is less metallic.
D The number of electronic shells in atoms X and Y must be the same.

22 Which statement about the manufacture of ammonia by the Haber process is correct?

A The reactants are both obtained from air.
B The reactants and product are compounds.
C The reactants and product are elements.
D The reactants and product are gases.

23 An alloy contains copper and zinc. Some of the zinc has been oxidized to zinc oxide.
What is the result of adding an excess of sulfuric acid to the alloy?

A A blue solution is formed and a white solid remains.
B A colourless solution is formed and a pink solid remains.
C The alloy dissolves completely to form a blue solution.
D The alloy dissolves completely to form a colourless solution.

[Turn over

24 Ethyne (H–C≡C–H) undergoes addition of hydrogen to form ethane as shown.

$$C_2H_2\ (g) + 2H_2\ (g) \rightarrow C_2H_6\ (g)$$

The average bond energies of the bonds in the substances involved are shown in the table below.

bond	C–H	C–C	C=C	C≡C	H–H
bond energy / kJ/mol	413	347	612	839	432

What is the enthalpy change for this reaction?

A –296 kJ/mol
B -176 kJ/mol
C +176 kJ/mol
D +296 kJ/mol

25 Ammonium chloride dissolves in water according to the equation below.

$$NH_4Cl\ (s) \rightarrow NH_4Cl\ (aq) \qquad \Delta H = +15.0\ kJ/mol$$

When 0.2 moles of ammonium chloride dissolves in 50.0 cm^3 of water,

1. the concentration of the solution is 4.0 mol/dm^3.
2. the energy level of NH_4Cl increases.
3. the heat liberated is 3.0 kJ.
4. the temperature of water falls.

Which of the above statements are correct?

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

[Turn over

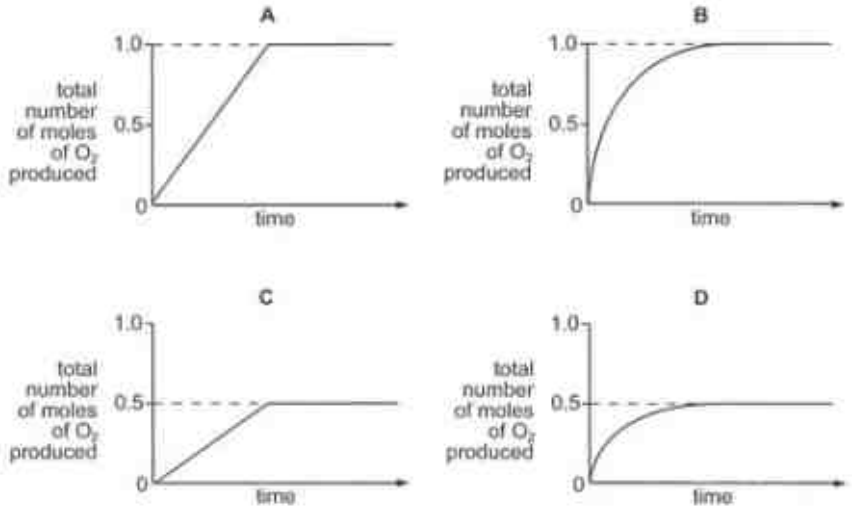
26 The anti-cancer drug, cisplatin, has the formula $Pt(NH_3)_2Cl_2$. In the human body, one of the chloride ions of cisplatin is replaced by one water molecule to form an aqua complex.

$$Pt(NH_3)_2Cl_2 + H_2O \rightarrow \underset{\text{aqua complex}}{[Pt(NH_3)_2(H_2O)Cl]^+} + Cl^-$$

What is the oxidation number of platinum in each of these substances?

	cisplatin	aqua complex
A	+2	+1
B	+2	+2
C	+4	+3
D	+4	+4

27 Manganese(IV) oxide catalyses the decomposition of hydrogen peroxide (H_2O_2) into oxygen and water.
Which curve represents the decomposition of 1.0 mol of hydrogen peroxide?

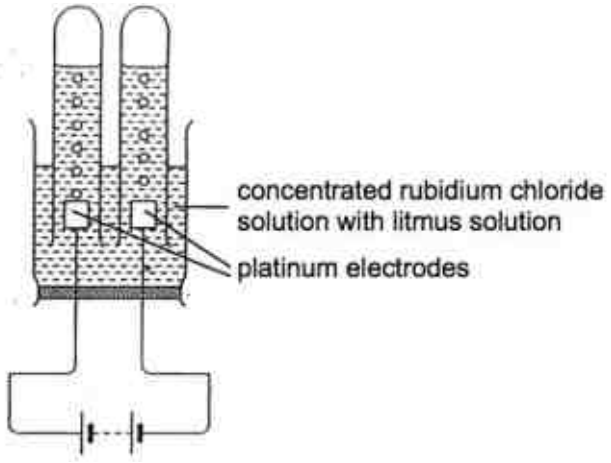


28 In which reaction is the underlined substance behaving as an oxidising agent?

A $\underline{BaCl_2} + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
B $3CuO + 2\underline{NH_3} \rightarrow 3Cu + N_2 + 3H_2O$
C $2\underline{FeCl_2} + Cl_2 \rightarrow 2FeCl_3$
D $2NaI + \underline{Br_2} \rightarrow 2NaBr + I_2$

[Turn over

29 A few drops of litmus solution were added to concentrated rubidium chloride solution and the resultant solution was electrolysed using platinum electrodes.

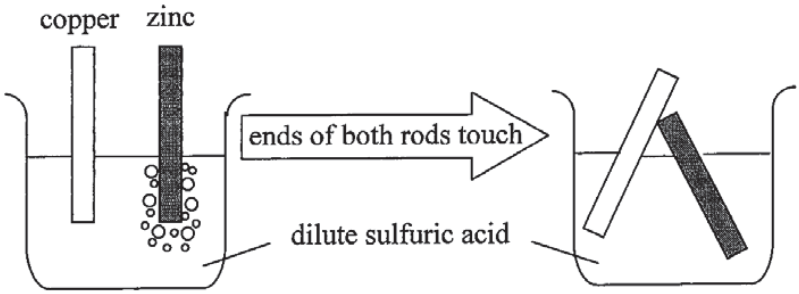


Which statement is true?

A A greenish-yellow gas is formed at the cathode.
B The anode decreases in mass.
C The pH of the electrolyte decreases.
D The solution turns purple around the cathode.

30 In an experiment, a copper rod and a zinc rod are placed into a beaker of sulfuric acid as shown below. Bubbles of gas are produced around the zinc rod only.

The experiment is repeated with the ends of both rods touching each other.

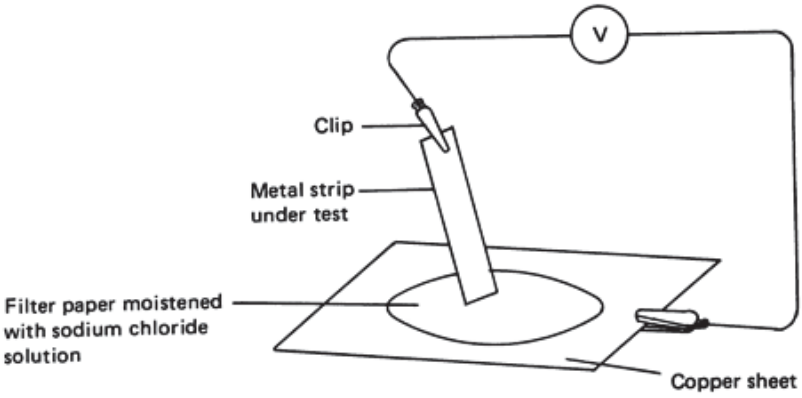


What happens when the ends of both rods touch each other?

A Bubbles of gas collect around both rods.
B Bubbles of gas collect around copper rod only.
C Bubbles of gas collect around zinc rod only.
D No bubbles of gas collect around both rods.

[Turn over

31 The diagram shows the apparatus used to investigate the relative reactivity of four metals. Strips of these metals were connected in turn with the copper sheet and the voltage was recorded in the table below.



Results table:

metal under test	direction of electron flow	voltage recorded (volts)
W	from W to Cu	+ 0.78
X	from Cu to X	– 2.22
Y	from Y to Cu	+ 1.39
Z	from Z to Cu	+ 0.28

What is the order of decreasing reactivity of the four metals?

	most reactive ⟶ least reactive			
A	W	Z	X	Y
B	X	Y	W	Z
C	Y	W	Z	X
D	Z	W	Y	X

[Turn over

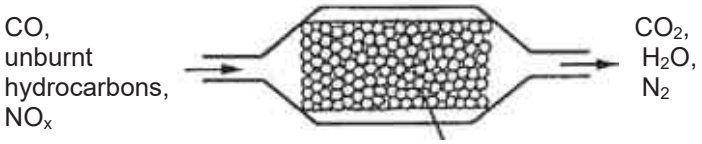
32 The table shows the results of adding weighed pieces of zinc metal in salt solutions of metals P, Q and R.

salt solution	initial mass of zinc / g	final mass of zinc after 15 minutes / g
P	6.0	0.0
Q	6.0	6.0
R	6.0	4.5

Which of the following shows the correct arrangement of metals in increasing reactivity?

A P, R, zinc, Q
B P, zinc, Q, R
C Q, P, R, zinc
D Q, zinc, R, P

33 The diagram below represents a section of a catalytic converter on the exhaust system of a car. Harmful gases are converted into carbon dioxide, nitrogen and water vapour.



Which process(es) take(s) place in this catalytic converter?

I. Carbon monoxide and unburnt hydrocarbons react together.
II. Carbon monoxide and nitrogen oxides react together.
III. Platinum and rhodium catalyse redox reactions.

A I only
B I and II only
C II and III only
D I, II and III

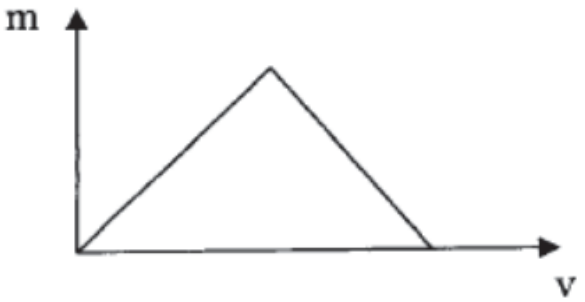
[Turn over

34 A salt has the chemical formula $(NH_4)_2Fe(SO_4)_2.12H_2O$.
Excess aqueous sodium hydroxide was added slowly, with shaking, to a hot solution of the salt in a boiling tube until there were no further reaction. The boiling tube was then left to stand for some time.

Which observation would not be made?

A A green precipitate was produced.
B A pungent gas which turned damp red litmus paper blue was produced.
C On standing, the precipitate turned brown.
D The precipitate dissolved in excess aqueous sodium hydroxide.

35 In a test for the presence of a cation in an aqueous salt solution, aqueous sodium hydroxide is added slowly until in excess. The diagram shows how the mass (m) of the precipitate varies with the volume (v) of sodium hydroxide added.



Which could not be the aqueous salt?

A aluminium nitrate
B calcium nitrate
C lead(II) nitrate
D zinc nitrate

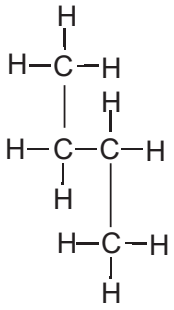
36 1 mole of a compound X reacts completely with 2 moles of hydrogen gas in the presence of a catalyst to form 1 mole of alkane.

Which compound could X be?

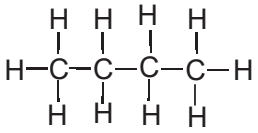
A $CH_2=CH-CH=CH-CH=CH_2$
B $CH_2=CH-CH_2-CH_2-CH=CH_2$
C $CH_2=CH-CH_2-CH_2-CH_2-CH_3$
D $CH_2=CH-CH_2-CH_2-COH=CH_2$

[Turn over

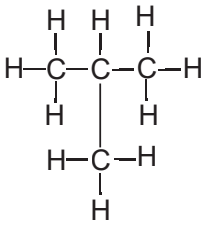
37 Which of these molecules have the same boiling points?



P



Q



R

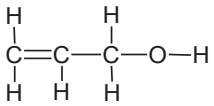
A P and Q
B P and R
C Q and R
D P, Q and R

38 An organic compound S has the following reactions:

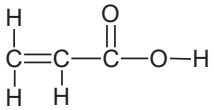
- neutralises sodium hydroxide
- decolourises aqueous bromine

Which structure represents S?

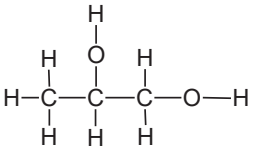
A



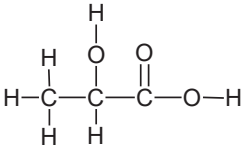
B



C



D

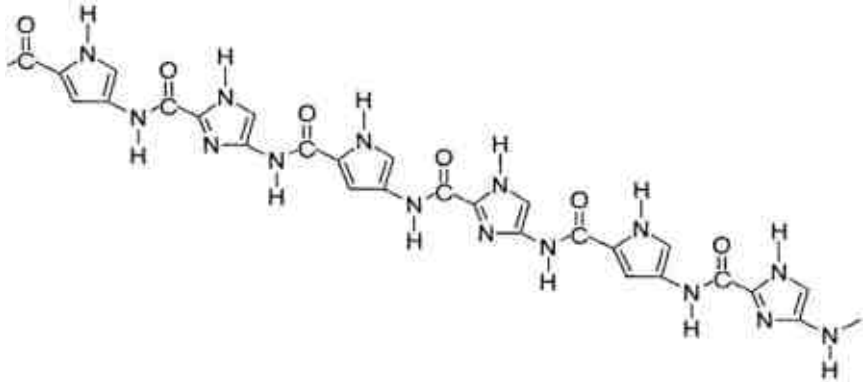


[Turn over

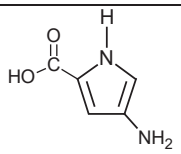
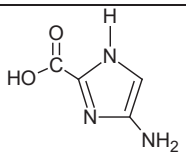
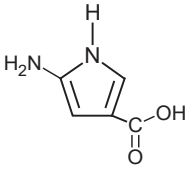
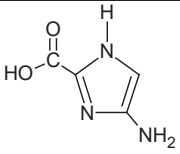
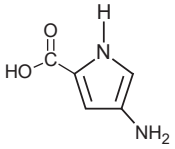
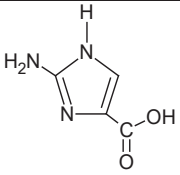
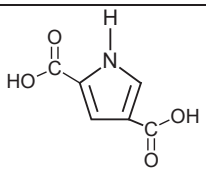
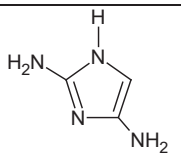
39 Which statement describes the property of the first fraction obtained from the fractional distillation of crude oil?

A It gives the most sooty flame when burnt.
B It has the highest boiling point.
C It is the most miscible with organic solvent.
D It is the most viscous.

40 The structure below shows part of a polymer.



Which option shows the correct monomers?

	monomer 1	monomer 2
A		
B		
C		
D		

[Turn over

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
						1 H hydrogen 1											2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									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.).

Register No.	Class
	4R1

Name ______________________________

BENDEMEER SECONDARY SCHOOL
2018 PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 2
6092/02

DATE : **15 August 2018**
DURATION : **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work you hand in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** three questions in the spaces provided. The last question is in the form of either/or and only one of the alternatives should be attempted.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.

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.

A copy of the Periodic Table can be found on page **22**.

/ 80

This document consists of **22** printed pages.

[Turn over

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 This question refers to the elements shown in the section of the Periodic Table below.

							H										He
Li	Be											B	C	N	O	F	Ne
Na	Mg											*Al*	Si	P	S	*Cl*	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

From this list of elements, identify in each case one element that has the property described. Give the symbol of the element.

(a) An element that sinks in cold water and reacts readily with it.

……. [1]

(b) An element that forms an oxide that is a reducing agent.

……. [1]

(c) An element in Period 3 that forms the smallest cation.

……. [1]

(d) 2 elements that react the most violently together to form a solid.

……. [1]

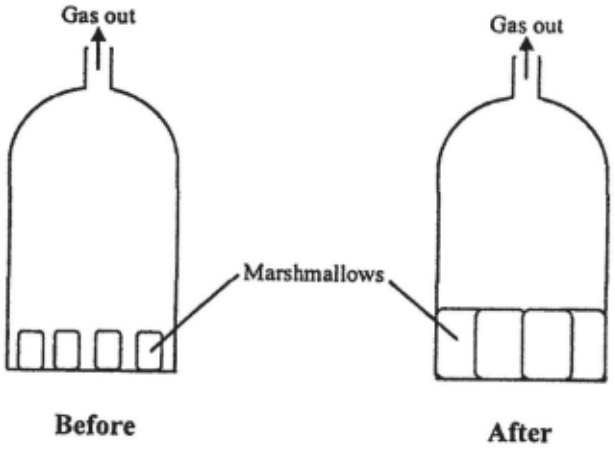
(e) An element that produces a reddish-brown solution with potassium iodide.

……. [1]

[Total: 5]

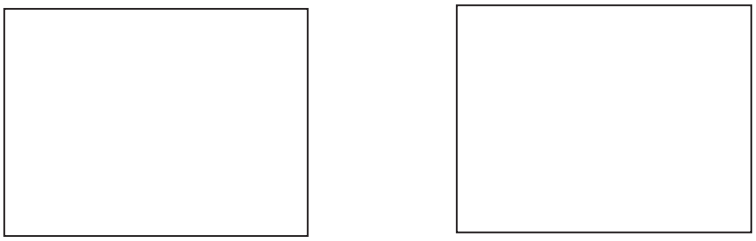
[Turn over

A2 A student carried out an experiment where she removed some gas from a gas chamber containing marshmallows.



The marshmallows were observed to have increased in size after some gas was removed from the sealed gas chamber.

(a) In the boxes below, draw the diagram for the gas in the chamber before and after some gas was removed from the chamber.



[1]

(b) Using the kinetic particle theory, provide an explanation for why the marshmallows increased in size.

…….

……..

…….. [2]

[Turn over

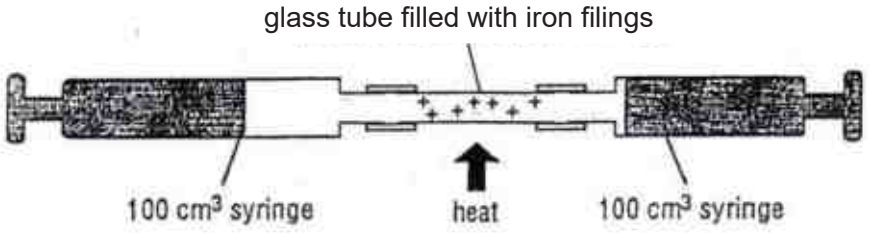
(c) When heat was applied to the gas chamber before gas was removed, the student theorized immediately that the space between the gas particles will be increased. Do you agree? Explain your answer.

……..

……... [2]

[Total: 5]

A3 (a) The percentage of oxygen in air can be determined by using the apparatus shown below. The glass tube was filled with iron filings (in excess) and the total volume of air in the syringes was 80 cm^3.



(i) Calculate the expected total volume of gas left remaining at the end of the experiment.

[1]

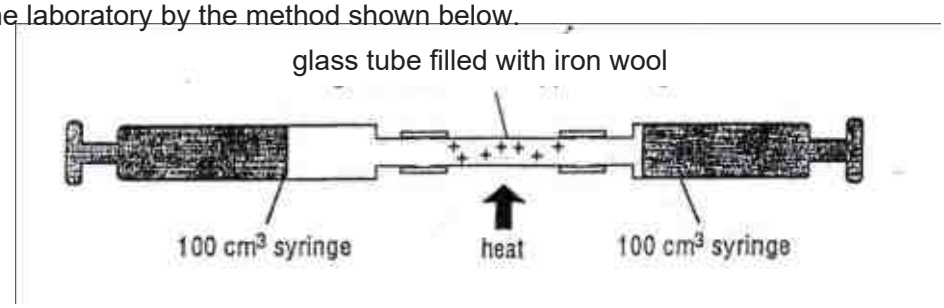
(ii) A student commented that the glass tube should be fully packed with iron to ensure accurate results.
Explain why the results obtained would be less accurate if the glass tube were only partially filled with iron filings.

……...

……... [1]

[Turn over

(b) The Haber Process which is used to manufacture ammonia can be demonstrated in the laboratory by the method shown below.



The mixture of nitrogen and hydrogen is passed back and forth over the hot iron wool until there is no further reaction.

(i) Suggest why it is important to ensure that no air is present in the apparatus shown above.

……

…… [1]

(ii) Write a balanced chemical equation for the reaction between nitrogen and hydrogen.

…… [1]

(c) Aqueous ammonia is formed when ammonia gas is dissolved in water. When aqueous ammonia is added dropwise to a sample of contaminated water, a mixture of white and blue precipitate is formed initially.
Upon adding excess aqueous ammonia, a dark blue solution is formed.

(i) Write the formula(e) of the possible cations present in the water sample.

…….. [2]

(ii) Write the ionic equation with state symbols for the reaction that forms the blue precipitate.

…… [1]

[Total: 7]

[Turn over

A4 At a children's birthday party, a magician told the children that he can change 'water' to 'milk' and then to a colourless fizzy drink like 7-up.

The magician had three glasses.
He began by holding the glass containing colourless solution **A** which he called 'water'. He then continued:

Step 1: The colourless solution **A** was poured into a seemingly empty glass containing a colourless solution **B** (which appeared to be invisible to the children). The 'water' turned into 'milk' instantly.

Step 2: The 'milk' was poured into another seemingly empty glass containing colourless solution **C** (which appeared to be invisible to the children). The 'milk' turned colourless and fizzing was observed.

The following chemicals were found in the magician's bag:

ammonia solution	calcium carbonate	methyl orange
sodium carbonate	magnesium carbonate	iron(III) chloride
sodium hydroxide	lead(II) nitrate	zinc sulfate
hydrochloric acid	acidified potassium manganate(VII) solution	

(a) What could be the substances involved in this demonstration?

solution **A**: ……. [1]

solution **B**: ……. [1]

solution **C**: …… [1]

(b) What is the chemical name of the 'milk' formed?

…….. [1]

(c) Explain why fizzing was observed in Step 2.

……. [1]

(d) The magician further demonstrated how he could change 'lemon drink' (yellow solution) to 'rose syrup' (pink solution).

(i) Which two substances did the magician use to prepare the yellow solution?

[1]

…….

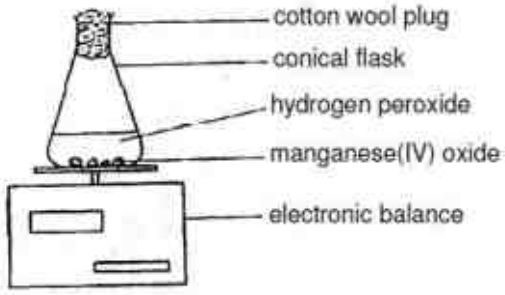
[Turn over

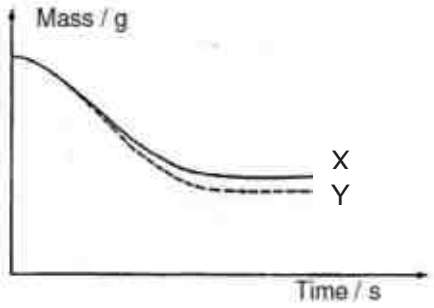
(ii) What is the colourless solution that the magician poured into the yellow solution to get a pink solution?

…… [1]

[Total: 7]

A5 The following experiment was carried out to investigate the rate of decomposition of hydrogen peroxide. A catalyst, manganese(IV) oxide, was added to a conical flask containing 50 cm^3 of aqueous solution of hydrogen peroxide. The mass of the flask was measured by an electronic balance as shown. The results were recorded and the graph obtained was labelled X.





(a) Write the chemical equation for the decomposition of hydrogen peroxide.

…… [1]

(b) Suggest the use of the cotton wool.

…… [1]

(c) Curve Y shows the results that is expected to be obtained.
Explain the difference between the actual curve X and theoretical curve Y.

……

…… [1]

(d) State one other way in which the rate of decomposition of aqueous hydrogen peroxide can be increased.

…… [1]

[Turn over

(e) Describe what you would do to show that manganese(IV) oxide is acting as a catalyst in this decomposition.

……

……

……

…… [3]

[Total: 7]

A6 A photographic plate is made up of a plastic base covered with a layer of 0.50 g silver bromide. After a photograph is taken, 35% of the silver bromide is reduced to silver. The image is then fixed by reacting the remaining silver bromide with aqueous sodium thiosulfate as shown in the equation below.

$$AgBr + 2Na_2S_2O_3 \rightarrow Na_3Ag(S_2O_3)_2 + NaBr$$

(a) What is the mass of silver bromide remaining on the plate after a photograph is taken?

mass of silver bromide = ……

[1]

(b) How many moles of sodium thiosulfate is needed to fix the plate?

moles of sodium thiosulfate = ……

[2]

(c) A 100 cm^3 sample of 0.200 mol/dm^3 sodium thiosulfate is used in the fixing process. Calculate the number of moles of thiosulfate left after the process.

moles of sodium thiosulfate = ……

[2]

[Turn over

(d) Explain using oxidation states, why the silver bromide is said to be reduced to silver.

……

…… [1]

(e) Silver bromide is a pale yellow insoluble halide salt. Briefly describe how a pure and dry sample of silver bromide can be prepared starting from silver nitrate.

……

……

……

…… [2]

[Total: 8]

A7 On a camping trip, a boy scout can only pack 1 kg of fuel for use. He has to decide which fuel to bring along. The table below shows the energy released by the complete combustion of some compounds used as fuels.

compound	M_r	boiling point/ ^oC	ΔH in kJ/mol
methane	16	-162	-880
propane	44	-42	-2200
heptane	100	98	-4800

(a) Explain why the fuels have relatively low boiling point.

……

…… [1]

(b) Which fuel produces the most energy when 1 kg of the compound is burnt? Hence, determine the fuel which the boy scout is most likely to bring along.

[2]

[Turn over

(c) The boy scout finally decided to bring along heptane for his camping trip. Using the data from the table, suggest why his decision differs from your answer in **(b)**.

……..

…….. [1]

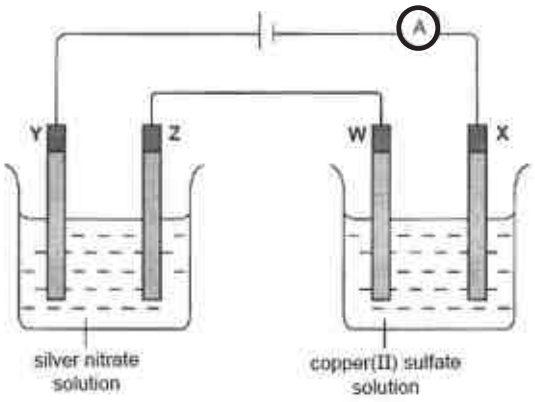
(d) Calculate the bond energy of the O=O bond in the combustion of methane given the following bond energies.

bond	bond energy in kJ/mol
C – H	410
O – H	460
C = O	740

[2]
[Total: 6]

[Turn over

A8 The diagram below shows the set-up of an electrolysis experiment.



W and X are copper electrodes while Y and Z are silver electrodes.

(a) Electrodes X and Z will increase in mass after some time.
Explain why, using half-equations to illustrate your answer.

……

……

…… [3]

(b) Electrode Z will increase in mass at a faster rate than electrode X.
Explain why this is so.

……..

……..

…….. [2]
[Total: 5]

[Turn over

Section B

Answer all **three** questions from this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

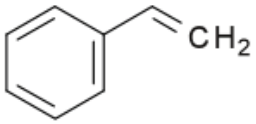
B9 Styrene, a liquid hydrocarbon that is important chiefly for its marked tendency to undergo polymerisation.

Styrene is employed in the manufacture of polystyrene, an important plastic, as well as a number of specialty plastics and synthetic rubbers.

Pure styrene is a clear, colourless, flammable liquid that boils at 145 °C and freezes at −30.6 °C.

Unless treated with inhibitor chemicals, it has a tendency to polymerise spontaneously during storage. It is slightly toxic to the nervous system if ingested or inhaled, and contact with the skin and eyes can cause irritation. Although it is suspected of being carcinogenic, studies have not proved it to be so.

The chemical formula for styrene is C_8H_8, but its structural formula, $C_6H_5CH{=}CH_2$, more clearly reveals the sources of its commercially useful properties.



Structural formula of styrene

Styrene is a member of a group of chemical compounds broadly categorised as vinyls—organic compounds whose molecules contain a double bond between two carbon atoms.

Under the action of chemical catalysts or initiators, this link contributes to the formation of polystyrene, in which thousands of styrene units are linked along a carbon backbone. Hanging from this backbone are phenyl groups (C_6H_5)—large ring-shaped units that interfere with the spontaneous motion of the chainlike polymer and lend polystyrene its well-known rigidity.

The phenyl group is one of the aromatic rings. Styrene, which gives off a penetrating sweetish odour, is therefore one of the aromatic hydrocarbons.

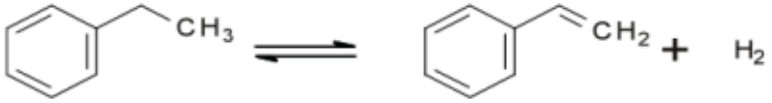
Industrial production from ethylbenzene

The modern method for production of styrene by *dehydrogenation* of ethylbenzene was first achieved in the 1930s. The production of styrene increased dramatically during the 1940s, when it was popularised as a feedstock for synthetic rubber.

Because it is produced on such a large scale, ethylbenzene is in turn prepared on a prodigious scale (by alkylation of benzene with ethylene).Ethylbenzene is mixed in the gas phase with 10–15 times its volume in high-temperature steam, and passed over

[Turn over

a solid catalyst bed. Most ethylbenzene dehydrogenation catalysts are based on iron(III) oxide, promoted by several percent potassium oxide or potassium carbonate.



Dehydrogenation of ethylbenzene

Steam serves several roles in this reaction. It is the source of heat for powering the *endothermic* reaction, and it removes coke that tends to form on the iron(III) oxide catalyst through the water gas shift reaction. The potassium promoter enhances this decoking reaction. The steam also dilutes the reactant and products, shifting the position of chemical equilibrium towards products.

A typical styrene plant consists of two or three reactors in series, which operate under vacuum to enhance the conversion and selectivity. Typical per-pass conversions are 65% for two reactors and 70-75% for three reactors. Selectivity to styrene is 93-97%. The main byproducts are benzene and toluene. Because styrene and ethylbenzene have similar boiling points (145 °C and 136 °C, respectively), their separation requires tall distillation towers and high return/reflux ratios. At its distillation temperatures, styrene tends to polymerise. To minimize this problem, early styrene plants added elemental sulfur to inhibit the polymerisation.

During the 1970s, new free radical inhibitors consisting of nitrated phenol-based retarders were developed. More recently, a number of additives have been developed that exhibit superior inhibition against polymerization. However, the nitrated phenols are still widely used because of their relatively low cost. These reagents are added prior to the distillation.

Laboratory synthesis

A laboratory synthesis of styrene entails the decarboxylation of *cinnamic acid*.

$C_6H_5CH{=}CHCO_2H \rightarrow C_6H_5CH{=}CH_2 + CO_2$

Incineration

If polystyrene is properly incinerated at high temperatures (up to 1000 °C) and with plenty of air (14 m^3/kg), the chemicals generated are water, carbon dioxide, and possibly small amounts of residual halogen-compounds from flame-retardants. If only incomplete incineration is done, there will also be leftover carbon soot and a complex mixture of volatile compounds. According to the American Chemistry Council, when polystyrene is incinerated in modern facilities, the final volume is 1% of the starting volume; most of the polystyrene is converted into carbon dioxide, water vapor, and heat. Because of the amount of heat released, it is sometimes used as a power source for steam or electricity generation.

Adapted from: https://www.britannica.com/science/styrene
https://en.wikipedia.org/wiki/Styrene
https://en.wikipedia.org/wiki/Polystyrene

[Turn over

(a) Draw the 'dot and cross' diagram of styrene, showing only the outermost electrons.

[2]

(b) Explain why styrene has a low melting point of −30.6 °C.

……

…… [2]

(c) Explain the type of reaction that occurs in the dehydrogenation process.

…… [1]

(d) Explain why tall distillation towers are necessary for the separation of styrene and ethylbenzene.

……

…… [1]

(e) Draw the repeating unit of polystyrene.

[1]

(f) Write down a balanced chemical equation for the incineration of polystyrene (2 repeat unit) in modern facilitates.

…… [1]

(g) Describe, with a balanced equation, what would be observed when sodium carbonate is put into cinnamic acid.

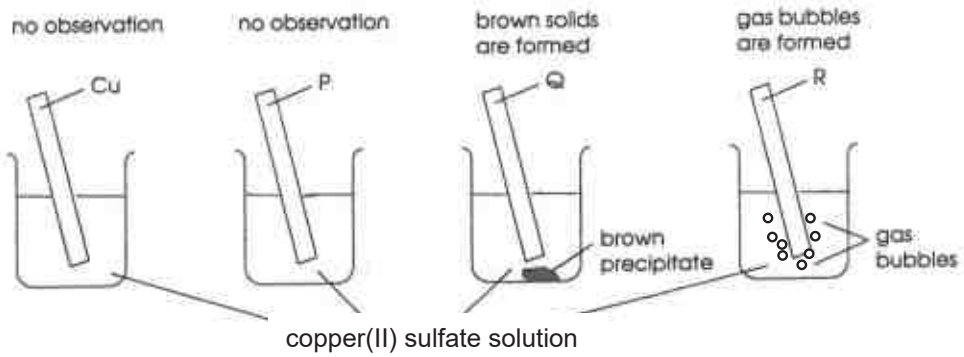
……

…….. [2]

[Total: 10]

[Turn over

B10 In the following experiment, copper and three other metals, P, Q and R are added separately to copper(II) sulfate solution.



The results for the action of heat on the oxides of copper, P, Q and R are given in the following table:

Metal oxide / Experiment	CuO	P_2O	QO	RO
Action of heat on metal oxide	No reaction	Metal P is formed	No reaction	No reaction

(a) (i) Explain the observations in the reactions of Q and R with copper(II) sulfate solution.

.....

.....

..... [2]

(ii) Write the balanced equations for these reactions.

.....

..... [2]

(b) Explain why metal P can be formed with direct heating on the oxide of P.

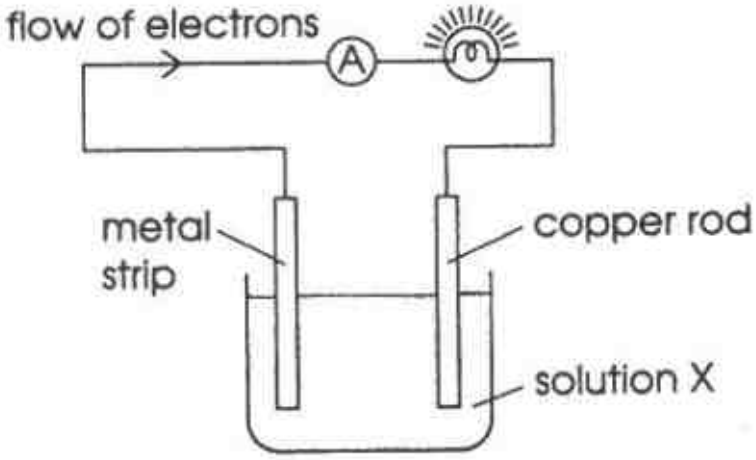
..... [1]

(c) Arrange the four metals in increasing order of reactivity.

..... [1]

[Turn over

(d) One of the three metals, P, Q and R, is used to make a chemical cell with a copper rod. The cell is shown in the following diagram:



(i) Which metal would you choose for the metal strip?
Give a reason for your choice.

……

…… [2]

(ii) If solution X is dilute sulfuric acid, write the ionic equations for the reactions that occur at the two electrodes.

……

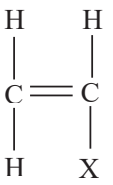
…… [2]

[Total: 10]

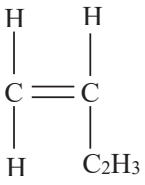
[Turn over

EITHER

B11 (a) Styrene-butadiene rubber is a synthetic rubber. It is made by polymerizing a mixture of the monomers butadiene and styrene.



styrene

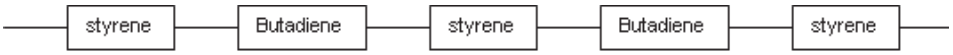


butadiene

(i) What type of polymerisation will take place when the monomers polymerize?

…… [1]

One possible structure for the polymer is shown below.



(ii) Give the full structural formula for the repeating unit in this polymer structure.

[1]

(iii) When the mixture of styrene and butadiene polymerizes, the polymer is unlikely to contain only this regular, repeating pattern. Explain why.

……

…… [1]

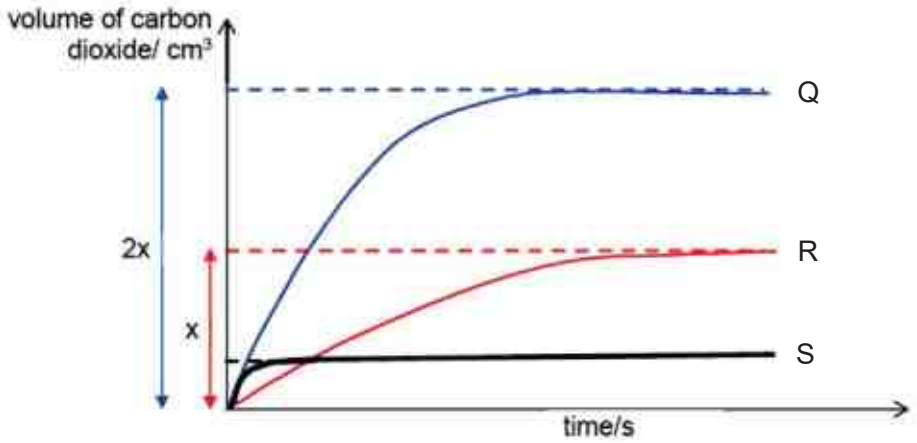
(iv) Butadiene is obtained from the cracking of butane. 2.90 kg of butane entered the cracking tower. The percentage yield of butadiene is 75%. Calculate the mass of butadiene obtained from the cracking process.

[1]

[Turn over

(b) Three different experiments were carried out using metal carbonates and acids. The table below shows the reactants used in each of the experiment. The graph shows the results of the experiments.

experiment	reactants
Q	150 cm^3 of 2.0 mol/dm^3 H_2SO_4 (aq) + 26.5g Na_2CO_3 (s)
R	v cm^3 of 1.0 mol/dm^3 H_2SO_4 (aq) + excess Na_2CO_3 (s)
S	150 cm^3 of z mol/dm^3 H_2SO_4 (aq) + excess $CaCO_3$ (s)



(i) Identify the limiting reagent in experiment Q.

[2]

[Turn over

(ii) Calculate the volume of carbon dioxide gas produced in experiment R and hence calculate the volume, v cm^3, of sulfuric acid used.

Volume of carbon dioxide = ……..

v = …….. [2]

(iii) From the graph, deduce the concentration of sulfuric acid used in experiment S.

Concentration of sulfuric acid = …… [1]

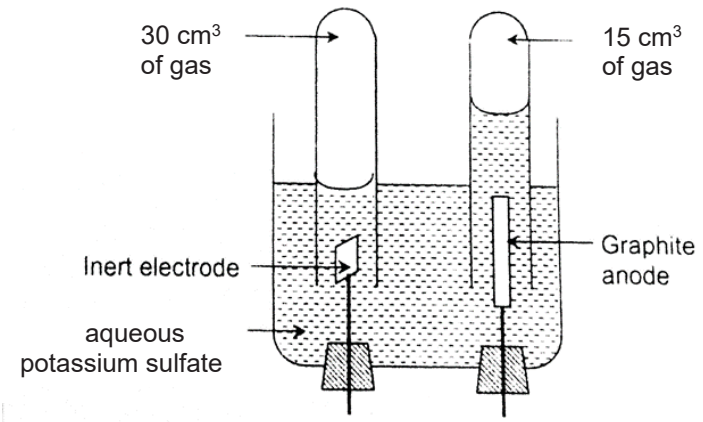
(iv) The mass of the salt formed in experiment S is much lower than expected. Write a balanced chemical equation, including state symbols, to suggest another reaction that can prepare a greater mass of this salt.

…… [1]
[Total: 10]

[Turn over

OR

B11 **(a)** When graphite anode and a very high current is used in this electrolysis, 30 cm^3 of gas is formed above the cathode and 15 cm^3 of gas is formed above the anode.



(i) Using a balanced equation, account for the volume of gas collected at both electrodes.

……

……

…… [2]

(ii) Explain, with a balanced equation, why the graphite anode has to be replaced periodically.

……

……

…… [2]

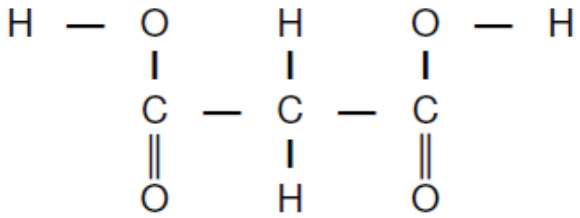
(b) An organic compound, X, contains carbon, oxygen and hydrogen only. The Percentage by mass of carbon and hydrogen are 47.4% and 10.5% respectively. The relative molecular mass of X is 76.

(i) Find the empirical formula of X.

[2]

[Turn over

(ii) X is a sharp smelling liquid at room temperature. It is soluble in water and can be oxidised to form Y whose structure is shown below.



Under suitable conditions, Y reacts with excess methanol to produce Z.
State the reagent needed to oxidise X to Y, and the colour change observed.

.....

..... [2]

(iii) Draw the full structural formula of X and Z.

[2]

[Total: 10]

End of Paper

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							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 –		

Key

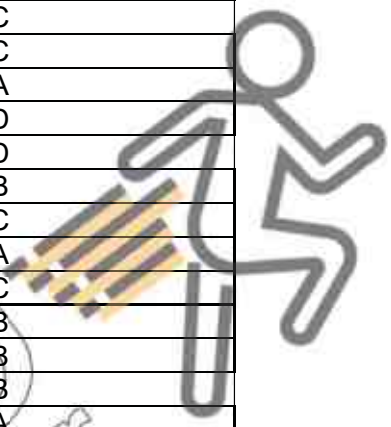
proton (atomic) number
atomic symbol
name
relative atomic mass

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.).

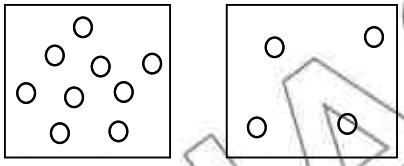
Chemistry
2018 Preliminary Examination
Answer Scheme

Qn	Answer
1	B
2	D
3	B
4	A
5	B
6	C
7	C
8	C
9	A
10	D
11	D
12	B
13	C
14	A
15	C
16	B
17	B
18	B
19	A
20	D
21	A
22	D
23	B
24	A
25	B
26	B
27	D
28	D
29	B
30	A
31	C
32	A
33	C
34	D
35	B
36	B
37	A
38	B
39	C
40	A



[Turn over

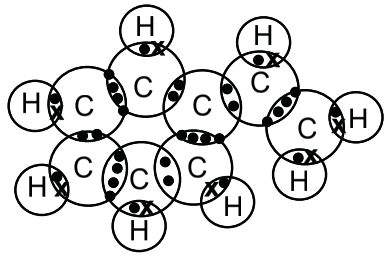
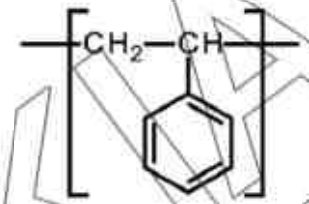
Bendemeer Secondary School
Preliminary Examination 2018
Chemistry 6092/02
Answer Scheme

Qn		Answer	Mks	Markers' Report
A1	(a)	Ca	1	For (a), some students either cannot even recall that the only 3 metals that react with water are K, Na and Ca or cannot recall the properties of Group I metals as having low density. For (e), many students wrote Br as the answer. Students failed to realize that after bromine itself is reddish-brown but once it is gone after displacing iodide from KI. They failed to recall the colour of aqueous iodine as reddish-brown.
	(b)	C/ S/ N/ H	1	
	(c)	Na	1	
	(d)	KF	1	
	(e)	Cl/ F	1	
A2	(a)	 Before After * Answer to clearly illustrate lesser gas particles (1) AND gas particles are further apart (1) when comparing before and after	1	Badly answered. Basic concepts of the kinetic particle theory is extremely weak.
	(b)	When all the air particles are removed, the vacuum created forces the air particles in the marshmallows to spread further apart. This action pushes against the marshmallows and causes it to swell / increase in size.	1 1	Badly answered. Students went to talk about the increase in pressure in the marshmallows.
	(c)	No, heating the chamber will cause the gas particles to increase in kinetic energy, making them vibrate and move faster OR	2	Almost all students failed to realise that gas particles have already filled up the available spaces in the

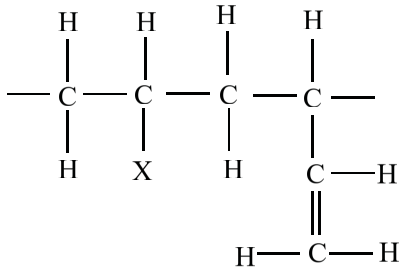
		No, the space in the gas chamber is the *same / fixed, so the particles will not move further apart. **only award max. of 1 mark for second answer as students failed to link that an increase a temperature (through heating) lead to an increase in kinetic energy.**		container. They managed to note that the gas particles will move faster with greater kinetic energy. Only Joven and Karthik realized that the number of particles is the same and hence the number of particles per unit volume remains the same.
A3	**(a)(i)**	80/100 x 80 = 64 cm^3	1	Some students could not even recall that the percentage of oxygen in air is 20%.
	(ii)	There would be air around the iron fillings if the glass tube is not fully filled. This would result in having more than 80 cm^3 of air present in the gas syringes.	1	Students gave very vague and ambiguous answers such as " iron and oxygen would not fully react"
	(b) (i)	Oxygen in air would react with the iron wool. This would make iron lose its role as the catalyst.	1	None of the students get this question correct. They could not link (a) to (b) that iron is used as a catalyst and if oxidized to iron(III) oxide, would lose its role as a catalyst and would affect the speed of reaction.
	(ii)	N_2 (g) + $3H_2$ (g) → $2NH_3$ (g)	1	There is still 1 student who wrote the formula of hydrogen gas as H.
	(c) (i)	Zn^{2+}, Cu^{2+}	2	Generally well answered.
	(ii)	Cu^{2+} (aq) + $2OH^-$ (aq) → $Cu(OH)_2$ (s)	1	Weak students could not even recall ionic equation for precipitation.
A4	**(a)**	A: sodium carbonate B: lead(II) nitrate C: hydrochloric acid	1 1 1	Badly answered. Weak students have no clue at all.
	(b)	Lead(II) carbonate	1	
	(c)	Carbon dioxide produced	1	Students wrote "Gas produced" without specifying the name of gas.
	(d) (i)	Methyl orange and sodium hydroxide/ ammonia solution	1	Some students did not even know the colour change of methyl orange.
	(ii)	Hydrochloric acid (in excess)	1	

A5	**(a)**	$2H_2O_2$ (l) → $2H_2O$ (l) + O_2 (g)	1	There are students who do not know the products of the decomposition of hydrogen peroxide. Weak students do not even know the formula of hydrogen peroxide.
	(b)	To prevent acid spray	1	Well-answered.
	(c)	Curve Y shows a slightly lower mass obtained/ greater mass lost. The actual mass lost is smaller due to a small amount of oxygen dissolving in the solution.	1	Many students do not know that oxygen is soluble in water.
	(d)	Heating up hydrogen peroxide solution/ using smaller pieces of manganese(IV) oxide.	1	A small number of very weak students could not even recall the factors that affect the speed of reaction.
	(e)	Weigh a fixed mass of manganese(IV) oxide and add to a solution of hydrogen peroxide. Monitor the mass loss. Once the mass loss reached a constant (the end of reaction), filter and measure the mass of manganese(IV) oxide at the end of the reaction. It would be noted that the mass of manganese(IV) oxide remains the same.	1 1 1	Badly answered. Students did not read the question carefully that it is asking with respect to this decomposition reaction. Hence there is only 1 experiment involved. Many wrote the experiment as conducting 1 without MnO_2 and 1 experiment with MnO_2.
A6	**(a)**	65/100 x 0.5 = **0.325g**	1	Very well-answered. Only 2 girls could not do this question. The rest of the class obtained full or close to full marks.
	(b)	No. of moles of AgBr = 0.325/ (108+80) = 0.001729 No. of moles of $Na_2S_2O_3$ = 2 x 0.001728 = **0.00348**	1 1	
	(c)	No. of moles of $Na_2S_2O_3$ used = 100/1000 x 0.2 = 0.02 No. of moles of $Na_2S_2O_3$ left = 0.02 – 0.00346 = **0.0165**	1 1	
	(d)	Oxidation state of silver decreases from +1 in AgBr to 0 in Ag.	1	Well-answered.
	(e)	Add silver nitrate to sodium bromide (any Group I bromide) until no more precipitate forms. Filter to obtain silver bromide as the residue. Wash the residue with a little distilled water and dry it in between 2 pieces of filter papers.	1 1	Many students cannot answer this simple preparation of salts question which is extracted form Sci (Chem). Some could not even differentiate between the filtrate and residue. A small number of students wrote "react silver nitrate with aqueous bromine."

A7	**(a)**	They are covalent compounds with **weak intermolecular forces of attraction** which require little energy to break.	1	Some students could not even answer this lower sec bonding question.
	(b)	No. of moles of methane = 1000/16 = 62.5 Amount of energy produced by burning 62.5 moles methane = 880 x 62.5 = 55 000 kJ No. of moles of propane = 1000/44 = 22.7 Amount of energy produced by burning 22.7 moles propane = 2200 x 22.7 = 49 940 kJ No. of moles of heptane = 1000/100 = 10 Amount of energy produced by burning 10 moles heptane = 4800 x 10 = 48 000 kJ Therefore, **methane** produces the most energy when burnt. The boy scout is most likely to bring along **methane**.	 1 1	Generally well-answered.
	(c)	Heptane is in the liquid state at room temperature. It is easier to be transported than methane which is a gas at room temperature.	1	Generally well-answered.
	(d)	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ Bond breaking = 4(410) + 2x Bond forming = 2(740) + 4(460) = 3320 kJ 4(410) + 2x – 3320 = -880 **x = 400 kJ/mol**	 ½ ½ 1	Many students are still unable to calculate
A8	**(a)**	X: Cu^{2+} (aq) + 2e → Cu (s) Z: Ag^{+}+ (aq) + e → Ag (s) Copper metal deposited on X and silver metal deposited on Z increases the mass of X and Z.	1 1 1	Generally well- answered
	(b)	Silver requires 1 mole of electrons to be discharged whereas copper requires 2 moles of electrons to be discharged. Hence Z will increase at a rate double that of X.	1 1	Generally well-answered. Students who got it wrong mentioned that silver is less reactive than copper hence it will be discharged faster. This concept is wrong.

B9	**(a)**		2	Dot-and-cross diagram of this compound was shown in class but students failed to register.
	(b)	It is a covalent compound with **weak intermolecular forces** of attraction which **requires little energy to break**.	2	Some students could not answer this basic question.
	(c)	Endothermic reaction	1	Badly done. Answer is in the data given.
	(d)	They are miscible liquids with very similar boiling points.	1	Most students were able to identify that styrene and ethylbenzene have similar boiling points but they failed to mention that they are miscible.
	(e)		1	Many students gave the drawing of the polymer rather than the repeating unit.
	(f)	$(C_8H_8)_2 + 20O_2 \rightarrow 8H_2O + 16CO_2$	1	Many students wrote the formula of 2 repeating units as $2C_8H_8$ which is wrong. Some even wrote the formula as $C_{16}H_{16}$.
	(g)	Effervesence seen. Gas produced forms white precipitate in limewater. $2C_6H_5CH=CHCO_2H + Na_2CO_3 \rightarrow 2C_6H_5CH=CHCO_2Na + CO_2 + H_2O$	1 1	Most students were able to state the observation but few got the equation correct.

B10	**(a)(i)**	In the reaction of Q with copper(II) sulfate, displacement reaction takes place. Copper, the reddish-brown solid, is displaced by Q, which is more reactive. In the reaction of R, the metal R is a very reactive metal. It reacts with water in copper(II) sulfate solution to form an alkali and hydrogen gas, which is observed as gas bubbles.	1 1	Most students were able to identify the displacement reaction in Q but were unable to identify the reaction of metal R with water in.
	(ii)	Q: $Q + CuSO_4 \rightarrow Cu + QSO_4$ R: $2R + 2H_2O \rightarrow 2R(OH)_2 + H_2$	1 1	Most students were able to write the equation at Q but not at R.
	(b)	P oxide decomposes upon heating.	1	Some students wrote "metal P is weak and decomposes on heating." This concept it wrong as metal P is an element.
	(c)	P, Cu, Q, R	1	Most students mixed up Q and R
	(d)(i)	Q. Q, being more reactive than Cu, will allow the flow of electrons from Q to Cu.	1 1	Generally well-answered
	(ii)	Q: $Q (s) \rightarrow Q^{2+} (aq) + 2e$ Cu: $2H^+ (aq) + 2e \rightarrow H_2 (g)$	1 1	Some students missed out the state symbols and were not given credit.
B11	**(a)(i)**	Addition Polymerisation	1	Not many students attempted this question. Some students wrote "polymerization" as the answer.

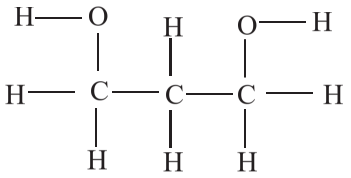
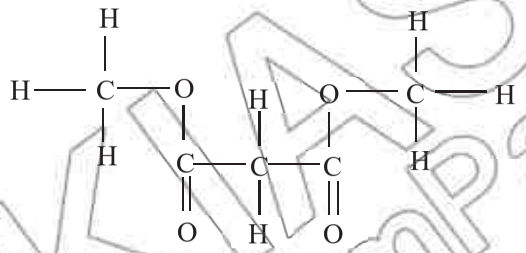
Either	**(ii)**		1	Many students drew the structure of the polymer instead of the repeating unit.
	(iii)	Poly(styrene) and Poly(butadiene) will be formed as well.	1	Many students gave vague answers like "styrene and butadiene will also combine with itself."
	(iv)	0.75 x 2.9 = 2.175 kg = 2.18 kg	1	Some students were unable to calculate this straight forward question.
	(b)(i)	$H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CO_2 + H_2O$ No. of moles of H_2SO_4 = 150/1000 x 2 = 0.3 No. of moles of Na_2CO_3 = 26.5/ 2(23)+12+3(16) = 0.25 Limiting reagent = sodium carbonate	 ½ ½ 1	Generally well-answered
	(ii)	No. of moles of carbon dioxide used in experiment Q = 0.25 Volume of carbon dioxide used in experiment Q = 0.25 x 24 = 6 dm^3 Volume of carbon dioxide produced in experiment R = 6/2 = **3 dm^3** No. of moles of sulfuric acid in experiment R = 0.25. Volume of sulfuric acid, v = 0.25/1.0 = **0.25 dm^3** = **250 cm^3**	 ½ ½ 1	Many students were able to calculate the volume of carbon dioxide produced but were unable to calculate the volume of sulfuric acid.
	(iii)	2.0 mol/dm^3	1	
	(iv)	$Ca(NO_3)_2$ (aq) + Na_2SO_4 (aq) → $CaSO_4$ (s) + 2$NaNO_3$ (aq)	1	

<table>
<tr>
<td>B11</td>
<td>(a)(i)</td>
<td>$4OH^-$ (aq) + $4H^+$ (aq) → $2H_2O$ (l) + O_2 (g) + $2H_2$ (g)
From the equation, the ratio of oxygen to hydrogen is 1 : 2.
Hence the volume of hydrogen formed at the cathode is double the volume of oxygen formed at the anode.</td>
<td>1

1</td>
<td>Many students only gave half equations instead of the overall equation.</td>
</tr>
<tr>
<td>OR</td>
<td>(ii)</td>
<td>Under the high temperature, oxygen produced burns the graphite anode off.
C + O_2 → CO_2</td>
<td>1

1</td>
<td>Students who answered this wrote “carbon reacts with oxygen.” There was no mention of the heat involved. These students were given BOD.</td>
</tr>
<tr>
<td></td>
<td>(b)(i)</td>
<td>
<table>
<tr><td></td><td>C</td><td>O</td><td>H</td></tr>
<tr><td>% by mass</td><td>47.4</td><td>42.1</td><td>10.5</td></tr>
<tr><td>Ar</td><td>12</td><td>16</td><td>1</td></tr>
<tr><td>No. of moles</td><td>47.4/12 = 3.95</td><td>42.1/16 = 2.63</td><td>10.5/1 = 10.5</td></tr>
<tr><td>÷ by smallest no.</td><td>3.95/2.63 = 1.5</td><td>2.63/2.63 = 1</td><td>10.5/2.63 = 4</td></tr>
<tr><td>ratio</td><td>1.5 x 2= 3</td><td>1 x 2 = 2</td><td>4 x 2 = 8</td></tr>
</table>
Empirical Formula = $C_3O_2H_8$
</td>
<td>1

1</td>
<td>Many students have forgotten how to calculate empirical formula.</td>
</tr>
<tr>
<td></td>
<td>(ii)</td>
<td>Add acidified potassium dichromate (VI).
Colour change from orange to green./
Add acidified potassium manganate (VII)
Colour change from purple to colourless</td>
<td>1
1</td>
<td>Well-answered.</td>
</tr>
</table>

	(iii)	 **X**  **Z**	1 1	Many students were able to draw the structure of X but not Z.

Bukit Batok Secondary School

PRELIMINARY EXAMINATION 2018

SEC 4 EXPRESS

CHEMISTRY **6092/01**

Paper 1 Multiple Choice

24 August 2018
0745 - 0845
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the Answer Sheet in the spaces provided.

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 at the end of the question paper.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of 15 printed pages.

1 The reaction scheme shows how hydrated copper(II) sulfate, $CuSO_4.5H_2O$, changes when heated.

$$CuSO_4.5H_2O \xrightarrow{90\ ^oC} CuSO_4.H_2O \xrightarrow{250\ ^oC} CuSO_4$$

A little water was accidentally spilled into a dish containing hydrated copper(II) sulfate. What could be done to remove the water, leaving pure, dry $CuSO_4.5H_2O$?

A Heat the dish over a boiling water-bath.
B Heat the dish to a constant mass.
C Heat the dish with a Bunsen burner.
D Let the dish stand in direct sunlight.

2 Aluminium sulfate is sometimes used in water treatment to remove impurities. Aqueous aluminium sulfate is acidic. The table shows the results of tests on four different samples of treated water.
To which sample had an excess of aluminium sulfate been added?

sample	pH of sample	reaction with an excess of aqueous ammonia
A	3	white precipitate
B	3	no reaction
C	7	no reaction
D	11	white precipitate

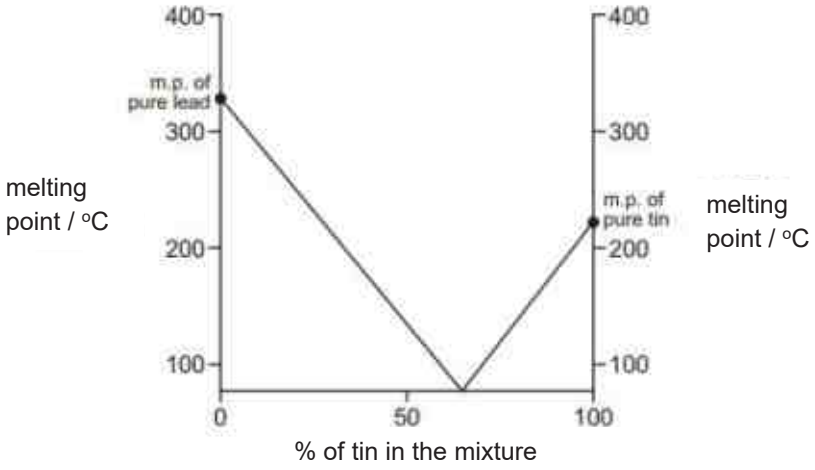
3 An acid, X, was added to a solution of the nitrate of a metal, Y. A dense white precipitate was formed
What are X and Y?

	acid X	metal Y
A	hydrochloric	calcium
B	nitric	zinc
C	sulfuric	aluminium
D	sulfuric	barium

4 A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.
What could **not** have been present in the solution?

A Al^{3+} **B** Ca^{2+} **C** NH_4^+ **D** Zn^{2+}

5 The graph gives the melting points (m.p.) of mixtures of lead and tin.



The graph shows that any mixture of lead and tin must have a melting point that is

A above that of tin.
B below that of lead.
C below that of both tin and lead.
D between that of tin and lead.

6 The isotopes of carbon and oxygen are given in the table.

Isotopes of carbon	^{12}C	^{13}C	^{14}C
Isotopes of oxygen	^{16}O	^{17}O	^{18}O

A molecule of carbon dioxide with molecular mass 46 could contain

A one ^{12}C atom and two ^{16}O atoms.
B one ^{14}C atom and two ^{18}O atoms.
C one ^{12}C atom, one ^{16}O atom and one ^{18}O atom.
D one ^{14}C atom, one ^{16}O atom and one ^{18}O atom.

7 Particles with the same electron arrangement are said to be isoelectronic.
Which of the following compounds contains ions which are isoelectronic?

A $CaCl_2$
B KBr
C $MgCl_2$
D Na_2S

8 The table shows information about particles X and Y.

	number of protons	number of neutrons	electronic structure
X	9	10	2, 8
Y	17	20	2, 8, 8

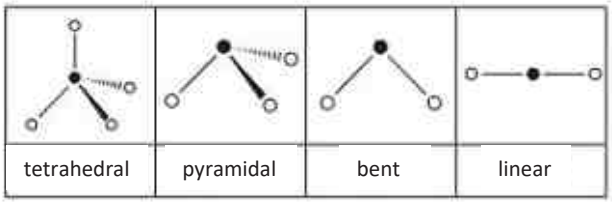
Which statement is correct for both X and Y?

A They are atoms of metals.
B They are atoms of noble gases.
C They are isotopes of the same element.
D They are negative ions.

9 The table shows some properties of four substances.
Which substance is an ionic compound?

	melting point /°C	conducts electricity when solid	dissolves in water	conducts electricity in aqueous solution
A	-102	no	yes	yes
B	801	no	yes	yes
C	842	yes	yes	yes
D	3000	yes	no	no

10 The shapes and names of some molecules are shown below.



Phosphine is a compound of phosphorus, an element in Group V, and hydrogen. The shape of a molecule of phosphine is likely to be

A bent.
B linear.
C pyramidal.
D tetrahedral.

11 Which sulfide contains the greatest mass of sulfur in a 10 g sample?

sulfide	formula	mass of one mole /g
A	NiS	91
B	FeS_2	120
C	MoS_2	160
D	PbS	239

12 Two of the reactions used in the manufacture of nitric acid, HNO_3, are shown.

$$2NO + O_2 \rightarrow 2NO_2$$
$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

What is the maximum number of moles of nitric acid which could be formed from one mole of nitrogen monoxide, NO?

A 0.5 **B** 1.0 **C** 2.0 **D** 4.0

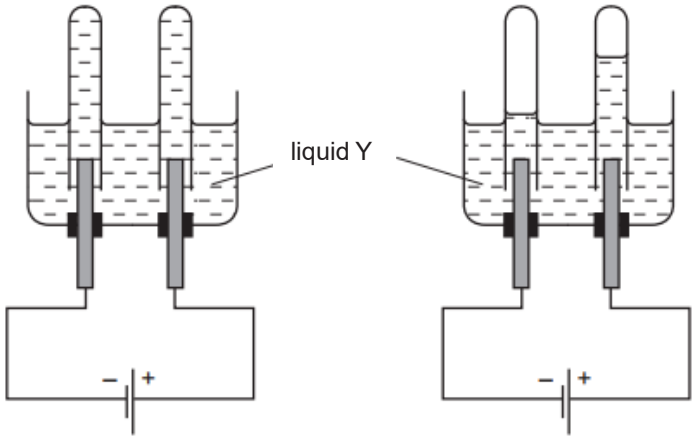
13 A piece of chalk has a mass of 23.0 g. Chalk is impure calcium carbonate. When analysed, the chalk is found to contain 0.226 moles of calcium carbonate.
What is the percentage purity of the piece of chalk?

A 0.983% **B** 1.02% **C** 77.0% **D** 98.3%

14 Which element requires the smallest number of electrons for one mole of atoms to be liberated during electrolysis?

A aluminium
B calcium
C copper
D sodium

15 The diagrams show an electrolysis experiment using inert electrodes.



before electrolysis after electrolysis

Which could be liquid Y?

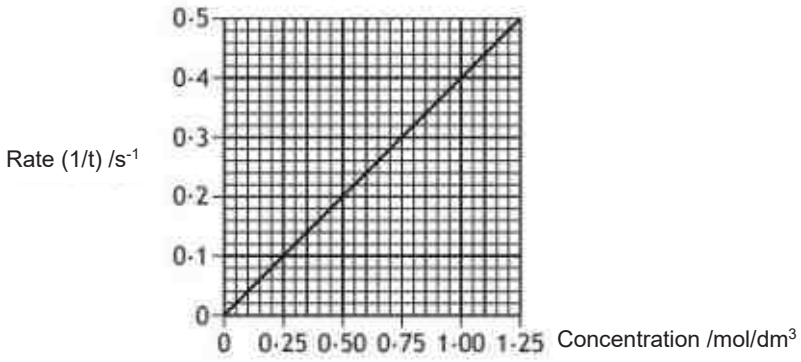
1 aqueous copper(II) sulfate
2 aqueous sodium nitrate
3 concentrated aqueous sodium chloride
4 dilute sulfuric acid

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

16 A student carries out a single experiment to determine the speed of reaction between calcium carbonate and an excess of hydrochloric acid.
Which of the following does **not** change during the course of the reaction?

A concentration of the hydrochloric acid solution
B mass of the calcium carbonate
C volume of carbon dioxide evolved
D volume of hydrochloric acid solution

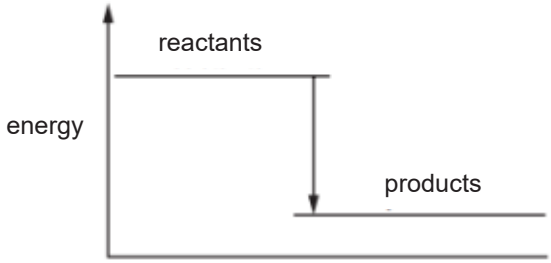
17 The graph shows how the rate of a reaction varies with the concentration of one of the reactants.



What is the reaction time, in seconds, when the concentration of the reactant was 0.50 mol/dm^3?

A 0.2 **B** 0.5 **C** 2.0 **D** 5.0

18 A diagram for the energy change during a chemical reaction is shown.



For which reaction(s) would this be an appropriate diagram?

1 $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
2 $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
3 $2C + O_2 \rightarrow 2CO$

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

19 The oxide of titanium, TiO_2, is used as a 'whitener' in toothpaste. It is obtained from the ore iron(II) titanate, $FeTiO_3$. What is the change, if any, in the oxidation number of titanium in the reaction $FeTiO_3 \rightarrow TiO_2$?

A It is oxidized from +3 to +4.
B It is reduced from +3 to +2.
C It is reduced from +6 to +4.
D There is no change in the oxidation number.

20 The pH of an aqueous solution of hydrochloric acid is 2.
What will be the pH of the acid after the addition of 10.0 g of sodium chloride?

A 2 **B** 5 **C** 7 **D** 9

21 Which row in the table correctly shows the properties of 0.100 mol/dm^3 hydrochloric acid when compared with 0.100 mol/dm^3 ethanoic acid?

	pH	conductivity	Rate of reaction with magnesium
A	lower	lower	slower
B	higher	higher	faster
C	lower	higher	faster
D	higher	lower	slower

22 Consider the three reactions below.

- reaction between nitric acid and calcium hydroxide
- ethane burning in air
- reaction between ethanoic acid and ethanol

A student made three statements about the three reactions above.

1 carbon dioxide is produced in all reactions
2 water is produced in all reactions
3 a salt is produced in all reactions

Which statement(s) is/are true?

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

23 Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3. Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide. What are the products?

A ammonia, sodium chloride and water
B ammonia, sodium hydrogencarbonate and sodium chloride
C methylamine, hydrogen chloride and water
D methylamine, sodium chloride and water

24 A student has five reagents.

- dilute hydrochloric acid
- dilute sulfuric acid
- dilute nitric acid
- solid calcium carbonate
- solid copper(II) carbonate

How many soluble salts can be prepared?

A 3 **B** 4 **C** 5 **D** 6

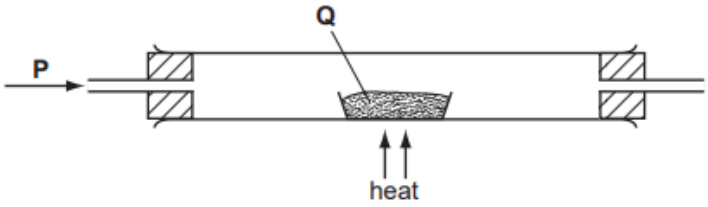
25 How can a pure sample of barium sulfate be obtained from barium carbonate?

A Dissolve it in dilute hydrochloric acid, add dilute sulfuric acid, filter and crystallise.
B Dissolve it in dilute hydrochloric acid, add dilute sulfuric acid, filter and wash.
C Dissolve it in water, add dilute sulfuric acid, filter and crystallise.
D Dissolve it in water, add dilute sulfuric acid, filter and wash.

26 An alloy of copper and zinc is added to an excess of dilute hydrochloric acid. The resulting mixture is then filtered.
Which observations are correct?

	filtrate	residue
A	colourless solution	none
B	colourless solution	pinkish brown
C	blue solution	grey
D	blue solution	none

27 In the apparatus shown, gas P is passed over solid Q.



No reaction occurs if P and Q are

	P	Q
A	hydrogen	lead(II) oxide
B	hydrogen	magnesium oxide
C	oxygen	carbon
D	oxygen	sulfur

28 The period 4 elements gallium (Ga), germanium (Ge), arsenic (As) and selenium (Se) are elements below aluminium, silicon, phosphorus and sulfur in the Periodic Table, a portion of which is shown below.

period 3 elements	Al	Si	P	S
period 4 elements	Ga	Ge	As	Se

The properties of each period 4 element resemble those of the period 3 element directly above it.
Which period 4 elements form oxides that dissolve in water to give an acid solution?

A As and Se
B Ga and Ge
C Ga and Se
D Se only

29 When a mineral was heated in a Bunsen flame to a constant mass, a colourless gas that produced a white precipitate in limewater, was given off. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen. What was the mineral?

A aragonite, $CaCO_3$
B artinite, $MgCO_3.Mg(OH)_2.3H_2O$
C barytocalcite, $BaCO_3.CaCO_3$
D dolomite, $CaCO_3.MgCO_3$

30 Listed below are four solutions.

1 aqueous sodium hydroxide
2 aqueous silver nitrate
3 aqueous potassium sulfate
4 dilute hydrochloric acid

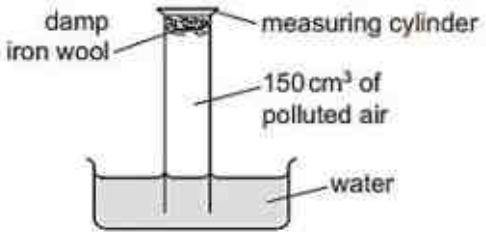
Which of the following solution(s) will react with magnesium metal?

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

31 Attaching pieces of magnesium to underground iron pipes can protect the iron from corrosion.
Which reaction protects the iron from corrosion?

A $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e$
B $Fe(s) \rightarrow Fe^{2+}(aq) + 2e$
C $Mg^{2+}(aq) + 2e \rightarrow Mg(s)$
D $Mg(s) \rightarrow Mg^{2+}(aq) + 2e$

32 An experiment to find the percentage of oxygen in 150 cm^3 of polluted air is shown.



The apparatus is left for one week.
After this time, the volume of gas in the measuring cylinder is 122 cm^3.
What is the percentage of oxygen, to the nearest whole number, in the polluted air?

A 19 % **B** 21% **C** 28 % **D** 81%

33 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.
Which compound would cause the most depletion of the ozone layer?

A CCl_3F **B** CF_4 **C** $CHClF_2$ **D** CH_2F_2

34 The compound, C_8H_{18} undergoes the following process.

$$C_8H_{18} \xrightarrow{\text{Process X}} \text{Ethene} + \text{Compound Y}$$

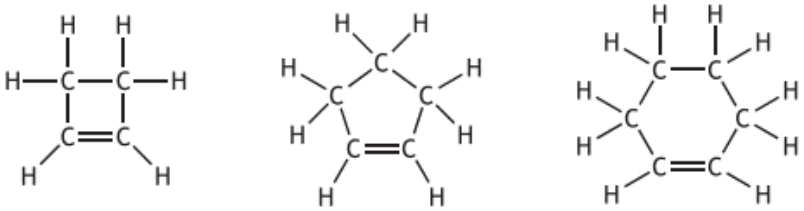
Which row in the table correctly identifies Process X and Compound Y?

	Process X	Compound Y
A	cracking	hexane
B	cracking	hexene
C	distillation	hexane
D	distillation	hexene

35 How many moles of hydrogen chloride are formed when one mole of methane is added to a large excess of chlorine in the dark?

A 0 **B** 1 **C** 2 **D** 4

36 Three members of the cycloalkene homologous series are shown:



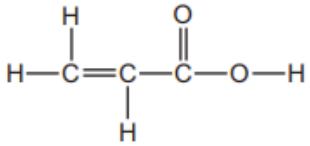
Which of the following is the general formula for this homologous series?

A C_nH_{2n-4}
B C_nH_{2n-2}
C C_nH_{2n}
D C_nH_{2n+2}

37 Oil contains carbon-carbon double bonds which can undergo addition reactions with iodine. The iodine number of an oil is the mass of iodine in grams that will react with 100 g of oil.
Which row in the table shows the oil that is likely to have the lowest melting point?

	oil	iodine number
A	corn	123
B	linseed	179
C	olive	81
D	soya	130

38 A compound has the following structure.



Which reaction(s) will occur with this compound?

1 Bromine water will decolourise.
2 It will react with an alcohol to form an ester.
3 It will react with sodium metal.

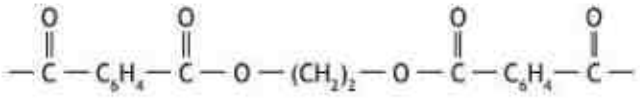
A 1 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

39 Polyvinyl chloride (PVC) is a man-made polymer used mainly in the manufacture of pipes. PVC pipes are strong, lightweight and does not rot.
Which statements correctly describe the polymer, polyvinyl chloride, PVC?

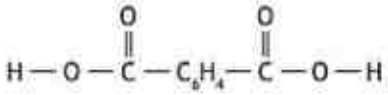
1 Combustion of PVC waste produces a highly acidic gas.
2 PVC molecules are saturated.
3 The empirical formula of PVC is the same as the empirical formula of its monomers.

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

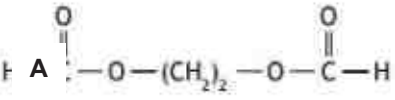
40. A section of a condensation polymer is shown below.

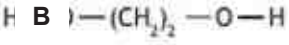


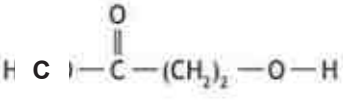
One of the monomers is

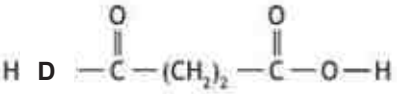


The structural formula of the other monomer is

A 

B 

C 

D 

End of paper

The Periodic Table of Elements

	Group																	
	I	II									III	IV	V	VI	VII	0
							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 -		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.).

Name: …… Index No. …… Class: ……

Bukit Batok Secondary School

PRELIMINARY EXAMINATION 2018

Sec 4 EXPRESS

CHEMISTRY **6092/02**

Paper 2

15 August 2018
1030 - 1215
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page.
Write in dark blue or black pen
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer **all** questions in the spaces provided.

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.
A copy of the Periodic Table is given at the end of the paper.

The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
Section A	/50
Section B	
B7	
B8	
B9	
Total	/80

This document consists of 23 printed pages.

Section A

Answer all the questions in this section in the spaces provided.

The total mark for this section is 50

A1(a) The grid below represents part of a blank periodic table, the numbers being the proton number of the elements.

In the grid below, write

(i) **P** in a space which could be occupied by a noble gas which is used to fill weather balloons. [1]

(ii) **Q** in a space which the most reactive non-metal would occupy. [1]

(iii) **R** in a space which could be occupied by a metal with the lowest density. [1]

(iv) **S** in a space which could be occupied by an element forming an amphoteric hydroxide. [1]

(v) **T** in a space which could be occupied by an element with an isotope that can be represented by $^{14}_{6}X$. [1]

.

1							2
3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18

(b) **(i)** Describe how the metallic character of the elements in Period 3 changes across the period from left to right.

……[1]

(ii) State how the metallic character of an element is related to its electronic structure.

…… [1]

(c) Explain what is meant by the term *periodicity*.

……

……[1]

[Total: 8]

A2 Carbon atoms can bond to each other to produce a variety of different structures, including diamond, graphite and buckminsterfullerene.

(a) There are similarities and differences in the structure and bonding in diamond and graphite.

(i) Describe two features of the structure and bonding in diamond that are similar to graphite.

……..

……..

……..

…….. [2]

(ii) Describe two features of the structure and bonding in diamond that are different from graphite.

……..

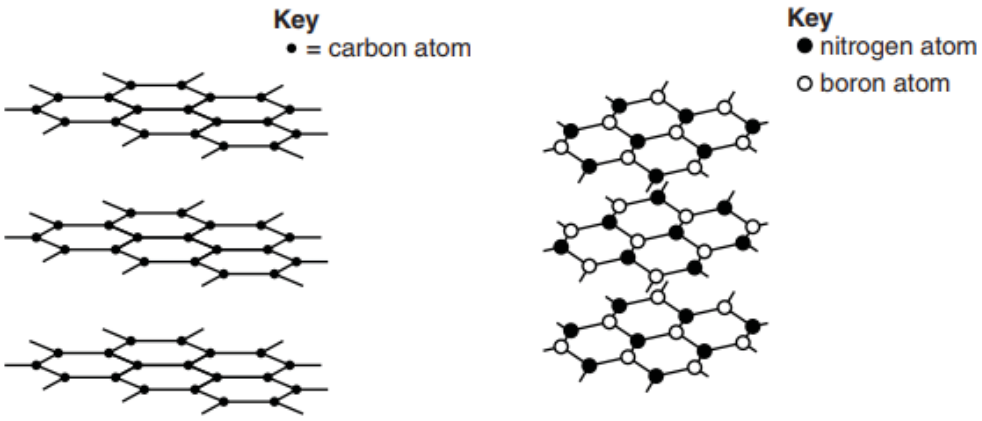
……..

……..

…….. [2]

(b) Buckminsterfullerene is a form carbon with the formula C_{60}. If it is burned completely in oxygen, it forms carbon dioxide as the only product.
Calculate the mass of carbon dioxide that is released when 51 g of buckminsterfullerene is completely burned in oxygen. [2]

(c) The structures of graphite and boron nitride are shown below.



graphite boron nitride

(i) What is the chemical formula for boron nitride? ……[1]

(ii) Like graphite, boron nitride feels slippery to the touch.
Explain, in terms of bonding and structure, why boron nitride feels slippery to touch.

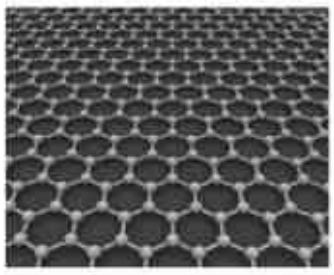
……

……

……

…….. [2]

(iii) The diagram below shows the structure of a solid form of carbon called graphene. Graphene contains **one layer** of carbon atoms.
Graphene is made from graphite but it is harder than graphite.



Explain, using ideas about structure and bonding, why graphene is hard.

.. ……

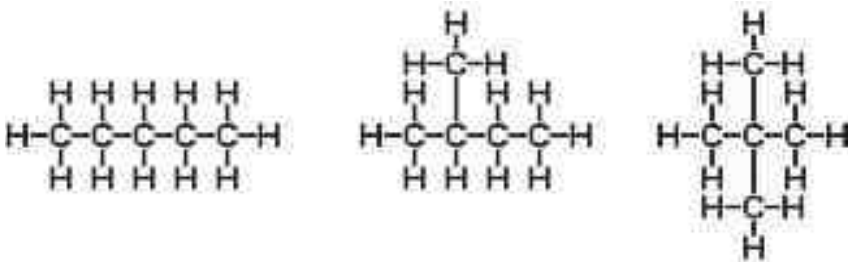
……[1]
[Total: 10]

A3 Alkanes like propane and butane are found in Liquefied Petroleum Gases(LPG).

(a) An experiment shows that complete combustion of 1.0 dm^3 (measured at room temperature and pressure) of butane produces 120 kJ of energy.
Calculate a value for the enthalpy change of complete combustion (kJ/mol) of butane, giving the correct sign.

[1]

(b)(i) The alkane with 5 carbon atoms, pentane exists as several isomers shown below. One is straight chain pentane while the other two are branched chain pentane.



Will the two isomers which are branched chain pentane have the same enthalpy change on complete combustion as the straight chain pentane?
Explain your reasoning.

……

……[1]

(ii) The table shows the enthalpy changes of combustion of hexane and heptane.

name	formula	enthalpy change of combustion / kJ/ mol
hexane	C_6H_{14}	-4163
heptane	C_7H_{16}	-4817

Using the data given, estimate the enthalpy change of combustion in kJ/mol of octane, C_8H_{18}. Explain the method you use to arrive at your answer.

……

……

……[2]

(c) Some students studied the graph below that shows the amount of fossil fuel burned in the world between 1960 and 2010.

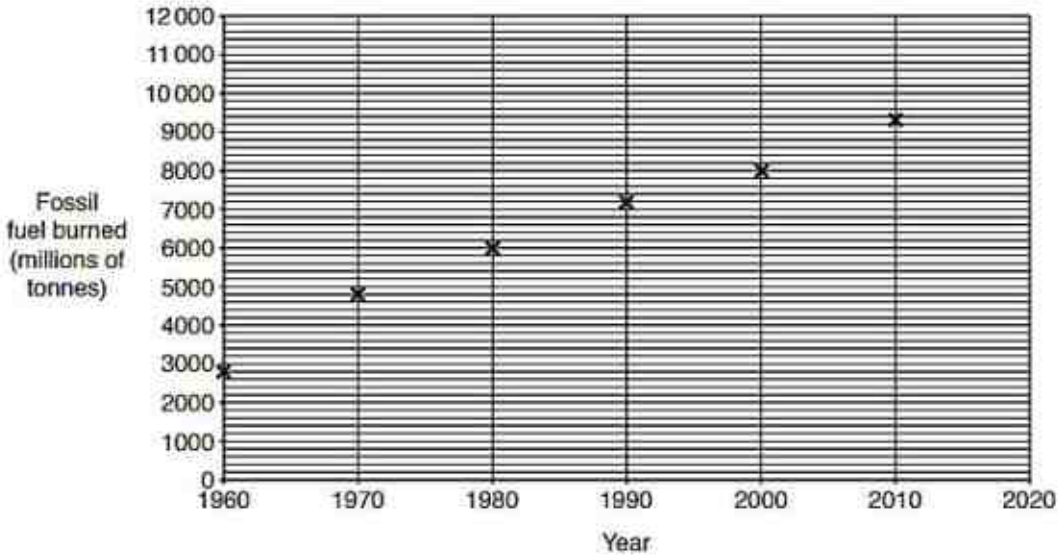


Fig 3.1

(i) One student says that the amount of fossil fuels burned has increased by the same amount every ten years.
Is the student correct? Use data from the graph to justify your answer.

……

……[1]

(ii) Another student says that it is very difficult to estimate the amount of fossil fuel we will use in 100 years' time. Suggest reasons the student could give to justify this statement.

……

……

……

…… [2]

(iii) The graph below shows the changes in average global temperature from 1960 to 2010.

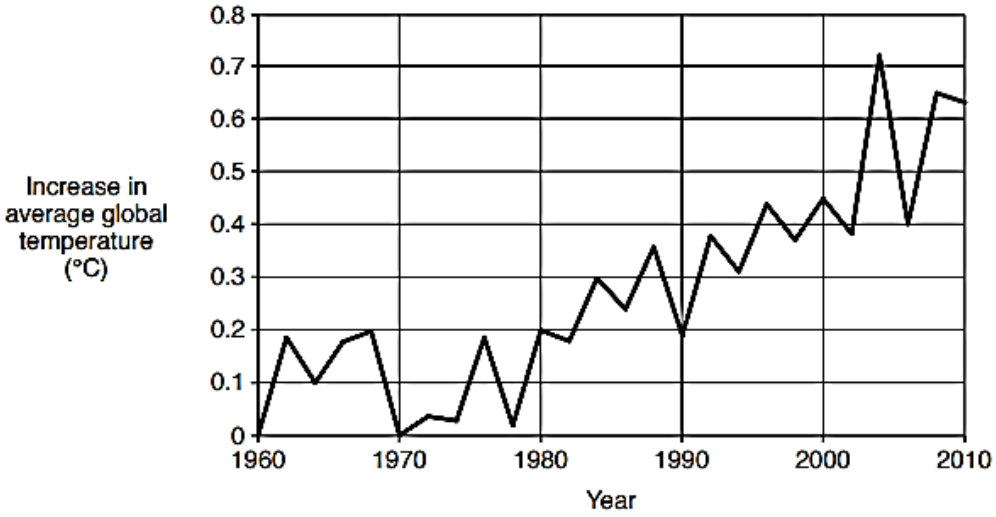


Fig 3.2

Describe the link between the trends shown in the graphs in Fig 3.1 and Fig 3.2.

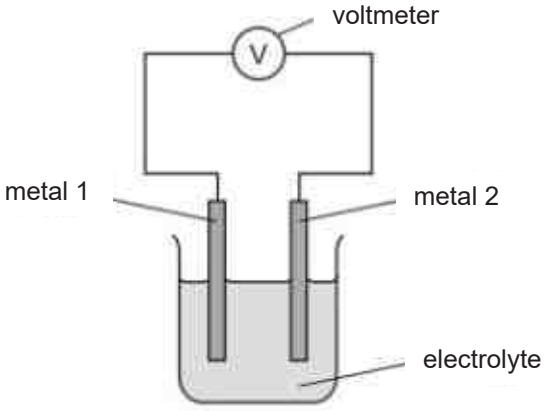
……

……[1]

[Total: 8]

A4 The diagram shows a simple cell, with two different metals as electrodes dipped in dilute nitric acid. A student did an experiment using the simple cell below.
The voltages were recorded in the table.

- If the voltage measured is positive then metal 2 is more reactive than metal 1.
- If the voltage measured is negative then metal 1 is more reactive than metal 2.



		metal 2				
		beryllium	cobalt	nickel	silver	vanadium
metal 1	beryllium	0.0 V	-1.6 V	-1.6 V	not measured	-0.7 V
	cobalt		0.0 V	0.0 V	-1.1 V	0.9 V
	nickel			0.0 V	-1.1 V	0.9 V
	silver				0.0 V	2.0 V
	vanadium					0.0 V

(a) (i) In the simple cell containing nickel and silver, it was observed that the electrolyte slowly turned pale green. Write the ionic equation to explain the colour change.

……[1]

(ii) What happened to the mass of the nickel electrode?

……...[1]

(b) (i) Using the data given, state the most reactive metal in the table above.
Explain your reasoning.

……

……

…… [2]

(ii) Predict the voltage produced by a simple cell with beryllium as metal 1 and silver as metal 2.

……[1]

(c) (i) The student wanted to rank the metals listed in the table according to their reactivity but he was not able to do so. Why?

……[1]

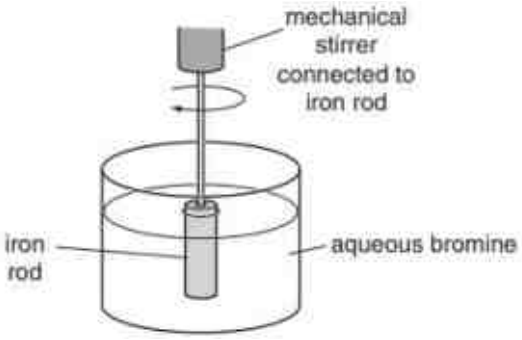
(ii) Briefly describe one **simple** experiment the student can do which will help him to solve the problem in **c(i).**

……

……...[1]

[Total: 7]

A5 The rate of reaction of iron with aqueous bromine is determined by using the apparatus shown below.



The iron is removed at regular intervals. It is washed, dried and then weighed.
The iron is then replaced in the solution.
The experiment is repeated twice, each time with a different concentration of aqueous bromine at room temperature, 25 °C. The results are shown in the table below.

Experiment	concentration of aqueous bromine mol/dm^3	speed of reaction mg iron reacted/min
1	0.050	9.2
2	0.10	18.1
3	0.15	27.2

(a) Describe how and explain why the speed of this reaction changes with concentration of bromine.

……

……

……...[2]

(b) (i) Experiment 1 is repeated after aqueous bromine has been cooled in an ice bath to 15°C.
Predict the speed of reaction, with appropriate unit……[1]

(ii) Using collision theory, explain your answer in **(b)(i).**

……

……

……

…… [2]

(c) Suggest another method for measuring the speed of this reaction.

……..[1]
[Total: 6]

A6 Ammonia, NH_3, is a colourless, pungent-smelling gas which has been known to man from the beginning of recorded time. Chemists have discovered a novel way of 'fixing' atmospheric nitrogen (converting nitrogen gas into its compounds). Moist nitrogen is passed over a TiO_2 plate which has been coated with other chemicals. The nitrogen is thought to react with moisture in the air at room temperature and pressure to form ammonia.
A *possible* equation for the reaction is given below.

$$5N_2(g) + 6H_2O(g) \rightleftharpoons 4NH_3(g) + 6NO(g) \quad \Delta H = +1808 \text{ kJ/mol}$$

(a) (i) Explain why there are only a few reactions that 'fix' nitrogen.

……

……

…… [2]

(ii) Suggest and explain one advantage and one disadvantage of the process given in the equation above as a method of making ammonia compared with the Haber process.

……

……

……

…… [2]

(b) 1.20 dm^3 of ammonia gas was dissolved in water to form 200 cm^3 of aqueous alkali at room temperature and pressure.

(i) Calculate how many moles of $NH_3(g)$ was dissolved in water.

[1]

(ii) Write the equation for the neutralisation of aqueous ammonia, $NH_3(aq)$ by dilute sulfuric acid.

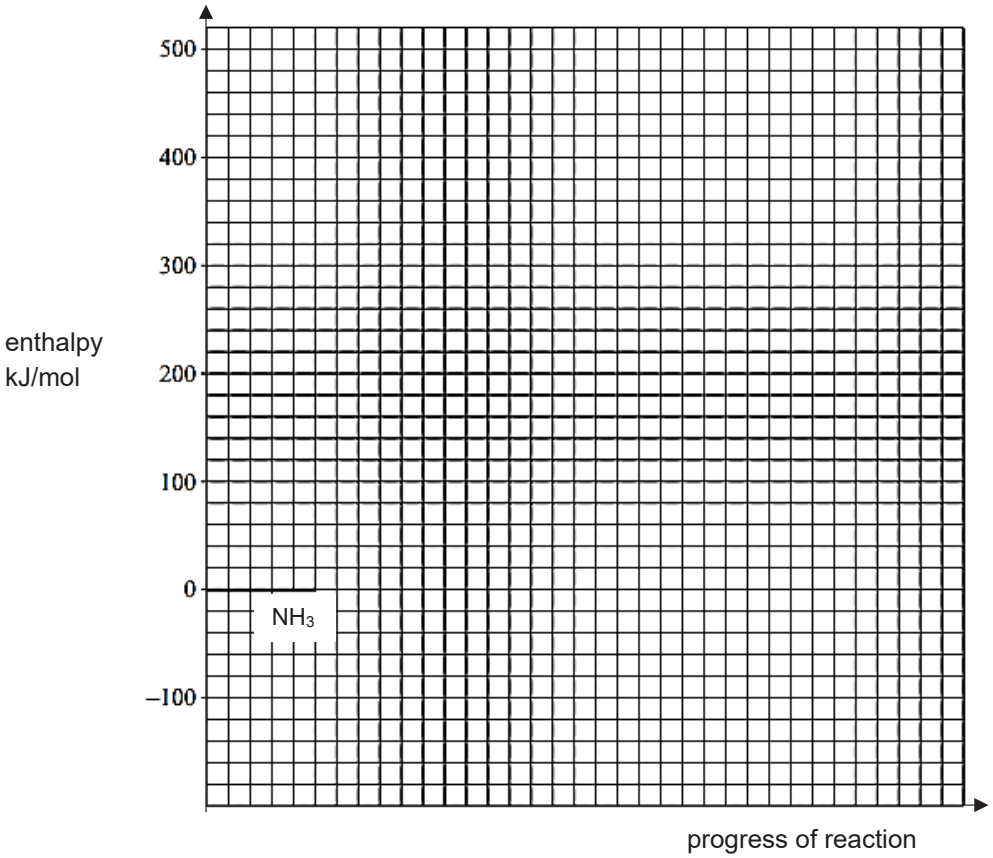
…….[1]

(c) The decomposition of ammonia is represented by the following equation.

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g) \quad \Delta H = +92 \text{ kJ/mol}$$

The activation energy, $\mathbf{E_a}$ for the uncatalysed reaction is 335 kJ/mol.
The activation energy, $\mathbf{E_a}$**"** for the reaction when tungsten is used as a catalyst is 163 kJ/mol.

(i) On the grid provided on page 12, draw a **labelled** energy profile diagram for the uncatalysed and catalysed reactions. [3]
Include the necessary information given.



(ii) When osmium is used as a catalyst, the activation energy is 197 kJ/mol. Which catalyst, osmium or tungsten, will cause ammonia to decompose at a faster rate? Explain your answer using ideas about particles.

……

……

…… [1]

(iii) State the activation energy for the uncatalysed reaction of the following:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

…… [1]

[Total:11]

Section B

Answer **all** three questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B7 Composition of sea water

The Earth's ocean holds about 1.5×10^{18} tonnes of water, which in turn contains 0.05×10^{18} tonnes of dissolved salts. The table below shows eight most common ions in the sea.

ion	% by mass of total dissolved solids	concentration in mol/dm^3
Chloride, Cl^-	55.04	0.535
Sodium, Na^+	30.42	0.457
Sulfate, SO_4^{2-}	7.69	0.028
Magnesium, Mg^{2+}	3.91	0.056
Calcium, Ca^{2+}	1.16	0.010
Potassium, K^+	1.10	0.0097
Carbonate, CO_3^{2-}	0.41	0.0023
Bromide, Br^-	0.19	0.00081

The dissolved ions in the sea form an essentially free source of materials to anyone with access to the sea. Evaporation of sea water produces sodium chloride and potassium chloride. The two other elements that can be obtained from sea water are bromine and magnesium.

Uses of Magnesium

Magnesium is the lightest structural metal used today, some 30% lighter than aluminium. Magnesium is the third most used metal in construction (after iron and aluminium). Nearly 70% of the world production of magnesium is used to make alloys. One example is Magnox which is an alloy of magnesium with small amount of aluminium and other metals.

Extraction of magnesium

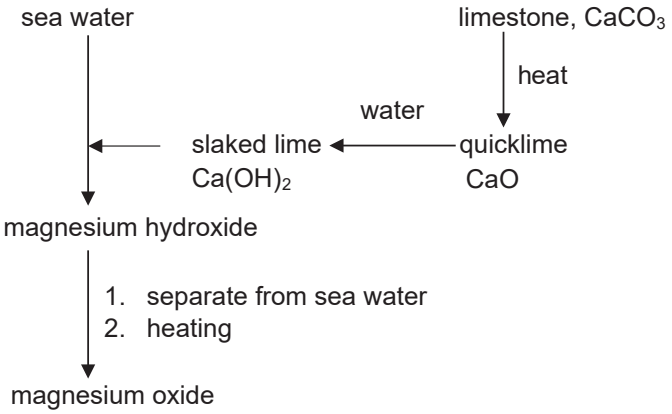
The first stage in the production of magnesium is to mix the sea water with a slurry of calcium hydroxide. This precipitates magnesium hydroxide.

This reaction can be represented as follows.

$$Mg^{2+}(aq) + Ca(OH)_2(aq) \rightarrow Mg(OH)_2(s) + Ca^{2+}(aq)$$

Magnesium hydroxide is then separated and heated to produce magnesium oxide.

The flow chart summarises the process mentioned



Conversion to magnesium chloride is achieved by heating the oxide, mixed with carbon, in a stream of chlorine at a high temperature in the furnace.

$2MgO(s) + C(s) + 2Cl_2(g) \rightarrow 2MgCl_2(s) + CO_2(g)$

The resulting anhydrous magnesium chloride is fed into electrolytic cells.
A schematic diagram of the electrolytic cell is shown below in Fig 7.1

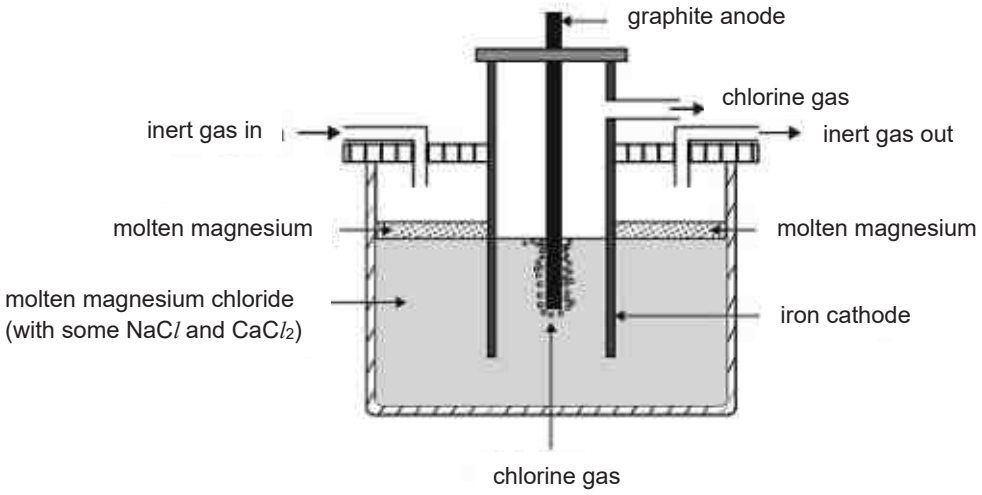


Fig 7.1

The design of this cell considers the following properties of both magnesium metal and magnesium chloride:

- molten magnesium reacts vigorously with oxygen
- at the temperature of molten magnesium chloride, magnesium is a liquid
- molten magnesium has a lower density than molten magnesium chloride and forms a separate layer on the surface.

(a) Name the most abundant ionic compound in sea water and determine the effective concentration of this compound in mol/dm^3.

[1]

(b) (i) From the information given, deduce the trend in solubility of the Group II metal hydroxide as the proton number increases.

……

……[1]

(ii) Calculate the mass of magnesium hydroxide precipitated when an excess of calcium hydroxide is added to 1000 dm^3 of sea water. [2]

(c) (i) Write an ionic equation for the reaction at the cathode in the electrolytic cell.

……...[1]

(ii) How does the design of the cell shown in the Fig 7.1, take into consideration the reaction of molten magnesium with oxygen?

……

……. [1]

(d) Electrolysis is an expensive process as high consumption of energy is needed. Using the information given, what is being done to lower the cost in industrial process?

……

……[1]

(e) A technician accidentally replaced the graphite electrode with a piece of silver metal.
How would the products of electrolysis be affected? Explain your answer.
Write an ionic equation to support your answer.

……

……

……

……

……

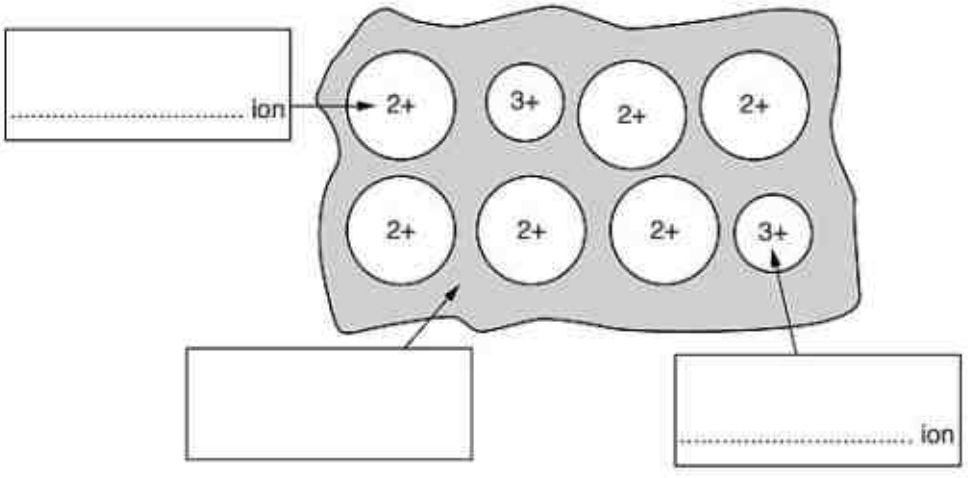
…… ...[3]

(f) State an example of recycling that is given in the information.

……..

…….... [1]

(g) The aluminium atoms in Magnox form a metallic structure with magnesium.
The figure below represents a simple illustration of the bonding in Magnox.
Use your knowledge of atomic structure and metallic bonding to label the boxes. [1]



[Total: 12]

B8 (a) A student reacted together an alcohol and a carboxylic acid under appropriate conditions to produce an ester.
A sweet smelling organic liquid, **Q**, with the empirical formula C_2H_4O was produced.
The M_r of **Q** was found by experiments to be 87.5.

(i) What is the molecular formula of **Q**? Show the necessary calculation. [1]

(ii) In the boxes below, draw the structural formula of **two** isomers with this formula that are **straight chain** esters. [2]

A sample of **Q** was heated with aqueous sulfuric acid. The product obtained was a mixture of the original alcohol and carboxylic acid. This mixture was heated under reflux with acidified potassium manganate(VII) to give a **single** product, **R**.
The product, **R**, was collected and subjected to the following tests:

- A sample of **R** gave no reaction with aqueous bromine.
- A second sample of **R** gave an effervescence with sodium carbonate.
- A third sample of **R** is completely miscible with water.

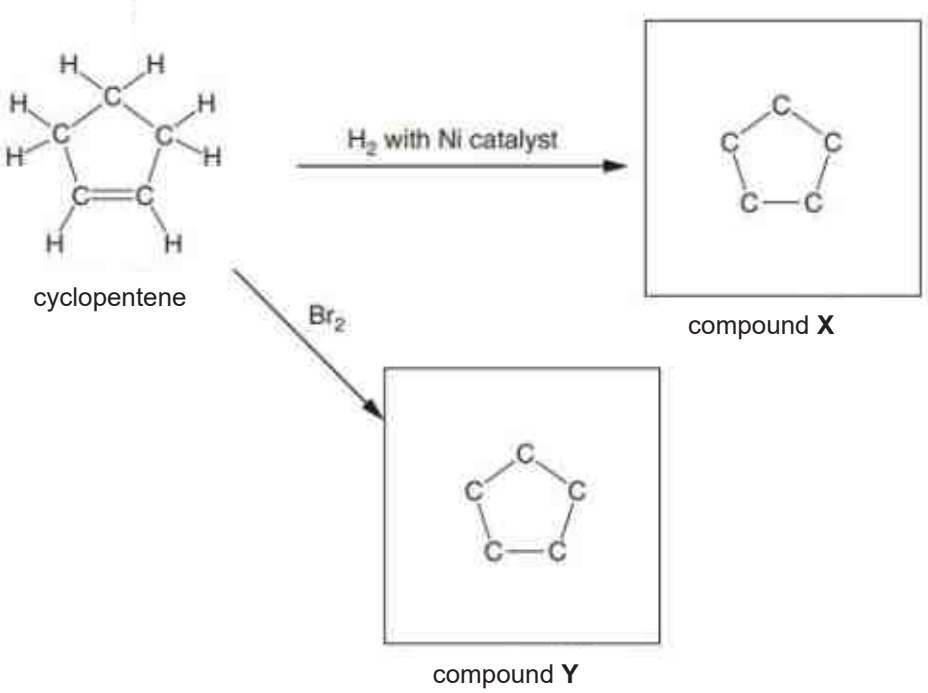
(iii) What is the identity of single organic compound **R**?

……[1]

(b) Cyclopentene is a cyclic alkene with the formula C_5H_8. It is a colourless liquid with a petrol-like odour. It is used as a monomers for synthesis of plastics.

The figure below shows some reactions involving cyclopentene

(i) Complete the partial structures of compounds **X** and **Y** which are the products of the reactions. [2]



cyclopentene

compound **X**

compound **Y**

(ii) Write a balanced chemical equation to show the reaction between cyclopentene and aqueous bromine.

…… [1]

(iii) Cyclopentene can be polymerised to give poly(cyclopentene). Draw a section of poly(cyclopentene) to show two repeat units. [1]

[Total: 8]

B9 Either

Aqueous iron(II) bromide is a pale green solution containing iron(II) ions and bromide ions. When chlorine is passed into aqueous iron(II) bromide, the colour of the solution changes from pale green to orange-red.

When the orange-red solution is heated, it gives off a brown vapour, leaving a yellow solution **S**. The brown vapour forms a dark orange liquid **T** on cooling. When ethene gas is bubbled into **T**, the dark orange colour disappears. Sodium hydroxide solution is added to solution **S** and a reddish brown precipitate was obtained.

(a) (i) Name liquid **T**. …….. [1]

(ii) Draw 'dot-and-cross' diagram to show the electron arrangement in **T.** Show only the outer electrons. [1]

(b) Name the yellow compound present in solution **S.**

…… [1]

(c) (i) Construct a balanced chemical equation for the reaction in which **S** and **T** are formed.

…… [1]

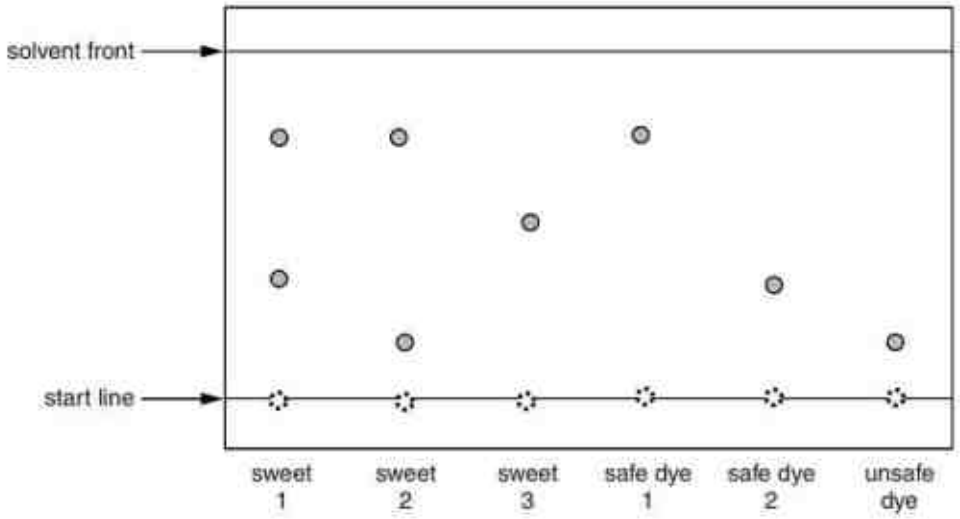
(ii) In this reaction in which **S** and **T** are formed, name the oxidising agent. Explain your answer, using **electron transfer**.

……

……

……[2]

(d) A student uses chromatography to analyse the food dyes used in a packet of sweets. The packet contains three different coloured sweets. He tests one sweet of each colour. He uses two known safe food dyes and one known unsafe dye as references.
The chromatogram below shows his results.



(i) The student looks at the results and makes this statement:
"The results show that it is possible that two of the sweets contain an unsafe dye."
Explain how the results of the chromatogram support the student's conclusion.

……

……

……[2]

(ii) Calculate the R_f value of the unsafe dye given in the chromatogram above.

[1]

(iii) The student also uses chromatography to identify the **flavourings** used in the sweets. He sprays his chromatogram with a locating agent.
Why does he need to use a locating agent?

……[1]

B9 Or

Both calcium and barium are elements in Group II of the Periodic Table. The trend of the reactivity of the elements in Group II is similar to that in Group I. Like Group I elements, calcium and barium form salts with the halogens.

The salt, calcium chloride, $CaCl_2$, can be made by different reactions.
A student prepared hydrated calcium chloride by carrying out the following experiment.

Step 1 The student added an excess of a solid calcium compound, **X**, to dilute hydrochloric acid. The mixture fizzed as the solid reacted.
Step 2 The student filtered the mixture to give an aqueous solution of $CaCl_2$.
Step 3 On evaporation, colourless crystals of hydrated calcium chloride were formed.

(a) Why is calcium chloride an example of 'salt'?

……..

…….. [1]

(b) A friend of the student suggested that solid **X** was calcium oxide. State one reason why the student's friend was **incorrect** and suggest a possible identity of solid **X**.

……..

……..

…….. ...[2]

(c) Hydrated calcium chloride has a molar mass of 219 g/mol.
Determine the formula of **hydrated** calcium chloride.
You must show your working. [2]

(d) Calcium chloride can also be formed by directly reacting calcium with chlorine gas. Explain, using **oxidation states**, why the formation of calcium chloride from its elements, is a redox reaction.

……

……

……[2]

(e) The student decided to prepare barium sulfate, $BaSO_4$, by adding barium metal to dilute sulfuric acid . Another student said this method should not be used to prepare the salt, barium sulfate.
Give **two** reasons why the other student is correct.

……

……

……

……[2]

(f) Barium atom has the electron arrangement 2, 8, 18, 18, 8, 2. Write the electron arrangement of the barium **ion**.

……[1]

End of paper

Group																	
I	II									III	IV	V	VI	VII	0
					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 -	113	114 Fl flerovium -	115	116 Lv livermorium -	117	118

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.).

2018 GCE O Prelim sec 4E Chemistry 6092 Paper 1

Answer & mark scheme

No.	*Ans*	*Remarks*
1	D	(A) A boiling water bath has a temperature of 100°C, so if heat over water bath, $CuSO_4.H_2O$ obtained (see eqn) (B) This will convert hydrated copper(II) sulfate to the anhydrous form. (C) Same as (B)
2	A	(See QA notes)
3	D	X has sulfate ion reacts with barium ion to form insoluble barium sulfate. This is not the reaction of the hydrogen ion in the acid.
4	B	Both aluminium ion and zinc ion forms white ppt which dissolves in excess aq NaOH giving colourless solution. Calcium ion forms white ppt that does not dissolve in excess aq NaOH.
5	B	
6	C	(add up nucleon no. given in the options and compare to 46)
7	D	(write down electron arrangement of ions given in the option and compare) Electron arrangement for: Ca^{2+} 2,8,8 Cl^- 2,8,8
8	D	(compare no. of protons and no. of electrons) X: 9 protons, 10 electrons so X is negative ion Y: 17 protons, 18 electrons, so Y is negative ion
9	B	(see the column for ability to conduct electricity in solid and in aq state)
10	C	(compare with N which is in Group V, compound of N and H is NH_3, so compound of P and H is PH_3. Check the no. of white dots which represent hydrogen atoms)
11	B	Mass of S = $\frac{\text{no. of S atom x Ar of S}}{\text{Mr}}$ x mass of sample
12	B	
13	D	Mass of calcium carbonate in the chalk = 0.226 x 100 = 22.6g % purity = 22.6 / 23.0 x 100 = 98.3%
14	D	(compare the charge of the positive ion, eg $Na^+ + e \rightarrow Na$)
15	C	Oxygen and hydrogen gas given off (see volumes of gas produced), so hydroxide ion and hydrogen ion discharged. In (1), copper(II) ion discharged instead of hydrogen ion. In (3), chloride ion discharged instead of hydroxide ion due to higher $[Cl^-]$
16	D	As reaction progresses: (A) Concentration of acid drops (B) More carbonate used (C) More gas produced
17	D	Reaction time, t = 1 / rate = 1 / 0.2 = 5.0 s
18	D	(2) is respiration which is exothermic. (see glucose react with oxygen. Both (1) and (3) are combustion of fuel so exothermic.

No.	*Ans*	*Remarks*
19	D	(assign oxidation numbers) In $FeTiO_3$, oxidation number of Ti is +4, in TiO_2, oxidation number is +4
20	A	Sodium chloride is neutral, does not react with hydrogen ions in the acid, so pH unchanged
21	C	Hydrochloric acid is strong acid, total ionization. ethanoic acid is weak acid, partial ionization.
22	A	Carbon dioxide is only produced in 2nd reaction. Salt is produced in 1st reaction.
23	D	(Recall properties of ammonium compound, apply this to methyl ammonium chloride) when ammonium chloride react with aq NaOH, ammonia gas, salt (sodium chloride) and water produced.
24	C	With calcium carbonate, soluble salts will be calcium chloride, calcium nitrate. NOT calcium sulfate as it is insoluble With copper(II) carbonate, soluble salts will be copper(II) chloride, copper(II) sulfate, copper(II) nitrate
25	B	Barium sulfate is insoluble, so need two soluble starting reagents. Barium carbonate is also insoluble. Add barium carbonate to dilute hydrochloric acid to form soluble barium chloride, before reacting with the second soluble reagent.
26	B	Copper will not react, remain as residue. Zinc react with dil hydrochloric acid to form colourless solution zinc chloride.
27	B	(A) Lead(II) oxide will be reduced by hydrogen gas to form lead and water (B) Magnesium is higher up in the reactivity series, so hydrogen is not able to reduce magnesium oxide (C) Carbon react with oxygen to form carbon dioxide (D) Sulfur react with oxygen to form sulfur dioxide
28	A	Both P and S are non-metals, so form acidic oxides which dissolves in water to form an acid.
29	C	Going down group II, the carbonate becomes more difficult to decompose. Both magnesium carbonate and calcium carbonate decomposes, but not barium carbonate.
30	C	(2) magnesium will displace silver from silver nitrate (4) magnesium will react with acid to form salt and hydrogen
31	D	Magnesium is a more reactive metal, so loses electron more easily.
32	A	Rusting uses up oxygen. Volume of oxygen used = 150 – 122 = 28 cm^3 % of oxygen = 28 / 150 x 100 = 18.7%
33	A	Chlorine atom reacts with the ozone molecules, so choose the option with largest no. of chlorine atoms.
34	A	Y is C_6H_{14}, so it is hexane
35	A	Absence of uv light, so no substitution occurs
36	B	Cyclobutene – C_4H_6, cyclopentane – C_5H_8, cyclohexene – C_6H_{10}
37	B	The oil with the lowest bp will have the largest no. of C=C bonds.

No.	*Ans*	*Remarks*
38	D	It has C=C so will react with aq bromine With the -COOH, it is an organic acid, so react with metal and alcohol
39	D	(1) True, Hydrogen chloride gas produed (2) True, no more C=C in addition poymers (3) True, only the polymer is produced
40	B	

Sec 4E GCE O Prelim Chemistry 6092
Answers & mark scheme

The paper was

A1a(i) P – box 2; Q – box 9; R – box 3; S – box 13 T – box 6 [1] each
(b) (i) elements becomes less metallic. [1]
(ii) metallic elements have fewer outer / valence electrons. [1]
(c) periodicity is a repeating pattern (across different periods) [1]

[Total: 8]

A2a(i) Both consists entirely of **carbon** atoms joined by **covalent** bonds; [1]
Both have giant lattice (or giant molecular) [1]
ii. In diamond every carbon atom is bonded to four other carbon atoms, but in graphite, each carbon atom is bonded to 3 atoms;
diamond has a tetrahedral arrangement of atoms but graphite has a layered arrangement;
graphite has delocalised electrons unlike diamond which do not. [any 2]
b. No. of mole of C_{60} = 51 / 720 = 0.0708 (eqn – optional)
No. of mole of CO_2 = 60 x no. of mole of C_{60} = 0.0708 x 60 = 4.24 [1]
Mass of C_{60} = 4.24 x 44 = 187 g [1]
c(i) BN [1]
ii. weak Van der Waal (or intermolecular) forces of attraction between layers; [1]
layers of **atoms** can slide over each other. [1]
iii. graphene has **many** strong covalent bond between carbon atoms. [1]

[Total: 10]

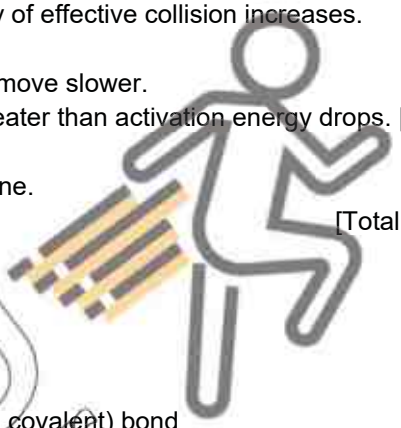
A3a. ΔH = - 24 x 120 = - 2880kJ/mol [reject if no unit and sign] [1]
b(i) Yes, same(not similar) type bond and same number of bond [1]
ii. difference in ΔH = 4817 – 4163 = 654 kJ [1]
from hexane to heptane, increase in one CH_2 group
from heptane to octane, same increase of one CH_2 group
so ΔH for octane = -(4187 + 654) = -5471 kJ/mol [1]
c(i) No, quote any two data that shows a difference for every ten years. [1]
Egs of data that can be used: 1960 -70, 2000 millions of tons bigger that 1970 to 80 which has increase 1200 millions of tons, or 1990 – 2000, increase of 800 millions of tons smaller than 2000 – 2010 increase of 1300 millions of tons.
ii. alternative / renewable forms of energy being used; [1]
fossil fuel running out. [1]
iii. As the amount of fossil fuel burnt increase, the increase average global temperature is higher. [1]

[Total: 8]

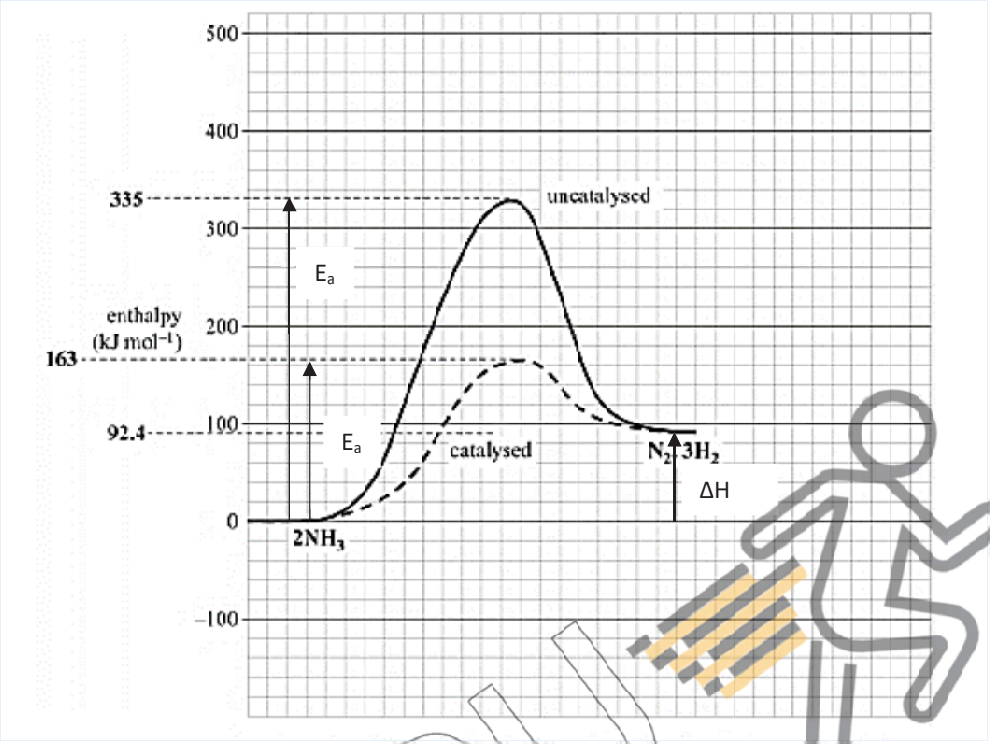
A4a(i) $Ni(s) \rightarrow Ni^{2+}(aq) + 2e$ [1]
ii. mass decrease [1]

b(i) beryllium; [1]
It has the largest voltage with cobalt/nickel [1]
ii. -2.7 V (V + Ag) + (V + Be) [1]
c(i). both nickel and cobalt has the same reactivity [1]
ii. Place a piece of nickel in cobalt nitrate solution. If nickel displaces cobalt, nickel is more reactive than cobalt. [1]
[Total: 7]

A5a. As concentration increases, the speed of this reaction increases. When concentration increases, there is greater number of particles in the same volume [1]
Particles are closer to each other so frequency of effective collision increases. [1]
b(i) 4.5 – 5.0 mg iron reacted/min (units needed)
ii. As temperature drops, particles loses energy, move slower. [1]
Number of particles with energy equal to or greater than activation energy drops. [1]
Frequency of effective collision decreases.
c. measure the colour intensity of aqueous bromine. [1]
[Total: 6]



A6a(i) N≡N triple bond; [1]
A lot of energy is needed to break the (strong covalent) bond [1]
ii. Advantage: lower temperature / lower pressure so save energy, lesser fossil fuel, or water, instead of hydrogen, water is used, so cheaper [1]
Disadvantage: nitrogen oxide produced, reacts with oxygen to form nitrogen dioxide which contribute to acid rain / an air pollutant [1]
b(i) no. of moles of ammonia = 1.20 / 24 = 0.05 [1]
(ii) $2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$ (state symbols not needed) [1]
c(i) correct shape and location for both graphs [1m each]
correct labels of Ea, Ea" and ΔH [1]



b(ii) Tungsten: with it, the reaction has a **lower activation energy**;
which means the **higher** proportion of collisions that are successful between ammonia molecules will be higher (not more collisions, both points needed) [1]

(iii) Ea' = 243 kJ/mol (units needed) [1]

[Total: 11]

Section B

B7a. sodium chloride, Conc(mol/dm^3) = 0.457 (sodium ion is the limiting reactant) [1]

b(i) as the proton number increases, the group II metal hydroxide becomes more soluble [1]

ii. no. of mol of Mg^{2+} in 1000 dm^3 sea water = 0.056 x 1000 = 56 mols [1]
no. of mol of $Mg(OH)_2$ = no. of mol of Mg^{2+} = 56 mol
mass of $Mg(OH)_2$ = 58 x 58 = 3248 g [1]

c(i) $Mg^{2+}(l) + 2e \rightarrow Mg(l)$ [1]

ii an inert gas, instead of air, is blown through the cathode compartment above molten magnesium [1]

d. sodium chloride and calcium chloride is added to molten magnesium chloride to **lower the melting point**, saving energy. [1]

e. at the anode, silver will be oxidised instead of chloride ion. Silver ion would be produced rather than chlorine at the anode. [1]
$Ag(s) \rightarrow Ag^+(l) + e$ [1]
the silver ion would move to the cathode, get discharged and silver is produced instead at the cathode. [1]

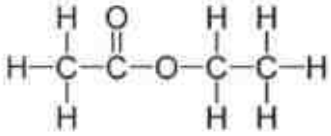
f. chlorine gas produced during electrolysis is used to convert magnesium oxide to magnesium chloride at the furnace. [1]

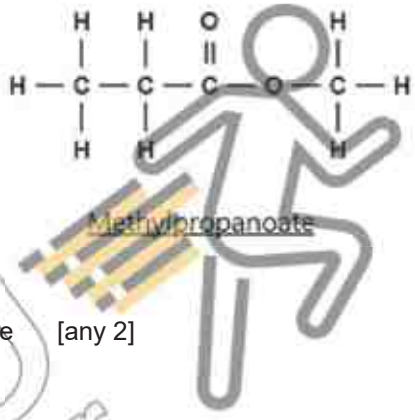
g. magnesium ion, aluminium ion, **delocalised** electron [all three correct -1]

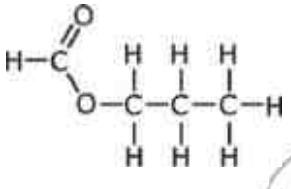
[Total: 12]

B8a(i) relative mass of C_2H_4O = 44
M_r ~ 88
N = 88 / 44 = 2
Relative molecular formula is $C_4H_8O_2$ [1]

ii. ethyl ethanoate



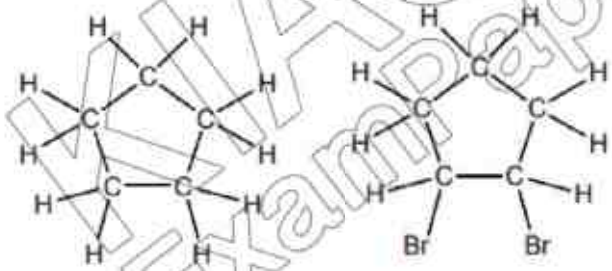




propyl methanoate [any 2]

iii. ethanoic acid [1]

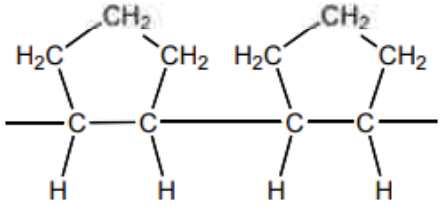
b(i)



Compound X compound Y [1m for each, all H atoms needed]

ii. $C_5H_8 + Br_2 \rightarrow C_5H_8Br_2$ [1]

iii.

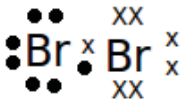


[Must have at least two repeat units and the free bonds at the end. All carbon-carbon bonds in the polymer chain must be shown.] [1]

[Total: 8]

B9 Either

a(i) bromine [1]

ii (dot-cross diagram of bromine molecule,  [1]

b. iron(III) chloride [1]

c(i) $3Cl_2 + 2FeBr_2 \rightarrow 2FeCl_3 + 2Br_2$
[1]

ii. chlorine [1]
chlorine removes electrons from iron(II) ion and bromide ion. [1]

d(i) sweet 2 contains an unsafe dye; [1]
unknown dye in sweet 3 does not match up with a safe dye [1]

ii. 0.8 / 5.2 = 0.154 (or 0.15) [1]

iii. to see the spots / make the colourless spots visible [1]
(ignore 'find / identify the spots')

[Total: 10]

B9 Or

a. Hydrogen ion / H^+ **ion** in acid replaced by calcium ion / Ca^{2+} **ion** or metal ion. [1]

b. The reaction produced a **gas** / calcium oxide does not produce a **gas** in reaction with acid. [1]
calcium carbonate. [1]

c. Mr of $CaCl_2 = 111$.

No. of water molecules = $\frac{219 - 111}{18}$ [1]

$= 6$

Formula: $CaCl_2.6H_2O$ [6 and $CaCl_2.6H_2O$ score the 2nd mark, allow no dot, $CaCl_26H_2O$] [1]

d. Calcium is oxidised as oxidation state of calcium increases from 0 to +2 [1]
Chlorine is reduced as oxidation state of chlorine decreases from 0 to -1 [1]

e barium is very reactive metal, so react violently with the acid, reaction not safe; [1]
barium sulfate formed is insoluble, so form a barrier on barium, preventing further reaction. [1]

(ii) 2, 8 , 18, 18, 8 [1]

[Total:10]

Geylang Methodist School (Secondary)
Preliminary Examination 2018

CHEMISTRY **6092/01**

Paper 1 Multiple Choice **Sec 4 Express**

Additional materials : OAS **1 hour**

Setter : Mrs Loh Kim Woon **20 August 2018**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and register number on the Answer Sheet in the spaces provided unless this has been done for you.

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.

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

[Turn over

1 Which of the following pairs of substances can be separated by heating?

A ammonium chloride and potassium iodide

B copper (II) nitrate and potassium iodide

C ammonium chloride and iodine

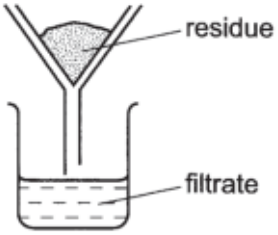
D sodium chloride and copper (II) nitrate

2 The table shows the colours and the solubilities in water of four solids.

solid	colour	solubility in water
W	blue	insoluble
X	blue	soluble
Y	white	insoluble
Z	white	soluble

A mixture containing two of the solids is added to excess water, stirred and filtered.

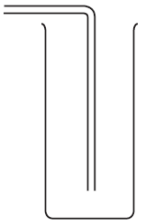
A blue filtrate and a white residue are obtained.



Which two solids are present in the mixture?

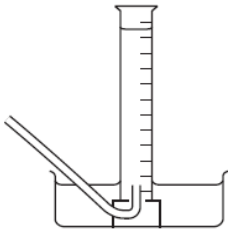
A W and X **B** W and Y
C X and Y **D** X and Z

3 An experiment is carried out to investigate the rate of reaction when calcium carbonate reacts with hydrochloric acid.
The volume of carbon dioxide gas given off is measured at different intervals of time.
The diagram shows pieces of apparatus used to collect gases.



1
downward delivery

2
calibrated gas syringe

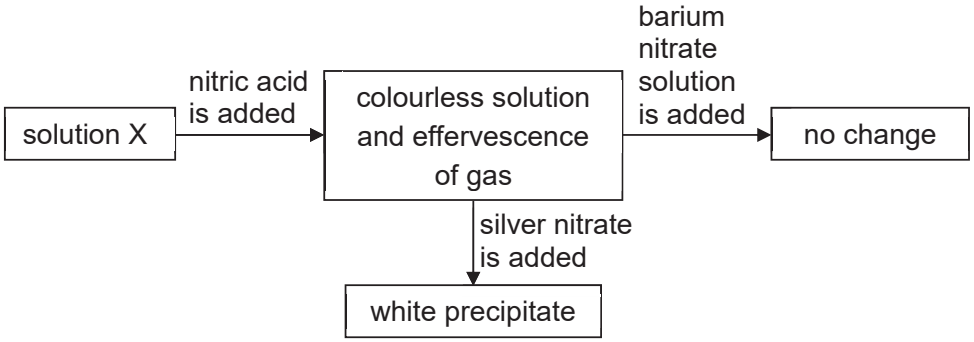


3
displacement of water with a graduated tube

Which apparatus is suitable to collect and measure the volume of the carbon dioxide?

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

4 Solution X contains two anions. Tests are carried out as shown in the diagram below.



What anions are found in solution X?

A sulfate ions and carbonate ions
B carbonate ions and chloride ions
C sulfate ions and chloride ions
D nitrate ions and carbonate ions

5 Which statement correctly explains why chlorine, Cl_2, at 40°C diffuses more slowly than neon, Ne, at 20°C?

A Chlorine has a relative molecular mass of 71 whilst neon has a relative atomic mass of 20.
B Chlorine is at a higher temperature than neon.
C Chlorine is diatomic and neon is monatomic.
D Chlorine is more reactive than neon.

6 Four statements are being made about elements, compounds and mixtures by a student.

Statement 1: Elements and compounds have fixed melting points.
Statement 2: The properties of a compound are similar to that of its elements.
Statement 3: A mixture can be separated into its components by physical means.
Statement 4: Elements can exist either in the form of atoms or molecules.

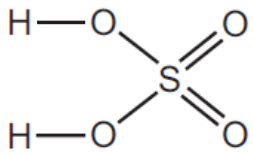
How many of the above statement(s) is/are **not** correct?

A one
B two
C three
D four

7 Deuterium, D, is an isotope of hydrogen.
Which statement about deuterium is **not** correct?

A It reacts with ethene, C_2H_4, to form a compound CH_2DCH_2D.
B An atom of deuterium contains one proton.
C It has the same density as hydrogen.
D It forms the ion D^+.

8 A molecule of sulfuric acid has the structural formula shown.



How many electrons are involved in forming all the covalent bonds in one molecule of sulfuric acid?

A 6 **B** 8 **C** 12 **D** 16

9 An investigation of the properties of the chlorides of Period III elements shows that the boiling points of sodium chloride and silicon tetrachloride are 1465°C and 57°C respectively. This difference in boiling points is a result of

A covalent bonds being weaker than ionic bonds.
B sodium chloride having strong metallic bonds.
C silicon tetrachloride having weak intermolecular forces of attraction.
D silicon forming weaker bonds with chlorine than does sodium.

10 Compound P is the only substance formed when two volumes of ammonia gas react with one volume of carbon dioxide gas (both volumes being measured at r.t.p.).

What is the formula of P?

A $NH_2CO_2NH_4$

B $(NH_2)_2CO$

C $NH_4CO_2NH_4$

D $(NH_4)_2CO_3$

11 When sugar (M_r = 342) is fermented using yeast, the following reaction takes place.

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$$

What volume of carbon dioxide, at r.t.p., would be produced by the complete fermentation of 1 kg of sugar?

A $\frac{342 \times 4 \times 24}{1000}$ dm^3

B $\frac{1000 \times 24}{342 \times 4}$ dm^3

C $\frac{342 \times 24}{1000 \times 4}$ dm^3

D $\frac{1000 \times 4 \times 24}{342}$ dm^3

12 On collision, airbags in cars inflate rapidly due to the production of nitrogen.
The nitrogen is formed, in two consecutive steps, according to the following equations.

Step 1: $2NaN_3 \rightarrow 2Na + 3N_2$

Step 2: $10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$

What is the **total** number of moles of nitrogen gas that can be produced from one mole of sodium azide, NaN_3?

A 1.5 **B** 1.6 **C** 3.2 **D** 4.0

13 Which property would all the hydrogen compounds of the Group VII elements possess?

A They form covalent compounds.
B They are solids at room temperature.
C They form alkaline aqueous solutions.
D They conduct electricity when molten.

14 The properties of the oxides of four elements K, L, M and N in the third period of the Periodic Table are given below.

- The oxide of K is insoluble in water and dilute acid but soluble in concentrated alkali.
- The oxide of L reacts with both dilute acid and dilute alkali.
- The oxide of M reacts with dilute alkali at room temperature.
- The oxide of N dissolves in water to form an alkaline solution.

If K, L, M and N are placed in order of increasing atomic number, which order is correct?

A K, L, M, N
B N, M, K, L
C N, L, K, M
D L, K, N, M

15 A coil of clean copper wire is suspended in aqueous silver nitrate. Crystals of silver are deposited on the copper wire.

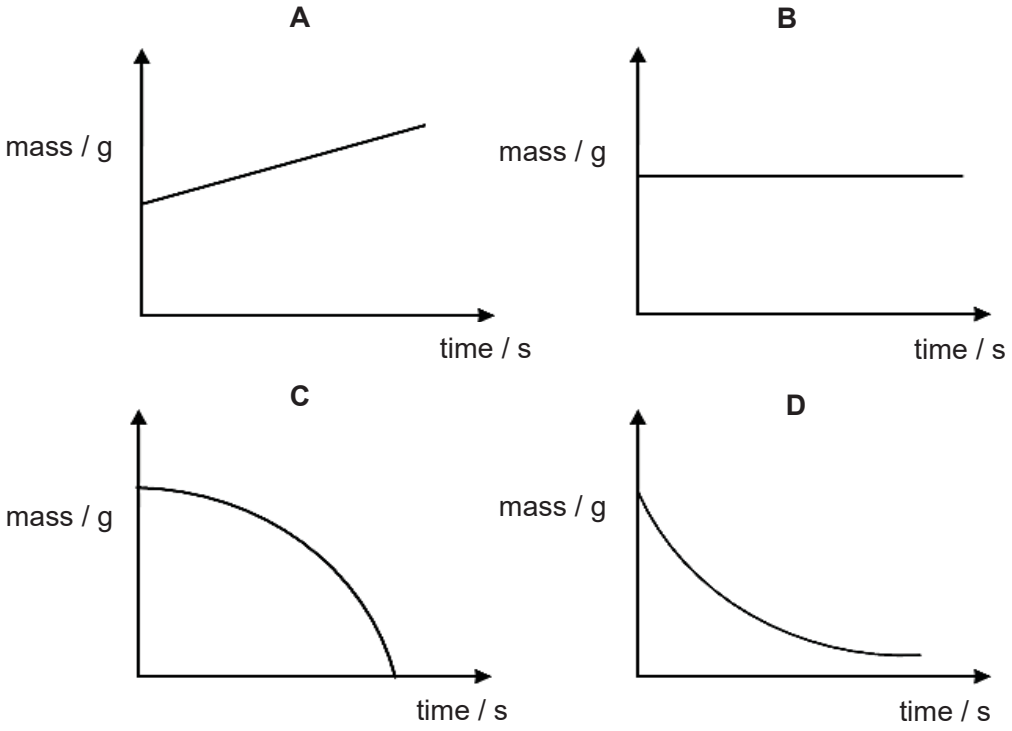
Which statement is **not** correct?

A The copper is oxidised.
B The total mass of the crystals of silver increases gradually.
C The total number of positive ions in the solution is unchanged.
D The solution turns blue.

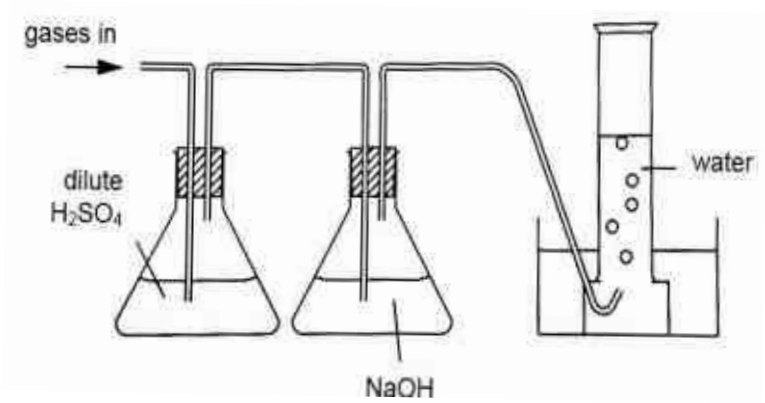
16 Which statement about the production of iron from iron oxide in a blast furnace is correct?

A Limestone is used to remove basic impurities.
B The reaction between the iron oxide and carbon monoxide liberates carbon dioxide.
C The iron is obtained using carbon monoxide as an oxidising agent.
D The iron oxide is reduced by carbon dioxide.

17 A known mass of potassium carbonate was placed in an open crucible and heated until there was no further change observed.
Which graph shows the change in mass of the crucible and its contents?



18 A sample of three gases was passed through the apparatus shown below. It was found that only one gas was collected in the gas jar at the end.



Which of the following could be the mixture of gases in the sample?

A ammonia, hydrogen, carbon monoxide
B ammonia, sulfur dioxide, carbon monoxide
C nitrogen, helium, carbon dioxide
D oxygen, nitrogen, hydrogen chloride

19 Nitrogenous fertiliser such as ammonium nitrate is used to increase crop yield.

Which substance can be added to increase the pH of acidic soil containing ammonium nitrate without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D potassium hydroxide

20 Which of the following does **not** show the appropriate reagents used for preparation of the named salts?

	salt	reagents
A	barium sulfate	barium nitrate and sulfuric acid
B	lead(II) chloride	lead(II) nitrate and hydrochloric acid
C	lithium nitrate	lithium hydroxide and nitric acid
D	magnesium chloride	magnesium sulfate and hydrochloric acid

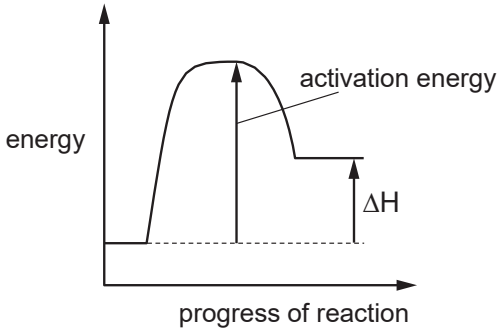
21 Which of the following is true about the Haber Process?

A The catalyst in the reaction is iron(III) oxide.
B The optimum temperature for the reaction is 450°C.
C A pressure of above 600 atm will result in lower yields.
D 1 mole of nitrogen reacts with 3 moles of hydrogen to form 2 moles of ammonia.

22 Which of the following statements best describes the mechanism of a hydrogen-oxygen fuel cell?

A Hydrogen and oxygen undergo redox reaction to generate electricity.
B Hydrogen ions react with hydroxide ions to generate electricity.
C Electricity is used to provide heat energy.
D Electricity is used to generate hydrogen and oxygen.

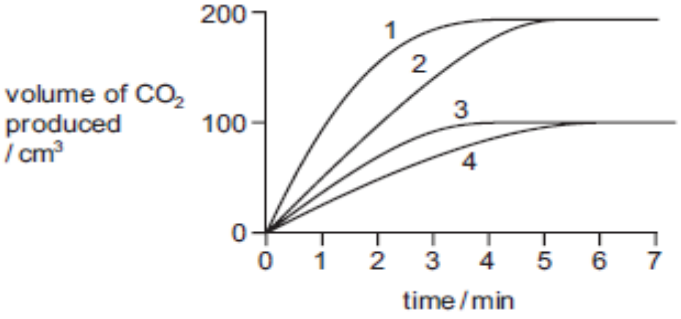
23 The energy profile diagram for the forward direction of a reversible reaction is shown.



For the reverse reaction, which row correctly shows the sign of the activation energy and the type of enthalpy change?

	sign of activation energy	type of enthalpy change
A	negative	endothermic
B	negative	exothermic
C	positive	endothermic
D	positive	exothermic

24 In four separate experiments, 1, 2, 3 and 4, nitric acid was added to excess marble chips and the volume of carbon dioxide formed was measured.
In all four experiments the same volume of nitric acid was used.
Its concentration, or temperature, or both concentration and temperature, were changed.
The results of the experiments are shown on the graph.



Which statement is correct?

A A lower concentration of acid was used in experiment 3 than in experiment 1.
B Experiment 4 was faster than experiment 3.
C The acid used in experiment 2 was of a lower concentration than in experiment 1.
D The temperature of the acid was the same in experiments 1 and 2.

25 The following changes could be made to the conditions in the reaction between zinc and hydrochloric acid.

1 increase in concentration of the acid
2 increase in particle size of the zinc
3 increase in pressure on the system
4 increase in temperature of the system

Which pair of changes will increase the rate of reaction?

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

26 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is an example of disproportionation?

A $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
B $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$
C $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$
D $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

27 Aqueous potassium iodide, KI(aq), can be used as a test reagent in redox reactions.

Iodide ions are readily ……X…… A positive result for the test is when the solution changes colour from ……Y…… to ……Z……..

Which words correctly complete gaps X, Y and Z?

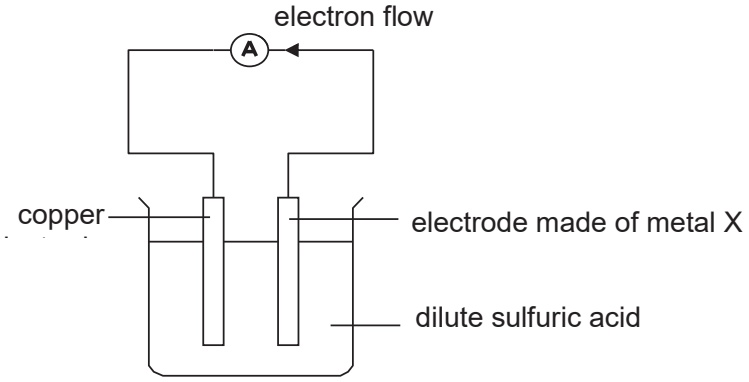
	X	Y	Z
A	oxidised	brown	colourless
B	oxidised	colourless	brown
C	reduced	brown	colourless
D	reduced	colourless	brown

28 In an electrolysis experiment, the same amount of charge deposited 54.0 g of silver and 8.5 g of vanadium.

What is the charge on the vanadium ion?

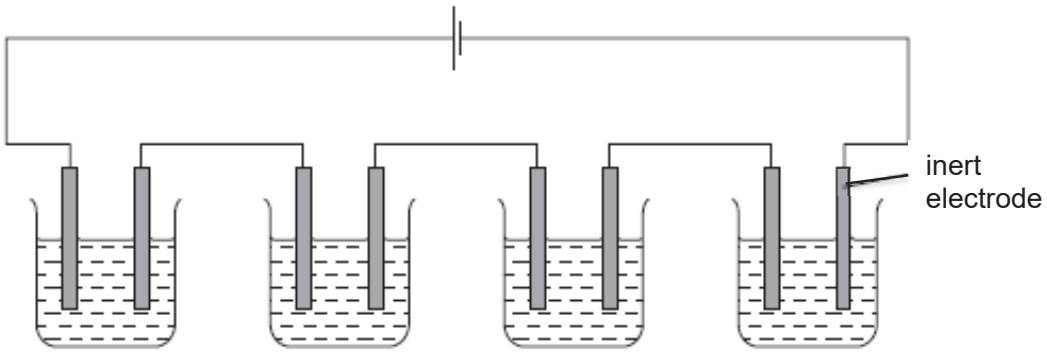
A 1+
B 2+
C 3+
D 4+

29 With reference to the diagram below, which of the following statements is correct?



A Copper electrode is the negative electrode.
B Metal X is below copper in the reactivity series.
C The mass of the copper electrode decreases.
D The mass of the metal X electrode decreases.

30 When electrolysed using inert electrodes, which dilute solution would produce the greatest increase in mass of the cathode?

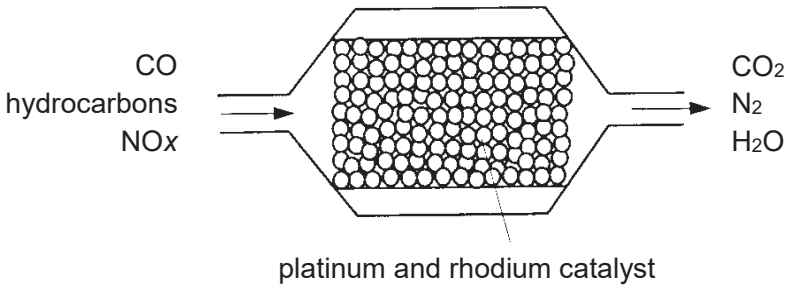


31 The table shows some atmospheric pollutants and their possible effects.

Which row is **not** correct?

	pollutant	effect
A	CFCs	cause depletion of the ozone
B	CO_2	layer forms photochemical smog
C	CO	is poisonous to humans
D	NO_2	forms acid rain

32 The diagram below represents a section of a catalytic converter on the exhaust system of a car. Harmful gases are converted into carbon dioxide, nitrogen and water vapour.



Which processes take place in this catalytic converter?

I Carbon monoxide and hydrocarbons react together.

II Carbon monoxide and nitrogen oxides react together.

III Platinum and rhodium catalyse redox reactions.

A I, II and III

B I and II only

C II and III only

D I and III only

33 Which statement(s) best explains why bitumen has a higher boiling point than paraffin?

1 Bitumen is more reactive than paraffin.
2 Bitumen is a pure substance whereas paraffin is a mixture.
3 Forces of attraction between the molecules of paraffin are weaker than that between the molecules of bitumen.
4 There are smaller molecules in bitumen compared to the molecules in paraffin.

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

34 Which compound is the most viscous and the least flammable?

A C_6H_{14} **B** C_8H_{18}
C $C_{10}H_{22}$ **D** $C_{12}H_{26}$

35 The second member of a homologous series has the formula C_7H_8.

What is the formula of the first member?

A C_6H_6 **B** C_6H_8
C C_6H_7 **D** C_7H_6

36 An ester is produced by reacting together the carboxylic acid HCO_2H and the alcohol $CH_3CH_2CH_2OH$.

What is the name and structure of this ester?

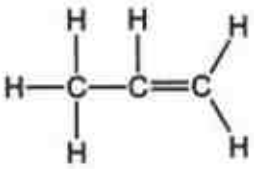
	name	structure
A	methyl propanoate	$CH_3CH_2CO_2CH_3$
B	methyl propanoate	$HCO_2CH_2CH_2CH_3$
C	propyl methanoate	$CH_3CH_2CO_2CH_3$
D	propyl methanoate	$HCO_2CH_2CH_2CH_3$

37 Compound Y

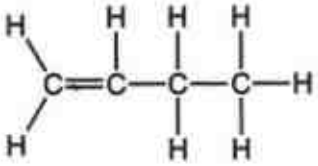
- has the empirical formula CH_2,
- has an M_r of 56,
- forms two alcohols that have different structural formulae when reacted with steam.

What is compound Y?

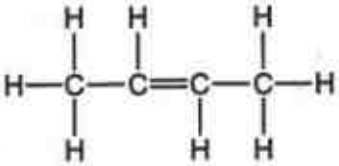
A



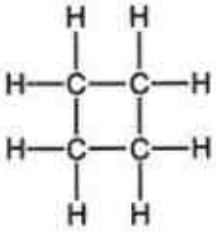
B



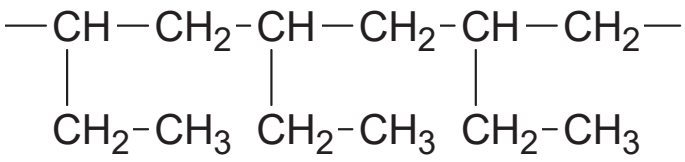
C



D



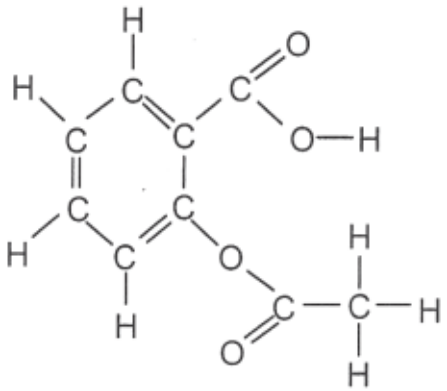
38 The structure of a polymer is shown below.



What is the molecular formula of the monomer?

A C_2H_4
B C_3H_8
C C_4H_8
D C_4H_{10}

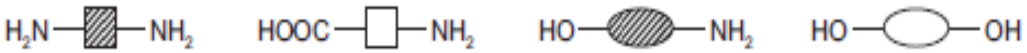
39 Aspirin is a drug which is used as a general pain killer. The structural formula of aspirin is shown below.



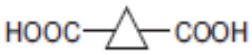
Which of the following statements about aspirin is **false**?

A Its aqueous solution reacts with sodium carbonate.
B It decolourised aqueous bromine.
C It is formed from an alcohol and a carboxylic acid.
D It turns purple acidified aqueous potassium manganate (VII) colourless.

40 The diagrams show four monomers.



How many of these monomers would react with the molecule below to form a polymer?



A 1
B 2
C 3
D 4

End of Paper

Geylang Methodist School (Secondary)
Preliminary Examination 2018

Candidate Name			
Class		Index Number	

CHEMISTRY **6092/02**

Paper 2 **Sec 4 Express**

Additional materials : Writing papers **1 hour 45 minutes**

Setter : Ms Tan Lay Ming **17 August 2018**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions, the last question is in the form either/or.
Write your answers in the writing papers provided.

At the end of the examination, hand in Section A and Section B separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 19.

For Examiner's Use	
Section A	/50
B8	/12
B9	/ 8
B10	/10
Total	80

This document consists of **19** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The following table shows some substances and their properties.

substance	melting point (°C)	boiling point (°C)	solubility in water	electrical conductivity	
				when solid	when liquid
A	3550	4830	insoluble	poor	poor
B	-55.6	-78.5	slightly soluble	poor	poor
C	1085	2562	insoluble	good	good
D	801	1413	soluble	poor	good
E	-38.8	357	insoluble	good	good

(a) Using the letters **A**, **B**, **C**, **D** and **E**, which substance(s) is/are likely to have a

(i) simple molecular structure, ……. [1]

(ii) giant covalent structure, ……. [1]

(iii) giant metallic structure. ……. [1]

(b) Suggest a possible identity for element **E**.

……..... [1]

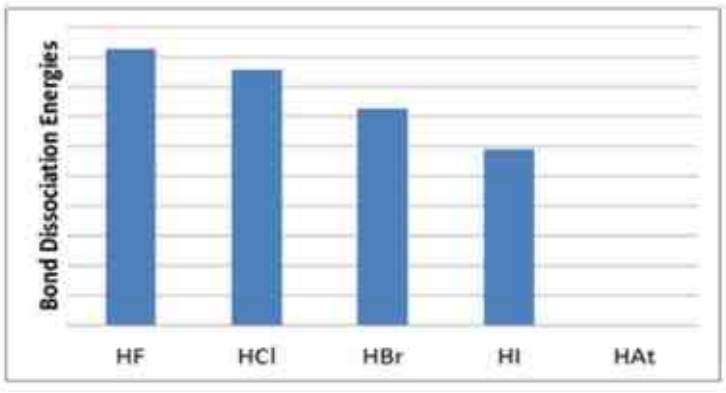
(c) A student passed a current through molten substance **D** and after a while, a gas which rekindled a glowing splint was produced at the anode.

Write an ionic half-equation, including state symbols, for the reaction that happened at the anode.

……..... [2]

[Total: 6]

A2 The bond dissociation energies of some hydrogen halides are shown in the chart below. Bond dissociation energy is the energy that must be provided to the molecule in order to break the bond.



(a) Describe the trend shown in the above chart.

…… [1]

(b) Predict the bond dissociation energy of hydrogen astatide, HAt, by drawing the rectangular bar in the chart above. [1]

(c) **(i)** Suggest which one of the hydrogen halides forms the strongest acid.

…… [1]

(ii) Explain your answer to **(c)(i)**.

……

…… [2]

(d) Hydrogen bromide can be produced by reacting hydrogen and bromine according to the following reaction.

$$H_2\,(g) + Br_2\,(g) \rightarrow 2HBr\,(g)$$

The bond energies of some bonds are shown in the table below.

bond	H-H	H-Br	Br-Br
bond energy (kJ/mol)	432	363	193

Calculate the enthalpy change of this reaction and state whether it is exothermic or endothermic.

[2]

[Total: 7]

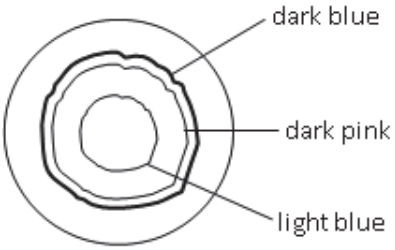
A3 This information comes from a textbook about elderberries.

Elderberries are widely used in wine making. Extract of elderberries is a useful pH indicator and it can be separated by chromatography.

As an indicator, the colour of the extract changes to pink at a pH of 2 – 3 and to blue at a pH of 11 – 12.

elderberries

(a) The chromatogram shown below was obtained when water was added to a drop of elderberries extract at the centre of a filter paper.

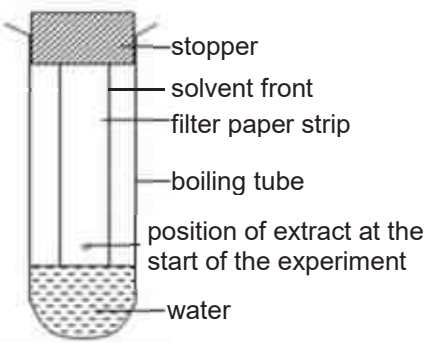


(i) Predict the colour of the elderberries extract at pH 7.

……[1]

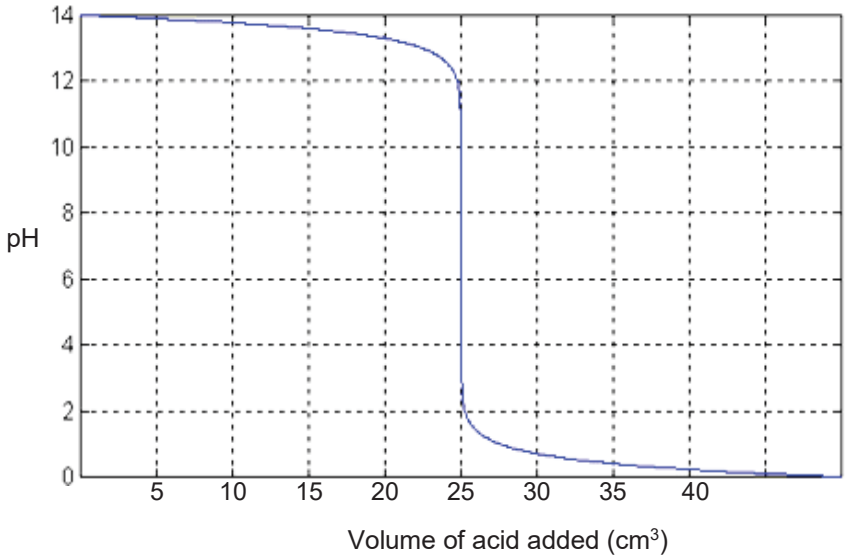
(ii) An alternative set-up for the above experiment was shown below.

dye	R_f value	distance travelled (cm)
light blue	0.2	
dark pink	0.4	1.00
dark blue	0.5	



Given that the distance travelled by the dark pink dye is 1.00 cm, complete the table above by stating the distance travelled by the light blue and dark blue dyes. [2]

(b) The diagram below shows how pH values changed during a titration when an acid was added from a burette into a solution of an alkali. Some drops of elderberries extract were added at the start of titration.



(i) Suggest one possible chemical formula of the alkali.

…….. [1]

(ii) State the colour of the elderberries extract when the volume of acid added was

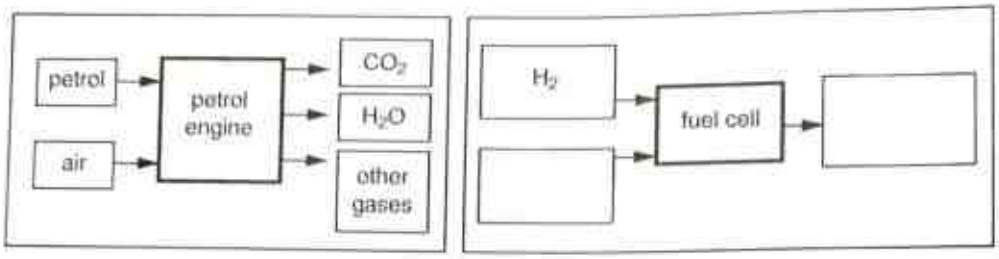
20 cm^3, …… [1]

30 cm^3. …… [1]

[Total: 6]

A4 Most vehicles have petrol or diesel engines, but some use fuel cells.

The flow charts show the substances entering and leaving a petrol engine and a fuel cell.



(a) Complete the flow chart for the fuel cell by filling in the empty boxes. [1]

(b) The waste products from vehicles with petrol engines cause more harm to human health than those from vehicles with fuel cells.

Explain why this statement is true.

.....

.....

.....

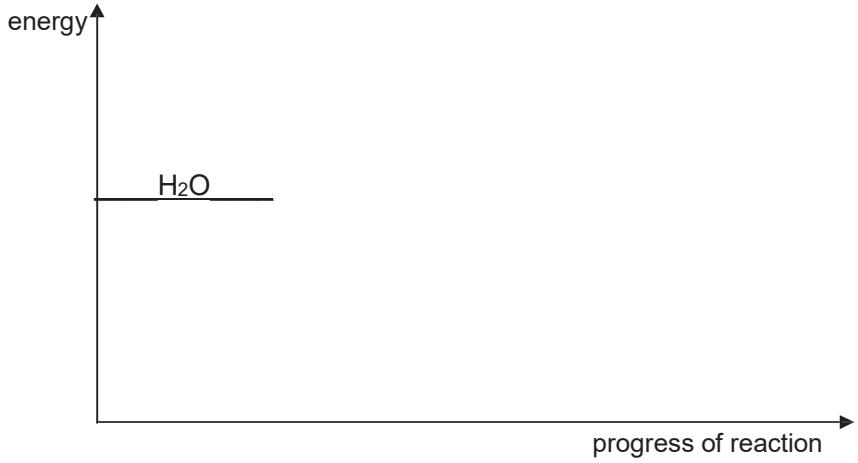
..... [3]

(c) Hydrogen for fuel cells can be obtained from water by electrolysis.

Electricity is used to provide energy for the electrolysis.

Complete the energy profile diagram for the electrolysis of water.

Your diagram should include
- the **formulae of the products** of the electrolysis,
- a label for the **enthalpy change of reaction**.



[2]

[Total: 6]

A5 A laboratory assistant has six elements that are **consecutively** arranged in the Periodic Table. He randomly assigns each element a letter, T, V, W, X, Y and Z. The letters do not represent the atomic symbols and the order of the elements.

He carried out some experiments on the elements and found the following properties.

- V_2 reacts with X_2 to form a compound VX_3.
- Y forms a carbonate that decomposes to carbon dioxide and an oxide on heating.
- W reacts with T_2 to form W_2T. W_2T dissolves in water to form a solution that turns purple with addition of Universal Indicator.
- Z is a gaseous element. It is used in advertising strip lights.

(a) Identify the following elements

(i) T, ………………………………………… [1]

(ii) W, ………………………………………… [1]

(iii) Z. ………………………………………… [1]

(b) Write down the product(s) formed from the reaction between

(i) Y and Cl_2, ………………………………………………………………… [1]

(ii) X_2 and NaC*l*. ………………………………………………………………... [1]

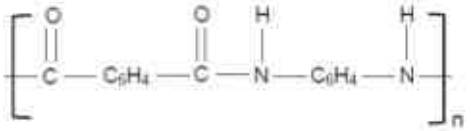
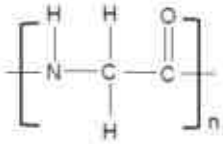
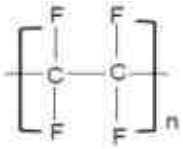
(c) State the industrial conditions required to produce VH_3. (H is hydrogen).

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

[Total: 7]

A6 The table below shows some information regarding three materials. They are Kevlar, polyglycine and Teflon.

name of material	structure of polymer
Kevlar	
polyglycine	
Teflon	

(a) Identify the reaction that formed

(i) Kevlar, …… [1]

(ii) polyglycine, …… [1]

(iii) Teflon. …… [1]

(b) During polymerisation to form Kevlar and polyglycine, hydrogen chloride and water are released respectively.

Draw the structure of the monomer(s) that formed

(i) Kevlar,

[2]

(ii) polyglycine.

[1]

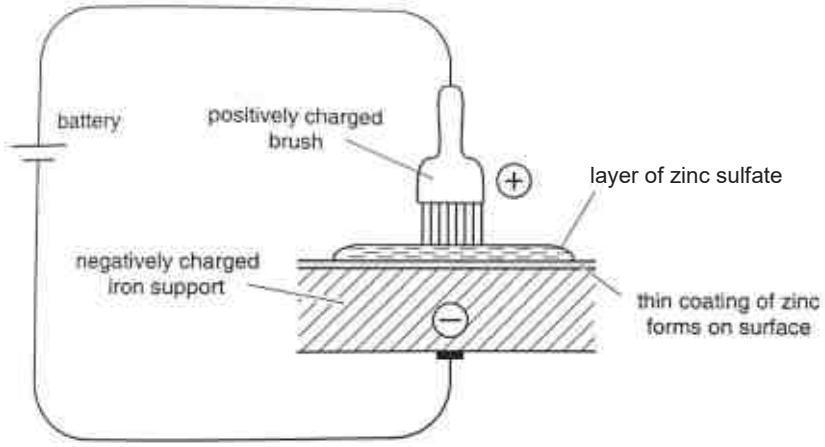
(c) Suggest the structural formulae of the products formed from a reaction between glycine and ethanol.

[2]

[Total: 8]

A7 A new type of electroplating is known as 'brush electroplating'.
It is used to electroplate zinc onto very large iron supports to be used in buildings.
The iron supports are too big to be plated in a normal electrolysis tank.

During the process, a metal brush spreads a layer of aqueous zinc sulfate over the iron surface.
A battery gives the brush a positive charge and gives the iron support a negative charge.
A layer of zinc forms on the surface of the iron support.



(a) The surface of the iron acts as a cathode.
Zinc ions from the solution form zinc on the surface of the iron.

Write an ionic half-equation, with state symbols, for this reaction.

…… [2]

(b) Two different designs of metal brush are available.
One type of brush is made from zinc, one type is made from platinum.
As the electrolysis takes place, each brush has a different effect on the concentration of zinc ions in the solution.

(i) What will happen to the concentration of the zinc ions during the electrolysis if the brush is made from platinum?

…… [1]

(ii) What will happen to the concentration of the zinc ions during the electrolysis if the brush is made from zinc?

……... [1]

(iii) Platinum brushes are much more expensive than zinc brushes.
However, zinc brushes need replacing regularly but platinum brushes do not.
Explain why.

…….

……..…. [2]

(c) During the process, a worker needs to hold the brush.

Which of the following materials would be a good choice for the handle of the brush? Give a reason for your answer.

chromium copper graphite iron poly(ethene)

material …… [1]

reason …….. [1]

(d) Explain why iron supports coated with zinc do not rust, even if the zinc coating is damaged.

…….

……... [2]

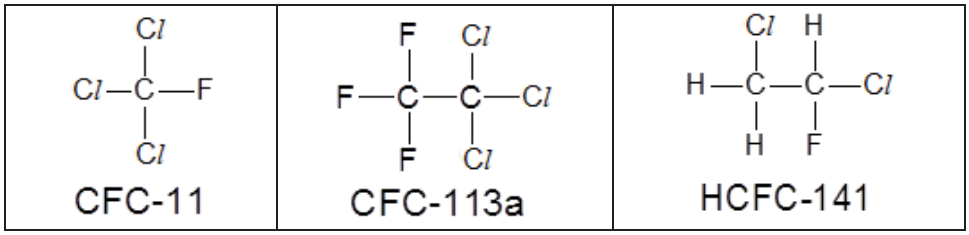
[Total: 10]

End of Section A

Section B

Answer all **three** questions from this section.
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.
The total mark for this section is 30.
Write your answers in the writing papers provided.

B8 Chlorofluorocarbons (CFCs) are inert on the Earth's surface. However in the stratosphere, they are very reactive. CFCs are part of a group of compounds which can be classfied as ozone depleting compounds. Other than CFCs, there are also hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs) and perfluorocarbons (PFCs). Some common examples of CFC and HCFC molecules are shown below with their names.



A naming system for these substances was devised several decades ago. The prefixes to the name tell us the elements present in the compound as shown in the table below.

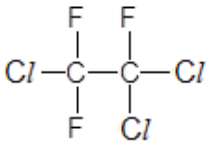
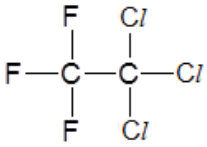
prefix	elements present
PFC	carbon, fluorine
CFC	carbon, fluorine, chlorine
HFC	hydrogen, carbon, fluorine
HCFC	hydrogen, carbon, fluorine, chlorine

The numbers suffixed to the names of the compounds give us the number of each type of atom present in one molecule of the compound. The key to decoding the number is simply to add 90 to the number suffixed to the name.

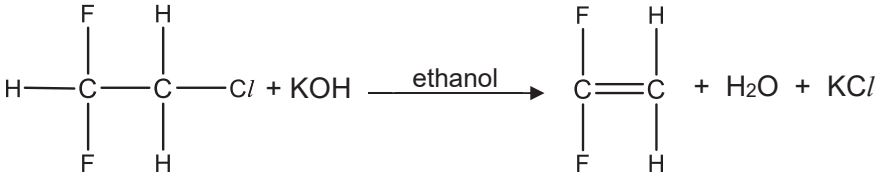
.

For example, to decode the number of atoms in CFC-113a, we add 113 to 90 to obtain 203. The first number, 2, tells us the number of carbon atoms, the second number, 0, tells us the number of hydrogen atoms, and the third number, 3, tells us the number of fluorine atoms. Chlorine atoms make up the remaining bonds since all these compounds are saturated.

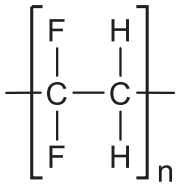
The letter ‘a’ in CFC-113a tells us about the structural formula of the compound. The arrangement of the type of atoms in the compound that most evenly distributes atomic masses has no letter. The second most even distribution is given the letter ‘a’, the third most even distribution is given the letter ‘b’, so on and so forth.

molecule	atomic mass on left carbon	atomic mass on right carbon
 CFC-113	73.5	90
 CFC-113a	57	106.5

Although most of these substances are harmful to the ozone layer, they can also be used to make polymers by first converting them to alkenes. For example, HCFCs react with potassium hydroxide which is dissolved in ethanol (solvent) to give an alkene, potassium chloride and water. An example of the reaction is shown below.



The alkene produced from the above reaction can be used to make useful polymers such as the one shown below.



(a) Draw the structure of a PFC molecule with two carbon atoms. [1]

(b) Copy the table below and draw the other two isomers of HCFC-141 in the correct respective boxes. [2]

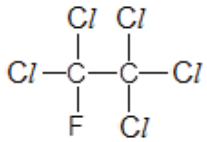
HCFC-141a	HCFC-141b

(c) A student comments that HFCs are safer alternatives to CFCs as HFCs do not harm the environment like CFCs do.

Explain why the student is correct. [1]

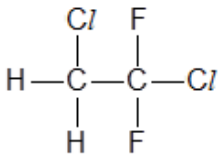
(d) Use the naming system discussed in the passage, write down the names of the following molecules.

(i)



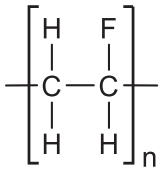
[1]

(ii)



[2]

(e) **(i)** A scientist wants to produce the polymer, polyvinyl fluoride, using HCFCs.



polyvinyl fluoride

Using a suitable HCFC, write down **two** equations showing the reactions he has to carry out to produce polyvinyl fluoride. Show the structures of all the organic compounds in your equations. [3]

(ii) Samples of the polyvinyl fluoride polymer produced were analysed and found to have a maximum relative molecular mass of 12000.

What is the maximum number of repeating units for this polymer? [2]

[Total: 12]

B9 Fats and oils such as butter, lard, tallow and coconut are compounds formed by the reaction between fatty acids and an alcohol. Fatty acids may be saturated or unsaturated in nature.

A student collected some data about fatty acids present in some common types of oil or fats, which are shown in the table below.

	% by mass of fatty acid present in substance				
types of fatty acids / types of oil or fats	lauric acid	palmic acid	stearic acid	oleic acid	linoleic acid
butter	2-3	23-26	10-13	30-40	4-5
lard	<1	28-30	12-18	41-48	6-7
tallow	<1	24-32	14-32	35-38	2-4
coconut	45-51	4-10	1-5	2-10	0-2

Lauric acid, palmic acid and linoleic acid are unsaturated fatty acids while stearic acid and oleic acid are saturated fatty acids. Fats and oils containing saturated fatty acids are less healthy than unsaturated ones.

(a) Linoleic acid, $C_{17}H_{31}COOH$ is a fatty acid found mainly in sunflower or palm oil. Stearic acid has a molecular formula of $C_{17}H_{35}COOH$.

(i) State the reagent and conditions required to form stearic acid from linoleic acid in the laboratory. [2]

(ii) Describe an experiment to show that all the linoleic acid had reacted completely to produce stearic acid. You are to include the expected observation. [3]

(b) Which types of oil or fats is the healthiest? Explain your answer. [1]

(c) 10 g of oil (M_r = 800) completely reacted with 1.8 dm^3 of hydrogen measured at room temperature and pressure.

Calculate the number of moles of hydrogen that react with one mole of the oil. Hence, deduce how many C = C bonds there are in one molecule of this oil. [2]

[Total: 8]

EITHER

B10 Sulfur dioxide reacts with chlorine gas in the presence of a catalyst to form a single liquid product, sulfuryl chloride, $SO_2C\mathit{l}_2$.

(a) Draw a 'dot-and-cross' diagram for chlorine gas.
Show the outer shell electrons only. [2]

(b) Student A says, "The sulfur in sulfur dioxide is oxidised."
Student B says, "Sulfur dioxide is an oxidising agent."

Do you agree with both of them, one of them or neither of them?
Explain your answer. [2]

(c) Sulfuryl chloride can be heated to produce sulfur dioxide and chlorine.

How can the identities of these two gases be confirmed? [2]

(d) Sulfuryl chloride reacts with water to form two strong acids. One is a dibasic acid while the other is a monobasic acid.

(i) Write down the equation for this reaction. [1]

(ii) Calculate the volume of 0.5 mol/dm^3 of dilute sodium hydroxide required to completely neutralise the acidic solution produced by reacting one mole of sulfuryl chloride with water. [3]

[Total: 10]

OR

B10 Calcium carbonate decomposes when it is heated.

$$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g)$$

In an experiment, 10.5 g of calcium carbonate was heated to a constant temperature.

(a) Sketch a graph to show how the volume of carbon dioxide collected changes with time.
Explain your answer. [4]

(b) Calculate the maximum volume of carbon dioxide, at room temperature and pressure, that can be formed from 10.5 g of calcium carbonate. [2]

(c) The experiment was repeated under the same conditions using zinc carbonate instead of calcium carbonate.

(i) Describe how the rates of the reactions would be different.
Explain your answer. [2]

(ii) The same mass (10.5 g) of zinc carbonate was used. Would the total volume of carbon dioxide formed be the same?
Explain your answer. [2]

[Total: 10]

End of paper

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Marking Scheme

Geylang Methodist School (Secondary)
Preliminary Exam 2018
Chemistry 6092

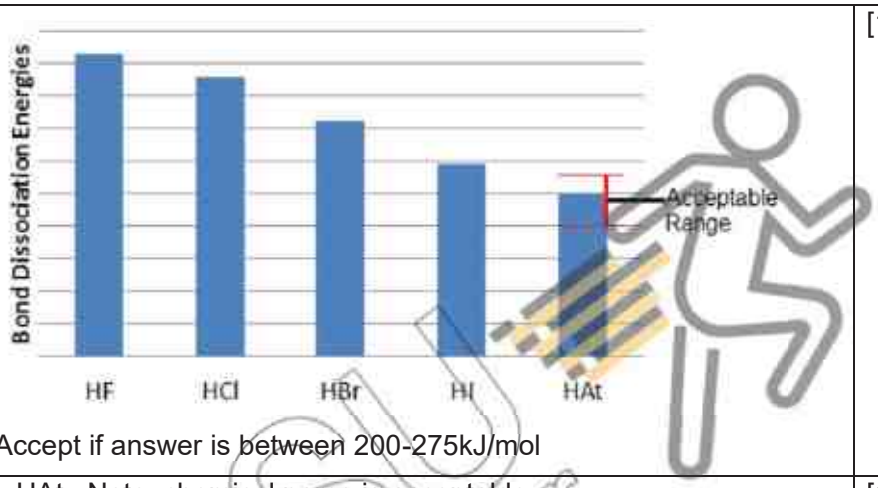
Paper 1

1	A	11	D	21	B	31	B
2	C	12	B	22	A	32	C
3	C	13	A	23	D	33	C
4	B	14	C	24	A	34	D
5	A	15	C	25	B	35	A
6	A	16	B	26	C	36	D
7	C	17	B	27	B	37	B
8	D	18	B	28	C	38	C
9	C	19	A	29	D	39	D
10	A	20	D	30	D	40	C

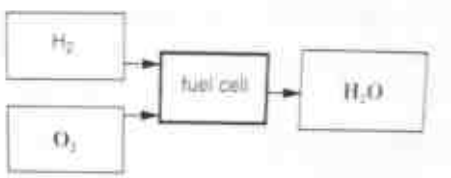
Paper 2
Section A

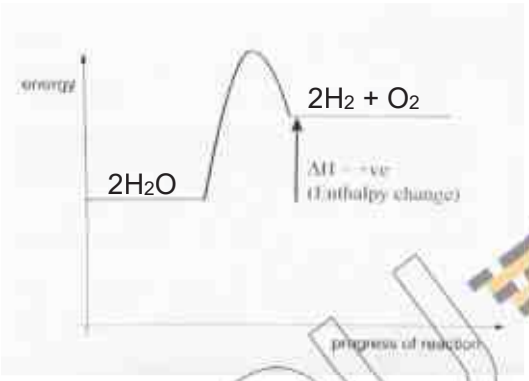
A1	(a)	i. B ii. A iii. C and E Note: both answers must be correct to award 1 mark.	[1] [1] [1]
	(b)	Mercury	[1]
	(c)	$2O^{2-}(l) \rightarrow O_2(g) + 4e$ Note: [1] for chemically balanced ionic equation without state symbols.	[2]

A2	(a)	The bond dissociation energies of hydrogen halides decreases from HF to HAt.	[1]

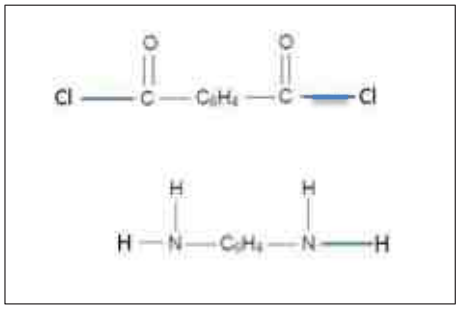
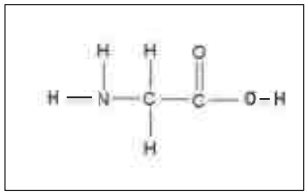
A2	(b)	 Accept if answer is between 200-275kJ/mol	[1]
	(c)	i. HAt Note: chemical name is acceptable. ii. HAt has the lowest bond dissociation energy therefore hydrogen ions will be produced most easily.	[1] [1] [1]
	(d)	Enthalpy change = 432 + 193 – 2(363) = -101 kJ Exothermic reaction	[1] [1]

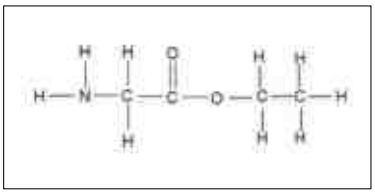
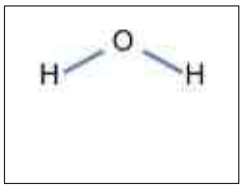
A3	(a) i	Purple / violet Acceptable: bluish-purple or purplish-blue	[1]
	(a) ii	Light blue – 0.500 (3sf) Dark blue – 1.25 (3sf)	[1] [1]
	(b) i	Any strong alkali such as NaOH, KOH	[1]
	(b) ii	20 cm^3 – blue 30 cm^3 - pink	[1] [1]

A4	(a)	 Note: Both answers must be correct to award 1 mark.	[1]
	(b)	Steam, which is the product of fuel cell, has no adverse effect on human health. Waste product, like carbon monoxide, from incomplete combustion of petrol, can react with haemoglobin in blood to form carboxyhaemoglobin. As a result, haemoglobin cannot transport oxygen to the rest of the body.	[1] [1] [1]

A4	(c)	 [1] – correct graph [1] – for correct labelling	[2]

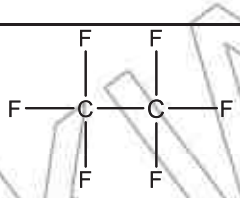
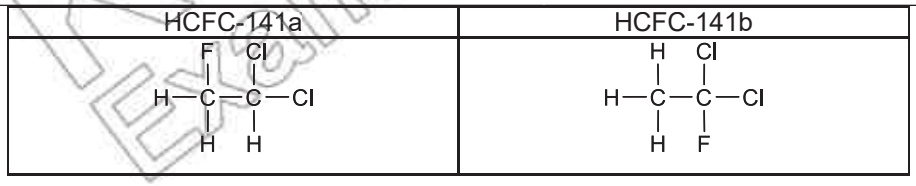
A5	(a)	i. Oxygen ii. Sodium iii. Neon	[1] [1] [1]
	(b)	i. YCl_2 Accept: magnesium chloride ii. NaX **and** Cl_2 Accept: sodium fluoride and chlorine	[1] [1]
A5	(c)	200-250atm 400-500°C Iron catalyst <u>Note</u>: 2 marks for 3 correct answers; 1 mark for 2 correct answers.	[2]

A6	(a)	i. condensation polymerisation ii. condensation polymerisation iii. addition polymerisation	[1] [1] [1]
	(b)	i. 	[1] [1]
		ii. 	[1]

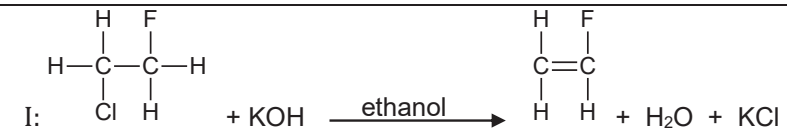
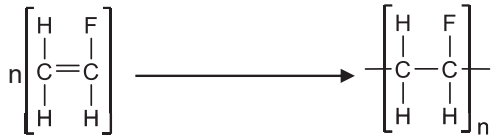
	(c)	 	[1] for each

A7 (a)	Zn^{2+} (aq) + 2e → Zn (s)	[2]
(b)	i. Concentration of zinc ions will decrease over time. ii. Concentration of zinc ions will remain constant throughout electrolysis. iii. Zinc brush will form zinc ions during electrolysis and will be used up whereas platinum is an inert electrode therefore no change in mass.	[1] [1] [1] [1]
(c)	Material – poly(ethene) Reason – It does not conduct electricity.	[1] [1]
A7(d)	Zinc is <u>more reactive</u> than iron and therefore <u>provides sacrificial protection</u> by corroding in place of iron.	[1] [1]

Section B

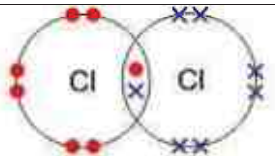
B8 (a)		[1]
(b)	 HCFC-141a | HCFC-141b [1] for each box.	[2]
(c)	HFCs do not contain <u>chlorine atoms</u> which will <u>deplete the ozone layer</u>.	[1]
(d)	i. CFC-111 ii. HCFC-132a Note: 1 mark for 132, 1 mark for a	[1] [2]

i.

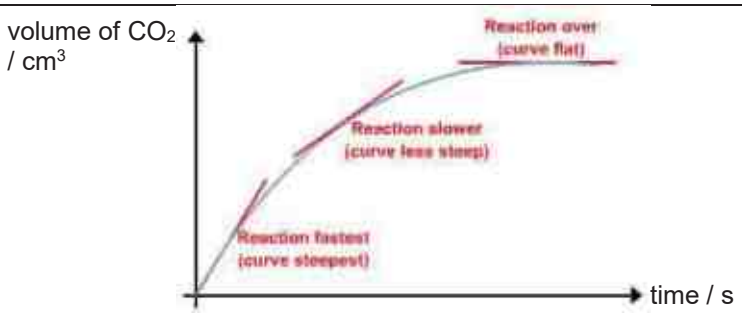
B8(e)	I:  1 mark for correct HCFC used; 1 mark for equation. II: 	[2] [1]
(e)	ii. M_r of repeating unit: 12 x 2 + 19 + 1 x 3 = 46 No. of repeating units: 12000/46 = 260 (round down)	[1] [1]

B9(a)	i. Reagent: hydrogen gas Conditions: Nickel as catalyst, 200 °C ii. Add aqueous bromine to the reaction mixture. If all the linoleic acid has reacted, the reddish-brown colour of bromine remains. If some linoleic acid is present, the reddish-brown colour of bromine decolourises rapidly.	[1] [1] [1] [1] [1]
B9(b)	Coconut oil is the healthiest. It contains the <u>highest</u> percentage of unsaturated fatty acids/ It contains the <u>lowest</u> percentage of saturated fatty acids. <u>Note</u>: Explanation must be correct in order to award mark.	[1]
(c)	No. of moles of hydrogen reacted = 1.8/24 = 0.075 mol Number of moles of oil = 10/800 = 0.0125 mol } [1] Number of moles of hydrogen : number of moles of oil 0.075 : 0.0125 6 : 1 There are 6 double bonds in one molecule of oil. } [1]	[2]

Either

B10(a)	 1 mark for correct bonding, 1 mark for correct number of electrons for each element.	[2]
(b)	Student A is correct as the oxidation state of sulfur in sulfur dioxide increases from +4 to +6. Student B is wrong as sulfur dioxide reduces the oxidation state of chlorine from 0 to -1, hence sulfur dioxide is the reducing agent.	[1] [1]
(c)	SO_2, when bubbled through acidifed potassium manganate(VII), will decolourise the purple solution. A damp blue litmus paper when placed near the heated liquid will turn red before being bleached by Cl_2.	[1] [1]
(d) i.	$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$	[1]
(d) ii.	No. of moles of H_2SO_4 = 1 mole No. of moles of HCl = 2 moles $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ (equation not needed) No. of moles of NaOH needed to neutralise 1 mole of H_2SO_4 = 2 moles [1] $HCl + NaOH \rightarrow NaCl + H_2O$ (equation not needed) No. of moles of NaOH needed to neutralise 2 moles of HCl = 2 moles [1] Total moles of NaOH needed = 4 moles Volume of NaOH needed = $4 \div 0.5 = 8\ dm^3$ [1]	[3] Refer to marks allocation on the left.

OR

B10(a)	 Note: There isn't a need to indicate the reaction rate on the graph. The initial rate of decomposition is the fastest therefore the gradient is the steepest. As the rate of decomposition slows down, the gradient becomes less steep. Finally reaction stops when all calcium carbonate is used up and gradient is zero.	[1] – graph [1] - correct labels and units [1] [1]
(b)	No. of moles of $CaCO_3$ = 10.5 / 100 = 0.105 mol Volume of CO_2 = 0.105 x 24 = 2.52 dm^3	[1] [1]
(c)	i. The rate of decomposition of zinc carbonate will be faster than the rate of decomposition of calcium carbonate. Zinc carbonate is less thermally stable than calcium carbonate therefore it decomposes more readily than calcium carbonate. Note: Ignore reference to metal reactivity, no mark will be awarded.	[1] [1]
	ii. No. Possible explanation: No. of moles of $ZnCO_3$ = 10.5 / 125 = 0.084 mol Volume of CO_2 = 0.084 x 24 = 2.02 dm^3 **OR** Since there are fewer moles of zinc carbonate therefore the volume of carbon dioxide collected will be lesser.	no mark [1] [1] [1] [1]

END OF PAPER

Name:	Class	Index Number

Jurong West Secondary School

Preliminary Examinations 2018

40

CHEMISTRY 6092/01

Secondary Four Express **17 August 2018**

Paper 1 **1130 - 1230**

1 hour

Candidates answer on the Multiple Choice Answer Sheet.

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in soft pencil.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

There are **forty** questions. 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 question paper.

A copy of the Periodic Table is printed on page 15.

After checking of answer script		
Checked by Student	**Signature**	**Date**

This document consists of **15** printed pages.

Setter: Mr Edwin Kwek

1 Calcium carbonate reacts with hydrochloric acid, producing carbon dioxide gas.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

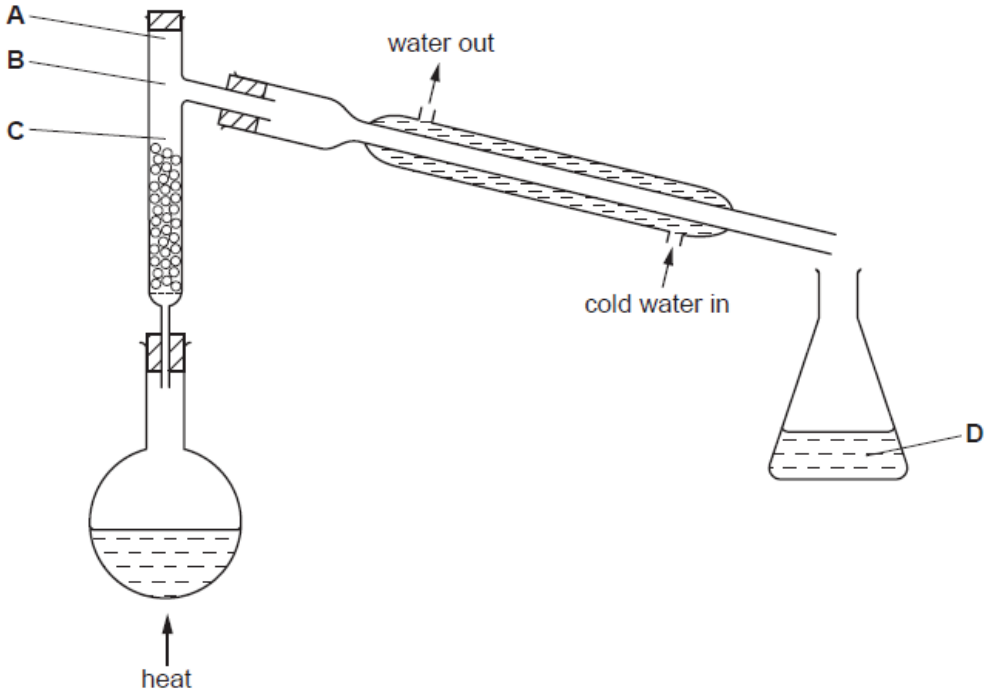
The rate of this reaction can be measured using the apparatus shown.

Which additional piece of apparatus is also required?

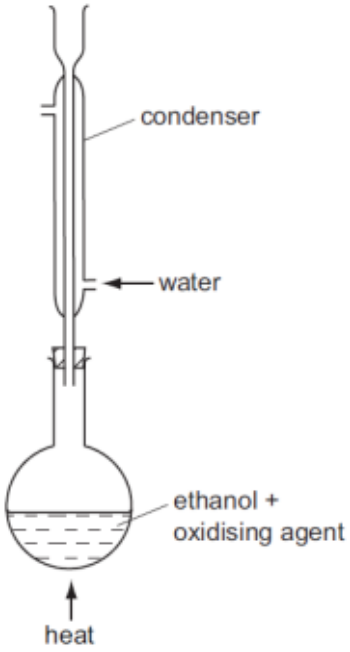
A a burette
B a clock
C a gas syringe
D a thermometer

2 The fractional distillation apparatus shown is being used to separate a mixture of two liquids. A thermometer is missing from the apparatus.

Where should the bulb of the thermometer be placed?



3 The oxidation of ethanol to ethanoic acid is often carried out in the apparatus shown.



What is the purpose of the condenser?

A to prevent any ethanol from escaping
B to prevent air from reacting with the ethanoic acid
C to prevent the ethanoic acid from reacting with the ethanol
D to prevent the ethanoic acid from changing back to ethanol

4 The table shows the results of two reactions of an aqueous solution of a salt.

reagents	final observation
excess aqueous sodium hydroxide	white precipitate
dilute nitric acid and aqueous silver nitrate	yellow precipitate

What is the name of the salt?

A calcium chloride
B calcium iodide
C zinc nitrate
D zinc sulfate

5 Which property or properties will affect the rate of diffusion of gases?

1 Temperature
2 Solubility
3 Molecular mass

A 1 only
B 1 and 2
C 1 and 3
D All of the above

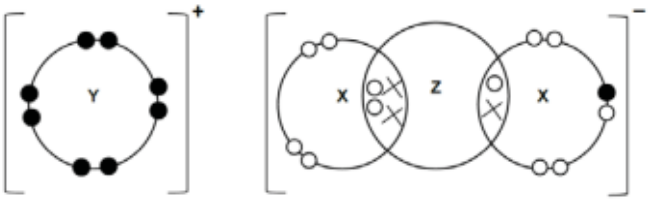
6 Alpha particles consist of two protons and two neutrons bound together into a particle identical to a helium-4 nucleus.

In the Rutherford gold foil experiment, a thin piece of pure gold foil was used. After alpha particles were shot at gold foil, scientists noticed only a tiny fraction of the alpha particles were deflected by a large angle. Most flew straight through the foil.

Suggest a reason for this phenomenon.

A The gold atoms consist of a small positively charged nucleus with large, empty spaces between the nucleus.
B The gold atoms consist of a small negatively charged nucleus with large, empty spaces between the nucleus.
C The gold atoms are surrounded by small positively charged electrons with large, empty spaces between the electrons.
D The gold atoms are surrounded by small negatively charged electrons with large, empty spaces between the electrons.

7 X, Y and Z are 3 different elements in the Periodic Table. The 'dot-and-cross' diagram of the compound formed from X, Y and Z is shown below. Only the valence electrons are shown.



Which statements are correct?

1 Element Y could be lithium.
2 Element X belongs to Group VI of the Periodic Table.
3 Elements X and Z are bonded together by covalent bonds.
4 There are more electrons than protons in ZX_2^-.

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

8 The table below shows the number of neutrons and electrons in the following four particles.

Particle	Number of neutrons	Number of electrons
W	18	8
X^+	12	10
Y^{2-}	16	10
Z	13	11

Which of the following atoms is an isotope of W?

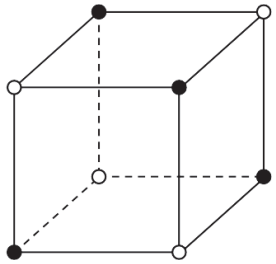
A X

B Y

C Z

D None of the above

9 The diagram shows the arrangement of the ions in an ionic crystal.



Key

○ = positive ion

● = negative ion

Which substance **cannot** have this arrangement of its ions?

A $CuSO_4$

B KC*l*

C MgO

D Na_2S

10 Which of the following correctly describes the particles in a **very dilute** sodium chloride solution at room temperature?

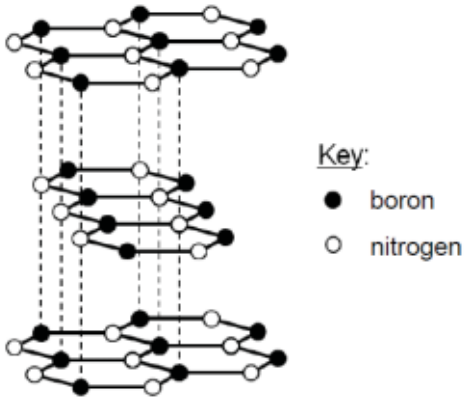
	ions of sodium chloride	water molecules
A	widely separated, moving at random	close together, moving at random
B	widely separated, vibrating about fixed positions	close together, moving at random
C	close together, moving at random	widely separated, moving at random
D	close together, vibrating about fixed positions	widely separated, moving at random

11 The table gives the properties of four substances.
Which substance is a solid metal at room temperature?

	melting point / °C	boiling point / °C	electrical conductivity when solid	electrical conductivity when molten
A	808	1465	×	✓
B	98	890	✓	✓
C	119	445	×	×
D	-39	357	✓	✓

key
✓ = conducts
× = does not conduct

12 The diagram shows the structure of hexagonal boron nitride.



Which property is hexagonal boron nitride most likely to have?

A It is soluble in water.
B It has a low melting point.
C It is soft and acts as a lubricant.
D It does not conduct electricity in solid state but conducts electricity in liquid state.

13 Which statement is **not** true for all metals when they are in solid state?

A They conduct heat.
B They are malleable.
C They conduct electricity.
D They form coloured compounds.

14 All of the following substances can conduct electricity.
Which substance's conductivity is not due to the movement of electrons?

A aluminium
B graphite
C lithium chloride
D mercury

15 One mole of a sample of hydrated sodium sulfide contains 162 g of water of crystallisation. What is the correct formula of this compound?

A $Na_2S.3H_2O$
B $Na_2S.5H_2O$
C $Na_2S.7H_2O$
D $Na_2S.9H_2O$

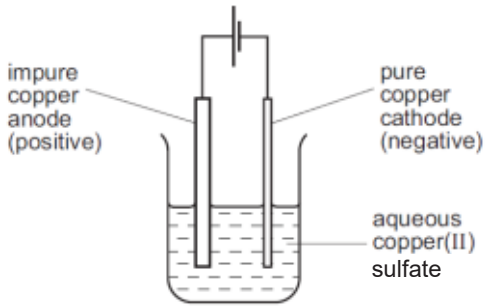
16 Hydrogen reacts with oxygen as shown in the equation below.

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

How much gas will remain if 2 dm^3 of hydrogen are reacted with 1 dm^3 of oxygen at room temperature?

A 0 dm^3
B 1 dm^3
C 2 dm^3
D 3 dm^3

17 A sample of copper contains a metal impurity which is below copper in the reactivity series. The diagram shows the apparatus used for refining the sample.



The loss in mass of the anode is 50 g and the gain in mass of the cathode is 45 g.

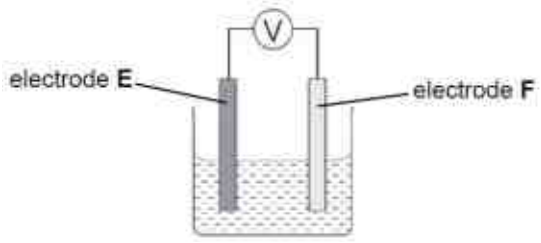
What is the percentage purity of this sample of copper?

A 10.0%
B 11.1%
C 90.0%
D 95.0%

18 What products are formed when concentrated aqueous potassium chloride is electrolysed?

	at the anode	at the cathode
A	chlorine	hydrogen
B	chlorine	potassium
C	oxygen	hydrogen
D	oxygen	potassium

19 A galvanic cell is set up as shown below.



Which pair of electrodes would give the largest magnitude on the voltmeter reading?

	electrode E	electrode F
A	copper	zinc
B	magnesium	copper
C	silver	magnesium
D	zinc	iron

20 Which of the following is an endothermic reaction?

A the combustion of ethanol in air
B the oxidation of carbon to carbon dioxide
C the reaction between hydrogen and oxygen
D the formation of a carbohydrate and oxygen from carbon dioxide and water

21 Nitrogen and hydrogen react to give ammonia according to the equation.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

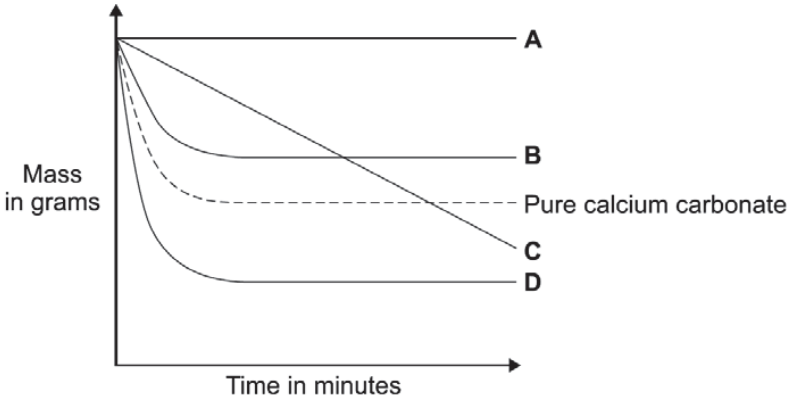
The bond energy of some covalent bonds are shown below.

bond	bond energy (kJ/mol)
N≡N	945
H–H	436
N–H	391

What is ΔH, in kJ/mol, for the reaction above?

A –1471
B –93
C 93
D 1471

22 Limestone usually contains impurities.
The diagram below shows the change in mass when pure calcium carbonate is heated.
Which graph, **A**, **B**, **C** or **D**, shows a sample of limestone, of the same mass, containing impurities that do not thermally decompose?



23 The following changes could be made to the conditions in the reaction between zinc and hydrochloric acid.

1 increase in concentration of the acid
2 increase in particle size of the zinc
3 increase in pressure on the system
4 increase in temperature of the system

Which pair of changes will increase the rate of reaction?

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

24 Why is nickel used in the addition of hydrogen to alkenes?

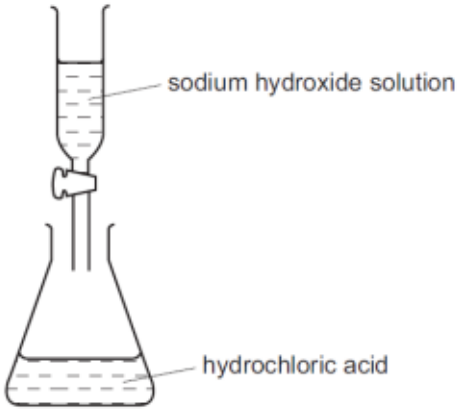
A It increases the yield of products.
B It makes the reaction more exothermic.
C It prevents a reverse reaction from occurring.
D It lowers the activation energy of the reaction.

25 Iron is extracted from its ore haematite, Fe_2O_3, by a reduction process in the blast furnace.

Which equation for reactions in the blast furnace shows the formation of the reducing agent?

A $CaCO_3 \rightarrow CaO + CO_2$
B $CaO + SiO_2 \rightarrow CaSiO_3$
C $CO_2 + C \rightarrow 2CO$
D $C + O_2 \rightarrow CO_2$

26 Sodium hydroxide solution was added to dilute hydrochloric acid. The pH of the solution in the flask was measured at intervals until no further change of pH took place.



What would be the pH change in this reaction?

A decrease to 1
B decrease to 7
C increase to 7
D increase to 12

27 Which metal has a soluble carbonate, chloride and sulfate?

A barium
B calcium
C copper
D potassium

28 Which substance would **not** be used for preparing a pure sample of crystalline magnesium sulfate by reaction with dilute sulfuric acid?

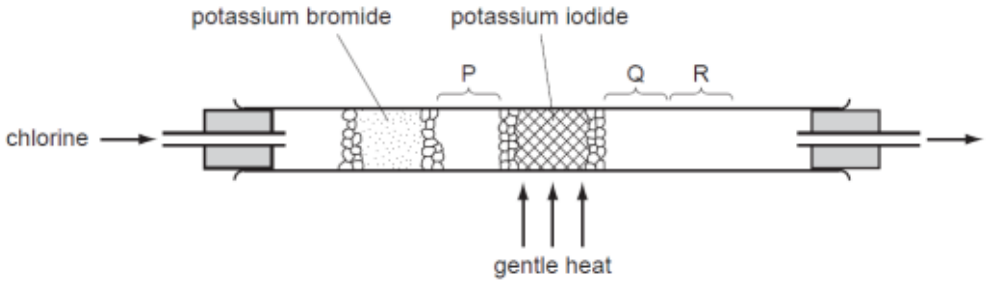
A magnesium carbonate
B magnesium hydroxide
C magnesium nitrate
D magnesium oxide

29 Which of the following methods would produce ammonia?

1 Heating aqueous barium nitrate with sodium hydroxide and aluminium powder.
2 Heating aqueous ammonium chloride with aqueous calcium hydroxide.
3 Heating solid ammonium sulfate with solid potassium hydroxide.
4 Heating aqueous ammonium chloride with dilute hydrochloric acid.

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

30 Using the apparatus shown, chlorine is passed through the tube.



After a short time, coloured substances are seen at P, Q and R.
What are these coloured substances?

	at P	at Q	at R
A	green gas	red brown vapour	violet vapour
B	green gas	violet vapour	black solid
C	red brown vapour	violet vapour	black solid
D	violet vapour	red brown vapour	red brown vapour

31 The table shows the reactions of metals **A**, **B**, **C** and **D** when placed in aqueous solutions of their nitrates.

metal	nitrate of **A**	nitrate of **B**	nitrate of **C**	nitrate of **D**
A	-	reacts	reacts	reacts
B	no reaction	-	reacts	no reaction
C	no reaction	no reaction	-	no reaction
D	no reaction	reacts	reacts	-

A mixture of aqueous solutions of nitrates of **A**, **B**, **C** and **D** are electrolysed using carbon electrodes.

Which metal ion of metals **A**, **B**, **C** or **D** would most readily be discharged at the negative electrode?

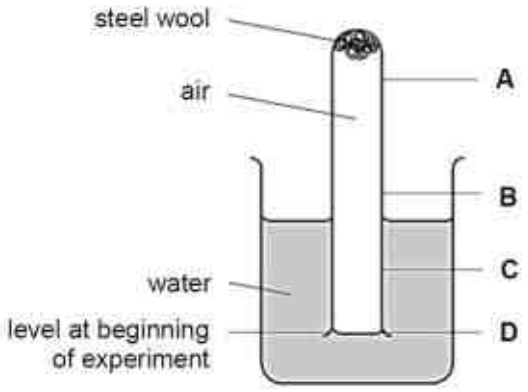
32 Experiments were carried out to determine the relative reactivity of three metals, S, T and U. The results were recorded in the table.

	metal S	metal T	metal U
Can the metal react with dilute hydrochloric acid?	yes	no	yes
Can the metal oxide be reduced by heating with carbon?	yes	yes	no

Which of the following shows the metals in order of **decreasing** reactivity?

A S, U, T
B T, S, U
C U, S, T
D U, T, S

33 The diagram shows steel wool inside a test-tube.



The test-tube is inverted in water, trapping air inside. What will be the water level inside the tube after several days?

34 The enthalpy change for the complete combustion of three different fuels, methane, ethanol and propene are as shown below.

fuel	formula	M_r	enthalpy change of combustion / kJ/mol
methane	CH_4	16	-100
ethanol	C_2H_5OH	46	-75
propene	C_3H_6	42	-170

What is the correct order of fuels, starting from the fuel that provides the most energy per gram of fuel, when the fuel undergoes complete combustion?

A methane, propene, ethanol
B methane, ethanol, propene
C propene, methane, ethanol
D ethanol, propene, methane

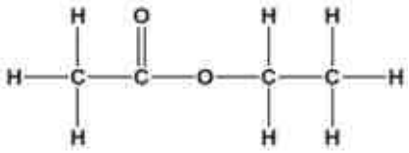
35 The table shows the boiling points of four fractions, P, Q, R and S, obtained when crude oil is distilled.

Fraction	P	Q	R	S
Boiling Range / ^{o}C	35-75	80-145	150-250	greater than 250

How is fraction P different from S?

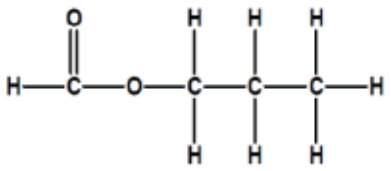
A Fraction P is more viscous than fraction S.
B Fraction P is in less demand than fraction S.
C Fraction P is more flammable than fraction S.
D Fraction P contains molecules of larger molecular masses than fraction S.

36 The diagram shows the structure of ethyl ethanoate.

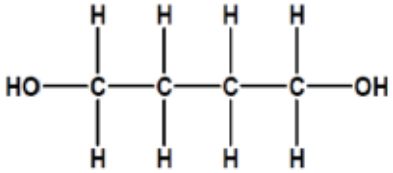


Which structure is **not** an isomer of ethyl ethanoate?

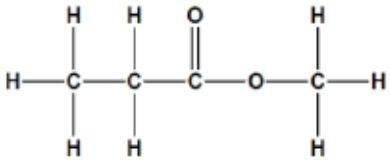
A



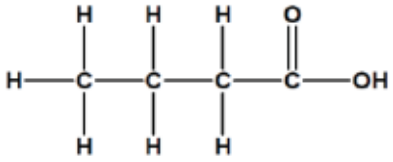
B



C



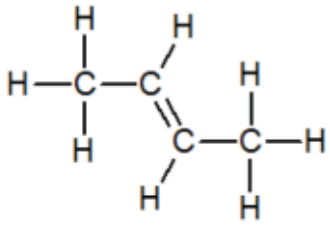
D



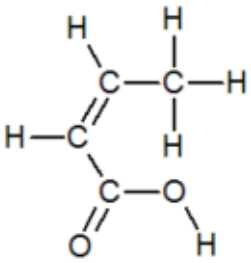
37 60 cm^3 of oxygen was mixed with 10 cm^3 of gaseous hydrocarbon in a closed vessel. After explosion and cooling, the gases occupied 50 cm^3 and after passing the gas through aqueous sodium hydroxide, 30 cm^3 of oxygen remained. Deduce the molecular formula of the hydrocarbon.

A CH_4
B C_2H_4
C C_2H_6
D C_3H_6

38 The full structural formulae of compounds X and Y are shown below.



Compound **X**



Compound **Y**

The **best** method to distinguish between X and Y visually is by using

A aqueous bromine
B potassium hydroxide solution
C potassium carbonate solution
D acidified potassium manganate(VII) solution

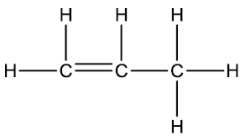
39 A food chemist wants to create the odour of pineapples for a product. An ester with this odour has the formula $C_3H_7CO_2C_4H_9$.

Which pair of substances will react to produce this ester?

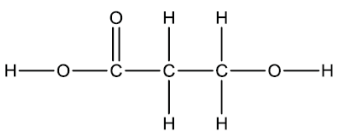
A $C_2H_5CO_2H$ and C_4H_9OH
B $C_2H_5CO_2H$ and C_3H_7OH
C $C_4H_9CO_2H$ and C_3H_7OH
D $C_3H_7CO_2H$ and C_4H_9OH

40 Which compounds would undergo polymerisation on their own?

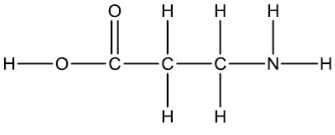
1



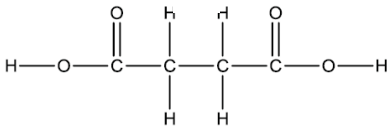
2



3



4



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

End of Paper

The Periodic Table of Elements

	Group																	
	I	II									III	IV	V	VI	VII	0
						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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.).

Name:	Class	Index Number

Jurong West Secondary School

Preliminary Examinations 2018

80

CHEMISTRY 6092/02

Secondary Four Express **21 August 2018**

Paper 2 **0800 – 0945**

1 hour 45 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form of either/or.
Answer **all** questions in the spaces provided.

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.
A copy of the Periodic Table is printed on page 20.

After checking of answer script		
Checked by Student	**Signature**	**Date**

This document consists of **20** printed pages.

Setter: Mr Edwin Kwek

Section A

Answer **all** the questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The diagram shows part of the Periodic Table. Only some of the elements are shown.

							H										
													C	N	O		
Na	Mg											Al	Si	P			
K	Ca						Fe			Cu	Zn						
Rb																	

Answer each of the following questions using only those elements shown in the diagram. Each element may be used once, more than once or not at all.

Give one element which

(a) has a giant molecular structure,

.....[1]

(b) combines with oxygen to form a gas which contributes to acid rain,

.....[1]

(c) forms an ion of type X^+ which has only three completely filled shells of electrons,

.....[1]

(d) has an atom with fourteen protons,

.....[1]

(e) can exist as two different allotropes in gaseous state,

.....[1]

(f) is the most reactive metal among the listed elements,

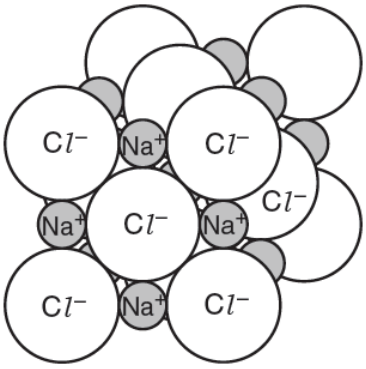
.....[1]

(g) has a chloride of type XCl_2, whose aqueous solution forms a green precipitate on addition of sodium hydroxide.

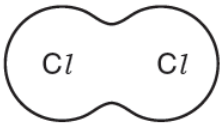
.....[1]

[Total: 7]

A2 The structures of sodium chloride and chlorine are shown below.



sodium chloride



chlorine

The melting point of sodium chloride is 801 °C.
The melting point of chlorine is –101 °C.

(a) Explain, in terms of structure and bonding, the difference between the melting points of these two substances.

.....

.....

.....

.....

.....[4]

(b) Predict whether magnesium oxide would have a higher or lower melting point than sodium chloride. Explain your answer in terms of bonding.

.....

.....

.....[2]

(c) Chlorine exists as a gas at room temperature while bromine exists as a liquid at room temperature. Explain your answer in terms of bonding.

.....

.....

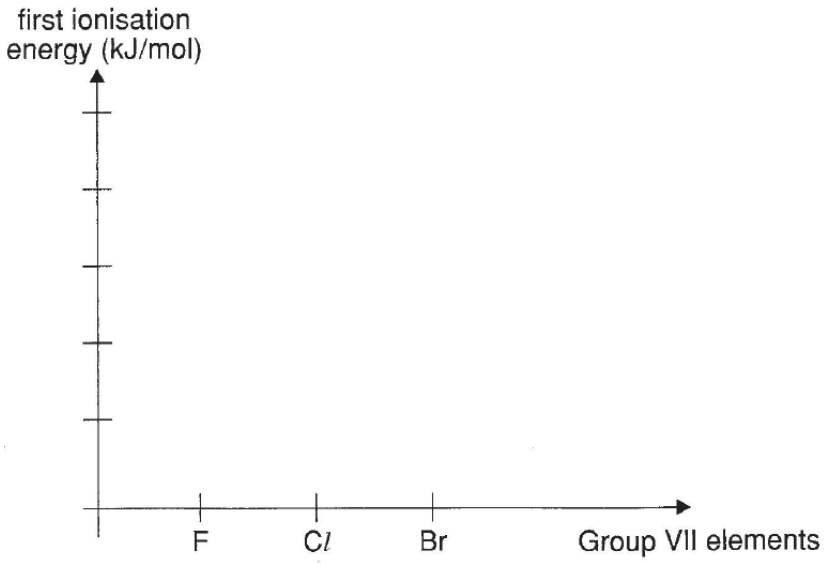
.....[2]

[Total: 8]

A3 First ionisation energy is the energy required to convert one mole of gaseous atoms into one mole of gaseous ions with a charge of +1.

The magnitude of the first ionisation energy increases in general as the number of electron shells decreases.

(a) **(i)** Draw, in the following graph, the trend in which the first ionisation energy changes down Group VII elements from fluorine to bromine.



[1]

(ii) Based on the trend of the change in first ionisation energy, suggest the relationship between the first ionisation energy and the reactivities of elements in Group VII.

.....[1]

(b) **(i)** What is observed if aqueous sodium iodide is reacted with aqueous chlorine?

.....[1]

(ii) Write an ionic equation, with state symbols, for the reaction in **(i)** above.

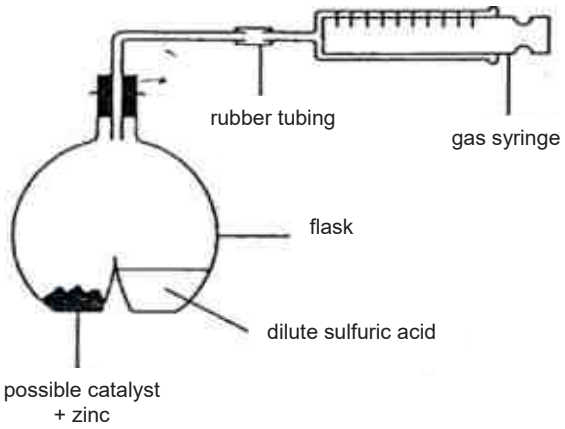
.....[2]

[Total: 5]

A4 The apparatus shown in the diagram was used to study the catalytic effect of certain

substances on the exothermic reaction between zinc and dilute sulfuric acid.

Several experiments were carried out. In each experiment, 50 cm^3 of 1.0 mol/dm^3 sulfuric acid, 1.0 g of zinc powder and 0.1g of a possible catalyst were used.



To start the reaction, the flask was shaken. The time taken to collect 50 cm^3 of hydrogen was recorded. Other observations are shown in the table.

Possible catalyst added	**Time to collect 50 cm^3 of hydrogen/s**	**Other observations**
No added catalyst	65	-
0.1 g of copper(II) sulfate	10	colourless solution obtained and a brown solid coated the zinc
0.1 g of copper(II) chloride	15	colourless solution obtained and a brown solid coated the zinc
0.1 g of copper powder	19	pink solid remained
0.1g of copper lumps	56	pink solid remained
0.1g of sodium chloride	65	colourless solution formed

(a) **(i)** Write the chemical equation for the reaction between zinc and dilute sulfuric acid.

.....[1]

(ii) Calculate the maximum volume of hydrogen gas that can be produced at

room temperature and pressure in the reaction.

[3]

(b) Which of the added substances behaved as a catalyst? Explain your answer using information from the table.

.....

.....

..... [2]

(c) Explain, in terms of activation energy, how a catalyst speeds up a reaction.

.....

.....

.....[2]

(d) Suggest whether the time taken to collect 50 cm^3 of hydrogen would be longer or shorter than 65 s when 1.0 g of zinc lumps was used in the absence of a catalyst.

Explain your answer in terms of colliding particles.

.....

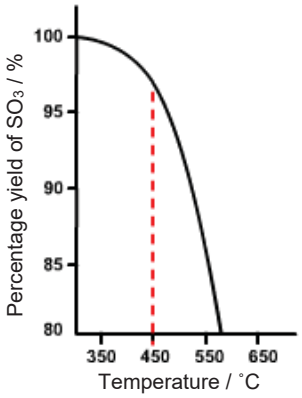
.....

.....[2]

[Total: 10]

A5 The graph below shows the percentage conversion to sulfur trioxide from sulfur dioxide

and oxygen gas during the Contact Process.



(a) Give two reasons, other than cost, why the optimal temperature for Contact Process is 450 ˚C.

.....

.....

..... [2]

(b) Write down the chemical equation for the formation of sulfur trioxide from sulfur dioxide and oxygen.

..... [1]

(c) Explain, in terms of bond breaking and bond forming, why the conversion of sulfur dioxide and oxygen to sulfur trioxide is an exothermic reaction.

.....

.....

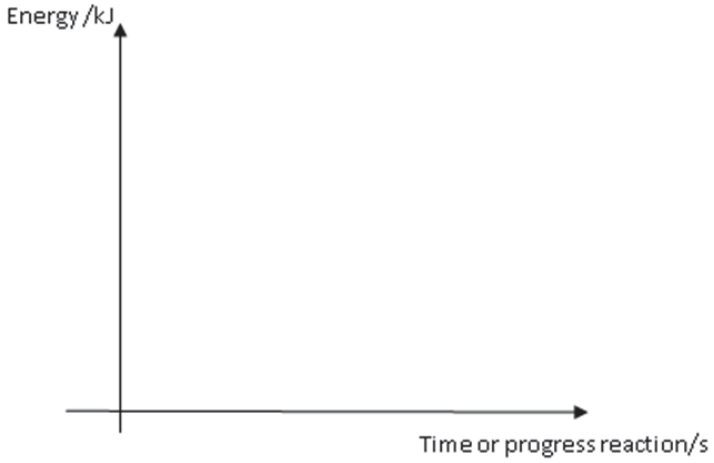
.....

..... [3]

(d) Draw an energy profile diagram to show the formation of sulfur trioxide from sulfur dioxide and oxygen.

Your diagram should show and label

- formulae of the reactants and products
- the activation energy for the reaction,
- the enthalpy change of reaction.



[3]

[Total: 9]

A6 The graph below shows the relationship between the concentration of carbon dioxide (in micromoles per kg of seawater) and the pH of the seawater across the years.

Historical and Projected pH and Dissolved Carbon

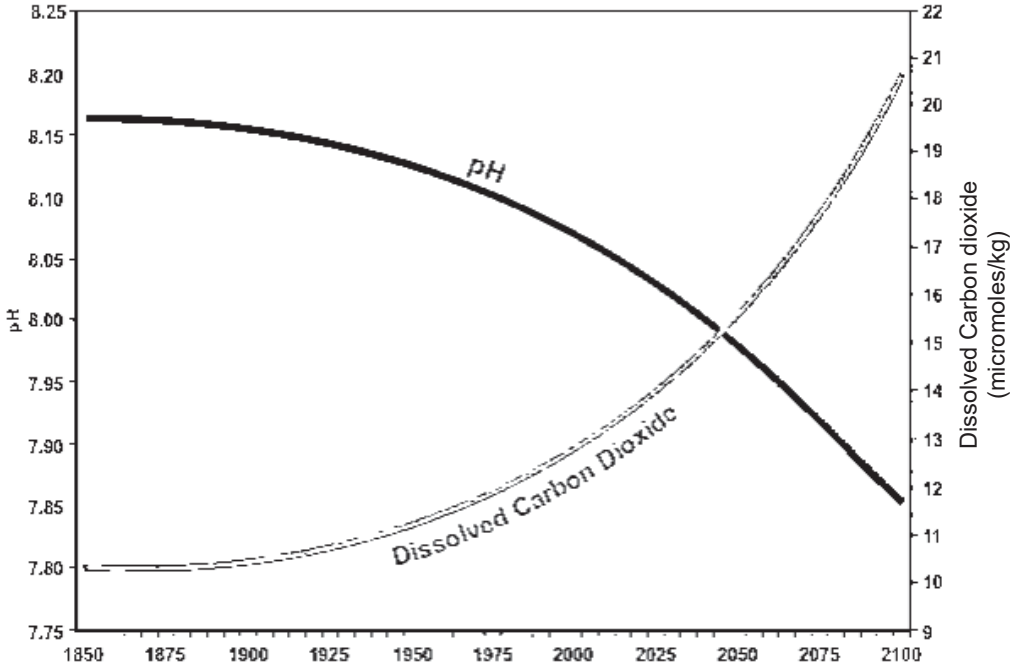


Figure 6.1

(a) **(i)** Describe how the concentration of dissolved carbon dioxide has changed across the years.

.....

.....

.....[2]

(ii) State the relationship between the concentration of carbon dioxide and the pH of the seawater across the years.

.....[1]

(b) **(i)** During the test for carbon dioxide, it is observed that white precipitate would be observed when the gas is bubbled into solution **X** initially.

Upon further bubbling of the carbon dioxide, the white precipitate would dissolve to form a colourless solution.

State the identity of solution **X**.

.....[1]

(ii) Suggest how the concentration of dissolved carbon dioxide would affect the formation of coral reefs which consist mainly of calcium carbonate.

.....

.....

.....

.....[2]

(c) Scientists have discovered that when carbon-neutral fuels, such as ethanol, are burnt, the amount of carbon dioxide in the atmosphere remains relatively constant.

Mary stated that ethanol obtained from all forms is considered to be a form of carbon-neutral fuel. John argued that only those obtained from the fermentation of glucose can be considered as carbon-neutral.

(i) Write down the chemical equation for the fermentation of glucose.

.....[1]

(ii) Who do you agree with, Mary or John? Explain your answer.

.....

.....

.....

.....

.....

.....[4]

[Total: 11]

Section B

Answer all **three** questions from this section in the spaces provided.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B7 Read the information about organic acids.

Organic acids as weak acids
A weak acid is one which ionises partially to produce hydrogen ions when it is dissolved in water.

Ethanoic acid is a typical weak acid. It ionises in water to produce hydrogen ions and ethanoate ions, but the backward reaction occurs more readily than the forward one. So the ions react very easily to reform the acid.

$$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$$

At any one time, less than 1% of the ethanoic acid molecules have converted into ions. The rest remain as simple ethanoic acid molecules.

Most organic acids are weak.

Comparing the strengths of weak acids using the acid dissociation constant, K_a
The position of equilibrium for the ionisation of each acid varies from one weak acid to another. The further to the left it lies, the weaker the acid is.

You can get a measure of the position of an equilibrium using the acid dissociation constant, K_a. The higher the value for the constant, the more the equilibrium lies to the right, the greater the extent of dissociation of the acid.

So the expression to determine the K_a of ethanoic acid is given by:

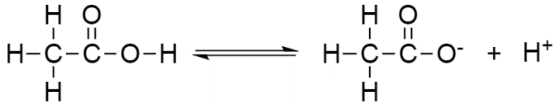
$$\frac{[H^+][CH_3COO^-]}{[CH_3COOH]},$$

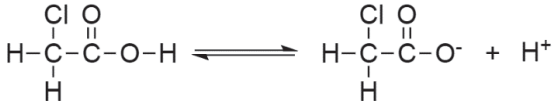
where the product of the concentration of the hydrogen ion, $[H^+]$, and the concentration of the ethanoate ion, $[CH_3COO^-]$, is divided by the concentration of the undissociated ethanoic acid, $[CH_3COOH]$.

As the extent of dissociation is very little, the concentration of the undissociated acid could be taken to be the same as the concentration of the ethanoic acid before dissociation occurs.

Electronegativity of substituents
Electronegativity refers to the tendency of an atom to attract shared electrons from the covalent bond towards itself.

Atoms of halogens are generally electronegative. When a hydrogen atom in an organic acid is replaced by a halogen atom, the halogen atom draws the electron density towards itself. This reduces the electron density of the functional group, allowing the anion formed to be more stable and recombined with the hydrogen ion less readily.

Dissociation of ethanoic acid: 

Dissociation of chloroethanoic acid: 

Comparing ethanoic acid and chloroethanoic acid, chloroethanoic acid will dissociate to a larger extent.

Acid dissociation constant, K_a, of different organic acids

The table below provides you with a list of K_a values of different organic acids.

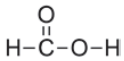
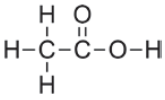
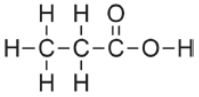
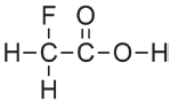
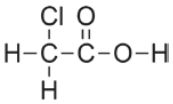
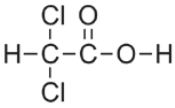
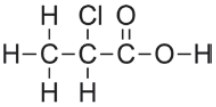
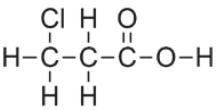
name	structure	K_a
methanoic acid		1.80×10^{-4}
ethanoic acid		1.75×10^{-5}
propanoic acid		1.34×10^{-5}
fluoroethanoic acid		2.57×10^{-3}
chloroethanoic acid		1.35×10^{-3}
dichloroethanoic acid		4.47×10^{-2}
2-chloropropanoic acid		1.48×10^{-3}
3-chloropropanoic acid		1.05×10^{-4}

Table 7.1

Adapted from:
https://www.chemguide.co.uk/physical/acidbaseeqia/acids.html
https://chem.libretexts.org/Textbook_Maps/Organic_Chemistry_Textbook_Maps/Map%3A_Organic_Chemistry_(Bruice)

(a) Calculate the concentration of hydrogen ions, in mol/dm^3, present in 5 mol/dm^3 of ethanoic acid, with reference to Table 7.1 and the expression for K_a of ethanoic acid.

[2]

(b) Write down the expression to determine the K_a of fluoroethanoic acid.

[1]

(c) Using the information provided, describe how the number of the carbon atoms in the carboxylic acid affects the strength of the acid.

.....

.....

..... [2]

(d) Using the information provided, deduce whether fluorine or chlorine is more electronegative. Explain.

.....

..... [1]

(e) Suggest whether 2-fluoropropanoic acid or 3-fluoropropanoic acid would be a stronger acid. Explain your answer using an example.

.....

.....

..... [2]

(f) Suggest why trichloroethanoic acid would be stronger than both chloroethanoic acid and dichloroethanoic acid. Explain in terms of electron density around the carboxylate group.

.....

.....

..... [2]

[Total: 10]

B8 **(a)** What method would you use to extract magnesium metal from its naturally occurring compound, magnesium chloride, in seawater, given that aluminium is extracted from aluminium oxide by electrolysis? Explain your answer based on the reactivity of the two metals.

.....

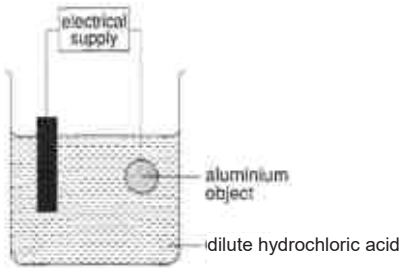
.....

.....

..... [2]

(b) Aluminium is a reactive metal and it reacts with atmospheric oxygen to form aluminium oxide, Al_2O_3. It is a metal that is widely used in various applications.

The layer of aluminium oxide can be thickened by the process known as 'anodising'. Anodising is carried out using electrolysis, in which the electrolyte is dilute hydrochloric acid. A simplified set-up is shown below.



(i) Write the ionic half equation, including state symbols, for the reaction occurring at the aluminium object, which is acting as the anode.

..... [2]

(ii) Suggest how the aluminium object is anodised during electrolysis.

.....

..... [1]

(iii) Explain the purpose of anodising the aluminium object.

.....

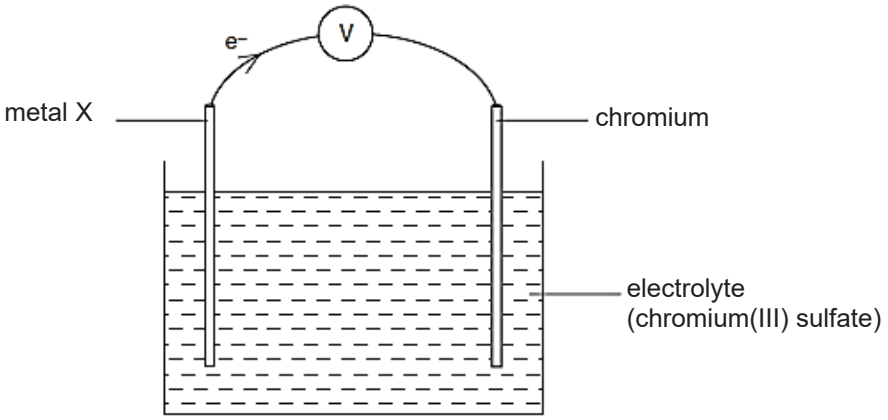
.....[1]

(iv) Aluminium is coated on an iron object to prevent the object from rusting. Explain how rusting is prevented by this method.

.....

.....[1]

(c) An electric current can also be generated by a simple electrochemical cell as shown below.



(i) Explain why the flow of electrons is in the direction shown in the diagram.

.....[1]

(ii) Chromium(III) sulfate solution is green in colour. Suggest why the colour of the chromium(III) sulfate solution fades over time.

.....

.....

.....[2]

[Total: 10]

EITHER

B9 The general structure of an amino acid is given below:

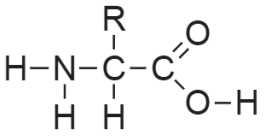


Figure 8.1

where R could just be a simple hydrogen atom or a functional group such as amino or carboxyl group.

The structure below gives a segment of a polypeptide chain with 2 amino acid residues, one with an amino group and another one with a carboxyl group for their R group, when placed in a solution with a pH of 7.

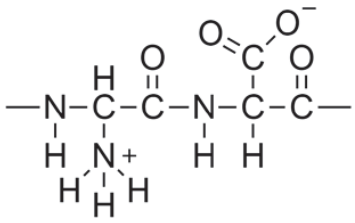


Figure 8.2

(a) Use the structures in Figures 8.1 and 8.2 to explain why

(i) an amino acid is said to be *amphoteric*; and

.....

.....

.....[2]

(ii) a polypeptide chain is said to be a *condensation polymer*.

.....

.....

.....[2]

(b) A protein molecule is formed by one or more polypeptide chains interacting and

folding into a three-dimensional structure.

At extreme pH values, this three-dimensional structure of the protein would be altered, causing the molecule to denature and lose its function.

With reference to Figure 8.2, suggest why the shape of the molecule would be altered at different pH values.

.....

.....

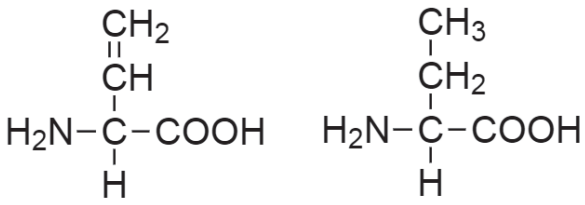
.....

..... [3]

(c) Name a synthetic polymer with similar linkage to polypeptides.

..... [1]

(d) You are given two bottles of solution, each containing a different amino acid as shown in Figure 8.3.



amino acid **J** amino acid **K**

Figure 8.3

Describe a simple chemical test to distinguish between these two amino acids, **J** and **K**.

.....

.....

..... [2]

[Total: 10]

OR

B9 Many biological molecules are able to undergo redox reaction. An example of such a molecule would be glucose.

The Benedict's solution contains copper(II) sulfate solution and it is often used to test for the presence of a reducing sugar. If a reducing sugar is present, a brick-red precipitate would be observed in the solution.

The colour of the obtained precipitate gives an idea about the quantity of sugar present in the solution, hence the test is semi-quantitative.

(a) Explain what it means by a *redox reaction*.

.....

.....[1]

(b) Predict what would happen to the reducing sugar, in terms of transfer of hydrogen, when the reducing sugar reacts with the Benedict's solution.

Explain your prediction.

.....

.....

.....[2]

(c) Samples of solutions with varying concentrations of glucose have been reacted with Benedict's solution and the results are as given below:

Solution	Observation after reaction with Benedict's solution
P	Solution remains blue.
Q	Orange-red precipitate observed.
R	Yellow precipitate observed.
S	Blue-green precipitate observed.
T	Brick-red precipitate observed.

(i) Place the solutions **P**, **Q**, **R**, **S** and **T** in order of their concentration of glucose present, starting with the one with the highest concentration.

.....[1]

(ii) It was later discovered that solution **R** contains trace amount of impurities from fructose, another reducing sugar.

Suggest the impact of this discovery on your answer in **(c)(i)**.

.....

.....

.....[2]

(d) A fatty acid consists of a long hydrocarbon chain attached to a carboxyl group.

Polyunsaturated fatty acids can undergo redox reaction through the addition of hydrogen.

(i) 1 mole of polyunsaturated fatty acid **Y** reacts completely with 8 g of hydrogen gas to become saturated.

Determine the molecular formula of **Y** given that each molecule has 16 carbon atoms.

[2]

(ii) Describe a simple chemical test to differentiate between **Y** and the product of the addition reaction in **(i)**.

.....

.....

.....[2]

[Total: 10]

End of Paper

The Periodic Table of Elements

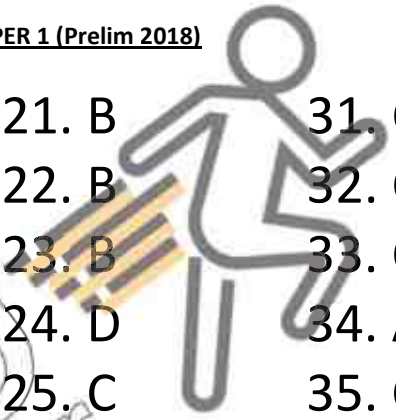
	Group																	
	I	II									III	IV	V	VI	VII	0
						1 H hydrogen 1										2 He helium 4
Key											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
proton (atomic) number atomic symbol name relative atomic mass	3 Li lithium 7	4 Be beryllium 9									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
	11 Na sodium 23	12 Mg magnesium 24														
	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.).

Answers for 4E CHEMISTRY 6092 PAPER 1 (Prelim 2018)

1. B	11. B	21. B	31. C
2. B	12. C	22. B	32. C
3. A	13. D	23. B	33. C
4. B	14. C	24. D	34. A
5. C	15. D	25. C	35. C
6. A	16. A	26. D	36. B
7. D	17. C	27. D	37. B
8. B	18. A	28. C	38. C
9. D	19. C	29. A	39. D
10. A	20. D	30. C	40. C



Answer Scheme for 4E Chemistry Prelim Paper 2

6092/2 – Setter: Edwin Kwek

Minus 1 mark overall for accuracy and units

A1	a) C / Si; b) N; c) K; d) Si; e) O; f) Rb; g) Fe;
A2	a) sodium chloride is giant ionic structure / has a continuous structure of ions / ions in lattice; strong electrostatics of forces between the ions so a lot of energy needed to break the strong forces; chlorine is a simple molecule / chlorine has simple covalent structure; chlorine has weak intermolecular forces between the molecules so small amount of energy required to separate the molecules; b) Ions of magnesium oxide have higher charges than those of sodium chloride; so they form stronger electrostatic forces of attraction which require larger amount of energy to overcome; c) Bromine has higher relative molecular mass than chlorine; so bromine has stronger intermolecular forces between the molecules than chlorine so more energy is required to separate the molecules;
A3	a(i) Downward trend; a(ii) The higher the first ionisation energy, the higher the reactivity of the halogen; b(i) The solution turns from colourless to reddish brown; b(ii) $Cl_2(aq) + 2Do^-(aq) \rightarrow 2Cl^-(aq) + Do_2(s)$ (balanced equation; state symbols;)
A4	a(i) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ a(ii) Number of moles of Zn = 1/65 = 0.015385 mol Number of moles of H_2SO_4 = 50/1000 x 1 = 0.0500 mol; Zinc is the limiting reactant Number of moles of H_2 = 0.015385 mol; Volume of H_2 = 0.015385 x 24 = 0.369 dm^3; b) Copper metal/powder/lumps. It speeds up the rate of reaction; while remains chemically unchanged at the end of the reaction; c) A catalyst provides an alternative pathway with a lower activation energy; more particles would have sufficient energy to overcome the activation energy; d) Longer. Lumps of zinc have less total surface area compared to powdered zinc; So the frequency of effective collisions decreases and speed of reaction decreases;

A5	a) When the temperature is too low, the speed of reaction is slow; When the temperature is too high, the yield of the reaction is low; b) $2SO_2 + O_2 \rightarrow 2SO_3$; c) The total energy absorbed to break bonds in 2 moles of SO_2 and 1 mole of O_2 is less than the total energy released to form bonds in 2 moles of SO_3. (energy absorbed to break bonds; energy released to form bonds; correct comparison; (minus 1 if reactants and products are not specified)) d) reaction pathway with names of products and reactants; activation energy; enthalpy change;
A6	a(i) The concentration of dissolved carbon dioxide remains fairly constant from 1850 to 1880; The concentration of dissolved carbon dioxide increases at an increasing rate after 1880; a(ii) The higher the concentration of dissolved carbon dioxide, the lower the pH; b(i) Calcium hydroxide / limewater; b(ii) Under high concentration of dissolved carbon dioxide, calcium carbonate would dissolve to form a colourless solution; This prevents calcium carbonate from accumulating to form coral reefs; c(i) $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$; c(ii) I agree with John. The amount of carbon dioxide absorbed by plants to make glucose during photosynthesis is equal to; the release of carbon dioxide during fermentation of glucose and combustion of ethanol; However, ethene is obtained by cracking of crude oil, a non-renewable source; So the carbon dioxide released from the burning of ethanol produced from addition of steam to ethene would increase the carbon dioxide in the atmosphere;
B7	a) $[H^+][CH_3COO^-] = 1.75 \times 10^{-5} \times 5 = 8.75 \times 10^{-5}$; $[H^+] = 0.0093541 = 0.00935$ mol/dm^3; b) $\frac{[H^+][CH_2FCOO^-]}{[CH_2FCOOH]}$; c) When the number of carbon atoms increases from methanoic acid to propanoic acid increases, K_a decreases; So the strength of the carboxylic acid decreases; d) Fluorine is more electronegative; Fluoroethanoic acid is a stronger acid / has a higher K_a than chloroethanoic acid; e) 2-fluoropropanoic acid would be a stronger acid; Comparing 2-chloropropanoic acid and 3-chloropropanoic acid, when the chlorine atom is closer to the carboxyl group as in 2-chloropropanoic acid, the K_a would be higher; f) Trichloroethanoic acid has more electronegative chlorine atoms than the other 2; so this reduces the electron density of the carboxylate group, allowing the anion formed to be more stable and recombined with the hydrogen ion less readily;

B8	a) Magnesium would be extracted by electrolysis; as magnesium is more reactive than aluminium; b(i) $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$; b(ii) The oxygen produced during the electrolysis reacts with the aluminium metal to form a layer of aluminium oxide; b(iii) The layer acts as an impermeable layer to prevent the unreacted aluminium from reacting with other substances; b(iv) Aluminium acts as a coat around iron, preventing iron from coming into contact with water and oxygen; OR Aluminium is also more reactive than iron, so it would lose electrons more readily than iron, preventing iron from being oxidised; c(i) Metal X is more reactive than chromium; c(ii) Chromium(III) ions are discharged/reduced at the cathode (chromium metal); This causes the concentration of chromium(III) ions to decrease over time;
B9E	a(i) The amino group is able to gain hydrogen ion to act as a base; the carboxyl group is able to lose hydrogen ion to act as an acid; a(ii) It is formed when many small molecules link together to form a long-chained molecule; without the loss of a small molecule; b) At low pH, the polypeptide chain may gain hydrogen ions and become positively charged; At high pH, the polypeptide chain may lose hydrogen ions and become negatively charged; The change in the charges would affect the electrostatic interactions within the molecules; c) Nylon; d) Add aqueous bromine to a sample of each. Amino acid J will turn red-brown aqueous bromine colourless; amino acid K will not cause a change in colour in aqueous bromine;
B9O	a) It is a reaction where oxidation and reduction occur simultaneously; b) The reducing sugar would lose hydrogen atoms; Since copper(II) ions in Benedict's solution are reduced to form copper(I) ions, the reduced sugar would be oxidised; c(i) T, Q, R, S, P; c(ii) R would have a lower than expected amount of glucose present; Fructose can also reduce copper(II) ion to copper(I) ions, forming the precipitate; d(i) Number of moles of H_2 = 8/2 = 4 moles; $C_{15}H_{23}COOH$; d(ii) Add aqueous bromine to a sample of each. Y will turn red-brown aqueous bromine colourless; the product will not cause a change in colour in aqueous bromine;

Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/01

Secondary 4 Express

16 August 2018

Paper 1 Multiple Choice **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions in 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 Multiple Choice 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 question paper.
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is printed on page 16.

Parent's / Guardian's Signature: ……..

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

Do not turn over the page until you are told to do so.

[Turn over

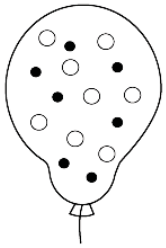
1 Which diagram shows the arrangement of particles inside a balloon containing a mixture of the gases nitrogen and oxygen?

key

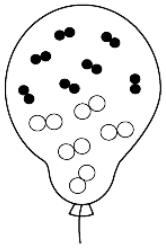
● nitrogen atom

O oxygen atom

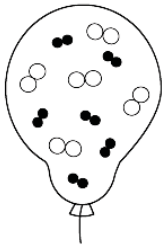
A



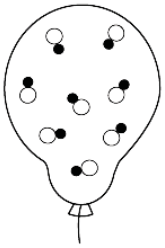
B



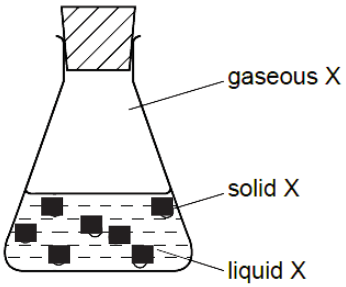
C



D



2 The conical flask contains compound X which is present in solid, liquid and gaseous states.



Which statement is correct?

A A gaseous X molecule has a lower mass than a liquid X molecule.

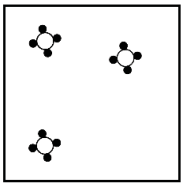
B Energy is released when X changes from liquid to solid.

C Liquid X is at a higher temperature than solid X.

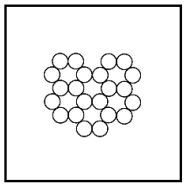
D Liquid X molecules vibrate about fixed positions.

3 Which diagram represents the arrangement of particles in an alloy?

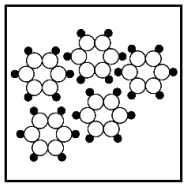
A



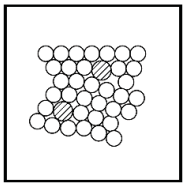
B



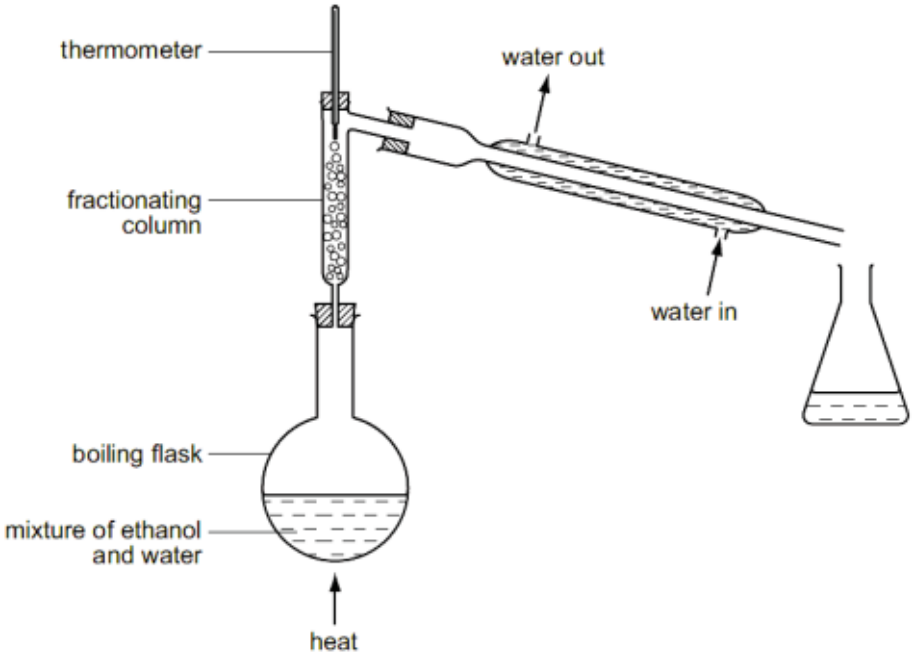
C



D

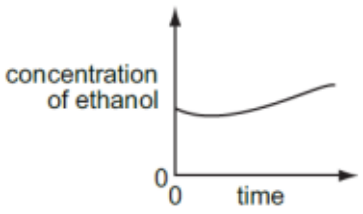


4 The apparatus shown is used to distil a dilute solution of ethanol (boiling point: 78°C) in water.

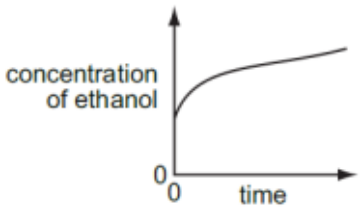


Which graph shows a change in concentration of the ethanol in the boiling flask as the distillation proceeds?

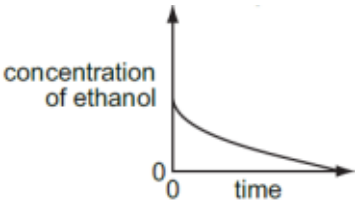
A



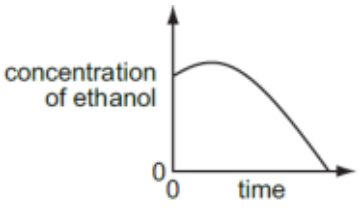
B



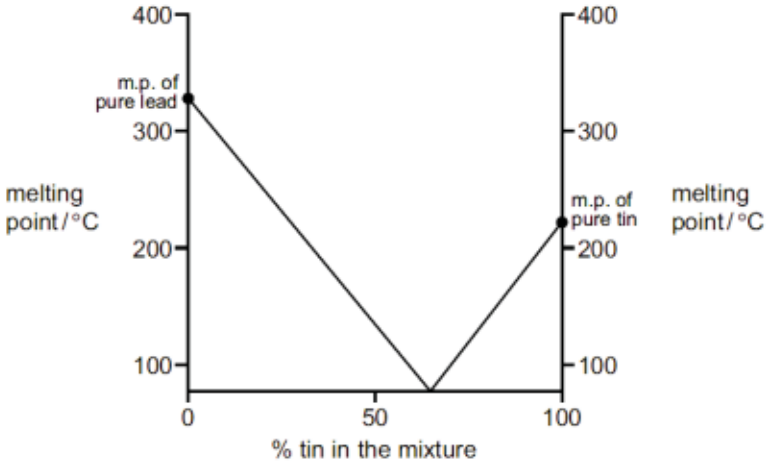
C



D



5 The graph shows the melting points (m.p.) of mixtures of lead and tin.



The graph shows that any mixture of lead and tin must have a melting point that is

A above that of tin.

B below that of lead.

C below that of both lead and tin,

D between that of lead and tin.

6 Naturally-occurring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative isotopic masses 79 and 81.

What can be deduced about the naturally-occurring bromine from this information only?

A Bromine contains the two isotopes in equal proportions.

B Bromine has different oxidation states.

C Bromine isotopes have different number of protons.

D Bromine is radioactive.

7 Which statement about diamond and graphite is correct?

A Both diamond and graphite are used as abrasives.

B Diamond and graphite have different arrangements of carbon atoms.

C The carbon atoms in graphite have a different number of neutrons from those in diamond.

D The carbon atoms in both graphite and diamond have four covalent bonds.

8 The complete combustion of 20 cm^3 of a gaseous alkane, Y, requires 130 cm^3 of oxygen. Both volumes were measured at r.t.p..

What could be the identity of Y?

A butane
B ethane
C methane
D propane

9 1.0 mole of Cu_3FeS_3 and 1.0 mole of O_2 are allowed to react according to the equation.

$$2Cu_3FeS_3\ (s) + 7O_2\ (g) \rightarrow 6Cu\ (s) + 2FeO\ (s) + 6SO_2\ (g)$$

Which of the following is true?

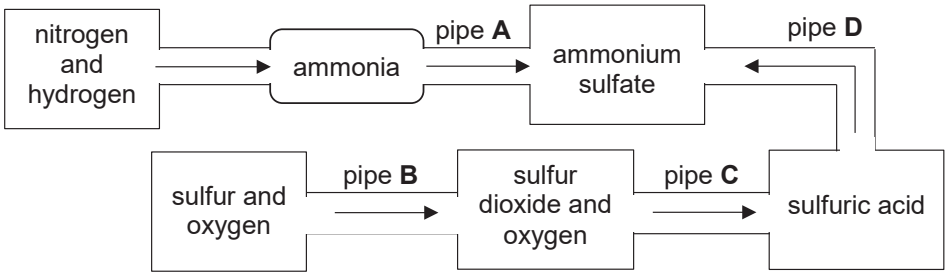
A 0.286 mole of Cu_3FeS_3 is in excess
B 0.714 mole of Cu_3FeS_3 is in excess
C 5.0 moles of O_2 is in excess
D no reagent is in excess

10 A solution containing lead(II) ions is added to a solution containing iodide ions. A yellow precipitate is formed.

What is the equation for the reaction that occurs?

A $Pb^+ + I^- \rightarrow PbI$
B $Pb^+ + 2I^- \rightarrow PbI_2$
C $Pb^{2+} + I^- \rightarrow PbI$
D $Pb^{2+} + 2I^- \rightarrow PbI_2$

11 The diagram shows some of the stages in the manufacture of ammonium sulfate.



From which of the connecting pipes would a major leak result in the highest increase in the pH of the rain?

12 A colourless solution is known to contain a sodium salt.

Tests were carried out to determine the identity of the anion in the solution.

test	observation
dilute hydrochloric acid	no reaction
dilute nitric acid followed by aqueous silver nitrate	no precipitate
dilute nitric acid followed by aqueous barium nitrate	no precipitate

Which anion could the solution contain?

A carbonate **B** chloride **C** nitrate **D** sulfate

13 Which equation represents a redox reaction?

A $4CuO + CH_4 \rightarrow 4Cu + 2H_2O + CO_2$

B $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

C $CuCO_3 \rightarrow CuO + CO_2$

D $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

14 Disproportionation is a reaction in which the same element is both oxidised and reduced.

Which reaction is **not** an example of disproportionation?

A $2CuCl \rightarrow CuCl_2 + Cu$

B $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$

C $2H_2O_2 \rightarrow 2H_2O + O_2$

D $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

15 What is the function of silica, SiO_2, in the equation shown below?

$$CaO + SiO_2 \rightarrow CaSiO_3$$

A a basic oxide **C** an acidic oxide

B a reducing agent **D** an oxidising agent

16 Which statement is true for both aluminium and iron?

A Both are transition metals.

B Both form amphoteric oxides.

C The manufacture of both metals involves the reduction of the metal ions.

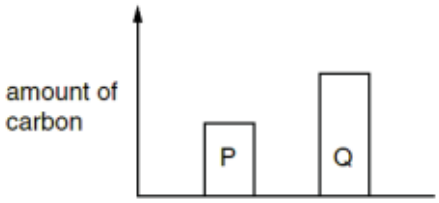
D They are both normally manufactured by electrolysis.

[Turn over

17 Which oxide is most readily reduced to the metal by heating in a stream of hydrogen?

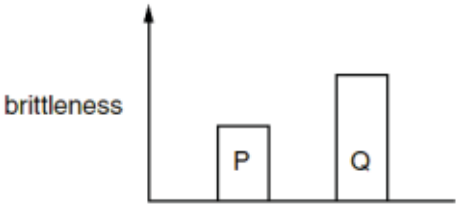
A calcium oxide
B iron(III) oxide
C sodium oxide
D zinc oxide

18 The diagram compares the amount of carbon in two steels, P and Q.

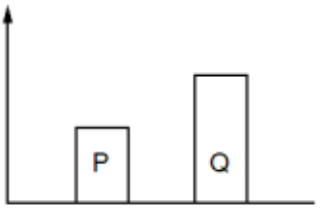


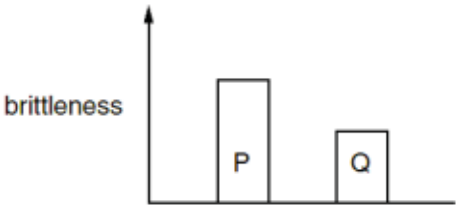
Which two diagrams correctly compare the strength and brittleness of P and Q?

A



B





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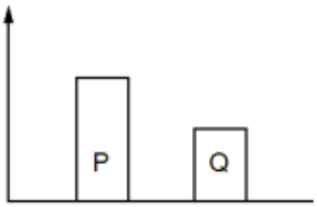
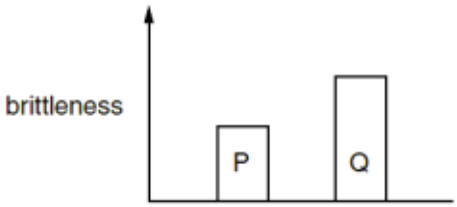
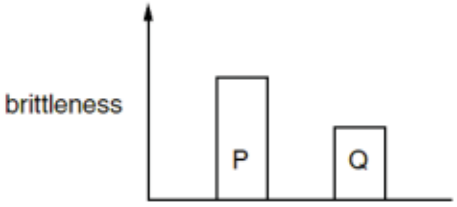




D



19 The element chromium liberates hydrogen from dilute hydrochloric acid although it does not react with cold water.

When a piece of chromium is placed in lead(II) nitrate solution, crystals of lead appear.

What is the order of decreasing reactivity on the three metals, lead, calcium and chromium?

A calcium, chromium, lead

B calcium, lead, chromium

C chromium, calcium, lead

D lead, chromium, calcium

20 Aluminium is often used to make caps for bottles. When thrown away and buried in the soil, the caps do not corrode.

Which of the following explains the observation above?

A Aluminium does not react with acids.

B Aluminium does not react with alkalis.

C Aluminium is alloyed with other metals.

D Aluminium is protected by a layer of oxide.

21 Which arrangement is used to electroplate copper onto a steel key?

	electrolyte	anode (positive electrode)	cathode (negative electrode)
A	aqueous copper(II) sulfate	piece of pure copper	steel key
B	aqueous copper(II) sulfate	steel key	piece of pure copper
C	aqueous sulfuric acid	piece of pure copper	steel key
D	aqueous sulfuric acid	steel key	piece of pure copper

22 In an electrolysis experiment, the same amount of charge deposited 54.0g of silver and 8.5g of vanadium.

What is the charge on the vanadium ion?

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

23 A simple cell can be made using two different metals as the electrodes and an aqueous solution as the electrolyte.

Which statements about simple cells are correct?

1 A greater voltage is produced using magnesium and silver than using magnesium and copper.

2 The electrolyte is an aqueous solution that contains both positive and negative ions.

3 The more reactive metal will lose electrons more readily than the less reactive metal.

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

24 Lithium and rubidium are both in Group I of the Periodic Table.

Which statement is correct?

A Lithium atoms and rubidium atoms have the same number of electrons in their outer shell.

B Lithium atoms are larger than rubidium ions.

C Lithium ions and rubidium ions have the same number of electrons in their outer shell.

D Rubidium ions are larger than rubidium atoms.

25 Which statement about both the Group I and Group VII elements is correct?

A They conduct electricity when molten.

B They form covalent compounds when bonded to non-metals.

C They exists as diatomic molecules.

D When Group I elements combine with Group VII elements, ionic compounds form.

26 The table compares the strengths of the bonds for the reactions of $X_2 + Y_2 \rightarrow 2XY$.

Which reaction will be most exothermic?

	bond in X_2	bond in Y_2	bond in XY
A	strong	strong	strong
B	strong	strong	weak
C	weak	weak	strong
D	weak	weak	weak

27 It has been suggested that the cars of the future could be powered by fuel cells. One type of fuel cell uses the chemical reaction between oxygen and hydrogen to produce electricity.

What would be a disadvantage of using this type of fuel cell to power a car?

A A car cannot be powered by electricity.

B The hydrogen tank might split in an accident, leading to an explosion.

C The product of the reaction between oxygen and hydrogen is toxic.

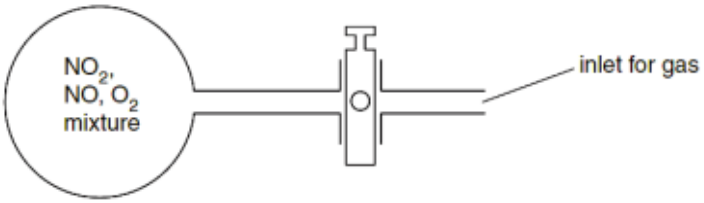
D The oxygen would need to be obtained from air.

28 Nitrogen dioxide, NO_2, is a dark brown gas that decomposes at equilibrium, as shown.

$$2NO_2\ (g) \rightleftharpoons 2NO\ (g) + O_2\ (g)$$

dark brown colourless

The diagram shows a glass flask containing a mixture of the three gases.
The mixture is pale brown.



More oxygen is formed in the flask.

What colour change is seen in the flask?

A There is no change.

B It turns colourless.

C It becomes darker brown.

D It becomes paler brown.

29 In the Haber process, nitrogen and hydrogen react to form ammonia.

$$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2NH_3\ (g) \qquad \Delta H = -92\ kJ$$

Which factor increases both the speed of reaction and the amount of ammonia produced?

A addition of a catalyst

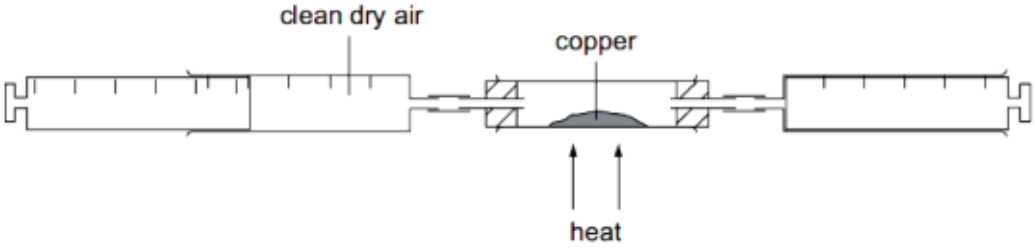
B decreasing the temperature

C increasing the pressure

D increasing the temperature

[Turn over

30 A sample of clean, dry air is passed over hot copper until all the oxygen in the air reacts with the copper.



The volume of air decreases by 30 cm^3.

What was the initial volume of the sample of air?

A 60 cm^3 **B** 100 cm^3 **C** 150 cm^3 **D** 300 cm^3

31 Why are catalytic converters fitted to car exhausts?

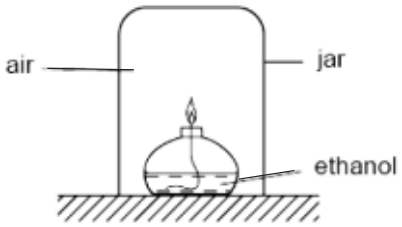
A to decrease the amount of carbon dioxide emitted
B to decrease the amount of nitrogen oxides emitted
C to improve energy conservation
D to reduce global warming

32 Dry air is a mixture of gases of which 99% is nitrogen and oxygen.

What is the main constituent of the remaining 1%?

A argon **C** hydrogen
B helium **D** water vapour

33 The diagram shows ethanol burning in a sealed jar.



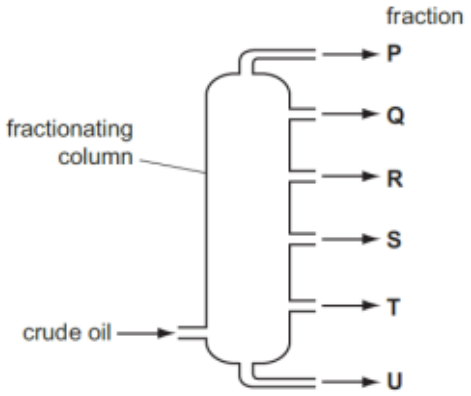
The mass of one gas in the jar does not change.

Which gas is this?

A carbon dioxide **C** oxygen
B nitrogen **D** water vapour

[Turn over

34 The diagram shows the fractional distillation of crude oil.



Which statement is correct?

A Each fraction consists of a single compound.

B Fraction P has the highest boiling point.

C The highest temperature is at the top of the column.

D The naphtha fraction is used as feedstock for the chemical industry.

35 Which property of a liquid ester can be used to check its purity before use as a food flavouring?

A boiling point

B colour

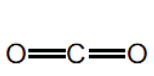
C smell

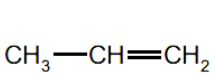
D solubility in water

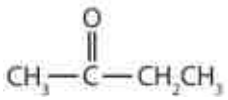
36 Which compound is the most viscous and the least flammable?

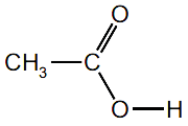
A C_6H_{14} **B** C_8H_{18} **C** $C_{10}H_{22}$ **D** $C_{12}H_{26}$

37 How many of the following structures show an unsaturated hydrocarbon molecule?



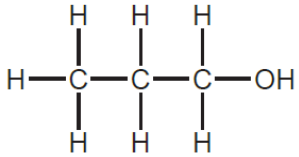






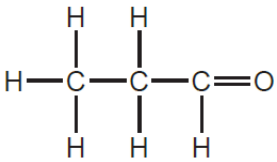
A 1 **B** 2 **C** 3 **D** 4

38 This is the structural of propan-1-ol.

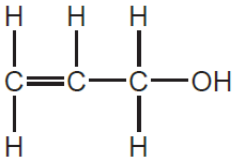


Which of the following is an isomer of propan-1-ol?

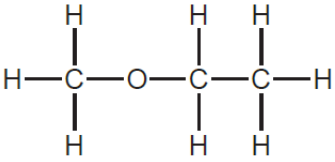
A



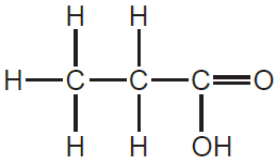
C



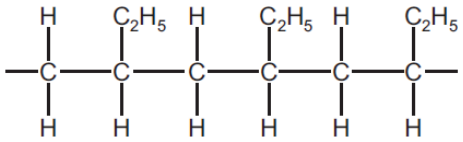
B



D



39 The diagram shows a section of a polymer.



Which alkene is used to make this polymer?

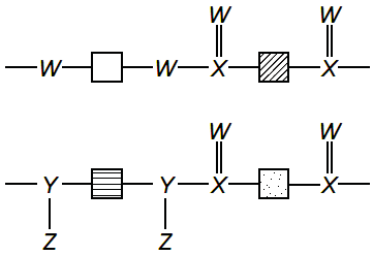
A $CH_3CH{=}CH_2$

B $CH_3CH_2CH{=}CH_2$

C $CH_3CH_2CH{=}CHCH_2$

D $CH_3CH{=}CHCH_3$

40 The diagram shows the partial structures of two different polymers.



Which chemical symbols should replace *W*, *X*, *Y* and *Z*?

	W	*X*	*Y*	*Z*
A	C	N	H	O
B	N	H	O	C
C	O	C	H	N
D	O	C	N	H

END OF PAPER

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key proton (atomic) number atomic symbol name relative atomic mass									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.).

Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/02

Secondary 4 Express

7 August 2018

Paper 2 Theory

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.

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.

A copy of the Periodic Table is printed on page 22.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
Section A	**/ 50**
1	/ 5
2	/ 3
3	/ 10
4	/ 7
5	/ 7
6	/ 9
7	/ 9
Section B	**/ 30**
8	/ 13
9	/ 7
10	/ 10
Total	**/ 80**
Total %	**/ 100**

Parent's / Guardian's Signature: ……..

This document consists of **22** printed pages.

Do not turn over the page until you are told to do so.

[Turn over

Section A

Answer **all** the questions in this section in the spaces provided.

A1 Fig. 1.1 shows part of the Periodic Table.

										He
					B	C	N	O	F	Ne
					Al	Si	P	S	Cl	Ar
Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
									I	Xe

Fig. 1.1

Answer the following questions using **only** the elements shown in Fig. 1.1.

Each element can be used once, more than once or not at all.

Write the **symbol** for

(a) an element which is used as a gas in balloons, …….. [1]

(b) an element which forms an ion of type X^{3-}, …….. [1]

(c) an element which is a catalyst for the production of ammonia, …….. [1]

(d) two elements which combine to form a compound that causes acid rain, …… and ……. [1]

(e) an element which forms ions in aqueous solution which gives a white precipitate on reaction with acidified silver nitrate. …….. [1]

[Total: 5]

A2 Chlorophyll is a green pigment found in green leaves. 'Old' chlorophyll can decompose into phaeophytin, a grey pigment molecule.

A student carried out a chromatography to compare the extracts of spinach leaves obtained from two different sources.

Fig. 2.1 shows the results on the chromatogram.

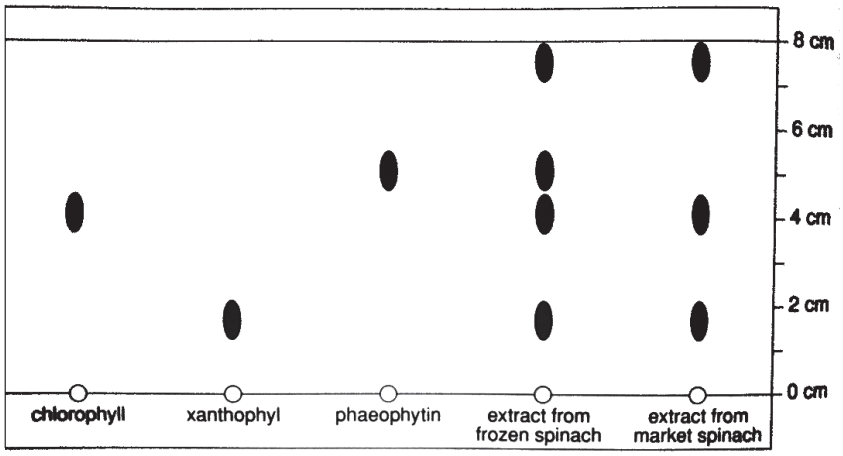


Fig. 2.1

(a) Using the information in Fig. 2.1, describe the result obtained for the extract from frozen spinach.

……

…… [1]

(b) Calculate the R_f value of chlorophyll in the experiment.

R_f value of chlorophyll …….. [1]

(c) The student concluded that the spinach bought from the market is fresher than the frozen spinach bought from the supermarket.

Using the information in Fig. 2.1, explain his reasoning.

…… [1]

[Total: 3]

[Turn over

A3 **(a)** Silicon has three naturally occurring isotopes.

Complete Table 3.1 for two of these isotopes.

Table 3.1

isotope	^{28}Si	^{30}Si
atomic number		14
number of neutrons	14	
nucleon number		

[2]

(b) Silicon(IV) chloride is a simple molecular compound and exists as a liquid at room temperature.

(i) Suggest **two** physical properties of silicon(IV) chloride, other than solubility.

…….

……. [2]

(ii) Draw a diagram to show the arrangement of electrons in a molecule of silicon(IV) chloride. You only need to show outer shell electrons.

[2]

[Turn over

(c) Silicon(IV) chloride reacts with water to form silicon(IV) oxide and an acidic product.

Fig. 3.2 shows part of the structure of silicon(IV) oxide.

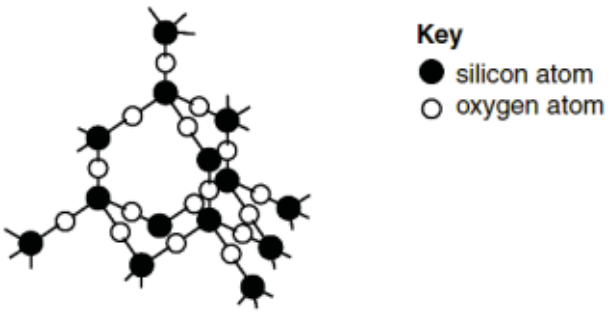


Fig. 3.2

(i) Construct an equation, including state symbols, for the reaction between silicon(IV) chloride with water.

……. [2]

(ii) A student claims that the physical properties of silicon(IV) oxide is similar to that of silicon(IV) chloride.

Explain, in terms of structure and bonding, why the student's claim is wrong.

…….

…….

…….

……. [2]

[Total: 10]

[Turn over

A4 Methane, ethane and propane are all gases at room temperature.

(a) State one possible environmental consequence of the presence of methane in the atmosphere.

…… [1]

(b) Ethane reacts with chlorine in the presence of ultraviolet light to give a number of different compounds.

A 1.00g sample of one of these compounds contains 0.040g of hydrogen, 0.242g of carbon and 0.718g of chlorine.

(i) Calculate the empirical formula of this compound.

empirical formula ……. [2]

(ii) The relative molecular mass of the compound is 99.

Deduce the molecular formula of the compound.

……. [1]

(c) **(i)** Explain why propane diffuses faster at 100°C than at 60°C.

……

……. [1]

(ii) Explain why diffusion could be used to separate a mixture of methane and propane.

……

……

……. [2]

[Total: 7]

[Turn over

A5 Lead is widely used to make lead-acid car batteries.

Lead can be extracted from cerrusite, $PbCO_3$, in a two-stage process.

Stage 1 $PbCO_3 \rightarrow PbO + CO_2$

Stage 2 $PbO + C \rightarrow Pb + CO$

(a) Explain if the reaction from stage 1 is exothermic or endothermic.

……

…… [2]

(b) Explain why the gas from stage 2 must be removed for the safety of the workers.

…… [1]

(c) In the laboratory, two experiments were set up using lead metal, as shown in Fig. 5.1.

Both experiments were conducted at room temperature of 25°C.

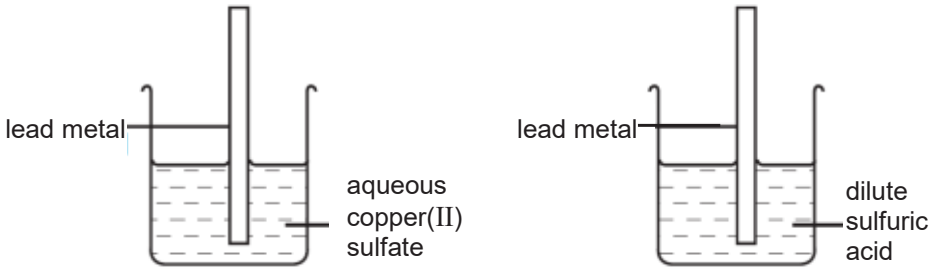


Fig. 5.1

For each experiment, describe what you would observe and how you would test any gas(es) evolved, if any. Write an equation for any **one** of the reactions in Fig. 5.1.

……

……

……

……

…… [4]

[Total: 7]

[Turn over

A6 Molten zinc chloride can be electrolysed using the apparatus as shown in Fig. 6.1.

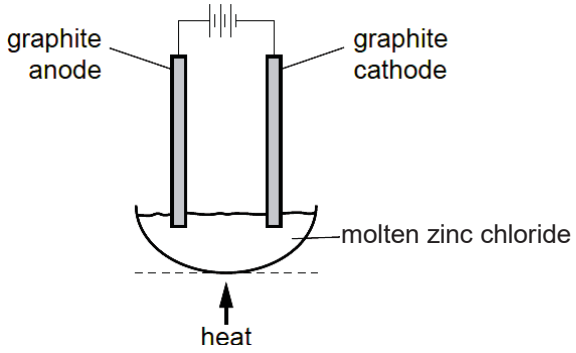


Fig. 6.1

(a) Explain why zinc chloride conducts electricity when molten, but not when solid.

……

……

…… [2]

(b) Predict the products of this electrolysis at

the anode, …… [1]

the cathode. …… [1]

(c) When a dilute aqueous solution of zinc chloride is electrolysed, hydroxide ions are converted to oxygen at the anode.

Write the ionic equation for the reaction that happens at the anode.

…… [1]

(d) Describe a positive test for zinc ions.

test ……

observations ……

…… [2]

[Turn over

(e) Solid zinc chloride absorbs ammonia to form tetra-ammine zinc chloride, $[Zn(NH_3)_4]Cl_2$.

$$ZnCl_2 + 4NH_3 \rightarrow [Zn(NH_3)_4]Cl_2$$

Calculate the maximum yield, in grams, of tetra-ammine zinc chloride formed when 3.4g of zinc chloride reacts with excess ammonia.

[2]

[Total: 9]

[Turn over

A7 This question is about the large scale production of ethanol.

(a) Ethanol can be made by reacting ethene with steam in the presence of a catalyst.

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g)$$

Fig. 7.1 shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures.

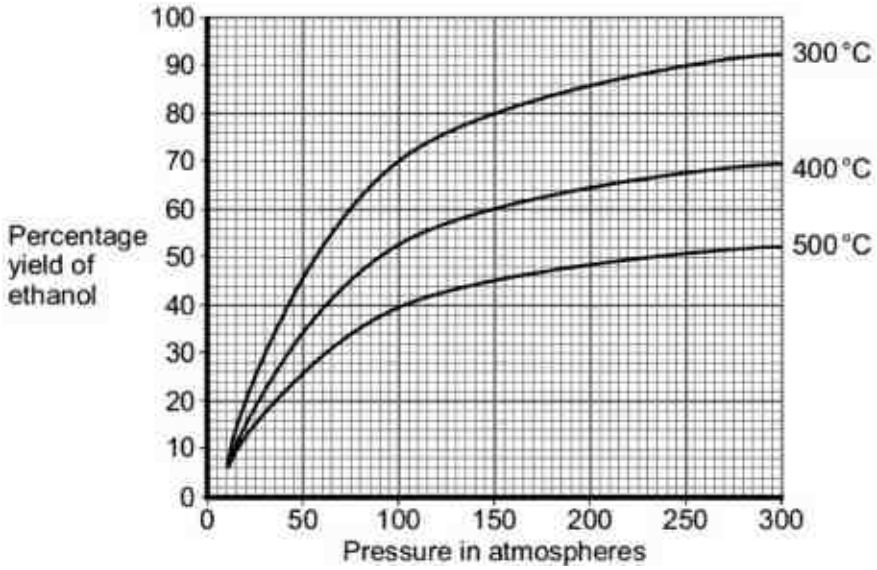


Fig. 7.1

Fig. 7.2 shows how the rate of reaction changes as the temperature changes at three different pressures.

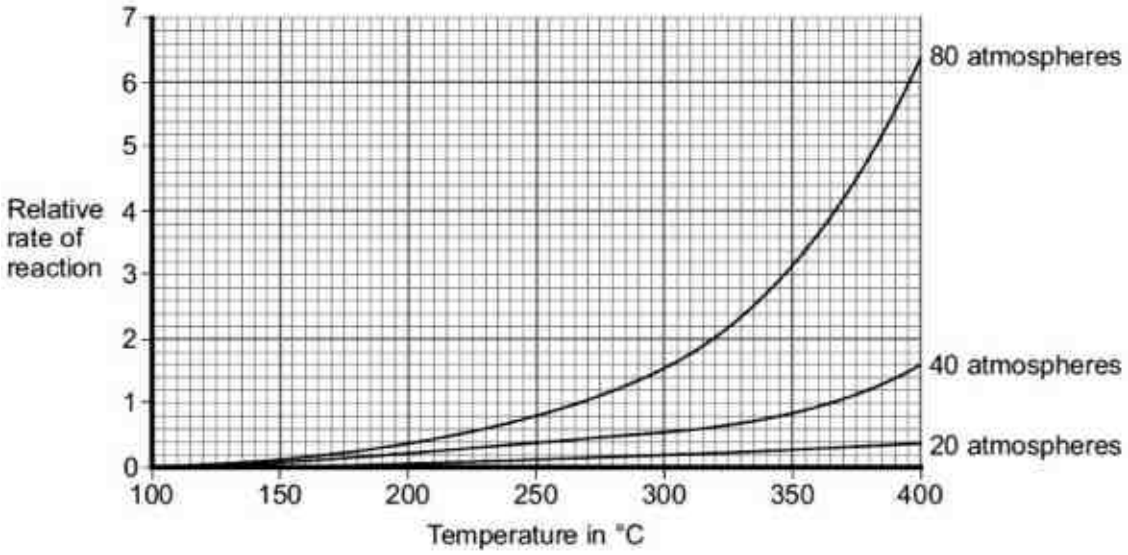


Fig. 7.2

[Turn over

In one process for the reaction of ethene with steam, the conditions are:

- 300°C
- 65 atmospheres
- a catalyst

Use the information in Fig. 7.1 and 7.2, and relevant chemistry knowledge, justify why the above three conditions are used.

……

……

……

……

……

……

……

…… [6]

(b) Other than the reaction of ethene with steam, ethanol can also be manufactured on a large scale by the fermentation of sugar.

Compare these two processes of making ethanol, in terms of

- the rate of reaction,
- concentration of the ethanol produced,
- the use of finite resources.

……

……

……

……

…… [3]

[Total: 9]

[Turn over

Section B

Answer all **three** questions in this section in the spaces provided.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 Fats and oils are triglycerides formed from the condensation reaction of propane-1,2,3-triol with long chain carboxylic acids (fatty acids). Each triglyceride is formed from three fatty acids.

Fig. 8.1 shows the structural formula of a triglyceride likely to be found in peanut oil.

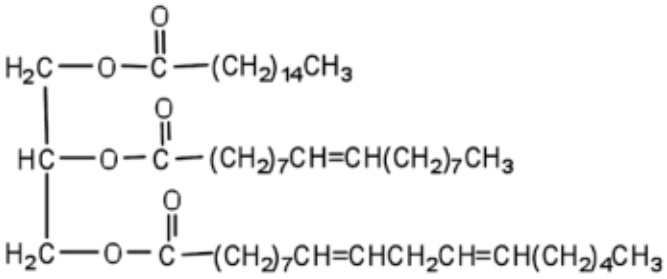


Fig. 8.1

A triglyceride is considered a fat if it is a solid at 25°C, whereas it is considered an oil if it is a liquid at 25°C. These differences in melting points reflect the differences in the degree of unsaturation and molar mass of the constituent fatty acids.

One method for checking the unsaturation level in fatty acids is to determine the iodine number. *Iodine number* is the number of grams of iodine consumed by 100 g of fat or oil. A higher iodine value indicates a higher degree of unsaturation.

Table 8.2 shows average figures for the percentage fatty acid composition of some common fats and oils.

Table 8.2

source of fat or oil	% saturated fatty acids (total)	% monounsaturated fatty acid, oleic acid ($C_{17}H_{33}COOH$)	% polyunsaturated fatty acids	
			linoleic acid ($C_{17}H_{31}COOH$)	linolenic acid ($C_{17}H_{29}COOH$)
beef fat	59	38	3	—
coconut oil	90	8	2	—
corn oil	25	26	47	2
cotton seed oil	22	35	43	—
olive oil	15	78	7	—
soybean oil	14	28	50	8

[Turn over

The *polyunsaturated/saturated (P/S) index* of a fat or oil is the ratio of polyunsaturated fat to saturated fat. It is sometimes used to compare the relative health benefits of different fats and oils in the diet.

The above passage is modified from https://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological/s20-lipids.html.

(a) **(i)** State the chemical linkage which is observed in Fig. 8.1.

…….. [1]

(ii) Identify the by-product formed for the reaction of propane-1,2,3-triol with three long chain carboxylic acids (fatty acids).

…….. [1]

(iii) Draw the structural formulae of **two** reactants that are used to produce the triglyceride, as seen in Fig. 8.1.

- reactant 1: propane-1,2,3-triol

- reactant 2: one of the carboxylic acids

[2]

(b) Using the information in Table 8.2, deduce and explain which fat or oil has the lowest iodine number.

……

…… [2]

[Turn over

(c) Although cotton seed oil and corn oil have similar iodine numbers, the melting point of cotton seed oil is higher than that of corn oil.

Suggest an explanation, in terms of the structure and bonding, in these two oils.

……

……

……

……

…… [2]

(d) Linoleic acid is a polyunsaturated fatty acid with molecular formula of $C_{17}H_{31}COOH$.

How many double bonds between carbon atoms are present in one molecule of linoleic acid? Explain your reasoning.

……

……

……

……

…… [2]

(e) A P/S value of greater than 1 is considered beneficial for health.

Calculate the P/S index of coconut oil and soybean oil, giving your answers to 3 significant figures.

Hence, determine which oil, coconut oil or soybean oil, is more beneficial for health.

…… [3]

[Total: 13]

[Turn over

B9 **(a)** A series of experiments was carried out to compare the rate of reaction of acid with magnesium under different conditions.

Excess magnesium and 25.0 cm^3 of acid were used. The conditions for each experiment are shown in Table 9.1.

Table 9.1

experiment	particle size of magnesium	concentration and type of acid used
A	lumps	0.1 mol/dm^3 HC*l*
B	lumps	0.2 mol/dm^3 HC*l*
C	lumps	0.1 mol/dm^3 CH_3COOH
D	powder	0.2 mol/dm^3 HC*l*

The gas evolved was collected and its total volume was measured every 30 seconds for 10 minutes. The results obtained for experiment **A** and **B** were plotted in Fig. 9.2.

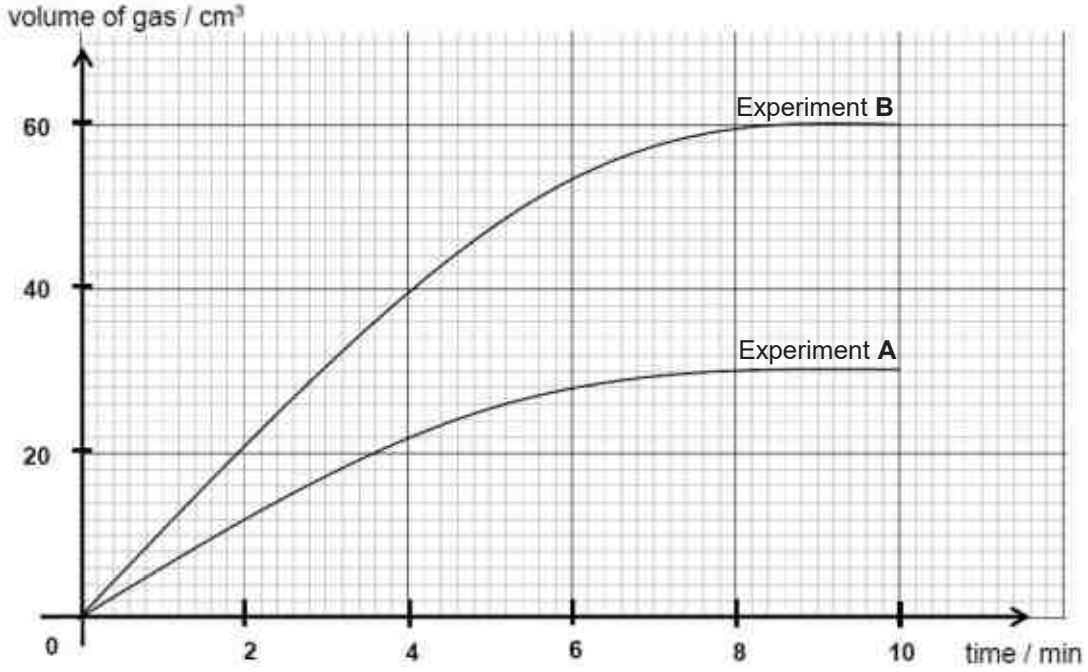


Fig. 9.2

(i) Sketch on Fig. 9.2 the curve that you would expect for experiment **C**, assuming that the reaction ended at the tenth minute. Label this curve as 'Experiment **C**'.

[1]

[Turn over

(ii) Explain, in terms of collisions between reacting particles, why there is a difference in the initial rate of reaction between experiments **B** and **D**.

……

……

……

…… [2]

(b) The acids from experiments **A** and **C** are used in titration experiments with potassium hydroxide.

In experiment **A-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute hydrochloric acid. A pH probe attached to a computer measured the pH during the titration experiment.

Fig. 9.3 shows the results.

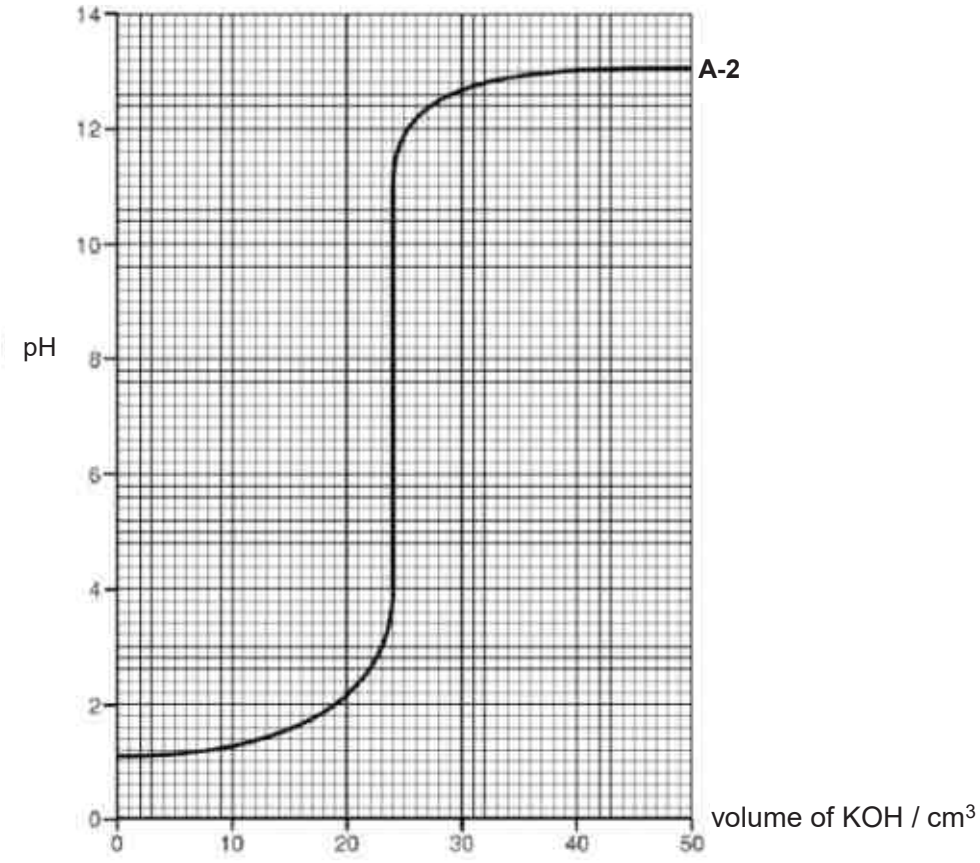


Fig. 9.3

In experiment **C-2**, 0.1 mol/dm^3 of potassium hydroxide was added from a burette to 24.0 cm^3 of dilute ethanoic acid.

[Turn over

(i) Using the graph in Fig. 9.3, state the pH value of hydrochloric acid used in experiment **A-2**.

……. [1]

(ii) The pH value of the ethanoic acid used in experiment **C-2** is 4. On the same axes on Fig. 9.3, sketch the curve you would expect for this experiment. Label this curve as '**C-2**'. [1]

(iii) The acids used in experiment **A-2** and **C-2** have the same concentration.

Explain why they have different pH values.

…….

…….

…….

……. [2]

[Total: 7]

EITHER

B10 This question is about the chemistry of chlorine and some of its compounds.

(a) Describe, with the aid of an ionic equation, the reaction of chlorine with aqueous potassium bromide. Explain why this reaction involves the reduction of chlorine.

……

……

……

……

…… [3]

(b) Describe a way to prepare a dry, pure sample of silver chloride, AgC*l*, from silver metal.

Use the following information to help you

- silver does not react with dilute hydrochloric acid,
- silver reacts with hot concentrated nitric acid to form silver nitrate,
- all nitrates are soluble in water,
- silver chloride is insoluble in water.

……

……

……

……

……

……

……

……

…… [4]

[Turn over

(c) The ozone layer in the atmosphere contains ozone, O_3.

The ozone absorbs ultraviolet light and breaks down to form oxygen.

$$2O_3 \xrightarrow{\text{ultraviolet light}} 3O_2$$

The ultraviolet light provides the activation energy for the reaction.

Fig. 10.1 shows the energy profile diagram for the above reaction.

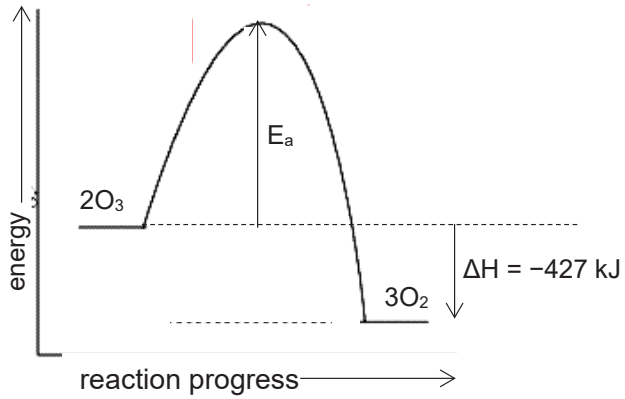


Fig. 10.1

(i) Chlorine atoms, pollutants in the ozone layer, catalyse the reaction that breaks down ozone and increase its rate.

Sketch the energy profile of the catalysed reaction in Fig. 10.1. [1]

(ii) Explain, in terms of energy and particle collisions, how a catalyst increases the rate of reaction.

……

……

…… [2]

[Total: 10]

[Turn over

OR

B10 (a) Some metal carbonates, when heated, decompose to produce carbon dioxide.

Fig. 10.2 shows the results from an investigation on the rate of decomposition of four metal carbonates.

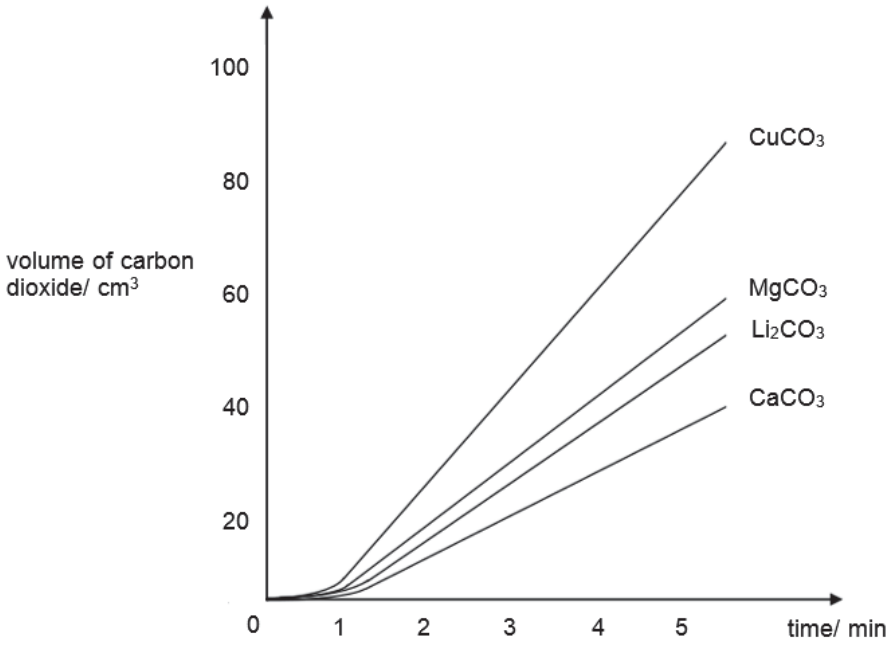


Fig. 10.2

In each experiment, 1.00 g of metal carbonate was heated to the same temperature using flame of the same intensity. The volume of carbon dioxide produced was measured at every minute interval.

(i) Suggest why very little carbon dioxide was collected at the start of each experiment.

……

…… [1]

(ii) Using the information in Fig. 10.2, explain why the decomposition of metal carbonates were **not** completed at the end of the investigation.

……

…… [1]

[Turn over

(iii) Using **only** the information in Fig. 10.2, state and explain which metal carbonate decomposed at the fastest rate.

……

……

…… [2]

(iv) Describe and explain how the volume of carbon dioxide will change with time if sodium carbonate was used for the experiment.

……

…… [2]

(b) Two samples of a copper ore have been discovered. They contain different amounts of copper(II) carbonate but no other carbonate.

When excess dilute acid is mixed with the powdered ore, a gas is produced. The volume of gas evolved is a measure of the amount of copper(II) carbonate in the ore.

Outline an experiment that compares the amounts of copper(II) carbonate in the two different ores. You may include a diagram if it helps you to answer the question.

……

……

……

……

……

……

……

…… [4]

[Total: 10]

END OF PAPER

[Turn over

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key proton (atomic) number atomic symbol name relative atomic mass									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.).

SECONDARY FOUR CHEMISTRY PRELIM EXAM MARKING SCHEME

PAPER 1 [40 marks]

1	2	3	4	5	6	7	8	9	10
C	B	D	C	B	A	B	A	B	D
11	12	13	14	15	16	17	18	19	20
A	C	A	D	C	C	B	A	A	D
21	22	23	24	25	26	27	28	29	30
A	C	A	A	D	C	B	D	C	C
31	32	33	34	35	36	37	38	39	40
B	A	B	D	A	D	A	B	B	D

PAPER 2 [80 marks]

Section A [50 marks]

A1 **(a)** He **[1]** **(b)** N/P/As **[1]** **(c)** Fe **[1]** **(d)** S and O/ N and O/ C and O **[1]**

(e) C*l* **[1]**

[Overall of 1 m will be deducted if candidates never follow the instruction to write chemical symbol.]

A2 **(a)** The extract from frozen spinach contains xanthophyll, chlorophyll, phaeophytin and a / one unknown spot / substance. **[1]**

(b) $R_f = \frac{4}{8} = 0.500$ (3 sig. fig.) **[1]**

(c) The frozen spinach contains the 'old' chlorophyll, phaeophytin, **[1]** indicating that it is no longer fresh. **or** The spinach bought from the market does not contain the 'old' chlorophyll, phaeophytin.

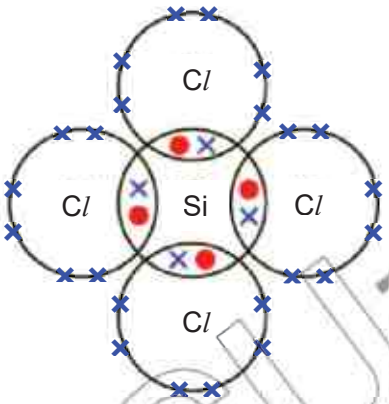
A3 **(a)** **[1 m for every 2 correct answers; max. of 2 m]**

isotope	^{28}Si	^{30}Si
atomic number	**14**	14
number of neutrons	14	**16**
nucleon number	**28**	**30**

(b) **(i)** **1 m for any correct answer; max. of 2 m:**

- low melting point and boiling point
- poor electrical conductor / cannot conduct electricity / good insulator

(ii)



[1 m for showing 1 Si atom with 4 Cl atoms;
1 m for showing correct number of electrons, including the sharing of electrons]

(c) **(i)** $SiCl_4\ (l) + 2H_2O\ (l) \rightarrow SiO_2\ (s) + 4HCl\ (aq)$

[1 m for all correct chemical formulae and balanced equation; 1 m for all correct state symbols]

(ii) **1 m** for mentioning SiO_2 having a three-dimensional giant molecular structure (whereas $SiCl_4$ has a simple molecular structure)

1 m for any following description related to bonding:

- each silicon atom is covalently bonded to 4 oxygen atoms and each oxygen atom is covalently bonded to 2 silicon atoms
- the strong covalent bonds in silicon(IV) oxide are difficult to overcome and hence, has a high melting point, unlike silicon(IV) chloride which has weak van der Waals forces of attraction / weak intermolecular forces of attraction between the molecules that is easy to overcome and hence, has a low melting point

A4 **(a)** Methane traps heat, causing global warming. **[1]**

(b) **(i)**

	C	H	Cl
Mass / g	0.242	0.04	0.718
A_r	12	1	35.5
No. of moles	$\frac{0.242}{12} = 0.02016$	$\frac{0.04}{1} = 0.04$	$\frac{0.718}{35.5} = 0.02022$
Ratio	$\frac{0.02016}{0.02016} = 1$	$\frac{0.04}{0.2016} \approx 2$	$\frac{0.02022}{0.02016} \approx 1$

[1] ***or*** **[1]**

Empirical formula = CH_2Cl **[1]**

(ii) M_r of CH_2Cl = 12 + 1 + 1 + 35.5 = 49.5

$n = \frac{99}{49.5} = 2$

Hence, molecular formula = $(CH_2Cl)_2$ = $C_2H_4Cl_2$ **[1]**

(c) **(i)** At higher temperature of 100°C, the propane molecules have more kinetic energy **[1]** and hence move faster, as compared to a lower temperature of 60°C.

(ii) Molecules/particles have different (relative molecular) masses, such that methane has a M_r of 16 whereas propane has a M_r of 44. **[1]**

Methane (molecules) move or diffuse faster / propane (molecules) move or diffuse slowest **[1]**

A5 **(a)** Endothermic **[1]**, because heat is taken in during decomposition **[1]** to break down the lead(II) carbonate into smaller compounds.

(b) Carbon monoxide is a toxic (poisonous) gas/pollutant.

or carbon monoxide combines with haemoglobin in our red blood cells to form a stable carboxyhaemoglobin, which deprives our body of oxygen.

Reject: CO is an air pollutant / causes death / breathing difficulty as no scientific explanation was given.

(c) Reaction of lead metal with aqueous copper(II) sulfate:

NOTE: Lead is a more reactive metal than copper and hence able to displace copper from copper(II) sulfate.

Observation: blue copper(II) sulfate fades (turns colourless) / Reddish-brown (pink) deposits seen. **[1]**

Equation: $Pb + CuSO_4 \rightarrow PbSO_4 + Cu$ **[2]**

Reaction of lead metal with dilute sulfuric acid:

NOTE: Lead(II) sulfate is an insoluble salt, which prevents further reaction of lead with dilute sulfuric acid. Hence, reaction will not go to completion and that lead will appear as if it is unreactive with the acid. No effervescence will be seen as the reaction is way too slow.

Observation: no visible (observable) change *or* white deposits on lead metal **[1]**

Reject: Effervescence (bubbles) seen. / Hydrogen gas evolved, which extinguishes the lighted splint with a 'pop' sound.

Equation: $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$ **[2]** (but reaction will NOT go to completion)

A6 **(a)** When molten, the strong electrostatic forces of attraction between the oppositely charged ions, Zn^{2+} and Cl^-, are overcome. *or* In solid state, the oppositely-charged ions are held together by the strong electrostatic forces of attraction and can only vibrate about in fixed position. **[1]**

In molten state, the ions can slide around / move / are mobile to carry the charges across to conduct electricity. **[1]** *or* There are free moving (mobile) ions in molten state.

(***Reject:*** any phrase on 'electrons' / 'sea of delocalised ions')

(b) at anode: Chlorine gas evolved. ($2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$) **[1]**

at cathode: Zinc metal deposited on the cathode. ($Zn^{2+}(l) + 2e^- \rightarrow Zn(s)$) **[1]**

(c) $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ **[1]**

(d) Test: add aqeuous sodium hydroxide (aqueous ammonia) dropwise, followed by in excess **[1]**

Observations: White precipitate, soluble in excess giving a colourless solution **[1]**

(e) M_r of $ZnCl_2 = 65 + 35.5 + 35.5 = 136$

No. of moles of $ZnCl_2 = \frac{3.4}{136} =$ 0.025 mol. **[1]**

No. of moles of $[Zn(NH_3)_4]Cl_2 = 0.025$ mol.

M_r of $[Zn(NH_3)_4]Cl_2 = 65 + 4(14 + 3) + (35.5 \times 2) = 204$

Mass of $[Zn(NH_3)_4]Cl_2 = 0.025 \times 204 =$ 5.10 g (3 sig. fig.) **[1]**

A7 **(a)** *Temperature:*

A lower (higher) temperature gives a higher (lower) yield

or A higher (lower) temperature gives a higher (lower) rate **[1]**

Pressure:

A higher pressure gives a higher yield (increase in yield gets less as pressure increases)

or A higher pressure gives a higher rate (increase in rate increases as pressure increases) **[1]**

Catalyst: using a catalyst speeds up the reaction **[1]**

Compromised conditions:

A higher pressure gives a higher rate and thereby a higher yield but increases costs and/or risk **[1]**

A lower temperature gives a higher yield but a lower rate resulting in lower economical production of ethanol. **[1]**

Catalyst makes reaction faster so a lower temperature can be used. **[1]**

(b) Formation of ethanol is faster for reaction of ethene with steam / faster reaction between ethene and steam (slower for fermentation) **[1]**

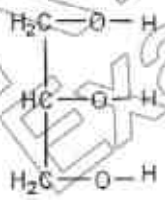
Concentration of ethanol is higher for reaction of ethene with steam (lower for fermentation) **[1]**

Non-renewable resource such as crude oil is used to produce ethene needed for the reaction of ethene with steam while renewable resources such as sugar cane plants are used to extract sugar for fermentation **[1]**

Section B [30 marks]

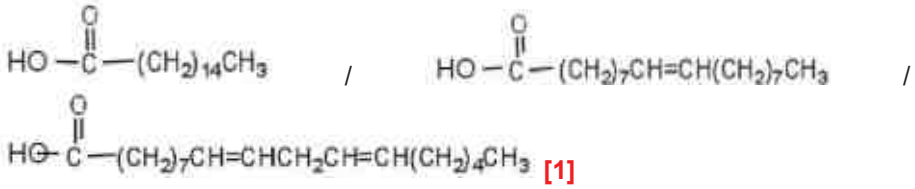
B8 **(a)** **(i)** Ester linkage **[1]** **(ii)** Water / H_2O **[1]**

(iii) Structural formula of propane-1,2,3-triol:



[1]

Structural formula of one of the carboxylic acids:



[1]

(b) Coconut oil **[1]**, as the percentage of unsaturation adds up to (8% + 2% =) 10% **[1]**, which is the lowest.

(c) ***NOTE: Since cotton seed molecules and corn oil molecules have similar iodine numbers, their melting points is not dependent on the degree of unsaturation.***

Cotton seed oil (molecules) have higher molar mass / relative molecular mass than

corn oil (molecules) **[1]**. More energy is needed to overcome the stronger intermolecular forces / Van der Waals' forces of attraction between the molecules. **[1]** *or* Corn oil (molecules) have lower molar mass / relative molecular mass than cotton seed oil (molecules). Lesser energy is needed to overcome the lesser intermolecular forces / Van der Waals' forces of attraction between the molecules.

Reject: the phrase 'bonds' in replacement of 'forces', 'break' in replacement of 'overcome', and 'atoms' in replacement of 'molecules'

(d) Since general formula of carboxylic acid is $C_nH_{2n+1}COOH$, a saturated fatty acid with 18 carbon atoms should have a molecular formula of $C_{17}H_{35}COOH$. **[1]**

Since a decrease in 2 hydrogen atoms indicates the present of one carbon-carbon double bond in each molecule, each molecule of linoleic acid ($C_{17}H_{31}COOH$) will contain two carbon-carbon double bonds. **[1]**

(e) P/S of coconut oil = $\frac{2}{90}$ = 0.0222 (3 sig. fig.) **[1]**

P/S of soybean oil = $\frac{50+8}{14}$ = 4.14 (3 sig. fig.) **[1]**

Soybean oil **[1]** is more beneficial for health than coconut oil.

B9 (a) (i) **[1 m for correct curve drawn, such than shallower gradient and same volume of gas collected as compared to Experiment A]**

(ii) Powdered magnesium was used in Experiment **D**, indicating that more surface area is exposed for more collisions **[1]** to occur. Hence, initial rate of reaction is higher **[1]** than that of Experiment **B**.

or Magesium lumps was used in Experiment **B**, indicating that lesser surface area is exposed for lesser collisions to occur. Hence, initial rate of reaction is lower than that of Experiment **D**.

Reject: 1) rate of reaction between Experiment **B** and **D** is different as this is a sweeping statement, which shows the lack of scientific content.

2) discuss about the concentration of acid.

(b) (i) pH 1.1 **[1]**

Reject: pH is 1 as this shows that students did not read off from the graph properly.

(ii) **[1 m for similar curve to A-2, except for an initial pH value of 4 (same volume of KOH used & same height at the end of the reaction)]**

(iii) In experiment **A**, hydrochloric acid, a strong acid, ionises/dissociates completely to produce a lot of hydrogen ions, while in experiment **C**, ethanoic acid, a weak acid, ionises/dissociates partially to produce little hydrogen ions. **[1]**

1 m for linking pH value to concentration of hydrogen ions, with any one of the following:

- Ethanoic acid has a lower concentration of hydrogen ions and therefore has a higher pH value.
- Hydrochloric acid has a higher concentration of hydrogen ions and therefore has a lower pH value.

EITHER

B10 (a) Chlorine is more reactive than bromine, and hence displaces bromine from potassium bromide (its salt solution). **[1]**

Cl_2 (g) + $2Br^-$ (aq) → $2Cl^-$ (aq) + Br_2 (aq) **[1]**

NOTE: Ionic equation should come with state symbols.

Reject: chemical equation

Chlorine is reduced due to a decrease in its oxidation state from 0 to −1. **[1]**

or chlorine is reduced due to a gain in electrons.

(b) Step:

1) Add excess silver metal to the hot concentrated nitric acid to form aqueous silver nitrate. **[1]**
2) Filter to collect the aqueous silver nitrate as filtrate / to remove the unreacted silver as residue. **[1]**
3) Add aqueous silver nitrate to sodium chloride (or any soluble chloride salt) to produce the white precipitate of silver chloride. **[1]**
4) Filter to collect the silver chloride as the residue. **[1]**
5) *(optional)* Wash the residue with deionised water and dry between filter papers.

(c) (i) **[1 m for showing a lower E_a but with same height for energy level of reactants and products]**

(ii) The catalyst provides a lower activation energy, whereby more colliding particles possess energy equal to or greater than the activation energy. **[1]**

The number of effective collisions increases, leading to higher rate of formation of product particles. **[1]**

OR

B10 (a) (i) Energy was still being absorbed to overcome the activation energy / most reactant particles have insufficient activation energy to undergo decomposition. **[1]**

Accept: little or not enough energy for decomposition

Reject: 'break' in replacement of 'overcome'

(ii) Volume of carbon dioxide has not reached a constant / is still increasing at the end of 5 minutes. **[1]**

Accept: CO_2 was still being produced

(iii) Copper(II) carbonate/ $CuCO_3$ **[1]**

Highest volume of carbon dioxide produced per unit time / most carbon dioxide produced throughout the experiment. **[1]**

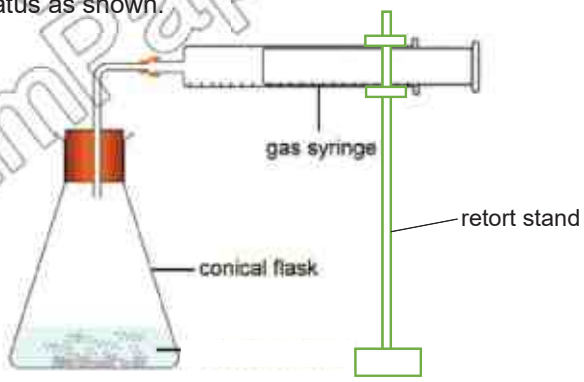
(iv) No carbon dioxide will be collected as time pass / volume of carbon dioxide remains zero / volume of carbon dioxide collected will be a horizontal / straight line. **[1]**

Sodium carbonate is stable to heat / does not decompose upon heating / very hard / hard to decompose sodium carbonate / sodium carbonate is thermally stable. **[1]**

(b) ***NOTE: 'Outline' means you need to describe how the experiment works, what measurement(s) to take and state the expected conclusion from the experiment.***

Step:

1) Measure 5.0g (or any reasonable mass) of one of the copper ore using an electronic balance and transfer into a conical flask. **[1]**
2) Measure 25.0cm^3 of 0.1 mol/dm^3 dilute hydrochloric acid (or any appropriate acid) using a pipette (or use a measuring cylinder/burette to measure volume of any other acid). **[1]**
3) Set up the apparatus as shown.



4) Record the final volume of carbon dioxide gas produced.
5) Repeat step 1 to 4 for the other copper ore. **[1]**

Conclusion: The ore that gives out more gas contains more copper(II) carbonate. **[1]**