2019

Secondary 4 Pure Chemistry

1.	Anderson Secondary	SA2
2.	Assumption English School	SA2
3.	Chua Chu Kang Secondary	SA2
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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2019
Secondary Four Express

CANDIDATE NAME:	
CLASS:	/
INDEX NUMBER:	

CHEMISTRY

6092/01

Paper 1 Multiple Choice

3 September 2019

1 hour

1000 – 1100h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.
Write your name, class and index number 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**, **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

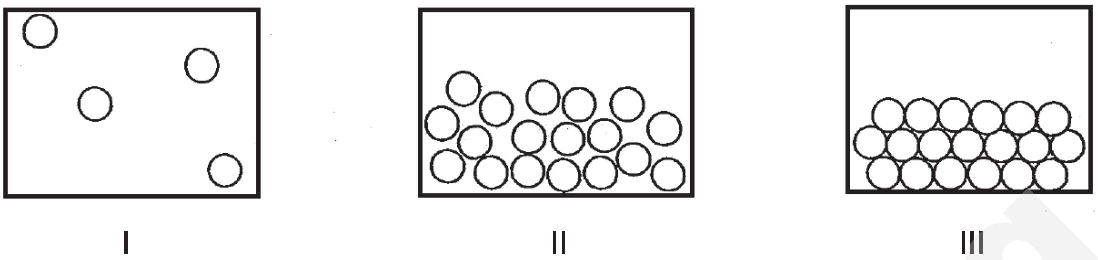
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for the wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page **21**.

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

This document consists of **21** printed pages.

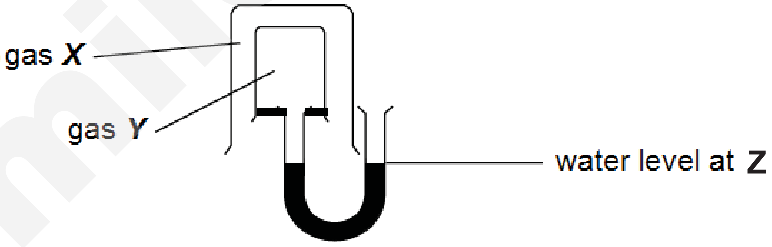
1 Diagrams I, II and III show the particles of three substances at room temperature and pressure.



Which of these substances are correctly represented by the corresponding diagram?

	I	II	III
A	ethanol	hydrogen chloride	dry ice
B	helium	mercury	zinc
C	methane	sodium chloride	copper
D	water	argon	mercury

2 The set–up below shows how the relative rate of diffusion of gas **X** and **Y** can be determined.



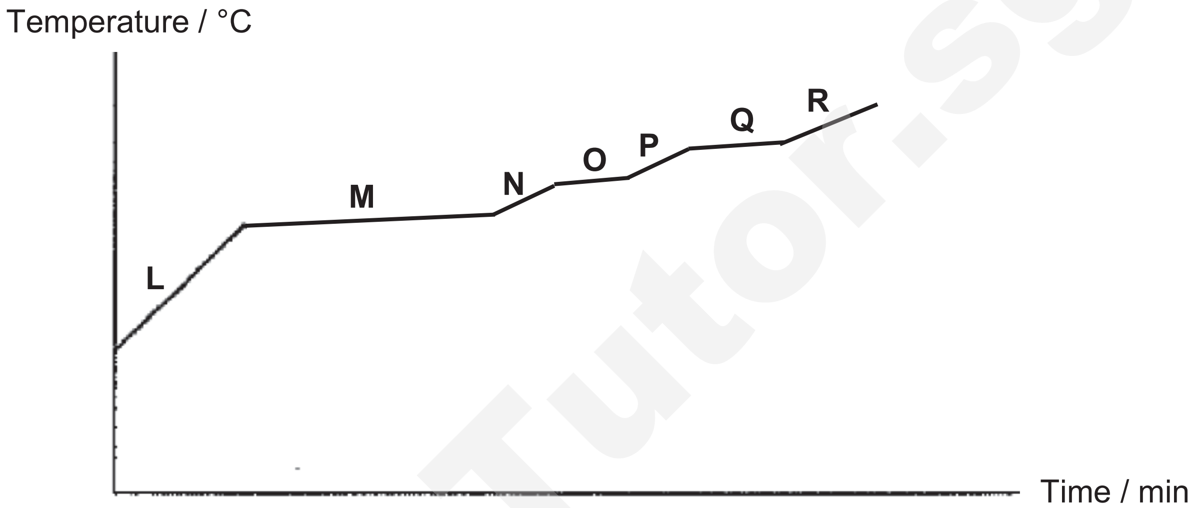
Which pair of substances could **X** and **Y** be if the water level at **Z** decreases?

	X	Y
A	ethane	argon
B	carbon monoxide	neon
C	methane	oxygen
D	nitrogen	carbon dioxide

3 The three main components of liquid air are nitrogen, oxygen and argon. Their respective boiling points are:

Nitrogen: –196°C
Oxygen: –183°C
Argon: –186°C

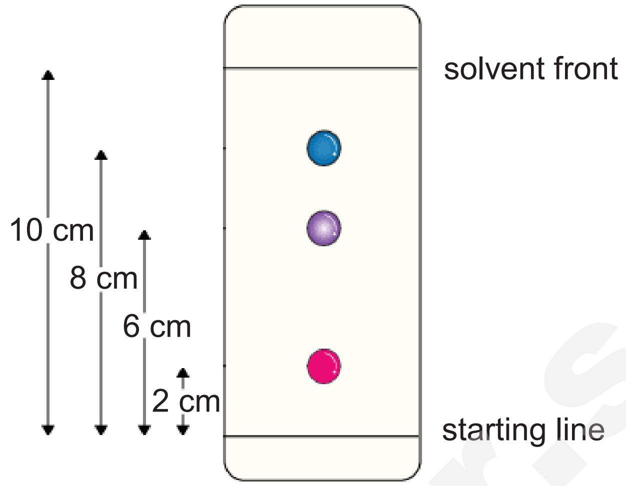
Liquid air can be separated into its three main components by fractional distillation. The graph shows the temperature of a liquid air mixture as it is heated.



In section **N** of the graph, the mixture remaining consists of

A liquid nitrogen and argon only.
B liquid nitrogen only.
C liquid oxygen and argon only.
D liquid oxygen only.

4 The diagram shows the chromatogram obtained by analysis of a dye mixture. Three measurements are shown in the diagram below.



What is the R_f value of the most soluble dye?

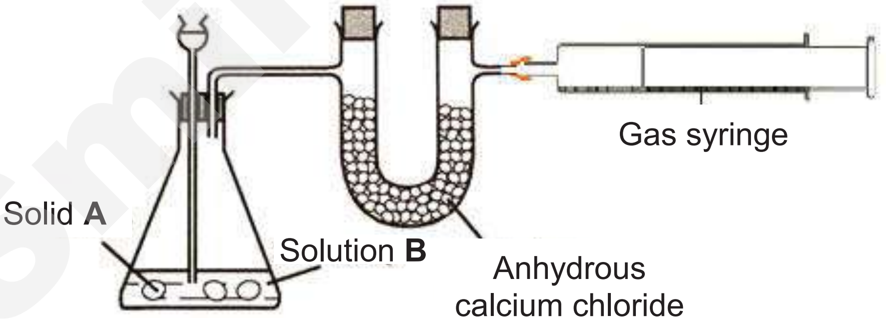
A 0.20

B 0.80

C 1.25

D 5.00

5 The diagram shows a simple laboratory set-up used to prepare and collect a dry gas.



Which pair of reagents would be most suitable to prepare the gas produced using this set-up?

	solid **A**	solution **B**
A	ammonium chloride	sodium hydroxide
B	calcium carbonate	aqueous ammonia
C	potassium hydroxide	sulfuric acid
D	zinc	hydrochloric acid

6 The solubilities of three solids in water and tetrachloromethane are given in the table below.

solid	**solubility in water**	**solubility in tetrachloromethane**
sand	not soluble	not soluble
sodium chloride	good	not soluble
sulfur	not soluble	good

Which of the experimental procedures would be suitable for obtaining pure sand from a mixture of sand, sodium chloride and sulfur?

A Add tetrachloromethane and stir, then filter to collect residue.

B Add tetrachloromethane and stir, then filter. Add the residue to water and stir, then filter to collect residue.

C Add water and stir, then filter. Evaporate the filtrate to dryness.

D Add water and stir, then filter. Add tetrachloromethane to filtrate and stir, then evaporate to dryness.

7 Brass is an alloy of copper and zinc. Copper has a melting point of 1085°C and zinc 419.5°C. Which of the following is a possible melting point of brass?

A Above 419.5°C

B Above 1085°C

C Below 1085°C

D Between 419.5°C and 1085°C

8 An ion of formula $\mathbf{X}^{2-}$ contains 18 electrons. If the relative atomic mass of **X** is 32, what is present in the nucleus of the ion?

A 16 protons and 16 neutrons
B 16 protons and 18 electrons
C 18 protons and 14 neutrons
D 18 protons and 18 electrons

9 Which statement correctly describes the properties of the compound copper(II) sulfide, CuS and mixture of copper and sulfur?

	copper(II) sulfide	**mixture of copper and sulfur**
1	copper and sulfur react when heated to form copper(II) sulfide	copper and sulfur mix together with no energy change
2	the ratio of copper to sulfur is always 1 : 1	the ratio of copper to sulfur can vary
3	copper(II) sulfide has the same properties as copper and sulfur	the mixtures do not have the same properties as copper and sulfur

A 1 only

B 1 and 2

C 2 and 3

D All the above

10 Which compound contains both ionic and covalent bonds?

A ammonia

B beryllium chloride

C ethyl ethanoate

D potassium nitrate

11 An investigation of the properties of the chlorides of Period 3 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 metallic character decreasing across the period.

C silicon forming weaker bonds with chlorine as compared to sodium.

D silicon tetrachloride having weak intermolecular forces of attraction.

12 Two comments about hydrogen chloride are made below.

Comment 1: Hydrogen chloride has strong covalent bonds in its simple molecular structure.
Comment 2: Hydrogen chloride is soluble in water.

Which statement is correct?

A Both comments are correct and comment 1 explains comment 2.
B Both comments are correct but comment 1 does not explain comment 2.
C Both comments are incorrect.
D Comment 2 is correct but comment 1 is incorrect.

13 The reaction of nitrogen dioxide with water is as shown.

$$\mathbf{w}\ NO_2 + \mathbf{x}\ H_2O \rightarrow \mathbf{y}\ HNO_3 + \mathbf{z}\ HNO_2$$

Which of the following values will give a balanced equation for the reaction above?

	w	**x**	**y**	**z**
A	1	1	1	1
B	2	1	1	1
C	2	2	1	1
D	4	2	2	2

14 Antimony is in the same group as nitrogen in the Periodic Table. What is the chemical formula of lithium antimonide?

A Li_3An
B $LiAnO_3$
C Li_3Sb
D $LiSbO_3$

15 Which statements about molecular mass is **incorrect**?

A It is the mass obtained on an electronic balance by 1g of the molecules.

B It is the ratio of the average mass of a molecule to the mass of a ^{12}C atom.

C It is the ratio of the mass of 1 mole of molecules to the mass of 1 mole of ^{12}C atom.

D It is the sum of the relative atomic masses of all the atoms within the molecules.

16 Which substance contains the greatest number of atoms in 1g?

A CO_2

B NO_2

C O_2

D SO_2

17 100 cm^3 of ammonia burns in 50 cm^3 of oxygen according to the following equation:

$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

What volume of gas will be collected at the end of the reaction when cooled to room temperature?

A	33.3 cm^3	**B**	50.0 cm^3
C	66.7 cm^3	**D**	166.7 cm^3

18 The fertilisers ammonium nitrate (NH_4NO_3, M_r = 80) is manufactured from ammonia (NH_3, M_r = 17) by a two-stage process.

Stage 1: $NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$
Stage 2: $HNO_3 + NH_3 \rightarrow NH_4NO_3$

What is the maximum mass of fertilizer that can be made if only 17 tonnes of ammonia is available?

A	34 tonnes	**B**	40 tonnes
C	80 tonnes	**D**	97 tonnes

19 Magnesium oxide is produced by heating magnesium carbonate.

$$MgCO_3 \rightarrow MgO + CO_2$$

When 84 g of magnesium carbonate is heated, 34 g of magnesium oxide is produced.
What is the percentage yield of magnesium oxide?
[M_r: $MgCO_3$, 84; MgO, 40]

A $\frac{34}{40} \times 100$

B $\frac{34}{84} \times 100$

C $\frac{40}{34} \times 100$

D $84 \times \frac{34}{40} \times 100$

20 35.0 cm^3 of 0.500 mol/dm^3 hydrochloric acid were added to 1.41 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 15.0 cm^3 of 0.400 mol/dm^3 of sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?
[M_r: HCl, 36.5; Na_2CO_3, 106; $NaOH$, 40]

A 43.2% **B** 45.1%

C 86.5% **D** 90.2%

21 Which method(s) is/are suitable to test the strengths of acids and alkalis?

1 titration
2 measuring their electrical conductivity
3 using a pH meter

A 1 only

B 1 and 3

C 2 and 3

D All of the above

22 Arsine (AsH_3) is a gas that behaves like ammonia. Which of the following particles are found in the solution when Arsine dissolves in water?

A As^+ and $OH^–$

B AsH_3, As^+ and $OH^–$

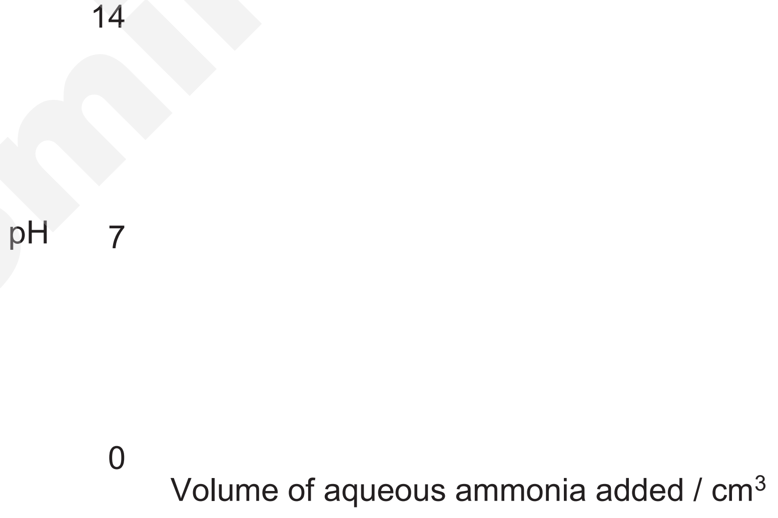
C AsH_4^+ and $OH^–$

D AsH_3, AsH_4^+ and $OH^–$

23 Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

indicator	pH range for the colour change	colour	
		lower pH	higher pH
indigo carmine	11.6 – 14.0	blue	yellow
methyl red	4.2 – 6.3	red	yellow
methyl violet	0.3 – 3.0	yellow	violet
phenolphthalein	8.2 – 10.0	colourless	pink

The graph below shows the change of pH when aqueous ammonia is added to a fixed volume of dilute hydrochloric acid in a titration.



Which indicator would be the best choice to use in this titration?

A indigo carmine

B methyl red

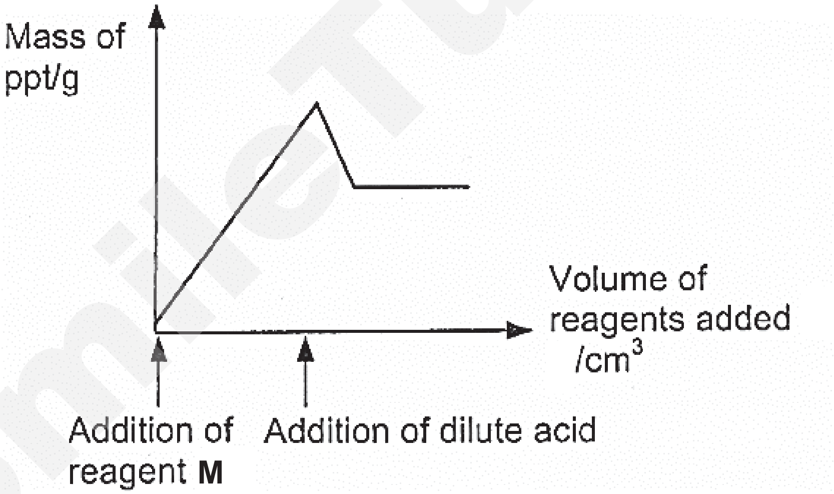
C methyl violet

D phenolphthalein

24 Which substance has metallic bonding?

substance	electrical conductivity		property of product formed from the reaction between substance and oxygen
	in solid state	in molten state	
A	X	X	reacts with alkali
B	X	✓	no reaction with acid or alkali
C	✓	✓	reacts with alkali
D	✓	✓	reacts with both acid and alkali

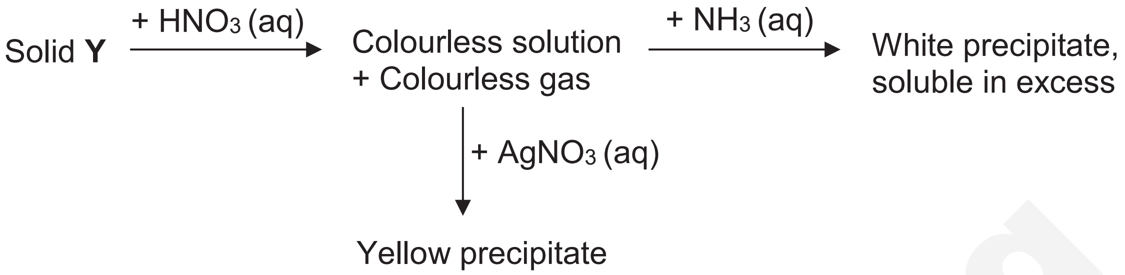
25 In a quantitative analysis, reagent **M** is gradually added to a salt solution **N** (that contains either 1 or 2 different anions), followed by the addition of a dilute acid. The graph below shows how the mass of precipitate formed changes with the reagents added.



Which of the following combinations would produce the graph above?

	anions in **N**	reagents (**M** and acid) added
A	CO_3^{2-}	$AgNO_3$ and HNO_3
B	CO_3^{2-}, Cl^-	$BaCl_2$ and HNO_3
C	CO_3^{2-}, SO_4^{2-}	$AgNO_3$ and HCl
D	CO_3^{2-}, SO_4^{2-}	$BaCl_2$ and HCl

26 Solid **Y** contains a mixture of two salts. The scheme below shows some reactions of solid **Y**.



Which of the following could be the two salts present in solid **Y**?

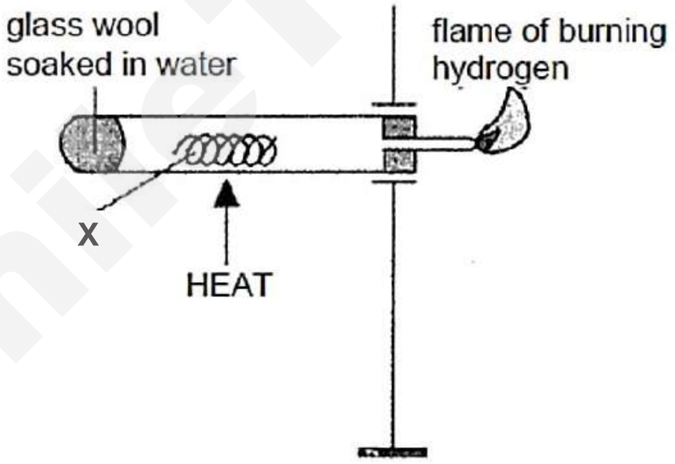
A aluminium carbonate and ammonium chloride

B calcium chloride and zinc carbonate

C lead(II) carbonate and sodium iodide

D zinc iodide and calcium carbonate

27 The set-up below shows the reaction of substance **X**.



What is the possible identity of **X**?

A **X** is a metal above hydrogen in the reactivity series.

B **X** is a metal below hydrogen in the reactivity series.

C **X** is an oxide of a metal that is above hydrogen in the reactivity series.

D **X** is an oxide of a metal that is below hydrogen in the reactivity series.

28 The following observations were made when nickel and iron were placed separately into solutions of metals **S**, **T** and **U**.

	salt solution of **S**	salt solution of **T**	salt solution of **U**
nickel	displaced	not displaced	not displaced
iron	displaced	displaced	not displaced

What is the correct order in increasing reactivity of the five metals?

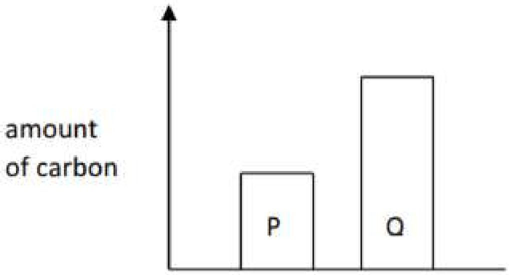
A **S** < Ni < Fe < **T** < **U**

B **S** < Ni < **T** < Fe < **U**

C **U** < Fe < **T** < Ni < **S**

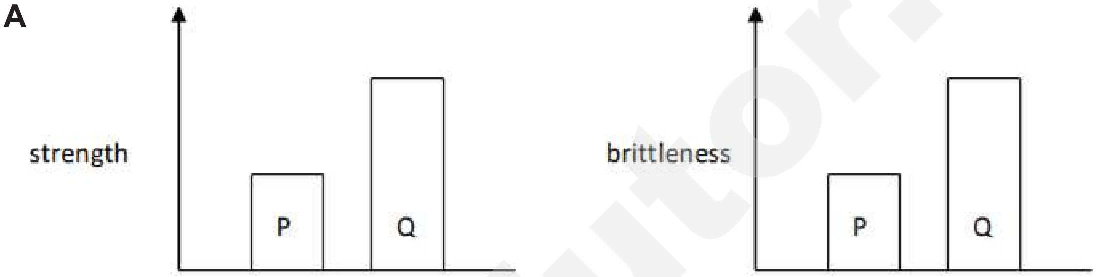
D **U** < **T** < Fe < Ni < **S**

29 The diagram compares the amount of carbon in two steels, **P** and **Q**?

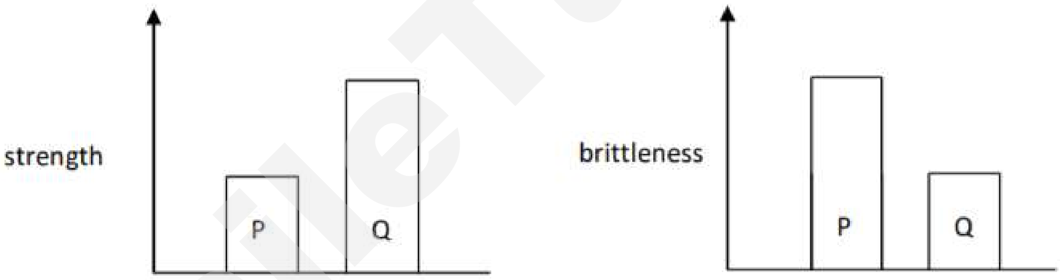


Which two diagrams correctly compare the strength and brittleness of **P** and **Q**?

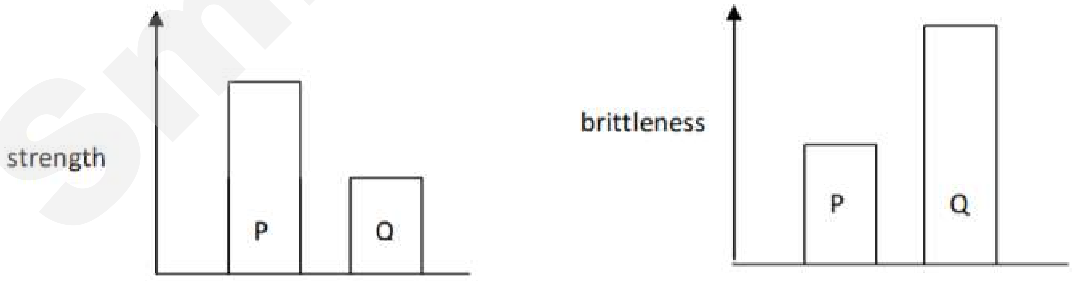
A



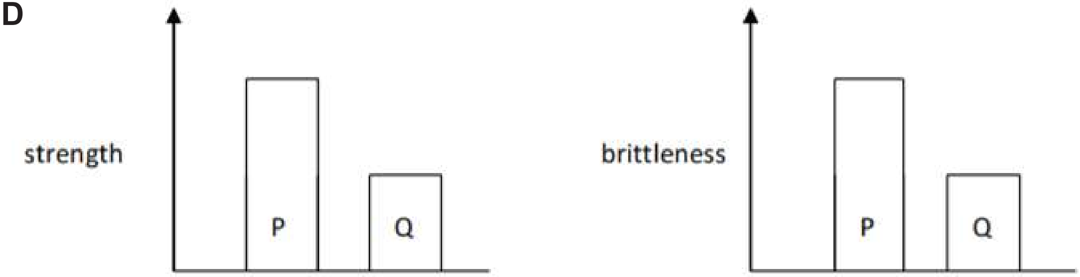
B



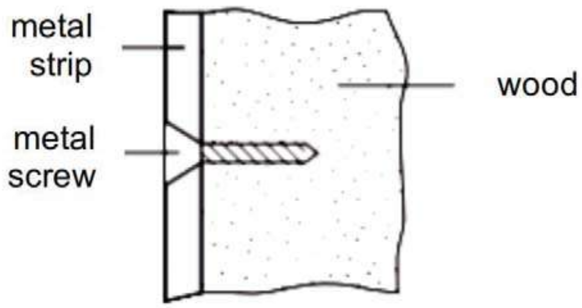
C



D



30 An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.



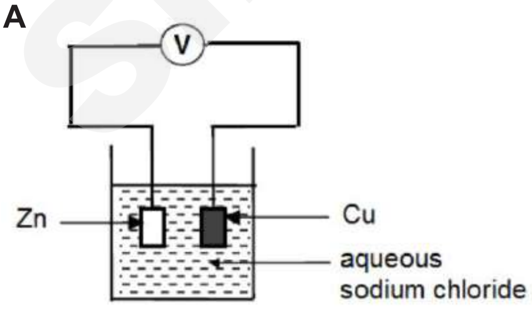
After a few weeks of being exposed to wind and rain, the screws are heavily corroded but the metal strips are not.

Which two metals would give this result?

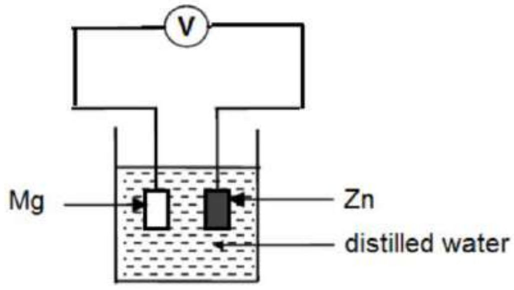
	screw	**strip**
A	copper	steel
B	copper	zinc
C	steel	copper
D	steel	magnesium

31 Which set–up would produce the greatest reading on the voltmeter?

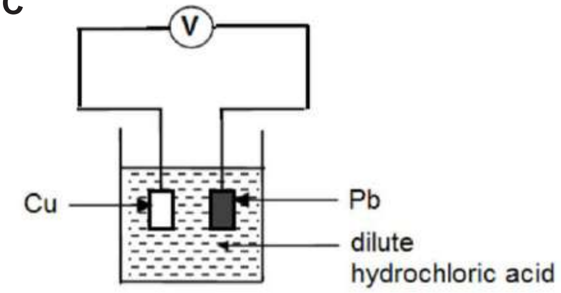
A



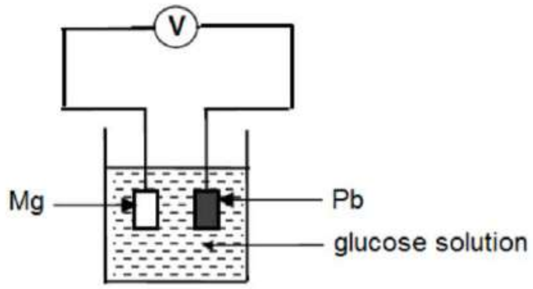
B



C



D



32 For which process is the enthalpy change always positive?

A combustion

B dissolving of acids in water

C evaporation

D respiration

33 Which of the following reactions takes place in a hydrogen fuel cell?

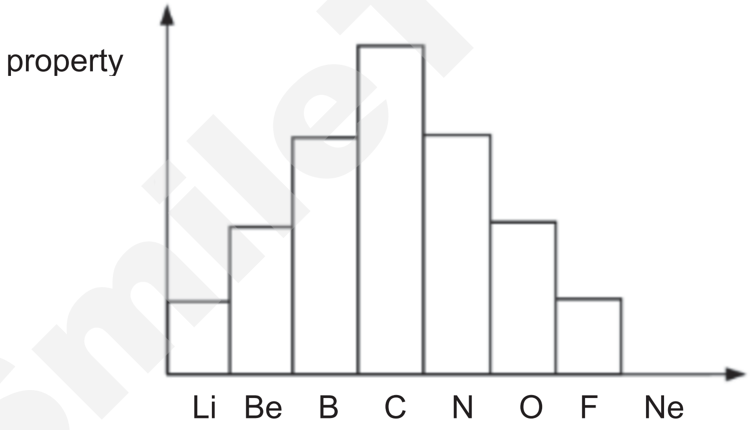
A Hydrogen ions are oxidised at the anode.

B Hydrogen ions are reduced at the cathode.

C Hydrogen loses electrons to form H^+ ions at the anode.

D Oxygen gains electrons to form O^{2-} at the cathode.

34 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon. Which property of these elements is shown in the chart?



A The atomic radius.

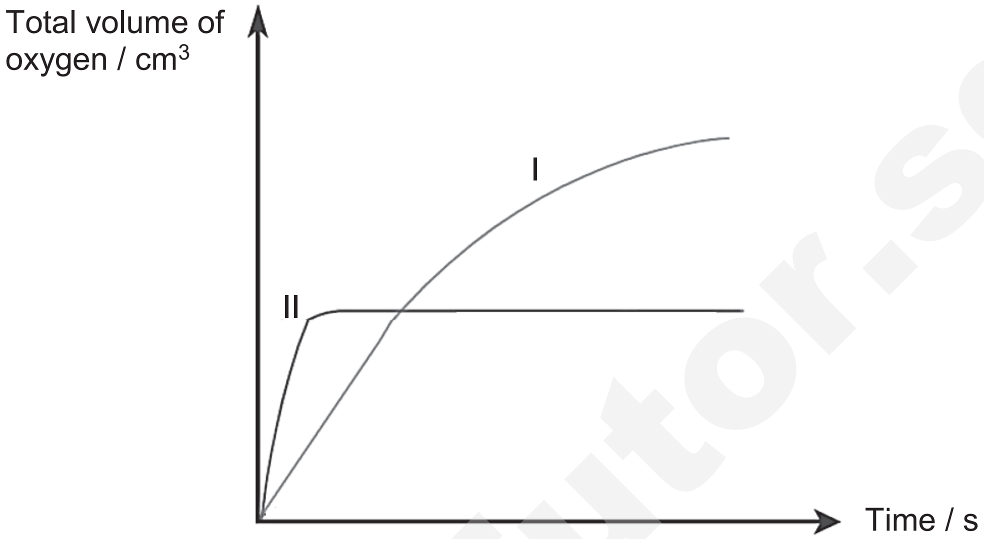
B The melting point.

C The number of electrons used in bonding.

D The number of shells holding electrons.

35 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen.

In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts were used and the temperature kept constant.



If curve I corresponds to 20.0 cm^3 of 4.0 mol/dm^3 of solution, curve II would correspond to

A 5.0 cm^3 of 8.0 mol/dm^3 solution.

B 10.0 cm^3 of 4.0 mol/dm^3 solution.

C 20.0 cm^3 of 2.0 mol/dm^3 solution.

D 20.0 cm^3 of 8.0 mol/dm^3 solution.

36 Which statement about the fractional distillation of crude oil is correct?

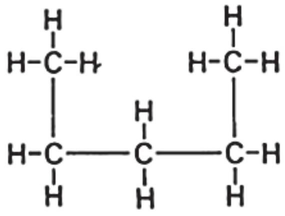
A At each level of the fractionating column, only one compound is collected.

B The higher up the fractionating column, the higher the temperature.

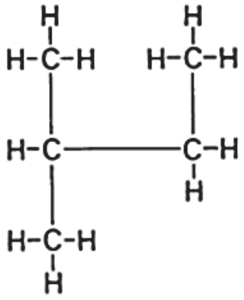
C The fraction at the top of the column are the least flammable.

D The fraction collected at the bottom of the column have the highest viscosity.

37 Five structural formulae are shown below.



1



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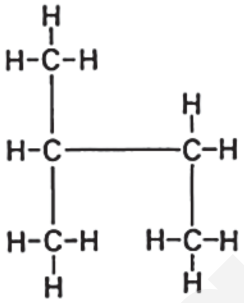

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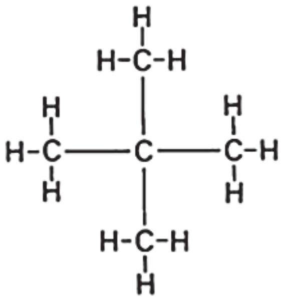

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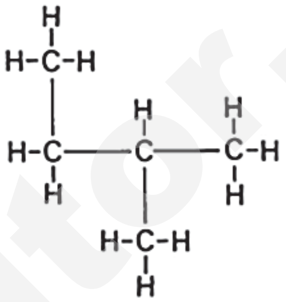


5

How many of the structures represent isomers of one another?

A	2	**B**	3
C	4	**D**	5

38 A student investigated the reaction of different vegetable oils and margarines with hydrogen.

100 cm^3 of hydrogen was passed through 1g samples containing a catalyst. The volume of hydrogen gas remaining in each reaction was recorded in the table below.

sample	volume of hydrogen remaining (cm^3)
P	0
Q	87
R	100

Which sample(s) is/are margarine?

A **P** only

B **P**, **Q** and **R**

C **P** and **Q**

D **R** only

39 In which reaction is water **not** a product?

A combustion of fossil fuels

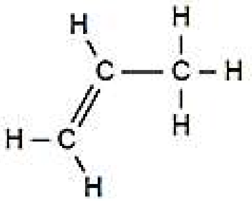
B esterification between ethanoic acid and ethanol

C fermentation of glucose

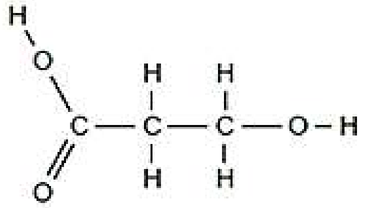
D neutralization between dilute hydrochloric acid and aqueous ammonia

40 Which of the following monomer(s) would undergo polymerisation on their own?

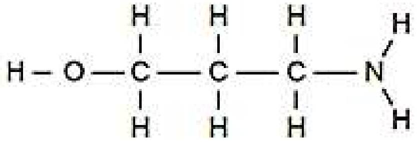
I



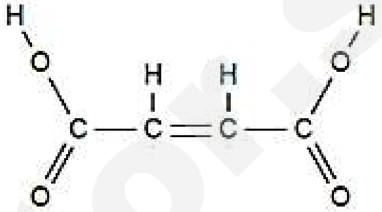
II



III



IV



A I, II and III

B I, II and IV

C II and III

D All of the above

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.).

O

ANDERSON SECONDARY SCHOOL
Preliminary Examination 2019
Secondary Four Express

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

CHEMISTRY **6092/01**

Paper 1 Multiple Choice

3 September 2019

1 hour

1000 – 1100h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

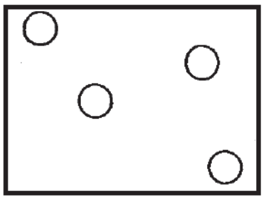
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C**, **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

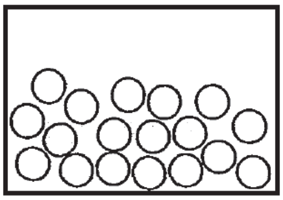
Read the instructions on the Answer Sheet very carefully.

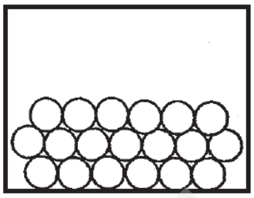
Each correct answer will score one mark. A mark will not be deducted for the wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page **21**.

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

1 Diagrams I, II and III show the particles of three substances at room temperature and pressure.


I

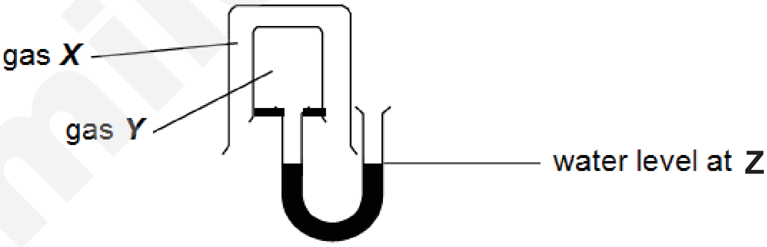

II


III

Which of these substances are correctly represented by the corresponding diagram?

	I	II	III
A	ethanol	hydrogen chloride	dry ice
B	helium	mercury	zinc
C	methane	sodium chloride	copper
D	water	argon	mercury

2 The set–up below shows how the relative rate of diffusion of gas **X** and **Y** can be determined.



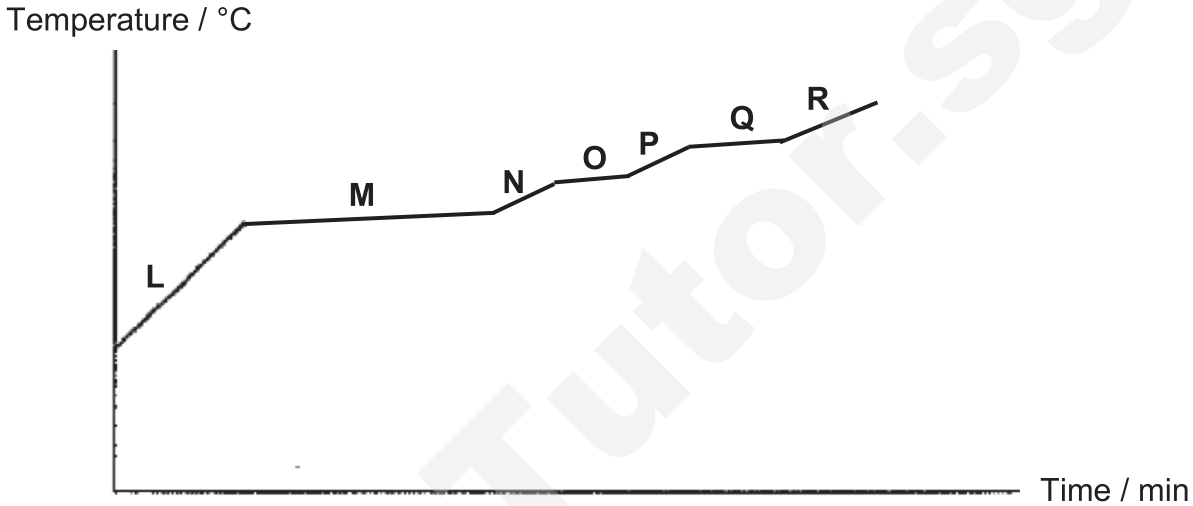
Which pair of substances could **X** and **Y** be if the water level at **Z** decreases?

	X	Y
A	ethane	argon
B	carbon monoxide	neon
C	methane	oxygen
D	nitrogen	carbon dioxide

3 The three main components of liquid air are nitrogen, oxygen and argon. Their respective boiling points are:

Nitrogen: –196°C
Oxygen: –183°C
Argon: –186°C

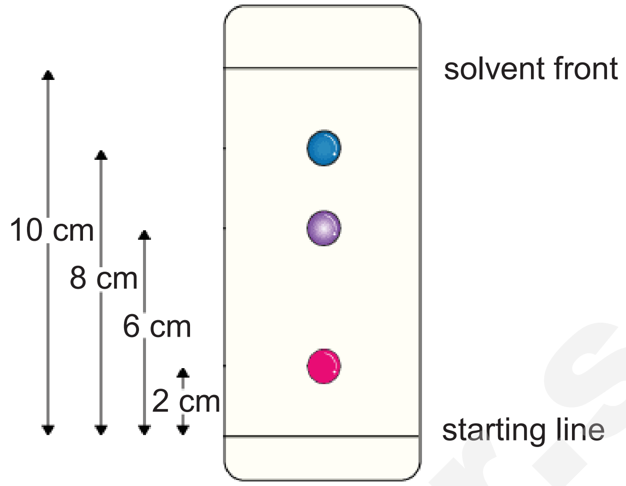
Liquid air can be separated into its three main components by fractional distillation. The graph shows the temperature of a liquid air mixture as it is heated.



In section **N** of the graph, the mixture remaining consists of

A liquid nitrogen and argon only.
B liquid nitrogen only.
C liquid oxygen and argon only.
D liquid oxygen only.

4 The diagram shows the chromatogram obtained by analysis of a dye mixture. Three measurements are shown in the diagram below.



What is the R_f value of the most soluble dye?

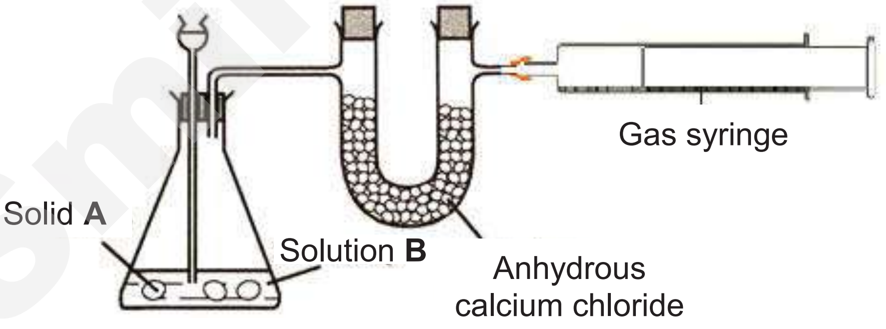
A 0.20

B 0.80

C 1.25

D 5.00

5 The diagram shows a simple laboratory set-up used to prepare and collect a dry gas.



Which pair of reagents would be most suitable to prepare the gas produced using this set-up?

	solid **A**	solution **B**
A	ammonium chloride	sodium hydroxide
B	calcium carbonate	aqueous ammonia
C	potassium hydroxide	sulfuric acid
D	zinc	hydrochloric acid

6 The solubilities of three solids in water and tetrachloromethane are given in the table below.

solid	**solubility in water**	**solubility in tetrachloromethane**
sand	not soluble	not soluble
sodium chloride	good	not soluble
sulfur	not soluble	good

Which of the experimental procedures would be suitable for obtaining pure sand from a mixture of sand, sodium chloride and sulfur?

A Add tetrachloromethane and stir, then filter to collect residue.

B Add tetrachloromethane and stir, then filter. Add the residue to water and stir, then filter to collect residue.

C Add water and stir, then filter. Evaporate the filtrate to dryness.

D Add water and stir, then filter. Add tetrachloromethane to filtrate and stir, then evaporate to dryness.

7 Brass is an alloy of copper and zinc. Copper has a melting point of 1085°C and zinc 419.5°C. Which of the following is a possible melting point of brass?

A Above 419.5°C

B Above 1085°C

C Below 1085°C

D Between 419.5°C and 1085°C

8 An ion of formula $\mathbf{X}^{2-}$ contains 18 electrons. If the relative atomic mass of **X** is 32, what is present in the nucleus of the ion?

A 16 protons and 16 neutrons
B 16 protons and 18 electrons
C 18 protons and 14 neutrons
D 18 protons and 18 electrons

9 Which statement correctly describes the properties of the compound copper(II) sulfide, CuS and mixture of copper and sulfur?

	copper(II) sulfide	**mixture of copper and sulfur**
1	copper and sulfur react when heated to form copper(II) sulfide	copper and sulfur mix together with no energy change
2	the ratio of copper to sulfur is always 1 : 1	the ratio of copper to sulfur can vary
3	copper(II) sulfide has the same properties as copper and sulfur	the mixtures do not have the same properties as copper and sulfur

A 1 only

B 1 and 2

C 2 and 3

D All the above

10 Which compound contains both ionic and covalent bonds?

A ammonia

B beryllium chloride

C ethyl ethanoate

D potassium nitrate

11 An investigation of the properties of the chlorides of Period 3 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 metallic character decreasing across the period.

C silicon forming weaker bonds with chlorine as compared to sodium.

D silicon tetrachloride having weak intermolecular forces of attraction.

12 Two comments about hydrogen chloride are made below.

Comment 1: Hydrogen chloride has strong covalent bonds in its simple molecular structure.
Comment 2: Hydrogen chloride is soluble in water.

Which statement is correct?

A Both comments are correct and comment 1 explains comment 2.
B Both comments are correct but comment 1 does not explain comment 2.
C Both comments are incorrect.
D Comment 2 is correct but comment 1 is incorrect.

13 The reaction of nitrogen dioxide with water is as shown.

$$\mathbf{w}\ NO_2 + \mathbf{x}\ H_2O \rightarrow \mathbf{y}\ HNO_3 + \mathbf{z}\ HNO_2$$

Which of the following values will give a balanced equation for the reaction above?

	w	**x**	**y**	**z**
A	1	1	1	1
B	2	1	1	1
C	2	2	1	1
D	4	2	2	2

14 Antimony is in the same group as nitrogen in the Periodic Table. What is the chemical formula of lithium antimonide?

A Li_3An
B $LiAnO_3$
C Li_3Sb
D $LiSbO_3$

15 Which statements about molecular mass is **incorrect**?

A It is the mass obtained on an electronic balance by 1g of the molecules.

B It is the ratio of the average mass of a molecule to the mass of a ^{12}C atom.

C It is the ratio of the mass of 1 mole of molecules to the mass of 1 mole of ^{12}C atom.

D It is the sum of the relative atomic masses of all the atoms within the molecules.

16 Which substance contains the greatest number of atoms in 1g?

A CO_2

B NO_2

C O_2

D SO_2

17 100 cm^3 of ammonia burns in 50 cm^3 of oxygen according to the following equation:

$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

What volume of gas will be collected at the end of the reaction when cooled to room temperature?

A 33.3 cm^3 **B** 50.0 cm^3

C 66.7 cm^3 **D** 166.7 cm^3

18 The fertilisers ammonium nitrate (NH_4NO_3, M_r = 80) is manufactured from ammonia (NH_3, M_r = 17) by a two-stage process.

Stage 1: $NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$
Stage 2: $HNO_3 + NH_3 \rightarrow NH_4NO_3$

What is the maximum mass of fertilizer that can be made if only 17 tonnes of ammonia is available?

A 34 tonnes **B** 40 tonnes

C 80 tonnes **D** 97 tonnes

19 Magnesium oxide is produced by heating magnesium carbonate.

$$MgCO_3 \rightarrow MgO + CO_2$$

When 84 g of magnesium carbonate is heated, 34 g of magnesium oxide is produced. What is the percentage yield of magnesium oxide?
[M_r: $MgCO_3$, 84; MgO, 40]

A $\frac{34}{40} \times 100$

B $\frac{34}{84} \times 100$

C $\frac{40}{34} \times 100$

D $84 \times \frac{34}{40} \times 100$

20 35.0 cm^3 of 0.500 mol/dm^3 hydrochloric acid were added to 1.41 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 15.0 cm^3 of 0.400 mol/dm^3 of sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?
[M_r: HCl, 36.5; Na_2CO_3, 106; NaOH, 40]

A 43.2% **B** 45.1%

C 86.5% **D** 90.2%

21 Which method(s) is/are suitable to test the strengths of acids and alkalis?

1 titration
2 measuring their electrical conductivity
3 using a pH meter

A 1 only

B 1 and 3

C 2 and 3

D All of the above

22 Arsine (AsH_3) is a gas that behaves like ammonia. Which of the following particles are found in the solution when Arsine dissolves in water?

A As^+ and OH^-

B AsH_3, As^+ and OH^-

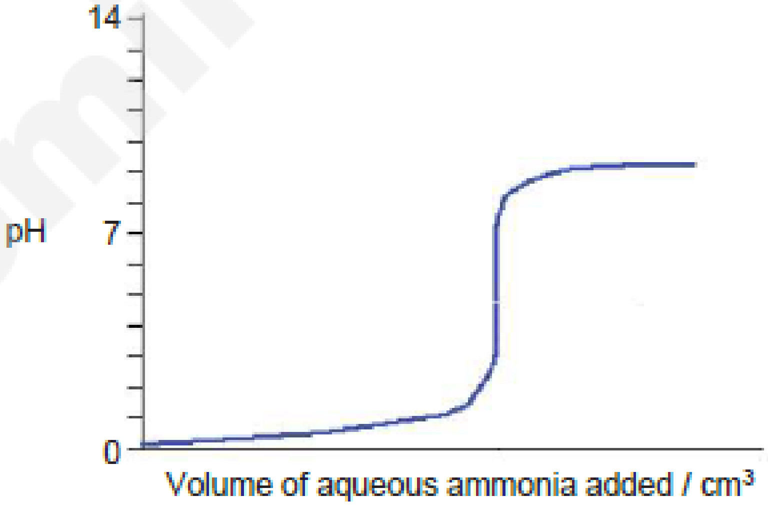
C AsH_4^+ and OH^-

D AsH_3, AsH_4^+ and OH^-

23 Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

indicator	pH range for the colour change	colour	
		lower pH	higher pH
indigo carmine	11.6 – 14.0	blue	yellow
methyl red	4.2 – 6.3	red	yellow
methyl violet	0.3 – 3.0	yellow	violet
phenolphthalein	8.2 – 10.0	colourless	pink

The graph below shows the change of pH when aqueous ammonia is added to a fixed volume of dilute hydrochloric acid in a titration.



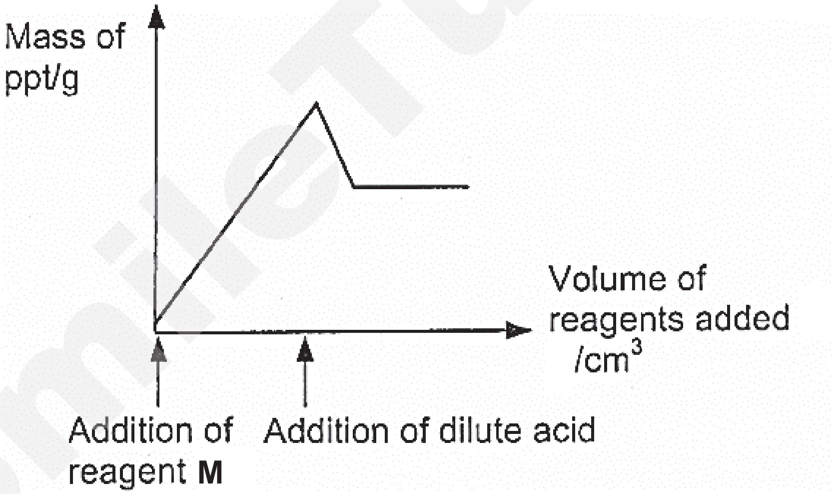
Which indicator would be the best choice to use in this titration?

A indigo carmine
B methyl red
C methyl violet
D phenolphthalein

24 Which substance has metallic bonding?

substance	electrical conductivity		property of product formed from the reaction between substance and oxygen
	in solid state	in molten state	
A	X	X	reacts with alkali
B	X	✓	no reaction with acid or alkali
C	✓	✓	reacts with alkali
D	✓	✓	reacts with both acid and alkali

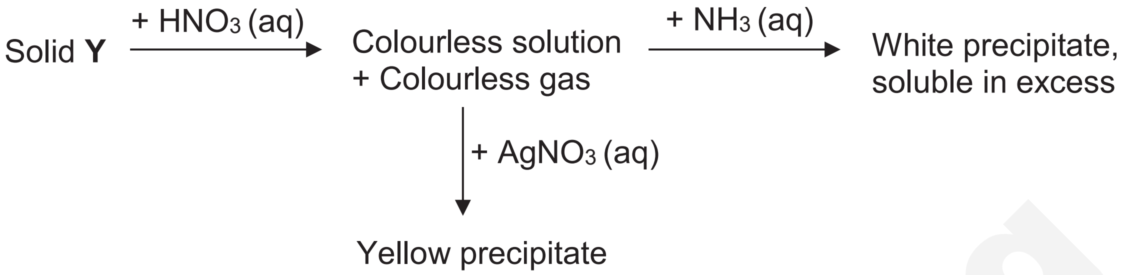
25 In a quantitative analysis, reagent **M** is gradually added to a salt solution **N** (that contains either 1 or 2 different anions), followed by the addition of a dilute acid. The graph below shows how the mass of precipitate formed changes with the reagents added.



Which of the following combinations would produce the graph above?

	anions in **N**	reagents (**M** and acid) added
A	CO_3^{2-}	$AgNO_3$ and HNO_3
B	CO_3^{2-}, Cl^-	$BaCl_2$ and HNO_3
C	CO_3^{2-}, SO_4^{2-}	$AgNO_3$ and HCl
D	CO_3^{2-}, SO_4^{2-}	$BaCl_2$ and HCl

26 Solid **Y** contains a mixture of two salts. The scheme below shows some reactions of solid **Y**.



Which of the following could be the two salts present in solid **Y**?

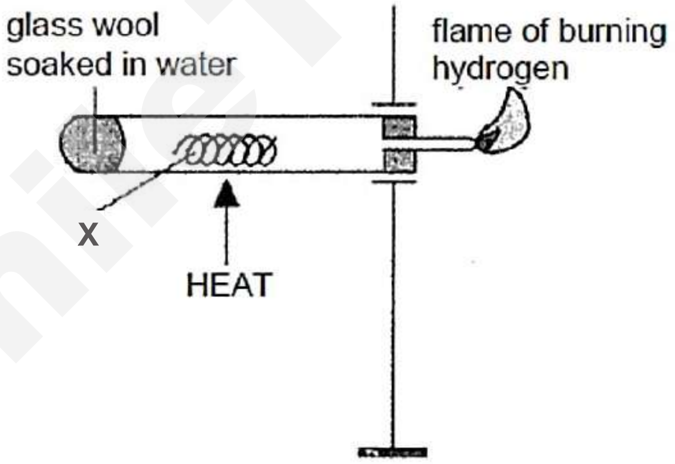
A aluminium carbonate and ammonium chloride

B calcium chloride and zinc carbonate

C lead(II) carbonate and sodium iodide

D zinc iodide and calcium carbonate

27 The set-up below shows the reaction of substance **X**.



What is the possible identity of **X**?

A **X** is a metal above hydrogen in the reactivity series.

B **X** is a metal below hydrogen in the reactivity series.

C **X** is an oxide of a metal that is above hydrogen in the reactivity series.

D **X** is an oxide of a metal that is below hydrogen in the reactivity series.

28 The following observations were made when nickel and iron were placed separately into solutions of metals **S**, **T** and **U**.

	salt solution of **S**	salt solution of **T**	salt solution of **U**
nickel	displaced	not displaced	not displaced
iron	displaced	displaced	not displaced

What is the correct order in increasing reactivity of the five metals?

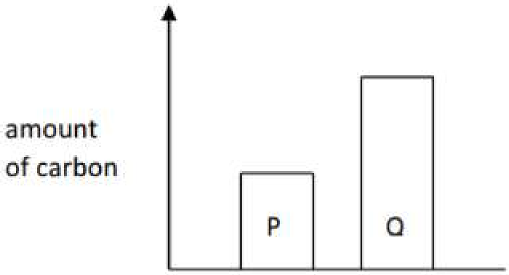
A **S** < Ni < Fe < **T** < **U**

B **S** < Ni < **T** < Fe < **U**

C **U** < Fe < **T** < Ni < **S**

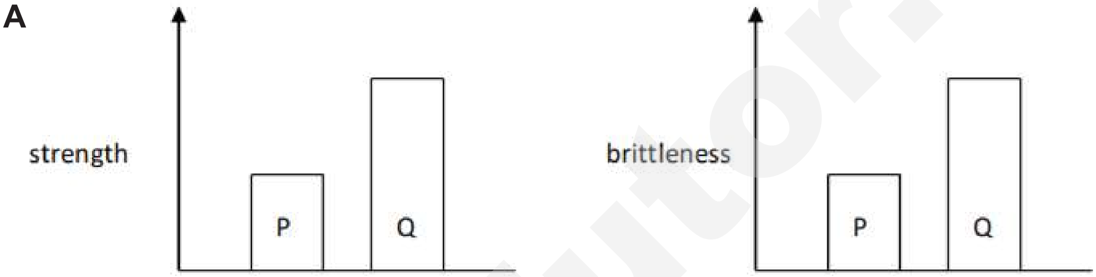
D **U** < **T** < Fe < Ni < **S**

29 The diagram compares the amount of carbon in two steels, **P** and **Q**?

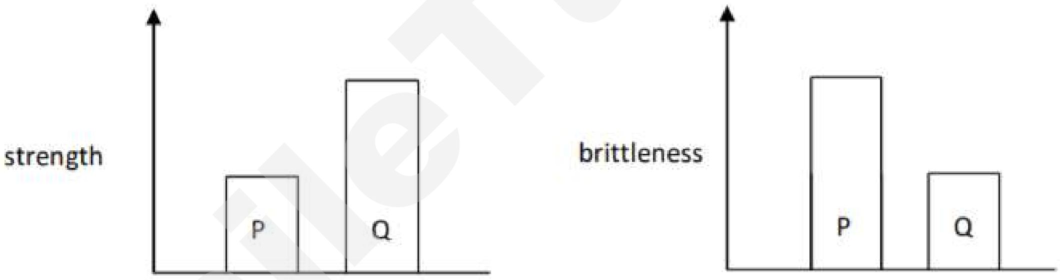


Which two diagrams correctly compare the strength and brittleness of **P** and **Q**?

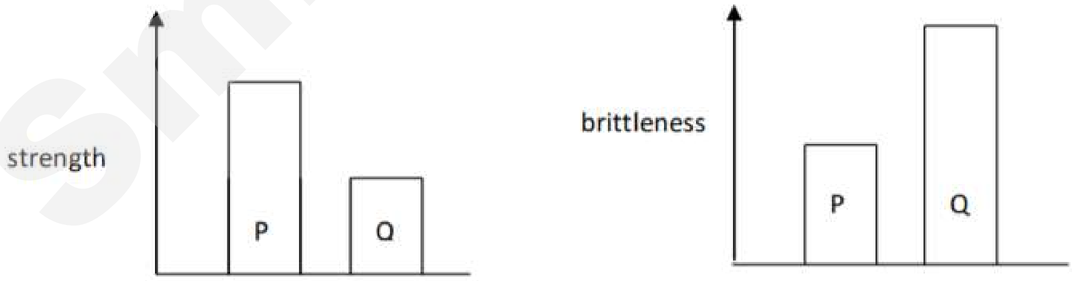
A



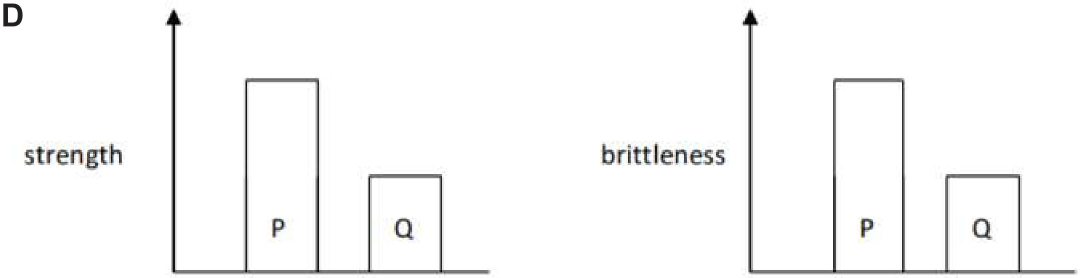
B



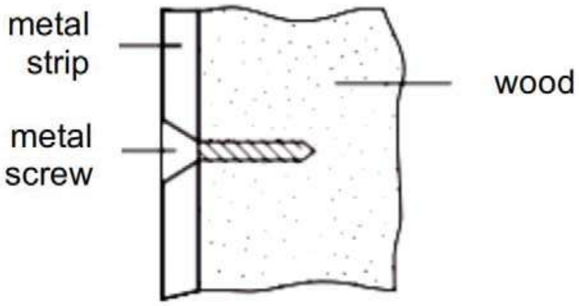
C



D



30 An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.



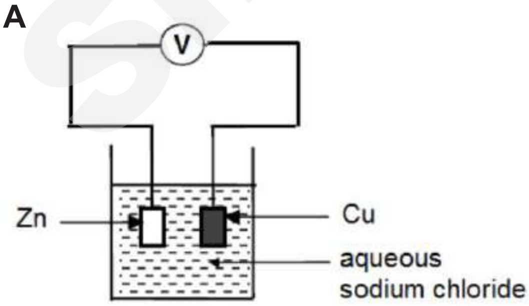
After a few weeks of being exposed to wind and rain, the screws are heavily corroded but the metal strips are not.

Which two metals would give this result?

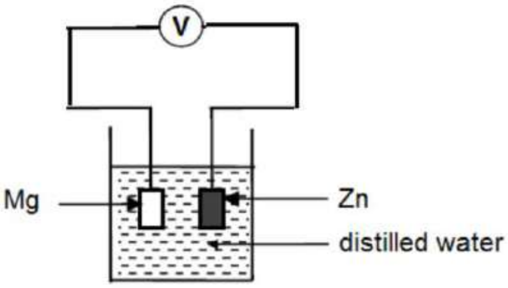
	screw	**strip**
A	copper	steel
B	copper	zinc
C	steel	copper
D	steel	magnesium

31 Which set–up would produce the greatest reading on the voltmeter?

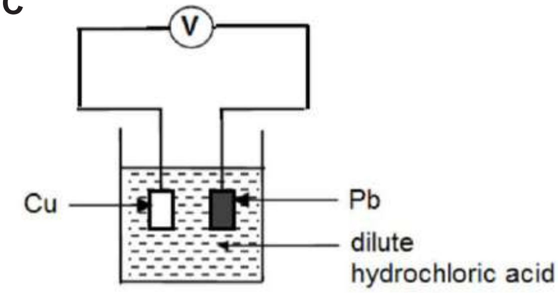
A



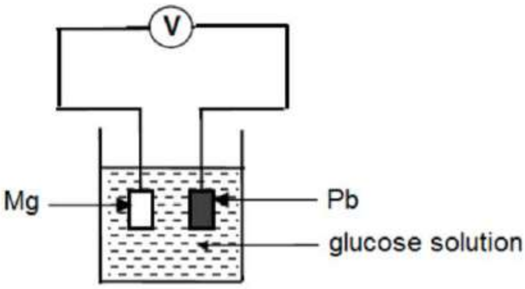
B



C



D



32 For which process is the enthalpy change always positive?

A combustion

B dissolving of acids in water

C evaporation

D respiration

33 Which of the following reactions takes place in a hydrogen fuel cell?

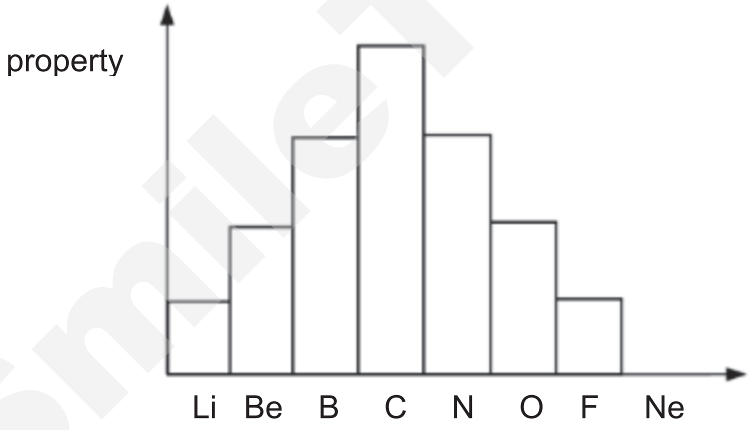
A Hydrogen ions are oxidised at the anode.

B Hydrogen ions are reduced at the cathode.

C Hydrogen loses electrons to form H^+ ions at the anode.

D Oxygen gains electrons to form O^{2-} at the cathode.

34 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon. Which property of these elements is shown in the chart?



A The atomic radius.

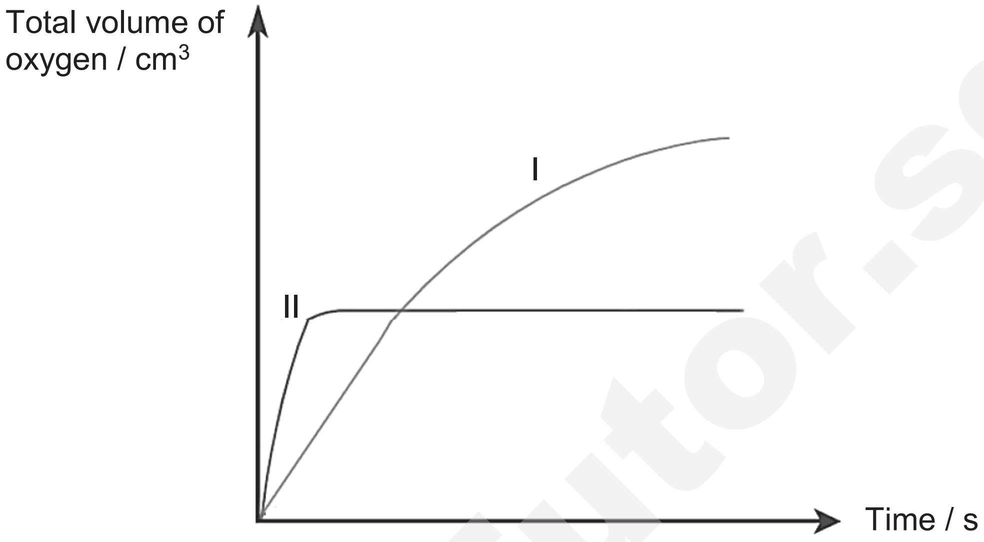
B The melting point.

C The number of electrons used in bonding.

D The number of shells holding electrons.

35 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen.

In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts were used and the temperature kept constant.



If curve I corresponds to 20.0 cm^3 of 4.0 mol/dm^3 of solution, curve II would correspond to

A 5.0 cm^3 of 8.0 mol/dm^3 solution.

B 10.0 cm^3 of 4.0 mol/dm^3 solution.

C 20.0 cm^3 of 2.0 mol/dm^3 solution.

D 20.0 cm^3 of 8.0 mol/dm^3 solution.

36 Which statement about the fractional distillation of crude oil is correct?

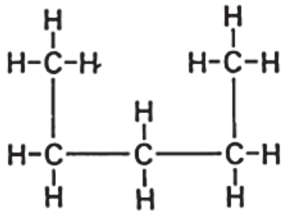
A At each level of the fractionating column, only one compound is collected.

B The higher up the fractionating column, the higher the temperature.

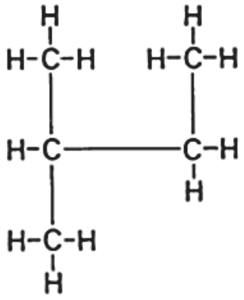
C The fraction at the top of the column are the least flammable.

D The fraction collected at the bottom of the column have the highest viscosity.

37 Five structural formulae are shown below.



1



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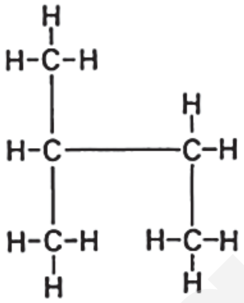

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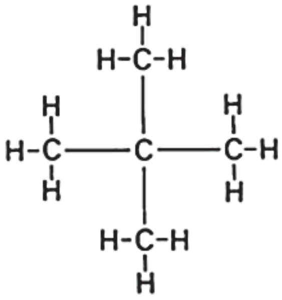

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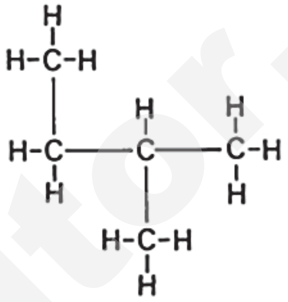


5

How many of the structures represent isomers of one another?

A 2 **B** 3

C 4 **D** 5

38 A student investigated the reaction of different vegetable oils and margarines with hydrogen.

100 cm^3 of hydrogen was passed through 1g samples containing a catalyst. The volume of hydrogen gas remaining in each reaction was recorded in the table below.

sample	volume of hydrogen remaining (cm^3)
P	0
Q	87
R	100

Which sample(s) is/are margarine?

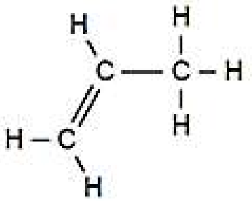
A **P** only
B **P**, **Q** and **R**
C **P** and **Q**
D **R** only

39 In which reaction is water **not** a product?

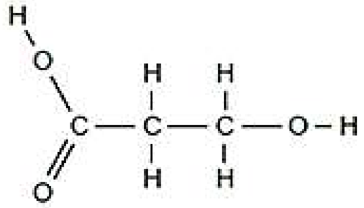
A combustion of fossil fuels
B esterification between ethanoic acid and ethanol
C fermentation of glucose
D neutralization between dilute hydrochloric acid and aqueous ammonia

40 Which of the following monomer(s) would undergo polymerisation on their own?

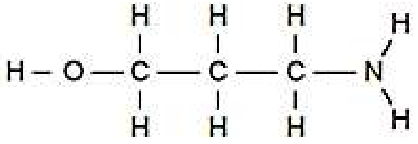
I



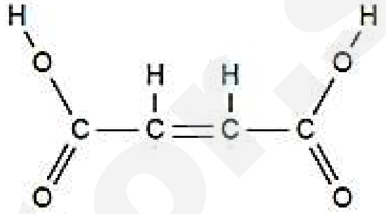
II



III



IV



A I, II and III

B I, II and IV

C II and III

D All of the above

The Periodic Table of Elements

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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 –		

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.).

O

ANDERSON SECONDARY SCHOOL
Preliminary Examination 2019
Secondary Four Express

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

CHEMISTRY

6092/01

Paper 1 Multiple Choice

3 September 2019

1 hour

1000 – 1100h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.
Write your name, class and index number 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**, **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.

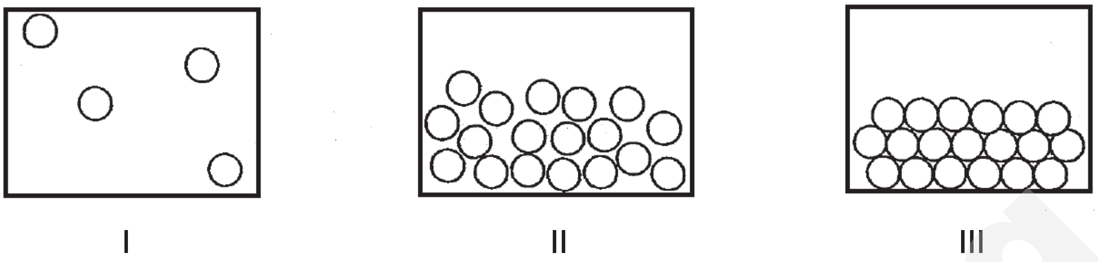
Each correct answer will score one mark. A mark will not be deducted for the wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page **21**.

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

This document consists of **21** printed pages.

Setter: Mrs Goh Li Eng

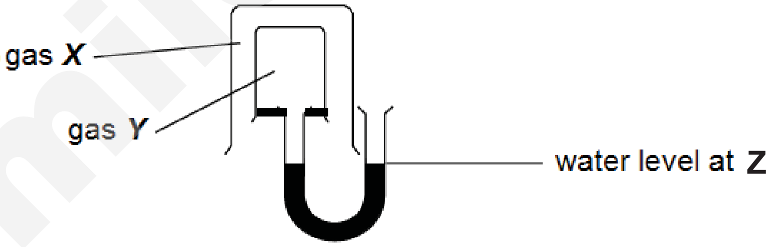
1 Diagrams I, II and III show the particles of three substances at room temperature and pressure.



Which of these substances are correctly represented by the corresponding diagram?

	I	II	III
A	ethanol	hydrogen chloride	dry ice
B	helium	mercury	zinc
C	methane	sodium chloride	copper
D	water	argon	mercury

2 The set–up below shows how the relative rate of diffusion of gas **X** and **Y** can be determined.



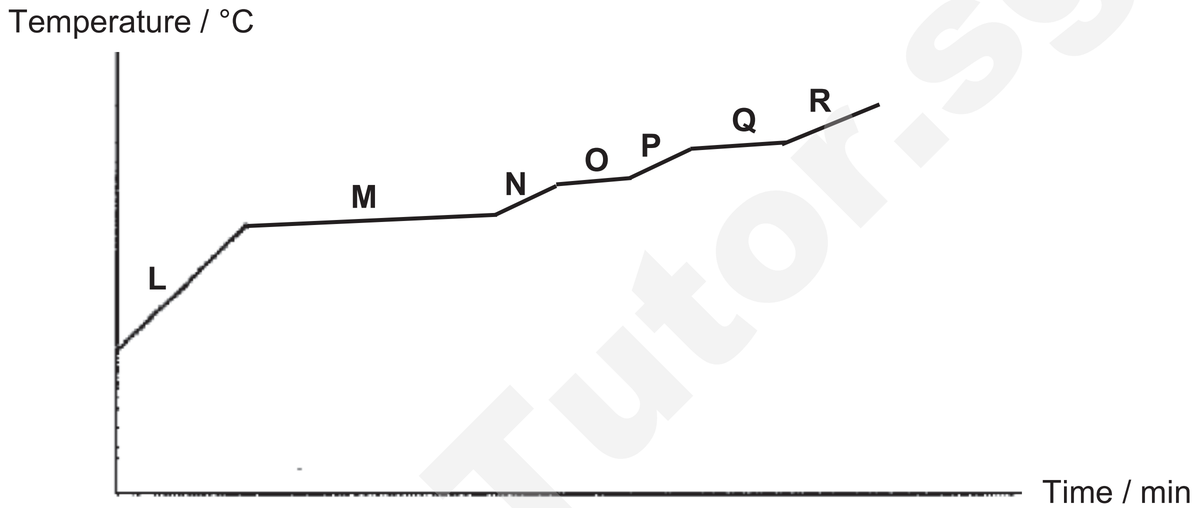
Which pair of substances could **X** and **Y** be if the water level at **Z** decreases?

	X	Y
A	ethane	argon
B	carbon monoxide	neon
C	methane	oxygen
D	nitrogen	carbon dioxide

3 The three main components of liquid air are nitrogen, oxygen and argon. Their respective boiling points are:

Nitrogen: –196°C
Oxygen: –183°C
Argon: –186°C

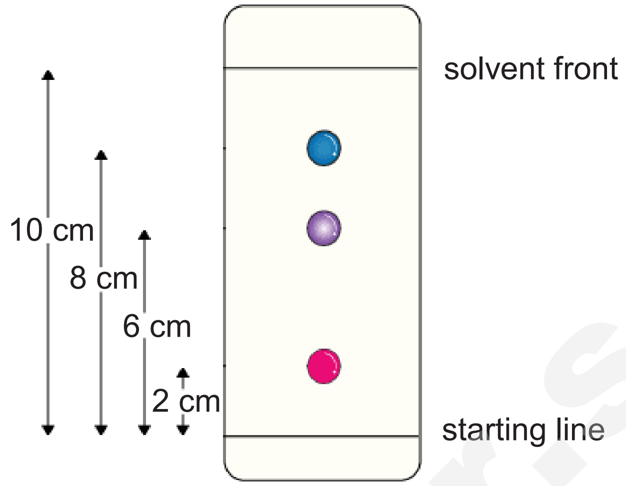
Liquid air can be separated into its three main components by fractional distillation. The graph shows the temperature of a liquid air mixture as it is heated.



In section **N** of the graph, the mixture remaining consists of

- **A** liquid nitrogen and argon only.
- **B** liquid nitrogen only.
- **C** liquid oxygen and argon only.
- **D** liquid oxygen only.

4 The diagram shows the chromatogram obtained by analysis of a dye mixture. Three measurements are shown in the diagram below.



What is the R_f value of the most soluble dye?

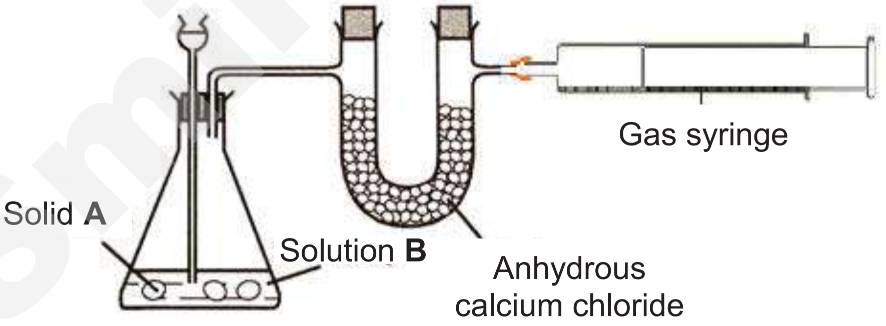
A 0.20

B 0.80

C 1.25

D 5.00

5 The diagram shows a simple laboratory set-up used to prepare and collect a dry gas.



Which pair of reagents would be most suitable to prepare the gas produced using this set-up?

	solid **A**	solution **B**
A	ammonium chloride	sodium hydroxide
B	calcium carbonate	aqueous ammonia
C	potassium hydroxide	sulfuric acid
D	zinc	hydrochloric acid

6 The solubilities of three solids in water and tetrachloromethane are given in the table below.

solid	**solubility in water**	**solubility in tetrachloromethane**
sand	not soluble	not soluble
sodium chloride	good	not soluble
sulfur	not soluble	good

Which of the experimental procedures would be suitable for obtaining pure sand from a mixture of sand, sodium chloride and sulfur?

A Add tetrachloromethane and stir, then filter to collect residue.

B Add tetrachloromethane and stir, then filter. Add the residue to water and stir, then filter to collect residue.

C Add water and stir, then filter. Evaporate the filtrate to dryness.

D Add water and stir, then filter. Add tetrachloromethane to filtrate and stir, then evaporate to dryness.

7 Brass is an alloy of copper and zinc. Copper has a melting point of 1085°C and zinc 419.5°C. Which of the following is a possible melting point of brass?

A Above 419.5°C

B Above 1085°C

C Below 1085°C

D Between 419.5°C and 1085°C

8 An ion of formula $\mathbf{X}^{2-}$ contains 18 electrons. If the relative atomic mass of **X** is 32, what is present in the nucleus of the ion?

A 16 protons and 16 neutrons

B 16 protons and 18 electrons

C 18 protons and 14 neutrons

D 18 protons and 18 electrons

9 Which statement correctly describes the properties of the compound copper(II) sulfide, CuS and mixture of copper and sulfur?

	copper(II) sulfide	**mixture of copper and sulfur**
1	copper and sulfur react when heated to form copper(II) sulfide	copper and sulfur mix together with no energy change
2	the ratio of copper to sulfur is always 1 : 1	the ratio of copper to sulfur can vary
3	copper(II) sulfide has the same properties as copper and sulfur	the mixtures do not have the same properties as copper and sulfur

A 1 only

B 1 and 2

C 2 and 3

D All the above

10 Which compound contains both ionic and covalent bonds?

A ammonia

B beryllium chloride

C ethyl ethanoate

D potassium nitrate

11 An investigation of the properties of the chlorides of Period 3 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 metallic character decreasing across the period.

C silicon forming weaker bonds with chlorine as compared to sodium.

D silicon tetrachloride having weak intermolecular forces of attraction.

12 Two comments about hydrogen chloride are made below.

Comment 1: Hydrogen chloride has strong covalent bonds in its simple molecular structure.
Comment 2: Hydrogen chloride is soluble in water.

Which statement is correct?

A Both comments are correct and comment 1 explains comment 2.
B Both comments are correct but comment 1 does not explain comment 2.
C Both comments are incorrect.
D Comment 2 is correct but comment 1 is incorrect.

13 The reaction of nitrogen dioxide with water is as shown.

$$\mathbf{w}\ NO_2 + \mathbf{x}\ H_2O \rightarrow \mathbf{y}\ HNO_3 + \mathbf{z}\ HNO_2$$

Which of the following values will give a balanced equation for the reaction above?

	w	**x**	**y**	**z**
A	1	1	1	1
B	2	1	1	1
C	2	2	1	1
D	4	2	2	2

14 Antimony is in the same group as nitrogen in the Periodic Table. What is the chemical formula of lithium antimonide?

A Li_3An
B $LiAnO_3$
C Li_3Sb
D $LiSbO_3$

15 Which statements about molecular mass is **incorrect**?

A It is the mass obtained on an electronic balance by 1g of the molecules.

B It is the ratio of the average mass of a molecule to the mass of a ^{12}C atom.

C It is the ratio of the mass of 1 mole of molecules to the mass of 1 mole of ^{12}C atom.

D It is the sum of the relative atomic masses of all the atoms within the molecules.

16 Which substance contains the greatest number of atoms in 1g?

A CO_2

B NO_2

C O_2

D SO_2

17 100 cm^3 of ammonia burns in 50 cm^3 of oxygen according to the following equation:

$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

What volume of gas will be collected at the end of the reaction when cooled to room temperature?

A 33.3 cm^3 **B** 50.0 cm^3

C 66.7 cm^3 **D** 166.7 cm^3

18 The fertilisers ammonium nitrate (NH_4NO_3, $M_r = 80$) is manufactured from ammonia (NH_3, $M_r = 17$) by a two-stage process.

Stage 1: $NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$
Stage 2: $HNO_3 + NH_3 \rightarrow NH_4NO_3$

What is the maximum mass of fertilizer that can be made if only 17 tonnes of ammonia is available?

A 34 tonnes **B** 40 tonnes

C 80 tonnes **D** 97 tonnes

19 Magnesium oxide is produced by heating magnesium carbonate.

$$MgCO_3 \rightarrow MgO + CO_2$$

When 84 g of magnesium carbonate is heated, 34 g of magnesium oxide is produced. What is the percentage yield of magnesium oxide?
[M_r: $MgCO_3$, 84; MgO, 40]

A $\frac{34}{40} \times 100$

B $\frac{34}{84} \times 100$

C $\frac{40}{34} \times 100$

D $84 \times \frac{34}{40} \times 100$

20 35.0 cm^3 of 0.500 mol/dm^3 hydrochloric acid were added to 1.41 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 15.0 cm^3 of 0.400 mol/dm^3 of sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?
[M_r: HC*l*, 36.5; Na_2CO_3, 106; NaOH, 40]

A	43.2%	**B**	45.1%
C	86.5%	**D**	90.2%

21 Which method(s) is/are suitable to test the strengths of acids and alkalis?

1 titration
2 measuring their electrical conductivity
3 using a pH meter

A 1 only

B 1 and 3

C 2 and 3

D All of the above

22 Arsine (AsH_3) is a gas that behaves like ammonia. Which of the following particles are found in the solution when Arsine dissolves in water?

A As^+ and OH^-

B AsH_3, As^+ and OH^-

C AsH_4^+ and OH^-

D AsH_3, AsH_4^+ and OH^-

23 Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

indicator	pH range for the colour change	colour	
		lower pH	higher pH
indigo carmine	11.6 – 14.0	blue	yellow
methyl red	4.2 – 6.3	red	yellow
methyl violet	0.3 – 3.0	yellow	violet
phenolphthalein	8.2 – 10.0	colourless	pink

The graph below shows the change of pH when aqueous ammonia is added to a fixed volume of dilute hydrochloric acid in a titration.

14

pH 7

0

Volume of aqueous ammonia added / cm^3

Which indicator would be the best choice to use in this titration?

A indigo carmine

B methyl red

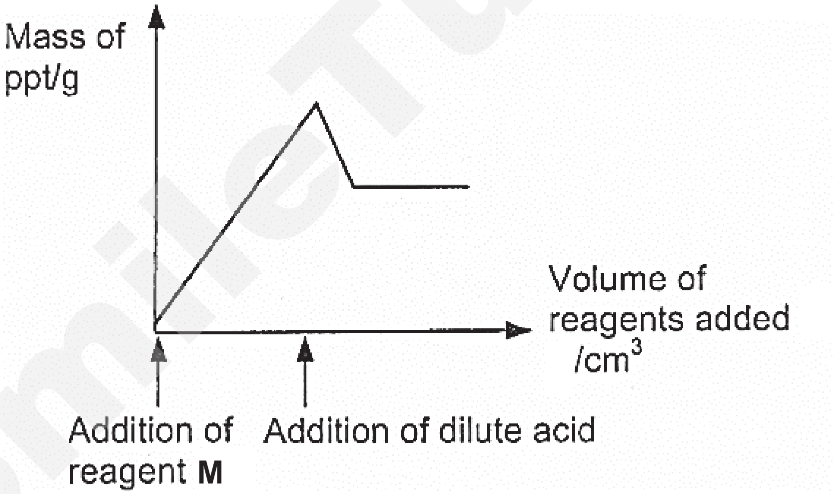
C methyl violet

D phenolphthalein

24 Which substance has metallic bonding?

substance	electrical conductivity		property of product formed from the reaction between substance and oxygen
	in solid state	in molten state	
A	X	X	reacts with alkali
B	X	✓	no reaction with acid or alkali
C	✓	✓	reacts with alkali
D	✓	✓	reacts with both acid and alkali

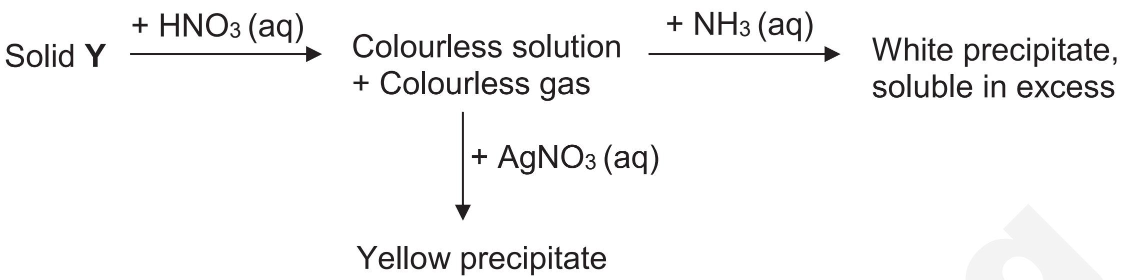
25 In a quantitative analysis, reagent **M** is gradually added to a salt solution **N** (that contains either 1 or 2 different anions), followed by the addition of a dilute acid. The graph below shows how the mass of precipitate formed changes with the reagents added.



Which of the following combinations would produce the graph above?

	anions in **N**	reagents (**M** and acid) added
A	CO_3^{2-}	$AgNO_3$ and HNO_3
B	CO_3^{2-}, Cl^-	$BaCl_2$ and HNO_3
C	CO_3^{2-}, SO_4^{2-}	$AgNO_3$ and HCl
D	CO_3^{2-}, SO_4^{2-}	$BaCl_2$ and HCl

26 Solid **Y** contains a mixture of two salts. The scheme below shows some reactions of solid **Y**.



Which of the following could be the two salts present in solid **Y**?

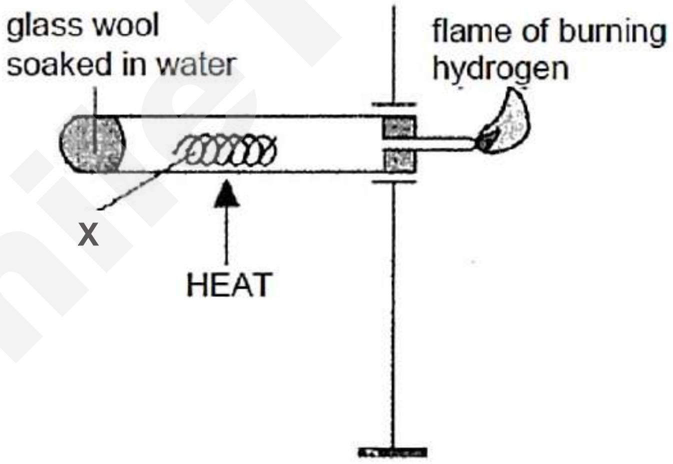
A aluminium carbonate and ammonium chloride

B calcium chloride and zinc carbonate

C lead(II) carbonate and sodium iodide

D zinc iodide and calcium carbonate

27 The set-up below shows the reaction of substance **X**.



What is the possible identity of **X**?

A **X** is a metal above hydrogen in the reactivity series.

B **X** is a metal below hydrogen in the reactivity series.

C **X** is an oxide of a metal that is above hydrogen in the reactivity series.

D **X** is an oxide of a metal that is below hydrogen in the reactivity series.

28 The following observations were made when nickel and iron were placed separately into solutions of metals **S**, **T** and **U**.

	salt solution of **S**	salt solution of **T**	salt solution of **U**
nickel	displaced	not displaced	not displaced
iron	displaced	displaced	not displaced

What is the correct order in increasing reactivity of the five metals?

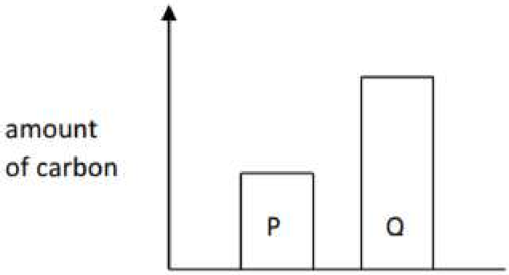
A **S** < Ni < Fe < **T** < **U**

B **S** < Ni < **T** < Fe < **U**

C **U** < Fe < **T** < Ni < **S**

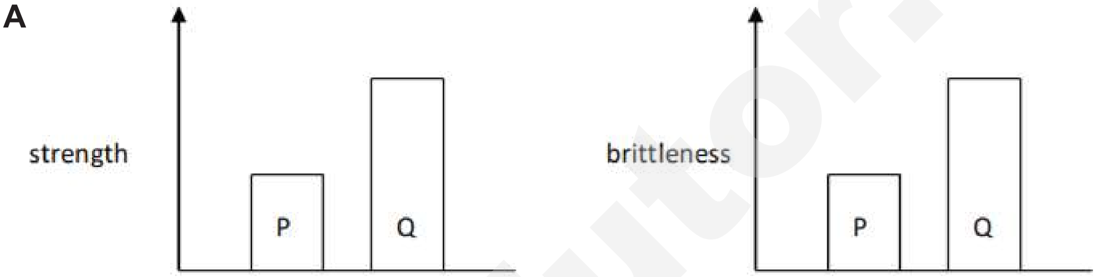
D **U** < **T** < Fe < Ni < **S**

29 The diagram compares the amount of carbon in two steels, **P** and **Q**?

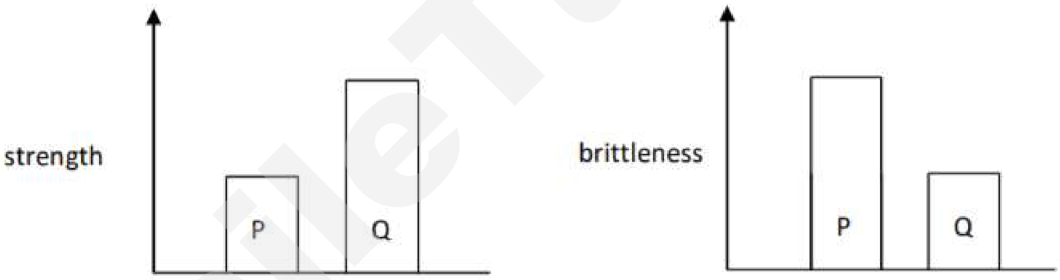


Which two diagrams correctly compare the strength and brittleness of **P** and **Q**?

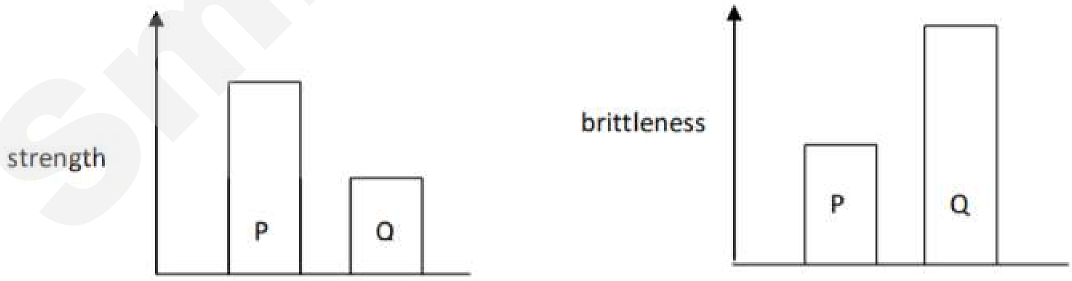
A



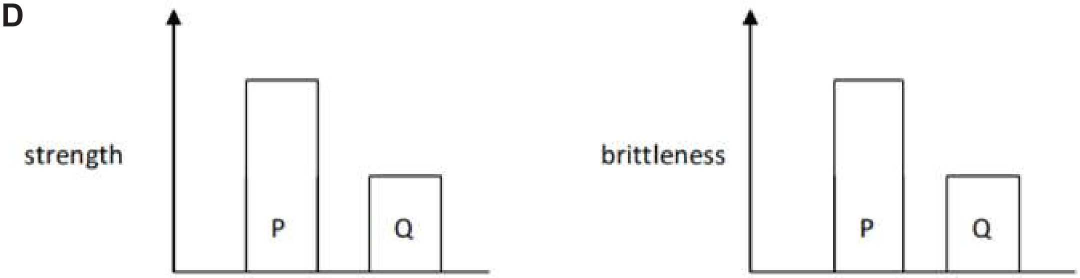
B



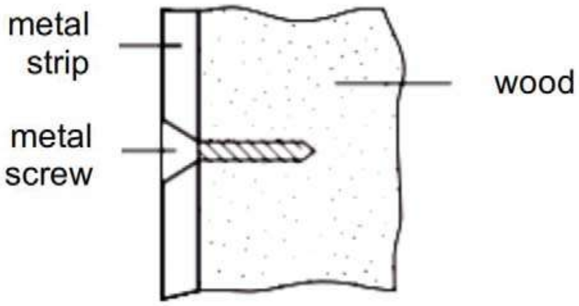
C



D



30 An old railway carriage is being restored by having metal strips secured to the outside of the wooden carriage by means of screws.



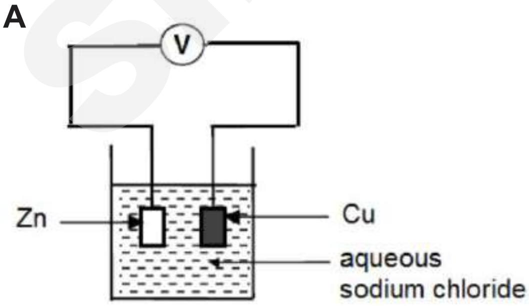
After a few weeks of being exposed to wind and rain, the screws are heavily corroded but the metal strips are not.

Which two metals would give this result?

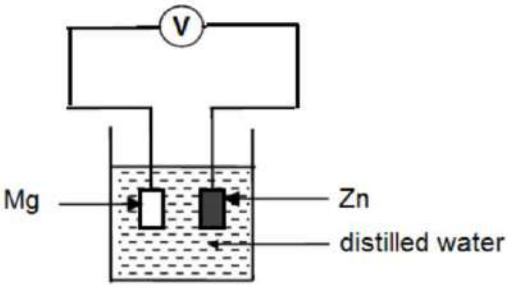
	screw	**strip**
A	copper	steel
B	copper	zinc
C	steel	copper
D	steel	magnesium

31 Which set–up would produce the greatest reading on the voltmeter?

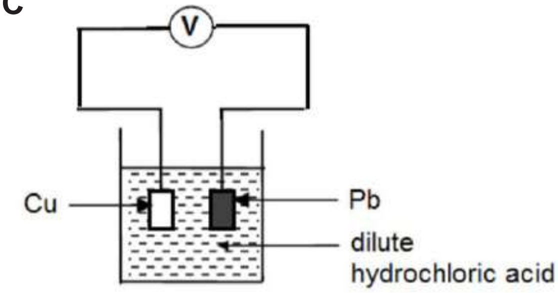
A



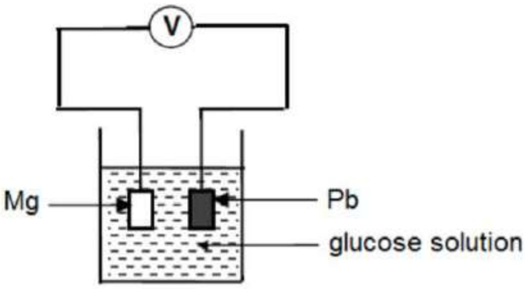
B



C



D



32 For which process is the enthalpy change always positive?

A combustion

B dissolving of acids in water

C evaporation

D respiration

33 Which of the following reactions takes place in a hydrogen fuel cell?

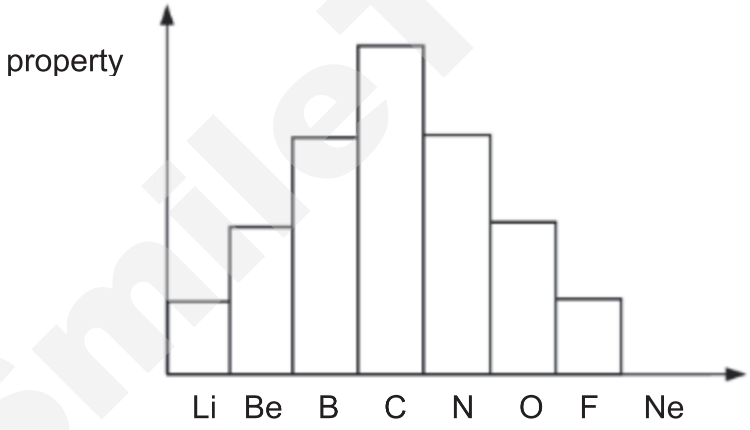
A Hydrogen ions are oxidised at the anode.

B Hydrogen ions are reduced at the cathode.

C Hydrogen loses electrons to form H^+ ions at the anode.

D Oxygen gains electrons to form O^{2-} at the cathode.

34 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon. Which property of these elements is shown in the chart?



A The atomic radius.

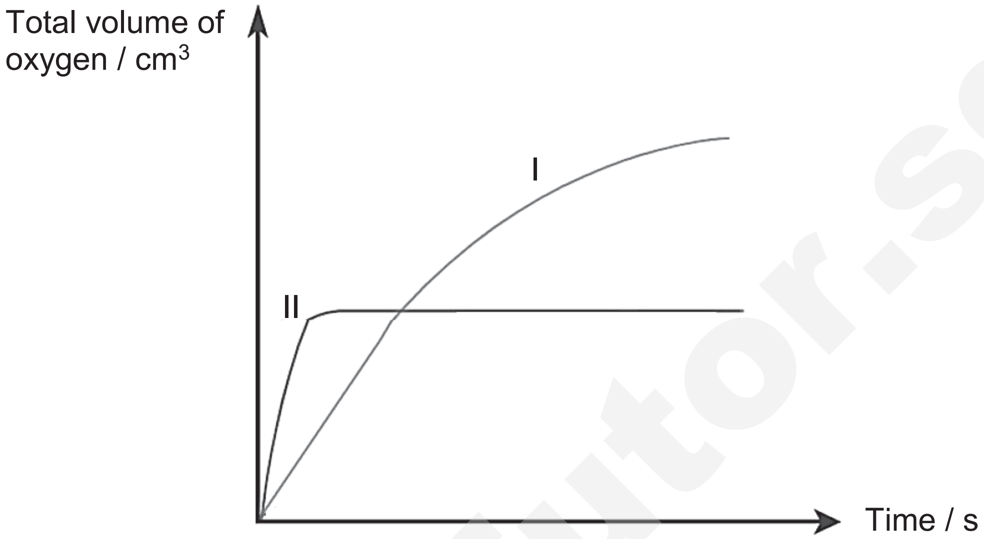
B The melting point.

C The number of electrons used in bonding.

D The number of shells holding electrons.

35 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen.

In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts were used and the temperature kept constant.



If curve I corresponds to 20.0 cm^3 of 4.0 mol/dm^3 of solution, curve II would correspond to

A 5.0 cm^3 of 8.0 mol/dm^3 solution.

B 10.0 cm^3 of 4.0 mol/dm^3 solution.

C 20.0 cm^3 of 2.0 mol/dm^3 solution.

D 20.0 cm^3 of 8.0 mol/dm^3 solution.

36 Which statement about the fractional distillation of crude oil is correct?

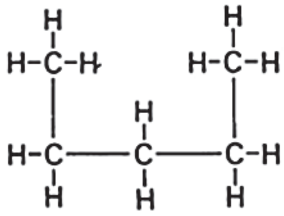
A At each level of the fractionating column, only one compound is collected.

B The higher up the fractionating column, the higher the temperature.

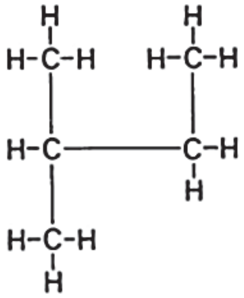
C The fraction at the top of the column are the least flammable.

D The fraction collected at the bottom of the column have the highest viscosity.

37 Five structural formulae are shown below.



1



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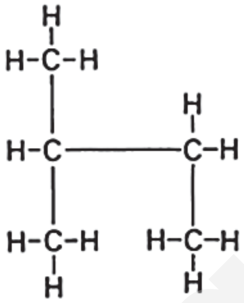

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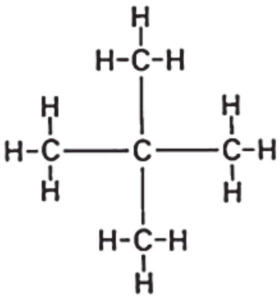

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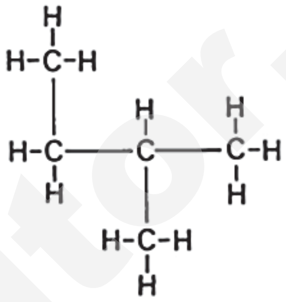


5

How many of the structures represent isomers of one another?

A 2

B 3

C 4

D 5

38 A student investigated the reaction of different vegetable oils and margarines with hydrogen.

100 cm^3 of hydrogen was passed through 1g samples containing a catalyst. The volume of hydrogen gas remaining in each reaction was recorded in the table below.

sample	volume of hydrogen remaining (cm^3)
P	0
Q	87
R	100

Which sample(s) is/are margarine?

A **P** only

B **P**, **Q** and **R**

C **P** and **Q**

D **R** only

39 In which reaction is water **not** a product?

A combustion of fossil fuels

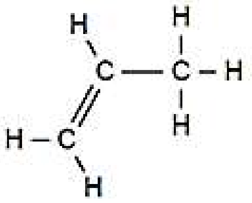
B esterification between ethanoic acid and ethanol

C fermentation of glucose

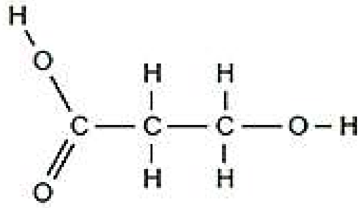
D neutralization between dilute hydrochloric acid and aqueous ammonia

40 Which of the following monomer(s) would undergo polymerisation on their own?

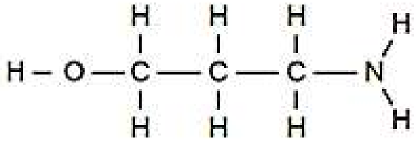
I



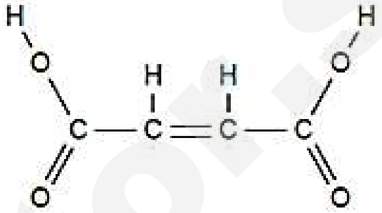
II



III



IV



A I, II and III

B I, II and IV

C II and III

D All of the above

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.).

Answer Scheme for 2019 Prelims Chemistry 6092/02

Section A [50 marks]

A1 **(a)** Ar [1]

(b) Ar and Ca [1]

(c) At and C [1]

(d) Na [1]

(e) Br [1]

(f) C and Pt [1]

[Total: 6]

A2 **(a)**

mixture	separation technique
iodine + sodium chloride	**sublimation [1]**
water + calcium sulfate	**filtration [1]**
ethanol + glucose solution	**fractional distillation [1]**

(b) (i) Soluble in organic solvent but insoluble in water. Low density. [2]

(b) (ii) It was stable on heating / did not decompose when it undergoes evaporation to dryness to remove the organic solvent. [1]

[Total: 6]

A3 **(a) (i)** 450 °C, 250 atm and Iron as catalyst. [2]

(b) (i) +92 kJ [1]

(b) (ii) No of mol of NH_3 = 230 / 92 x 2

= 5 [1]

(c) The total energy taken in for breaking 1 mol of N≡N bond and 3 mol of H-H bond is less than the total energy given out for forming 6 mol of N-H bond. Therefore energy is released resulting in the reaction being exothermic. [3]

(d) (i) As the no. of bonds between nitrogen atoms increases from single to triple bond, the bond energy increases from 160 kJ/mol to 941 kJ/mol. This is due to a stronger attraction between the nitrogen atoms due to more electrons shared between them, require more energy to break the bonds.

[2]

(d) (ii) 941 kJ [1]

[Total: 10]

A4 **(a)** Set–up **A**: Anticlockwise [1]

Set–up **B**: Clockwise [1]

(b) (i) Zn^{2+} (aq) + 2e → Zn (s) [1]

(b) (ii) The copper electrode in **A** will decrease in size whereas the copper electrode in **B** will increase in size.

The blue aq. $CuSO_4$ colour will intensify in **A** whereas the blue aq. $CuSO_4$ colour will fade in **B**. [2]

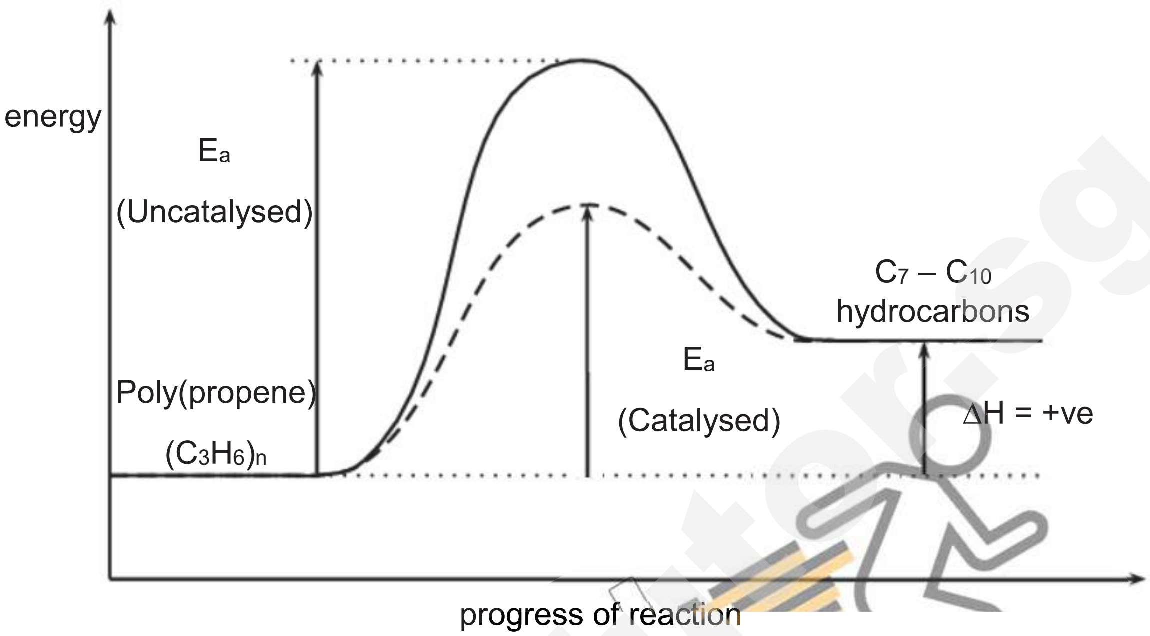
(c)

salt	formulae of starting reagents used	method used
$ZnSO_4$ (s)	**Zn (s) / ZnO (s) / $ZnCO_3$ (s)** …………………… HC*l* (aq)	Adding of excess solid to acid **Filtration** ………………………………………… **Evaporation** ………………………………………… **Crystallization** …………………………………………
$CuSO_4$ (s)	**CuO (s) / $CuCO_3$ (s)** …………………… HC*l* (aq)	

[2]

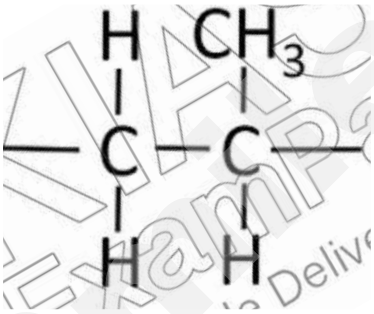
[Total: 7]

A5 (a)



[3]

(b) (i)



[1]

Empirical formula = CH_2 [1]

(For top right, diagram is not ideal. Should ensure that bond is drawn from carbon to carbon atom.)

(b) (ii) $2CH_2 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ [1]

(b) (iii) No. of mol of poly(propene) = 1000 / (12+2)

= 71.42 [1]

Mole ratio of CO_2 : Poly(propene) = 2 : 2

∴ No. of mol of CO_2 = 71.42

Vol of CO_2 = 71.42 x 24

= 1714.28

= 1710 dm^3 (to 3 s.f.) [1]

(c) Advantage: Poly(propene) is durable and does not rust unlike iron. [1]

Disadvantage: Poly(propene) is non-biodegradable and would contribute to waste, pollution problems. [1]

[Total: 10]

A6 **(a) (i)** Propanedoic acid [1]

$HOOCCH_2COOH$ [1]

(a) (ii) $HOOC(CH_2)_nCOOH$ [1]

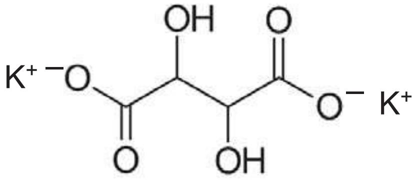
(b) The m.p. of dicarboxylic acid decreases as the no. of carbon atoms increases with the exception of butanedoic acid. [1]

(c) Disagree with the claim. It is unable to undergo condensation polymerization on its own as it only has carboxyl functional group. [1]

(d) (i) The term weak acid means the acid undergoes only partial dissociation in water to form H+ ions. [1]

The term dibasic acid means that every mole of acid produces 2 mole of H+ ions when dissociated in water. [1]

(d) (ii)



[1]

(d) (iii) Tartaric acid contain 2 carboxyl group (per molecule) whereas butanoic acid contains only 1 carboxyl group (per molecule).

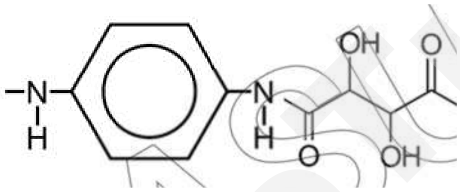
Tartaric acid contains 2 types of functional groups (per molecule), hydroxyl and carboxyl whereas butanoic acid contains only 1 type of function group (per molecule), carboxyl.

Tartaric acid contains a hydroxyl functional group (per molecule), whereas butanoic acid does not.

Tartaric acid contains 4 functional groups (per molecule), whereas butanoic acid contains only 1 functional group.

Any 2. [2]

(d) (iv)



[2]

[Total: 11]

Section B [40 marks]

B7 (a) Experiment 4. [1]

Comparing Expt 3 and 4, with the same concentration of ClO_2 and OH^-, the initial rate of reaction was higher for expt 4, 0.02014 mol/dm^3 s as compared to expt 3, 0.01104 mol/dm^3 s. Therefore expt 4 would have taken place at a higher temperature resulting in a higher initial rate of reaction. [1]

(b) (i) The rate of the reaction increases by 4 times (2^2) when the concentration

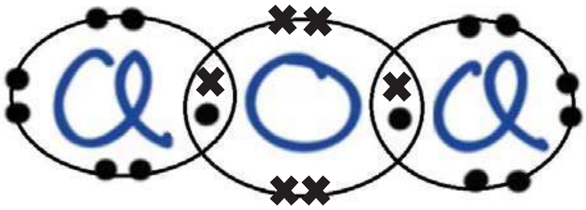
of ClO_2 doubles. From experiment 1 and 3, the rate of reaction increases from 0.00276 mol/dm^3 s to 0.01104 mol/dm^3 s when the concentration increases from 0.02 mol/dm^3 to 0.04 mol/dm^3. (OR expt 2 and 4 with evidence) [2]

(b) (ii) Second order reaction. [1]

(c) 0.00023 mol/dm^3 s [1]

(d) Increased concentration increases the number of particles per unit volume OR the distances between reacting particles decreases. This increases the frequency of collisions between reacting particles. As a results, the frequency of effective collisions increases and the speed of reaction increases. [2]

(e)



[2]

[Total: 11]

B8 **(a)** A_r of Pb = (1.4/100 x 204)+(24.1/100 x 206)+(22.1/100 x 207)+(52.4/100 x 208)

= 207.241

= 207 (nearest whole number) [2]

(b) (i)

Element	Pb	O
%	86.8	13.2
Ar	207	16
No. of mol / 100g	86.8 / 207 = 0.4193	13.2/16 = 0.825
Mole Ratio	0.4193 / 0.4193 = 1	0.825 / 0.4193 = 1.967
Simplest ratio	1	2

∴ Empirical formula is PbO_2 [2]

(b) (ii) Lead (IV) oxide [1]

(c) (i) Energy output for 1g of octane = 5509 x 1/(8 x 12 + 18 x 1)

= 48.3kJ

Energy output for 1g of octane = 1407 x 1/(2 x 12 + 6 x 1 + 1 x 16)

= 30.6 kJ [2]

(c) (ii) Gasohol provides a lesser amount of energy as compare to gasoline hence resulting in more volume needed for the same distance travelled. [1]

Ethanol is a renewable resource as compared to gasoline. /

Ethanol is a cleaner fuel as it does not produce any soot. /

Alternative fuels like ethanol will help reduce the need for gasoline which is a finite resource. [1]

[Total: 9]

Either

B9 (a) The main group metals have got low density of 0.9 g/cm^3 and 1.5 g/cm^3 and low m.p of 64°C and 842°C as compared transition metals which have high density of more than 3.0 g/cm^3 and high m.p of more than 1084°C. Main group metals also have a fixed oxidation state, +1 for potassium and +2 for calcium, whereas transition metals have multiple oxidation states, like +2 to +7 for manganese. [3]

(b) There will be flame observed when potassium is added to dilute hydrochloric acid whereas only effervescence when iron is added to dil. HC*l*. This is because potassium is a more reactive metal as compared to iron.

Dil. HCl solution will remain colourless when potassium is added whereas the dil. HCl solution will turn green / yellow / brown when iron is added. This is because the resulting solution of potassium chloride is colourless and the resulting solution of iron (II) chloride is green OR iron (III) chloride is yellow / brown. [4]

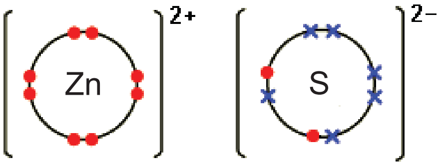
(c) (i) Step 1: Yellow, Step 2: Orange [2]

(c) (ii) The product formed, sodium, will react violently in water, also formed as a product, hence it should be carried out in a controlled environment as recommended by the student. [1]

[Total: 10]

OR

B9 **(a)**



[2]

(b) Zinc blende and diamond are both arranged in a tetrahedral structure.

In zinc blende, 1 Zn^{2+} ion is bonded to 4 S^{2-} ion and 1 S^{2-} ion is bonded to 4 Zn^{2+} ions which is similar to diamond where 1 C atom is bonded to 4 other C atoms.

Zinc blende has a giant ionic lattice structure whereas diamond has a giant molecular structure.

There are strong electrostatic forces of attraction between the oppositely charged Zn^{2+} and S^{2-} ions in zinc blende but strong covalent bonds between the C atoms in diamond. [3]

(c) **(i)** SO_2 forms acid rain when dissolved in clouds which corrodes limestone building when it falls. CO reacts with haemoglobin in blood to form carboxyhaemoglobin which reduces the ability to transport O_2 which causes breathing difficulties and even death. Treatment method for SO_2 is flue gas desulfurization and CO is catalytic converter. [3]

(c) **(ii)** Collect the gases formed in the blast furnace and pass them over filter paper soaked in acidified potassium manganate (VII). If the gas decolourises purple potassium manganate (VII), it would mean that it is true that the production worker added zinc blende directly as SO_2 is present.

[2]

[Total: 10]

Name: ………………………………………… ( )

ASSUMPTION ENGLISH SCHOOL
PRELIMINARY EXAMINATION 2019

CHEMISTRY
6092 / 01

ASSUMPTION ENGLISH SCHOOL ASSUMPTION ENGLISH SCHOOL ASSUMPTION ENGLISH SCHOOL ASSUMPTION ENGLISH SCHOOL
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LEVEL:	Sec 4 Express	**DATE:**	3 September 2019
CLASS:	Sec 4/2	**DURATION:**	1 hour

Additional materials provided: 1 sheet of OAS paper

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.

Write your NAME and INDEX NUMBER at the top of this page and on the OAS paper.
Shade your index number on the OAS paper.

PAPER 1
MULTIPLE CHOICE QUESTIONS (40 marks)
There are 40 questions in this section.
Answer **all** questions.
For each question, there are four possible answers A, B, C and D.

Choose the correct answer and record your choice in soft or 2B pencil on the OAS paper provided.
DO NOT fold or bend the OAS paper.

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

For Examiner's use:	
Paper 1	/ 40

At the end of the examination, hand in your OAS paper and question booklet separately.

This Question Paper consists of 19 printed pages including this page.

Multiple Choice Questions (40 marks)

There are **forty** questions in this section. 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 on the OAS in soft pencil.

1 Hydrogen sulfide, H_2S, is a colourless and poisonous gas which has an odour similar to that of rotten eggs. The melting point of hydrogen sulfide is –82 ˚C and the boiling point is –60 ˚C.

Which statement **correctly** describes the particles of hydrogen sulfide at –75 ˚C?

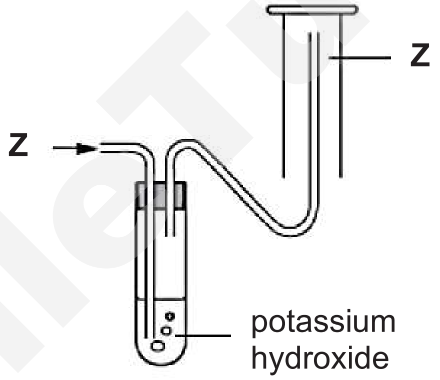
A closely packed, moving freely

B closely packed, vibrating slightly

C far apart, moving freely

D far apart, vibrating slightly

2 The following diagram shows a method to collect a sample of gas **Z**.



Which information can be deduced about gas **Z**?

1 **Z** is acidic.
2 **Z** is insoluble in water.
3 **Z** is less dense than air.

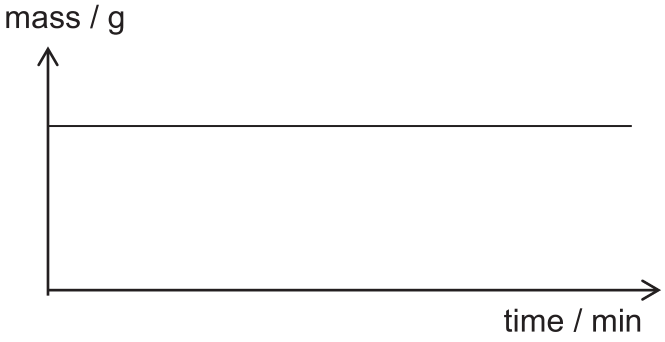
A 1 and 2

B 1, 2 and 3

C 3 only

D none of the above

3 Two solutions were mixed in a beaker and the mass of the beaker and contents was then recorded at various times. The graph shows the results.



What could the two solutions be?

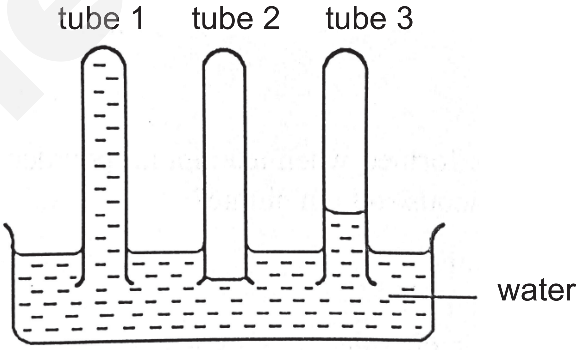
A aqueous sodium hydroxide and warm aqueous ammonium chloride

B aqueous silver carbonate and aqueous dilute hydrochloric acid

C dilute hydrochloric acid and aqueous potassium hydroxide

D dilute nitric acid and magnesium

4 Three dry test-tubes were filled with different gases of equal volume and placed in a trough of water. After a short time, the water had risen in two of the tubes as shown in the diagram.



Which gases could the tubes have contained?

	tube 1	tube 2	tube 3
A	ammonia	carbon dioxide	hydrogen
B	ammonia	hydrogen	carbon dioxide
C	carbon dioxide	hydrogen	ammonia
D	hydrogen	ammonia	carbon dioxide

5 The table below shows the information of some pure substances.

Which of the underlined substances has been wrongly classified as an element, mixture or compound?

	Property	classification
A	White solid melts over 56 – 58 °C.	mixture
B	Green powder on heating leaves black residue and a colourless gas is evolved.	compound
C	Black powder burns in air forming a colourless gas as the only product.	element
D	Colourless substance produces two colourless gases when an electric current is passed through it.	mixture

6 In an experiment, the boiling point of a substance P was found to be 83 °C, the same as cyclohexene. To check its identity, the experiment was repeated by using one part of the substance P mixed with two parts of pure cyclohexene. The boiling point of the mixture was found to be 90 °C.

What can be deduced from these experiments?

A P is a mixture.

B P is not cyclohexene.

C P is pure cyclohexene.

D P may contain cyclohexene.

7 An element X exists as 2 kinds of isotopes X-55 and X-65. Given that its relative atomic mass is 59, which is the correct relative abundance of X-55 and X-65?

	X-55	X-65
A	25 %	75 %
B	75 %	25 %
C	40 %	60 %
D	60 %	40 %

8 Oxygen consists of two isotopes, oxygen-16 and oxygen-18.

Which statement correctly describes the two isotopes of oxygen?

A Both oxygen-16 and oxygen-18 have the same relative atomic mass.

B Both oxygen-16 and oxygen-18 form ions with a charge of -2.

C Oxygen-16 has different chemical properties from oxygen-18.

D Oxygen-16 has electronic configuration of 2.8.6 while oxygen-18 has an electronic configuration of 2.8.8.

9 Element X is found in the Periodic Table with atomic number **p**. It forms an ionic oxide, X_2O. Element Y has an atomic number of **p+3**.

What is the formula of the oxide of Y?

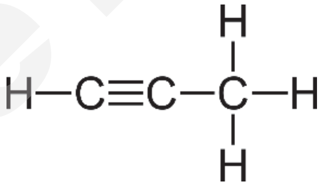
A YO

B YO_2

C Y_2O

D Y_2O_3

10 The diagram below shows the structural formula of an organic molecule.



What is the total number of shared electrons and number of electrons not involved in bonding?

	number of shared electrons	number of electrons not involved in bonding
A	12	2
B	12	6
C	16	2
D	16	6

11 Two isotopes of chlorine are ^{35}Cl and ^{37}Cl.

Using these isotopes, how many different relative molecular masses are possible for the compound with molecular formula CH_3Cl_3?

A 2

B 3

C 4

D 5

12 The equation below shows the reaction between element X and dilute sulfuric acid.

$$X\ (s) + H_2SO_4\ (aq) \rightarrow XSO_4\ (aq) + H_2\ (g)$$

Which particles are responsible for conducting electricity in dilute sulfuric acid and compound XSO_4?

	H_2SO_4	XSO_4
A	electrons	positive ions and negative ions
B	electrons	electrons
C	positive ions and electrons	electrons
D	positive ions and negative ions	positive ions and negative ions

13 Which of the following has 7.2×10^{23} atoms?

A 0.2 mol of magnesium metal

B 0.3 mol of ammonia gas

C 3.0 mol of carbon dioxide gas

D 4.0 mol of hydrogen chloride

14 Bones contain a complex mixture of calcium salts, protein and other material. When a bone is strongly heated in air, the only residue is calcium oxide.

From a sample of 50 g of bone, 14 g of calcium oxide were obtained.

What is the percentage by mass of calcium in the bone?

A 10.0 %
B 14.0 %
C 20.0 %
D 23.3 %

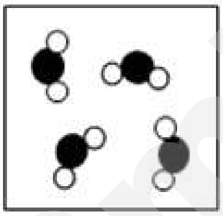
15 0.2 moles of XSO_4 combines with 21.6 g of water to form the hydrated salt of formula $XSO_4.nH_2O$.

What is the value of n?

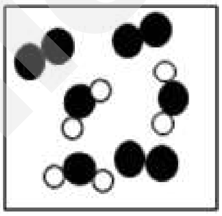
A 3
B 6
C 9
D 12

16 100 cm^3 of hydrogen is mixed and burnt in 100 cm^3 of oxygen.

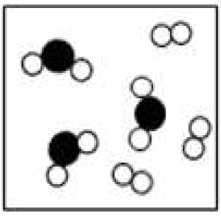
Which diagram represents the particles that remain in the reaction vessel?



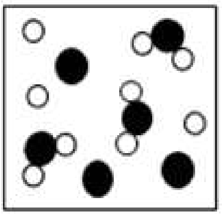
A



B



C



D

17 When 42.0 g of sodium hydrogen carbonate, $NaHCO_3$ (M_r = 84), was strongly heated, 3.00 dm^3 of carbon dioxide gas was released.

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

What was the percentage yield of carbon dioxide?

[All volumes are measured at room temperature and pressure.]

A 25 %

B 50 %

C 75 %

D 80 %

18 The table gives information about three indicators.

indicator	colour at pH 1	pH at which colour changes	colour at pH 12
thymol blue	red	3	yellow
congo red	blue	5	red
phenolphthalein	colourless	10	red

Which colours would be obtained when each indicator was added separately to pure water?

	thymol blue	congo red	phenolphthalein
A	red	blue	red
B	yellow	blue	colourless
C	yellow	blue	red
D	yellow	red	colourless

19 The dissociation constant for an acid indicates the extent to which it dissociates into ions. The higher the dissociation constant, the stronger the acid.

The dissociation constant for some acids are given below along with two possibly correct statements.

acid	dissociation constant
methanoic acid	1.80×10^{-4}
ethanoic acid	1.75×10^{-5}
propanoic acid	1.34×10^{-5}
bromoethanoic acid	1.30×10^{-3}

Statement 1: Increasing the length of the carbon chain makes the acid stronger.

Statement 2: Replacing a hydrogen by a bromine in ethanoic acid makes the acid stronger.

Based on the data above, which statement(s) is / are correct?

A both statements

B neither statement

C statement 1 only

D statement 2 only

20 Three elements X, Y and Z belong to the same period in the Periodic Table. The properties of their oxides are given below.

oxide of X:	soluble in both nitric acid and aqueous sodium hydroxide
oxide of Y:	insoluble in water and aqueous sodium hydroxide but dissolves readily in nitric acid
oxide of Z:	changes acidified potassium manganate(VII) from purple to colourless

Based on the statements above, arrange X, Y and Z in order of decreasing atomic numbers in the Periodic Table.

A Y, X, Z

B X, Y, Z

C Z, Y, X

D Z, X, Y

21 Which solution contains the greatest concentration of hydrogen ions?

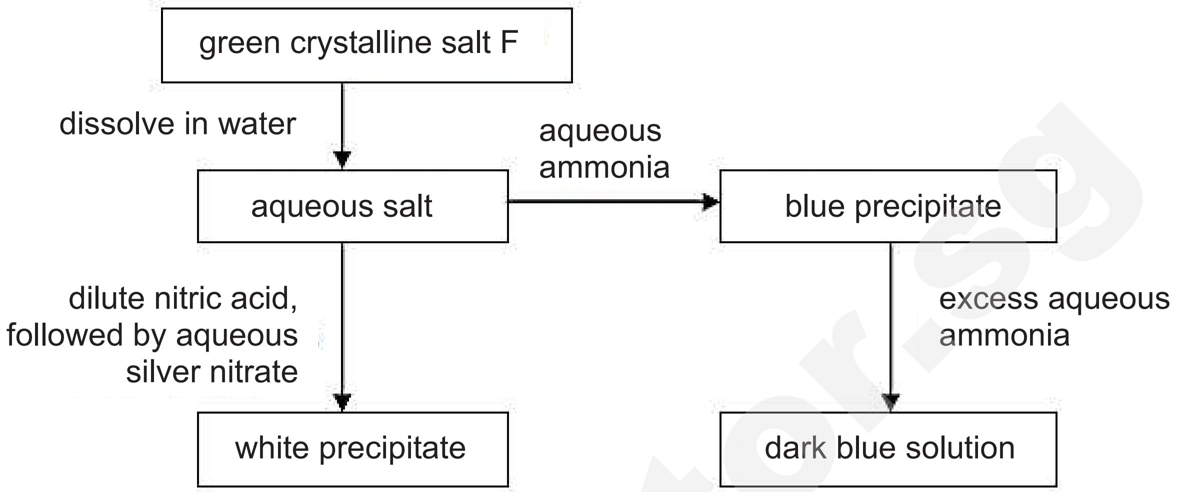
A 1 mol/dm³ phosphoric(V) acid, H_3PO_4

B 2 mol/dm³ sulfuric acid, H_2SO_4

C 3 mol/dm³ hydrochloric acid, HCl

D 3 mol/dm^3 ethanoic acid, CH_3COOH

22 The scheme below shows some reactions of salt F.



What is the identity of F?

A copper(II) chloride

B copper(II) iodide

C iron(II) chloride

D iron(II) iodide

23 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 is 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 blue was produced.

C On standing, the precipitate turned brown.

D The precipitate dissolved in excess sodium hydroxide.

24 When testing for a sulfate ion using barium nitrate, the solution must be acidified with nitric acid.

What is the purpose of the nitric acid?

A to act as a catalyst

B to adjust the pH such that it is suitable for the reaction to occur

C to prevent precipitation of barium carbonate

D to reduce the sulfate ion

25 In which equations are the underlined substances acting as a reducing agent?

I $\underline{ZnO\ (s)} + CO\ (g) \rightarrow Zn\ (s) + CO_2\ (g)$
II $Cu\ (s) + \underline{N_2O\ (g)} \rightarrow CuO\ (s) + N_2\ (g)$
III $3\ CuO\ (s) + \underline{2\ NH_3\ (g)} \rightarrow 3\ Cu\ (s) + N_2\ (g) + 3\ H_2O\ (l)$
IV $\underline{H_2S\ (g)} + Cl_2\ (g) \rightarrow 2\ HCl\ (aq) + S\ (s)$

A **I** and **III**

B **I** and **IV**

C **II** and **III**

D **III** and **IV**

26 Three mixtures are made.

1 $C + Fe_2O_3$
2 $Cu + Fe_2O_3$
3 $Mg + Fe_2O_3$

The mixtures are heated strongly.

Which of the elements C, Cu and Mg are reactive enough to reduce the iron(III) oxide to iron?

A C and Cu only

B C and Mg only

C C, Cu and Mg

D Cu and Mg only

27 The table below refers to four metals and some of their compounds.

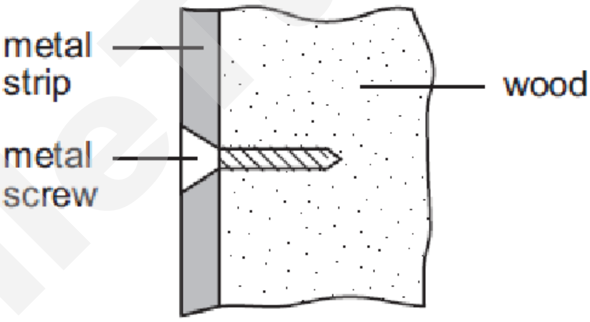
metal	action of dilute acid on metal	effect of hydrogen on heated oxide	action of metal on a solution of sulfate of J
G	hydrogen evolved	reduced	no reaction

H	no reaction	reduced	no reaction
I	hydrogen evolved	no reaction	J formed
J	hydrogen evolved	no reaction	no reaction

Which one of the following is the order of thermal stability of their carbonate towards heating?

	highest thermal stability		→	lowest thermal stability
A	H	G	J	I
B	H	J	G	I
C	I	J	G	H
D	I	G	J	H

28 An old railway carriage is being restored. Metal strips are secured on to the outside of the wooden carriage by means of screws. After a few weeks exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



Which two metals would give this result?

	screws	strips
A	aluminium	steel
B	copper	aluminium
C	copper	steel
D	steel	aluminium

29 An electric current was passed through molten calcium chloride, producing 2.00 g of calcium metal at the cathode.

What mass of chlorine was produced at the anode?

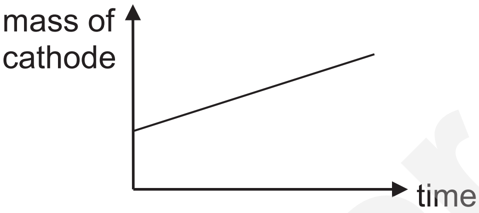
A 2.78 g

B 3.55 g

C 4.00 g

D 8.50 g

30 An aqueous solution T is electrolysed. The current is constant and the cathode is weighed at regular intervals. The graph below is obtained when the mass of cathode is plotted against time.



Which of the following will **not** produce the graph above?

	cathode	anode	solution T
A	graphite	graphite	dilute sulfuric acid
B	graphite	graphite	copper(II) nitrate solution
C	copper	copper	copper(II) nitrate solution
D	graphite	silver	silver nitrate solution

31 The formation of liquid water from hydrogen and oxygen occurs in three stages.

Stage I $2\ H_2\ (g) + O_2\ (g) \rightarrow 4\ H\ (g) + 2\ O\ (g)$
Stage II $4\ H\ (g) + 2\ O\ (g) \rightarrow 2\ H_2O\ (g)$
Stage III $2\ H_2O\ (g) \rightarrow 2\ H_2O\ (l)$

Which stage(s) is / are endothermic?

A I only

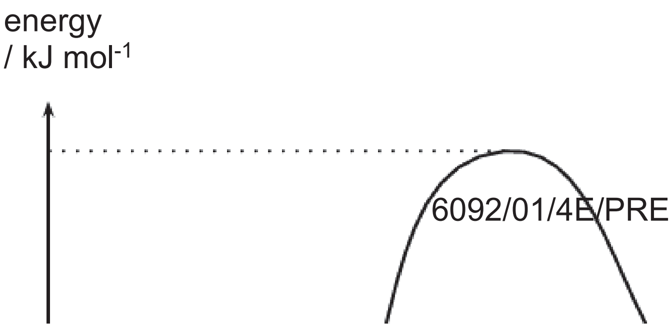
B II only

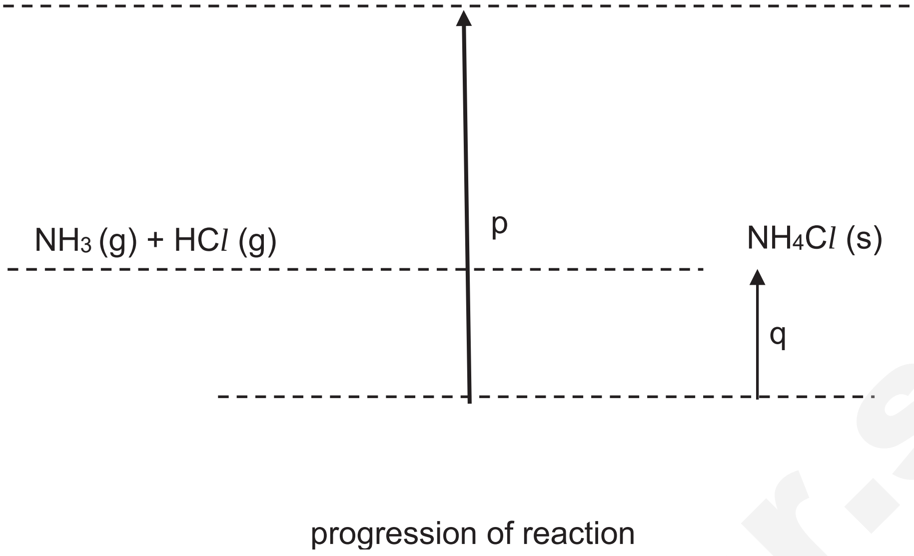
C III only

D I, II and III

32 The equation and energy profile diagram for the reaction between ammonia and dilute hydrochloric acid are shown.

$$NH_3\ (g) + HCl\ (g) \rightleftharpoons NH_4Cl\ (s)$$





Which statement about the reaction is **incorrect**?

A The activation energy for the reverse reaction is p – q.

B The activation energy for the forward reaction is p.

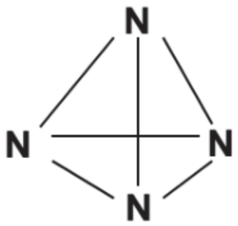
C The enthalpy change for the reverse reaction is p – q.

D The enthalpy change for the forward reaction is positive.

33 Nitrogen exists as the molecule N≡N. Nitrogen forms a molecule N_4 as shown below.

Chemical equation: $2\ N_2 \rightarrow N_4$

Structure of N_4:



By considering the bonds formed and the bonds broken, what would be the value for the energy change, for the above reaction?

[Bond energies: N−N, 160 kJ/mol; N≡N, 994 kJ/mol]

A –1348 kJ

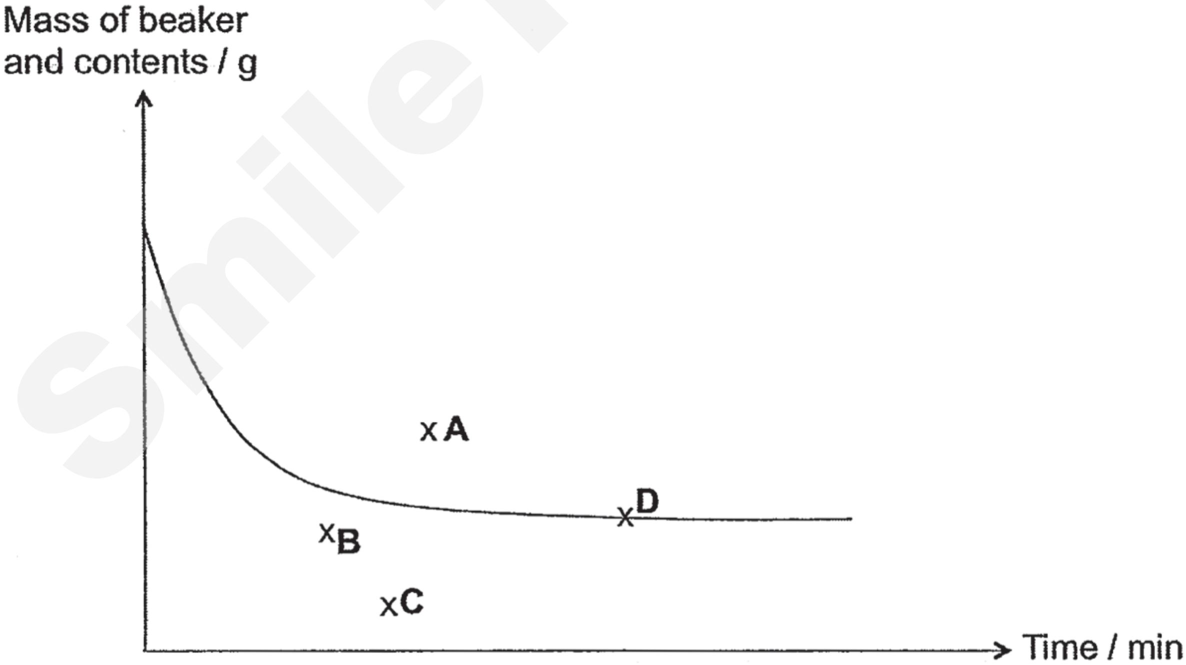
B +1028 kJ

C +1348 kJ

D +2628 kJ

34 In experiment 1, excess zinc carbonate was added to 100 cm^3 of 1.0 mol/dm^3 sulfuric acid in a beaker. The mass of the beaker and its contents were recorded at regular time intervals, and a graph was plotted as shown below.

In experiment 2, excess zinc carbonate was added to 100 cm^3 of 2.0 mol/dm^3 nitric acid in a beaker. At which of the points on the graph shown will the mass in experiment 2 reach a constant?



35 In the Haber process for the manufacture of ammonia, which statements are correct?

I The catalyst used is a transition metal.
II Unreacted nitrogen and hydrogen are circulated back into the system.
III Both reactants are obtained from the fractional distillation of liquefied air.
IV The reaction is never complete and yield achieved is only about 10 – 15%.

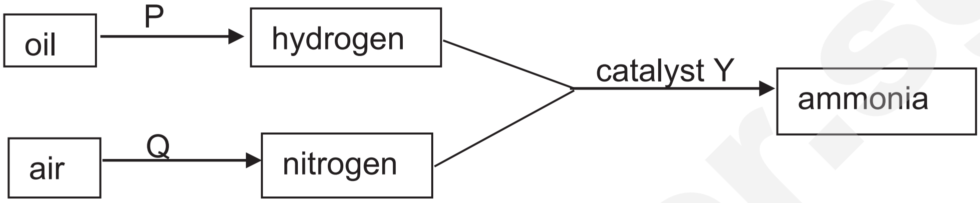
A I, II and III

B I, II and IV

C II, III and IV

D all of the above

36 The diagram shows the manufacture of ammonia using hydrogen and nitrogen in the presence of catalyst.



What are the processes P and Q and catalyst Y?

	process P	process Q	catalyst Y
A	cracking	fractional distillation	iron
B	cracking	fractional distillation	nickel
C	fractional distillation	fractional distillation	iron
D	fractional distillation	cracking	nickel

37 A sample of air along the Pan Island Expressway (PIE), where there is fast moving traffic, is collected and its composition is examined.

Which gas is least likely to be one of the components in the sample of air?

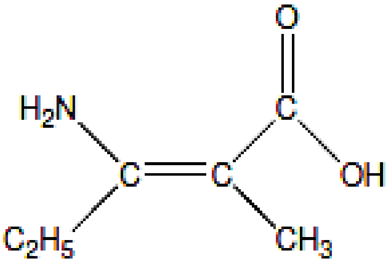
A carbon monoxide

B nitrogen dioxide

C nitrogen monoxide

D sulfur dioxide

38 Which statements about the organic molecule below are true?



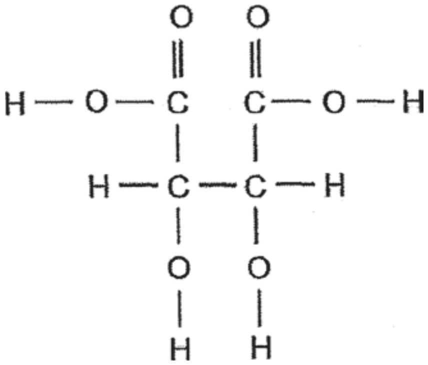
1 It will undergo complete combustion to form carbon dioxide and water only.
2 It forms an alcohol in the presence of steam under high pressure and with the use of a suitable catalyst.
3 It can undergo both addition and condensation polymerisation.

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

39 How many moles of hydrogen chloride are formed when one mole of methane reacts with a large excess of chlorine in sunlight?

A 1
B 2
C 3
D 4

40 The diagram below shows the structural formula of tartaric acid ($C_4H_6O_6$).



Which salt(s) could be formed upon reacting tartaric acid with potassium hydroxide?

1	$C_4H_5O_6K$
2	$C_4H_4O_6K_2$
3	$C_4H_3O_6K_3$
4	$C_4H_2O_6K_4$

A 1 and 2 only

B 2 only

C 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
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		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: ……………………………………….. ( )

ASSUMPTION ENGLISH SCHOOL
PRELIMINARY EXAMINATION 2019

CHEMISTRY
6092 / 02

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LEVEL: Sec 4 Express **DATE:** 27 August 2019

CLASS: Sec 4/2 **DURATION:** 1 hour 45 minutes

Additional materials provided: Nil

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your NAME and INDEX NUMBER at the top of this page.

This paper consists of 2 sections.

SECTION A
SHORT STRUCTURED QUESTIONS (50 marks)
Answer **all** questions in the spaces provided on the question paper.

SECTION B
FREE RESPONSE QUESTIONS (30 marks)
Answer all **three** questions, the last question is in the form of an either / or and only one of the alternatives should be attempted. Write your answers in the spaces provided on the question paper.

For Examiner's use:	
Paper 1	/ 40
Section A	/ 50
Section B	/ 30
Paper 2	/ 80
Paper 3	/ 40
Total	**/ 160**
100%	**/ 100**

A copy of the Periodic Table is printed on page 23.

This Question Paper consists of 23 printed pages including this page.

Section A – Short-Structured Questions (50 marks)

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

1 The data in the table below describes two properties of some substances.
The letters are **not** the actual symbols of the elements in the Periodic Table.

substance	**appearance at room temperature and pressure**	**products of burning in oxygen at 1 atm**
A	black solid	carbon dioxide
B	colourless gas	water
C	colourless gas	(does not burn in oxygen)
D	yellow solid	sulfur dioxide
E	colourless liquid	carbon dioxide and water
F	silvery metal	$\mathbf{F}_2$O

Use the letters **A**, **B**, **C**, **D**, **E** or **F** to answer the following questions. You may use the letters once, more than once or none at all.

(a) Which substance is most likely to be hydrogen?

………………………………………………………………………………………… [1]

(b) Which substance is most likely to be a compound?

………………………………………………………………………………………… [1]

(c) **(i)** Name another oxide that may be produced when substance **A** burns in oxygen.

………………………………………………………………………………………… [1]

(ii) State the nature of the oxide from **(c)(i)**.

………………………………………………………………………………………… [1]

(d) **(i)** Gas **C** is an element that does not burn in oxygen. Suggest the name of this substance **C**.

………………………………………………………………………………………… [1]

(ii) Explain your answer in **(d)(i)**.

………………………………………………………………………………………… [1]

(e) Predict the electrical conductivity of $\mathbf{F}_2$O in the solid state.

With reference to its structure and bonding, explain why.

………………………………………………………………………………………….

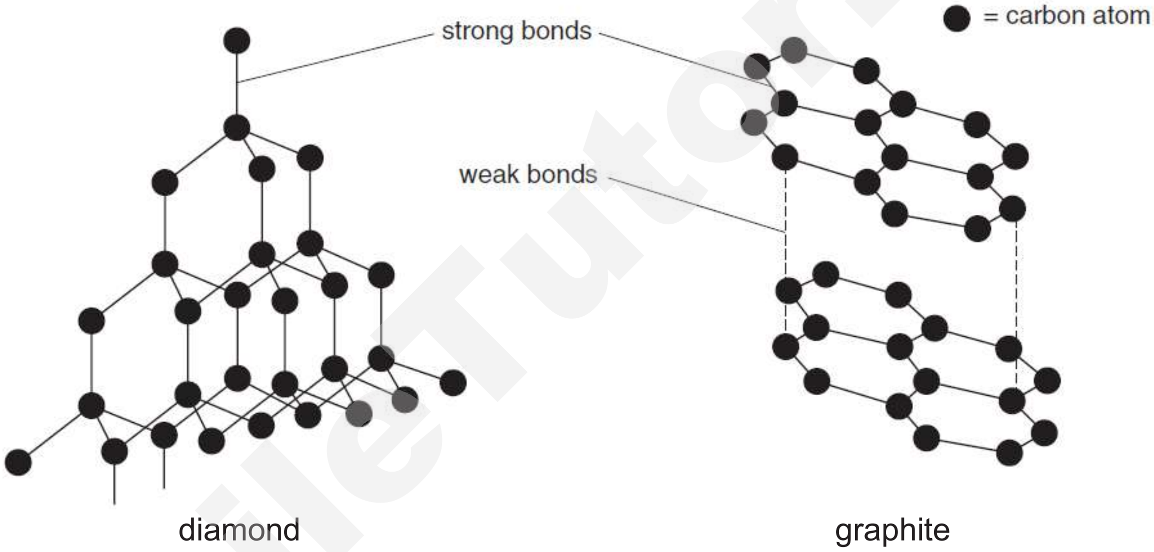
………………………………………………………………………………………….

………………………………………………………………………………………….

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

[Total: 8]

2 The structures of diamond and graphite are drawn below.



(a) Diamond has a melting point of about 3700 °C and graphite has a melting point of about 3300 °C.

(i) In terms of structure and bonding, explain why diamond has a high melting point.

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

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

(ii) Suggest why the melting point of graphite is lower than that of diamond.

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………... [1]

(b) When graphite is burnt in air, it produces carbon dioxide.

(i) Draw the electronic structure of carbon dioxide. Only the outer electrons are required.

[2]

(ii) In terms of structure and bonding, explain why graphite can conduct electricity.

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

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

(iii) Describe how one can determine that the carbon dioxide obtained from the burning of graphite is pure.

test …………………………………………………………………………...

observation ……………………………………………………………………. [1]

[Total: 8]

3 A pupil compared two solutions of monobasic acids, **HX** and **HY**, and obtained the following results.

	0.1 mol/dm^3 HX	**0.1 mol/dm^3 HY**
electrical conductivity/ mA	90	15
pH	1.0	3.5

(a) What can you deduce regarding the strength of the acids?
Explain your answer.

……………………………………………………………………………………………

……………………………………………………………………………………………

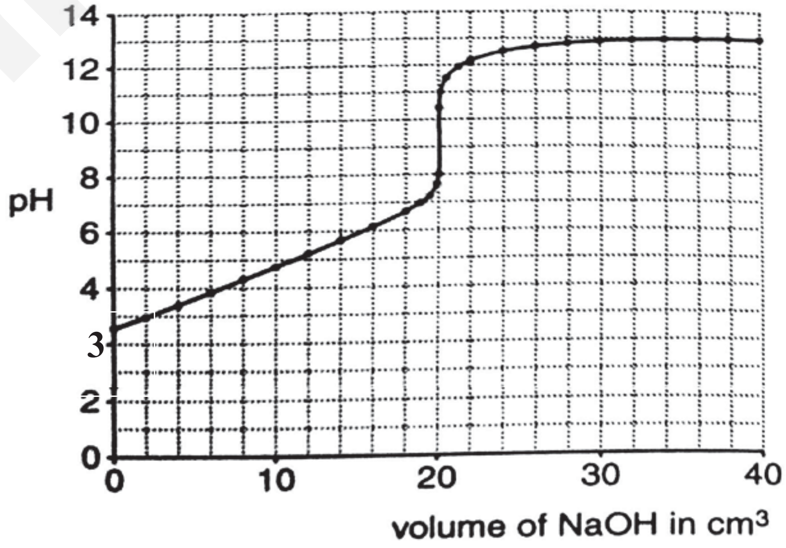
……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(b) A pH meter and a data logger are used to monitor the pH changes during a series of titrations. In each titration, the same concentration of sodium hydroxide solution is added from a burette into a solution of 20 cm^3 of **HX** and **HY** acid solutions. During the titrations, the pH does not change smoothly. The data logger gives a graph for the titration with **HY.**

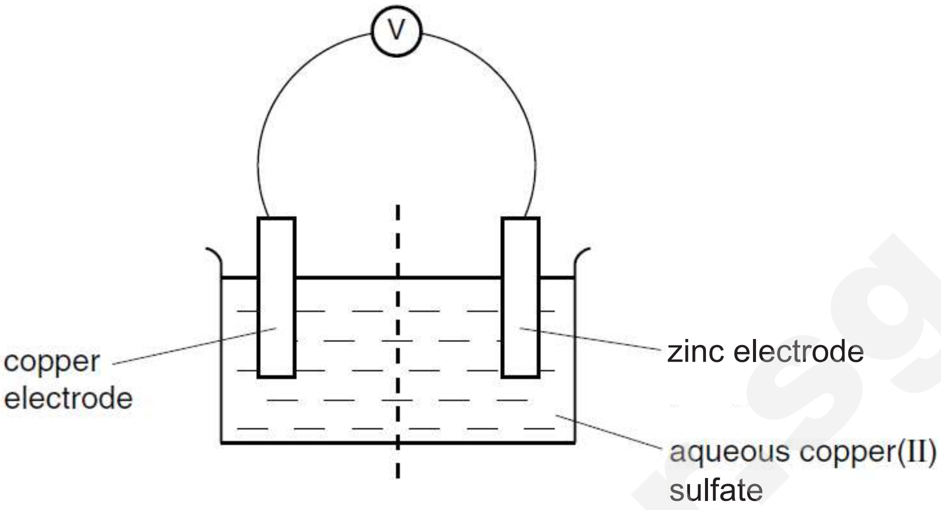
Sketch the graph on the same axes below to show the change in pH between sodium hydroxide and **HX** solutions until the reaction stops. Clearly label the graph with **HX.**



[1]

[Total: 4]

4 This reaction can be used to generate electricity in a cell.



(a) Draw an arrow on the diagram to show the direction of the flow of electrons in the wire. [1]

(b) Write the ionic equation for the reaction at the copper electrode.

………………………………………………………………………………………… [1]

(c) The voltage of the cell was measured when the following metals replaced the zinc electrode.

copper **iron** **silver** **zinc**

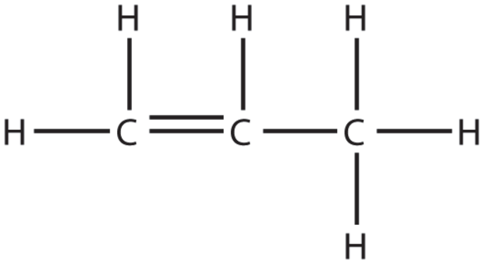
Complete the table by entering the metals in the correct order.

meter reading / V	*metal*
+1.10	
+0.78	
0.00	
–0.46	

[2]

[Total: 4]

5 The diagrams below show the structure of propene.



(a) Calculate the mass of bromine liquid required to react with 1 g of propene.

mass of bromine liquid = ……………….. g [2]

(b) Propene can undergo addition polymerisation to form polymer X.
Draw the structure of the polymer X.

[1]

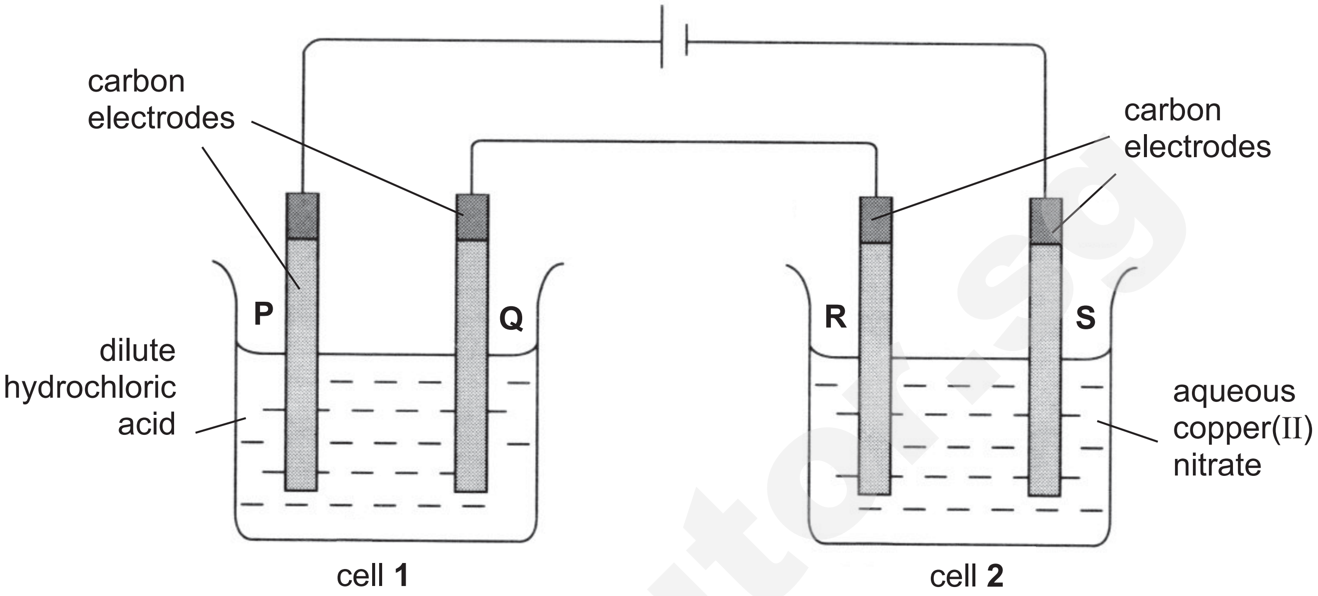
(c) A sample of polymer X was analysed and found to have an average relative molecular mass of 7350.

How many carbon atoms are present in an average chain?

number of carbon atoms = ……………….. [2]

[Total: 5]

6 The following experiment was set up to study the electrolysis of dilute hydrochloric acid and aqueous copper(II) nitrate using carbon electrodes as shown in the diagram below.



(a) Write the half equations at electrodes **P** and **S**.

electrode **P** ....

electrode **S** .... [2]

(b) With reference to the diagram, explain why there is a change in the pH of the electrolyte in cell **2** after some time.

....

....

....

.... [2]

[Total: 4]

7 Three methods for preparing salts are listed below:

method 1: precipitation
method 2: reacting excess metal with dilute acid
method 3: titration

(a) Place a tick (✓) in **one** box in each row to show the correct method to use to prepare each of the following salts.

salt	**method 1**	**method 2**	**method 3**
ammonium chloride			
lead(II) sulfate			
sodium sulfate			
zinc nitrate			

[2]

(b) Copper(II) chloride is a salt that cannot be prepared using any one of the three methods shown above.

(i) Explain why copper(II) chloride cannot be prepared by any one of the three methods shown above.

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………...

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

(ii) Suggest an experimental procedure to prepare a dry sample of copper(II) chloride using suitable reagents commonly found in a laboratory.

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………... [3]

[Total: 7]

8 Sulfur dioxide is used to manufacture sulfuric acid, by a three-stage process called the Contact Process. The first stage is to convert sulfur dioxide to sulfur trioxide. During this process, sulfur dioxide gas and sulfur trioxide gas are released to the environment.

$$2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g) \qquad \Delta H = -\ 197\ \text{kJ/mol}$$

(a) The above reaction takes place at a moderate temperature of 450 °C. Suggest why this temperature is used in the Contact Process instead of a lower or higher temperature.

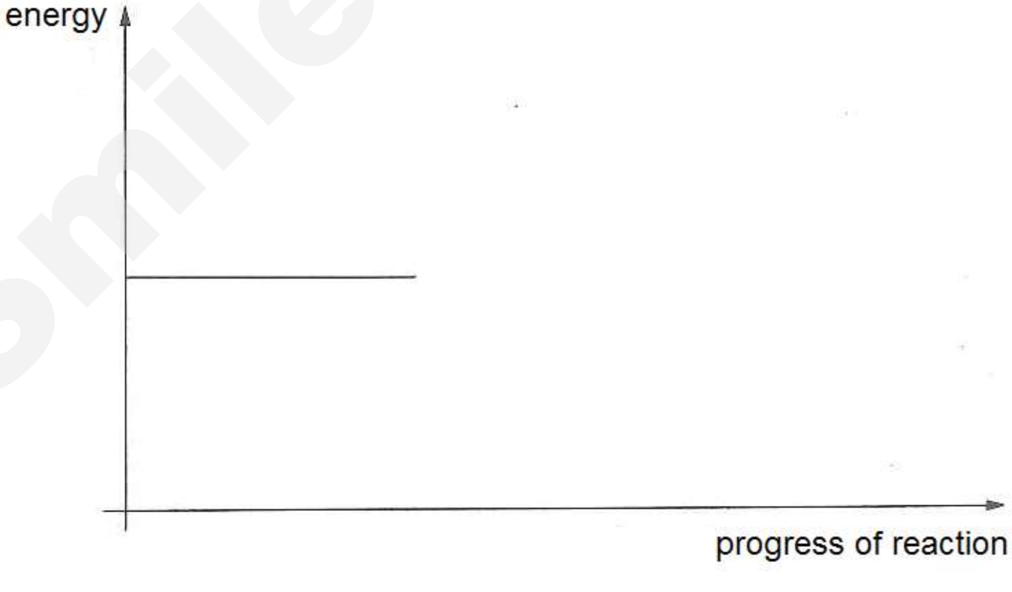
……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(b) Complete the energy profile diagram for the forward reaction in the production of sulfur trioxide.

Your diagram should include
- the **formulae of the reactants and products** of the reaction,
- a label for **the activation energy of reaction**,
- a label for **the enthalpy change of reaction**.



[2]

(c) Using ideas about colliding particles, state and explain how the rate changes when the pressure is increased.

……………………………………………………………………………………

……………………………………………………………………………………

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

(d) The product of the Contact Process is concentrated sulfuric acid (98%) with only 2% of the mass being water.

Explain why it is possible to transport sulfuric acid of such high concentration using steel tanks but not for dilute sulfuric acid.

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(e) Suggest a possible metal that can be used as a catalyst for this reaction, stating your reason clearly.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(f) Draw in the box below, the particulate diagram showing the particles of sulfur trioxide.

[1]

[Total: 10]

SECTION B: FREE-RESPONSE QUESTIONS [30 MARKS]

Answer **all** the questions in the spaces provided. The last question is in the form of an EITHER / OR and only one of the alternatives should be attempted.

9 **The Drive for Cleaner Emissions by John Uhrich**

The air pollutants emitted by a car come from undesirable chemical reactions that occur during fuel combustion inside the engine. In the most common type of combustion reaction, gasoline or diesel, reacts with oxygen to form water and carbon dioxide. During this reaction, the chemical energy of the fuel is released and harnessed to run the engine.

$$C_xH_y + (x + \frac{y}{4})\ O_2 \rightarrow x\ CO_2 + \frac{y}{2}\ H_2O$$

Petrol and diesel are both obtained by fractional distillation of crude oil. However, they differ in their composition. Diesel is a fraction of crude oil that is removed at a higher boiling point than petrol.

In petrol engines, oxygen (from the air) and fuel are designed to be almost exactly stoichiometrically balanced, so that, ideally, there is no excess of either reactant at the end of the reaction. Car manufacturers must ensure that the reactants are balanced as the reactants can have a large effect on the amount of pollution a car produces. For instance, the presence of too little oxygen can result in incomplete fuel combustion, which produces carbon monoxide and unburnt hydrocarbon, both of which are considered pollutants when present in the air at ground level. Also, nitrogen from the air is quite inert, but if too much oxygen is present (more than the stoichiometric amount) at high temperatures, the extra oxygen can react with the nitrogen to produce other pollutants, called nitrogen oxides.

To reduce the potentially harmful pollutants that are created as by-products of combustion, the exhaust passes through a catalytic converter, which converts carbon monoxide, unburnt hydrocarbons, and various nitrogen oxides into less-harmful chemical compounds before they are released into the air.

There are two kinds of catalytic converter – two-way catalytic converter and three-way catalytic converter.

A two-way catalytic converter has two simultaneous reactions:

a) Conversion of carbon monoxide to carbon dioxide

$$2\ CO + O_2 \rightarrow 2\ CO_2$$

b) Conversion of unburnt hydrocarbons to carbon dioxide and water

$$C_xH_y + (x + \frac{y}{4})\ O_2 \rightarrow x\ CO_2 + \frac{y}{2}\ H_2O$$

A three-way catalytic converter has three simultaneous reactions:

a) Decomposition of nitrogen oxides to nitrogen and oxygen:

$$2\,NO_x \rightarrow x\,O_2 + N_2$$

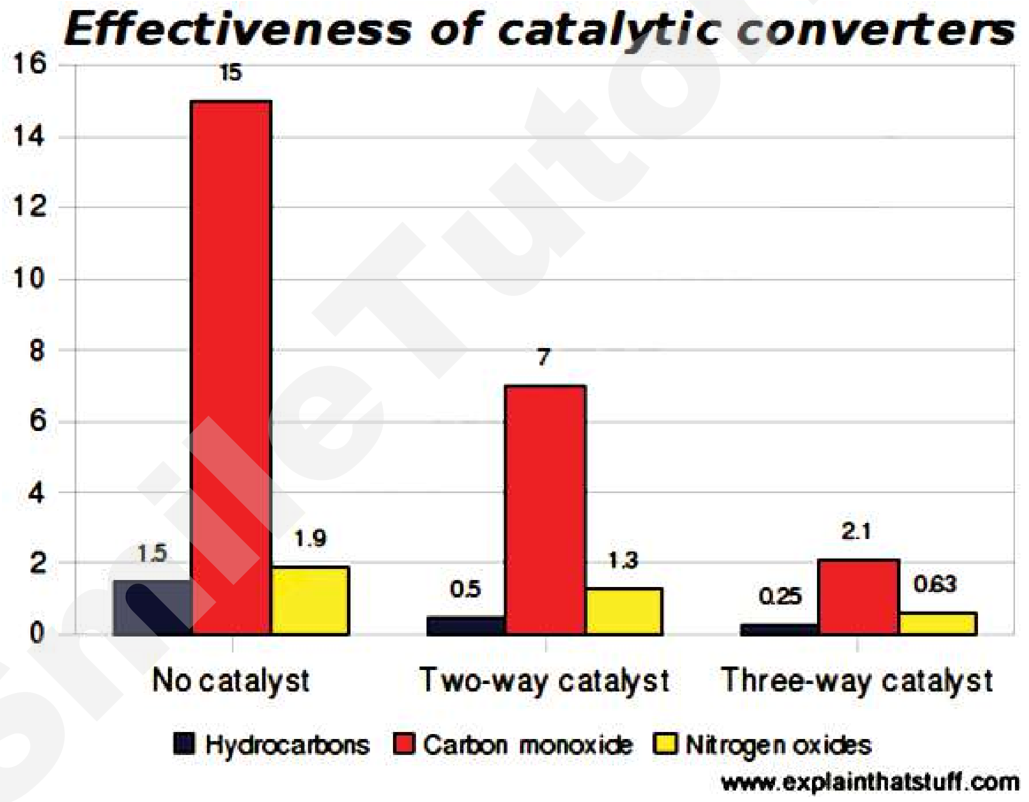
b) Conversion of carbon monoxide to carbon dioxide:

$$2\,CO + O_2 \rightarrow 2\,CO_2$$

c) Conversion of unburnt hydrocarbons to carbon dioxide and water:

$$C_xH_y + (x + \frac{y}{4})\,O_2 \rightarrow x\,CO_2 + \frac{y}{2}\,H_2O$$

The chart shows pollutants in grams per kilometre at 80,000 kilometres.



Sources: https://www.catalyticconverters.com/types/ ,
http://www.explainthatstuff.com/catalyticconverters.html

(a) Octane, C_8H_{18}, is a common hydrocarbon found in gasoline.

(i) Write a balanced chemical equation to show the complete combustion of octane.

……………………………………………………………………………… [1]

(ii) Calculate the minimum volume of oxygen gas required to completely react with 3 moles of octane at room temperature and pressure.

volume of oxygen gas = ……………….. dm^3 [2]

(iii) Using the chemical equation in **(a)(i)**, show that the combustion of octane is a redox reaction.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… [2]

(b) The article says "Petrol and diesel are both obtained by fractional distillation of crude oil. However, they differ in their composition. Diesel is a fraction of crude oil that is removed at a higher boiling point than petrol."

Based on the statement, what can you infer about the difference in the number of carbon atoms in petrol and diesel fraction?

How does the number of carbon atoms have effect on the boiling point?

Explain your reasoning.

………………………………………………………………………………...

………………………………………………………………………………...

………………………………………………………………………………...

………………………………………………………………………………...

………………………………………………………………………………... [3]

(c) A car manufacturer has plans to install a catalytic converter in the manufactured car. Which of the two catalytic converters would you recommend the manufacturer to install?

Explain your reasoning.

…………………………………………………………………………………….......

…………………………………………………………………………………….....

…………………………………………………………………………………….... [1]

(d) What additional environmental problem does a two-way catalytic converter cause?

…………………………………………………………………………………….....

…………………………………………………………………………………….... [1]

[Total: 10]

10 Nitrogenous fertilisers are soluble salts used to increase crop yield. Two commonly used nitrogenous fertilisers are ammonium chloride and ammonium phosphate.

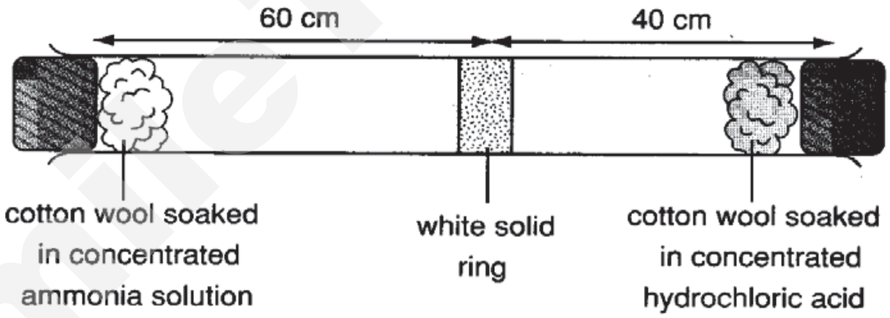
(a) Ammonium chloride can react with sodium hydroxide.
Write an ionic equation for this reaction.

……………………………………………………………………………………… [1]

(b) Calculate the percentage mass of nitrogen in ammonium chloride.

percentage mass of nitrogen = ……………….. % [1]

(c) A metre-long tube was set up with a plug of concentrated ammonia solution at the left end and a plug of concentrated hydrochloric acid at the right end. After a while, the two gases (ammonia and hydrogen chloride gas) met and a white solid of ammonium chloride was produced as shown.



(i) Explain why the white solid ring of ammonium chloride is formed at the specific location.

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… [2]

(ii) Explain the change in time taken for the white solid to appear when the above setup is carried out at a higher temperature.

………………………………………………………………………………

……………………………………………………………………………… [1]

(d) Aqueous ammonium chloride was added to aqueous bromine. State the observation for this reaction, if any, and suggest a reason for the outcome.

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(e) Suggest in steps, a method to separate a mixture of solid ammonium chloride and solid sodium chloride. You may draw a labelled diagram to support your answer.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(f) State a trend in physical properties of the halogens.

…………………………………………………………………………………………

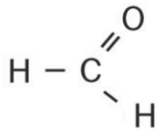
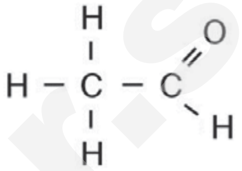
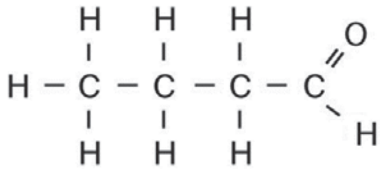
………………………………………………………………………………………… [1]

[Total: 10]

EITHER

11 Organic acids are commonly used in the preservation of food.

Organic acids can be made from the atmospheric oxidation of aldehydes in air. The names and structural formulae of the aldehydes are shown in the table below.

aldehyde	chemical formula	structural formula
methanal	CH_2O	
ethanal	C_2H_4O	
butanal	C_4H_8O	

(a) **(i)** Complete the table above to show the name, chemical formula and structural formula of the aldehyde that occurs between ethanal and butanal. [1]

(ii) Using the data given, explain in two ways how you can tell that these compounds are from the same homologous series.

……………………………………………………………………………………...

……………………………………………………………………………………...

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

(b) Give the name of an oxidising agent that can oxidise methanal to methanoic acid. Explain what you would observe when the oxidation process is completed.

oxidising agent ……………………………………………………………………..

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

(c) The organic acids made from aldehydes can then undergo condensation reactions with alcohols to make esters. One such example is butyl ethanoate, which gives an apple smell present in perfumes.

(i) Explain the term '*condensation reaction*'.

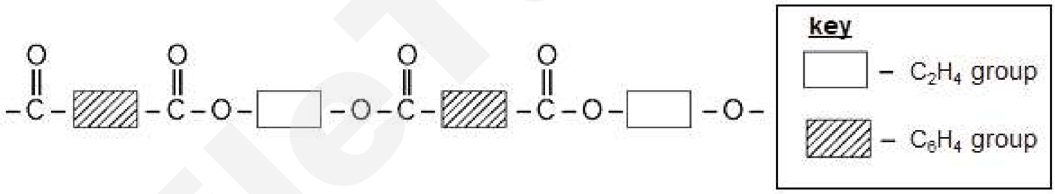
……………………………………………………………………………………...

……………………………………………………………………………………... [1]

(ii) Draw the full structural formula of butyl ethanoate.

[1]

(d) Terylene, a synthetic polyester, is also made from the condensation reaction of organic acids and alcohols. It contains the ester linkage which is strong and durable and is commonly used in the manufacture of sleeping bags and clothings. The structure of Terylene is shown below.



(i) Give **one** similarity and **one** difference between the condensation reaction of the formation of butyl ethanoate and the formation of Terylene.

similarity ……………………………………………………………………………..

……………………………………………………………………………………...

difference …………………………………………………………………………

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

(ii) The strength and durability of Terylene can also cause environmental problems. Suggest why.

……………………………………………………………………………………...

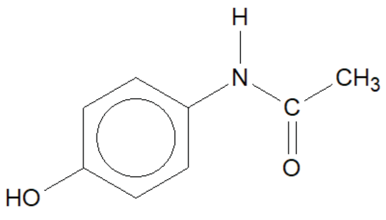
……………………………………………………………………………………... [1]

[Total: 10]

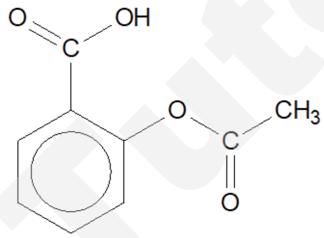
OR

11 Chromatography is the general name applied to a series of separation methods that employ a system with two phases of matter; a mobile phase and a stationary phase. Analytes in a mixture to be separated interact with the stationary phase with different affinities. While moving through the system, carried along by the mobile phase (solvent), analytes with a low affinity for the stationary phase will tend to move along rapidly, while those with a high affinity will tend to lag behind. Thin Layer Chromatography (TLC) is a fast and inexpensive form of chromatography that has many uses in the organic laboratory. The retention factor (R_f) is simply the fractional distance the solute spot moves along the plate relative to the solvent front. The stationary phase in TLC is typically an adsorbant made of silica gel.

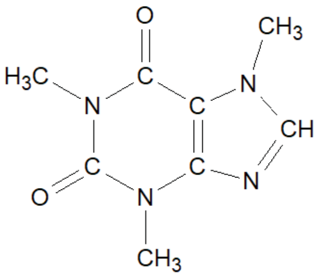
Analgesics are substances that relieve pain. The most common of these is aspirin. Other common analgesics include acetaminophen. In many cases these analgesics are used in combination to enhance or complement their individual affects; e.g., acetaminophen. Additionally, to counteract the acidic properties of aspirin, an inorganic buffering agent is added to some preparations. In some cases, caffeine is added to counteract the sedative effects of the analgesic.



acetaminophen



aspirin



caffeine

TLC will be used to analyse a commercial analgesic tablet. The above-mentioned compounds will also be run on the same TLC for comparison. The retention factor value for each standard and each analyte spot produced by the commercial analgesic tablet will be determined. This will then allow the compounds used in the analgesic tablet to be identified.

Literature values of the compounds are listed as followed.

compound	melting point / ˚C	retention factor
acetaminophen	168.0	0.333
aspirin	136.0	0.639
caffeine	236.1	0.125

The retention factor values are obtained after each of the components, **X**, **Y** and **Z**, are isolated and were analysed using TLC.

compound	melting point / ˚C	retention factor
X	132.1 – 132.2	0.676
Y	166.2 – 168.2	0.378
Z	234.3 – 235.5	0.189

Source: *https://infohost.nmt.edu/~jaltig/TLC.pdf*

(a) Use the literature information provided to name the components, **X, Y** and **Z.**

X ……..……………………..... **Y** ……..…………………….....

Z ……..…………………….…... [2]

(b) Based on the literature R_f values, which compound has the highest affinity to the stationary phase, silica gel?

Explain your reasoning.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

(c) What can you conclude about the literature melting points and the experimental melting points?

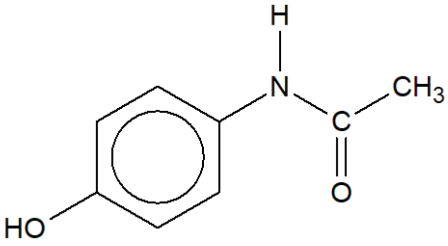
Explain your reasoning.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

(d) A way to produce acetaminophen is to react two molecules to form an amide linkage. This process is similar to the process of esterification.



(i) Name the conditions required to produce acetaminophen.

…………………………………………………………………………………….…..

………………………………………………………………………………………... [1]

(ii) Draw the structure of the two molecules that can form acetaminophen.

[2]

(iii) In practice, when the two molecules react in **(d)(ii)**, the yield of acetaminophen is never 100%.

Suggest a reason why.

………………………………………………………………………………………...

………………………………………………………………………………………... [1]

[Total: 10]

– END OF PAPER –

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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 –

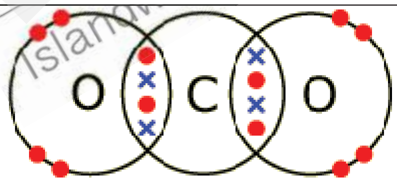
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

6092 Chemistry Preliminary Examination 2019 Marking Scheme

Multiple-Choice Questions [40 M]

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

Section A: Short-Structured Questions [50 M]

1	**(a)**	B		**[1]**
	(b)	E		**[1]**
	(c)	**(i)**	Carbon monoxide	**[1]**
		(ii)	neutral	**[1]**
	(d)	**(i)**	Any noble gas (e.g. helium, neon, argon, etc)	**[1]**
		(ii)	It has a complete valence shell / complete outermost shell / noble gas configuration and does not need to gain / lose / share electrons.	**[1]**
	(e)	It is an ionic compound. Since its ions are held / fixed in an ionic lattice structure, no mobile ions are available to act as charge carriers. Hence **F**$_2$O does not conduct electricity in the solid state.		**[1]** **[1]**
2	**(a)**	**(i)**	Each C atom is bonded to 4 other C atoms by strong covalent bonds in a tetrahedral structure; large amount of energy is needed to break these strong bonds, resulting in a high melting point	**[1]** **[1]**
		(ii)	The network of covalent bonds is less extensive than diamond / each carbon atom is bonded to 3 carbon atoms in graphite while each carbon atom is bonded to 4 carbon atoms in diamond	**[1]**
	(b)	**(i)**	 **[1]: Electrons involved in bonding are drawn correctly** **[1]: No other valence electrons are drawn**	**[2]**
		(ii)	Each C atom is bonded covalently to 3 other atoms in a hexagonal structure. Free moving electron from each C atom can act as charger carriers to move across layers to conduct electricity.	**[1]** **[1]**
		(iii)	test: measure the melting point / boiling point of carbon dioxide observation: melting point / boiling point is fixed OR melting point / boiling point matches the recorded melting point / boiling point in scientific data. Award [1] only if both test and observation are correct.	**[1]**

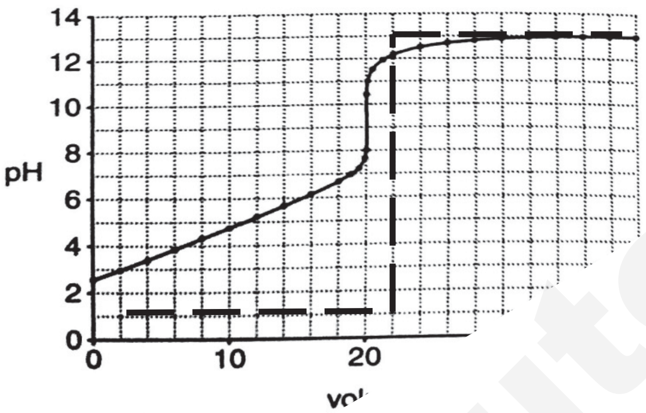
<table>
<tr><td>3</td><td>(a)</td><td>1.HX is a strong acid due to its: lower pH; higher electrical conductivity OR
HY is a weak acid due to its: higher pH. lower electrical conductivity;

2. Strong acid dissociates completely in water to form H^+ ions. Weak acid dissociates partially in water to form H^+ ions.

3. The higher concentration of H^+ ions contributes to its high conductivity; The low concentration of H^+ ions contributes to its low electrical conductivity.

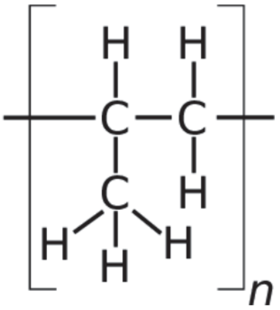
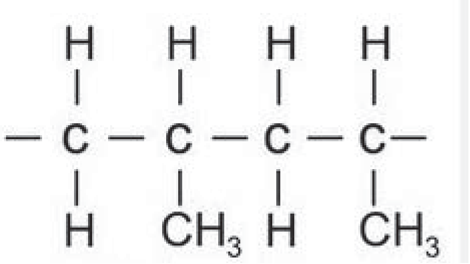
Answers like difference of pH2 or higher or lower pH did not score marks.</td><td>[1]

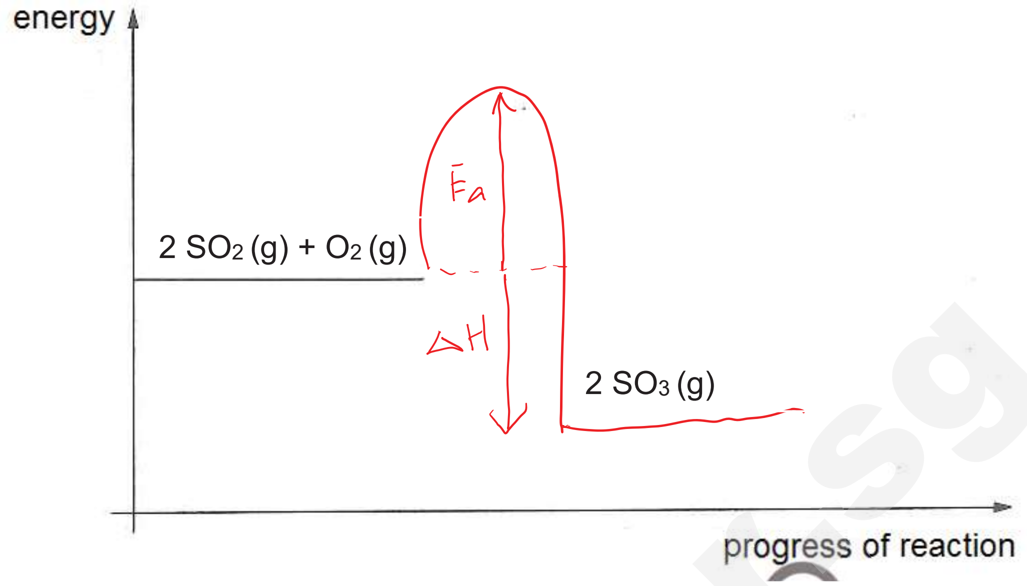
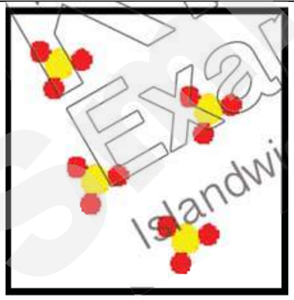
[1]

[1]</td></tr>
<tr><td></td><td>(b)</td><td>

Graph should show the same volume of NaOH ;
Starts at pH 1 ; Ends at pH 12</td><td>[1]</td></tr>
<tr><td>4</td><td>(a)</td><td>zinc to copper in the wire</td><td>[1]</td></tr>
<tr><td></td><td>(b)</td><td>Cu^{2+} (aq) + 2e → Cu(s)</td><td>[1]</td></tr>
<tr><td></td><td>(c)</td><td><table>
<tr><th><i>meter reading / V</i></th><th><i>metal</i></th></tr>
<tr><td>+1.10</td><td>Zinc</td></tr>
<tr><td>+0.78</td><td>Iron</td></tr>
<tr><td>0.00</td><td>Copper</td></tr>
<tr><td>-0.46</td><td>Silver</td></tr>
</table>
Award [1] for every 2 correct answers</td><td>[2]</td></tr>
<tr><td>5</td><td>(a)</td><td>Mr of propene = 3(12) + 6(1) = 42
Number of moles of propene
= 1/42
= 0.0238095238 mol
Number of moles of bromine = Number of moles of propene
∴ mass of bromine
= 0.0238095238 x 2(80)
= 3.80952380952
≈ 3.81 g (3 s.f.)</td><td>[1]

[1]</td></tr>
</table>

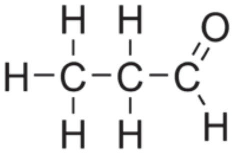
<table>
<tr><td></td><td>(b)</td><td colspan="2">
or
</td><td>[1]</td></tr>
<tr><td></td><td>(c)</td><td colspan="2">Mr of propene = 42
Number of propene molecules
= 7350 / 42
= 175
Number of carbon atoms
= 175 x 3
= 525</td><td>[1]
[1]</td></tr>
<tr><td>6</td><td>(a)</td><td colspan="2">electrode P: $4OH^-$ (aq) → $2H_2O$ (l) + O_2 (g) + 4e
electrode S: Cu^{2+} (aq) + 2e → Cu (s)</td><td>[1]
[1]</td></tr>
<tr><td></td><td>(b)</td><td colspan="2">Hydroxide ions are discharged at electrode R (anode) to give oxygen gas.
Hence, with the decrease in concentration of hydroxide ions, the pH decreases as the solution becomes less alkaline.</td><td>[1]
[1]</td></tr>
<tr><td>7</td><td>(a)</td><td colspan="2"><table>
<tr><th>salt</th><th>method 1</th><th>method 2</th><th>method 3</th></tr>
<tr><td>ammonium chloride</td><td></td><td></td><td>✓</td></tr>
<tr><td>lead(II) sulfate</td><td>✓</td><td></td><td></td></tr>
<tr><td>sodium sulfate</td><td></td><td></td><td>✓</td></tr>
<tr><td>zinc nitrate</td><td></td><td>✓</td><td></td></tr>
</table>
Award [1] for every 2 correct answers</td><td>[2]</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>• Copper(II) chloride is soluble, so cannot use method 1
• Copper cannot react with dilute acid, so cannot use method 2
• Copper oxide, hydroxide and carbonate are all insoluble, so cannot use method 3
Deduct [1] for every 1 mistake</td><td>[2]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>• Add <u>excess</u> copper(II) oxide/hydroxide/carbonate to dilute hydrochloric acid
• Filter the mixture
• Heat the filtrate until saturated
• Cool the hot filtrate to allow it to crystallize
• Collect crystals and wash with cold deionised water
Award [1] for every 2 correct steps
Award [3] for all correct steps</td><td>[3]</td></tr>
<tr><td>8</td><td>(a)</td><td colspan="2">When the temperature is too low, the speed of reaction is too low;
when the temperature is too high, the cost of maintaining the high temperature is too high;
(also accept: when the temperature is too high, the yield is too low)</td><td>[1]
[1]</td></tr>
</table>

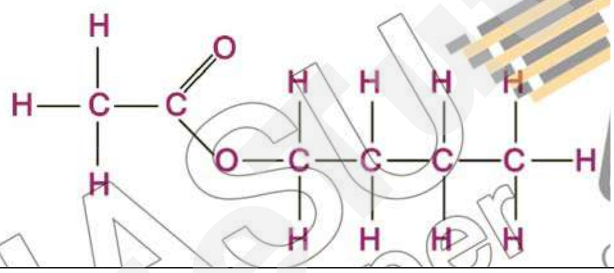
	(b)	 • the **formulae of the reactants and products** of the reaction, • a label for **the activation energy of reaction**, • a label for **the enthalpy change of reaction**. Deduct [1] for every 1 error.	**[2]**
	(c)	When pressure increases, there are more molecules of sulfur dioxide and oxygen per unit volume; frequency of effective collisions increases so rate increases	**[1]** **[1]**
	(d)	In the absence of water (or little amount of water), most of the sulfuric acid molecules do not ionise to form hydrogen ions, hence it would not react with steel; in dilute sulfuric acid, the hydrogen ions from the acid ionises completely, reacting with the iron in steel tanks;	**[1]** **[1]**
	(e)	Any transition metal (e.g. copper, silver, gold) that is below hydrogen in reactivity series. It has multiple oxidation state.	**[1]**
	(f)		**[1]**

Section B: Long-Structured Questions [30M]

9	**(a)**	**(i)**	2 C_8H_{18} + 25 O_2 → 16 CO_2 + 18 H_2O	**[1]**
		(ii)	Mole ratio of [allow ecf for mole ratio] 2 C_8H_{18} : 25 O_2 3 : 37.5 Number of moles of O_2 = $\frac{3}{2}$ x 25 = 37.5 mol [1] Volume of O_2 = 37.5 x 24.0 = 900 dm^3 [1]	**[2]**

		(iii)	$2 C_8H_{18} + 25 O_2 \rightarrow 16 CO_2 + 18 H_2O$ C_8H_{18} loses H atom / gains O atom to form CO_2, hence C_8H_{18} is reduced. O_2 gains H atom / loses O atom to form H_2O, hence O_2 is oxidised.	 **[1]** **[1]**
	(b)		Diesel contains a higher number of carbon atoms than petrol [1]. As the number of carbon atoms increases, the molecular size of the hydrocarbons increases. The **intermolecular forces of attraction** between the hydrocarbons **increases**. [1] Hence **more energy** is needed to **overcome the intermolecular forces of attraction between the hydrocarbons**. Hence diesel is a fraction of crude oil that is removed at a higher boiling point than petrol. [1]	**[3]**
	(c)		Three-way catalytic converter. Based on the chart, the three-way catalytic converter produces the lowest mass of hydrocarbons, carbon monoxide and nitrogen oxides as compared to two-way catalytic converter. Hence the three-way catalytic converter is a more effective catalytic converter. [1] *OR* Three-way catalytic converter can remove hydrocarbons, carbon monoxide and nitrogen oxides while two-way catalytic converter can only remove hydrocarbons and carbon monoxide. Hence the three-way catalytic converter is a more effective catalytic converter.	**[1]**
	(d)		Nitrogen oxides are not converted in a two-way catalytic converter. As a result, the nitrogen oxides react with oxygen and dissolve in rainwater to form acid rain, which corrodes limestone buildings, destroys aquatic life and plants.	**[1]**
10	**(a)**		$NH_4^+ (aq) + OH^- (aq) \longrightarrow NH_3 (g) + H_2O (l)$	**[1]**
	(b)		Percentage mass of nitrogen in ammonium chloride = 14 / (14 + 4 + 35.5) x 100 = 26.2% (3 s.f.)	**[1]**
	(c)	**(i)**	Ammonia has a relative molecular mass of 17, and is less dense than hydrogen chloride gas, with a relative molecular mass of 36.5. Hence ammonia gas diffuse faster than hydrogen chloride gas, forming the white solid ring closer to concentrated hydrochloric acid.	**[1]** **[1]**
		(ii)	The white solid would appear faster as the rate of diffusion is faster;	**[1]**
	(d)		No visible change will be observed. Bromine is less reactive than chlorine and is unable to displace chloride from ammonium chloride.	**[1]** **[1]**
	(e)		Step 1: In an evaporating dish, heat gently to sublime ammonium chloride. Step 2: Place an inverted filter funnel over the evaporating dish to cool down and condense the gaseous ammonium chloride to form white solid. Diagram drawn must be labelled properly to be awarded [1]. Student will need to state step 2 to get full credit.	**[1]** **[1]**
	(f)		As we go down the group, the boiling point or melting point increases / density increases / colour intensity increases / changes from gas to liquid to solid.	**[1]**

<table>
<tr><td>11</td><td colspan="4">Either</td></tr>
<tr><td></td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>aldehyde</th><th>chemical formula</th><th>structural formula</th></tr>
<tr><td>propanal</td><td>C_3H_6O</td><td></td></tr>
</table>
Award [1] only when all answers are correct</td><td>[1]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>These molecules have the same functional group of CHO./
These molecules have the same general formula, $C_nH_{2n}O$./
Each member's molecular formula differs from the next member by CH_2.

Award [1] for each correct answer.</td><td>[2]</td></tr>
<tr><td></td><td>(b)</td><td colspan="2">Oxidising agent: acidified potassium manganate
Observation: Violet potassium manganate decolourises.</td><td>[1]
[1]</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>Condensation reaction occurs when the molecules join with one another covalently to form a new product, with the elimination of small molecules such as water.</td><td>[1]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td>[1]</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td>Similarity:
Both reactions eliminate / release / produce water molecules / involve esther bond formation [1].

Difference:
Ethyl pentanoate is a simple molecule but Terylene is a macromolecule / Terylene has more than one ester linkage but ethyl pentanoate has only one. [1]</td><td>[2]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Terylene is non-biodegradable and will remain on Earth for a long time. Hence, Terylene will take up space in landfill sites, causing land pollution.</td><td>[1]</td></tr>
<tr><td>11</td><td colspan="4">Or</td></tr>
<tr><td></td><td>(a)</td><td colspan="2">X: aspirin
Y: acetaminophen
Z: caffeine
Award [1] for 1 or 2 correct answer
Award [2] for all correct answers</td><td>[2]</td></tr>
<tr><td></td><td>(b)</td><td colspan="2">Based on the R_f values, caffeine has the highest affinity for the silica gel. [1]

Caffeine has the lowest R_f value as compared to aspirin and acetaminophen, this shows that the distance moved by caffeine on the TLC plate is the shortest distance. Hence this shows that caffeine has high affinity for silica gel. [1]</td><td>[2]</td></tr>
</table>

	(c)		The experimental melting points for all three compounds are lower than the literature values. [1] A possible reason is that compounds **X**, **Y** and **Z** are not 100% pure [1] Or the compounds may contain impurities.	**[2]**
	(d)	(i)	Concentrated sulfuric acid, warm/heat (under reflux)	**[1]**
		(ii)	Award [1] for each correct answer	**[2]**
		(iii)	The process is similar to esterification, which is a reversible process. Hence some of the product, acetaminophen, formed is converted back to reactant particles.	**[1]**

Preliminary Examination 2019
Secondary Four Express
Chemistry
Paper 1 (6092/1)

Date of Examination: 4 September 2019 **Duration: 1 hour**

Chua Chu Kang Secondary School Chua Chu Kang Secondary School Chua Chu Kang Secondary School
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Name : ____( ) Class : _____________

Instructions to Candidates

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 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 Optical Answer Sheet **(OAS)**.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done on this paper.
A copy of the Periodic Table is printed on page **20**.
The use of an approved scientific calculator is expected, where appropriate.

Paper	Marks
1	40

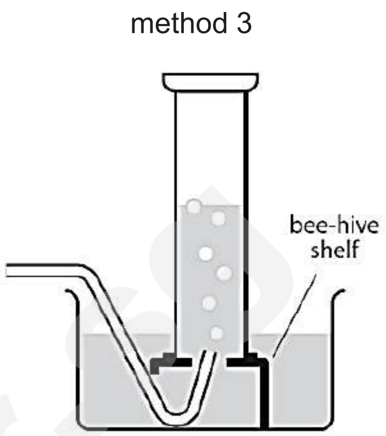
Set by: Mdm Asmahan Aman

Vetted by: Mr Benjamin Pooi, Mdm Fiona Tay and Mrs Shaima Anshad

This Paper consists of **20** printed pages, including the cover page.

1 Magnesium carbonate was reacted with excess dilute hydrochloric acid.

The diagram below shows the methods to collect gaseous products.



Which method(s) can be used to collect the gas evolved from the reaction?

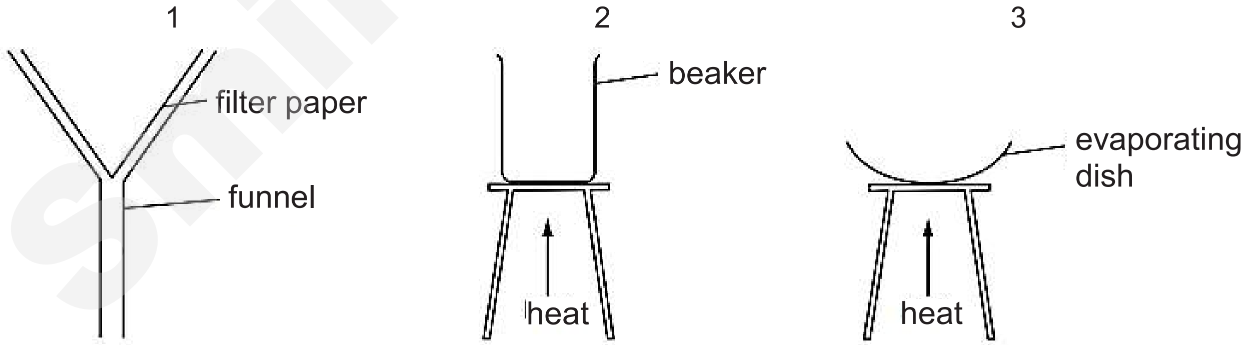
A 1 only

B 2 only

C 1 and 3

D 2 and 3

2 The diagram shows three sets of apparatus.



Which apparatus could be used to separate a mixture of copper(II) chloride and copper(II) oxide and obtain a pure sample of each solid?

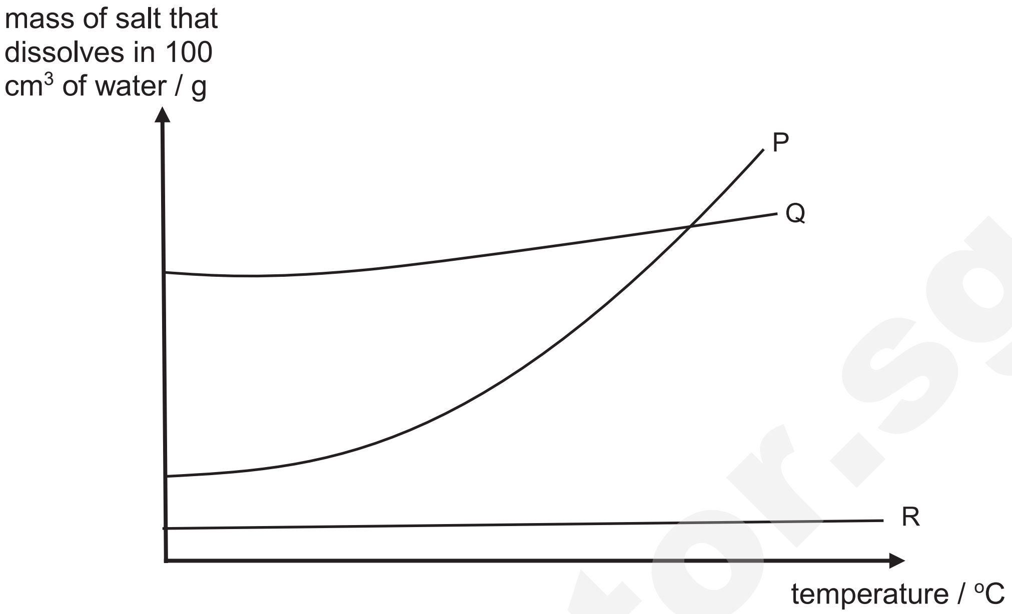
A 1 only

B 1 and 3

C 2 and 3

D 3 only

3 The diagram below shows the solubility curves of 3 salts, P, Q and R over a range of temperatures. P, Q and R are added to separate beakers of water.



Which of the following shows the best method of obtaining a solid sample from the mixture?

	salt P	salt Q	salt R
A	crystallisation	filtration	evaporate to dryness
B	evaporate to dryness	evaporate to dryness	filtration
C	evaporate to dryness	crystallisation	evaporate to dryness
D	crystallisation	evaporate to dryness	filtration

4 The following reactions are carried out on solid T.

solid T + heat → brown liquid X

solid T + O_2 → colourless gases evolved

solid T + water → colourless solution Y

Which conclusion is correct?

A solution Y is a mixture

B brown liquid X is a compound

C solid T is a mixture

D solid T is a compound

5 The gases making up dry air can be separated by fractional distillation of liquid air.

The boiling points of five of the gases in dry air are given below.

gas	boiling point / °C
N_2	– 210
O_2	– 220
Ar	– 186
Ne	– 246
Kr	– 152

In the fractional distillation of liquid air, which gas will distil off first and which gas will distil off last?

	first	last
A	N_2	O_2
B	O_2	Ne
C	Ar	N_2
D	Ne	Kr

6 Z has the atomic number 8 and mass number 18.

What are the particles present in a Z^{2-} ion?

	electrons	neutrons
A	8	8
B	8	10
C	10	18
D	10	10

7 When sucrose is heated, it melts at 192 °C. At this temperature it starts to decompose, and the liquid sucrose turns dark brown.

Which conclusion is correct?

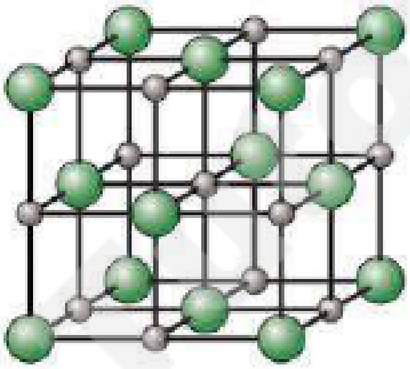
A the covalent bonds are stronger than the intermolecular forces

B the intermolecular forces, and some covalent bonds, are about the same strength

C the intermolecular forces are stronger than the covalent bonds

D the structure of the solid is a lattice structure

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



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

A lithium nitrate

B zinc sulfate

C sodium oxide

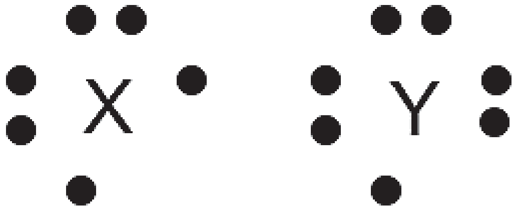
D lead(II) sulfate

9 Nitrogen forms compounds with the elements fluorine, oxygen, calcium and sodium. These compounds have the formulae NQ_2, X_3N, Y_3N_2 and NZ_3, where N represents nitrogen.

What are the identities of Q, X, Y and Z?

	F	O	Ca	Na
A	Q	X	Y	Z
B	X	Y	Z	Q
C	Y	Z	X	Q
D	Z	Q	Y	X

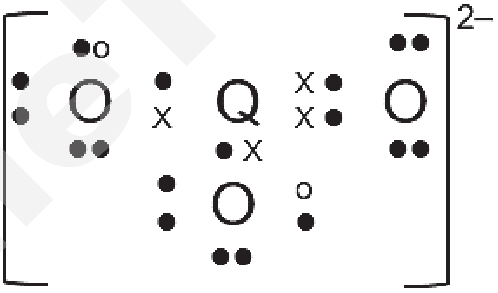
10 The diagram below shows the valence electrons of elements X and Y.



Which of the following correctly shows the type of bonds and chemical formula of the compound formed between X and Y?

	type of bonds	chemical formula
A	covalent	XY_2
B	ionic	XY
C	ionic	X_2Y_3
D	covalent	X_3Y_2

11 The ion QO_3^{2-} can be represented by the dot-and-cross diagram shown.



Which Group in the Periodic Table does Q belong to?

A I

B III

C IV

D VI

12 Which statement about the substance formed when a given mass of an element burns in excess oxygen is **always** correct?

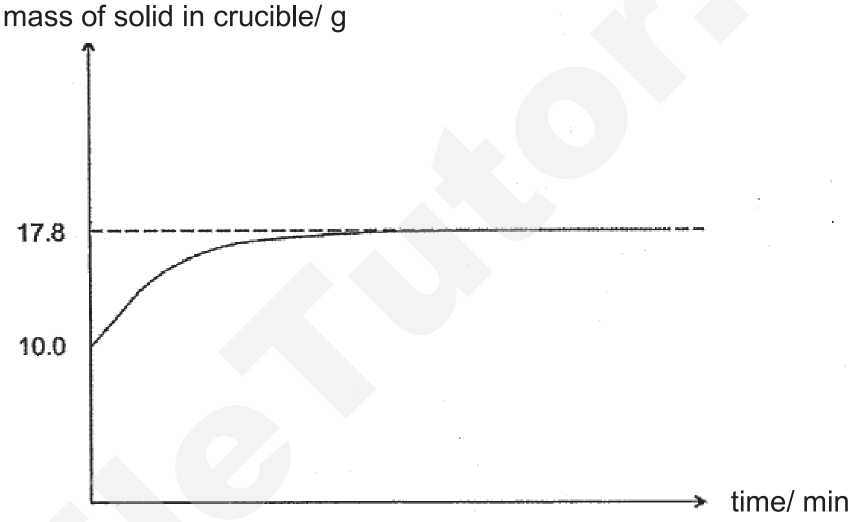
A denser than the element

B greater mass than the element

C soluble in water

D white in colour

13 10.0 g of vanadium was placed in a crucible and heated strongly in excess oxygen to produce an oxide of vanadium of unknown chemical formula. The mass of the sample in the crucible was recorded over time as shown in the graph below.



What is the formula of the oxide obtained?

A VO

B VO_2

C V_2O_3

D V_2O_5

14 A solution contains a mixture of 0.2 mol of sodium chloride and 0.2 mol of another metal chloride. The solution contains 0.6 mol of chloride ions.

Which of the following is the other metal chloride?

A potassium chloride

B magnesium chloride

C aluminium chloride

D lead(IV) chloride

15 The gaseous hydride of a certain element X has a chemical formula XH_4. At room temperature and pressure, 7.2 dm^3 of this hydride has a mass of 9.6 g.

What is the relative atomic mass of element X?

A 12

B 24

C 28

D 32

16 In which pair does neither of the gases change the colour of damp blue litmus paper?

A ammonia and chlorine

B ammonia and hydrogen chloride

C carbon monoxide and hydrogen

D carbon dioxide and sulfur dioxide

17 An unlabelled bottle is known to contain either aqueous sodium chloride or aqueous ammonium carbonate.

How should the solution be tested in order to determine which compound is present?

A by adding aqueous barium nitrate

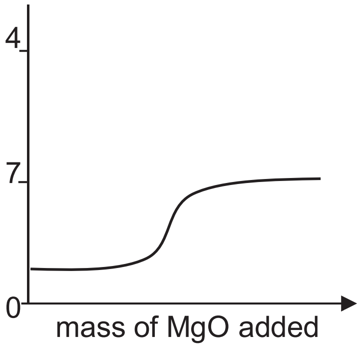
B by adding aqueous silver nitrate

C by adding aqueous potassium manganate(VII)

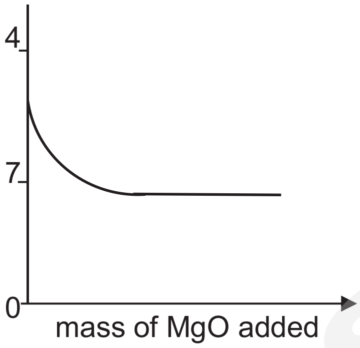
D by adding aqueous ammonia

18 Which graph shows the changes in pH as an excess magnesium oxide, MgO is added to hydrochloric acid?

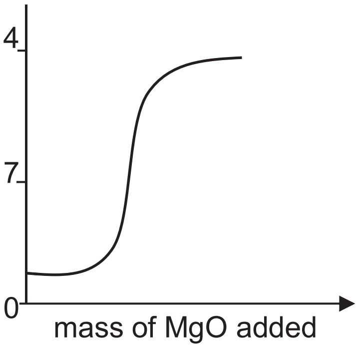
A



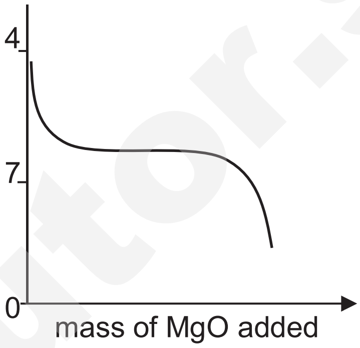
B



C



D



19 Which pair of substances would **not** be suitable for producing a large quantity of carbon dioxide?

A iron(II) carbonate and hydrochloric acid

B lead(II) carbonate and hydrochloric acid

C sodium carbonate and sulfuric acid

D calcium carbonate and nitric acid

20 Propanoic acid, ethanoic acid, hydrochloric acid and sulfuric acid each dissociate in solution.

If Universal Indicator is placed in 0.1 mol/dm^3 of each solution, which solution will produce a colour indicating the lowest pH?

A sulfuric acid

B ethanoic acid

C hydrochloric acid

D propanoic acid

21 An atmospheric pollutant can be removed by the process of oxidation.

Which pollutant is removed by this process?

A carbon monoxide in a catalytic converter

B nitrogen dioxide in acid rain by reaction with calcium carbonate

C nitrogen dioxide in a catalytic converter

D sulfur dioxide from the flue gases by reaction with calcium carbonate

22 A student investigated the effect of heat on copper(II) nitrate crystals in a test-tube. She observed that a brown gas P was given off, and a black solid Q remained in the test-tube. The black solid was hard to clean off the glass. She added solution S to dissolve the solid.

Which of the following correctly identifies substances P, Q and S?

	brown gas P	black solid Q	solution S
A	nitrogen	copper	sodium hydroxide
B	nitrogen	copper(II) oxide	hydrochloric acid
C	nitrogen dioxide	copper	sodium hydroxide
D	nitrogen dioxide	copper(II) oxide	hydrochloric acid

23 Four elements identified only as W, X, Y and Z are all found in the third period of the Periodic Table.

1 The atomic size of Z is less than X.
2 The energy required to remove the first electron from atom Y is greater than that from the atom of Z.
3 W forms an ion which has a larger size than an atom of W.
4 X, Y and Z form ions which are smaller than their parent atoms.

Using the information, what is the most likely order of arrangement of these elements from left to right in the third period?

A X, Z, Y, W

B X, Y, Z, W

C Z, Y, W, X

D W, Y, Z, X

24 Three types of steel have different properties.

steel 1	is easily shaped
steel 2	is brittle
steel 3	is resistant to corrosion

What are the names of these three types of steel?

	steel 1	steel 2	steel 3
A	high carbon	mild	stainless
B	high carbon	stainless	mild
C	mild	high carbon	stainless
D	mild	stainless	high carbon

25 The following shows some of the results when metals W, X and Y were added to cold water, steam and hydrochloric acid separately.

1. Only metal X does not react with cold water.
2. Metal W reacts with steam.
3. Metals W and Y react with hydrochloric acid.

Which conclusion is **not** correct?

A W is more reactive than X.

B X reacts with steam.

C Y is more reactive than X.

D Y reacts with steam.

26 Three stages in making steel from iron ore are listed.

1 carbon dioxide reacts with carbon
2 metal oxides and oxygen are added
3 haematite is reduced

In which order do these stages occur?

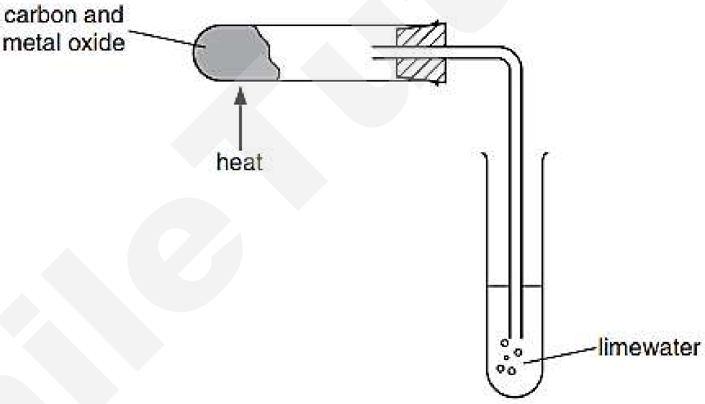
A 1 → 2 → 3

B 1 → 3 → 2

C 2 → 1 → 3

D 3 → 2 → 1

27 A metal oxide is mixed with carbon and heated as shown.



The limewater turns cloudy.

Which of the following **cannot** be the metal oxide?

A zinc oxide

B magnesium oxide

C copper(II) oxide

D iron(III) oxide

28 Limestone can be changed into slake lime in two chemical reactions.

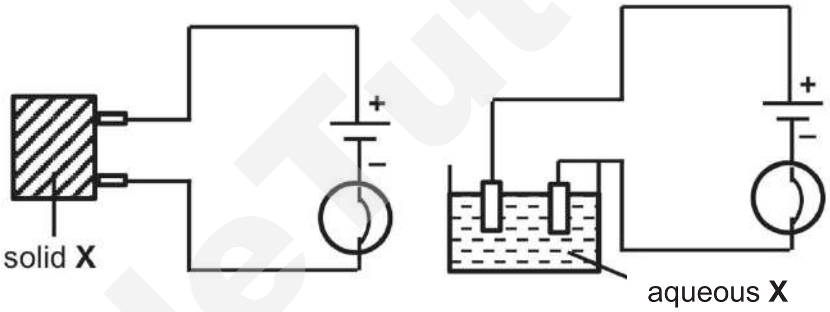
1 When limestone is heated it decomposes into lime, CaO.

2 Water is slowly dripped onto the cooled lime. The lime appears to expand and steam is produced. Slaked lime, $Ca(OH)_2$, is formed.

Which row shows the correct description of each of the chemical reactions?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

29 Two circuits are shown below. The light bulb lights up in only one of the circuits.



What is the identity of X?

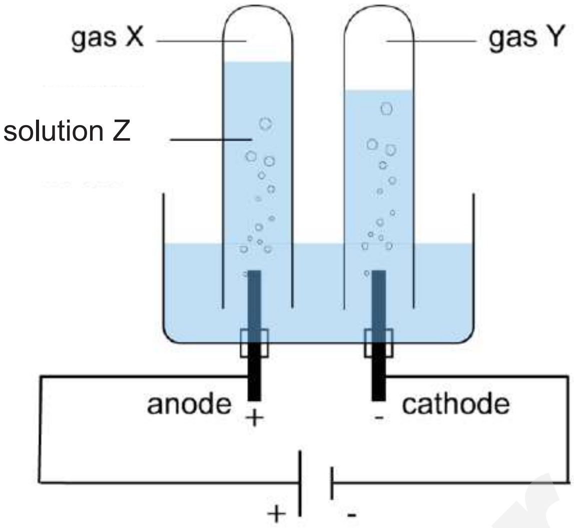
A lead(II) chloride

B sugar

C poly(ethene)

D sodium oxide

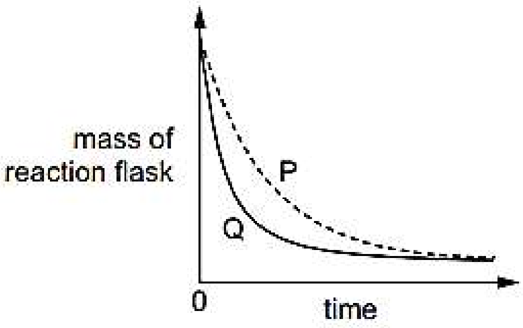
30 The diagram below is a typical electrolysis set-up that collects gaseous products.



Which of the following correctly shows the identities of solution Z, gas X and Y?

	solution Z	gas X	gas Y
A	hydrochloric acid	chlorine	hydrogen
B	sodium sulfate	hydrogen	oxygen
C	sulfuric acid	oxygen	hydrogen
D	concentrated sodium chloride	chlorine	hydrogen

31 A student investigates the rate of reaction between marble chips and hydrochloric acid.
The mass of the reaction flask is measured.
The graph shows the results of two experiments, P and Q.



Which change explains the difference between P and Q?

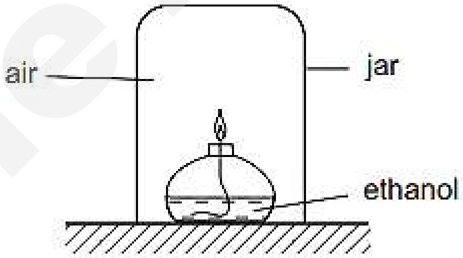
A A catalyst is added in P.

B A higher temperature is used in P.

C Bigger marble chips are used in Q.

D Hydrochloric acid is more concentrated in Q.

32 The diagram shows ethanol burning inside a sealed jar.



The mass of one gas in the jar does not change.

Which gas is this?

A carbon dioxide

B nitrogen

C oxygen

D water vapour

33 Which one of the following conversion is an industrial process catalysed by nickel?

A ethene and hydrogen into ethane

B nitrogen monoxide into nitrogen

C nitrogen and hydrogen into ammonia

D hydrogen and chlorine into hydrogen chloride

34 Which of the following could **not** be produced when methane reacts with chlorine in the presence of ultraviolet light?

A hydrogen chloride

B tetrachloromethane

C chloromethane

D hydrogen

35 The structures of two isomers of butane, C_4H_8, are given below.

$CH_3CH_2CH{=}CH_2$ and $CH_3CH{=}CHCH_3$

How many of the statements about these two isomers are correct?

- Both will react with 1 mole of bromine to produce the same mass of products.
- Both produce the same molecule when reacted with steam.
- Both produce the same molecule when reacted with hydrogen.
- Combustion of 10 g of each isomer will produce the same volume of gas.

A 1

B 2

C 3

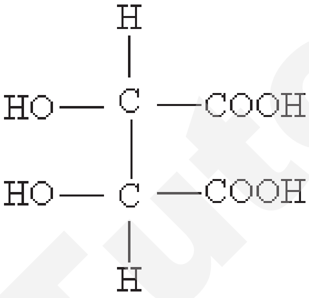
D 4

36 Compound P reacts with compound Q to form product R.

Which of the following correctly identifies P, Q and R?

	P	Q	product R
A	CH_3OH	CO_2H	$HCO_2C_2H_5$
B	CH_3CO_2H	Na	CH_3CO_2Na
C	C_3H_7OH	$KMnO_4$	C_3H_7COOH
D	CH_3CO_2H	CH_3OH	$CH_3CO_2CH_3$

37 The diagram below shows the structural formula of tartaric acid.



Which of the following salt(s) could be formed upon reacting tartaric acid with potassium hydroxide?

1 $C_4H_5O_6K$
2 $C_4H_4O_6K_2$
3 $C_4H_3O_6K_3$
4 $C_4H_2O_6K_4$

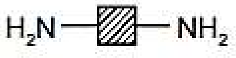
A 2 only

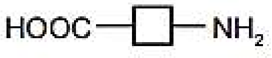
B 1 and 2

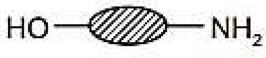
C 2 and 3

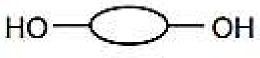
D 1, 2, 3 and 4

38 The diagrams show four monomers.

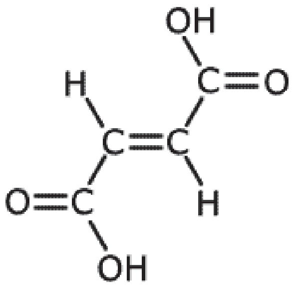








How many of these monomers would react with the molecule below to form a polymer?



A 1

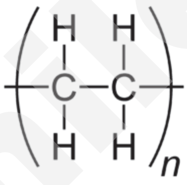
B 2

C 3

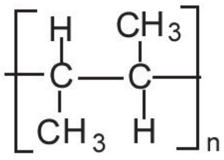
D 4

39 Which polymer does **not** have an empirical formula CH_2?

A



B



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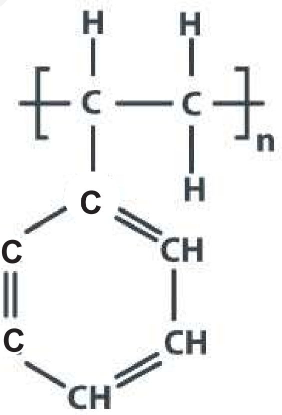
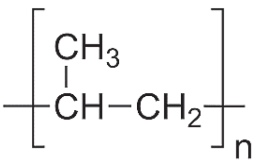


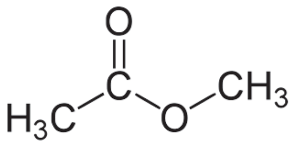
D



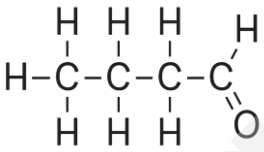
40 Ester methyl propanoate has the molecular formula $C_4H_8O_2$.

Which compound is an isomer of methyl propanoate?

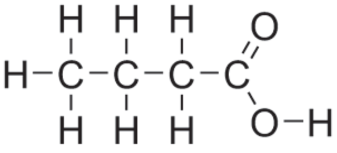
A



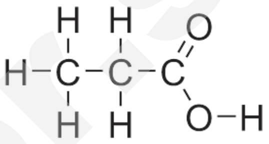
B



C



D



END OF PAPER 1

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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.).

Preliminary Examination 2019
Secondary Four Express
Chemistry
Paper 2 (6092/2)

Date of Examination: 2 September 2019 **Duration: 1 hour 45 minutes**

Chua Chu Kang Secondary School Chua Chu Kang Secondary School Chua Chu Kang Secondary School
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Chua Chu Kang Secondary School Chua Chu Kang Secondary School Chua Chu Kang Secondary School

Name : ____( ) Class : ____________

Instructions to Candidates

Write your name, index number and class in the spaces provided on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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

Section B
Answer all **three** questions, the last question is in the form 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 18.

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

Section	Marks
A	/ 50
B	/ 30
Total	/ 80

Set by: Mdm Asmahan, Ms Lim CF and Mdm Yasmeen

Vetted by: Mr Benjamin Pooi, Mdm Fiona Tay and Mrs Shaima Anshad

This Paper consists of **18** printed pages, including the cover page.

Section A

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

A1 **(a)** Use the following list of substances to answer the questions.

iodine
magnesium
chlorine
sodium chloride
graphite

(i) Which substance conducts electricity when molten but not in solid?

…………………………………………………………………………………… [1]

(ii) Which substance is a solid which sublimes at a low temperature?

…………………………………………………………………………………… [1]

(iii) Which **two** substances conduct electricity when in a solid form?

…………………………………………………………………………………… [1]

(iv) Which substance is a diatomic gas?

…………………………………………………………………………………… [1]

(v) Which substance reacts with acidified silver nitrate to give a white precipitate?

…………………………………………………………………………………… [1]

(b) Manganese is a typical transition metal element.
State **three** properties that its oxides will have.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

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

[Total: 7]

A2 Explain why

(a) carelessly discarding plastics can result in **long-term** pollution,

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(b) not recycling metals can cause problems for **future** generations,

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(c) the **incomplete** combustion of carbon-containing fuels can be dangerous to people,

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

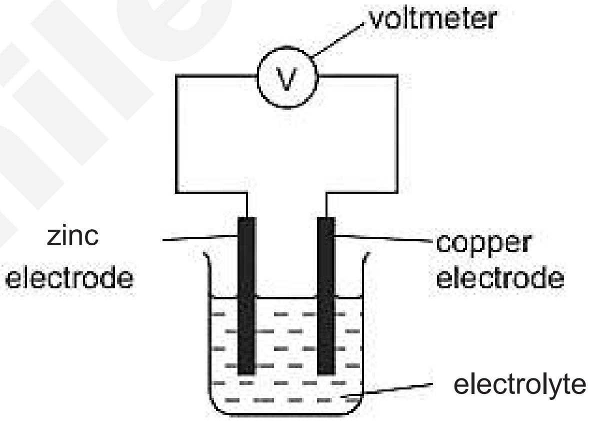
(d) the **combustion** of fossil fuels can eventually damage buildings.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

[Total: 4]

A3 The diagram shows a simple cell set up.



The table shows information about zinc–copper simple cells.

Complete the table by filling in the missing information.

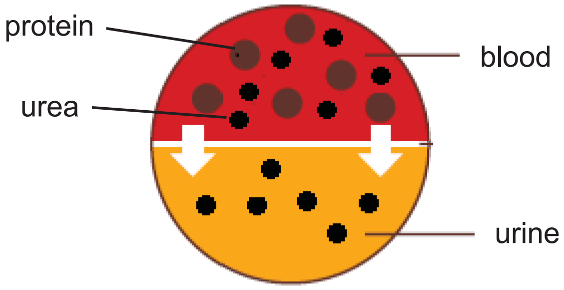
electrolyte	electrodes used	product of reaction at positive electrode	product of reaction at negative electrode
dilute hydrochloric acid	copper and zinc		
	copper and zinc	copper	

[3]

[Total: 3]

A4 Glomerular Filtration Rate (GFR) is a test to check how well the kidneys are working. It estimates the rate at which blood passes through the kidney and urea is removed. In a healthy individual with a fully functioning kidney, the average rate of GFR is 120 ml/min.

The diagram below shows the movement of particles from blood to urine in the kidney.



(a) How does the kidney remove urea from the blood?

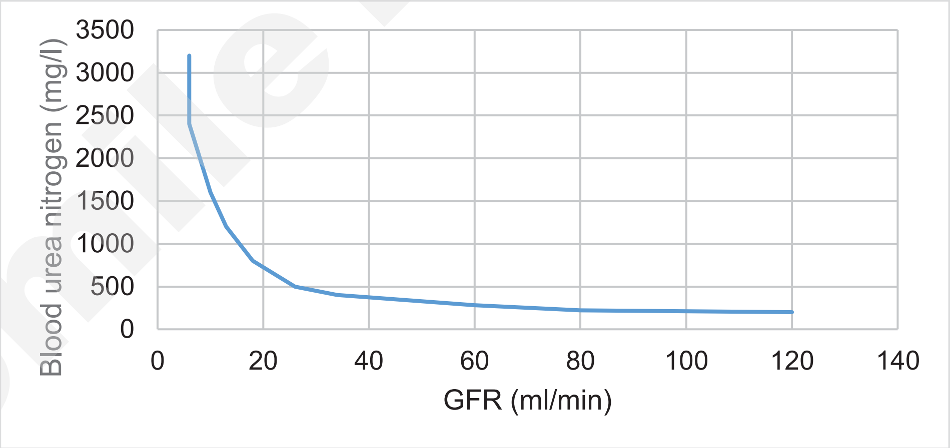
……

…… [2]

(b) Blood sample of elderly patients tend to contain traces of protein. Suggest a reason.

…… [1]

(c) The following graph shows the relationship between blood urea nitrogen levels and GFR.



(i) With reference to the graph above, state how the glomerular filtration rate (GFR) affects the blood urea nitrogen levels.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

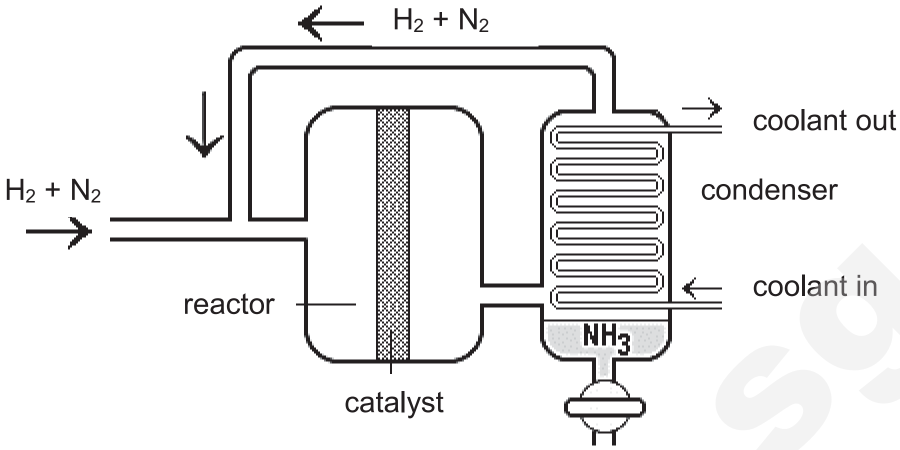
………………………………………………………………………………………………… [2]

(ii) Deduce, from the graph, the normal blood urea levels in a healthy individual.

………………………………………………………………………………………………… [1]

[Total: 6]

A5 The diagram shows some information about the Haber process for making ammonia.



(a) Write a balanced chemical equation for the process.

……………………………………………………………………………………………… [1]

(b) Name the catalyst used.

……………………………………………………………………………………………… [1]

(c) When the mixture of hydrogen, nitrogen and ammonia enters the condenser, the ammonia turns to a liquid but the other gases do not.

What does this tell you about the boiling point of ammonia?

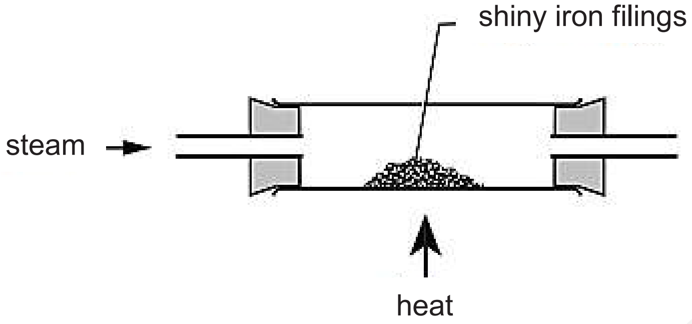
……………………………………………………………………………………………… [1]

(d) Give an advantage, other than cost, of recycling unreacted nitrogen and hydrogen.

……………………………………………………………………………………………… [1]

[Total: 4]

A6 The diagram below shows an experiment in which steam is passed over hot iron filings. The iron filings glow, turns black and then forms a red brown iron oxide solid and a gas which burns with a blue flame.



(a) Describe how the observations would be different if the experiment was repeated using each of the following two metals in place of the iron filings.

(i) magnesium

……………………………………………………………………………………………………

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

(ii) copper

…………………………………………………………………………………………… [1]

(b) Iron is manufactured from haematite, an oxide of iron.

Describe the manufacture of iron from haematite.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

[Total: 6]

A7 **P** is a mixture of iron(II) sulfate and ammonium sulfate.

The tests on **P** and some of the observations are recorded in the following table.

Complete the table by filling in the missing information.

tests			observations
(a)	Appearance of solution **P**.		……………………………………………… ……………………………………………… [1]
(b)	Aqueous barium nitrate was added to a portion of solution **P** followed by dilute nitric acid.		……………………………………………… ……………………………………………… [2]
(c)	**(i)**	Excess aqueous sodium hydroxide was added to a portion of solution **P**.	……………………………………………… ……………………………………………… [2]
	(ii)	The mixture from **(c)(i)** was filtered and the filtrate heated. The gas given off was tested with damp litmus paper.	……………………………………………… ……………………………………………… [1]

(d) When equal volumes of potassium manganate(VII) solution and solution **P** are mixed, potassium manganate(VII) decolourises.

(i) State another observation when both solutions are mixed.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

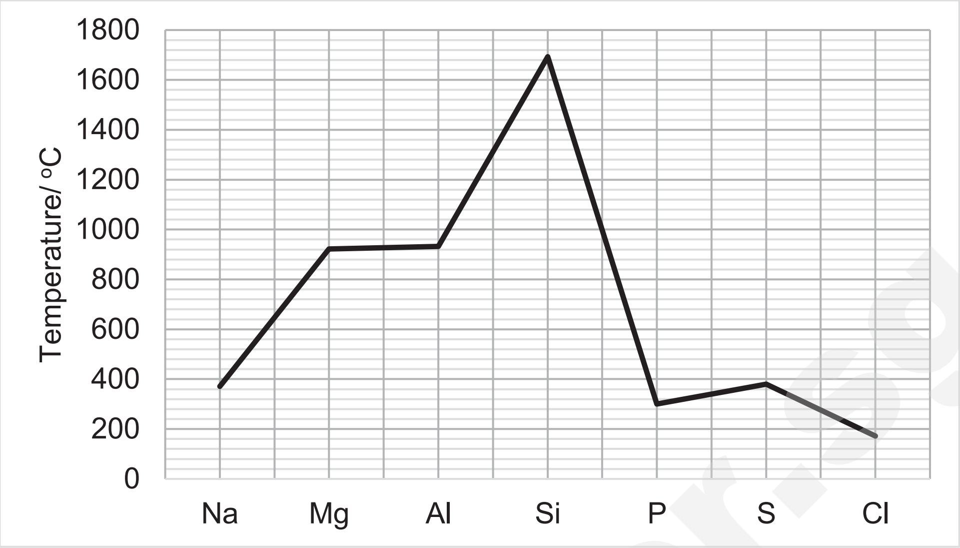
(ii) Explain, in terms of electron transfer, your answer in **(d)(i)**.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

[Total: 8]

A8 The following graph shows the melting points of elements in Period 3 of the Periodic Table.



(a) Describe the general trend in the melting points of the elements in Period 3.

……

……

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

(b) Explain the reasons, in terms of bonding, for the trend in the melting points of the elements.

……

……

……

……

……

……

……

………………………………………………………………………………………………… [4]

(c) Chlorine forms various oxides. The formulas and boiling points of two such oxides are given below.

name	formula	boiling point / °C
dichlorine monoxide	Cl_2O	2
dichlorine hexoxide	Cl_2O_6	200

(i) Draw a 'dot-and-cross' diagram for dichlorine monoxide.

[2]

(ii) Suggest a reason for the difference in the boiling points of the two compounds.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

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

(d) Predict and explain the difference in electrical conductivities of molten magnesium oxide and liquid dichlorine monoxide, in terms of structure and bonding.

……

……

……

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

[Total: 12]

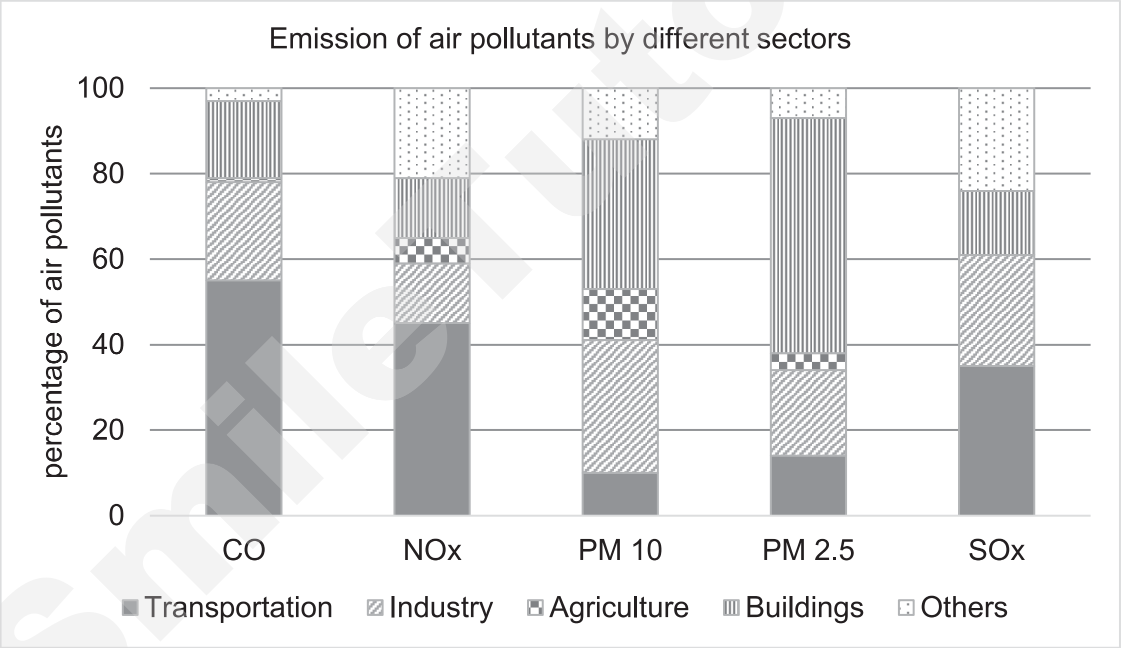
Section B

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.

B9 Country **X** has been addressing the emission of air pollutants from various sectors. They have placed many regulations in place to enhance air quality. In many cases, these changes have led to a general decline in the total emissions of air pollutants. Over recent years, there has also been a modernisation of road vehicles, including the introduction of more vehicles with improved emission control.

Though many efforts have been put in place, natural causes of air pollution are still prevalent. Additionally, global shipping has been identified as one of the growing sector that releases high volumes of air pollutants. There has also been an increase in the awareness of the contribution made by national and international shipping traffic to SO_x emissions and NO_x emissions.

The stacked chart below shows the emission of air pollutants by various sectors in country **X**.



(a) Referring to the information and chart above, suggest the main source of air pollution in Country **X**. Give reason for your choice.

……

……

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

(b) A student made the following comment after studying the chart.

"The chart shows that transportation vehicles produce a greater volume of carbon dioxide than oxides of nitrogen. Carbon monoxide, which is colourless, dissolves in rainwater to form acid rain."

Identify **two** mistakes in the student's comments. Explain why.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

(c) State a method used to convert carbon monoxide and nitrogen monoxide into less harmful substances in vehicles. Write a chemical equation to show the reaction.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

(d) Apart from the solutions suggested in **(c)**, describe **two** methods to reduce the emission of air pollutants.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

(e) PM10 refers to particulate matter which is 10 micrometre and smaller in size – about one-seventh the diameter of a strand of human hair. This is also found in high percentage in haze brought about by forest fires.

Suggest a possible chemical that is classified as PM10. Explain why this chemical is present in the haze.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

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

[Total: 10]

B10 A student carried out an experiment to investigate the reaction between bromide ions and chlorine gas.

She bubbled chlorine gas through dilute aqueous potassium bromide for 6 minutes. She took samples of the reactive mixture every 30s and measured the colour intensity of each sample using a colorimeter.

A colorimeter measures the intensity of light that is absorbed by a coloured solution. The darker the colour of the solution, the more light is absorbed and the higher the reading on the colorimeter.

(a) Write an ionic equation, with state symbols, for the reaction between chlorine gas and bromide ions.

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

(b) Describe and explain how the absorbance reading change as the reaction takes place.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(c) The student carried out three more experiments to determine the time taken for each reaction to finish. She used the same volume of potassium bromide solution each time. She recorded the time taken and the absorbance reading at the end of each reaction in a table.

experiment	time taken for reaction to finish/ min	absorbance reading at the end of reaction
1	5.00	0.8
2	6.00	0.4
3	2.50	0.8
4	2.50	0.9

(i) Which experiment uses potassium bromide of a lower concentration than in experiment 1?

…………………………………………………………………………………… [1]

(ii) Which two experiments show the same concentration of reactants being used but at different temperatures?

…………………………………………………………………………………… [1]

(d) Chlorine, bromine and iodine are elements from Group VII of the Periodic Table and they are known as halogens.

The student decided to repeat the experiment using different halide solutions. State and explain how the absorbance reading will be higher, lower or no change compared to experiment 1.

(i) chlorine and potassium iodide

……………………...……………………………………………………………………..

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

(ii) bromine and potassium chloride

……………………...……………………………………………………………………..

……………………...…………………………………………………………………… [1]

[Total: 10]

EITHER

B11 Magnesium and calcium occur naturally in the anhydrous mineral dolomite, $MgCO_3.CaCO_3$, a mixture of insoluble carbonates. Useful products such as calcium sulfate can be obtained by first adding excess hydrochloric acid to form mixture **A** and then sulfuric acid to form mixture **B**.

(a) Write one chemical equation that represents one possible chemical reaction that occurs in the scheme shown, include state symbols.

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

(b) State the compounds present in mixture **A**.

………………………………………………………………………………………………

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

(c) In order to produce calcium sulfate from dolomite, it is important to add excess hydrochloric acid before sulfuric acid. Explain why.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(d) Describe the steps to obtain dry calcium sulfate powder after the addition of sulfuric acid to mixture **A.**

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(e) Calcium sulfate could also be produced by the following reaction.

$$Ca(NO_3)_2 + Na_2SO_4 \rightarrow CaSO_4 + NaNO_3$$

Discuss why this method is more environmentally friendly compared to the method in (d).

……

……

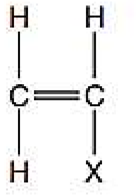
……

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

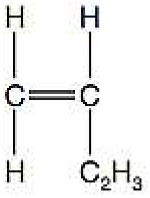
[Total: 10]

OR

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



styrene



butadiene

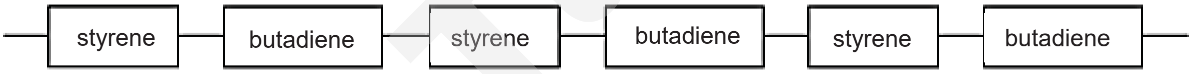
(a) What type of polymerisation will take place when the monomers polymerise? Explain your reasoning.

………………………………………………………………………………………………………..

………………………………………………………………………………………………………..

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

(b) One possible structure for the polymer is shown below.



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

[2]

(ii) When the mixture of styrene and butadiene polymerises, the polymer is unlikely to contain only this regular, repeating pattern. Suggest a reason.

………………………………………………………………………………………………………..

……………………………………………………………………………………………….. [1]

(c) Butadiene can be made by cracking butane in a cracking tower.

(i) Butane cracks to form butadiene and one other product.
Write an equation to show this reaction.

……………………………………………………………………………………… [1]

(ii) Give a use of the other product in this reaction.

……………………………………………………………………………………… [1]

(d) 2.90 kg of butane entered the cracking tower. After the reaction, 2.16 kg of butadiene was made.

Calculate the percentage yield of butadiene.

[3]

[Total: 10]

END OF PAPER 2

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* 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 T*l* 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 F*l* 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 4E
Chemistry
Preliminary Examination 2019

Mark Scheme

Paper 1 (40 marks)

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

A – 8 B – 11, C – 11, D - 10

Paper 2
Section A (50 marks)

A1(a)(i)	sodium chloride	1
(ii)	Iodine	1
(iii)	Magnesium and graphite	1
(iv)	Chlorine	1
(v)	Sodium chloride Misconception: Chlorine reacts with silver nitrate (confused QA and displacement)	1
(b)	Basic oxide, high melting point, solid Any other acceptable properties of ionic or basic compound Did not see property of oxide. Explain in terms of the metal	1m -2 correct 2m – all correct
		Total: 7
A2 (a)	Plastics are non-biodegradable and when disposed in landfills it cause land pollution/ water pollution.	1
(b)	Metals are finite resources and it will be not available for future generations if it is used up	1
(c)	Carbon monoxide is produced and it reduces the ability of the blood to carry oxygen Reasons state like headaches, breathing difficulty and fatigue.	1
(d)	Sulfur dioxide is produced and cause acid rain when dissolved in rainwater. Acid rain corrodes building Incomplete answers and students tend to think that carbon dioxide and oxides of nitrogen are formed	1
		Total: 4

<table>
<tr><td>A3</td><td>
<table>
<tr><th>electrolyte</th><th>electrodes used</th><th>product of reaction at positive electrode</th><th>product of reaction at negative electrode</th></tr>
<tr><td>dilute hydrochloric acid</td><td>copper and zinc</td><td>hydrogen [1]</td><td>zinc ions</td></tr>
<tr><td>any copper(II) salt solution [1]</td><td>copper and zinc</td><td>copper</td><td>zinc ions</td></tr>
</table>
Very badly done</td><td>Both zinc ions correct – 1m</td></tr>
<tr><td></td><td></td><td>Total: 3</td></tr>
<tr><td>A4(a)</td><td>Kidney uses the concept of filtration to separate smaller solids from liquid blood, using membrane /filter.
Particles smaller than the holes/pores of the filter layer passes over to the urine, while the particles bigger cannot be filtered.

Biology students answered with biology content that is not relevant.</td><td>1

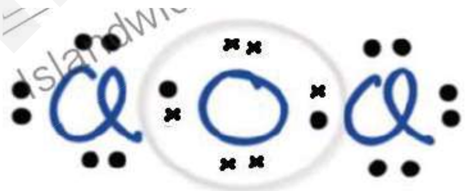
1</td></tr>
<tr><td>(b)</td><td>The filter layer in elderly patients probably have enlarged hole or torn surface.</td><td>1</td></tr>
<tr><td>(c)(i)</td><td>When GFR is high (above 40 ml/min), blood urea nitrogen level in low, below 250 mg/l.
When GFR drops below 30 ml/min, blood urea nitrogen level exponentially increases to as high as 3000 mg/l./ When GFR goes from about 5 to 30 ml/min, the blood urea nitrogen drops drastically from about 3200 to 500 mg/l.

No data was used. Wrong data was used.</td><td>1

1</td></tr>
<tr><td>(ii)</td><td>200 – 250 mg/l</td><td>1</td></tr>
<tr><td></td><td></td><td>Total: 6</td></tr>
<tr><td>A5(a)</td><td>$N_2 + 3H_2 \rightleftharpoons 2NH_3$
Wrong arrow used</td><td>1</td></tr>
<tr><td>(b)</td><td>Iron</td><td>1</td></tr>
<tr><td>(c)</td><td>Boiling point of ammonia is higher than nitrogen and hydrogen.</td><td>1</td></tr>
<tr><td>(d)</td><td>Increase yield of ammonia/ conserve hydrogen since it is produced from cracking/ electrolysis of water</td><td>1</td></tr>
<tr><td></td><td></td><td>Total: 4</td></tr>
<tr><td>A6(a)(i)</td><td>Magnesium burns brightly/ white light
White solid magnesium oxide formed</td><td>1
1</td></tr>
<tr><td>(ii)</td><td>No visible change
A few students thought that copper will react with steam</td><td>1</td></tr>
<tr><td>(b)</td><td>Coke reacts with oxygen to form carbon dioxide.
Carbon dioxide reacts with more coke to form carbon monoxide.
Carbon monoxide reduces iron(III) oxide to form iron and carbon dioxide.
Limestone decompose to form calcium oxide.
Calcium oxide reacts with impurity sand to form slag.</td><td>1

1

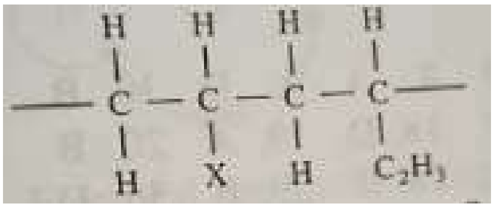
1</td></tr>
</table>

		Total: 6
A7(a)	Green	1
(b)	White precipitate. Precipitate insoluble in acid/ no visible change observed with acid	1 1
(c)(i)	Green precipitate insoluble in excess	2
(ii)	Red litmus paper turns blue	1
(d)(i)	Green solution turns yellow / reddish brown Not familiar with iron (II) oxidising to iron (III)	1
(ii)	Iron (II) ions in P lose electrons to form iron(III) ions. A number thought that ammonium sulfate is an oxidising agent	1
		Total: 8
A8(a)	Melting point of elements increase rapidly from sodium to silicon, with the exception of magnesium and aluminium with almost the same point. The melting point drops from silicon to phosphorus, and the value rises slightly from phosphorus to sulfur and drops from sulfur to chlorine. The trend was poorly described; as students were not able to use appropriate words.	1 1
(b)	Magnesium and aluminium have strong electrostatic forces of attraction between cations and delocalised electrons. Lots of energy needed to overcome the attraction. Sodium is an exception with lower melting point as it is from group I. Silicon has strong covalent bonds between atoms. Lots of energy needed to overcome the bonds. [Silicon– giant molecular structure] Phosphorus, sulfur and chlorine has weak intermolecular forces of attraction between molecules. Little energy needed to overcome the forces of attraction. Students did poorly for this question; they confused the elements with oxides of the elements. Proper usage of keywords such as atoms/ ions/ molecules.	1 1 1 1
(c)(i)	 correct number of bonding electrons 1m correct number of electrons around atom 1m dot-and-cross diagram was well done.	Max 2
(c)(ii)	Dichlorine hexoxide is a bigger molecule than dichlorine monoxide. Hence the intermolecular forces of attraction between molecules are higher compared to dichlorine monoxide. Hence more energy needed to overcome the forces of attraction. Poorly done; students confused breaking of molecule with breaking of bonds in molecule during melting.	1 1

(d)	Molten magnesium oxide has free moving cations and anions to carry electric charges. Hence able to conduct electricity. Liquid dichlorine monoxide has no free moving electrons to carry electric charges. Hence unable to conduct electricity. Well done by majority; some students poorly used keywords such as cations and electrons.	1 1
		Total: 12

Section B (30 marks)

A8(a)	Vehicles / ships {Transportation alone – No marks} As carbon monoxide, oxides of nitrogen and sulfur dioxide are common air pollutants, transportation contributes the highest percentage of these pollutants. Students predicted transportation as the main reason, but failed to suggest the exact reason.	1 1
(b)	Carbon monoxide is a neutral compound, Hence it cannot produce acid when in contact with rain water. The chart shows values for carbon monoxide; values of carbon dioxide cannot be predicted from the graph. The chart did not show that the vehicles produce a greater volume of carbon monoxides than oxides of nitrogen. Instead it shows the percentage contribution of each sector / the charts are independent of each other and cannot be compared. (any two) Relatively well done; but students confused percentage graph to volume graph.	1 each Max 2
(c)	Catalytic converter can be fixed in cars to convert carbon monoxide and nitrogen monoxide into carbon dioxide and nitrogen gas, which are less harmful. $2CO + 2NO \rightarrow N_2 + 2CO_2$ Well done; but students did not study the equation.	1 1
(d)	Sulfur emission from industries can be reduced by flue gas desulfurization. / remove sulfur from fossil fuels before they are burnt / advise clean alternate fuels for vehicles such as hydrogen or biofuels / use electric cars. (any two reasonable answers) Well done; vague answers were rejected.	2
(e)	Unburnt carbon/ unburnt hydrocarbon from incomplete combustion of trees rich in carbon compounds. Poorly done; students were not able to relate the reason for haze.	1 1
		Total: 10
B10(a)	$Cl_2 (g) + 2Br^- (aq) \rightarrow Br_2 (aq) + 2Cl^- (aq)$ Students wrote chemical equations, wrong or missing state symbols 1m - eqn 1m – state symbols	2

(b)	Reading increase as reaction takes place as more bromine is formed. Chlorine displaces bromide to form bromine and hence turns darker/brown causing the reading to increase Students are not able to explain displacement correctly.	1 1 1
(c)(i)	2	1
(ii)	1 and 3	1
(d)(i)	Higher Iodine is darker than bromine. / Iodine is black.	1 1
(ii)	No change as no reaction. Students did not realise that the solution appears reddish brown so no change to the reading.	1
		Total: 10
B10(a)	$CaCO_3$ (s) + 2HCl (aq) → $CaCl_2$ (aq) + CO_2 (g) + H_2O (l) $MgCO_3$ (s) + 2HCl (aq) → $MgCl_2$ (aq) + CO_2 (g) + H_2O (l) $CaCl_2$ (aq) + H_2SO_4 (aq) → $CaSO_4$ (s) + 2HCl (aq) (any one equation)	1 for balanced eqn; 1 for state symbols
(b)	Magnesium chloride and calcium chloride	2
(c)	If sulfuric acid is added in the first step, an insoluble salt, calcium sulfate will be formed on the surface of dolomite, hence preventing further reaction. Also it would not be possible to remove calcium sulfate from the dolomite, as both the reactants as well as the products are insoluble.	1 1
(d)	Filter the mixture to obtain the precipitate as the residue. Wash the precipitate with distilled water. Dry the precipitate between sheets of filter papers.	1 1
(e)	Adding hydrochloric acid to the insoluble carbonates will produce a lot of carbon dioxide gas; while adding sodium sulfate to calcium nitrate does not produces any toxic gas. Carbon dioxide is a greenhouse gas that would contribute to global warming.	1 1
		Total: 10 marks
B11OR (a)	Addition polymerisation. Both monomers are unsaturated/ contain C=C	1 1
b(i)	 1m 1m	2
(b)(ii)	Polymerisation is random/ Styrene can add to another styrene resulting in polystyrene. Butadiene can also polymerise into polybutandiene. If styrene and butadiene were to polymerise	1

	randomly, the chain will be irregular such as styrene – styrene - butadiene - …	
(c)(i)	$C_4H_{10} \rightarrow C_4H_6 + 2H_2$	1
(ii)	Rocket fuel / manufacture of ammonia in Haber process / fuel cell / convert alkene to alkane (hydrogenation)	1
(d)	Moles of butane = 2.9 / (12 x 4 + 10) = 0.05 Moles of butadiene = 0.05 Mass of butadiene = 0.05 x (12 x 4 + 6) = 2.7 kg % yield = 2.16/ 2.7 x 100% = 80%	1 1 1
		Total: 10

	Class	Index No.
Candidate Name:		

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examinations 2019

4E

CHEMISTRY 6092/01

Paper 1 Multiple Choice

2 September 2019
0755 – 0855
1 hour

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Write your name and index 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 provided.

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 13.

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

PARENT'S SIGNATURE	FOR EXAMINER'S USE
	/40

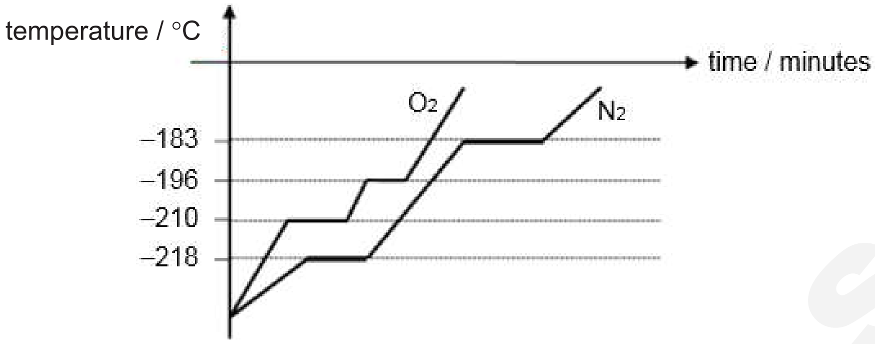
Setter: *Mdm Hia Soo Ching* *Vetter:* *Mr Elton Tan*

This question paper consists of 13 printed pages including this page.

Multiple Choice Questions [40 marks]

Answer **all** questions and shade your answers on the OMR sheet provided.

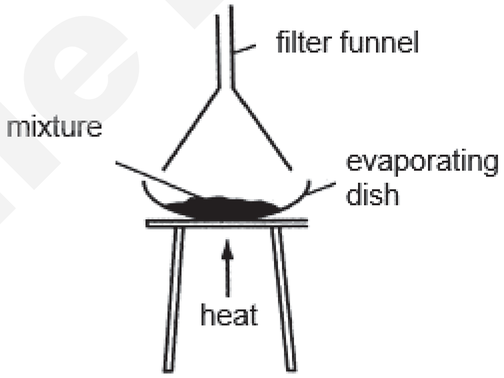
1 The graphs (not drawn to scale) show the heating curves of oxygen and nitrogen over a period of time.



Which of the following statements about a mixture of oxygen and nitrogen is correct?

A At -190°C, both oxygen and nitrogen exist as a liquid.
B At -200°C, both oxygen and nitrogen exist in the same state.
C At -215°C, both nitrogen and oxygen molecules are vibrating about fixed positions.
D At -185°C, both oxygen and nitrogen molecules move rapidly in all directions.

2 Refer to the following setup.



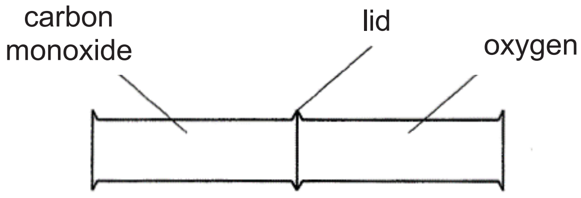
Which of the following mixtures can be separated into its components using this setup?

A ammonium chloride and iodine
B copper(II) sulfate and sodium chloride
C potassium iodide and copper(II) sulfate
D sodium chloride and ammonium chloride

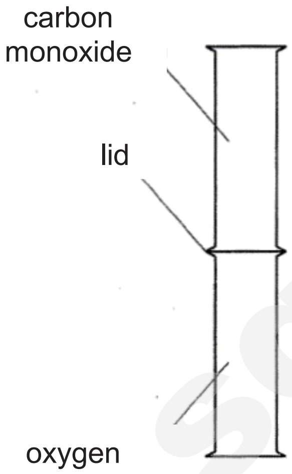
3 Which of the following substances does **not** contain atoms bonded to other atoms by four covalent bonds?

A graphite
B polypropene
C silicon dioxide
D terylene

4 The diagram shows the start of experiment 1 and 2 using gas jars of carbon monoxide and oxygen arranged in two different orientations.
All other conditions are kept constant.



experiment 1



experiment 2

The lids are removed and the gases are allowed to mix.
Which of the following observations would you expect for the experiments?

A The rate of oxygen diffusing is much faster than rate of carbon monoxide diffusing in both experiments.
B The rate of carbon monoxide diffusing is much faster in experiment 1 than in experiment 2.
C In experiment 2, the final concentration of carbon monoxide in the top jar will be less than its original concentration.
D The final concentration of carbon monoxide in the left jar in experiment 1 is the same as the final concentration of carbon monoxide in the top jar in experiment 2.

5 A salt, P, on warming with aqueous sodium hydroxide, showed no visible reaction. When aluminium powder was added, a gas that turned damp red litmus paper blue evolved. What is salt P?

A $Ca(NO_3)_2$
B KNO_3
C NH_4Cl
D NH_4NO_3

6 Tritium is an isotope of hydrogen and has the symbol T.
Which formula is **incorrect** for a tritium compound?

A CaOT
B NT_3
C TNO_3
D T_2O

7 Compound X contains two elements, metal Y and non-metal, Z.

X consists of a lattice of positive and negative ions. Each positive ion is surrounded by eight anions and each negative ion is surrounded by four cations.

What ions are present in, and what is the formula of, compound X?

	ions present	formula
A	$Y^+ Z^{2-}$	Y_2Z
B	$Y^{2+} Z^-$	YZ_2
C	$Z^+ Y^{2-}$	Z_2Y
D	$Z^{2+} Y^-$	ZY_2

8 Which of the following substances contain delocalised electrons?

1 iron
2 steel
3 diamond
4 graphite

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

9 Aqueous lead(II) nitrate can be distinguished from aqueous zinc nitrate by adding any of the following solution except

A aqueous potassium chloride.
B aqueous sodium sulfate.
C dilute sulfuric acid.
D sodium hydroxide solution.

10 5 g of element X reacted completely with 8 g of element Y to form a compound with the formula XY_2.
Given that the relative atomic mass of Y is 80, what is the relative atomic mass of X?

A $\frac{5}{13} \times 80 \times 2$

B $\frac{5}{13} \times 80 \times \frac{1}{2}$

C $5 \times \frac{8}{80} \times \frac{1}{2}$

D $5 \times \frac{80}{8} \times 2$

11 In an experiment, 8.0 cm^3 of 1.00 mol/dm^3 aqueous barium chloride was mixed with 8.0 cm^3 of 1.00 mol/dm^3 of aqueous silver nitrate.
Which of the following ions are present in the solution produced?

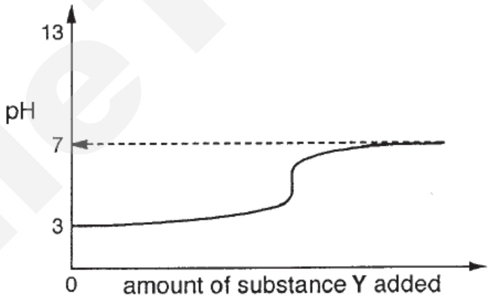
1 Ba^{2+}
2 Cl^-
3 Ag^+
4 NO_3-

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

12 Solutions P and Q were tested with a few drops of Universal Indicator.
Solution P turned the indicator red while solution Q turned the indicator yellow.
It can be deduced that

A Solution P has a higher pH than solution Q.
B Solution Q is more alkaline than solution P.
C Solution Q reacts with calcium carbonate to give carbon dioxide gas.
D The concentration of hydrogen ions in Q is higher than the concentration of hydrogen ions in solution P.

13 Substance Y was added bit by bit, with stirring, to aqueous solution Z.
The changes in pH of the mixture are shown in the graph.



What could Y and Z be?

	Y	Z
A	aluminium oxide	hydrochloric acid
B	calcium oxide	nitric acid
C	sodium oxide	ethanoic acid
D	zinc oxide	propanoic acid

14 An element burns in air to form a compound which does not react with both acids and alkalis.
Which element could it be?

A aluminium
B carbon
C iron
D phosphorus

15 Which of the following properties shows that a certain substance, M, is alkaline?

A Solution M dissolves copper(II) oxide.
B On adding dilute hydrochloric acid to solution M, carbon dioxide is given off.
C Solution M when warmed with aqueous ammonium chloride gives off ammonia gas.
D Solution M forms brown precipitate when reacted with iron(III) chloride solution.

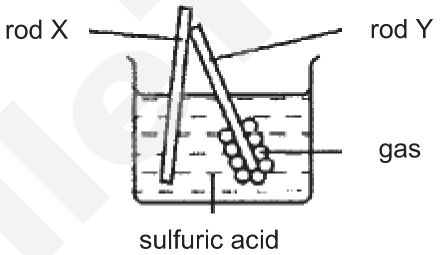
16 In which of the following experiments will a redox reaction occur?

A Adding nitric acid to aqueous ammonia.
B Adding copper turnings to aqueous silver nitrate.
C Adding chlorine water to aqueous potassium fluoride.
D Adding aqueous sodium hydroxide to aqueous copper(II) nitrate.

17 In which of the following does vanadium have the lowest oxidation number?

A V^{3+}
B VO^{2+}
C NH_4VO_3
D V_2O_5

18 In an experiment, two different metal rods, X and Y, were dipped in dilute sulfuric acid, with their top ends touching. A gas was collected around rod Y.



Which of the following can you conclude about this experiment?

A Electrons flow from rod Y to X.
B Rod X is more reactive than rod Y.
C Rod Y reacts with acid to produce hydrogen gas.
D Ions of Y can be found in the solution but not ions of X.

19 Which of the following reactions is **not** involved in the manufacture of iron from the blast furnace?

A Coke burns in air to form carbon dioxide.
B Acidic impurities are removed by calcium oxide.
C Limestone is decomposed to form calcium oxide.
D Haematite is reduced by carbon dioxide to form iron.

20 W, X, Y and Z are four metals which form cations W^+, X^{2+}, Y^+ and Z^{2+}.
The following are information on some of the reactions that the metals undergo.

$$X^{2+}(aq) + W(s) \rightarrow \text{no reaction}$$
$$Z^{2+}(aq) + 2W(s) \rightarrow 2W^+(aq) + Z(s)$$
$$Y_2CO_3(s) \xrightarrow{\text{heat}} \text{no reaction}$$
$$Z(s) + 2H^+(aq) \rightarrow Z^{2+}(aq) + H_2(g)$$

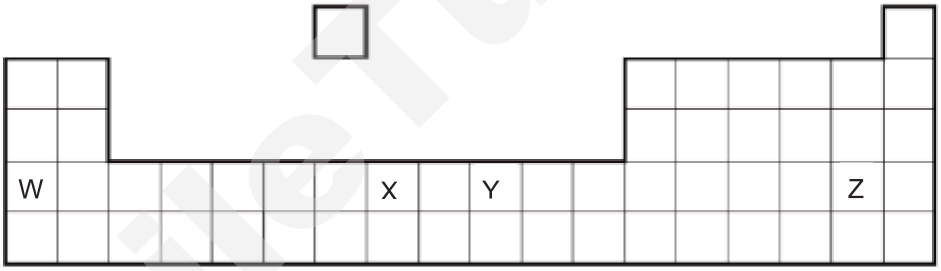
The order of decreasing reactivity of the metals are

A X, W, Z, Y.
B X, Y, Z, W.
C Y, X, W, Z.
D Z, W, X, Y.

21 Which of the following method is most likely used to extract an element with an electronic structure of 2.8.8.2?

A electrolysis of its aqueous chloride
B electrolysis of its molten ore
C reduction with carbon
D reduction with hydrogen

22 Part of the Periodic Table is shown below.



1 Elements W, X and Y have high melting points.
2 Y is less reactive than W.
3 Z can form both ionic and covalent compounds.
4 X and Y form compounds that are coloured.

Which of the following statements are correct?

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

23 Which statement is most likely to be true for astatine, which is in Group VII of the Periodic Table?

A Astatine is a stronger oxidising agent than chlorine.
B Astatine reacts with hydrogen to form a compound with formula HAt_2.
C Aqueous potassium astatide reacts with aqueous silver nitrate to form aqueous silver astatide.
D Sodium astatide is less stable than sodium chloride.

24 Which of the following reactions is endothermic?

A $2H \rightarrow H_2$
B $H_2O(l) \rightarrow H_2O(g)$
C $2H_2 + O_2 \rightarrow 2H_2O$
D $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

25 What are the effects of temperature of reactants and use of a catalyst on the activation energy and enthalpy change of a reaction?

	effect of temperature		effect of catalyst	
	activation energy	enthalpy change	activation energy	enthalpy change
A	decreases	no change	decreases	no change
B	decreases	decreases	no change	no change
C	no change	no change	decreases	no change
D	no change	no change	no change	no change

26 In the reaction between calcium carbonate and ethanoic acid, the following changes could be made to the conditions.

1 Increase the concentration of ethanoic acid
2 Increase the particle size of calcium carbonate.
3 Increase the temperature of the system.
4 Increase the pressure of the system.

What changes would increase the rate of reaction?

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

27 Refer to the following bond energy table.

bond	bond energy / kJ mol^{-1}
F - F	158
H - H	436
H - F	556

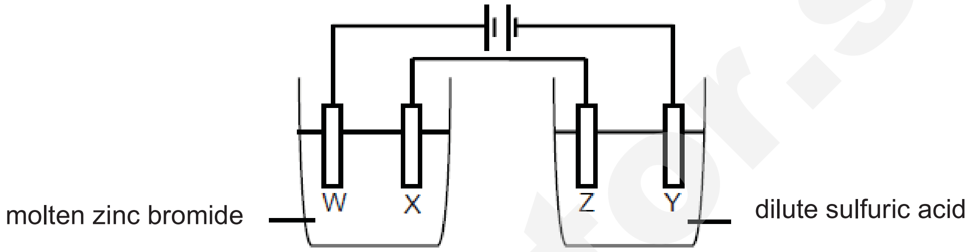
It can be deduced that

A the bonds in fluorine is the strongest.
B fluorine gas is more reactive than hydrogen gas.
C hydrogen fluoride molecules are the least stable.
D the energy produced when forming 1 mole of hydrogen fluoride molecules from its elements is 518 kJ.

28 Which statement is true for both simple and electrolytic cells.

	simple cell	electrolytic cell
A	It converts electrical energy into chemical energy.	It converts chemical energy into electrical energy.
B	Oxidation occurs at negative electrode.	Oxidation occurs at positive electrode
C	Electrons flow from the cathode to the anode.	Electrons flow from the cathode to the anode.
D	Mass of the anode will decrease.	Mass of the anode may increase.

29 Refer to the following electrolytic setup. All electrodes used are graphite.



What could be observed after a few minutes?

A A silvery solid is formed at electrode W.
B A red brown liquid is formed at electrode X.
C A pale yellow gas is formed at electrode Y.
D A colourless and odourless gas is formed at electrode Z.

30 In electroplating a silver spoon with copper, which combination of anode, cathode and electrolyte is the most suitable?

	anode	cathode	electrolyte
A	copper	silver spoon	copper(II) nitrate solution
B	copper	silver spoon	silver nitrate solution
C	silver spoon	copper	copper(II) nitrate solution
D	silver spoon	copper	silver nitrate solution

31 Some properties of substances P, Q, R and S are given in the table below.

substance	percentage composition by mass	electrical conductivity when solid	effect of heat
P	constant	yes	solid burns in air to form an oxide.
Q	varies	no	liquid burns to form carbon dioxide and water.
R	constant	no	solid decomposes to form two products.
S	varies	yes	solid melts

Which classification of the substances as an element, a mixture or a compound is correct?

	element	mixture	compound
A	P	S	Q, R
B	S	Q	P, R
C	R	S	P, Q
D	P	Q, S	R

32 Ammonium nitrate, NH_4NO_3, ammonium sulfate, $(NH_4)_2SO_4$, urea, $(NH_2)_2CO$ and ammonium phosphate, $(NH_4)_3PO_4$ are all fertilisers that can be produced from ammonia.

Which of these contains the most nitrogen per kilogram of fertiliser?

A ammonium nitrate
B ammonium sulfate
C ammonium phosphate
D urea

33 The Haber process is a reversible reaction as some of the ammonia formed is unstable as it decomposes readily back into its reactants.
Which of the following method is used to prevent this from happening?

A Adding water to dissolve ammonia.
B Cooling the mixture to liquefy ammonia.
C Filter the mixture to remove ammonia.
D Fractional distil the mixture to separate ammonia gas.

34 What is the volume of air required for a mixture of 20 cm^3 of methane and 40 cm^3 of carbon monoxide to burn completely?

A 60 cm^3
B 80 cm^3
C 300 cm^3
D 400 cm^3

35 Which of the following reagents could be used to distinguish between samples of ethanol and ethanoic acid?

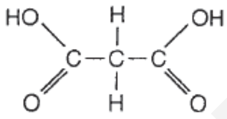
1 aqueous bromine
2 sodium carbonate
3 aqueous sodium chloride
4 litmus solution

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

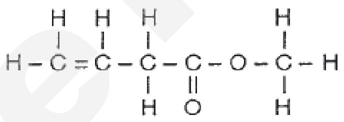
36 How does the number of carbon, hydrogen and oxygen atoms in an ester differ from the total number of carbon, hydrogen and oxygen atoms in the alcohol and carboxylic acid from which the ester was derived?

	carbon atoms	hydrogen atoms	oxygen atoms
A	same	same	same
B	less	same	less
C	same	less	less
D	less	less	less

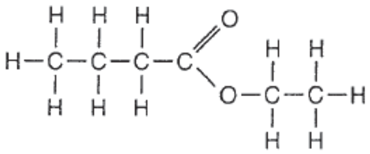
37 Which of the following tests can be used to distinguish the following organic compounds, **I**, **II** and **III** separately from each other.



I



II



III

test	1	Adding aqueous bromine.
	2	Adding powdered magnesium.
	3	Warming with acidified potassium manganate(VII).

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

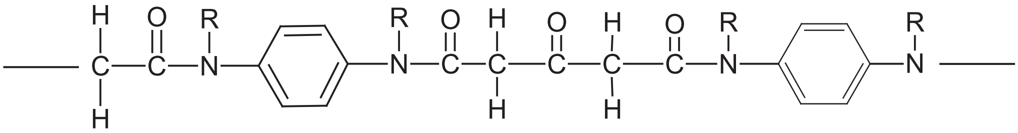
38 The chemical equation for a reaction is shown below.

$$CH_3COOH + Br_2 \rightleftharpoons CH_2BrCOOH + HBr$$

This reaction is an example of a/an

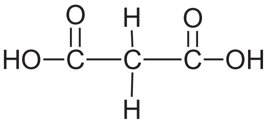
A addition reaction.
B condensation reaction.
C esterification reaction.
D substitution reaction.

39 A section of a polymer is shown below.



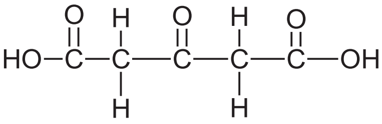
Which of the following shows a monomer involved in the formation of the above polymer?

A



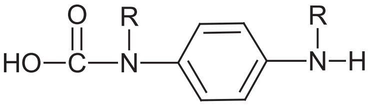
$HO-CO-CH_2-CO-OH$

B

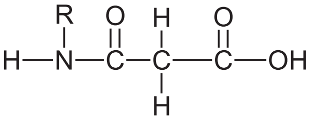


$HO-CO-CH_2-CO-CH_2-CO-OH$

C



D



$H-NR-CO-CH_2-CO-OH$

40 Three metal oxides each have the formula G_2O_3.
Which statements about these oxides are correct?

1 If the relative molecular mass for the oxide is 152, metal G is a transition element.

2 If the relative molecular mass for the oxide is 160, the oxide of metal G can react with both acid and alkali.

3 If the relative molecular mass for the oxide is 102, the oxide of G is formed when metal G reacts with steam.

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

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.).

Candidate Name: ____________________

Class	Index No.

FUHUA SECONDARY SCHOOL

Secondary Four Express

Preliminary Examinations 2019

4E

Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary
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CHEMISTRY

6092/02

Paper 2

28 August 2019
1115 – 1300
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces provided on top of this page.

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A (50 marks)
Answer **all** questions.
Write your answers in the spaces provided.

Section B (30 marks)
Answer all **three** questions, the last question is in the form of either/or.
Write your answers in the spaces provided.

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.

PARENT'S SIGNATURE

FOR EXAMINER'S USE		
Section A	Section B	**Total**
/50	**/30**	**/80**

Setter: *Mdm Hia Soo Ching*

Vetter: *Mr Elton Tan*

This question paper consists of 22 printed pages including this page.

Section A [50 marks]

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

A1 Table A1.1 shows sub-atomic particles found in particles, L to S. The letters are not the symbols of the elements.

particle	electrons	protons	neutrons
L	6	6	6
M	10	8	8
N	8	8	10
O	12	12	12
P	10	12	12
Q	13	13	13
R	1	1	1
S	13	13	14

Table A1.1

Use the letter(s) to answer the following questions.

(a) Which particle is an atom of oxygen?

______________________________ [1]

(b) Which particle will combine with oxygen atoms to form a compound that does **not** react with alkali and acid?

______________________________ [1]

(c) Which pair of particles are isotopes?

______________________________ [1]

(d) **(i)** Which pair of particles are found in a compound that can conduct electricity in aqueous and molten states?

______________________________ [1]

(ii) Draw a 'dot-and-cross' diagram for the compound in **(d)(i)**.
Show outer electrons only.

[2]

(e) Which particle is an atom of an element that can have oxidation states +1, 0 and -1? Explain your answer.

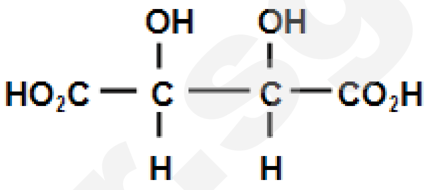
[2]

[Total: 8]

A2 Both phosphoric acid and tartaric acid are weak acids. The formulae of both acids are given as follows:

H_3PO_4

phosphoric acid



$HO_2C-\overset{OH}{\underset{H}{C}}-\overset{OH}{\underset{H}{C}}-CO_2H$

tartaric acid

(a) Describe a simple test that can be used to show that tartaric acid or phosphoric acid is a weak acid.

[1]

(b) Describe a chemical test to distinguish phosphoric acid from tartaric acid respectively.

[2]

(c) A solution of 0.200 mol/dm^3 potassium hydroxide was titrated against phosphoric acid and tartaric acid separately.

Deduce the ratio of the volume of potassium hydroxide used in titrating fixed volumes and concentrations of phosphoric acid and tartaric acid respectively.

[1]

(d) Tartaric acid and its salts have many applications. One such salt is copper(II) tartarate which is insoluble in water.
Describe how you will prepare a pure and dry sample of this salt in the laboratory,

____

____

____

____ [2]

(e) A 2.0 cm length of magnesium ribbon was added to 100 cm^3 of 2.00 mol/dm^3 phosphoric acid. All the magnesium reacted and the temperature of the acid increased by 6.0°C.

(i) Predict the temperature change when 1.0 cm length of magnesium ribbon was reacted with 100 cm^3 of 2.00 mol/dm^3 phosphoric acid.

____ [1]

(ii) Predict the temperature change when 2.0 cm length of magnesium ribbon was reacted with 100 cm^3 of 2.00 mol/dm^3 tartaric acid. Again, all the magnesium reacted. Explain your answer.

____

____

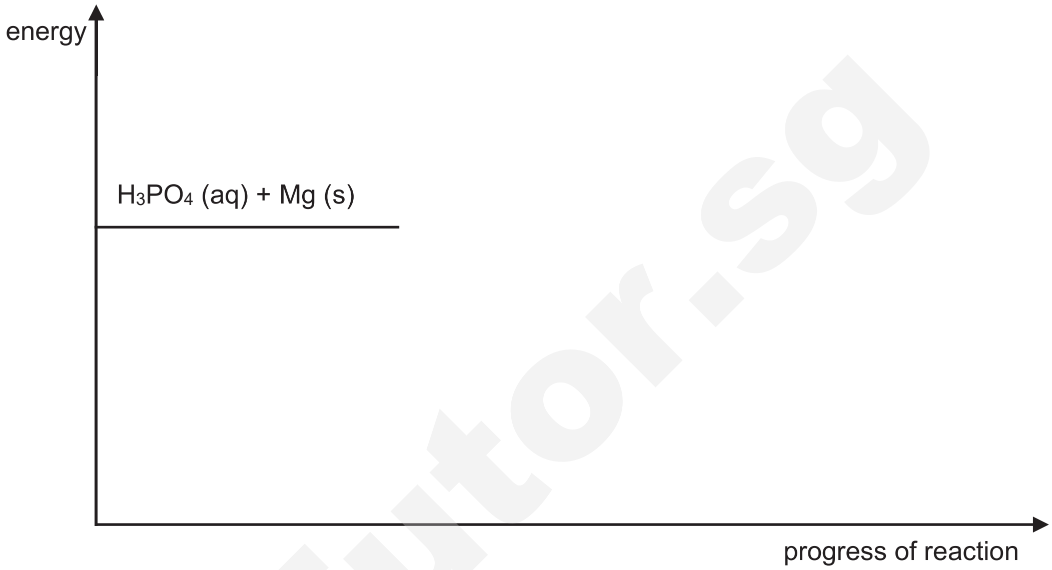
____

____ [3]

(iii) Complete the energy profile diagram for the reaction between magnesium ribbon and phosphoric acid.

Your diagram should include:

- the formulae of the products,
- the activation energy and
- a label for the enthalpy change of reaction.



[2]

[Total: 12]

A3 **(a)** Table A3.1 shows information about some organic compounds.
Complete the table by filling in the missing name, formulae and by completing the description of the processes.

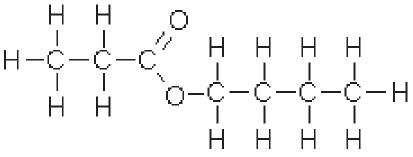
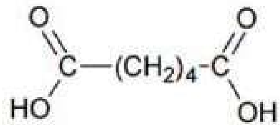
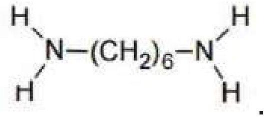
name of compound	**structural formula**	**process(es) used to produce the compound**
		Warming of ________________ and ______________________ with concentrated sulfuric acid.
propane		Catalytic ________________ ________________ to propene.
polybutene		________________________ of butene
nylon-6,6		________________________ of monomers  and  .

Table A3.1

[4]

(b) Alkyl halides are a homologous series of organic compounds. They are formed when one halogen atom (X = C*l*, Br, I) bonds with carbon atoms.

Table A3.2 shows the condensed formulae and boiling points of some alkyl halides.

condensed formula	**boiling point / °C**		
	X		
	C*l*	**Br**	**I**
CH_3X	-24.2	3.6	42.4
CH_3CH_2X	12.3	38.4	72.3
$CH_3CH_2CH_2X$	46.6	71.0	102.5
$CH_3CH_2CH_2CH_2X$	78.4	101.6	130.5

Table A3.2

(i) Besides having the same functional group, use the information in the table to give **two** other pieces of evidence that suggest that alkyl halides are a homologous series.

[2]

(ii) Describe and explain the trend in boiling points of alky halides when the halogen atom changes from C*l* to I.

[3]

(iii) Alkyl halides can be prepared by the reaction of halogen acids with alcohols. For example, hydrochloric acid reacts with methanol to produce methyl chloride and water.

Write an equation for the preparation **ethyl iodide**, showing the displayed formulae of all organic compounds.

[2]

[Total: 11]

A4 Three reactions take place in the catalytic converter installed in car exhaust systems.

1. Conversion of nitrogen oxides (NO, NO_2) into nitrogen.
2. Conversion of carbon monoxide into carbon dioxide.
3. Conversion of hydrocarbons into carbon dioxide and water.

The air/fuel ratio in the car engine affects the conversion efficiency of the catalytic converter. A 'lean' air/fuel mixture to the engine has a higher ratio of air to fuel while a 'rich' air/fuel mixture has a lower ratio of air to fuel.

Figure A4.1 gives the conversion efficiency of a converter based on air/fuel ratio.

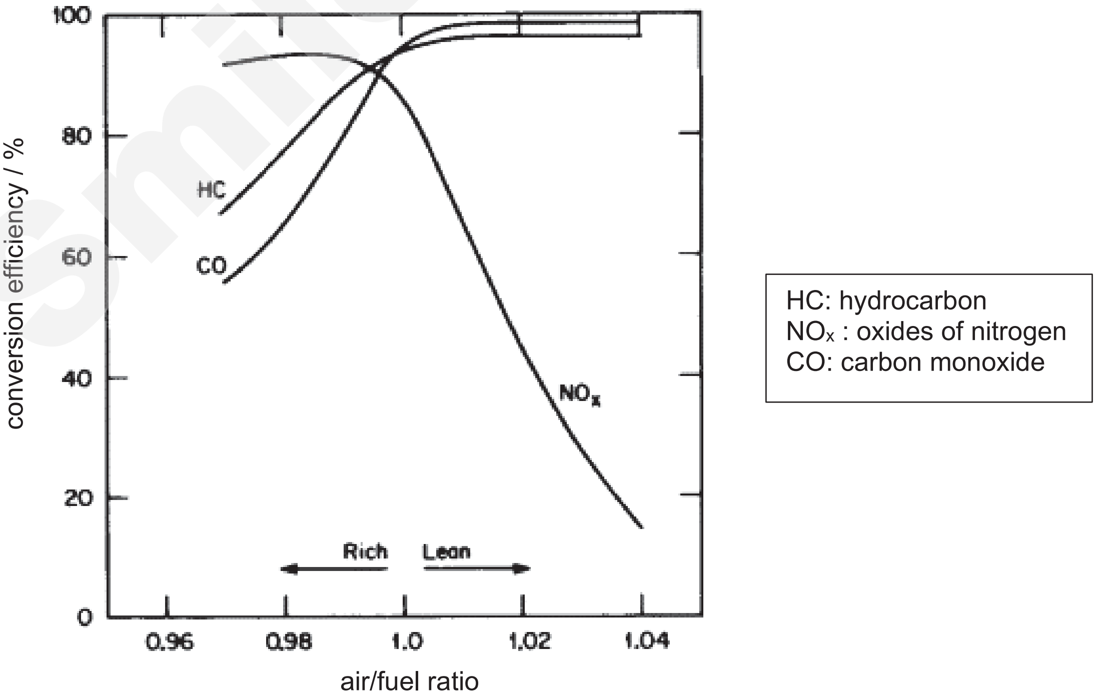


Figure A4.1

(a) Use oxidation states to explain whether reaction 1 and 2 involves oxidation and reduction.

[2]

(b) Describe and explain how does changing the air/fuel ratio from 'rich' to 'lean' affect the conversion efficiency of carbon monoxide, nitrogen monoxide and hydrocarbons in the catalytic converter.

[4]

(c) The exhaust gas from vehicles without catalytic converters cause more harm to human health than those from vehicles fitted with catalytic converters.
Explain why this is true.

[2]

[Total: 8]

A5 Figure A5.1 shows the structures of four solids, A to D.

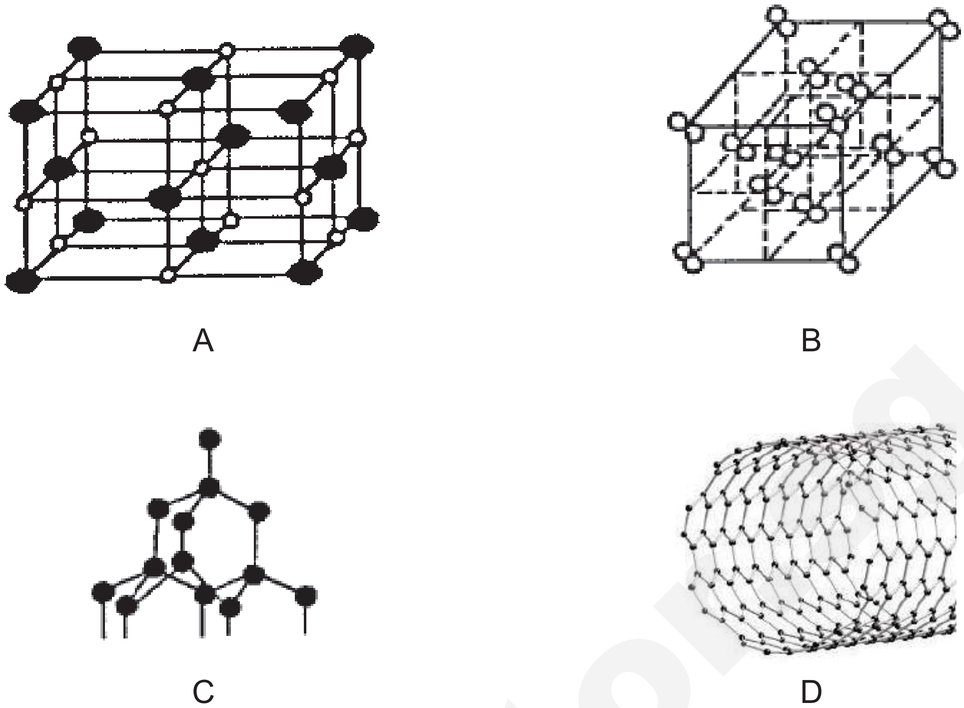

A B C D

Figure A5.1

Solid C and D are both allotropes of carbon.

(a) State one similarity and one difference in the structure and bonding of solids B and C.

[2]

(b) Compare the electrical conductivity of solids C and D.
Explain in terms of bonding and structure.

[2]

(c) Both copper(II) oxide and potassium chloride have similar structure as solid A. Explain why the melting point of copper(II) oxide is much higher than that of potassium chloride.

____

____

____

____ [2]

[Total: 6]

A6 Some samples of carbonates are heated strongly until there is no further change in mass. Table A6.1 shows the mass of solid remaining at the end of the heating.

carbonate	mass before heating / g	mass after heating / g
copper(II) carbonate	2.00	1.29
magnesium carbonate	2.00	0.95
sodium carbonate	2.00	?
zinc carbonate	2.00	1.30

Table A6.1

(a) Although each carbonate is fixed at 2.00 g, the mass of solid remaining is different. Explain why.

____

____ [2]

(b) State the mass of solid remaining when sodium carbonate is heated strongly.

____ [1]

(c) Pure metal can be extracted by further heating the mass of the solid remaining at the end of the reaction in Table A6.1 with dry hydrogen.
State the metal(s) that can be extracted. Write the chemical equation for one such reaction.

____

____ [2]

[Total: 5]

Section B: Free Response Questions [30 marks]

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 The Electrochemical Series

When electrodes of metallic and non-metallic elements in contact with their ions are arranged on the basis of the values of their **standard reduction potentials**, E°, the resulting series is called the **electrochemical series** of the elements.

The **standard reduction potential** of an element is the measure of the tendency of the element to get reduced by gaining electrons. All reduction potentials are measured against the standard hydrogen electrode which is the reference electrode.

The standard potential of any metal or non-metal is measured when in contact with aqueous solutions of their ions at a concentration of 1 mol/dm^3 and temperature of 25 °C. Any gases involved are maintained at a pressure of 1 atmosphere.

Figure B7.1 shows the setup to measure the standard reduction potential of copper. The Cu/Cu^{2+} half-cell is connected to the hydrogen half-cell.

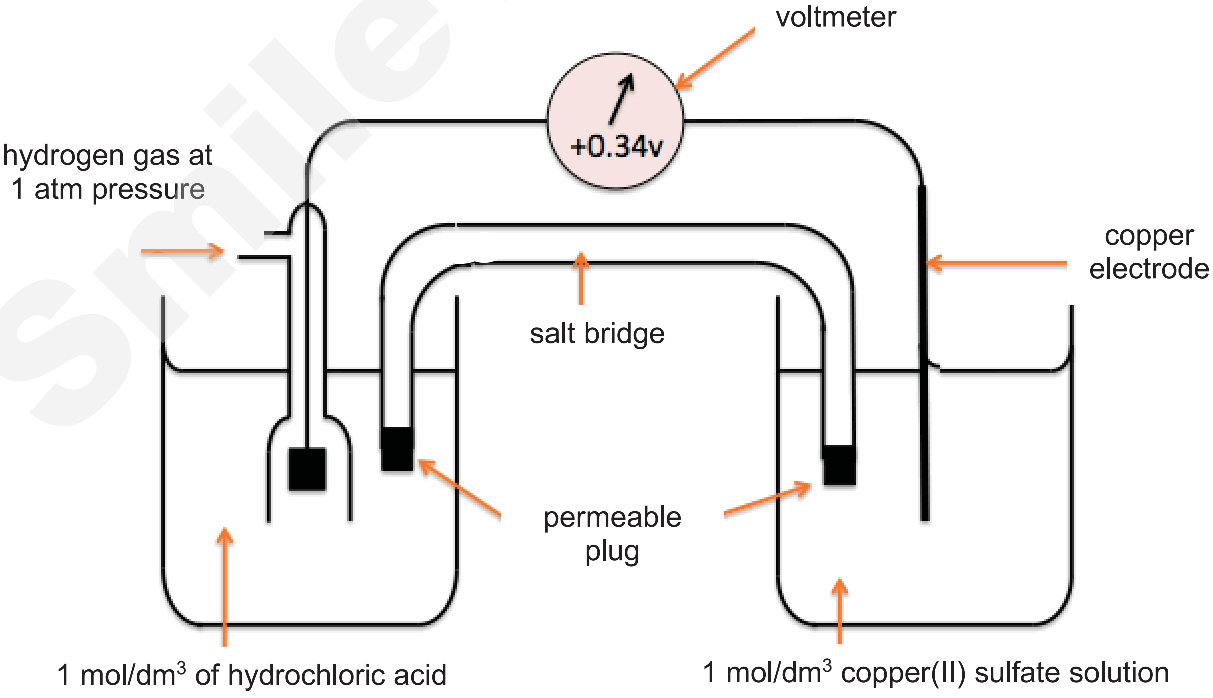


Figure B7.1

[*Source:* https://derekcarrsavvy-chemist.blogspot.com/]

By international convention, the standard potentials of electrodes are tabulated for reduction half reactions. Electrodes with positive E° values indicate the tendencies of the electrodes to gain electrons more readily and behave as cathodes.

Table B7.2 gives the standard reduction potential, E° of some elements.

element	electrode reaction	standard reduction potential, E° / V
Li	$Li^+ + e^- \rightarrow Li$	-3.05
K	$K^+ + e^- \rightarrow K$	-2.93
Na	…	-2.71
Zn	…	-0.76
Cr	$Cr^{3+} + 3e^- \rightarrow Cr$	-0.74
Fe	$Fe^{2+} + 2e^- \rightarrow Fe$	-0.44
Ni	$Ni^{2+} + 2e^- \rightarrow Ni$	-0.25
Sn	$Sn^{2+} + 2e^- \rightarrow Sn$	-0.14
H_2	$2H^+ + 2e^- \rightarrow H_2$	0.00
Cu	…	+0.34
I_2	…	+0.54
Ag	…	+0.80
Cl_2	…	+1.36
F_2	…	+2.87

Table B7.2

Predicting Displacement Reactions

The electrochemical series help us to predict whether displacement reactions can occur.

Metallic elements having lower reduction potential will lose electrons more readily and will displace elements having higher reduction potential from its salt solution. For example, zinc will displace copper from its salt solution because it has E° value of -0.76V while copper has E° value of +0.34V

On the contrary, non-metallic elements with higher reduction potential will displace other non-metallic elements with lower reduction potential.

For displacement of hydrogen from dilute acids by metals, the metal which can provide electrons to H^+ ions present in dilute acids for reduction, evolve hydrogen from dilute acids. Metals having negative values of reduction potential possess the property of losing electron(s).

Determining the Products of Electrolysis

In the event that two or more positive ions are present in the solution during electrolysis, the ion which is the stronger oxidising agent or has the higher value of standard reduction potential is discharged first at the cathode. For example, in a solution containing potassium and silver ions, silver ions are discharged first.

(a) It is difficult to set up the Na/Na^+ and K/K^+ half cells to measure their E° value and hence sometimes scientists have to conduct indirect experimental methods and perform calculations to estimate these values.
Explain why it is difficult to set up these half cells.

____

____ [1]

(b) **(i)** With reference to Table B7.2, construct the electrode equation for I_2.

____ [1]

(ii) Using the reaction between chlorine and aqueous solution containing iodide ions as an example, explain why '*non-metallic elements with higher reduction potential displace other non-metallic elements with lower reduction potential*'.

____

____

____ [1]

(c) Which of the following displacement reactions is likely to occur?
Put a tick (√) if a reaction is likely to occur.

	chromium	tin
aqueous solution of nickel(II) ions		
aqueous solution of iron(II) ions		
dilute nitric acid		

[2]

(d) Describe how the trend in reactivity of Group I and Group VII elements compare to their trends in standard reduction potentials as shown in Table B7.2.

____

____

____

____

____ [3]

(e) Complete the following table for the electrolysis of different aqueous solutions using platinum electrodes.

solutions	name of products of electrolysis that would be produced first		ionic equation for the reaction at each electrode
concentrated magnesium chloride	at negative electrode		
	at positive electrode		
mixture of aqueous silver nitrate and aqueous copper(II) chloride	at negative electrode		
	at positive electrode		

[4]

[Total:12]

B8 Nitrogen monoxide and hydrogen reacts at 400 °C according to the following equation.

$$2NO\ (g) + 2H_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g)$$

Different initial concentrations of nitrogen monoxide and hydrogen were used to investigate the rate of reaction. In each experiment, the initial rate of reaction was measured.

Table B8.1 shows the results obtained in each experiment.

experiment	initial concentration of NO / mol dm^{-3}	initial concentration of H_2 / mol dm^{-3}	initial rate of reaction / mol dm^{-3} s^{-1}
1	0.0060	0.0010	1.8×10^{-4}
2	0.0060	0.0020	3.6×10^{-4}
3	0.0010	0.0060	0.3×10^{-4}
4	0.0020	0.0060	1.2×10^{-4}
5	0.0040	0.0030	?

Table B8.1

(a) A student makes the following statement.

> Increasing the concentration of NO increases the rate of reaction to a greater extent than increasing the concentration of H_2.

Does the information in the table support the statement made by the student? Explain your reasoning.

____

____

____

____

____

____ [3]

(b) Experiment 5 was conducted using 0.0040 mol dm^{-3} of NO and 0.0030 mol dm^{-3} of H_2. Predict the initial rate of formation of N_2.

____ [1]

(c) Calculate the final volume of gases remaining in the reaction vessel when 20 cm^3 of NO reacted with 15 cm^3 of H_2 at 400 °C.
Show all working clearly.

[2]

(d) Explain, in terms of collisions between (reacting) particles, how operating at a lower temperature of 250 °C affects the rate of reaction in the reactor.

____

____

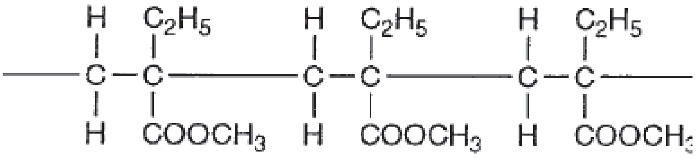
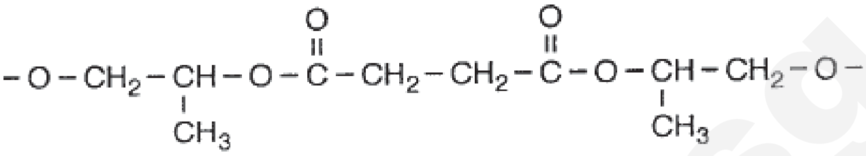
____

____ [2]

[Total: 8]

B9 ***Either***

The structures of two polymers X and Y are shown below.

polymer X	
polymer Y	

(a) A potential customer requires the chain length of the polymer X to be controlled so that the polymer molecules have an average relative molecular mass in the range of 20 000 to 50 000.

What is the range of the average number of repeat units in the polymer molecules? Show your working.

[2]

(b) **(i)** Draw the structural formulae of the monomers where polymer Y could be made from.

[2]

(ii) Calculate the mass of polymer Y produced when 1 kg of each of the monomers reacted.

[3]

(c) Describe three differences between polymer X and polymer Y.

____

____

____

____

____ [3]

[Total: 10]

B9 ***OR***

Figure B9.1 shows the Haber process.

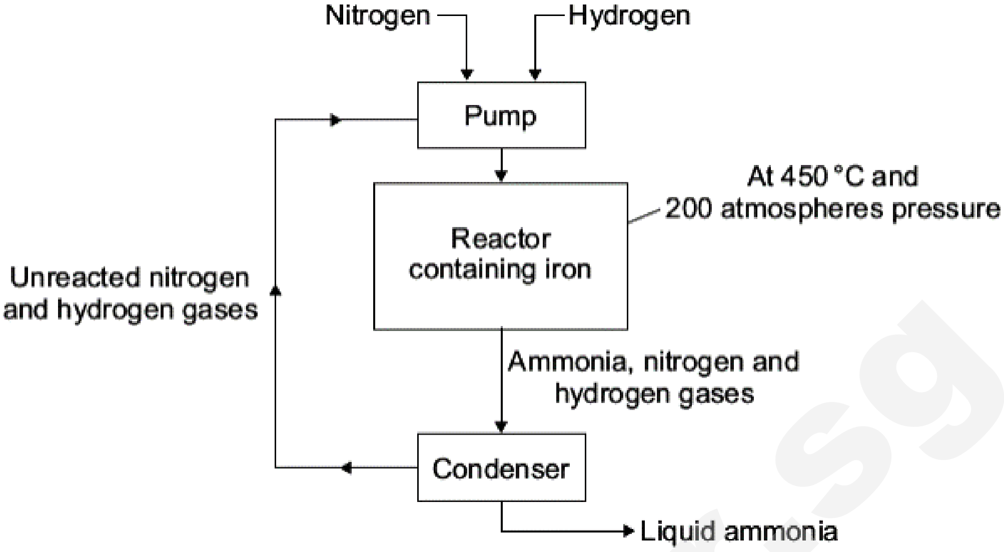


Figure B9.1

Figure B9.2 shows the yield of ammonia that is made under different conditions.

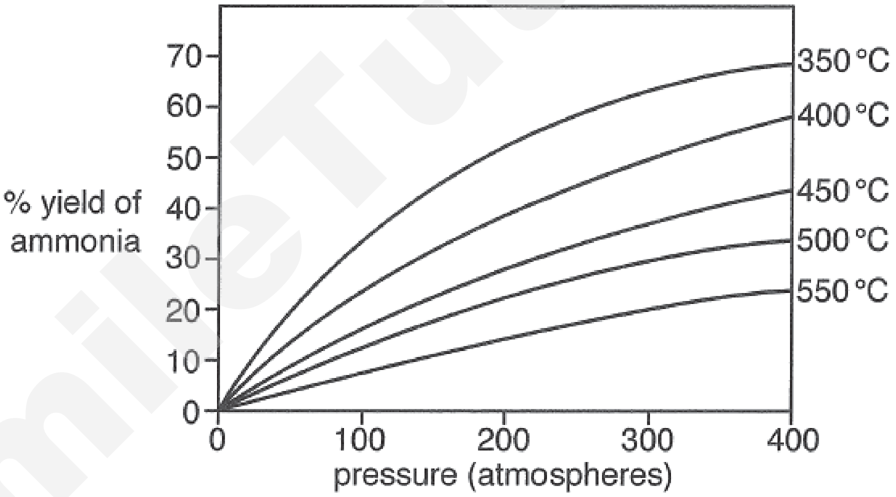


Figure B9.2

(a) In present times, the Haber process has been adapted to work at a lower temperature of 250 °C. Predict and explain how a lower temperature affects the relative amounts of ammonia, nitrogen and hydrogen that leaves the reactor.

____

____

____ [2]

(b) In the condenser, ammonia is separated out as a liquid. Explain how this is achieved.

____

____ [1]

(c) The percentage yield for the production of ammonia is typically low. Explain why.

____

____ [1]

(d) 60 dm^3 of nitrogen and 60 dm^3 of hydrogen were each pumped into the reactor The volume of ammonia produced was found to be 6 dm^3.
Calculate the percentage yield of ammonia for the reaction.

[2]

(e) Aqueous ammonia is formed when ammonia gas is dissolved in water. When aqueous ammonia is added dropwise until excess to a sample of contaminated water, a mixture of white and blue precipitate was formed initially. The resulting mixture was a dark blue solution.
State the formula(e) of the possible cations present in the water sample.

____ [2]

(f) Ammonium nitrate is a common fertiliser used by farmers. Rain water can wash ammonium nitrate off the farmland and into rivers and lakes. Ammonium nitrate in drinking water supplies is harmful to health.
Describe tests to identify the presence of ammonium nitrate in drinking water.

____

____

____

____ [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		**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 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* 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 T*l* 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 F*l* 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.).

2019 Preliminary Examination **Fuhua Secondary School**
Marking scheme for Secondary 4
CHEMISTRY 6092/1

Paper 1 (Multiple choice questions)

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

Paper 2 (Structured and Free Response)

A1 **(a)** N [1]

Comment incorrect answer is M. M is an ion and not an atom.

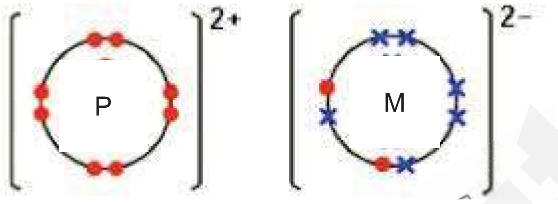
(b) L or R or L and R [1]

(c) Q and S [1]

(d) **(i)** P and M [1]

Badly done.
The particles found in the ionic compound must be ions.

(ii) [2]



ion of P [1]
ion of M [1]
Although (d)(i) is incorrect,
Accept $Mg^{2+}O^{2}$
Accept $O^{2+}N^{2-}$

(e) R.[1] [2]

Atom of H can gain 1 electron to form H^{-} [;] or
lose 1 electron to form H^{+} [;] to achieve stable electronic structure of a noble gas. Hence having oxidation state of -1 and +1. [1]
Atoms of H can be covalently bonded to form H_2 with an oxidation state of 0. [;]
3; [1]

Many scored only 1 m.
Accept because o.s of H is 0 in H_2, +1 in HC*l* and -1 in NaH.
Accept when H combine with metal, o.s. -1, combine with non-metal o.s. +1 and with itself o.s. 0.

A2 **(a)** Measure each sample of acid with a pH meter [1] [2]
If the pH reading ranges from 3 to 6, then it is a weak acid [1]

OR 2;[1]
Add a few drops of Universal Indicator to each sample.
Reject 'indicator'
Reject red

If the indicator changes to a yellow or orange colour, it is a weak acid.
'simple test' – reject use of chemical reagents. This is in the UCLES report.

(b) Warm each sample with acidified potassium manganate(VII). [1] [2]
All conditions to be mentioned such as 'warming/heating' , 'acidified'.

If acidified potassium manganate(VII) turned colourless, the sample is tartaric acid. If it remains purple, the sample is phosphoric acid. [1]

Badly done, many did not discover the presence of –OH group in tartaric acid.

Accept
- just one significant postitive observation for one sample.

- react with alcohol/carboxylic acid in presence of conc. sulfuric acid and warm and if sweet smell is detected, the sample is tartaric acid. OR

- react a fixed concentration and volume of each acid with a fixed mass of Mg of same particle size, measure the volume of gas given off in a fixed time. The sample that gives a larger volume of gas is phosphoric acid.

(c) volume ratio 3: 2 [1]

Badly done. There is a similar question in the alcohols worksheet.
Accept
- vol of tartaric acid : KOH = 1: 2, phoshoric acid : KOH = 1 : 3

(d) 1. Add aqueous sodium tartarate to a fixed volume of aqueous copper(II) nitrate in a beaker till no more precipitate is formed. [1] [2]
'aqueous' must be stated for ionic precipitation method

2. Filter the mixture to obtain copper(II) tartarate as a residue
3. Wash the residue with a little distilled water and pat dry between pieces of filter paper.
step 2 and 3 [1]

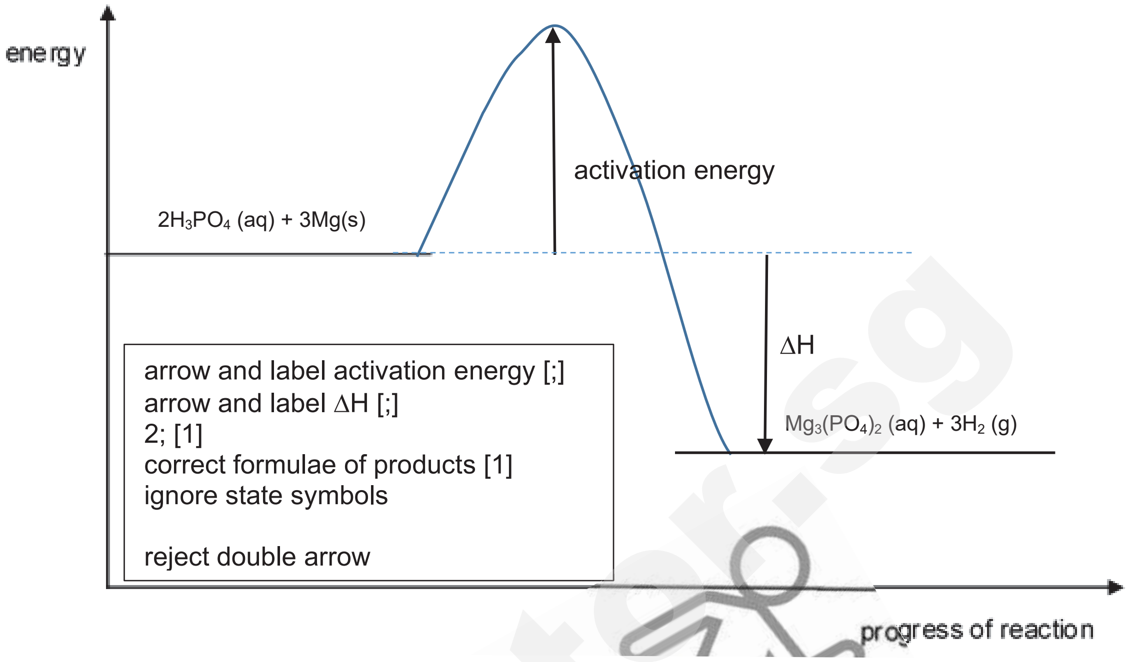
Accept
If step 1 or method is incorrect but step 2 and 3 correct, 1 m awarded.

(e) **(i)** 3.0°C [1] [1]

(ii) 6.0°C [1] [3]

Since the magnesium ribbon is the limiting reactant [1],
amount of heat energy given out is the same for 2.0 cm ribbon and phosphoric acid [1]

(iii)



arrow and label activation energy [;]
arrow and label ΔH [;]
2; [1]
correct formulae of products [1]
ignore state symbols

reject double arrow

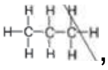
[2]

Accept if equation not balanced.

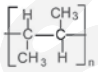
A handful still drew the profile for endothermic reaction
temperature of mixture increases → exo
some did not revise for this topic.

A3 **(a)** butyl propanoate, butanol, propanoic acid [1] [4]

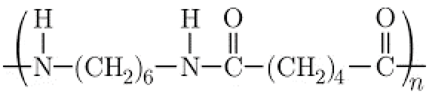
Common incorrect answer ‘butyl-propanoate’, ‘buthyl’


$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H$, addition of hydrogen [1]

Accept catalytic hydrogenation.


$\left[\overset{H}{\underset{CH_3}{C}}-\overset{CH_3}{\underset{H}{C}}\right]_n$, addition polymerisation [1]

Reject ‘additional polymerisation’


$\left(\overset{H}{N}-(CH_2)_6-\overset{H}{N}-\overset{O}{C}-(CH_2)_4-\overset{O}{C}\right)_n$, condensation polymerisation [1]

Common incomplete response left out ($)_n$

Award 1 m if structure correct but left out ($)_n$ for both polymers

(b) **(i)** Any two of the following: [2]

- Members have the same general formula $C_nH_{2n+1}X$
- There is gradual increase in boiling point as the number of carbon atoms increases
- Successive members differ from the next by a $–CH_2$ group.

Take note: If three evidences stated, and one is incorrect, it would negate a correct mark awarded. This is stated in UCLES report.

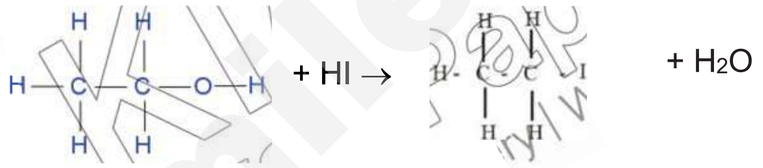
(ii) As the halogen atom changes from *Cl* to I, the boiling point of the alkyl halide increases. [1] [3]

The size of halogen atom increases from C*l* to I, <u>molecular mass / molecular size of alky halide increases</u> [1] and hence boiling point increases.

<u>Intermoleular forces of attraction between molecules increases</u> and <u>amount of energy taken in to overcome these forces increases</u> [1]

Many misconceptions:
- reactivity of halogen affect the boiling points of alkyl halides.
- break covalent bond between C-X
Note: ‘ akyl halides consist of molecules held by weak intermolecular forces of attraction’

(d) [2]



displayed formulae of organic compounds [1]
balanced equation and formulae of other chemicals [1]

A4 **(a)** The oxidation state of nitrogen decreases from +4 in NO_2 / +2 in NO to 0 in N_2. Hence conversion of NO_x to nitrogen involves reduction.[1] [2]

The oxidation state of carbon increases from +2 in CO to +4 in CO_2. Hence conversion of CO to CO_2 is involves oxidation. [1]

Omission of ‘increase/decrease’ only 1 mark awarded.
Focus of this question is on the conversion of NO_x in reaction 1 and CO in reaction 2.

(b) As the air/fuel ratio changes from rich to lean, the conversion efficiency of CO and HC increases but that of NO_x decreases. [1] [4]

As the air/fuel ratio changes from rich to lean, the amount of oxygen available to oxidise CO to CO_2 increases, [1]
amount of oxygen available to oxidise HC to CO_2 increases. [1]
lesser CO amount available to reduce NO and hence conversion of NO_x decreases [1]
Reject less incomplete combustion and hence lesser CO, this is catalytic converter and not internal combustion engine.

Badly done.

Reactions in the engine are not the same as reactions in the catalytic converter – refer to O levels 2015 B8.

Common misconceptions:
'Combustion of CO and HCs take place in catalytic converter.'
The reactions in the catalytic converter are redox and for CO and HCs are oxidation reactions.

(c) Any two health effects [2] [2]

- Nitrogen oxide causes respiratory problems/ irritate eyes and lungs
- Inhalation of carbon monoxide prevents haemoglobin from absorbing oxygen and may lead to suffocation / organ failure / headaches.
- Unburnt hydrocarbons cause cancer / carcinogenic

[NB: discuss effect of each gas separately]
Common mistakes:
NO_x cause respiratory problems but not breathing difficulties.
CO causes breathing difficulties but not respiratory problems.

Take Note: It is necessary to discuss the health effect of each gas separately. This is stated in the UCLES markers' report.

A5 **(a)** Similarity: [2]
In both B and C, the atoms are held by strong covalent bonds. [1]

Difference:
Any one of the two: [1]

- B has simple covalent structure while C has giant molecular structure.
- B consists of molecules held by weak intermolecular forces of attraction while C does not contain molecules and only atoms held by strong covalent bonds' .

Bonding remains the most important topic that candidates do not fare well in
Common misconception:
- 'B is ionic compound.' B has structure of solid iodine which has a simple covalent structure consisting of diatomic I_2 molecules held by weak intermolecular forces of attraction.

(b) C cannot conduct electricity while D conducts electricity [no mark given] [2]

In C, each carbon atom uses 4 out of 4 outer electrons to form covalent bonds and hence there are no mobile electrons [1]
Accept: each C atom uses all its valence electrons in bonding.
Reject: C has all valence electrons used in bonding with no mention of atoms at all. Question states both C and D are allotropes of carbon.
while in D, each carbon atom uses 3 out of 4 outer electrons to form covalent bonds, leaving one unused.These delocalised electrons conduct electricity. [1]

delocalised/mobile electrons must be mentioned in first or second point to get full credit.

The focus of this answer is on the 'valence electrons of each C atom'

But many candidates based their responses on each C atom is bonded to three / four other C atoms → meant for question involving hardness or m.pt.

Award 1 m although not in answer scheme
- In C, one C atom bonded to 4 other C and in D, each C atom bonded to 3 other C atoms.

(c) Cu^{2+} and O^{2-} have a higher charge than K^+ and Cl^-. [1] [2]
Reject CuO have a higher charge.

Stronger electrostatic forces of attraction between Cu^{2+} and O^{2-} ions
and hence larger amount of energy required to overcome these forces. [1]

A6 **(a)** The relative formula masses or M_r of the carbonates are different.[1] [2]

Hence the same mass of carbonate will produce different number of moles of carbon dioxide and hence different mass of carbon dioxide given off and thus varying decrease in mass [1]

Very badly done.

Common misconception:
- No such thing as 'reactivity of carbonates' – reactivity of metals and relate to thermal stability of the metal carbonates.
- Most did not explain how CO_2 produced leads to a decrease in mass of carbonate.

(b) 2.00 g [1] [1]
Badly done. Many did not understand sodium carbonate is not decomposed.

(c) Copper [1] [2]
$CuO + H_2 \rightarrow Cu + H_2O$ [1]

Accept
- copper(II) carbonate

Incorrect answers ~~are~~
copper, zinc, lead (lead carbonate not even an entry in the table.)
ZnO is not reduced by hydrogen.

B7 **(a)** Sodium and potassium are alkali metals which **react readily with water** in aqueous salt solution to form alkali and hydrogen gas.[1] [1]
Not possible for Na/K to remain as an electrode in aqueous **solutions** to measure potential difference.

Accept: react with oxygen in the air, react explosively causing hazard, which links to question of being difficult to set up the half cells

Reject: react with acid / only mention reactive but not linked to why it is difficult to set up half-cell.

(b) **(i)** $I_2 + 2e- \rightarrow 2I^-$ [1]

No state symbols required

Very few candidates scored this mark as many wrote the oxidation equation or placed electrons wrongly. Quite a number gave wrong charges for iodide such as I^+.

(b) (ii) Chlorine has a higher reduction potental than iodine AND and hence chlorine can displace iodine from its solution. / chlorine gains electrons more readily. [1]

Most candidates managed to score for this question.

(c) [2]

	chromium	tin
aqueous solution of nickel(II) ions	√	
aqueous solution of iron(II) ions	√	
dilute nitric acid	√	√

All 4 ticks [2], 2 ticks [1]

Relatively well answered part for B7.

(d) [3]

	reactivity	standard reduction potentials
Group I	**Reactivity increases from Li to K / down the group** which indicates the tendency to lose electrons increases from Li to K. [;]	**Standard reduction potential increases from Li to Na then decreases from Na to K** which indicates Li lose electrons more easily than K and Na.[1]
Group VII	**Reactivity decreases from F_2 to I_2 / down the group** which indicates the tendency to gain electrons decreases from F_2 to I_2 [;] 2;[1]	**Standard reduction potential decreases from F_2 to I_2,** indicating the tendency to gain electrons decreases from F_2 to I_2 [1] Accept comparison between 2 halogens.

[1] for reactivity trend in group I and group VII.
[1] for reduction potential trend in group I
[1] for reduction potential trend in group VII

Many candidates lost marks because they did not mention about the trend in reactivity in the group or link the reactivity with the elements. Majority of candidates did not managed to identify the decrease in reduction potential from Na to K.

[1] for correct trend of group VII reduction potential without mention of elements. Eg. As the elements get more reactive in group VII, reduction potential increases.

(e) [4]

solutions	name of products of electrolysis that would be produced first		ionic equation for the reaction at each electrode
concentrated magnesium chloride	at negative electrode	hydrogen	$2H^+(aq) + 2e^- \rightarrow H_2(g)$
	at positive electrode	chlorine	$2Cl^-(aq) \rightarrow Cl_2\ (g) + 2e^-$
mixture of dilute silver nitrate and copper(II) chloride	at negative electrode	silver	$Ag^+(aq) + e^- \rightarrow Ag(s)$
	at positive electrode	oxygen and water	$4OH^-(aq)$ $\rightarrow 2H_2O(l) + O_2\ (g) + 4e^-$

2 correct blanks [1]
ecf [2] for eqn given if products at electrodes are mixed up.

Common mistakes include wrong products at the electrode, giving formula rather than name as stated in question, writing ionic equation without state symbols or balancing the equation wrongly. Candidates must take note that silver ion is Ag^+ not Ag^{2+}

B8 **(a)** Agree. Increasing concentration of NO increases the rate to a greater extent than increasing the concentration of H_2. [3]

Comparing experiment 1 and 2 where concentration of NO was kept constant at 0.0060 mol dm^{-3} , increasing the concentration of H_2 by a factor of 2 from 0.0010 to 0.0020 mol dm^{-3} increases the rate of reaction by a factor of 2 from 1.8 × 10^{-4} to 3.6. × 10^{-4} mol dm^{-3}s^{-1}.

Comparing experiment 3 and 4 where concentration of H_2.was kept constant at 0.0060 mol dm^{-3} , increasing the concentration of NO by a factor of 2 from 0.0010 to 0.0020 mol dm^{-3} increases the rate of reaction by a factor of 4 from 0.3 × 10^{-4} to 1.2. × 10^{-4} mol dm^{-3}s^{-1}.

Many candidates interpreted the data wrongly by comparing the increase in rate of reaction when concentration of NO and H_2 was changed, rather than comparing the number of times the concentration changed.
[1] given quoting data correctly.

[1] for wrong interpretation of data (increase of 1.8 x 10^{-4} mol dm^{-3} s^{-1} from expt 1 to expt 2, is more than increase of 0.9 x 10^{-4} mol dm^{-3} s^{-1} from expt 3 to expt 4) but able to quote correct data.

(b) 2.4 × 10^{-4} mol dm^{-3}s^{-1}. [1]
Badly done, not many candidates are able to state the rate. Many did not include units but were not penalised.

(c) Molar volume ratio of H_2 (g) : N_2 (g) + H_2O (g) = 2 : 3 [2]
Therefore volume of N_2 (g) + $2H_2O$ (g) produced = 3/2 × 15 = 22.5 cm^3 [1]
unreacted NO = 5 cm^3
Volume of gases remaining = 27.5 cm^3 [1]
Many candidates did not take into account unreacted NO.
A few used wrong methods to calculate the mole of gas.

(d) At lower temperature, the reacting **NO and H_2 molecules** have **less kinetic energy** and move slower / collide less frequently [;] [2]
Less reacting molecules collide with **energy more than or equal to the activation energy** [;]
Hence the frequency of **effective collisions** between NO and H_2 decreases[;]
3; [2]
Many candidates did not make reference to the specific reactant particles and majority did not mention the point about activaion energy.

[1] decreased number of effective collisions between NO and H_2
[1] decrease KE/move slower and lesser number of particles with energy greater than/equal to activation energy.

B9E (a) More popular of the B9 questions. Most did relatively well. [2]

Mr of repeat unit = 114
When M_r = 20 000, number of repeating units
= 20 000/114 [1]
= 175.43 = 176 [**round up**] [;]

When Mr = 50 000, number of repeating units
= 50 000/114
= 438.596 = 438 [**round down**] [;]

Therefore, the range of the average number of repeating units is between 176 and 438 [1] inclusive.

Wrong Mr but correct rounding, ecf [1]
Most are able to calculate correctly.

(b) (i) $HOOCCH_2CH_2COOH$ [1] [2]
and
$HOCH(CH_3)CH_2OH$ [1]
Well answered

(b) **(ii)** M_r of dicarboxylic acid ($C_4H_6O_4$) = 118 [3]
M_r of diol ($C_3H_8O_2$) = 76
No of moles of dicarboxlic acid = 1000/118 = 8.47458
No of moles of diol = 1000/76 = 13.1579

Dicarboxylic acid is limiting. [1]

No of moles of polymer = 8.47458 [1]

Mass of polymer produced = 8.47458 × (158) [Mr of 1 repeat unit]
= 1338.9 g = 1.39 kg [1] (3sf)
Many candidates did not take into account the loss of water in calculating Mr.
-1 for sf

(c) Any three of the following [3]

Polymer X	**Polymer Y**
Formed by joining of unsaturated monomers/ monomers containing C=C carbon covalent bonds	Formed by joining monomers with two different functional groups present such as –COOH and –NH_2 or -OH.
Polymer has C-C linkage	Polymer has ester linkage.
Addition polymer is formed from joining of monomers without losing of any molecules or atoms	Condensation polymer is formed from joining of monomers with losing of atoms or small molecules eg. water
Empirical formula of polymer and monomer are same.	Empirical formula of polymer is different from that of the monomer.

Accept: X is made up of 1 type of monomer, Y is made up of 2 types of monomers
X is formed by addition polymerisation, Y by condensation polymerisation.
Repeating unit of X has 6 carbon atoms, repeating unit of Y has 7 carbon atoms.

Reject: polymer X undergoes addition polymerisation.
Y has sweet smell, X has no sweet smell.
X has no linkage.

B9 OR **(a)** According to the graph, as the temperature decreases, a higher percentage yield of ammonia is obtained.[1] [2]
This would result in a increase in the amount of ammonia that leaves the main reactor and an decrease in the amount of unreacted hydrogen and nitrogen.[1]

Some students did not mention that yield of ammonia will increase.

(b) By maintaing the condenser temperature to be lower than the boiling point of ammonia but higher than boiling points of nitrogen and hydrogen. / Ammonia has a higher boiling point than nitrogen and hydrogen hence will condense first when cooled. [1]

Many candidates wrote fractional distillation.

(c) The reaction of nitrogen and hydrogen to profuce ammonia is a **reversible** reaction and some ammonia produced is **decomposed/converted back** to form the reactants. [1]

Reject: turn back

(d) Molar volume ration of N_2 : H_2 : NH_3 = 1: 3 : 2 [2]
Since H_2 is limiting, theoretical volume of ammonia produced = 2/3 × 60 = 40 dm^3 [1]
Percentage yield of ammonia = 6/40 × 100% = 15% [1]

(e) Zn^{2+}, Cu^{2+} [2]
Most candidates able to identify Cu^{2+}

(f) Add aqueous sodium hydroxide to a sample of water and warm the mixture. [2]
If a pungent and colourless gas that turned moist red litmus blue is produced, then ammonium ion is present [1]
Add aqueous sodium hydroxide, Al foil and warm the mixture.
If a pungent and colourless gas that turned moist red litmus blue is produced, then nitrate ion is present [1]
Majority of candidates did not mention this part well, and only added sodium hydroxide and confirmed identity without aluminium foil, showing poor knowledge of test for nitrates.
Some candidates used indicator.

Geylang Methodist School (Secondary)
Preliminary Examination 2019

CHEMISTRY **6092/01**

Paper 1 Multiple Choice **Sec 4 Express**

Additional materials : OAS **1 hour**

Setter : Mr Jeryl Goh **16 September 2019**

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 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 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 paper.
A copy of the Periodic Table is printed on page 14.

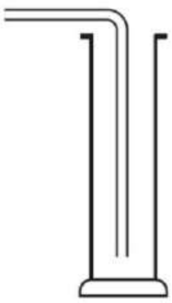
This document consists of **14** printed pages.

[Turn over

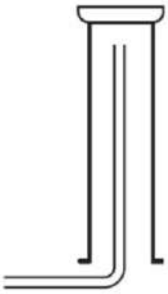
1 In an experiment, a student reacts hydrochloric acid with magnesium ribbons and wants to collect and measure the amount of gas produced at 30-second intervals.

Which apparatus is most suitable for collecting the gas produced?

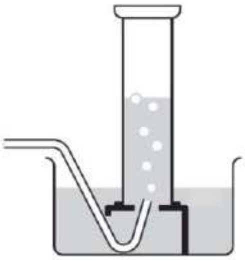
A



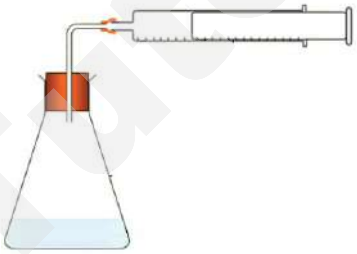
B



C



D



2 Mary performed paper chromatography on a dye and obtained only one spot with an R_f value of 0.68.

Which of the following statements is true about her chromatogram?

A Changing the solvent will not affect the R_f value.
B Using a more concentrated dye solution will increase the R_f value.
C The dye is likely to be a pure substance.
D The spot is closer to the starting line than it is to the solvent front.

3 In which of the following solid mixtures can the underlined substance be obtained by adding water, stirring and filtering?

A mixture of iron and <u>iron(II) chloride</u>
B mixture of <u>lithium</u> and copper(II) sulfate
C mixture of sand and <u>iron</u>
D mixture of <u>sodium chloride</u> and sodium hydroxide

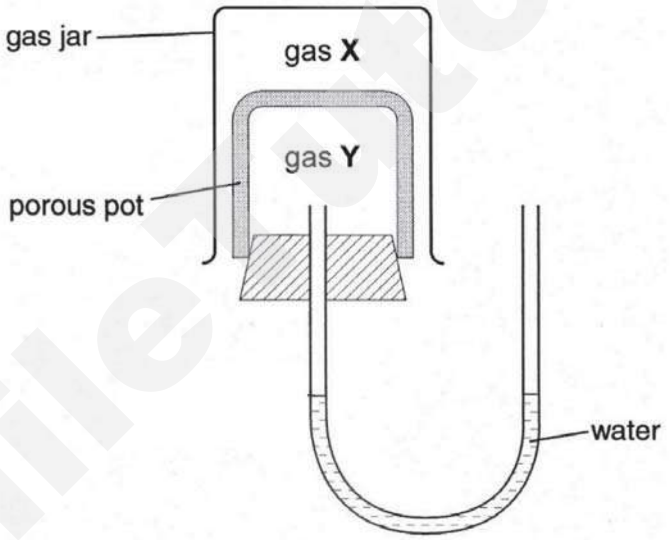
4 A series of chemical tests performed on an unknown solution produced the following results.

test	observation
add aqueous sodium hydroxide, warm gently	effervescence produced
add acidified barium nitrate	white precipitate formed, no effervescence produced

Which of the following substance could be present in the solution?

A ammonium carbonate
B ammonium sulfate
C calcium sulfate
D sodium hydrogencarbonate

5 The following apparatus was set up as shown below.



Which of the following pair of gases X and Y will result in no movement of the water in the U-shaped tube?

	gas X	gas Y
A	H_2	He
B	N_2	CO
C	O_2	CH_4
D	SO_2	NO_2

6 Which of the following groups of substances contain an element, a compound and a mixture?

A brass, rust, haematite
B diamond, graphite, air
C ozone, cast iron, slag
D silica, diamond, petrol

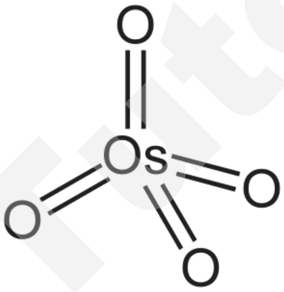
7 The following table lists the atomic structure of three particles W, X, Y and Z.

particle	proton	electron	neutron
W	7	10	7
X	7	7	8
Y	7	10	8
Z	8	8	8

Which two particles are isotopes of each other?

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

8 Osmium tetroxide has the structural formula as shown.



What is the valency of osmium?

A 4
B 8
C 12
D 16

9 Which of the following statements explains why copper conducts electricity?

A Copper atoms are held together by weak intermolecular forces.
B Copper has free moving atoms.
C Copper has free moving electrons.
D Copper has free moving ions.

10 How many oxygen atoms are there in 0.05 moles of ozone gas?

A 3×10^{22}
B 3×10^{23}
C 9×10^{22}
D 9×10^{23}

11 In a titration, 26.4 cm^3 of 0.2 mol/dm^3 calcium hydroxide was required to completely neutralize 19.0 cm^3 of hydrochloric acid.

What is the concentration of the acid used?

A 0.28 mol/dm^3
B 0.36 mol/dm^3
C 0.56 mol/dm^3
D 0.84 mol/dm^3

12 A 5.0 g sample of a mixture of sand and calcium carbonate was heated strongly in an open flask until there was no further change in mass.

Determine the percentage calcium carbonate in the mixture if the final recorded mass was 4.2 g.

A 36%
B 52%
C 72%
D 84%

13 Which of the following properties increases down the group in Group I?

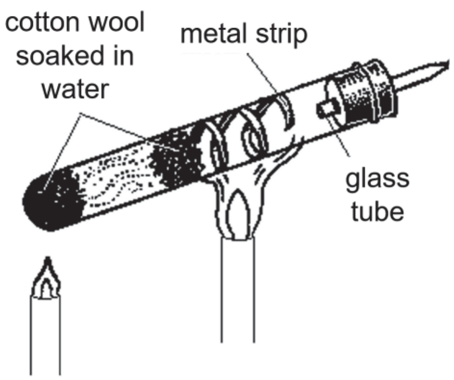
A ease of losing an electron
B ionic charge
C melting point
D non-metallic character

14 A new halogen discovered, X, forms a compound with potassium with the formula KX. A solution of KX was found to be displaced by iodine.

Which of the following most likely describes the appearance and physical state of X_2?

A a dark coloured liquid
B a dark coloured solid
C a pale coloured liquid
D a pale coloured solid

15 In the experiment shown below, a strip of metal was heated in a test-tube. When a spark was created at the outlet of the glass tube, no flame was observed.



Which of the following metal could be in the test-tube?

A calcium
B magnesium
C tin
D zinc

16 When nickel is placed in copper(II) nitrate solution, the solution gradually turns green.

Which statement is true about the reaction?

A Copper atoms gain electrons.
B Copper ions gain electrons.
C Nickel atoms gain electrons.
D Nickel ions gain electrons.

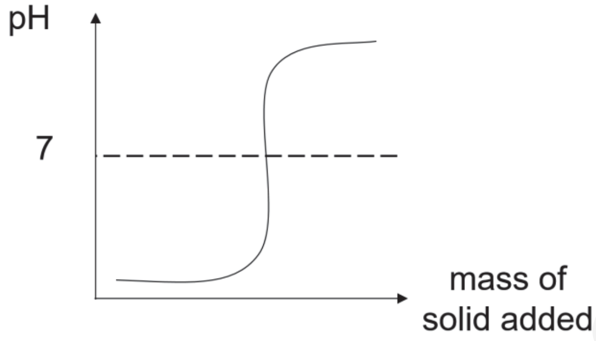
17 Which of the following reactions does **not** occur in the extraction of iron in the blast furnace?

A $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
B $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
C $CaCO_3 + 2NO_2 \rightarrow Ca(NO_3)_2 + CO_2$
D $C + CO_2 \rightarrow 2CO$

18 What ions are present in dilute aqueous ammonia?

A H^+ and OH^-
B NH_4^+, H^+, Cl^-, OH^-
C NH_4^+, H^+, OH^-
D NH_4^+, OH^-

19 A solid was added, bit by bit, to a solution of hydrochloric acid. The graph below shows the change in pH.



What could the solid be?

- **A** Li_2O
- **B** MgO
- **C** P_4O_{10}
- **D** SiO_2

20 A student wants to prepare crystals of zinc chloride.

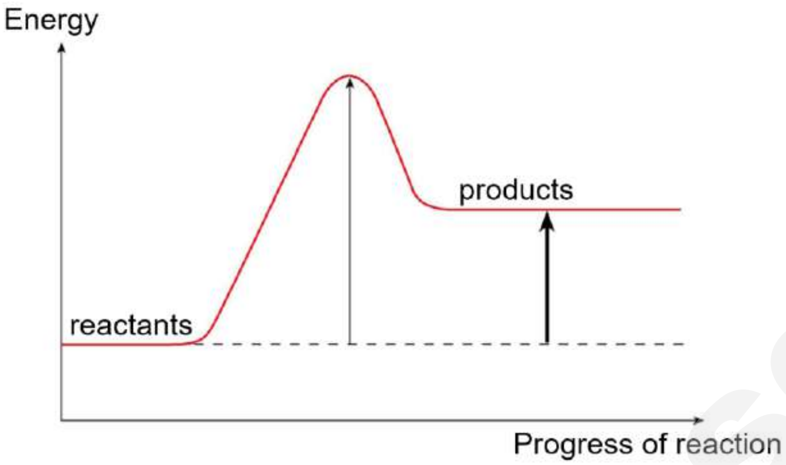
Which method is most suitable for this preparation?

- **A** displacement of magnesium chloride by zinc
- **B** neutralization between zinc oxide and hydrochloric acid
- **C** precipitation from zinc nitrate and sodium chloride
- **D** titration of zinc hydroxide and hydrochloric acid

21 Which compound will likely be the best plant fertilizer?

- **A** aluminium nitrate
- **B** ammonium nitrate
- **C** ammonium chloride
- **D** sodium nitrate

22



Which of the following reactions could have the above energy profile?

A $CuCO_3$ (s) → CuO (s) + CO_2 (g)
B 2NaOH (aq) + H_2SO_4 (aq) → Na_2SO_4 (aq) + $2H_2O$ (*l*)
C CH_4 (g) + $2O_2$ (g) → CO_2 (g) + $2H_2O$ (g)
D H_2O (g) → H_2O (*l*)

23 Which of the following statements best explains why sodium reacts spontaneously with water?

A Plenty of heat energy is given out during the reaction.
B Sodium atoms are exceptionally energetic.
C The activation energy of the reaction is small.
D The bonds in the products are very strong.

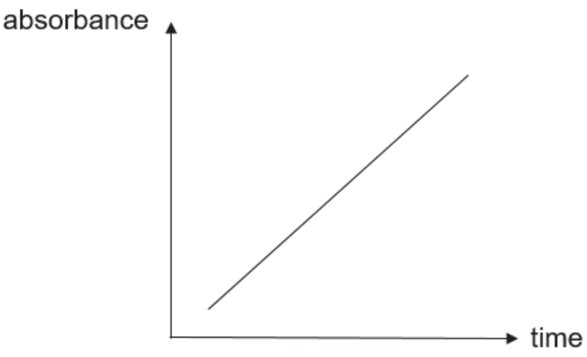
24 How will the addition of a catalyst affect the energy of particles and the activation energy of the reaction?

	energy of particles	activation energy
A	increases	decreases
B	increases	remains the same
C	remains the same	decreases
D	remains the same	remains the same

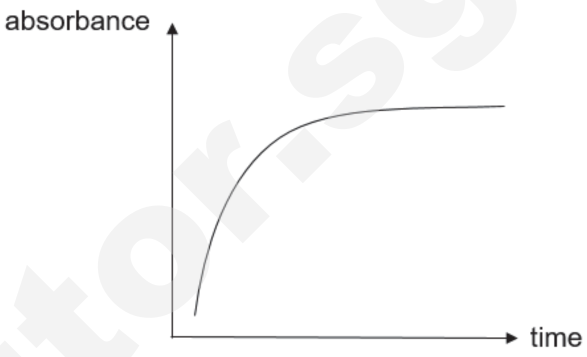
25 Octene (C_8H_{16}) is able to absorb UV light. The Beer-Lambert Law states that the amount of UV light absorbed is proportional to the concentration of the compound present. In one experiment, bromine water was added dropwise until in excess to a solution of octene and the absorbance of UV light by the mixture was tracked over time.

Which of the following graphs represents how the absorbance of UV light changes over time?

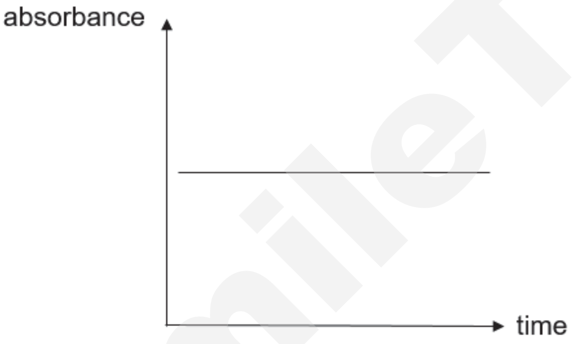
A



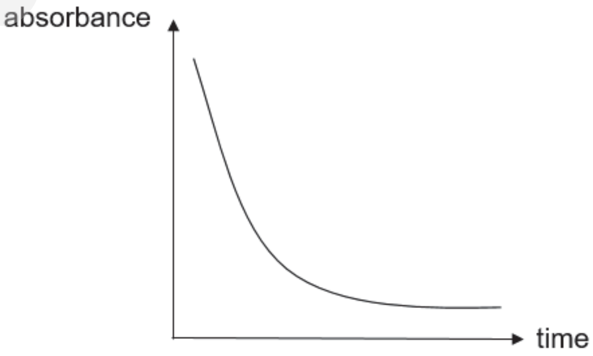
B



C



D



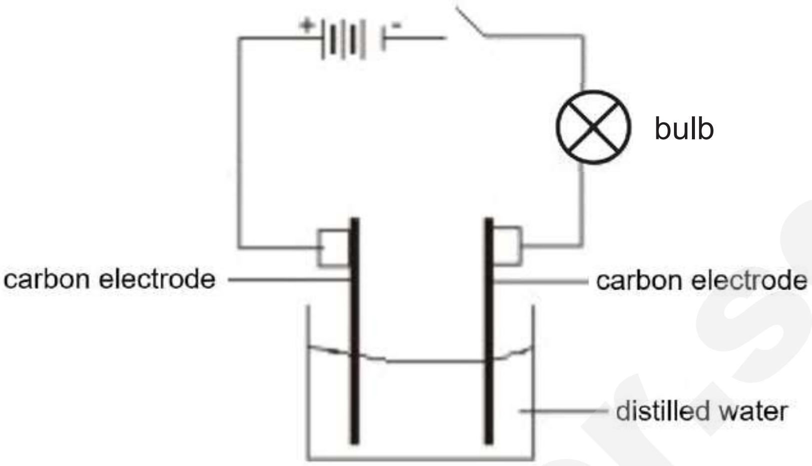
26 Which of the following correctly identifies the oxidation state of the underlined element?

	substance	oxidation state
A	$\underline{Cu}_2O$	+2
B	$H_2\underline{S}O_3$	+4
C	$K\underline{Br}O_3$	+6
D	$P_4\underline{O}_{10}$	+5

27 Which of the following does **not** show a redox reaction?

A $C + CO_2 \rightarrow 2CO$
B $Fe + H_2O \rightarrow FeO + H_2$
C $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$
D $Zn + FeSO_4 \rightarrow ZnSO_4 + Fe$

28 The diagram below shows an electrolytic cell. Initially, the bulb does not light up when the switch is closed.



Which of the following substances, when added, will cause the bulb to be the brightest?

A ethanoic acid
B magnesium carbonate
C sodium hydroxide
D sugar

29 Concentrated hydrochloric acid was electrolysed using inert electrodes.

Which of the following best describes how the pH of the electrolyte changes in the first five minutes?

A increases
B decreases
C remains constant at pH 1
D remains constant at pH 7

30 Three electric cells are set up using zinc metal and three unknown metals, U, V and W as electrodes.

The potential differences between the metals are given in the table below.

electric cell	metals used	voltage / V	positive electrode
1	Zn, U	–0.45	Zn
2	Zn, V	+2.71	V
3	Zn, W	+1.11	W

From these results, deduce which arrangement correctly lists the metals in the order of **decreasing** reactivity.

A U, Zn, V, W
B U, Zn, W, V
C V, W, Zn, U
D V, Zn, W, U

31 Which statement best explains why carbon monoxide is harmful?

A It causes acid rain.
B It combines strongly with haemoglobin.
C It contributes to global warming.
D It irritates the eyes and lungs.

32 Which molecule has the greatest ozone-depleting potential?

A $CFClBr$
B $CFCl_3$
C CF_3Cl
D CH_2F_2

33 Which of the following is true about kerosene?

A Kerosene has a lower viscosity than petrol.
B Molecules of kerosene are larger than those in naphtha.
C Molecules in kerosene are used to make petrochemicals.
D Molecules of kerosene burn with a smokier flame than those in diesel.

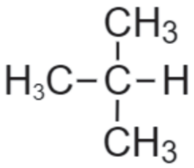
34 Which of the following fuel would produce the greatest mass of carbon dioxide per kilogram when burnt in an excess supply of air?

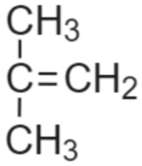
A $CH_2CHCOOCH_2CH_3$
B $(CH_3)_3COH$
C $CH_3CH_2C(CH_3)_2CH_2CH_3$
D $CH_3CH_2CH_2CH_2CH_2OH$

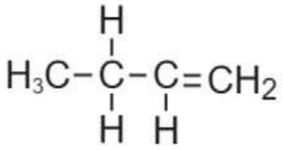
35 What catalyst is required for the addition of steam to an alkene?

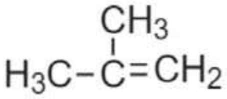
A aluminium oxide
B concentrated sulfuric acid
C nickel
D phosphoric(V) acid

36 The structures of four hydrocarbons are shown below.


$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-H$


$\overset{CH_3}{\underset{CH_3}{C}}=CH_2$


$H_3C-\overset{H}{\underset{H}{C}}-\underset{H}{C}=CH_2$


$H_3C-\overset{CH_3}{C}=CH_2$

How many isomers of butene are there?

A 1
B 2
C 3
D 4

37 Which of the following substances **cannot** be used to distinguish between ethanol and ethanoic acid?

A acidified potassium manganate(VII)
B aqueous bromine
C lithium carbonate
D moist blue litmus paper

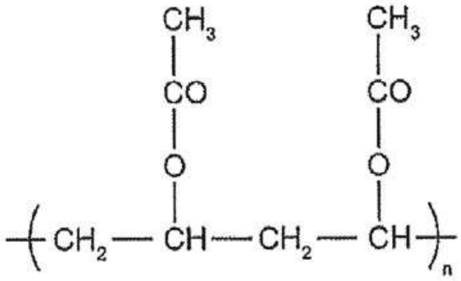
38 Which bond is broken during esterification?

A C – C bond
B C – H bond
C C – O bond
D C = O bond

39 Which of the following statements is true about nylon and terylene?

A Both nylon and terylene have a carboxylic acid as one of their monomers.
B Nylon has ester linkages while terylene has amide linkages.
C Only one product is formed during their manufacturing processes.
D They are both made from addition polymerisation reactions.

40 The diagram shows the formula of a polymer.



Which of the following could be used to make this polymer?

A $CH_3–COO–CH=CH_2$
B $HOOC–CH_2–COOH$ and $HO–CH_2CH_2–OH$
C $CH_3–CO–CH=CH_2$
D $CH_3–COO–CH_2=CH_2–OOC–CH_3$

End of Paper

Geylang Methodist School (Secondary)
Preliminary Examination 2019

Candidate Name	
Class	
Index Number	

CHEMISTRY **6092/02**

Paper 2 **Sec 4 Express**

Additional materials: Nil **1 hour 45 minutes**

Setter: Ms Ng Peck Suan **28 August 2019**

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 in the spaces provided, the last question is in the form either/or.

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 17.

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

This document consists of **17** printed pages and **1** blank page.

[Turn over

Section A

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

A1 The equations **A**, **B**, **C**, **D** and **E** show some reactions involving compounds of Y.

A	$\mathbf{Y}CO_3$ (s) $\rightarrow$ $\mathbf{Y}O$ (s) + CO_2 (g)
B	$2\mathbf{Y}O$ (s) + C (s) $\rightarrow$ $2\mathbf{Y}$ (s) + CO_2 (g)
C	$\mathbf{Y}O$ (s) + H_2SO_4 (aq) $\rightarrow$ $\mathbf{Y}SO_4$ (aq) + H_2O (*l*)
D	$\mathbf{Y}SO_4$ (aq) + 2NaOH (aq) $\rightarrow$ $\mathbf{Y}(OH)_2$ (s) + Na_2SO_4 (aq)
E	$\mathbf{Y}(OH)_2$ (s) + 2HC*l* (aq) $\rightarrow$ $\mathbf{Y}Cl_2$ (aq) + $2H_2O$ (*l*)

Use the letters **A**, **B**, **C**, **D** and **E** to answer parts **(a)** – **(c)** below.

(a) Which equation shows a change in the oxidation state of Y?

.... [1]

(b) Which three of the above equations are exothermic reactions?

.... [3]

(c) Which of these equations illustrates thermal decomposition?

.... [1]

(d) When reaction D is carried out, a blue precipitate which is insoluble in excess aqueous sodium hydroxide is observed.

(i) State the expected observation when aqueous ammonia is added dropwise until in excess into a portion of aqueous $\mathbf{Y}SO_4$.

....

.... [2]

(ii) Write an ionic equation to represent reaction **D**.

.... [2]

[Total: 9]

A2 The diagram shows part of the Periodic Table. Only some of the elements are shown.

							H										
													C	N	O		
Na												Al		P			
K	Ca						Fe			Cu	Zn						
Rb																	

Answer each of the following questions using only those elements shown in the diagram above. Each element may be used once, more than once or not at all.

(a) Give one element which

(i) has a giant molecular structure,

……………………………………………………………………………….. [1]

(ii) combines with oxygen to form a gas which contributes to acid rain,

……………………………………………………………………………….. [1]

(iii) forms an ion of type X^+ which has only three completely filled shells of electrons,

………………………………………………………………………………. [1]

(iv) has a chloride of type XCl_2, whose aqueous solution forms a white precipitate with aqueous sodium hydroxide but insoluble in excess of it.

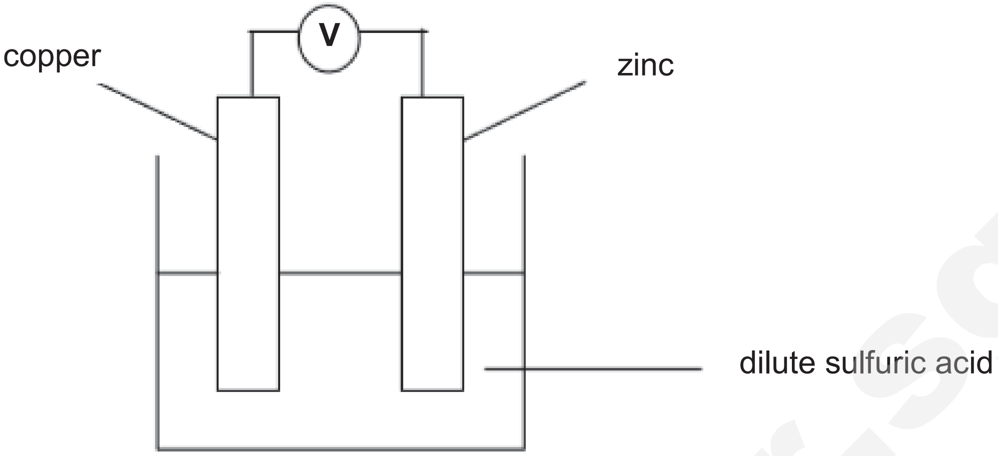
……………………………………………………………………………….. [1]

(b) Draw a 'dot and cross' diagram to show the chemical bonding in XCl_2.
Show only the outer shell electrons.

[2]

[Total: 6]

A3 The diagram below shows an electric cell.



(a) **(i)** Indicate with arrows on the diagram to show the direction of the flow of electrons in the wire.

[1]

(ii) Write an ionic half equation for the reaction taking place at the negative electrode.

………………………………………………………………………………….. [2]

(b) The experiment is repeated with the zinc electrode replaced by iron.

(i) State and explain the change in voltmeter reading obtained.

…………………………………………………………………………………….

………………………………………………………………………………… [2]

(ii) State the colour change in the solution that will be different from that of copper with zinc.

…………………………………………………………………………………….

………………………………………………………………………………….. [1]

[Total: 6]

A4 Small pieces of different metals were added to different solutions of metal ions in water. The results are summarised in the following table.

Metal / Solution	**V**	**W**	**X**	**Y**	**Z**
V^{4+}	--------	displacement occurs	displacement occurs	displacement occurs	displacement occurs
W^{3+}	no reaction	--------	displacement occurs	displacement occurs	displacement occurs
X^{2+}	no reaction	no reaction	--------	displacement occurs	displacement occurs
Y^{3+}	no reaction	no reaction	no reaction	--------	no reaction
Z^{2+}	no reaction	no reaction	no reaction	displacement occurs	--------

(a) Place the five metals in order of chemical reactivity, with the most reactive first.

…………………………………………………………………………………………...... [1]

(b) Magnesium is a more reactive metal than X but less reactive than Z,

(i) suggest the method of extraction for Z.

……………………………………………………………………………..…………… [1]

(ii) suggest the identity of metal Z.

……………………………………………………………………………………….. [1]

(iii) write a chemical equation for the reaction of metal Z with water.

……………………………………………………………………..……………… [1]

(c) Iron is extracted in the blast furnace before it is made into alloys.
Draw the structure of the bonding present in iron. Label your diagram.

[2]

[Total: 6]

A5 Barium is a metal found in Group II. Barium salts can be prepared using the various salt preparation methods. In an experiment, barium nitrate was prepared by adding 5 g of barium carbonate to 25.0 cm^3 of 0.400 mol/dm^3 dilute nitric acid.

(a) Identify the limiting reactant. Show your calculation clearly.

[3]

(b) A mass of 1.00 g of barium nitrate was obtained.

Calculate the percentage yield of barium nitrate.

[3]

(c) Calcium is another metal found in Group II.

State the two starting reagents for preparation of calcium sulfate.

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

[Total: 8]

A6 Excess methane reacts with insufficient oxygen to give only two products – steam and a gaseous carbon-containing compound. The energy released from the reaction was 1080 kJ/mol. The table below shows some bond energies:

Covalent bond	**Bond energy (kJ/mol)**	**Covalent bond**	**Bond energy (kJ/mol)**
H – H	436	C – H	412
Cl – Cl	242	H – Cl	431
C – C	348	C = C	612
O – H	463	O = O	496

(a) Write a balanced chemical equation for the reaction. Include state symbols.

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

(b) Calculate the bond energy in the carbon-containing product in kJ/mol.

[2]

(c) Explain whether the reaction is exothermic or endothermic, in terms of bond-breaking and bond-forming.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

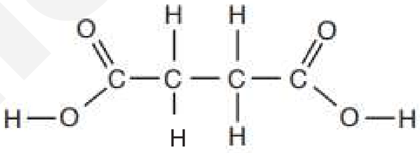
…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………….. [3]

[Total: 7]

A7 Carboxylic acids contain the –COOH group. The following shows the full structural formula of carboxylic acid **W**.



(a) Magnesium was added to carboxylic acid **W** to form a salt and another product.

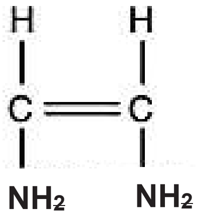
Describe your test and observations for another product obtained from the reaction between magnesium and carboxylic acid **W**.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(b) The following compound **X** can undergo two types of polymerisation, one of which is condensation polymerisation when it reacts with acid **W**.

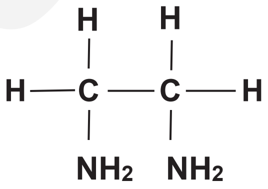


compound **X**

Draw two repeat units of the polymer formed when compound **X** and carboxylic acid **W** undergo condensation polymerisation. Circle the linkage.

[2]

(c) Compound **X** can then be converted into the following compound **Y**:



compound **Y**

State the reagent and conditions needed.

Reagent: ………………………………………………………………………… [1]

Conditions: ……………………………………………………………………... [2]

(d) Predict your observation when compound **X** was added to bromine solution.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

[Total: 8]

End of Section A

Name:	Class:	Index No:	Marks:

Section B

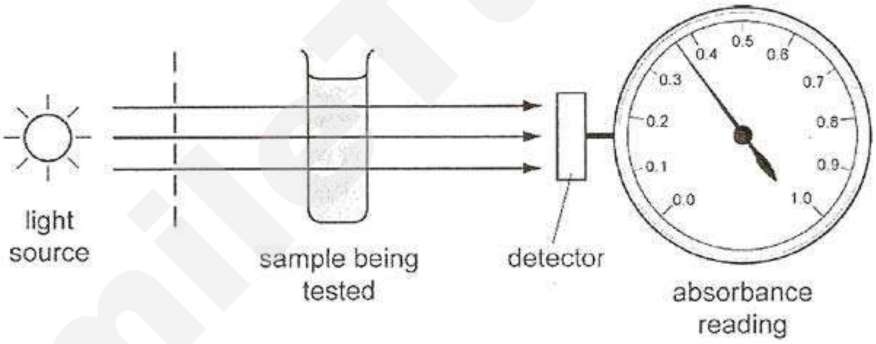
Answer all **three** questions from this section.
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.
Write your answers in the spaces provided.

B8 Bromine is an important chemical used for making flame retardants. Bromine is extracted from seawater, which is naturally rich in bromide ions. Chlorine can be bubbled through seawater to convert bromide ions into bromine.

A student carried out an experiment in a laboratory to investigate the reaction between bromide ions and chlorine gas.

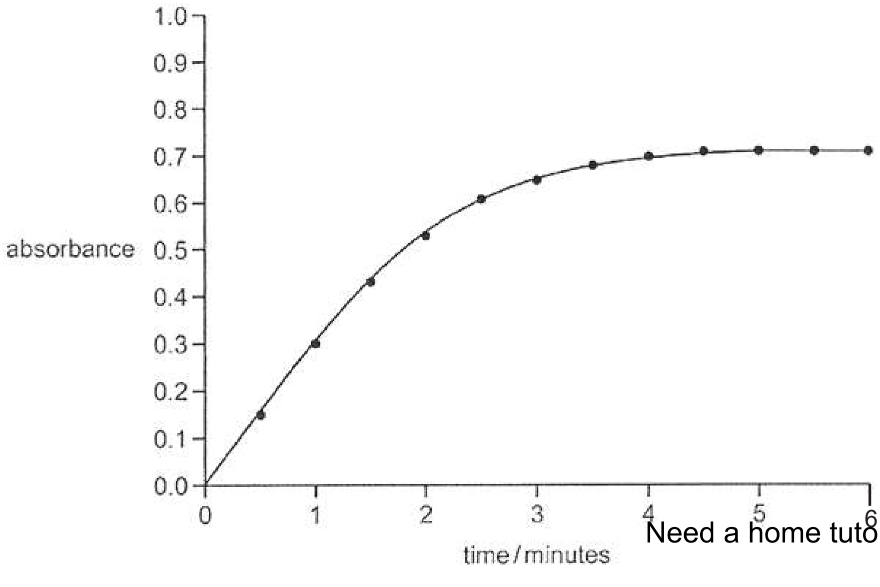
She bubbled chorine through aqueous potassium bromide for 6 minutes. She took samples of the reaction mixture every 30 s and measured the colour intensity of each sample using a colorimeter.

A colorimeter measures the amount of light absorbed by the solution when the light passes through a coloured solution.
The diagram shows how a colorimeter works.



The darker the colour of the solution, the greater the amount of light absorbed and the higher the absorbance reading on the colorimeter. Aqueous bromine absorbs more light than aqueous chlorine or aqueous potassium bromide.

The student plotted her results on a graph.



(a) Write an ionic equation to represent the reaction between chlorine gas and aqueous potassium bromide.

……………………………………………………………………………………… [1]

(b) State and explain, with reference to the reaction, the relationship between absorbance and time in the **first minute** of the experiment.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [2]

(c) Describe and explain with the aid of the Collision Theory, the changes in speed of reaction shown by the graph.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [3]

(d) The student carried out **four** more experiments to determine the time taken for each reaction to finish. She used the same volume of aqueous potassium bromide each time and recorded the results as shown in the table below.

experiment	time taken for reaction to complete / min	absorbance reading at the end of reaction
1	5.00	0.8
2	6.00	0.4
3	2.50	0.8
4	2.50	0.9

(i) Which experiment uses potassium bromide of a lower concentration than that in experiment 1?

……………………………………………………………………………… [1]

(ii) How does the time taken for the reaction to complete relate to the rate of the reaction?

……………………………………………………………………………………… [1]

(iii) If the initial concentration of the reactants is the same, suggest explanations for the results obtained in experiments 1 and 3.

………………………………………………………………………………………

………………………………………………………………………………………

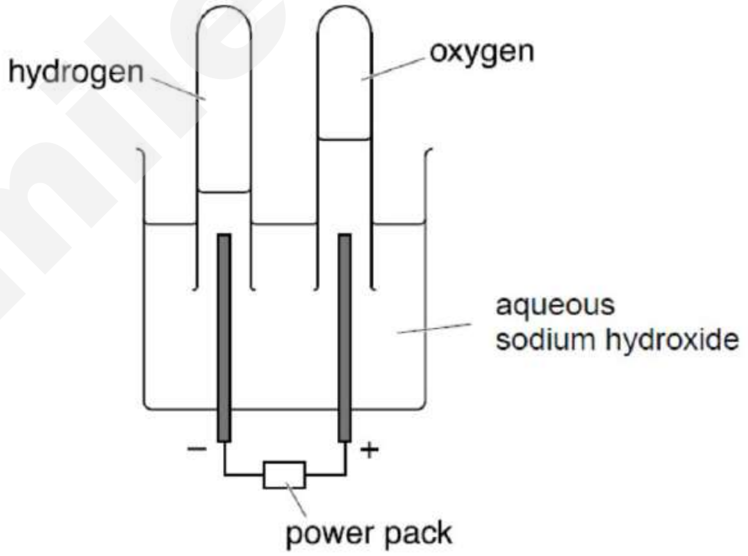
………………………………………………………………………………………

……………………………………………………………………………………… [2]

[Total: 10]

B9 Instead of carrying many tanks of oxygen and adding to the mass of the submarine, which makes it inefficient to move, naval forces sometimes make use of chemistry to constantly generate sufficient oxygen for the soldiers in the submarine to breathe.

One such method is the electrolysis of aqueous sodium hydroxide. The diagram below shows the schematic diagram of a set-up used for this purpose.

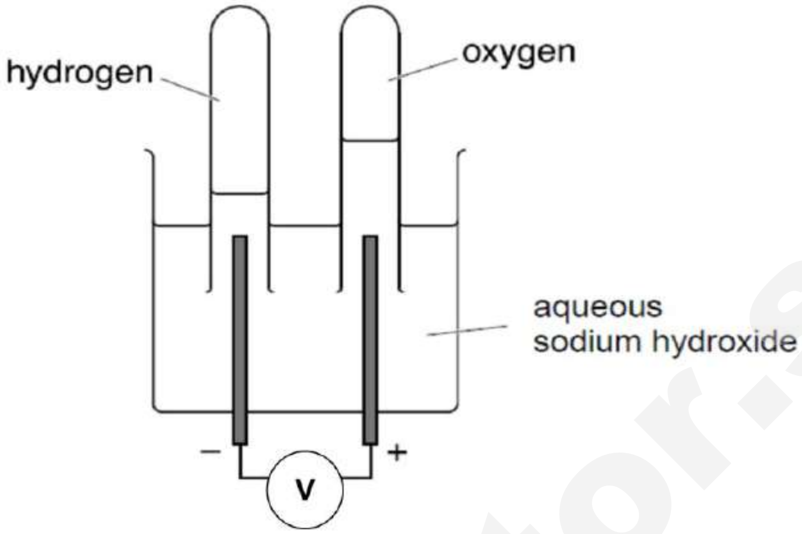


(a) State how the composition of the electrolyte changes after the electrolysis has been running for some time.

………………………………………………………………………………………......

……………………………………………………………………………………….. [1]

(b) After some time, the power pack can be replaced by a voltmeter. This set-up as shown below then acts like a fuel cell to provide additional electricity to power the submarine.



The left hand electrode in the diagram becomes the negative terminal of the cell and the right hand electrode becomes the positive terminal.

(i) State the direction of the electron flow in the external circuit.

……………………………………………………………………………… [1]

(ii) Construct an ionic equation to represent the reaction that occurs at the negative terminal in this fuel cell.

……………………………………………………………………………… [1]

(c) Other than submarines, cars can also be fitted with an engine powered by a hydrogen fuel cell or a conventional petrol engine.

One of the advantages of hydrogen fuel cells over the use of petrol in cars is that the only by-product is water, making it a clean fuel. A hydrogen fuel cell in operation, however, can sometimes achieve temperatures that are comparable to the conventional petrol engine.

(i) Suggest an environmental disadvantage of using petrol to power car engines.

………………………………………………………………………………..

………………………………………………………………………………..

……………………………………………………………………………… [2]

(ii) Suggest why hydrogen as a fuel (in the fuel cell) may not be that economically viable.

……………………………………………………………………………………..

……………………………………………………………………………………..

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

(iii) Explain why it is possible for nitrogen oxides to be produced in both types of car engines.

…………………………………………………………………………………….

…………………………………………………………………………………….

.... [2]

(iv) Suggest why a catalytic converter installed in a car powered by a hydrogen fuel cell, will fail to reduce nitrogen oxide levels as compared to that in a car powered by petrol.

…………………………………………………………………………………….

……………………………………………………………………………………. [1]

[Total: 10]

EITHER

B10 Long chain alkanes such as octane, C_8H_{18}, can be 'cracked' to produce shorter chain hydrocarbons which could then be separated by fractional distillation.

octane → **B** + a mixture of **C**, **D** and **E**
C_8H_{18} C_3H_6 (isomers of C_5H_{12})

(a) State the conditions necessary for this reaction to take place.

……………………………………………………………………………………………. [1]

(b) Write the full structural formula of **B**.

[1]

(c) Describe the process of separating mixtures **C**, **D** and **E** by fractional distillation.

……………………………………………..………………………………….

………………………………………………………………………………

……..……………………………………………………………………….

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… [3]

(d) **C**, **D** and **E** exhibit structural isomerism. They are isomers of pentane, C_5H_{12}.

(i) Define the term *isomerism*.

……………………………………………………………………………….

……………………………………………………………………………….. [1]

(ii) Complete the table below to show all possible isomers for pentane.

isomers of pentane		
C	**D**	**E**

[2]

(e) In a separate experiment, one of the alkanes **C**, **D** or **E** reacted with bromine under ultraviolet light and produced **only one** bromoalkane compound **F**, with the formula, $C_5H_{11}Br$.

Suggest the structure of **F** and the structure of alkane used to form **F**.

structure of F	structure of alkane used, C_5H_{12}

[2]

[Total: 10]

OR

B10 Ammonia is a compound of nitrogen and hydrogen with the formula NH_3. Ammonia exists in nature as a colourless gas with a characteristic pungent smell. The undesirable smell is commonly associated with toilets as ammonia gas is given off from urine.

The nitrogen-containing substance in urine is urea, $CO(NH_2)_2$ which undergoes hydrolysis with water to form ammonia and a colourless acidic gas.

(a) Construct a chemical equation, including state symbols, for the hydrolysis of aqueous urea.

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

In the past, ammonia was obtained via the distillation of camel dung. Nowadays, ammonia is obtained via the Haber Process.

(b) State the **three** operating conditions of the Haber Process.

…………………………………………………………………………………………. [1]

(c) In addition, ammonia burns in **pure oxygen** according to the equation given below.

$$4NH_3\ (g) + 2O_2\ (g) \rightarrow 2N_2\ (g) + 6H_2O\ (l)$$

(i) Explain whether the reaction stated in **(c)** is a redox reaction in terms of oxidation numbers.

…………………………………………………………………………………………...

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

(ii) State the reducing agent in reaction **(c)**.

…………………………………………………………………………………. [1]

(iii) Given that 40 cm^3 of ammonia gas was completely reacted, calculate the minimum volume of **air** required.

[1]

(d) When ammonia dissolves in water, the water feels cold.

NH_3 (g) + H_2O (*l*) → NH_4OH (aq)

Draw an energy profile diagram, using the axes given below, for this reaction showing the activation energy and enthalpy change of the reaction. Label the axes.

[3]

[Total: 10]

End of paper

DATA SHEET
The Periodic Table Of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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 162	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 –	91 Pa protactinium –	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

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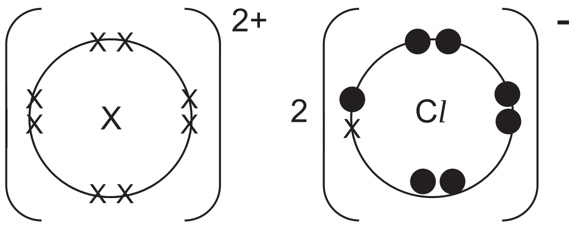
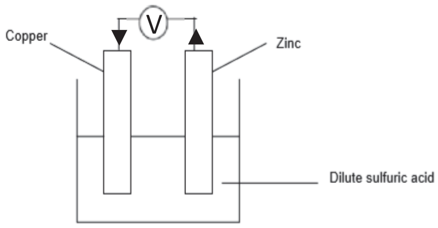
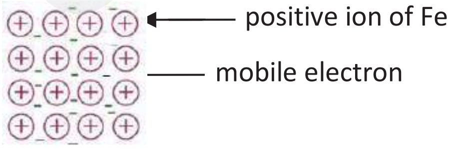
Geylang Methodist School (Secondary)
Prelim 2019
4Exp Chemistry 6092

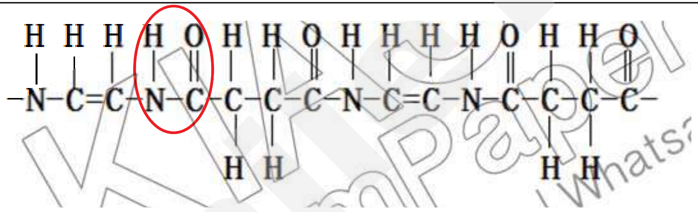
Paper 1

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

Paper 2

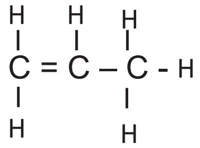
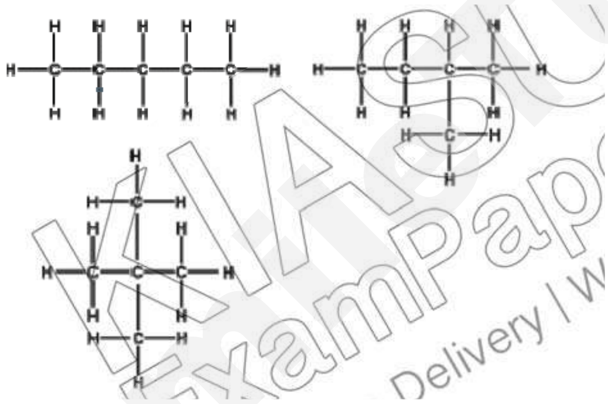
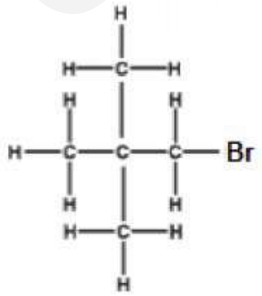
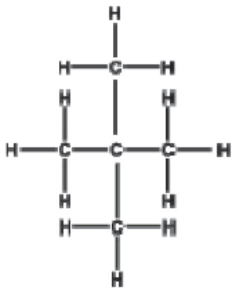
Section A (50 marks)		
A1		Marks allocation
(a)	B	1
(b)	C, D and E	3
(c)	A	1
(d)(i)	Blue precipitate forms. Blue precipitate dissolves in excess aqueous ammonia to form a dark blue solution.	1 1
(ii)	Y^{2+} (aq) + $2OH^-$ (aq) → $Y(OH)_2$ (s)	1 for correct ionic eqn 1 for correct state symbols
A2		
(a)(i)	C	1
(ii)	N	1
(iii)	K	1
(iv)	Ca	1

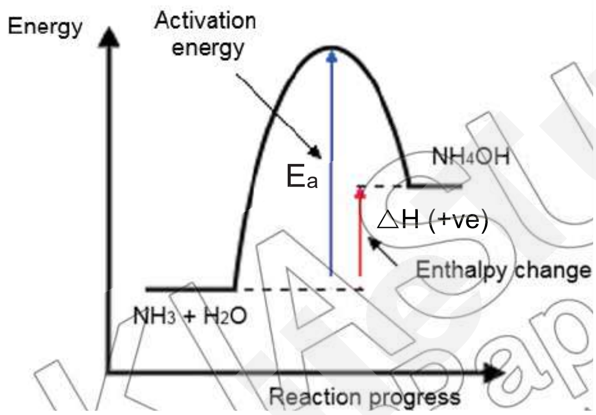
(b)	 Legends: X : electron for X atom ● : electron for Cl atom	1 for X^{2+} ion 1 for Cl^- ion
A3 **(i)**		1
(ii)	$Zn(s) \rightarrow Zn^{2+}(aq) + 2e$	1 for balanced ionic half equation 1 for correct state symbols
(b)(i)	The voltmeter reading will be **lower than that with zinc**. **Iron is below zinc** in the **reactivity series**. Hence, the **closer the metals are in the reactivity series**, the **smaller** the difference in voltage across the two electrodes.	1 1
(ii)	Colourless solution will turn pale green.	1
A4 **(a)**	Y, Z, X, W, V	1
(b)	**(i)** Electrolysis of molten ionic compound of Z. **(ii)** Calcium **(iii)** $Z + 2H_2O \rightarrow Z(OH)_2 + H_2$ or $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$	1 1 1
(c)		1 for diagram 1 for labelling of positive ions and electrons
A5 **(a)**	$BaCO_3 + 2HNO_3 \rightarrow Ba(NO_3)_2 + CO_2 + H_2O$ No. of moles of barium carbonate = 5 / (137+12+3x16) = 0.025381 mol No. of moles of dilute HNO_3 = (25/1000) x 0.4 = 0.01 mol Hence, HNO_3 is the limiting reactant.	1 1 1
(b)	No. of moles of HNO_3 : no. of moles of $Ba(NO_3)_2$ = 2:1	

	No. of moles of $Ba(NO_3)_2$ = 0.01 / 2 = 0.005 mol Mass of theoretical barium nitrate = 0.005 x (137 + 14 x 2 + 16 x 6) = 1.305 g Percentage yield = 1 / 1.305 x 100% = 76.6 % (to 3 s.f.)	1 1 1
(c)	calcium nitrate solution / aqueous calcium nitrate and dilute sulfuric acid / any soluble sulfate	1 1
A6 **(a)**	$2CH_4 (g) + 3O_2 (g) \rightarrow 2CO (g) + 4H_2O (g)$	1 for correct eqn 1 for state symbols
(b)	Let bond energy in carbon monoxide by X. 8(+412)+3(+496)+8(-463)-2X = -1080 kJ X = 1080 kJ/mol	1 1
(c)	The reaction is **exothermic** as the energy taken in to break bonds in the molecules of methane (8 C-H bonds) and oxygen (3 O=O bonds) is less than energy given out to form the bonds in the molecules of carbon monoxide (2 C≡O bonds) and water (8 O-H bonds).	1 for exothermic 2 for explanation
A7 **(a)**	Place a lighted splint at the mouth of the test tube. The lighted splint will extinguish with a pop sound.	1 1
(b)		1m for the two repeat units drawn 1m for circling the correct linkage
(d)	Reagent: Hydrogen Conditions: 200°C, nickel catalyst	1 1 1
(e)	The aqueous bromine will turn from reddish brown to colourless. Or The reddish-brown aqueous bromine will be decolourised.	1
B8		
(a)	$Cl_2 (g) + 2Br^- (aq) \rightarrow 2Cl^- (aq) + Br_2 (aq)$	1
(b)	Absorbance increases with time. Bromide ions are slowly oxidised to bromine. Colour intensity is gradually increasing.	1 1

(c)	1st mark: Speed of reaction was **fast initially**. **Maximum/ high** concentration/amount of **bromide ions** and chlorine Very **high frequency of effective collision** between particles. 2nd mark: As reaction progresses, concentration/number of reacting particles **decreases, frequency of effective collision decreases**, **speed** of reaction **decreases**. 3rd mark: Absorbance is maximum/ no increase/ remains constant. Speed of reaction is **zero** as **all bromide ions are used up**.	1 1 1
(d) (i)	Experiment 2 [1]	
(ii)	Rate of reaction is **inversely** proportional to the time taken for the reaction to complete. OR The shorter the time taken for complete reaction, the faster the reaction rate.	
(iii)	Same absorbance reading at the end of the reaction was obtained because of the **same number of moles / concentration of bromide ions (limiting reactant) was reacted in both experiments**. A shorter time taken was taken (faster rate) for experiment **3** for reaction to finish because the **reaction was carried out at a higher temperature.** **OR** reverse argument	1 1
B9 (a)	Concentration of Na^+ and OH^- increases OR Concentration of sodium hydroxide increases. *Reject: concentration of electrolyte increases.*	1
(b)(i)	From the negative terminal to the positive terminal OR From left to right. *Reject: from anode to cathode unless student has identified which electrode is anode/cathode.*	1
(ii)	$2H_2 (g) + 4OH^- (aq) \rightarrow 4H_2O(l) + 4e^-$ *State symbols are required.*	1 *(no state symbols = 0 m)*

(c)(i)	Formation of **carbon dioxide** due to complete combustion. [1] A **greenhouse** gas that can cause global warming, resulting in rising sea levels + melting ice caps [1] **OR** Formation of **carbon monoxide** due to incomplete combustion. [1] A **poisonous** gas as it combines irreversibly with haemoglobin in blood to form carboxyhaemoglobin which reduces ability of haemoglobin to carry oxygen to different parts of the body, resulting in breathing difficulties and eventually death [1] **OR** Unburnt hydrocarbons may be released due to incomplete combustion. [1] Formation of photochemical smog when present with other polluting gases [1] **OR** Formation of **nitrogen oxides** due to high temperatures in engine. Nitrogen oxides results in **acid rain** which increases acidity of lakes and rivers harming aquatic life / corrode metal and limestone structures / increases acidity of soil hindering plant growth.	2 *Reject: production of sulfur dioxide*
(ii)	To obtain hydrogen, we require **cracking of longer-chain hydrocarbons** [1] which requires **large amount of heat** [1] OR To obtain hydrogen, **electrolysis of water** must be carried out [1] which requires **large amount of electricity** [1] OR Hydrogen is **difficult to store as it is a gas / flammable / explosive**[1], hence it is expensive to construct special containers/equipment [1] to store it.	} 1 1
(iii)	**Nitrogen reacts with oxygen in air to form nitrogen oxides** [1] Both types of engines work / function at **high temperatures**. [1] *Reject: both engines are at comparable temperatures.*	
(iv)	In a hydrogen fuel cell powered engine, there is **absence of carbon monoxide to function as a reducing agent** in the catalytic converter. **OR** For a catalytic converter to remove NO, the following must happen: **$2CO + 2NO \rightarrow 2CO_2 + N_2$** However, there is **no carbon monoxide present** in the engine powered by the fuel cell. **OR** NO is **soluble in water** present in the fuel cell, and **will not reach the catalytic converter** for reaction to occur.	Any one. 1

B10 E		
(a)	aluminium oxide / silicon dioxide and high temperature at 600°C OR High temperature / catalyst	1
(b)	 $\begin{array}{ccccc} H & & H & & H \\ \mid & & \mid & & \mid \\ C & = & C & - & C - H \\ \mid & & & & \mid \\ H & & & & H \end{array}$	1
(c)	Mixture of hydrocarbons C, D and E is heated [1] and the vaopur [1] is passed into the fractionating coloumn. The hydrocarbon with the lowest boiling point [1] will be distilled and collected at the higher outlet in the fractionating column while hydrocarbon with the next higher b.p. will be distilled and collected at the lower outlet in the column. *Acceptable: methods which describe small scale fractional distillation*	1 1 1
(d) (i)	Isomerism is the existence of two or more compounds with the same molecular formula but with different structural formulae.	1
(ii)		2 m for all 3 correct isomers. 1 m for any 2 correct isomers. 0 m for only 1 correct isomer
(e)	Structure **F**:  Structure of the alkane used: 	

OR **B10**		
(a)	$CO(NH_2)_2$ (aq) + H_2O (*l*) → $2NH_3$ (g) + CO_2 (g)	[1] correct equation [1] state symbols
(b)	400°C to 450°C 200 - 250 atm Iron catalyst	[1] for all 3 conditions correct
(c)(i)	It is a redox reaction. The oxidation state of N increases from **–3 in NH_3 to 0 in N_2.** [1] The oxidation state of O decreases from **0 in O_2 to –2 in H_2O.** [1]	
(c) (ii)	Ammonia	[1]
(c) (iii)	By volume ratio, volume of O_2 needed = 20 cm^3 Hence, volume of air needed = $20 \times \frac{100}{21} = 95.2$ cm^3 (3 s.f.)	[1]
(d)		Correct axes [1] Correct shape [1] Correct label [1]

Name	Reg. No	Class

4EX

PURE CHEMISTRY

6092/01

Paper 1 [40 Marks]

PRELIMINARY EXAMINATION
September 2019
1 hour

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

INSTRUCTIONS TO CANDIDATES:

Do not start reading the questions until you are told to do so.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class, and index number on the OTAS provided.

INFORMATION FOR CANDIDATES:

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 **OTAS**.

Read the instructions on the OTAS 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.

Page 18 is a blank page

A copy of the Periodic Table is printed on page 19

This question paper consists of **19** printed pages.

Setter: Chen Yanhui Timothy

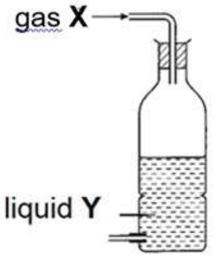
Vetter: Mdm Jarina Banu

Paper 1: Multiple Choice Questions (40 marks)

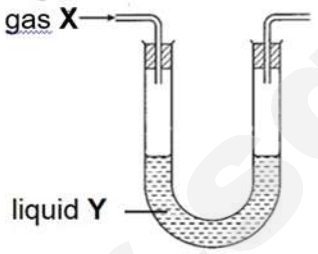
Answer **all** the questions in the OTAS provided.

1 Which of the following shows the most suitable set-up to purify gas **X** using liquid **Y**?

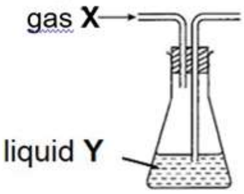
A



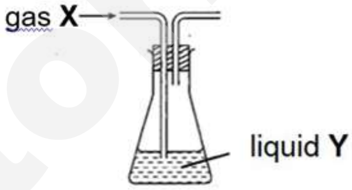
B



C

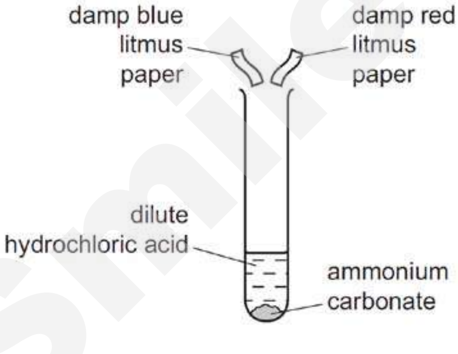


D

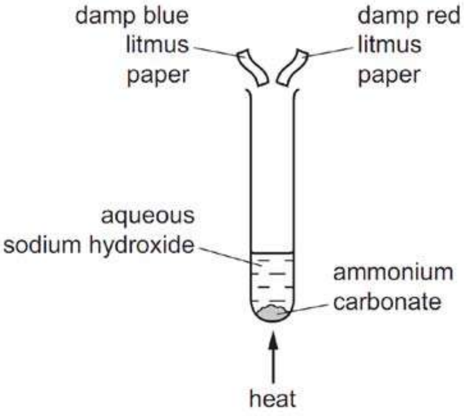


2 Two experiments were carried out.

In each experiment, the gas evolved was tested with damp blue litmus paper and damp red litmus paper.



experiment 1



experiment 2

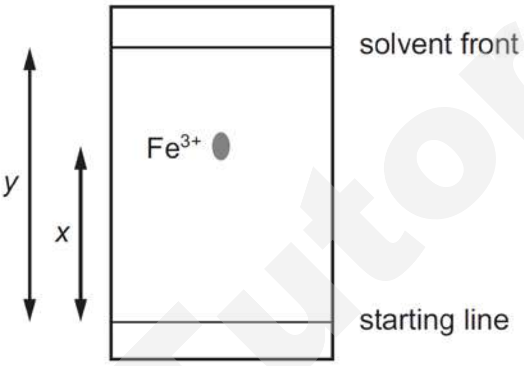
Which row correctly shows the colour of both the pieces of litmus paper at the end of each experiment?

	experiment 1	experiment 2
A	blue	blue
B	blue	red
C	red	blue
D	red	red

3 Which substance would diffuse most quickly?

A carbon dioxide at 0 °C
B carbon dioxide at 25 °C
C neon at 0 °C
D neon at 25 °C

4 A paper chromatography experiment is carried out to find an Rf value for $Fe^{3+}(aq)$. The result is shown.



To make the spot containing $Fe^{3+}(aq)$ more visible, the paper is sprayed with aqueous sodium hydroxide so that a precipitate of iron(III) hydroxide forms.

Under the conditions of the experiment, the R_f of $Fe^{3+}(aq)$ is given by **(a)** and the colour of the precipitate is **(b)**.

	(a)	**(b)**
A	x/y	red-brown
B	x/y	green
C	y/x	red-brown
D	y/x	green

5 Which statement about chlorine atoms and chloride ions is correct?

A They are both isotopes of chlorine.
B They have the same number of protons.
C They have the same physical properties.
D They undergo the same chemical reactions.

[Turn over

6 **X** represents the element of atomic number 8 and **Y** represents the element of atomic number 19.
The two elements react together to form a compound.

Which row is correct for the compound formed?

	formula	bonding
A	X_2Y	covalent
B	X_2Y	ionic
C	Y_2X	covalent
D	Y_2X	ionic

7 Some ionic compounds can have covalent character.

In general, the greater the positive charge of the cation, the more it causes the electron cloud of the anion to be distorted, causing covalent behavior.
In addition, if the size of the anion is larger, the electron cloud is more easily distorted compared to one that is smaller.

According to the information provided, which compound below exhibits the **greatest** covalent character?

A aluminum iodide
B calcium chloride
C lithium fluoride
D sodium oxide

8 Solid copper metal, aqueous copper(II) sulfate, solid graphite and molten magnesium chloride will all conduct electricity.

Which pair will conduct electricity because they both contain mobile electrons?

A aqueous copper(II) sulfate and molten magnesium chloride
B aqueous copper(II) sulfate and solid copper metal
C molten magnesium chloride and solid graphite
D solid copper metal and solid graphite

9 Which ionic equation best represents the reaction between aqueous potassium hydroxide with dilute nitric acid?

A $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
B $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(aq)$
C $K^+(aq) + HNO_3(aq) \rightarrow KNO_3(aq) + H^+(aq)$
D $KOH(aq) + H^+(aq) \rightarrow K^+(aq) + H_2O(l)$

10 The characteristics of a gas, **G**, are given.

- **G** reduces copper(II) oxide to a pink-brown solid.
- 1.4 g of **G** has a volume of 1.2 dm^3 at room temperature and pressure.

What is **G**?

A carbon monoxide
B hydrogen gas
C nitrogen gas
D nitrogen monoxide

11 In an experiment, 1 cm^3 of a gaseous hydrocarbon, **Z**, requires 5 cm^3 of oxygen for complete combustion to give 3 cm^3 of carbon dioxide. All gas volumes are measured at room temperature and pressure.

Which formula represents **Z**?

A C_2H_2 **B** C_2H_4 **C** C_3H_6 **D** C_3H_8

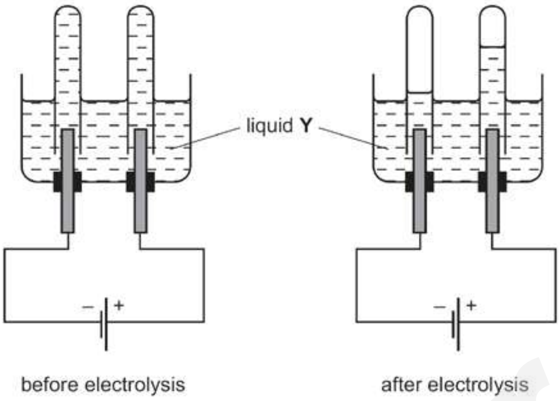
12 Analysis of a sample of a substance has the following composition by mass.

- percentage by mass of carbon is 41.9%
- percentage by mass of hydrogen is 3.1%
- percentage by mass of chlorine is 55%

What is its molecular formula?

A $C_3H_6Cl_4$
B $C_4H_9Cl_4$
C $C_8H_4Cl_9$
D $C_9H_8Cl_4$

13 The diagrams show an electrolysis experiment using inert electrodes.



What could liquid **Y** be?

A aqueous copper(II) sulfate
B concentrated aqueous sodium chloride
C dilute sulfuric acid
D ethanol

14 During the electroplating of a metal spoon using silver,

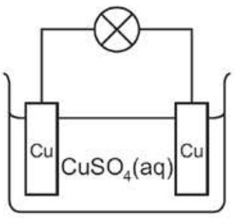
1. the anode is the silver metal.
2. the spoon is made the cathode.
3. the electrolyte used is aqueous silver nitrate.
4. the concentration of the electrolyte decreases during electroplating.

Which of the above statements are true?

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

15 In which circuit does the bulb light?

A



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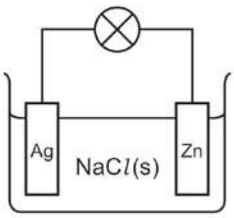

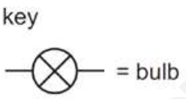

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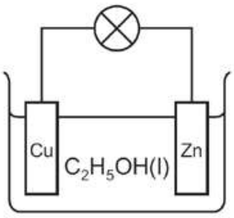

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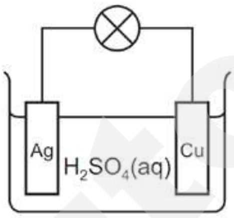
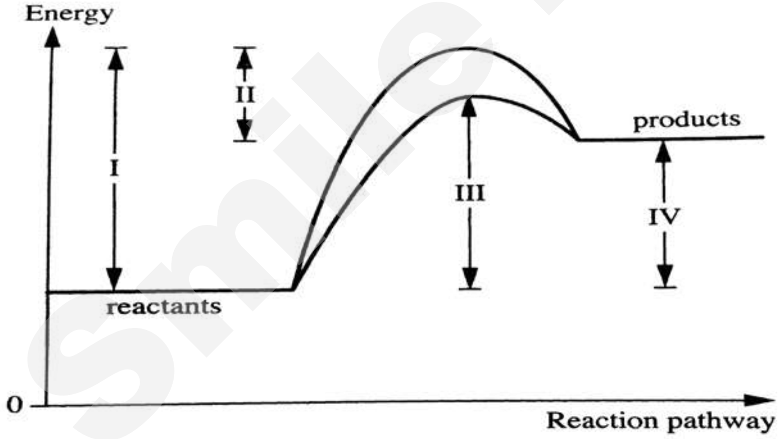


16 Below is an energy profile diagram for a chemical reaction showing the energy changes **I**, **II**, **III** and **IV**.



Which of the following energy changes indicates the activation energy for the catalyzed reaction?

A I **B** II **C** III **D** IV

17 Compound **Y** reacts with oxygen and this reaction has a positive enthalpy change of reaction.

What information can be deduced about **Y** and its reaction with oxygen?

A Compound **Y** can be used as a fuel.

B In the reaction the energy absorbed to break bonds is greater than the energy released when bonds are made.

C In the reaction the products are at a lower energy level than the reactants.

D The reaction could be combustion.

18 A student wrote two conclusions about calcium carbonate.

conclusion 1: The reaction with dilute hydrochloric acid is faster with powdered calcium carbonate than with large pieces of calcium carbonate.

conclusion 2: Grinding large pieces of calcium carbonate to form powder increases the particle size.

Which statement is correct?

A Both conclusions are correct and conclusion 2 explains conclusion 1.

B Both conclusions are correct but conclusion 2 does not explain conclusion 1.

C Conclusion 1 is correct but conclusion 2 is not correct.

D Conclusion 2 is correct but conclusion 1 is not correct.

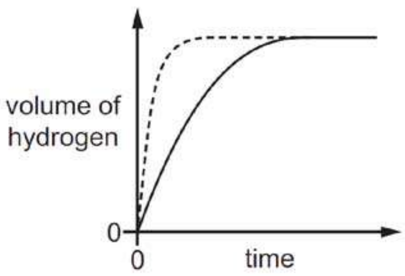
19 Magnesium reacts with dilute sulfuric acid.
Two experiments were carried out.

experiment 1: 24.0 g of magnesium was reacted with 100 cm^3 of 1.0 mol/dm^3 sulfuric acid.
experiment 2: 24.0 g of magnesium was reacted with 100 cm^3 of 2.0 mol/dm^3 sulfuric acid.

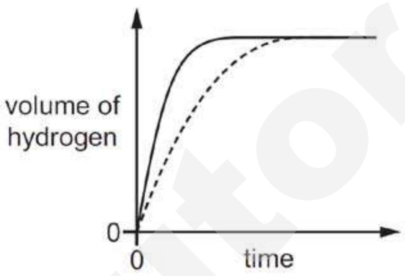
In each experiment the volume of hydrogen was measured at various times. The results were plotted on a graph.

Which graph is correct?

A

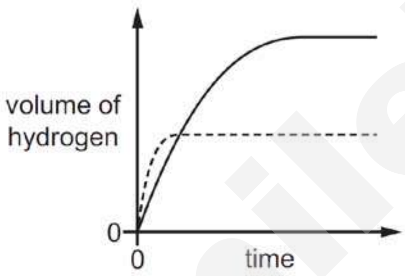


B



key
—— experiment 1
------ experiment 2

C



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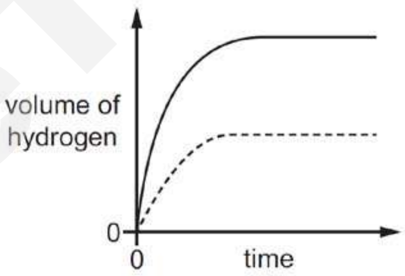


20 Which reaction does **not** involve oxidation or reduction?

A $2H_2 + O_2 \rightarrow 2H_2O$
B $Fe^{2+} \rightarrow Fe^{3+} + e^-$
C $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$
D $CuO + H_2 \rightarrow Cu + H_2O$

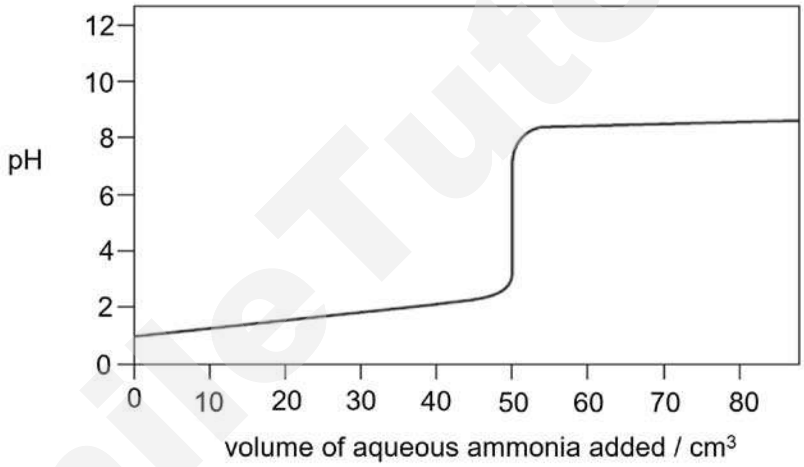
21 The reaction between iron(II) ions and manganate(VII) ions is represented by the following equation.

$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

Which one of the following statements is correct?

A Fe^{2+} gained electrons to form Fe^{3+}.
B Fe^{2+} is a reducing agent.
C The oxidation state of hydrogen had decreased.
D The oxidation state of manganese has increased.

22 The graph below shows the pH changes when 0.1 mol/dm^3 of aqueous ammonia solution is added to 50.0 cm^3 of 0.1 mol/dm^3 of hydrochloric acid.



Which of the following indicators is **not** suitable for use in determining the endpoint for the neutralisation reaction above?

	indicator	pH range of indicator
A	bromothymol blue	6.0 – 7.6
B	bromothymol red	5.2 – 6.8
C	methyl orange	3.1 – 4.4
D	phenolphthalein	8.3 – 10.0

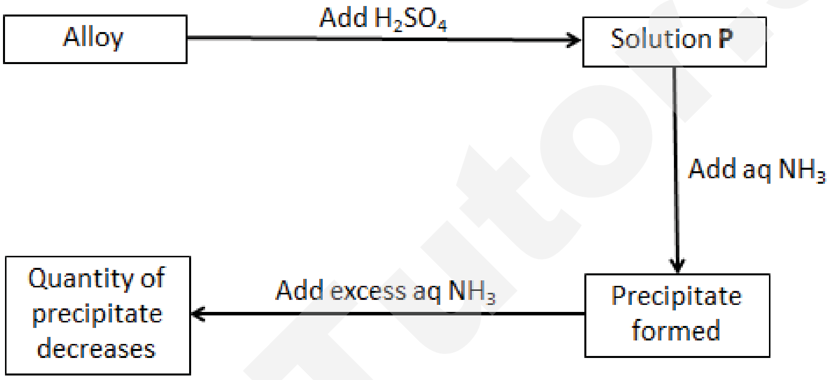
23 Which of the following statements about oxides is correct?

A A basic oxide is an oxide of a non-metal.
B Acidic oxides contain ionic bonds.
C Amphoteric oxides contain a metal.
D Basic oxides are always gases.

24 Which of the following reactants when mixed produces a salt that can be obtained as a residue after filtration?

A aqueous copper(II) sulfate and aqueous sodium nitrate
B aqueous sodium hydroxide and dilute nitric acid
C dilute sulfuric acid and aqueous barium nitrate
D zinc metal and dilute hydrochloric acid

25 A sample of an alloy containing two metals was subjected to the following tests.
What are the two metals present in the alloy?



A copper and zinc
B iron and copper
C iron and lead
D iron and zinc

26 Element **X** has the following properties.

- forms **X**F_3 when heated with fluorine
- forms **X**SO_4 when reacted with dilute sulfuric acid

To which part of the Periodic Table does Q belong?

A Group II
B Group III
C Group IV
D Transition metals

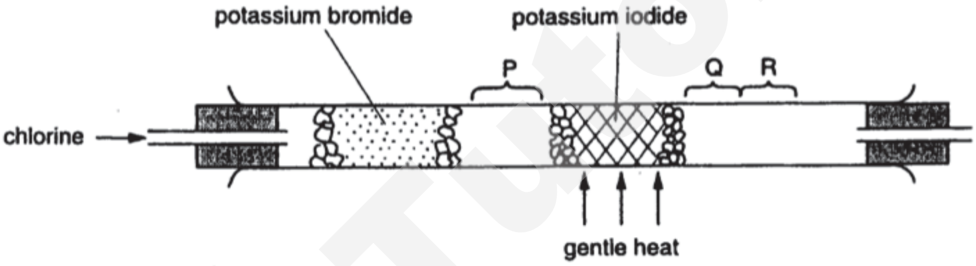
27 Caesium, Cs, is an element in the same group of the Periodic Table as lithium, sodium and potassium. Some statements of caesium metal is given below.

- It reacts explosively with cold water.
- It forms a soluble carbonate salt.
- It forms a carbonate with a formula of $CsCO_3$.
- It can be extracted via electrolysis of concentrated aqueous $CsCl$.

How many statements about caesium are likely to be **wrong**?

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

28 Using the apparatus shown, chlorine is passed through the tube. After a short time, coloured substances are seen at **P**, **Q** and **R**.



What would be observed at P, Q and R?

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

29 The following table refers to four metals and some of their compounds.

Metal	Action of dilute sulfuric acid on metal	Effect of carbon on heated oxide	Action of metal on a solution of the sulfate of H
E	hydrogen evolved	reduced	no reaction
F	no reaction	reduced	no reaction
G	hydrogen evolved	no action	metal H formed
H	hydrogen evolved	no action	no reaction

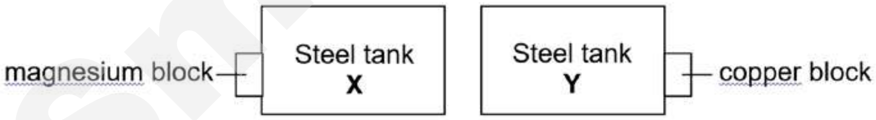
Which of the following lists the metals in order of **decreasing** reactivity?

A	F	E	H	G
B	G	H	E	F
C	G	H	F	E
D	H	G	E	F

30 Which statement about the extraction of iron in the blast furnace is correct?

A Carbon reacts with carbon dioxide to produce carbon monoxide
B Iron(III) oxide reacts with carbon dioxide to produce molten iron.
C Limestone is added to remove basic impurities.
D Molten iron floats on molten slag at the bottom of the furnace.

31 A block of magnesium and a block of copper were attached to underground steel tanks, **X** and **Y** as shown below.



Which pair of equation would represent the reactions that would occur at tanks **X** and **Y**?

	Steel tank **X**	Steel tank **Y**
A	$Fe \rightarrow Fe^{2+} + 2e$	$Cu \rightarrow Cu^{2+} + 2e$
B	$Fe \rightarrow Fe^{2+} + 2e$	$Fe \rightarrow Fe^{2+} + 2e$
C	$Mg \rightarrow Mg^{2+} + 2e$	$Cu \rightarrow Cu^{2+} + 2e$
D	$Mg \rightarrow Mg^{2+} + 2e$	$Fe \rightarrow Fe^{2+} + 2e$

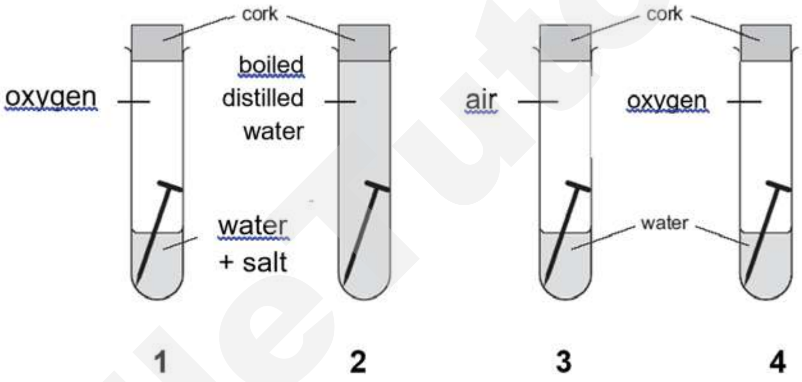
[Turn over

32 A recycling company is to decide on which metals to recycle.

Based on the information provided in the table below, for which metal is the company **least** likely to recycle?

	Abundance of raw metal/metal ore on Earth	Ease of extracting metal from the Earth	Cost of preparing the used metal for recycling
A	High	Low	Moderate
B	Low	High	High
C	Low	High	Low
D	Moderate	High	High

33 An experiment was set up as shown below to investigate the rate of rusting under different conditions.

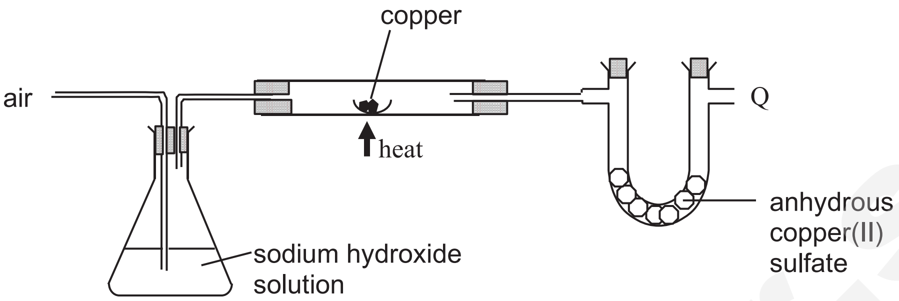


Predict the order of the test-tubes in which rust would first appear.

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

34 In the experiment below, an air sample is bubbled into excess sodium hydroxide solution, then passed over excess copper and finally into some anhydrous copper(II) sulfate.

What is the constituent of the gas that came out from **Q**?

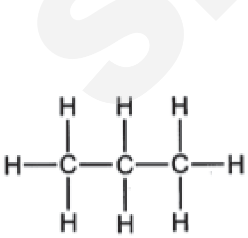
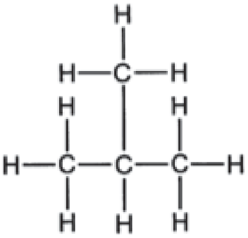
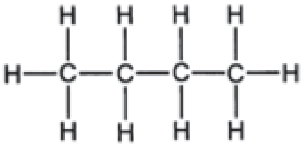


A nitrogen, noble gases
B nitrogen, noble gases and carbon dioxide
C nitrogen, noble gases and oxygen
D water vapour and noble gases

35 Which row correctly compares carbon dioxide and methane?

	both contain carbon	both are described as a greenhouse gas	both increases the pH of water when they dissolve in it
A	✓	×	✓
B	✓	✓	×
C	×	✓	✓
D	×	✓	×

36 The diagrams show the structures of three hydrocarbons.

Which statement is correct for **all** three compounds?

A They are isomers of each other.
B They have the same general formula.
C They have the same physical properties.
D They react with aqueous chlorine.

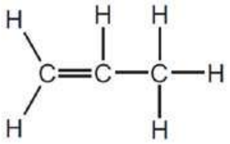
[Turn over

37 **Z** is a compound that:

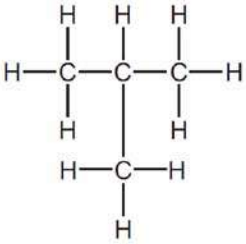
- can be formed, as the only other product, when the alkane C_8H_{18} is cracked to produce butane
- decolourises bromine water

What is the formula of **Z**?

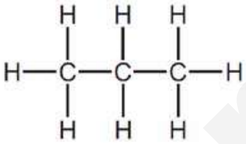
A



B



C



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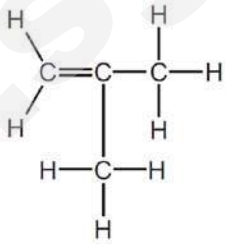
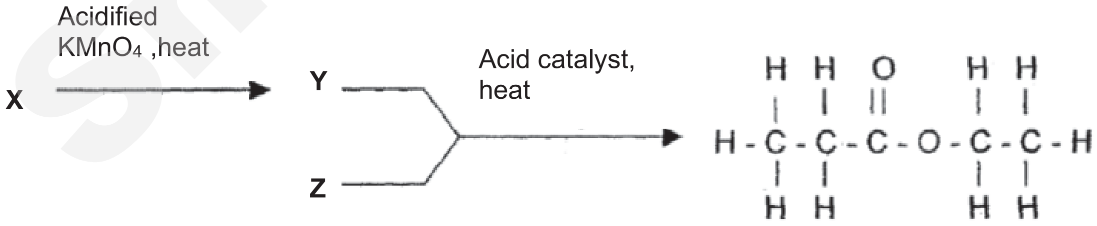


38 Under certain conditions, 1 mole of ethane reacts with 2 moles of chlorine in a substitution reaction.

What is the formula of the organic product in this reaction?

A C_2H_5Cl
B $C_2H_4Cl_2$
C $C_2H_2Cl_4$
D CH_2Cl_2

39 The following reaction scheme shows the reactions of three substances, **X**, **Y** and **Z**.

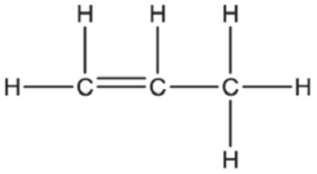


What are the molecular formulae of substances, **X**, **Y** and **Z**?

	X	Y	Z
A	C_3H_8O	$C_3H_6O_2$	C_2H_6O
B	C_2H_6O	$C_3H_6O_2$	C_2H_6O
C	C_3H_6	C_3H_8O	$C_2H_5O_2$
D	C_3H_8O	$C_4H_8O_2$	C_2H_6O

40 Which compounds would undergo polymerisation on their own?

1



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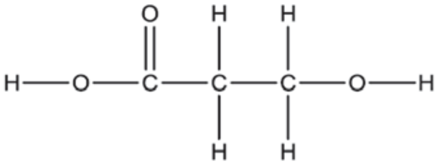

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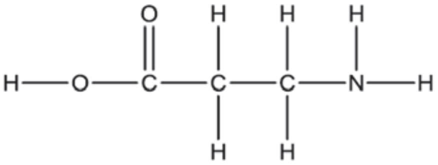

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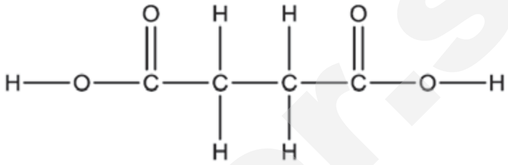

A 1 and 2 only
B 1, 2 and 3 only
C 1, 2, 3 and 4
D 2 and 3 only

- - - - - End of Paper 1 - - - -

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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	Reg. No	Class

MAYFLOWER SECONDARY SCHOOL

4EX

PURE CHEMISTRY

6092/02

Paper 2
[80 Marks]

PRELIMINARY EXAMINATION
September 2019
1 hour 45 minutes

Additional Materials:
Approved calculator

INSTRUCTIONS TO CANDIDATES:

Do not open this booklet until you are told to do so.
Write your name, index number and class in the spaces at the top of this page and on any separate answer paper used.
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 space provided.

Paper 2: Section B
Answer **three** questions in the space provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

FOR EXAMINER'S USE	
Section	**Marks**
Paper 1 MCQ	/ 40
Paper 2: A	/ 50
Paper 2: B	
B 8	/ 10
B 9	/ 10
B10 Either / Or	/ 10
Total	**/ 120**

INFORMATION FOR CANDIDATES:
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**.

This question paper consists of **22** printed pages

Setter: Chen Yanhui Timothy
Vetter: Mdm Jarina Banu

Section A (50 marks)

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

A1 **(a)** Choose from the list of gases to answer the questions.

ammonia
carbon monoxide
chlorine
butane
hydrogen
nitrogen
oxygen
propane
sulfur dioxide

Each gas can be used once, more than once or not at all.
Which gas:

(i) burns in air to give only water

....[1]

(ii) is acidic

....[1]

(iii) has a molecule containing only 11 atoms

....[1]

(iv) Is the most abundant gas in dry air

....[1]

(v) is released when calcium hydroxide is added to soil that contains the fertilizer ammonium nitrate?

....[1]

(b) 2 gases in the list reacts to form ammonia gas in the Haber Process.

(i) Write a balanced chemical equation for this reaction to form ammonia

....[2]

(ii) List the three optimal conditions for the formation of ammonia in Haber Process.

....

....[1]

[Total: 8]

A2 Sodium and calcium hydrides react with water to form the hydroxide and hydrogen.

$$NaH + H_2O \rightarrow NaOH + H_2$$

$$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$$

(a) **(i)** Deduce the general ionic equation for these reactions.

....[1]

(ii) Hence, explain why this reaction is considered a redox reaction, in terms of oxidation state.

....

....

....

....

....

....[3]

(b) Sodium is a soft metal with little catalytic activity.
Nickel is a hard metal which is often used as a catalyst.

(i) Describe two other differences in the physical properties of sodium and nickel.

1...

....

2...

....[2]

(ii) State one industrial use of nickel as a catalyst.

....[1]

[Turn over

(iii) Explain why an alloy of nickel and copper is less malleable than copper alone.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

[Total: 9]

A3 James is given four samples of metals. He labelled them **W**, **X**, **Y** and **Z** and carried out two experiments. His findings were as follows:

Experiment 1: Oxide of **W** would only react with **Z**.

Experiment 2: Oxide of **X** reacts with all metals but **not Y**.

(a) Arrange the four metals **W**, **X**, **Y** and **Z** in order of descending reactivity.

…………………………………………………………………………………………………[1]

(b) James noted that **X** is a silvery metal and has a melting point of 1528 °C.

He added a sample of **X** to a solution of dilute hydrochloric acid. This reaction produces a colourless gas and a coloured solution.

(i) Name the colourless gas.

………………………………………………………………………………………………[1]

(ii) When aqueous sodium hydroxide was added into the solution, a dirty-green precipitate was formed.

Determine the identity of **X**.

………………………………………………………………………………………………[1]

(iii) Hence, predict the identity of metal **Y**.

………………………………………………………………………………………………[1]

[Total: 4]

A4 Alcohols can react with copper(II) oxide to form compounds called aldehydes.

Table 4.1 shows the aldehyde formed from the respective alcohol.

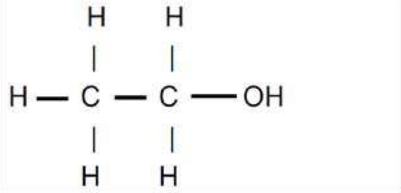
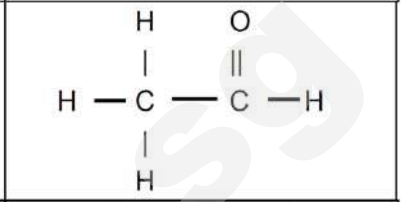
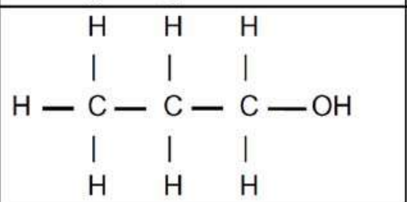
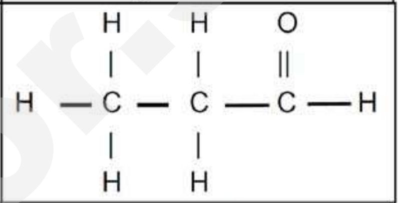
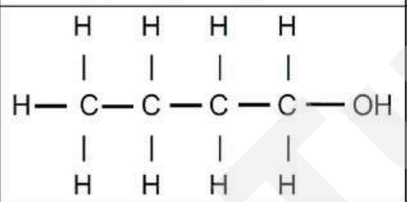
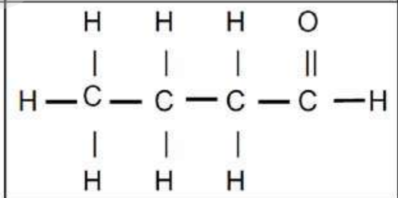
Alcohol	**Structural formula of alcohol**	**Aldehyde**	**Structural formula of aldehyde**
Ethanol		Ethanal	
Propanol		Propanal	
Butanol		Butanal	

Table 4.1

(a) Aldehydes are an example of a homologous series.

(i) Explain how the information in Table 4.1 show this.

....

....[1]

(ii) Predict three differences in physical property between ethanal and propanal.

....

....

....

....[2]

(b) A by-product from the reaction to form ethanal is water.

(i) Write a balanced chemical equation for the formation of ethanal.

....[1]

[Turn over

(ii) A sample of the alcohol with a mass of 15 g was used to make ethanal.

Determine the percentage purity of the ethanol if 11 g of ethanal was formed from the reaction.

[3]

(c) A student describes aldehydes as isomers of alcohol.

Explain, with a relevant example, whether this is a correct statement.

....

....

....

....

....[2]

[Total: 9]

A5 Carbon suboxide (O=C=C=C=O), C_3O_2 is a colourless compound discovered in 1873.

(a) Predict the physical state of carbon suboxide at room conditions. Explain your answer in terms of bonding and structure.

....

....

....

....[2]

(b) Draw a 'dot and cross' diagram to show the bonding in carbon suboxide, showing only outermost electrons.

[2]

(c) Theoretically this compound can be polymerized to produce polymers that are rigid, which has great potential for molecular nanotechnology.

(i) Name the type of polymerisation.

....[1]

(ii) Draw the structure of the polymer showing only 2 repeating units.

[2]

[Total: 7]

[Turn over

A6 Magnesium and calcium occur naturally in the mineral dolomite, $MgCO_3.CaCO_3$, a mixture of insoluble carbonates.

Useful products like magnesium sulfate and calcium sulfate can be obtained indirectly by adding dilute hydrochloric acid and some other chemicals into dolomite.

Calcium sulfate is used in the production of cement board and magnesium sulfate is used as fireproofing fabrics.

A simplified reaction scheme of the process is shown in Fig. 6.1.

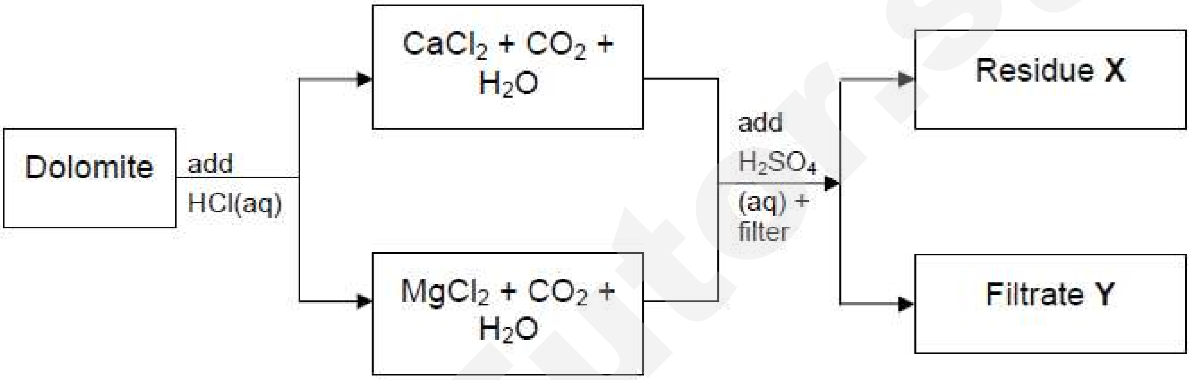


Fig. 6.1

(a) Identify residue **X** and filtrate **Y**.

residue X: ....

filtrate Y: ....[2]

(b) Explain why dolomite is added in excess to aqueous hydrochloric acid.

....

....[1]

(c) Describe the steps to obtain hydrated crystals from filtrate **Y**.

....

....

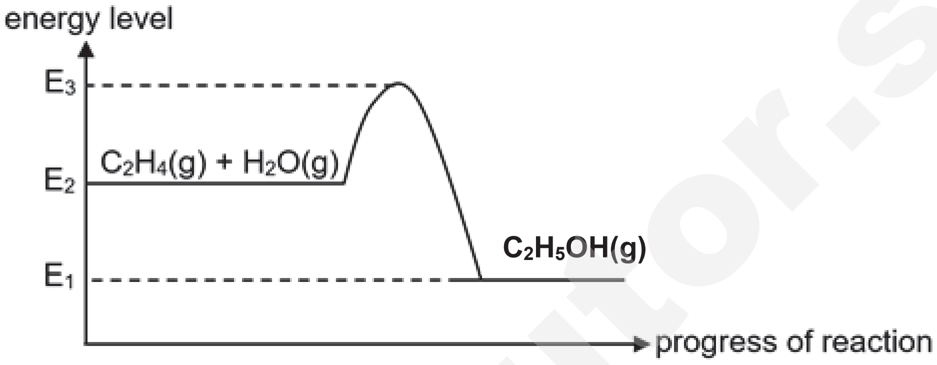
....[2]

[Total: 5]

A7 The reaction between ethene and steam is reversible as shown by the equation.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The energy profile diagram depicts the changes in energy levels as the forward reaction proceeds. [Grab your reader's attention with a great quote from the document or use this space to emphasize a key point. To place this text box anywhere on the page, just drag it.]



(a) What does each of the energy changes represent?

(i) E_2 – E_1 : ……………………………………………………………………………………………

(ii) $E_3 – E_1$: ……………………………………………………………………………………………

(iii) $E_3 – E_2$: ……………………………………………………………………………………………[3]

(b) The table shows some bond energies, measured in kilojoules per mole.

bond	bond energy in kJ / mol
H - H	436
C - O	358
O - H	463

bond	bond energy in kJ / mol
C - C	348
C = C	612
C - H	412

(i) Using the information given, calculate the enthalpy heat change of the forward reaction.

[Turn over

[2]

(ii) Explain, in terms of bond making and breaking, if the forward reaction results in any temperature change.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………….

……………………………………………………………………………………………………[3]

[Total: 8]

- - - - End of Section A - - - -

Section B (30 marks)

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 The polycarbonates are polymers which have organic functional groups linked together by carbonate groups.

There are many polycarbonates which vary in properties depending on their molecular mass and structure. As the molecular mass increases, the polymer becomes more rigid. Further, the properties are changed by blending it with other polymers, for example, with ABS and polyesters such as PET.

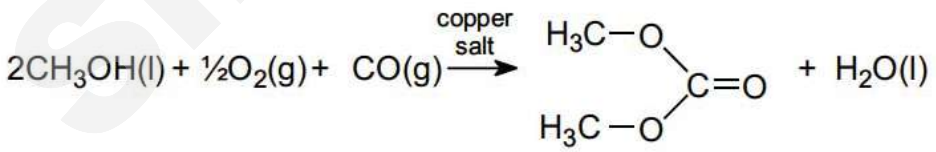
Polycarbonates used in engineering are strong, tough materials, and some grades are optically transparent. Application include the making of cell phone frames, data storage and aircraft components.

Disposal of objects containing polycarbonate in landfills is an issue as it forms BPA and carbon dioxide at higher temperatures. BPA is non-biodegradable and can leach into water bodies from the landfills. In addition, it leaches more over time as it ages in landfills.

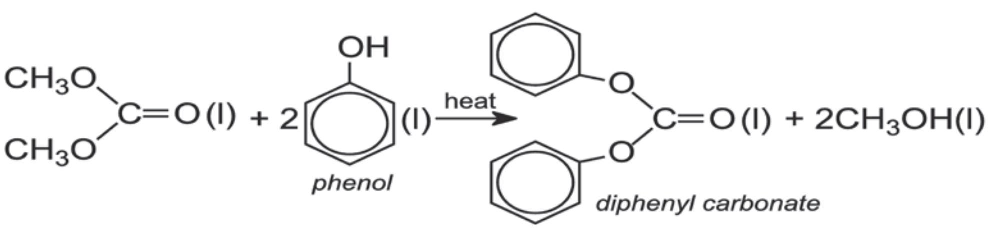
The polycarbonate can be manufactured by condensation polymerization between **bisphenol A** and **diphenyl carbonate**.

The production of diphenyl carbonate is a two-step process as shown below

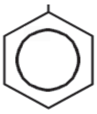
1. Reaction of **methanol**, oxygen and carbon monoxide, in the presence of a copper salt such as copper(II) chloride, to form dimethyl carbonate. The copper salt is not used up and can be recycled for further reactions.



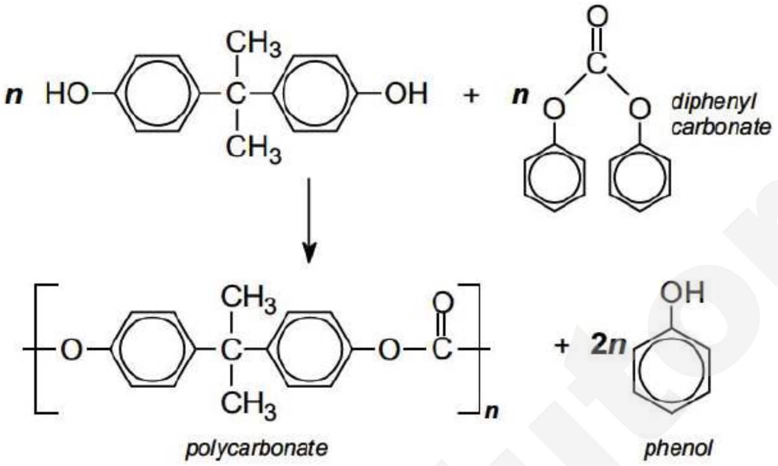
2. Dimethyl carbonate reacts with phenol to form diphenyl carbonate.



[Turn over

where  represents $\mathbf{C_6H_x}$

Finally, Bisphenol A and the diphenyl carbonate are heated together to form a molten mass of polymer:



The phenol and excess reactants are removed by distillation under reduced pressure.

(a) Draw the structural formula of the linkage that is present in polycarbonates.

[1]

(b) Based on the information given, predict the adverse effects on the environment due to the disposal of polycarbonates.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………….. [3]

(c) **(i)** State the role of copper(II) chloride in the first reaction. Explain how you reach this conclusion.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

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

(ii) If the relative mass of phenol is 94, predict the value of x in $\mathbf{C_6H_x}$.

[1]

(iii) The relative mass of the polycarbonate ranges from 18 000 to 32 000.

Find the minimum value of n for the polycarbonate and, hence, determine the minimum mass of phenol required for the formation of polycarbonates.

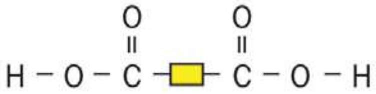
[3]

[Turn over

(d) Bisphenol A can also react with a dicarboxylic acid to form a polyester.

Draw the structural formula of the polyester formed.

The dicarboxylic acid can be represented by:



[2]

[Total: 12]

B9 Diagram 9.1 shows the electrolysis of dilute magnesium chloride.

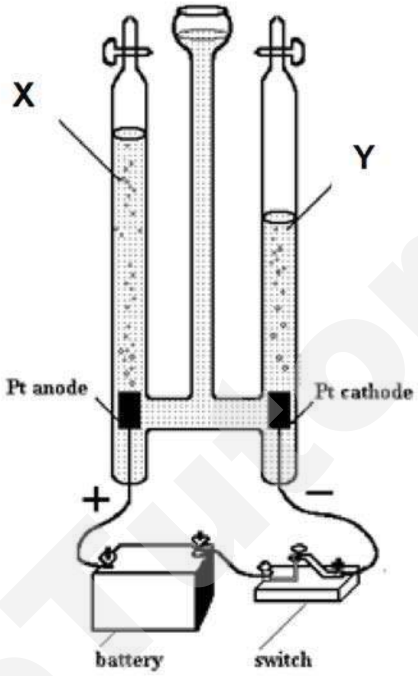


Diagram 9.1

(a) Write the balanced ionic equations, with state symbols, for the reactions at **X** and **Y**.

……

……[2]

(b) **(i)** Explain why the theoretical ratio of the volumes of gases collected at X and Y should be 1:2.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(ii) Knowing that the gas collected at **X** is much more soluble in water than that in **Y**, Explain how would the actual volume ratio compare to the one in theoretical?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

[Turn over

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

(c) A few drops of universal indicator is added to **Y**.

Determine and explain the observation at **Y**.

……………………………………………………………………………………..………………….

……………………………………………………………………………………………..………….

……[2]

[Total: 8]

Either

B10 Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.

Tiny particles of solids are produced when the fuel does not burn completely. This increases the level of particulates (PM10) in the atmosphere. These particles are small enough to pass through the throat and nose and enter the lungs.

One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels. Some of the relative amounts of these exhaust emissions are shown in Fig.10.1.

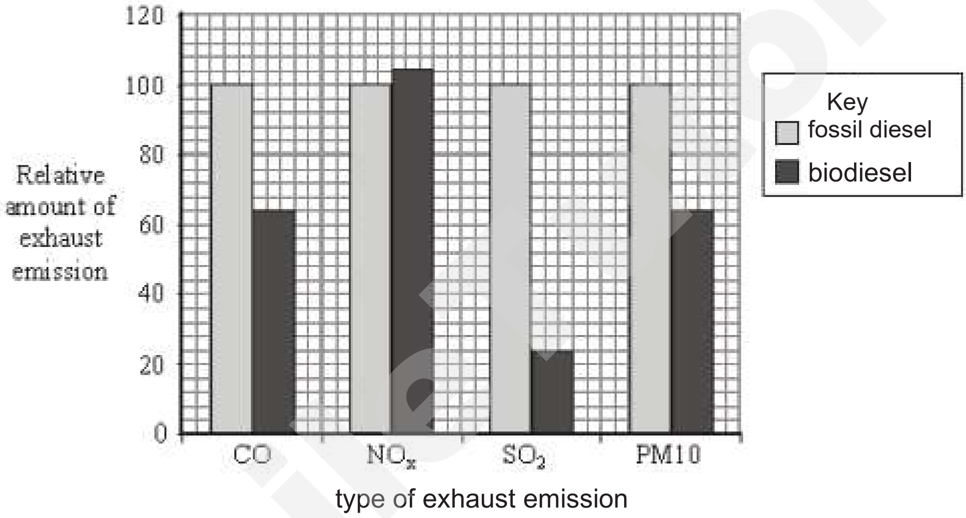


Fig. 10.1

(a) **(i)** Using the data given, compare the exhaust emission between fossil diesel and biodiesel.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

[Turn over

(ii) Exhaust emissions from fossil diesel cause more harm to human health than those from biodiesel. Explain why.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(b) Some scientists suggest that biodiesel is ***carbon neutral***. Explain why.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(c) Refrigerants are substances used to cool refrigerators and freezers. Until recently, many of the compounds used as refrigerants were chlorofluorocarbons (CFCs).

One such reaction with $CFCl_3$ is shown below.

$$CFCl_3 \xrightarrow{\text{UV light}} CFCl_2 + Cl$$

The Cl atom reacts with ozone in a two-step reaction.

Step 1: $Cl + O_3 \rightarrow ClO + O_2$
Step 2: $ClO + O \rightarrow Cl + O_2$

(i) One molecule of $CFCl_3$ can destroy thousands of ozone molecules. Explain why.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(ii) Fig. 10.2 below shows the mass and amount of carbon, fluorine and chlorine atoms in one mole of a certain compound of CFCs found in the aerosol can of hairspray.

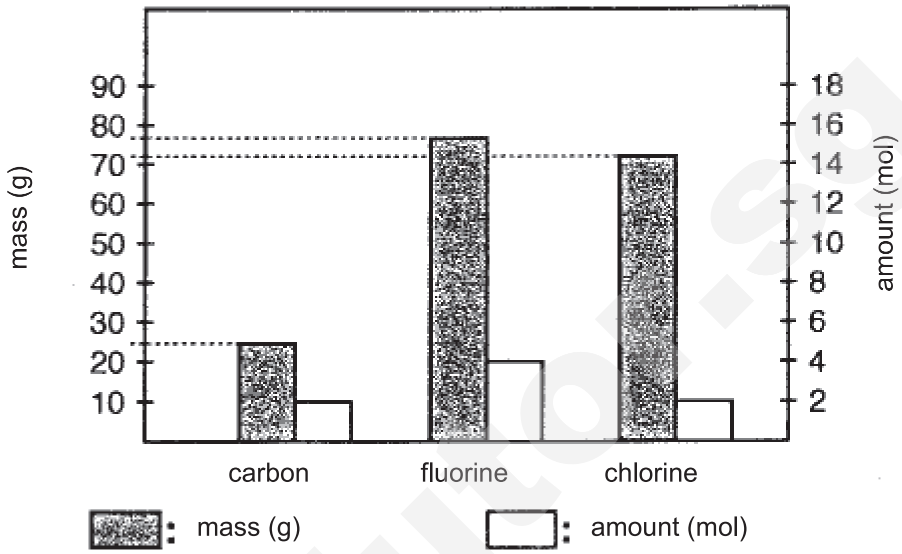


Fig. 10.2

Using the above information, determine the molecular formula of this CFCs compound.

[2]

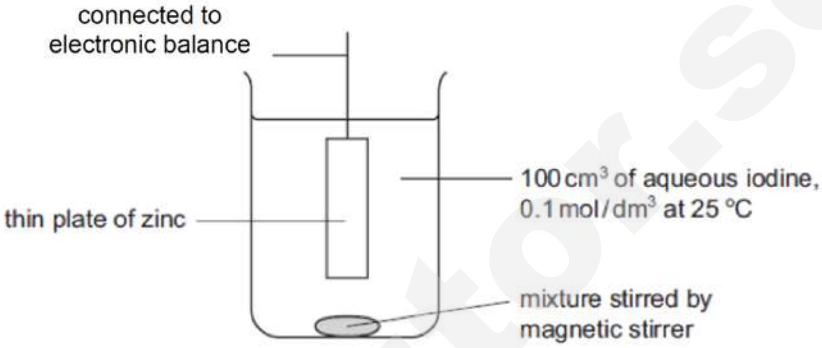
[Total: 10]

[Turn over

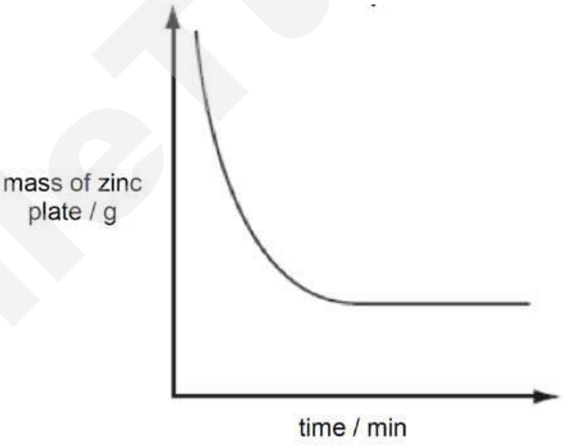
Or

B10 Zinc reacts with aqueous iodine to form zinc iodide. The following apparatus below was used to measure the rate of the reaction between zinc and aqueous iodine at 25 °C.

The mass of the zinc plate was measured every minute until the reaction was completed.



Graph 10.1 below shows the results obtained.



Graph 10.1

(a) Identify the reagent that was used in excess.

....[1]

(b) **(i)** The experiment was repeated with 100 cm^3 of 0.05 mol/dm^3 of aqueous iodine and keeping all other conditions the same. On the same axes as **Graph 10.1** above, sketch the curve that would be obtained and label it '**Y**'.

[1]

(ii) Explain the shape of the graph obtained in **(b)(i)**.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

(c) Explain, in terms of collisions between reacting particles, the effect on the speed of reaction if the experiment was repeated at 30 °C with all other conditions kept constant.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………[3]

(d) Aqueous chlorine was bubbled into zinc iodide solution.

(i) Write the chemical equation for the reaction.

…………………………………………………………………………………………………[1]

(ii) Explain, in terms of electron transfer, why this reaction is considered a redox reaction.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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

[Total: 10]

- - - - - End of Section B - - - -

- - - - - 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 –

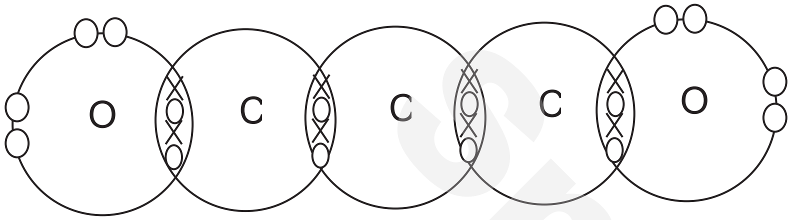
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

2019 Sec 4EX Prelims Pure Chem MS

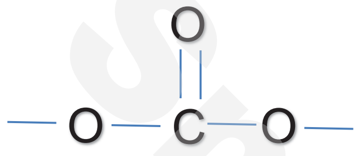
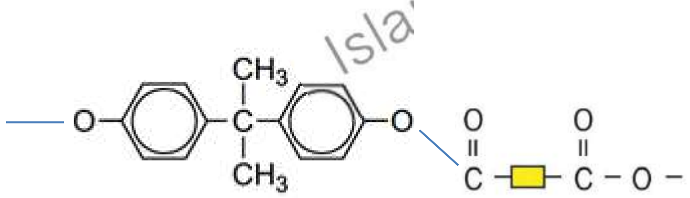
	MCQ							
1	D	**11**	D	**21**	B	**31**	D	
2	C	**12**	D	**22**	D	**32**	A	
3	D	**13**	C	**23**	C	**33**	B	
4	A	**14**	A	**24**	C	**34**	A	
5	B	**15**	D	**25**	D	**35**	B	
6	D	**16**	C	**26**	D	**36**	B	
7	A	**17**	B	**27**	B	**37**	D	
8	D	**18**	C	**28**	C	**38**	B	
9	A	**19**	A	**29**	B	**39**	A	
10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

	Section A			**Marks**	**Markers report**
A1	**(a)** **(b)** **(c)** **(d)** **(e)**	hydrogen sulfur dioxide propane nitrogen ammonia		[1] [1] [1] [1] [1]	
	(f)	**(i)** **(ii)**	$N_2 + 3H_2 \leftrightharpoons 2NH_3$ 450 – 500 °C 200 – 250 atm Powdered iron as catalyst	[1] [2 for 1m, 3 for 2m]	
A2	**(a)**	**(i)**	$H^+ + H_2O \rightarrow OH^- + H_2$	[1]	
		(ii)	Hydrogen has been reduced as the oxidation state of hydrogen decreases from +1 to 0 while Hydrogen ion has been reduced as the oxidation state of hydrogen increases from -1 to 0.	[0.5] [1] [0.5] [1]	
	(b)	**(i)**	Nickel has a much higher density compared to sodium Nickel has a much higher melting point compared to sodium	[1] [1]	
		(ii) **(iii)**	For the hydrogenation of vegetable oil to margarine. Since an alloy of nickel and copper consist of atoms of different	[1] [1]	

			sizes, Therefore, this disrupts the regular arrangement of the pure metal, making it harder to slide when a force is applied As a result, this causes it to be less malleable.	[1]	
A3	**(a)**	Z, W, X, Y		[1]	
	(b)	**(i)**	hydrogen gas	[1]	
		(ii)	iron	[1]	
		(iii)	lead / copper / silver	[1]	
A4	**(a)**	**(i)**	It has a functional group of CHO / it has a general formula of $C_nH_{2n+1}CHO$.	[1]	
		(ii)	Propanal has a higher melting / boiling point than ethanal Propanal has a higher viscocity than ethanal Propanal has a lower flammability than ethanal	[2 for 1m, 3 for 2m] [1] [1]	
	(b)	**(i)**	$C_2H_5OH + CuO \rightarrow CH_3CHO + Cu + H_2O$	[1]	
		(ii)	Mole of ethanal = 11 / 44 = 0.25 mol Mole ratio of ethanol: ethanal = 1:1 =0.25:0.25 Mass of ethanol = 0.25 * 46 = 11.5g Therefore, % purity of ethanol = 11.5 / 15 = 76.7 %	[1] [1]	
	(c)	Comparing relevant example (e.g ethanol and ethanal) with the same number of carbon atoms, the number of hydrogen atoms are different. Therefore, they are not isomers as this will result in different molecular formula.		[1] [1]	
A5	**(a)**	It should be a gas at room temperature. This is because it exist as a simple molecular structure in which molecules are held by weak intermolecular forces.		[1] [1]	

	(b)			[1m for the correct number of sharing electrons, 1m for correct number of unshared valence electrons]	
	(c)	**(i)** **(ii)**	Addition polymerisation	[1m for 2 repeat units, 1m for correct arrangement of a repeat unit]	
A6	**(a)**	Calcium sulfate Magnesium sulfate		[1] [1]	
	(b)	To make sure all the acid has been reacted.		[1]	
	(c)	Heat until a saturated solution is formed Cool the solution, crystallisation takes place Filter the crystals to remove left over solution / Dry crystals between filter paper		[1] [1]	
A7	**(a)**	**(i)**	$E_2 – E_1$: enthalpy change/ ΔH $E_3 – E_1$: activation energy for backward reaction $E_3 – E_2$: activation energy for forward reaction.	[1] [1] [1]	
	(b)	**(i)**	Bond breaking: (1 x 612)+(4 X 412) + (2 x 463) = +3186 kJ	[1]	

			Bond making: (5 x 412) + 463 + 348 + 358 = -3229 kJ	[1]	
			Overall Enthalpy = +3186kJ -3229kJ = -43 kJ		
		(ii)	less energy is taken in during the breaking of bonds in ethane and steam molecules compared to	[1]	
			energy given out during making of bonds in ethanol molecules	[1]	
			Therefore, energy is released to the surroundings which raises temperature.	[1]	

	Section B				
B8	**(a)**			[1]	
	(b)	Disposal of polycarbonates results in the formation of BPA and carbon dioxide. Carbon dioxide is a greenhouse gas which will result in global warming. In addition, BPA is non-biodegradable and can leach into water bodies which could cause harm to marine life. It leaches more over time as it ages in the landfills		[1] [1] [1]	
	(c)	**(i)**	It is acting as a **catalyst** for the reaction. It is not used up over time.	[1] [1]	
		(ii)	94 – 16 – 6(12) – 12 = 4 Therefore, x = 4.	[1]	
		(iii)	n for the polycarbonate = 18 000 / (4 * 76 + 4*12 + 3*16 + 6) = 44.33 ≈ 45	[1]	
			45 moles of diphenyl carbonate is required to form the poly carbonate. Therefore, 90 moles of phenol is required.	[1]	
			Mass of phenol required = 90 * 94 = 8460 g.	[1]	
	(d)			[1m for correct formula, 1m for n]	

B9	**(a)**	X: $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$ Y: $2H^+(aq) + 2e^- \rightarrow H_2(g)$		[1] [1]	
	(b)	**(i)**	The overall equation of the electrolysis: $2H_2O \rightarrow 2H_2 + O_2$ Therefore, 1 mole of oxygen is formed at X for every moles of hydrogen formed at Y. / For every **4** moles of electrons, 1 mole of oxygen gas is formed at X while 2 moles of hydrogen are formed at Y.	[1] [1] [1] [1]	
		(ii)	Since oxygen is more soluble than hydrogen, less oxygen will be collected at X. Therefore, the ratio of hydrogen collected compared to oxygen will be greater than 2:1	[1] [1]	
	(c)	The universal indicator will turn purple at Y The is because there is a reduction in H^+ ions, resulting in a decrease in acidity / increase in alkalinity		[1] [1]	
B10	**(a)**	**(i)**	The amounts of CO, SO_2 and PM10 emissions are lower when using biodiesel than fossil diesel. [1] On the contrary, the amount of NOx exhaust emission is higher when burning biodiesel than fossil diesel. [1]	[1] [1]	
		(ii)	There is more amount of CO produced. CO is a pollutant which binds irreversibly with haemoglobin in red blood cell to form carboxyhaemoglobin, impairing its ability to transport oxygen causing breathing difficulties and death. There is more SO_2 produced. SO_2 irritate the eyes and lungs and causes breathing difficulties	[1] [1]	
	(b)	Burning of biodiesel releases CO_2 to the atmosphere. Biodiesel is formed from plants which absorb CO_2 in the atmosphere during photosynthesis.		[1]	

[Turn over

Hence there is no net increase of CO_2 in the atmosphere. [1]

(c) **(i)** One molecule of $CFCl_3$ produces a Cl atom under UV light which reacts with one molecule of O_3 to form one molecule of ClO [1]

Another Cl atom is regenerated when one molecule of ClO reacts with an O atom. [1]

(ii) From graph,

	C	F	C*l*
moles	2	4	2
simplest ratio	1	2	1

The empirical formula is CF_2Cl. [1]

From graph,

	C	F	C*l*
Mass of 1 mole of compound/g	24	76	71

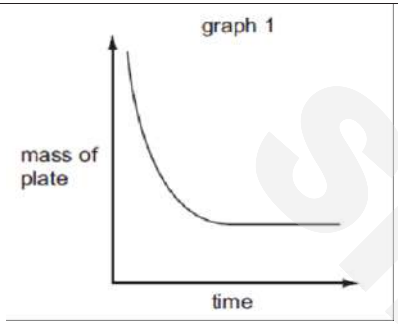
Mr of CFCs = 171

n = 2

Molecular formula is $C_2F_4Cl_2$ [1]

Or B10 **(a)** zinc [1]

[Turn over

	(b)	**(i)**		[1]	
		(ii)	Gradient is less steep as the concentration of iodine is halved, resulting in a slower speed of reaction. Half the mass of zinc reacted since only half the number of mole of the limiting reagent, iodine is present.	[1] [1]	
	(c)		At 15 °C, the zinc atoms and iodine molecules have lower kinetic energy. Hence, less particles have energy greater or equal to the activation energy. The frequency of effective collisions between the zinc atoms and iodine molecules decreases. Hence, speed of reaction decreases.	[1] [1] [1]	
	(d)	**(i)**	$ZnI_2 + Cl_2 \rightarrow ZnCl_2 + I_2$	[1]	
		(ii)	I^- loses electrons to form I_2 while Cl_2 gains electrons to form Cl^- ions Therefore, I^- has being oxidised while Cl_2 is reduced	[1] [1]	

Name: ………………………………………………….. (   )   Class: Sec 4A

Queenstown Secondary School

Preliminary Examination 2019
Secondary Four Express
Chemistry
6092/01

4 September 2019
Wednesday

Time: 1145 – 1245h
Duration: 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, class and index number on the Answer Sheet in the spaces provided.

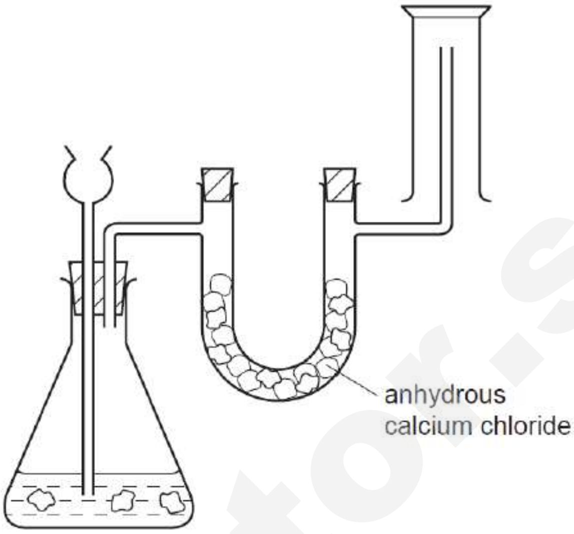
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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 on page 18.
The use of an approved scientific calculator is expected, where appropriate.

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

1 The diagram shows a simple laboratory apparatus for the preparation and collection of a dry gas.



What is the gas?

A carbon dioxide **C** hydrogen

B chlorine **D** hydrogen chloride

2 A student accidentally mixed 50 cm^3 of hexane with 50 cm^3 of sodium chloride solution.
Which methods would allow him to obtain pure samples of hexane and solid sodium chloride respectively?

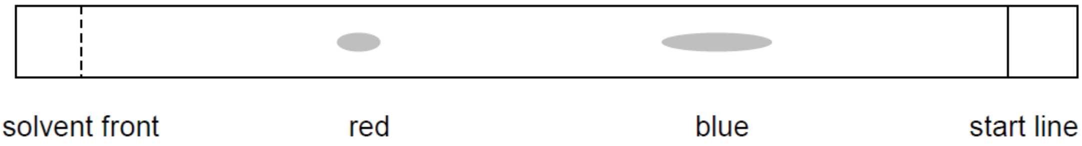
A filtration followed by crystallisation

B fractional distillation followed by evaporation to dryness

C simple distillation followed by crystallisation

D using a separating funnel followed by evaporation to dryness

3 The paper chromatogram of a sweet is shown in the diagram.



Which of the following statements can be deduced from the chromatogram?

A The sweet is blue in colour.

B The red dye has a higher solubility than that of the blue dye.

C The molecules of the blue dye are heavier than that of the red dye.

D The R_f value of the blue dye is greater than that of the red dye.

4 Four bottles containing colourless solutions have no labels.

A series of individual tests are carried out on each of the solutions.

Which bottle contains aluminium nitrate solution?

	test 1: add excess aqueous sodium hydroxide	test 2: add excess aqueous ammonia	test 3: add warm aqueous sodium hydroxide with Al foil
A	white precipitate formed, soluble in excess	white precipitate formed, insoluble in excess	white precipitate formed; gas produced which turns damp red litmus blue
B	white precipitate formed, soluble in excess	white precipitate formed, soluble in excess	white precipitate formed
C	white precipitate formed, insoluble in excess	white precipitate formed, insoluble in excess	white precipitate formed
D	white precipitate formed, insoluble in excess	white precipitate formed, soluble in excess	white precipitate formed; gas produced which turns damp red litmus blue

5 The rate of diffusion of methane and butane was compared at 30°C and 70°C.

Which would have the fastest rate of diffusion?

A butane at 30°C

B butane at 70°C

C methane at 30°C

D methane at 70°C

6 An ion, X^{2-}, has a mass number of m and it contains n electrons.

What does the nucleus of an atom of X contain?

	number of protons	number of neutrons
A	n – 2	m – n
B	n – 2	m – n + 2
C	n + 2	m – n + 2
D	n + 2	m – n – 2

7 A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance **cannot** be an element?

A It has a fixed melting point.

B When heated in air, it forms two oxides.

C It dissolved in water to give a colourless solution.

D Electrolysis of the molten substance gave two products.

8 In the lattice structure of ionic compounds, the coordination number of each ion is the number of neighbouring ions of opposite charge.

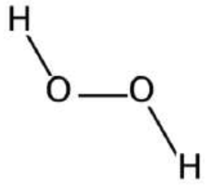
The table below shows the ions present and the coordination number of the ions in some ionic compounds. Taking sodium chloride for instance, each sodium ion is surrounded by 6 chloride ions, while each chloride ion is surrounded by six sodium ions. Hence, the coordination number for both the sodium ions and chloride ions is 6.

ionic compound	ions present		coordination number of		formula
	cation	anion	cation	anion	
sodium chloride	Na^+	Cl^-	6	6	NaC*l*
titanium(IV) oxide	Ti^{4+}	O^{2-}	6	3	TiO_2
P	Q	R	4	8	?

Using information from the table, what is the formula for compound P?
What is the formula of compound P?

A QR_2 **B** Q_2R **C** QR_4 **D** Q_4R

9 The diagram shows the structural formula of hydrogen peroxide.



Which statement is true of the number of electrons in the molecule?

	total number of electrons used in bonding	total number of electrons **not** used in bonding
A	4	4
B	6	6
C	4	8
D	6	12

10 Fibreglass is used as a reinforcing agent in many polymer products.
It contains a mixture of ionic oxides and giant covalent oxides.

Which substance is **not** a possible constituent of fibreglass?

A CaO	**B** Cr_2O_3	**C** P_4O_9	**D** SiO_2

11 The following shows information on bronze, boron nitride and silicon carbide.

- Bronze is an alloy of copper and tin.
- Boron nitride, BN, has a structure similar to graphite.
- Silicon carbide, SiC, has a structure similar to diamond.

Which of the statements about their physical properties are correct?

1 All atoms are bonded covalently.
2 All have high melting and boiling point.
3 All except bronze are soluble in organic solvent.
4 All except silicon carbide conduct electricity when solid.

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

12 In leaded petrol, an additive is added.
This additive is a compound made up of lead, carbon and hydrogen only.
An analysis of this compound shows that it contains 29.7% carbon and 6.19% hydrogen by mass.

What is the value of x in the empirical formula, PbC_8H_x?

A 5	**B** 10	**C** 15	**D** 20

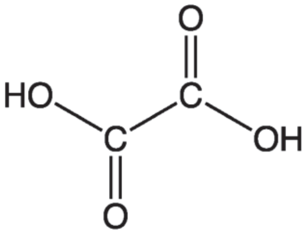
13 Upon strong heating, a metal nitrate compound undergoes decomposition according to the following equation:

$$2XNO_3\ (s) \rightarrow 2X\ (s) + 2NO_2\ (g) + O_2\ (g)$$

Complete decomposition of 3.40 g of the nitrate gives 240 cm^3 of oxygen, measured at room temperature and pressure. What is the relative atomic mass of X?

A 85	**B** 108	**C** 133	**D** 170

14 The structure of oxalic acid is shown.

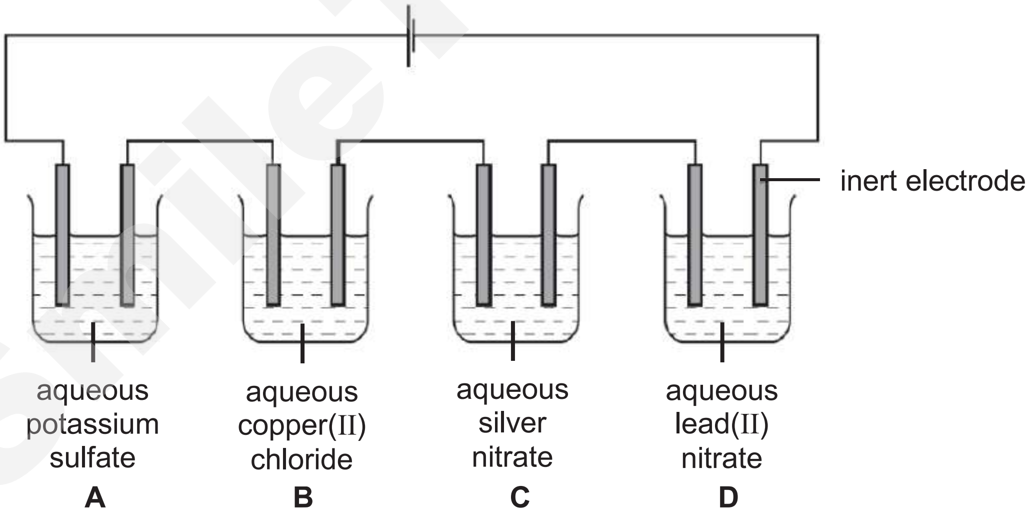


A 25.0 cm^3 solution of oxalic acid reacts completely with 15.0 cm^3 of 2.50 mol/dm^3 aqueous sodium hydroxide. What is the concentration of the oxalic acid?

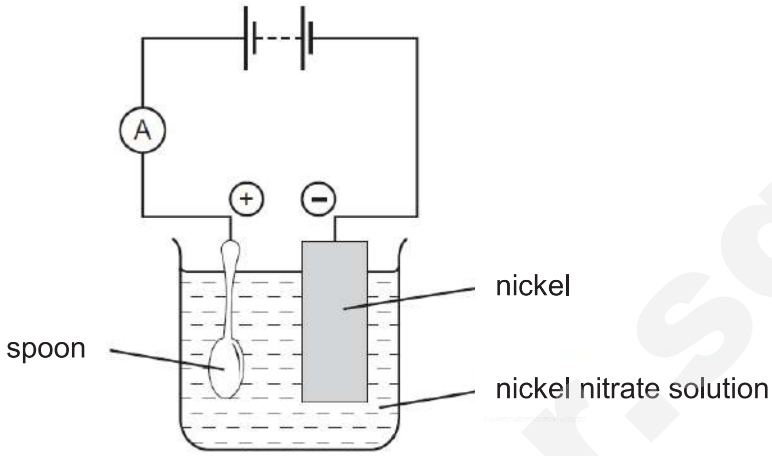
A 0.750 mol/dm^3 **B** 2.08 mol/dm^3 **C** 1.50 mol/dm^3 **D** 4.17 mol/dm^3

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

[A_r: K, 39; Cu, 64; Ag, 108; Pb, 207]



16 The apparatus shown below was set up to electroplate the metal spoon with nickel.



The experiment did **not** work. What was the mistake in the apparatus?

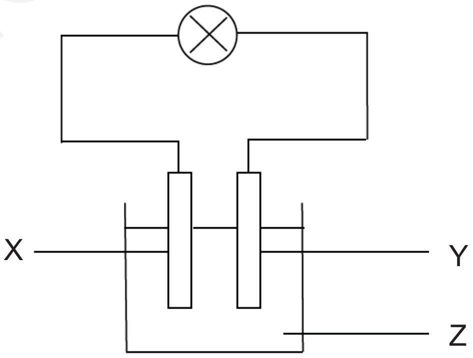
A A variable resistor should be included in the electrical circuit.

B Dilute nitric acid should be used as the electrolyte.

C The nickel electrode should be fully immersed in the solution.

D The spoon should be the negative electrode.

17 A simple cell was set up to light up a bulb, as shown in the diagram.



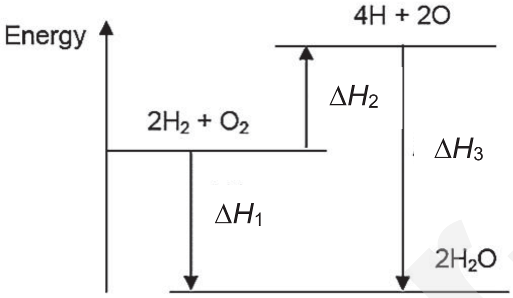
What should X, Y and Z be for the bulb to light up the brightest?

	X	Y	Z
A	lead	zinc	dilute salt solution
B	lead	iron	dilute sugar solution
C	silver	zinc	dilute salt solution
D	silver	iron	dilute sugar solution

18 Hydrogen and oxygen react to form steam, as shown in the equation below.

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

The energy level diagram below represents this reaction.



Which symbols represent the energy involved in bond breaking and formation?

	energy involved in bond breaking only / kJ	energy involved in bond formation only / kJ
A	ΔH_1	ΔH_2
B	ΔH_1	ΔH_3
C	ΔH_2	ΔH_1
D	ΔH_2	ΔH_3

19 Phosphorus pentachloride, PCl_5, is a dangerous substance as it reacts violently with water. It is also corrosive when in contact with skin and can be fatal when inhaled.

Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating.

$$PCl_5\,(g) \rightarrow PCl_3\,(g) + Cl_2\,(g)$$

The table below gives the bond energies.

bond	bond energy / kJ mol^{-1}
P – C*l*	330
C*l* – C*l*	240

What is the enthalpy change of the decomposition of phosphorus pentachloride?

A +90 kJ **B** -90 kJ **C** +420 kJ **D** -420 kJ

20 Hydrogen peroxide can be used for the sterilisation of surgical tools.
It decomposes according to the equation:

$$2H_2O_2\,(aq) \rightarrow 2H_2O\,(l) + O_2\,(g)$$

What would be the effect on the initial rate of reaction and the volume of oxygen gas produced, if an equal volume of water was added to the hydrogen peroxide solution at the start of the reaction?

	initial rate of reaction	volume of oxygen gas produced
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	unchanged	unchanged

21 In which reaction is pressure **least** likely to affect the rate of reaction?

A $N_2\,(g) + 3H_2\,(g) \rightarrow 2NH_3\,(g)$
B $HCl\,(g) + NH_3\,(g) \rightarrow NH_4Cl\,(s)$
C $CO_2\,(g) + Ca(OH)_2\,(aq) \rightarrow CaCO_3\,(s) + H_2O\,(l)$
D $NaOH\,(aq) + HCl\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l)$

22 Chromium and manganese are two transition elements.
In which of the following pairs is the oxidation number of chromium more than that of manganese?

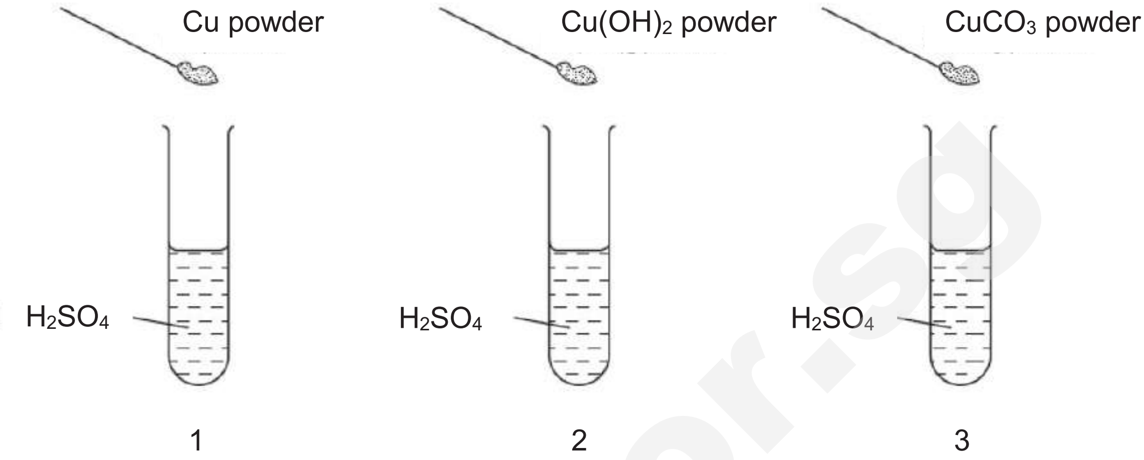
A $K_2\underline{Cr}O_4$ and $K\underline{Mn}O_4$
B $\underline{Cr}Cl_3$ and $\underline{Mn}O_2$
C $\underline{Cr}_2(SO_4)_3$ and $\underline{Mn}SO_4$
D $K_2\underline{Cr}_2O_7$ and $\underline{Mn}O_4^-$

23 Which of the following illustrates a correct result of adding an oxidising agent?

A It turns aqueous potassium iodide brown.
B It turns aqueous iron(III) nitrate pale green.
C It turns aqueous copper(II) sulfate colourless.
D It turns acidified aqueous potassium manganate(VII) colourless.

24 The diagrams show three experiments using sulfuric acid.

Three different powders are added to the acid. The mixtures are stirred.



Which test-tubes will contain aqueous Cu^{2+} ions?

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

25 A solution of a salt X gives an insoluble hydroxide Y on reacting with aqueous sodium hydroxide. Y dissolves in excess aqueous sodium hydroxide to give solution Z. On adding dilute hydrochloric acid to Z, the precipitate Y reappears but dissolves in excess dilute hydrochloric acid.

What is the nature of hydroxide Y?

A acidic
B amphoteric
C basic
D neutral

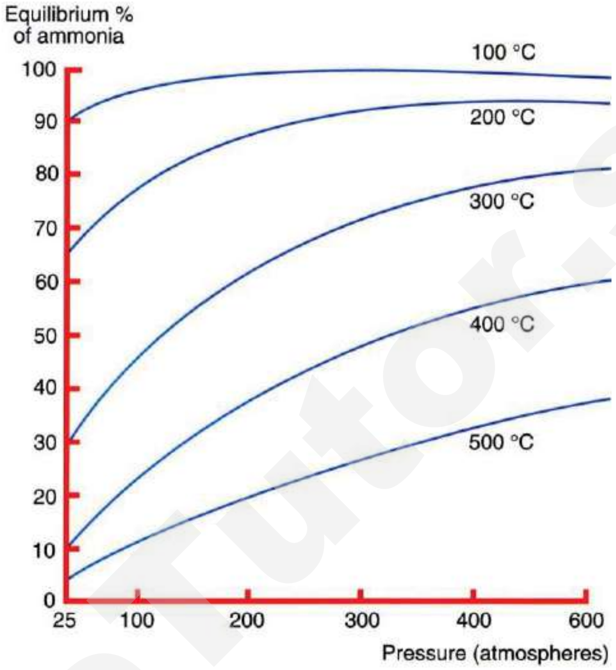
26 Which of the following method could **not** be used to prepare a dry sample of lead salt?

	name of salt	method
A	lead(II) carbonate	add aqueous sodium carbonate to aqueous lead(II) nitrate
B	lead(II) chloride	add hydrochloric acid to aqueous lead(II) nitrate
C	lead(II) iodide	add nitric acid to lead(II) carbonate, then add aqueous potassium iodide
D	lead(II) sulfate	add sulfuric acid to lead(II) carbonate

27 Ammonia is produced from Haber Process using a suitable catalyst.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

The following graph shows the different yields of ammonia at different temperature and pressure.



Which of the following is **not** true?

A A higher percentage yield of ammonia can be obtained at higher pressure.

B A higher percentage yield of ammonia can be obtained at lower temperature.

C Some of the ammonia formed will decompose to form hydrogen and nitrogen.

D At the right conditions of temperature and pressure, all of the hydrogen and nitrogen can be converted into ammonia.

28 Germanium, Ge, is in the same group as carbon and silicon in the Periodic Table.

Which is the correct formula for its chloride, hydride and oxide?

	chloride	hydride	oxide
A	$GeCl$	GeH	GeO
B	$GeCl$	GeH_4	GeO_2
C	$GeCl_4$	GeH	GeO
D	$GeCl_4$	GeH_4	GeO_2

29 Excess bromine is shaken with a mixture of sodium chloride and sodium iodide solutions. Which substances will the final mixture contain?

- **A** bromine, iodine, sodium bromide
- **B** bromine, iodine, sodium bromide, sodium chloride
- **C** bromine, iodine, sodium bromide, sodium iodide
- **D** iodine, sodium bromide, sodium chloride

30 In an experiment to determine the order of reactivity, metals Q, R and S were placed into four separate solutions containing aqueous metal ions.

metal	aqueous metal ion			
	P^{2+}	Q^{2+}	R^{2+}	S^{2+}
Q	✓	✗	✓	✓
R	✗	✗	✗	✗
S	✗	✗	✓	✗

What is the order of reactivity of the metals?

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

31 Approximately 40% of all iron and steel are produced by recycling.

The following statements are possible reasons for recycling iron.

1 Recycling reduces the need to collect scrap iron and steel.
2 Recycling reduces the amount of waste taken to landfill sites.
3 Recycling reduces the amount of pollution at the site of the ore extraction.
4 Scrap steel contains a higher percentage of iron than iron ore.

Which of the statements are correct?

- **A** 1 and 2 only
- **B** 1, 2 and 3 only
- **C** 1, 2 and 4 only
- **D** All of the above

32 An iron nail takes three days to rust completely when exposed to water and air. Two different metals, X and Y, are attached separately to the same type of iron nail. The time taken for the iron nail to rust completely is measured and shown in the following table.

metal attached to iron nail	time taken for iron nail to rust / days
X	2
Y	5

Using the data above, arrange iron, metal X and metal Y, in ascending order of their reducing power.

A iron, X, Y

B X, iron, Y

C Y, X, iron

D Y, iron, X

33 Biodiesel, an alternative fuel made from vegetable oil, can be used as a fuel for vehicles. Although carbon dioxide is released during the combustion of biodiesel, scientists still claim that it is a carbon neutral fuel.

Which is the basis for this claim?

A Biodiesel is not a carbon compound.

B Biodiesel produces less carbon dioxide when it burns.

C Plants release carbon dioxide during respiration.

D Plants absorb carbon dioxide during photosynthesis.

34 Petrol and diesel are two common fuels used by cars and buses respectively. The combustion of these fuels produces air pollutants. The following table shows the mass of pollutants found in the exhaust fume when 1 kg of each fuel is burnt.

pollutant	mass of pollutant in petrol engine / g	mass of pollutant in diesel engine / g
carbon monoxide	14	10
oxides of nitrogen	30	60
sulfur dioxide	1	4
unburnt hydrocarbons	15	20

Which of the following statements can be inferred using the data in the table?

A Petrol contributes more towards the formation of acid rain.

B The temperature in petrol engine is lower than that in diesel engine.

C The amount of oxygen in petrol engine is higher than that in diesel engine.

D All the pollutants listed in the table can be removed by installing a catalytic converter.

35 Petrol and diesel are fractions obtained from the fractional distillation of petroleum.

Which row explains why petrol is collected above diesel?

	relative molecular mass of petrol	boiling point of petrol	flammability of petrol
A	lower than diesel	higher than diesel	lower than diesel
B	higher than diesel	higher than diesel	higher than diesel
C	lower than diesel	lower than diesel	higher than diesel
D	higher than diesel	lower than diesel	lower than diesel

36 The table shows the properties of four hydrocarbons.

hydrocarbon	1	2	3	4
state at room temperature	gas	gas	liquid	liquid
reaction with aqueous bromine	decolourises bromine	no reaction	decolourises bromine	no reaction

Which of the following statements is true of the hydrocarbons?

A Hydrocarbons 1 and 2 are in the same homologous series.

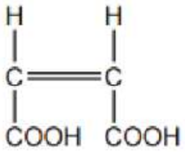
B Hydrocarbon 1 is less viscous than hydrocarbon 3.

C Hydrocarbons 2 and 4 are unsaturated.

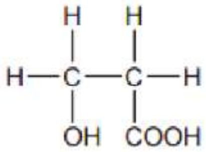
D Hydrocarbon 3 could be ethene.

37 The structures of compounds W, X, Y and Z are shown below.

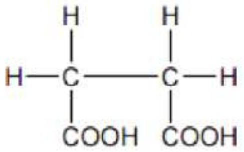
W



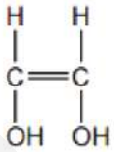
X



Y



Z



What reactions do compounds W, X, Y and Z undergo?

	decolourises aqueous bromine	decolourises acidified aqueous potassium manganate(VII)	effervescence with aqueous sodium carbonate
A	X and Y	X and Z	W and Y
B	X and Y	W, X and Y	W and Y
C	W and Z	X and Z	W, X and Y
D	W and Z	W, X and Y	W, X and Y

38 Two esters have the same molecular formula, $C_3H_6O_2$.

What are the names of these two esters?

1 methyl ethanoate
2 ethyl methanoate
3 ethyl propanoate
4 propyl methanoate

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

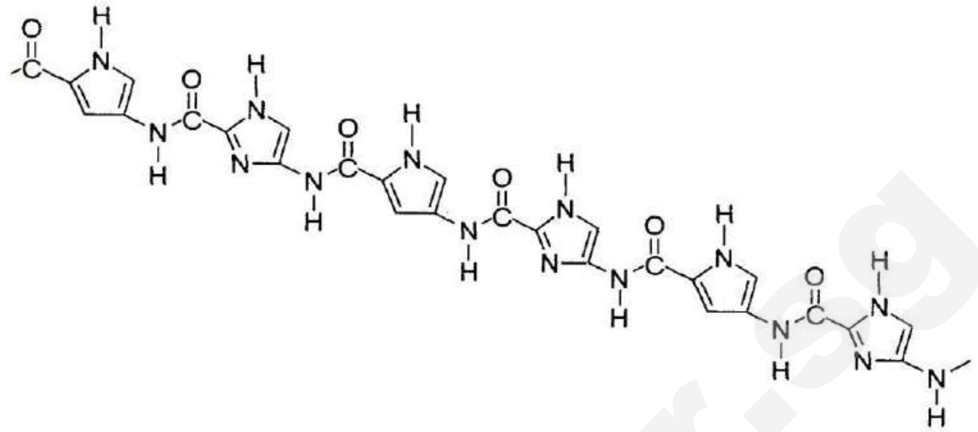
39 Engine oil is used to lubricate the car engine. Certain polymers are added to improve the viscosity of engine oil. A portion of the chain of one such polymer is shown below.

$$–CH_2–CH(CH_2CH_2CH_3)–CH_2–CH(CH_2CH_2CH_3)–CH_2–CH(CH_2CH_2CH_3)–$$

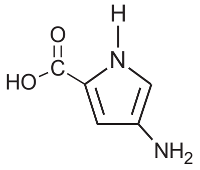
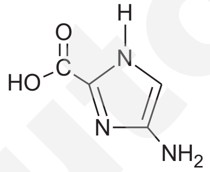
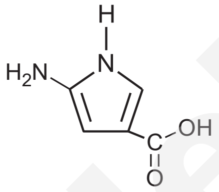
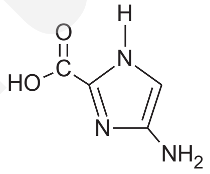
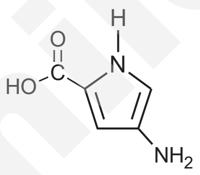
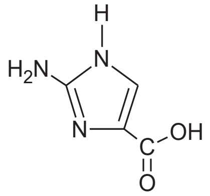
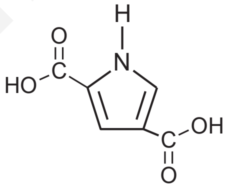
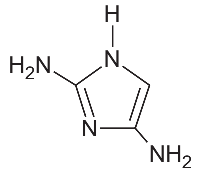
A molecule of this polymer contains 40 carbon atoms. How many molecules of monomer are required to form one molecule of this polymer?

A 4 **B** 5 **C** 8 **D** 10

40 The structure below shows part of a polymer.



Which one of the following options show the correct monomers?

A		
B		
C		
D		

[insert Periodic Table here]

Name: ………………………………………………….. (   )   Class: Sec 4A

Queenstown Secondary School

Preliminary Examination 2019
Secondary Four Express
Chemistry
6092/02

27 August 2019
Tuesday

Time: 1100 – 1245h
Duration: 1 hour 45 minutes

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

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 or graphs.
Do not use staples, paper clips, 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.
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 21.

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

Examiner's Use	
Section A	/50
Section B	/30
B1	
B2	
B3	
TOTAL	**/80**

This document consists of **21** printed pages.

Section A

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

The total mark for this section is 50.

A1 Choose from the following substances to answer the questions.

ammonium sulfate	**calcium sulfate**	**carbon tetrachloride**
copper(II) chloride	**hydrogen chloride**	**magnesium nitrate**
	zinc iodide	

Each substance can be used once, more than once or not at all.

Name the substance which

(a) produces a gas that turns damp red litmus paper blue only when reacted with warm aqueous sodium hydroxide and aluminium foil,

.... [1]

(b) reacts with water to form a solution that turns the Universal Indicator red,

.... [1]

(c) is produced from a substitution reaction,

.... [1]

(d) when dissolved in water leads to a decrease in the temperature of water,

.... [1]

(e) contains both ionic and covalent bonding,

.... [1]

(f) is prepared by reacting aqueous solutions followed by filtration,

.... [1]

(g) is prepared by the use of a pipette and burette.

.... [1]

[Total: 7]

A2 There are four bottles of solutions, silver nitrate, copper(II) nitrate, potassium carbonate and hydrochloric acid.

Julian mixed the pairs of the solutions together and obtained the following results.

reactants	observation
solution **P** and solution **Q**	no visible reaction
solution **R** and solution **Q**	green precipitate
solution **S** and solution **R**	effervescence formed
solution **P** and solution **R**	white precipitate
solution **P** and solution **S**	white precipitate

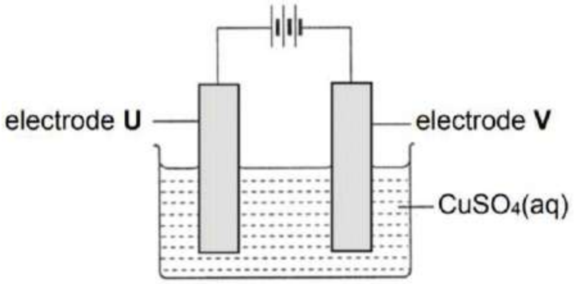
Use information in the table to identify the four solutions.

reactants	identity
solution **P**	
solution **Q**	
solution **R**	
solution **S**	

[4]

[Total: 4]

A3 In an experiment, a cell was set up to obtain pure copper from 150 g of a copper-silver alloy as shown below.



When a current of 40.0 A flows through the electrolyte for 26.8 minutes, the mass of the anode left was 136.5 g, while the cathode increases by 12.6 g.

(a) **(i)** Identify which electrode should be pure copper and which should be the copper-silver alloy.

electrode **U**: ……………………….. electrode **V**: ……………………….. [2]

(ii) Hence, write the half equations for the reactions occurring at both electrodes.

electrode **U**: ………………………………………………………………….

electrode **V**: …………………………………………………………………. [2]

(b) Calculate the percentage of silver present in the alloy.

percentage of silver ……………………….. [1]

(c) The experiment was repeated with the change of electrolyte to $CuCO_3$.

Explain why the setup will be unable to obtain pure copper.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

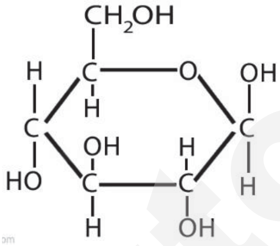
[Total: 6]

A4 Respiration is a reaction that occurs in all living things so as to produce energy. It is a process which produces energy and carbon dioxide from the intake of food and oxygen. The reaction is catalysed by enzymes.

The overall reaction is as shown below.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \qquad \Delta H = -2803 \text{ kJ/mol}$$

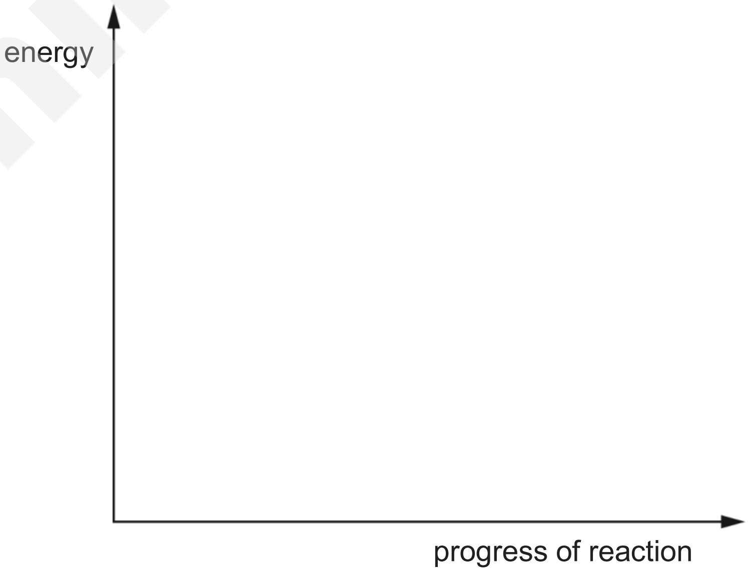
The structural formula of glucose, $C_6H_{12}O_6$, is as shown below.



(a) Draw an energy profile diagram for respiration using the axes shown.

Your diagram should include

- the reaction pathway for the reaction, and
- labels to show the enthalpy change of reaction and the activation energy.



[3]

(b) **(i)** Using ideas about activation energy, explain how the enzyme catalyst affects the rate of respiration.

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(ii) In the school laboratory, this reaction is warmed to 40°C.

Using ideas about collisions between particles, explain how an increase in temperature increases the rate of respiration.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(c) Using ideas about bond breaking and bond making, explain why this reaction is exothermic.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [3]

(d) Using the chemical equation and the bond energies below, calculate the bond energy of the O–H bond.

bond	C–H	O=O	O–O	C–C	C–O	C=O
bond energy / kJ mol^{-1}	413	495	146	347	358	799

bond energy of the O–H bond ……………………….….. [3]

[Total: 12]

A5 Helium, neon, argon, krypton and xenon are five noble gases.
They are monatomic elements.

(a) State the meaning of the term *monatomic*.

……………………………………………………………………………………………… [1]

(b) Explain, using the electronic structures of helium and neon, why they are chemically similar.

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(c) Scientists have managed to form compounds using xenon.
The compound is very unstable and hydrolyses to produce dangerous substances.

(i) A 1.0 g sample of this xenon compound contains 0.549 g of xenon, 0.134 g of oxygen and the rest of the compound is made up of fluorine.
Calculate the empirical formula of this compound.

empirical formula ……………………….. [2]

(ii) State **one** piece of information you need to deduce the chemical formula of this compound.

……………………………………………………………………………………… [1]

[Total: 6]

A6 Tungsten, also known as wolfram, is an element with a proton number of 74. It was first isolated as a metal in 1781 from tungsten(VI) oxide, WO_3.

In the natural state, tungsten can be found as four different particles, namely tungsten-182, tungsten-183, tungsten-184 and tungsten-186.

In January 2019, the Straits Times published an article on the poor air quality of Bangkok. It contained harmful levels of cadmium, tungsten, arsenic and polycyclic aromatic hydrocarbons (PAH).

Traffic, factories and crematoriums are found to be the major sources of air pollution in Bangkok. In the transport sector, the incomplete burning of fuel in the vehicles emits a large amount of PAH, which is cancer causing. Also, the city's traffic congestion causes an increase in the level of tungsten in the air as the drivers apply their car brakes, in which tungsten carbide is used as a brake lining. Hence, tungsten particles are released into the air.

Source is extracted from https://www.straitstimes.com/asia/se-asia/bangkok-air-full-of-toxic-heavy-metals-studies-show

(a) Which of the following statements is/are true for tungsten?

Put a tick (✓) in **one** box in each row.

	true	false
It has a low melting point.		
It forms coloured compounds.		
It can form oxides with these formulae WO_2, WO_3, W_2O_3.		
It contains positive ions in a sea of delocalised negative ions.		

[2]

(b) **(i)** What is the term used to describe the four particles of tungsten?

………………………………………………………………………………………... [1]

(ii) Compare and contrast the number of sub-atomic particles in the four particles of tungsten.

………………………………………………………………………………………...

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

(c) Tungsten is obtained from heating its ore, tungsten(VI) oxide, with hydrogen.

(i) Write a balanced chemical equation to show the reaction between tungsten(VI) oxide, WO_3, and hydrogen.

………………………………………………………………………………………... [1]

(ii) Use oxidation states to explain why this is a redox reaction.

………………………………………………………………………………………...

………………………………………………………………………………………...

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

(iii) Predict the position of tungsten in the reactivity series with reference to hydrogen.

………………………………………………………………………………………... [1]

(d) Besides air pollution caused by PAH, heavy metals and so on, there are other air pollutants that contribute to the poor air quality in Bangkok from traffic, factories and crematoriums.

Name **two other** air pollutants that contribute to the poor air quality.
What are the harmful effects of these air pollutants.

air pollutant ……………………………………………………………………………

harmful effect …………………………………………………………………………

…………………………………………………………………………………………..

air pollutant ……………………………………………………………………………

harmful effect …………………………………………………………………………

………………………………………………………………………………………….. [3]

[Total: 12]

A7 Tetradecane, $C_{14}H_{30}$, can be cracked to produce octane, C_8H_{18}, and one other hydrocarbon, **T**.

(a) Give the conditions for cracking to occur.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(b) Draw the full structural formulae of two isomers of **T**.

isomer 1	isomer 2

[2]

[Total: 3]

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.

B8 Many carbonates thermally decompose to form an oxide and carbon dioxide.

Six 2.00 g samples of metal carbonates are heated strongly until there is no further change in mass. The table shows the mass of solid remaining at the end of the heating process.

carbonate	mass before heating / g	mass after heating / g
metal carbonate **1**	2.00	1.12
metal carbonate **2**	2.00	1.29
metal carbonate **3**	2.00	1.24
metal carbonate **4**	2.00	0.95
metal carbonate **5**	2.00	2.00
metal carbonate **6**	2.00	1.30

(a) **(i)** Using information from the table, arrange the metal carbonates in order of decreasing thermal stability. Explain your answer.

order ………………………………………………………………………………… [1]

explanation …………………………………………………………………………

………………………………………………………………………………………..…

………..………………………………………………………………………………

…………………………………………………………………………………….. [1]

(ii) Suggest a possible name for any **two** of the metal carbonates.

metal carbonate (**1**, **2**, **3**, **4**, **5** or **6**)	name of metal carbonate

[2]

(b) Cement can be produced when clay is heated with powdered calcium carbonate. As the temperature is high, calcium carbonate decomposes to form calcium oxide and carbon dioxide.

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

(i) Draw the "dot and cross" diagrams for calcium oxide and carbon dioxide, showing only the outer shell electrons.

calcium oxide	carbon dioxide

[2]

(ii) If the percentage yield of the reaction is 90%, calculate the mass of calcium oxide formed when 200 kg of calcium carbonate is used.

mass of calcium oxide ……………………….. [2]

(iii) Describe a chemical test to show that carbon dioxide is formed.

chemical test ………………………………………………………………

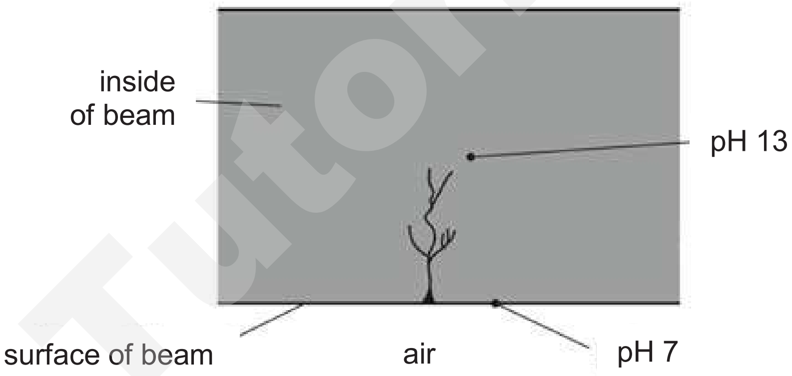
result ……………………………………………………………………….

………………………………………………………………………………. [1]

(iv) Concrete is made from cement, sand and water and it is slightly porous. When rain water soaks through concrete, some of the calcium oxide dissolves in rain water to form calcium hydroxide.

The aqueous calcium hydroxide in wet concrete reacts with carbon dioxide in the air to form a white solid and water.

The diagram shows the pH at various points inside a cracked concrete beam.



Explain why the surface of the beam has a lower pH than the centre of the beam.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

[Total: 10]

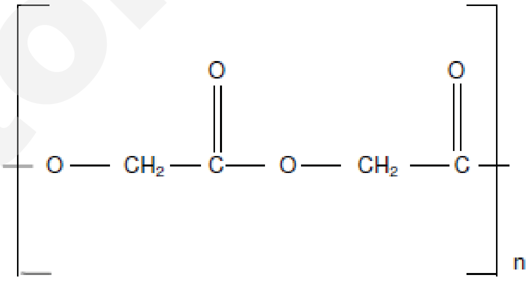
B9 The table below shows some information of the different types of plastics that are commonly used.

plastics	tensile strength / MPa	density / g cm^{-3}	number of years to break down plastic
biopolymers	36	1.24	0.5
poly (propene)	40	0.92	20-30
kevlar	3620	1.44	-

Extracted from http://www.matweb.com/reference/tensilestrength.aspx

Note: Tensile strength measures the resistance of a material to breaking under tension.

Biopolymers are renewable plastic materials manufactured from biomass such as corn, wheat, sugar cane and potatoes. An example of the structure of a type of biopolymer, polylactic acid (PLA), is as shown.



(a) **(i)** With reference to the structural formula of PLA, state the type of polymerisation for its formation.

.... [1]

(ii) This biopolymer can be broken down easily to its monomer.

Draw the full structural formula of this monomer when the biopolymer is being broken down.

[1]

(iii) Based on the given information, discuss **one** advantage and **one** disadvantage of using biopolymers to make plastic products.

advantage ……………………………………………………………………………

…………………………………………………………………………………… [1]

disadvantage …………………………………………………………………………

…………………………………………………………………………………… [1]

(b) Poly (propene) is used in piping systems due to its high strength and rigidity.

(i) Draw the structure of poly (propene) showing three repeating units.

[1]

(ii) Describe a chemical test to differentiate between poly (propene) and its monomer.

chemical test …………………………………………………………………………

result with poly (propene) ……………………………………………………..

……………………………………………………………………………………

result with monomer ……………………………………………………………

…………………………………………………………………………………… [2]

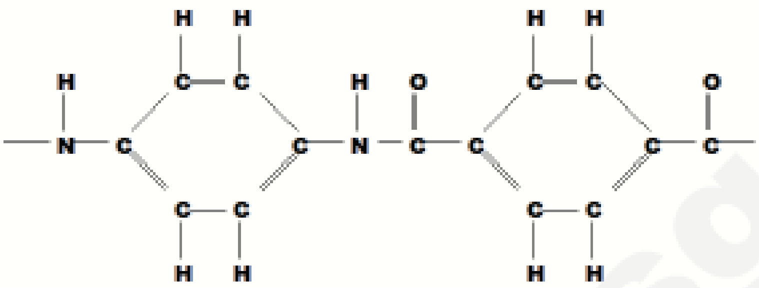
(iii) Poly (propene) is non-biodegradable.

Describe **one** environmental issue when poly (propene) is burnt.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(c) Kevlar is a polyamide. Its structure is as shown below.



Kevlar is a heat-resistant and strong synthetic fiber, which when spun into fibers or fabric sheets. It is a plastic that is five times stronger than steel, and can stop bullets from penetrating it.

Deduce the structural formula of the two monomers that react to form the polyamide above.

monomer 1	monomer 2

[2]

[Total: 10]

EITHER

B10 Alkynes are a homologous series of unsaturated hydrocarbons, with at least one carbon-carbon triple bond. The table shows information about some alkynes.

alkyne	molecular formula	melting point / °C	boiling point / °C
ethyne	C_2H_2	-81.5	-84
propyne	C_3H_4	-102.7	-23.2
pentyne	C_5H_8	-90	39.3

(a) Use the information in the table to give **two** pieces of evidence that suggest that the alkynes are a homologous series.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(b) Butyne is an alkyne.

Deduce the formula and predict the boiling point of butyne.

formula ……………………….. predicted boiling point ……………………….. [2]

(c) At room temperature, propyne diffuses at a slower rate than ethyne.

Explain why.

……………………………………………………………………………………………

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

(d) Ethyne, C_2H_2, reacts with basic sodamide, $NaNH_2$, to form a sodium salt and ammonia gas.

(i) Describe a chemical test to check if the reaction is occurring.

chemical test ……………………………………………………………………………

result ………………………………………………………………………………….. [1]

(ii) Write a balanced chemical equation for the reaction mentioned above.

……………………………………………………………………………………… [1]

(iii) Ammonia can also be produced from Haber process.

Describe how is ammonia produced in the industry.

Include a balanced chemical equation in your answer.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [2]

[Total: 10]

OR

B10 Deepwater Horizon was an ultra-deepwater, offshore drilling rig, built in South Korea in 2001 by Hyundai Heavy Industries. The concrete foundation of the rig usually includes massive steel legs. The rig drilled the deepest oil well in history at a vertical depth of about 10 683 m. The rig exploded in 2010, when a surge of natural gas blasted through the concrete core, which killed 11 crewman, and the fire was inextinguishable.

Extracted from https://en.wikipedia.org/wiki/Deepwater_Horizon

(a) Steel can be obtained by mixing 70% iron with 30% carbon.

(i) Explain why steel is used instead of pure iron, which has a lower cost.

………………………………………………………………………………………

……………………………………………………………………………………… [2]

(ii) Draw a labelled diagram to show the arrangement of the particles in steel containing 70% iron with 30% carbon.

[1]

(iii) Iron is produced in a blast furnace by heating a mixture of iron(III) oxide, coke and limestone with air.

With the help of relevant equations, describe how iron is produced.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [3]

(b) What is the main component found in natural gas?

…………………………………………………………………………………… [1]

(c) Describe how petrol can be obtained from the oil from oil rigs.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(d) A protocol called the Convention for the Protection of the Marine Environment of the North East Atlantic, which came into force in 1998, stated that offshores platforms cannot be disposed of at sea or simply be left to rust and corrode if they weigh less than 10 000 tonnes. The scrap metals are then sent to a shore-based recycling centre.

Obtained from http://www.bbc.com/future/story/20160804-what-it-takes-to-dismantle-an-oil-rig

Apart from the potential issues that affect the marine life, explain why the scrap metals from the rigs need to be recycled.

.... [1]

[Total: 10]

[insert Periodic Table]

MARK SCHEME

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

MARK SCHEME

Section A

A1 (a) magnesium nitrate (b) hydrogen chloride [2]

(c) carbon tetrachloride (d) ammonium sulfate [2]

(e) magnesium nitrate / ammonium sulfate / calcium sulfate [1]

(f) calcium sulfate (g) ammonium sulfate [2]

A2 **P** = silver nitrate **R** = potassium carbonate [2]

Q = copper(II) nitrate **S** = hydrochloric acid [2]

A3 (a) (i) **U** = copper-silver alloy **V** = pure copper [2]

(ii) **U** = $Cu (s) \rightarrow Cu^{2+} (aq) + 2e^-$ **V** = $Cu^{2+} (aq) + 2e^- \rightarrow Cu (s)$ [2]

(b) mass loss at anode = 150 -136.5 = 13.5 g

mass copper deposited at cathode = 12.6 g

mass of silver at anode = 13.5 -12.6 = 0.9 g

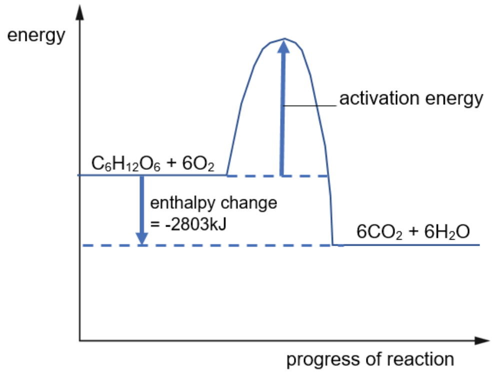
% impurities = 0.9 / 13.5 x 100 = 6.6667 % = 6.67% (to 3 s.f.) [1]

(c) As $CuCO_3$ is insoluble, there are no mobile **ions** present to carry the electric current. [1]

A4 (a) 1m – correct reaction pathway, showing the reactants and products [3]

1m – correct labelling of the enthalpy change with a single-sided arrow

1m – correct labelling of the activation energy with a single-sided arrow



(b) (i) The enzyme catalyst provides an alternative pathway with a lower activation energy, thus increasing the rate of respiration. [1] [1]

(ii) An increase in temperature increases the kinetic energy of the reactant particles. The particles move faster, resulting in more effective collisions, hence leading to an increase in the rate of respiration. [1]

(c) The energy released from bond-forming (i.e. C=O and O-H bonds) is more than the energy absorbed from bond-breaking (i.e. C-C, C-H, C-O, O-H and O=O bonds). [3]

(d) Let the bond energy of the O-H bond be x.

Energy absorbed = 5 C-C + 7 C-H + 7 C-O + 5 O-H + 6 O=O

= $5(347) + 7(413) + 7(358) + 5x + 6(495)$

= $10102 + 5x$ kJ/mol [1]

Energy released = 12 C=O + 12 O-H

= $12(799) + 12x$

= $9588 + 12x$ kJ/mol [1]

$10102 + 5x - 9588 - 12x = -2803$

x = 474 kJ/mol [1]

A5 (a) Monatomic means that the element exists as one / a single atom. [1]

(b) Helium has an electronic structure of 2, while neon has an electronic structure of 2,8. Since both have a stable electronic configuration, they do not lose, gain or share electrons (i.e. unreactive). [1] [1]

(c)(i)

	xenon	oxygen	fluorine
Mass	0.549 g	0.134 g	0.317 g
A_r	131	16	19
mass ÷ A_r	0.0041908	0.008375	0.016684
÷ 0041908	1	2	4

∴ empirical formula = XeO_2F_4 [1] [1]

(ii) relative molecular mass [1]

A6 (a)

	true	false
It has a low melting point.		✓
It forms coloured compounds.	✓	
It can form oxides with these formulae WO_2, WO_3, W_2O_3.	✓	
It contains positive ions in a sea of delocalised negative ions.		✓

[1]

[1]

(b) (i) isotope [1]

(ii) All the four particles of tungsten have 74 protons and 74 electrons in each of their atom. [1]

The atoms of tungsten-182 has 108 neutrons, tungsten-183 has 109 neutrons, tungsten-184 has 110 neutrons and tungsten-186 has 112 neutrons. [1]

(c) (i) $WO_3 + 3H_2 \rightarrow W + 3H_2O$ [1]

(ii) WO_3 is reduced to W, as the oxidation state of $\boxed{\text{tungsten}}$ decreases from +6 in WO_3 to 0 in W. H_2 is oxidised to H_2O, as the oxidation state of $\boxed{\text{hydrogen}}$ increases from 0 in H_2 to +1 in H_2O. [1] [1]

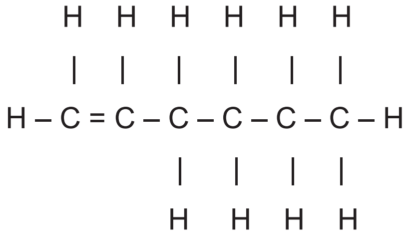
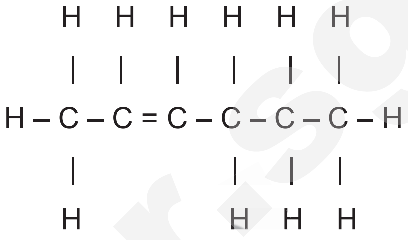
(iii) It is lower than hydrogen. [1]

(d) Choose any two: 1m for naming the two air pollutants; 1m for each effect [3]

air pollutant	harmful effect
Carbon monoxide	When inhaled, carbon monoxide combines with haemoglobin, causing the body to be starved of oxygen, leading to death.
Nitrogen dioxide / Sulfur dioxide	When inhaled, nitrogen dioxide / sulfur dioxide corrodes the body's internal organs. OR They form acid rain, which corrodes limestone buildings.

A7 (a) Cracking takes place in the presence of high temperature, high pressure, usually in the presence of a catalyst (e.g. aluminium oxide, silicon dioxide, broken porous pot, broken glass). [1]

(b) [2]

isomer 1	isomer 2
	

Section B

B8 (a) (i) order: **5, 6, 2, 3, 1, 4** [1]

explanation: The metal carbonate with no mass loss after heating is the most stable (i.e. metal carbonate **5**). The metal carbonate with the smallest mass loss is the second most stable (i.e. metal carbonate **6**) while the metal carbonate with the largest mass loss is the least stable (i.e. metal carbonate **4**). [1]

(ii)

metal carbonate	name of metal carbonate	
5	potassium / sodium carbonate	[1]
4	copper(II) carbonate	[1]

(b) (i) 'Dot-and-cross' diagram for calcium oxide – ionic $[Ca]^{2+}$ $[O]^{2-}$ [1]

'Dot-and-cross' diagram for carbon dioxide – covalent O=C=O [1]

(ii) $CaCO_3$ (s) → CaO (s) + CO_2 (g)

Fr. Eqn.: 1 1 1

Given : 200 000 g

M_r : 100 56

$\boxed{2000 \text{ mol}}$ $\boxed{2000 \text{ mol}}$ [1]

Mass of CaO formed = 2000 mol x 56 x 90%

= 100 800 g / 100.8 kg [1]

(iii) chemical test : Deliver the gas into a test-tube of limewater. [1]

result : Gas evolved gives a white precipitate with limewater,

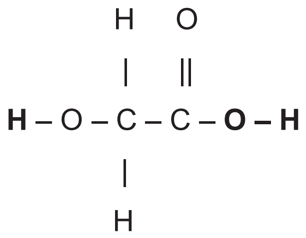
(iv) On the surface of the beam, acidic carbon dioxide neutralises the alkaline calcium hydroxide, causing the pH to be 7. [1]

Inside the beam, the crack allows little or no carbon dioxide to enter.

Hence, calcium hydroxide, being alkaline, causes the pH to be 13.

B9 (a) (i) Condensation polymerisation [1]

(ii) [1]

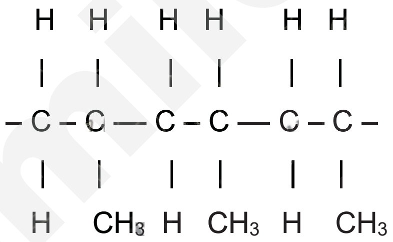


$$\mathrm{\mathbf{H}-O-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\|}{C}}-\mathbf{O-H}}$$

(iii) advantage: As it takes only 0.5 years to break down, it will not cause landfill problems. [1]

disadvantage: As it has a low tensile strength of 36 MPa, it breaks easily. [1]

(b) (i) [1]



$$-\underset{H}{\overset{H}{C}}-\underset{CH_3}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{CH_3}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{CH_3}{\overset{H}{C}}-$$

(ii) chemical test : Pass both substances into aqueous bromine. [1]

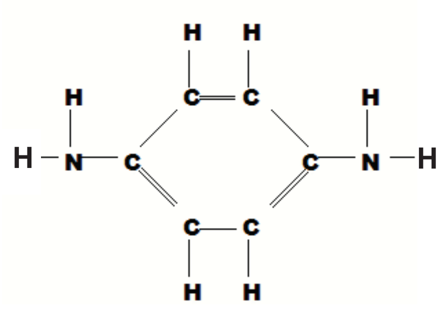
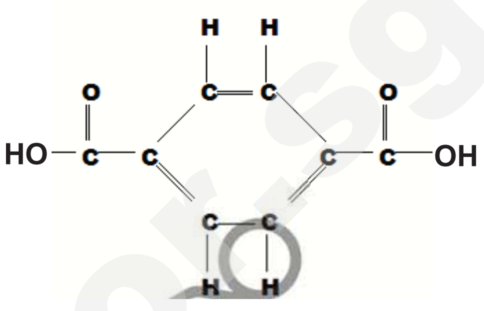
result with poly (propene) : No visible reaction. [1]

result with monomer : The red-brown aqueous bromine turns colourless **immediately**.

(iii) When burnt, poly (propene) undergoes incomplete combustion to produce a toxic gas, carbon monoxide. When inhaled, carbon monoxide combines with haemoglobin, causing the body to be starved of oxygen, leading to death. OR [1]

When burnt, poly (propene) produces a greenhouse gas, carbon dioxide. The trapping of heat on Earth's surface results in the melting of ice caps causing flooding in some areas.

(c) [2]

monomer 1	monomer 2
	

B10 **Either**

(a) Choose any two: [2]

- Alkynes have the same general formula, C_nH_{2n-2}.
- Alkynes have the same functional group, C≡C triple bond.
- Alkynes have names ending with ~yne.

(b) C_4H_6, 8.08°C [2]

(c) Propyne (M_r = 40), having a higher relative molecular mass than ethyne (M_r = 26), diffuses at a slower rate. [2]

(d) (i) chemical test : Insert a piece of damp red litmus paper into the test-tube of gas. [1]

result : Gas evolved turns the damp litmus paper blue.

(ii) $C_2H_2 + NaNH_2 \rightarrow C_2HNa + NH_3$ [1]

(iii) Ammonia can be produced from the Haber process at 450°C, 200 atm, using finely divided iron as catalyst. [1]

$N_2 (g) + 3H_2 (g) \leftrightarrow 2NH_3 (g)$ [1]

B10 Or

(a) (i) Steel is harder and stronger than iron. [1]

Steel contains different-sized atoms (i.e. bigger iron atoms and smaller carbon atoms), which disrupt the orderly arrangement of atoms, making it difficult for the layers to slide over each other. [1]

(ii) On diagram (70% iron : 30% carbon) [1]

(iii) The coke burns in air to produce carbon dioxide and a large amount of heat. $C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$ [1]

The carbon dioxide reacts with more coke to produce carbon monoxide. $CO_2\ (g) + C\ (s) \rightarrow 2CO\ (g)$ [1]

The carbon monoxide reacts with the iron(III) oxide to produce molten iron. $Fe_2O_3\ (s) + 3CO\ (g) \rightarrow 2Fe\ (s) + 3CO_2\ (g)$ [1]

(b) methane / CH_4 [1]

(c) Petrol can be obtained from petroleum (crude oil) by fractional distillation. [1]

Petrol, with the second lowest boiling point, will be collected second from the top, of the fractionating column. [1]

(d) Choose any one: [1]

The scrap metals need to be recycled:

- to conserve Earth's limited resource
- to save costs from extracting the metal from its ore
- to prevent pollution caused by the extraction of metal from its ore

Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/01

Secondary 4 Express **02 September 2019**

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 15.

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.

1 A student accidentally mixed 60 cm^3 of water with 60 cm^3 of oil.

Which method would allow her to obtain 30 cm^3 of the oil most easily?

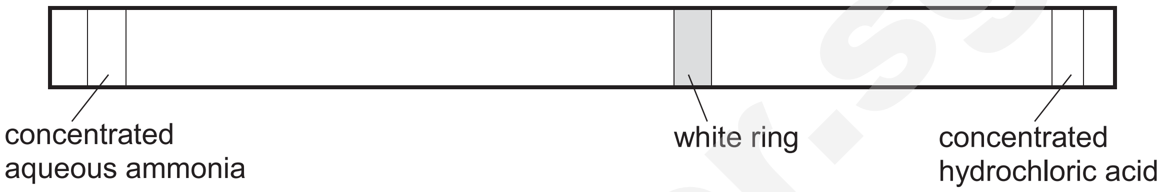
A chromatography

B evaporation

C filtration

D use of a separating funnel

2 When concentrated aqueous ammonia and concentrated hydrochloric acid are placed at opposite ends of a tube, a white ring of ammonium chloride forms nearer to the hydrochloric acid.



Which conclusion about this experiment is correct?

A The boiling point of ammonia is less than that of hydrogen chloride.

B The concentration of the aqueous ammonia is less than that of the acid.

C The reactivity of ammonia is less than that of hydrogen chloride.

D The relative molecular mass of ammonia is less than that of hydrogen chloride.

3 Aqueous ammonia is added to a solution of a salt. A white precipitate is formed which dissolves in an excess of aqueous ammonia.

Which metal ion could the salt contain?

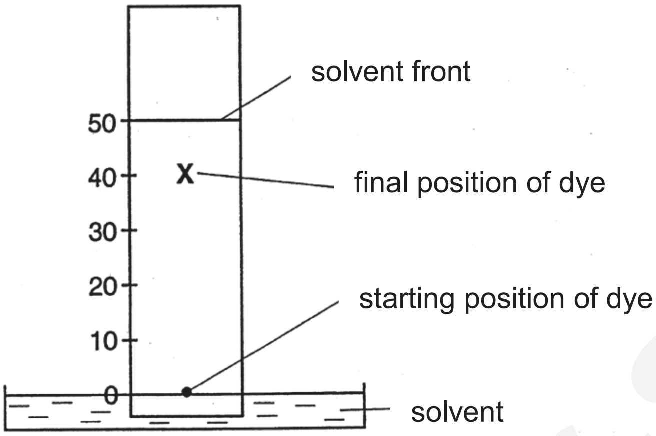
A Al^{3+}

B Ca^{2+}

C K^+

D Zn^{2+}

4 The diagram shows the chromatogram for a dye.



Which fraction shows the R_f value for the dye?

A $\frac{10}{50}$

B $\frac{50}{10}$

C $\frac{50}{40}$

D $\frac{40}{50}$

5 The table shows the structure of different atoms and ions.

particle	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Mg	12	24	12	W	12
Mg^{2+}	X	24	12	12	10
F	9	19	9	Y	9
F^{-}	9	19	9	10	Z

What are the values of W, X, Y and Z?

	W	X	Y	Z
A	10	10	9	9
B	10	12	10	9
C	12	10	9	10
D	12	12	10	10

6 Metals have positive ions in a 'sea of electrons'.

Which metal atom contributes the most electrons to the 'sea of electrons'?

A aluminium

B barium

C rubidium

D zinc

7 Which two elements react together to form a compound that can conduct electricity only when it is in the molten or aqueous states?

element	electronic structure
R	2, 4
T	2, 8
X	2, 8, 1
Z	2, 8, 7

A R and T

B T and X

C X and Z

D Z and R

8 Element J forms an acidic, covalent oxide.

Which row shows how many electrons there could be in the outer shell of an atom of J?

	number of outermost electrons			
	1	2	6	7
A	✓	✓	x	x
B	✓	x	✓	x
C	x	x	✓	✓
D	x	✓	x	✓

9 The chemical formulae of two substances, W and X, are given.

W $NaAlSi_3O_8$
X $CaAl_2Si_2O_8$

Which statements are correct?

1 W and X contain the same amount of oxygen.
2 W contains three times as much silicon as X.
3 X contains twice as much aluminium as W.

A 1 and 2

B 1 and 3

C 2 and 3

D 1, 2 and 3

10 An atmospheric pollutant can be removed by the process of reduction.

Which pollutant is removed by this process?

A carbon monoxide in a catalytic convertor
B nitrogen dioxide in acid rain by reaction with calcium carbonate
C nitrogen oxide in a catalytic convertor
D sulfur dioxide from flue gases by reaction with calcium carbonate

11 Which quantity is the same for one mole of ethanol and one mole of ethane?

A mass
B number of atoms
C number of molecules
D volume at r.t.p

12 What is the volume of hydrogen produced at room temperature and pressure, when 4.6 g of sodium is reacted with an excess of water?

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

A 1.2 dm^3
B 2.4 dm^3
C 4.8 dm^3
D 12 dm^3

13 The Apollo moon missions used hydrazine, N_2H_4, as rocket fuel. Hydrazine is made by reacting ammonia with sodium chlorate(I), $NaClO$.

$$2NH_3(g) + NaClO(s) \longrightarrow N_2H_4(g) + NaCl(s) + H_2O(l)$$

If 28 g of hydrazine is made from 34 g of ammonia, what is the percentage yield of hydrazine?

A 12.5%
B 17.0%
C 87.5%
D 100%

14 When pink cobalt(II) chloride crystals are heated, they form steam and a blue solid.
When water is added to the blue solid, it turns pink and becomes hot.

Which terms describe the pink cobalt(II) chloride crystals and the reactions?

	pink cobalt(II) chloride	reactions
A	aqueous	irreversible
B	anhydrous	reversible
C	hydrated	irreversible
D	hydrated	reversible

15 Which pairs of statements correctly describe the differences between the conduction of electricity during electrolysis and the conduction of electricity by metals?

	conduction during electrolysis	conduction by metals
1	The current is due to the movement of both positive and negative ions.	The current is due to the movement of electrons.
2	Charged particles move towards both electrodes.	Charged particles move in one direction only.
3	It results in a chemical change.	It does not result in a chemical change.

A 1, 2 and 3 are correct

B 1 and 2 only are correct

C 2 and 3 only are correct

D 1 only is correct

16 When the wick of a candle is touched by a lit match, the candle begins to burn. When the match is removed, the candle continues to burn.

What is the role of the match in the reaction involving the candle wax?

A It acts as a catalyst.

B It increases the rate of combustion.

C It lowers the activation energy barrier.

D It supplies the activation energy.

17 Which of the following statements is **not** true?

A An endothermic reaction requires a constant supply of heat as long as the reaction proceeds.

B An exothermic reaction only needs heat to initiate.

C Photosynthesis is an exothermic reaction.

D Reactions with high activation energies do not occur spontaneously and may require heat or the addition of catalyst to initiate the reaction.

18 Hydrogen is increasingly being investigated as a fuel for the future. It burns in oxygen to produce water.

Which of the following describe(s) the advantages of carrying out the above reaction in a fuel cell rather than burning hydrogen and converting the heat into electricity?

1 It reduces pollution to the environment.
2 Less energy is wasted or lost during conversion.
3 It increases the ease of storage and handling of hydrogen.

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

19 The table compares the properties of four different fuels.

property	ethanol	hydrogen	methane	petrol
molar mass (g/mol)	46	2	16	114
density (kg/*l*)	0.79	8.4×10^{-5}	6.4×10^{-4}	0.69
enthalpy change (kJ/mol)	−1360	−285	−891	−5460

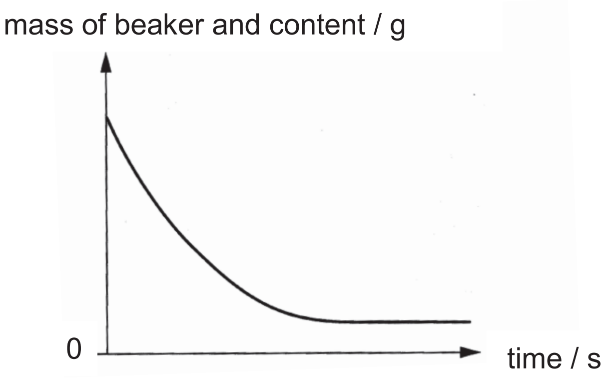
Which of the following shows the correct order of fuels which produce decreasing amounts of energy when 1 g of the compound is completely burnt?

A hydrogen, methane, ethanol, petrol
B hydrogen, methane, petrol, ethanol
C methane, hydrogen, ethanol, petrol
D methane, hydrogen, petrol, ethanol

20 Which set of conditions is ideal for the manufacture of ammonia in the Haber process?

	pressure / atm	temperature / °C	ratio of $H_2 : N_2$
A	250	450	3 : 1
B	250	450	1 : 3
C	450	250	3 : 1
D	450	250	1 : 3

21 Two reagents were mixed in a beaker and the mass of the beaker and its content was recorded as the reaction progressed. The graph shows the result that was obtained.



Which of the following reactions could **not** have produced the graph?

A $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$

B $ZnCO_3(s) + 2HNO_3(aq) \longrightarrow Zn(NO_3)_2(aq) + CO_2(g) + H_2O(l)$

C $NaNO_2(aq) + NH_4Cl(aq) \longrightarrow NaCl(aq) + 2H_2O(l) + N_2(g)$

D $(NH_4)_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2NH_3(aq) + 2H_2O(l)$

22 A poorly ventilated flour mill has a higher risk of explosion as compared to a bakery with similar ventilation.

What could be the most likely reason for the higher risk of explosion in the poorly ventilated flour mill?

A The flour mill has a higher temperature than the bakery.

B The flour mill has more gaseous pollutants than the bakery.

C The flour mill has more fine particles of flour in the air as compared to the bakery.

D The flour mill has more oxygen in the air than the bakery.

23 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through powdered calcium carbonate.

Which waste gas will **not** be removed by the powdered calcium carbonate?

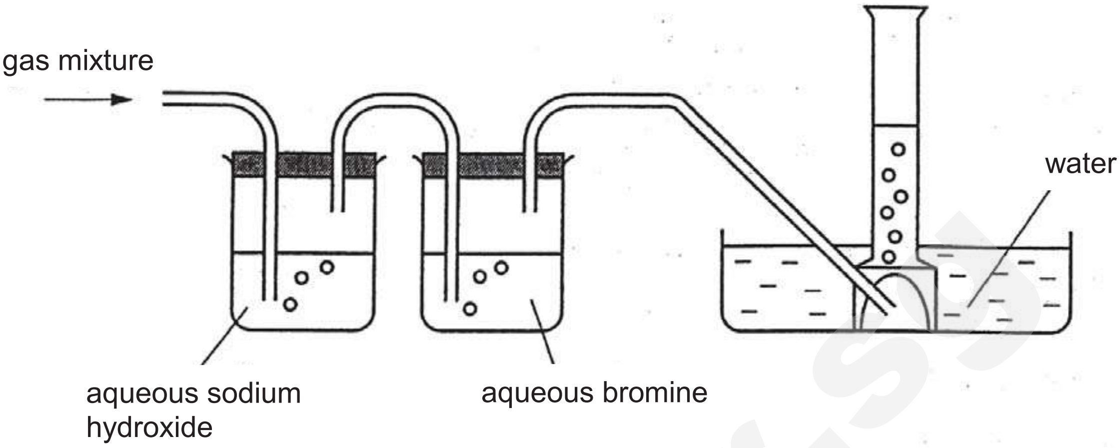
A carbon monoxide

B nitrogen dioxide

C phosphorus(V) oxide

D sulfur dioxide

24 A gaseous mixture of ethene, hydrogen and sulfur dioxide is passed through the apparatus shown. Only one of the gases is collected.



What is a property of the gas collected?

A burns with a lilac flame

B extinguishes a lighted splint with a "pop" sound

C relights a glowing splint

D turns purple acidified potassium manganate(VII) colourless

25 The elements W, X, Y and Z have increasing proton numbers. They are all in period 3 of the Periodic Table but are not necessarily next to each other.

Which statement is correct?

A The chloride of Z is ionic.

B The oxides of W and Z are both amphoteric.

C W and Y contain the same number of shells of electrons.

D X and Y could be in the same Group in the Periodic Table.

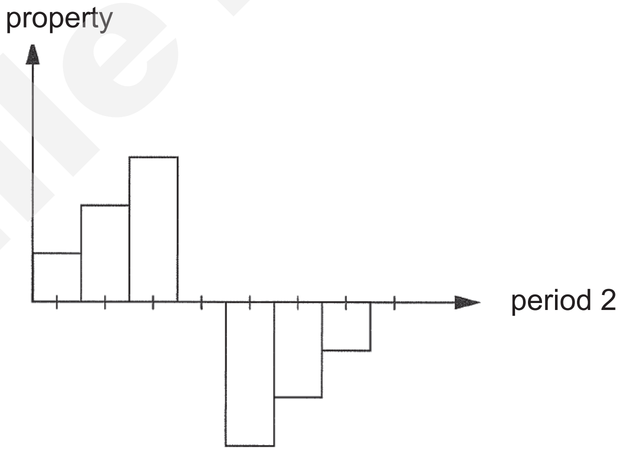
26 The atomic radii of four Group I elements of the Periodic Table are given below in picometres.

element	atomic radius / pm
P	231
Q	152
R	248
S	186

What are the possible melting points of the four elements?

	melting point (°C) of element			
	P	Q	R	S
A	39	98	64	180
B	64	180	39	98
C	98	64	39	180
D	180	98	64	39

27 The bar graph below shows the trend in a property for elements across period 2 of the Periodic Table.



Which of the following properties could be represented by the bar graph?

A charge of ion

B melting point

C size of ion

D valency

28 Which metal should be used in the sacrificial protection of the hull of a boat made from iron?

A	calcium	**C**	lead
B	copper	**D**	zinc

29 What is a disadvantage of recycling metals?

A Collection and transportation costs money.
B Metal ores are a finite resource.
C Most metals corrode slowly in the environment.
D Scrap metal melts when heated.

30 The welding of railway tracks was done in the past with the aid of a chemical reaction known as the Thermite reaction. The Thermite reaction involves the displacement of a metal from its solid oxide by another metal.

Which of the following equations could represent the Thermite reaction?

A $Al_2O_3 + 3Zn \longrightarrow 3ZnO + 2Al$
B $2Fe + Al_2O_3 \longrightarrow 2Al + Fe_2O_3$
C $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$
D $MgO + Zn \longrightarrow Mg + ZnO$

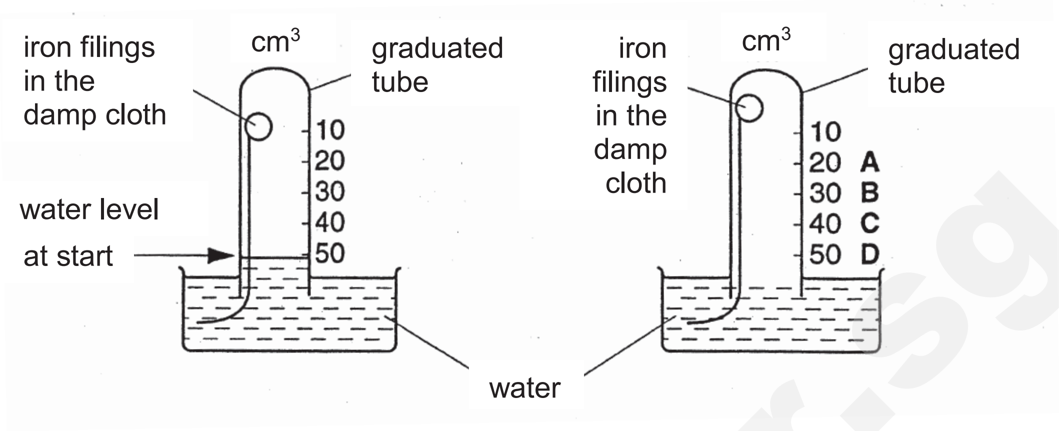
31 Metal A is higher than metal B in the reactivity series.

Which of the following statements is true?

A Metal A is a stronger oxidising agent than metal B.
B Metal A forms a stronger acid than metal B.
C Metal A forms more stable compounds than metal B.
D Metal A takes in more energy than metal B when reacting to form compounds.

32 Iron filings are wrapped in a damp cloth and left to rust in the apparatus as shown.

Which letter indicates the water level when rusting has been completed?



33 The average temperatures of the Earth have been observed to be increasing very gradually.

Which of the following statements describe the environmental consequences of an increase in global warming?

1 depletion of the ozone layer
2 increase in the acidity of the soil, leading to poor cop output
3 increase in droughts and wildfires, and heavier rainfall
4 increase melting of glaciers and ice caps, leading to increase in sea levels

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

34 Anhydrous ammonia, also known as 'the other hydrogen', has been described as the closest thing to a perfect transportation fuel. Its combustion does not produce any environmental pollutants.

Which of the following are possible products obtained from the combustion of ammonia?

A nitrogen and hydrogen only
B nitrogen and water only
C nitrogen oxides and hydrogen only
D nitrogen oxides and water only

35 Photosynthesis and respiration are important natural processes.

Which of the following statements is correct?

A Carbon dioxide is formed by the reaction of glucose with water during photosynthesis.
B Carbon dioxide is removed from the air by respiration.
C Glucose reacts with water to form oxygen during respiration.
D Photosynthesis produces glucose and oxygen.

36 Which of the following is the same for all the members of a homologous series?

A empirical formula
B general formula
C molecular formula
D physical properties

37 Which of the following alkenes can form an alcohol which can only have three structural isomers?

A butene
B ethene
C pentene
D propene

38 A mixture containing 1 mole of ethene and 4 moles of oxygen is ignited, in a sealed container at 100°C. The reaction is as shown below.

$$C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(g)$$

What is the total number of moles of gas at the end of the reaction?

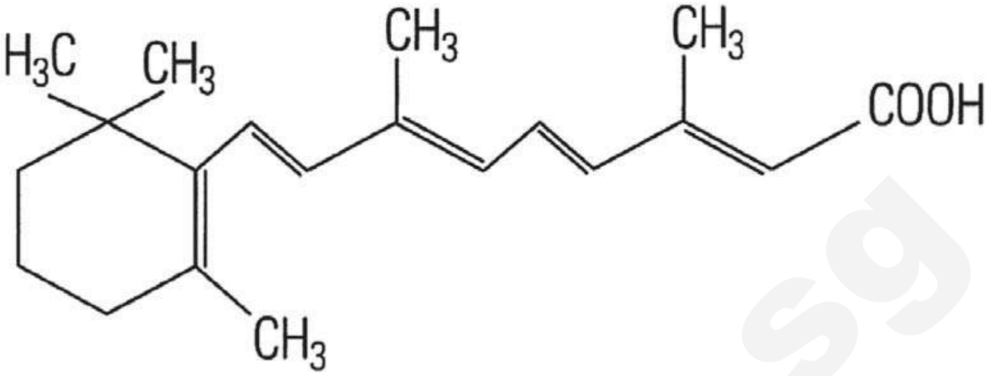
A 2
B 3
C 4
D 5

39 Four drops of Universal Indicator were added to a solution of glucose that has undergone fermentation.

Which of the following is observed?

A The Universal Indicator is decolourised.
B The Universal Indicator remains green.
C The Universal Indicator turns purple.
D The Universal Indicator turns red.

40 Vitamin A is an important vitamin required by humans to prevent problems such as night blindness. The structure of Vitamin A is as shown below.



Which of the following pairs of reagents will **not** react with Vitamin A?

A aqueous bromine, sodium carbonate

B ethanol, sodium hydroxide

C hydrogen gas with nickel, chlorine gas in UV light

D magnesium, steam

END OF PAPER

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* 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 T*l* 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 F*l* flerovium –		116 Lv livermorium –		

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

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

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Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/02

Secondary 4 Express

04 September 2019

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	/ 6
3	/ 7
4	/ 9
5	/ 6
6	/ 5
7	/ 12
Section B	**/ 30**
8	/ 12
9	/ 8
10E	/ 10
10OR	/ 10
Total	**/ 80**
Total %	**/ 100**

Parent's / Guardian's Signature: ……………………………………..

This document consists of **21** printed pages and **1** blank page.

Do not turn over the page until you are told to do so.

Section A

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

1 The structures of some substances containing nitrogen are shown in Fig. 1.1.

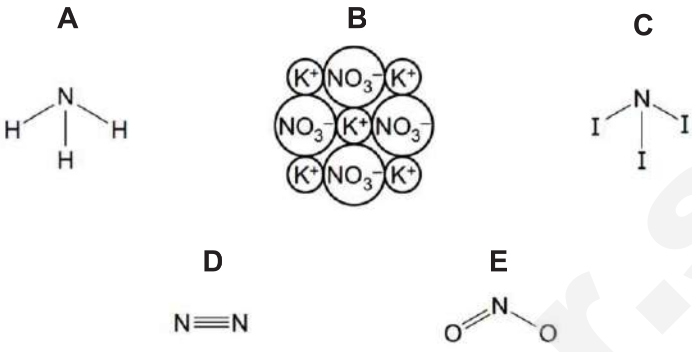

Fig. 1.1

Answer the following questions by choosing from the structures **A**, **B**, **C**, **D** or **E**.
You can use each structure once, more than once or not at all.

Which structure represents

(a) an acidic oxide,

.... [1]

(b) a salt,

.... [1]

(c) a gas which turns damp red litmus paper blue,

.... [1]

(d) a compound which is formed under conditions of high temperature and pressure in car engines,

.... [1]

(e) a molecule containing halogen atoms?

.... [1]

[Total: 5]

2 Table 2.1 shows the **most common** oxidation states of some elements **A**, **B**, **C**, **D** and **E** in their compounds.

Table 2.1

element	most common oxidation states	metal or non-metal?
A	−2	
B	+2, +3, +4, +6, +7	
C	+1	non-metal
D	+3	
E	−1	

(a) Complete Table 2.1 by filling in the last column to show which elements are **metals** and which are **non-metals**. [1]

(b) Use the letters **A**, **B**, **C**, **D** and **E** to answer the following questions.

(i) Which element is most likely to be hydrogen?

.... [1]

(ii) Which element is most likely to be in Group VI?

.... [1]

(iii) Which element is most likely to form coloured compounds?

.... [1]

(c) No elements from Group 0 appear in Table 2.1.
Use the information in Table 2.1 to explain why this statement is true.

....

....

.... [2]

[Total: 6]

3 Dilute ethanoic acid reacts with metal oxides.
Dilute hydrochloric acid also react with metal oxides.

(a) How are the reactions of the two acids with metal oxides similar?

....

.... [1]

(b) The rate of reaction of dilute ethanoic acid with metal oxides is observed to be slower than that of dilute hydrochloric acid at the same concentration and temperature.

With your knowledge of Collision Theory, explain the observation above.

....

....

....

.... [2]

(c) Table 3.1 shows some information on the mixing of three different sets of solutions.

Table 3.1

solutions that are mixed	**formula of precipitate**	**colour of precipitate**
aqueous copper(II) sulfate and aqueous sodium hydroxide		
aqueous potassium iodide and aqueous silver nitrate		
dilute sulfuric acid and aqueous barium chloride		

Complete Table 3.1. [4]

[Total: 7]

4 Chromium is commonly used to electroplate steel objects.
Fig. 4.1 shows how this could be done.

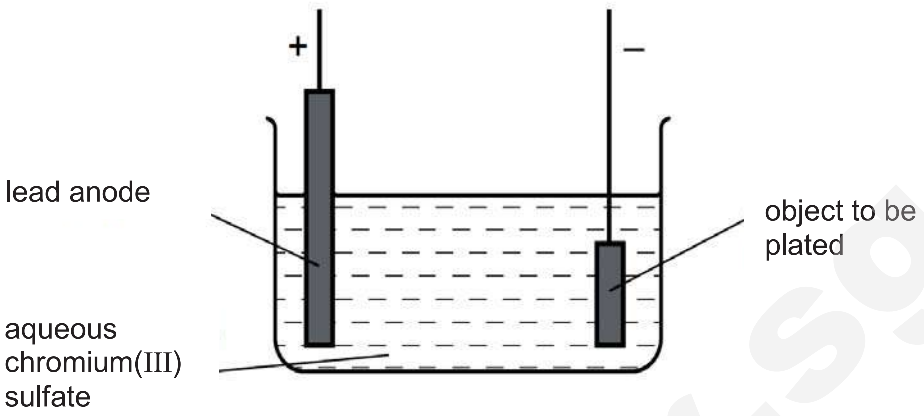

Fig. 4.1

(a) Give **two** reasons why steel objects are plated with chromium.

1 ……………………………………………………………………………………

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

(b) Deduce the chemical formula for chromium(III) sulfate.

…………………………………………………………………………………………… [1]

(c) Construct the ionic half-equation, with state symbols, for the reaction at the cathode.

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

(d) Effervescence is observed at the anode.
Identify the gas that is produced at the anode, and state the chemical test that can be carried out to confirm the identity of the gas.

name of gas: ……………………………………………………………………… [1]

chemical test: ………………………………………………………………………..

…………………………………………………………………………………………… [1]

(e) During electroplating, it is necessary to add more aqueous chromium(III) sulfate but during copper plating using a copper anode, it is **not** necessary to add more aqueous copper(II) sulfate.

Explain the difference.

....

....

.... [2]

[Total: 9 marks]

5 The Ostwald Process is a chemical process for manufacturing nitric acid, HNO_3. It is done via two stages.

The following chemical equation illustrates the chemical reaction that occurs in Stage One.

Stage One: $4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(g)$ $\Delta H = -905.2$ kJ

(a) Draw an energy profile diagram for the reaction in Stage One, and you are to indicate the enthalpy change and activation energy clearly.

[2]

(b) In terms of oxidation states, explain why Stage One is a redox reaction.

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(c) Stage Two consists of **two** steps.

Step 1: $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

In **Step 2**, NO_2 that is produced in **Step 1** is absorbed by water readily to form dilute nitric acid as well as nitrogen monoxide, which is recycled to be used in **Step 1**.

(i) Construct a chemical equation to show the reaction in **Step 2**.

…………………………………………………………………………………..... [1]

(ii) Name a physical process that can be carried out to increase the concentration of the dilute nitric acid that is obtained at the end of Stage Two.

……………………………………………………………………………………. [1]

[Total: 6]

6 Chlorine can react with many substances and has different uses in our daily life.

(a) **(i)** Name the products that are formed when aqueous chlorine reacts with aqueous potassium bromide.

………………………………………………………………………………………. [1]

(ii) State **one** observation that you can **see** from the reaction in **(a)(i)**.

………………………………………………………………………………………. [1]

(b) An oxide of chlorine was analysed. A 0.366 g sample was found to contain 0.224 g of oxygen.

Calculate the empirical formula of this oxide.

empirical formula of this oxide is ……………………………………………... [3]

[Total: 5]

7 A kiln is a special kind of oven for firing things like pottery and bricks.
Fig. 7.1 shows a rotary lime kiln used to make lime from limestone. The chemical name for limestone is calcium carbonate. Limestone is fed in at the top of the kiln and lime comes out at the bottom.

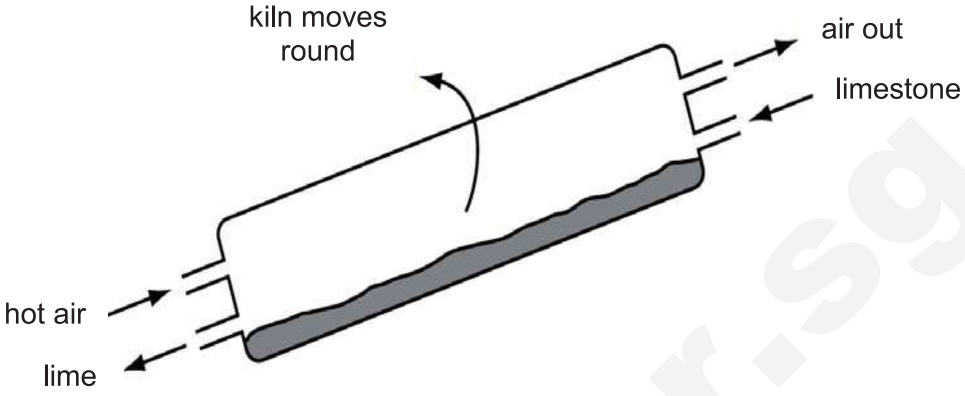

Fig. 7.1

(a) State the chemical name for lime.

.... [1]

(b) State the name of the type of chemical reaction that takes place in the rotary kiln.

.... [1]

(c) Suggest why the air coming out of the kiln has a greater percentage of carbon dioxide than the air entering the kiln.

....

.... [1]

(d) State **one** use for lime.

.... [1]

(e) A student compared the rates of reaction of three metal carbonates. She measured the volume of gas released using the apparatus shown in Fig. 7.2.

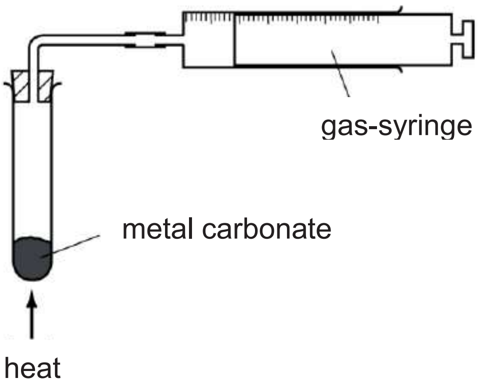

Fig. 7.2

State **one** thing that must be kept constant if the rates of the three reactions are to be compared in a fair way.

.... [1]

(f) The graph in Fig. 7.3 shows the volumes of carbon dioxide released when the three metal carbonates were heated.

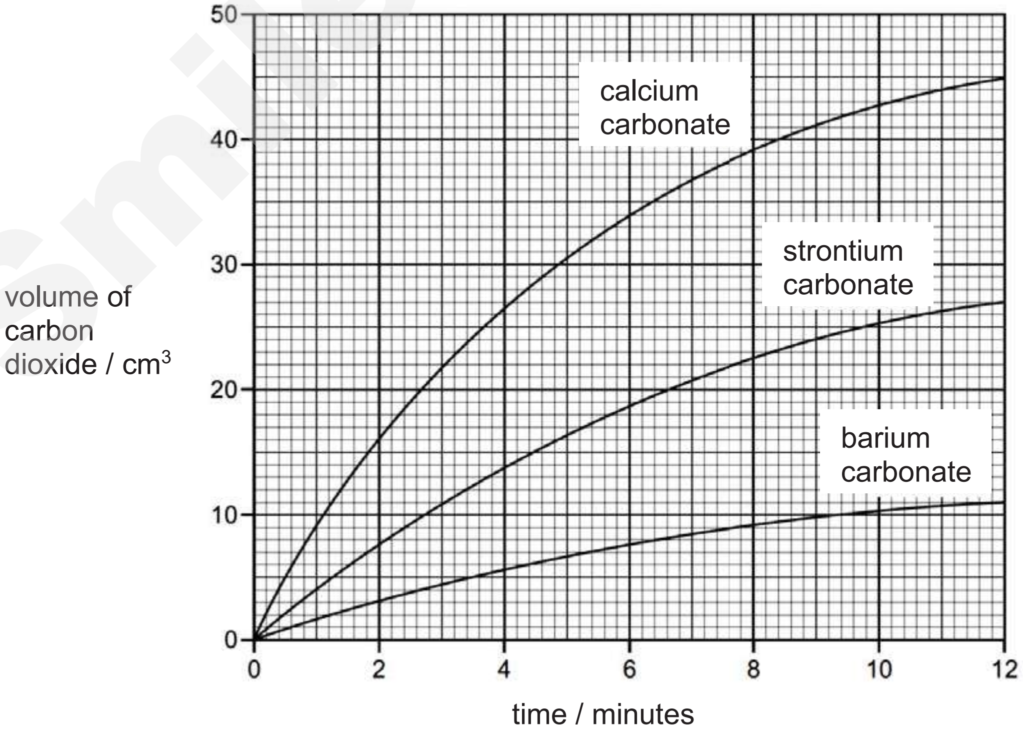

Fig. 7.3

(f) **(i)** With reference to Fig. 7.3, which carbonate produced carbon dioxide at the highest rate?

…………………………………………………………………………………… [1]

(ii) What volume of carbon dioxide was produced by strontium carbonate in twelve minutes? You need to **indicate clearly** on Fig. 7.3 how you obtained the answer.

…………………………………………………………………………………… [1]

(iii) How do the rates of the reactions of these three metal carbonates relate to the position of calcium, strontium and barium in the Periodic Table?

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(g) Describe how hydrochloric acid and limewater can be used to show that carbonate ions are present in calcium carbonate.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [3]

[Total: 12]

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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.

8 Mass spectrometry is an important technique which can identify the amount and type of chemicals present in a sample by using a machine called a mass spectrometer. In general, the two quantities that can be measured are the **mass/charge ratio (m/z)** and the **relative abundance** of particles in the sample.

Mass/charge (m/z) ratio: This is calculated by dividing the mass of an ion by its charge. For example, a sodium-23 ion, $^{23}_{11}\text{Na}^{+}$, would have a m/z value of 23. , Hence, the m/z value of an ion with a charge of 1+ is essentially its relative mass.

Relative abundance: This refers to the percentage of a particular isotope which occurs in nature. For example, in a sample of chlorine, the relative abundance of chlorine-35 is 75% and chlorine-37 is 25%.

The following steps show how mass spectrometry is done.

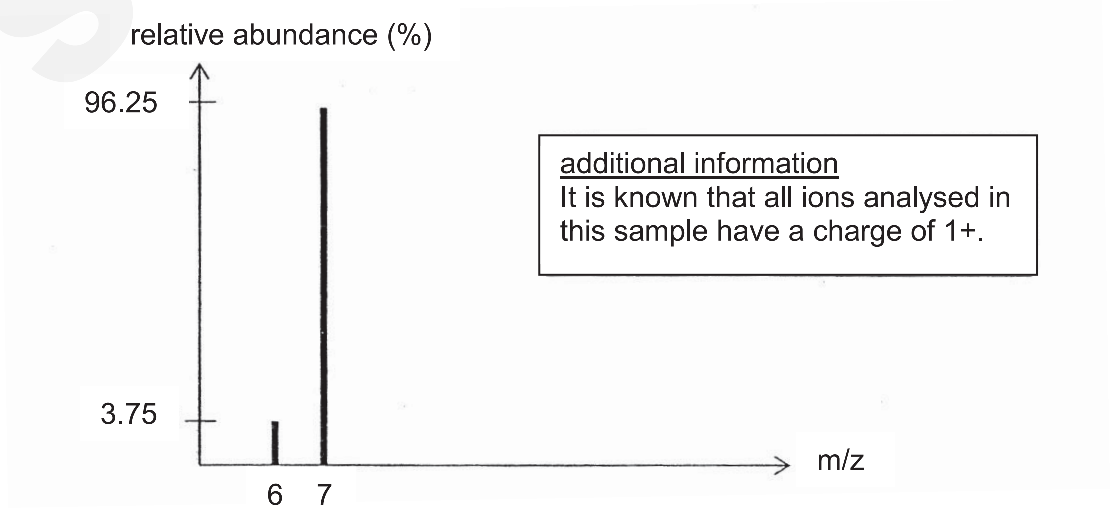
Step 1: Ionisation – the sample is vapourised. Energy is then used to knock off one or more electrons from atoms or molecules in the sample, changing them into positive ions. If enough energy is supplied, some bonds of the molecules are broken, and smaller ions are formed.

Step 2: Acceleration – the ions formed from **Step 1** are accelerated through the spectrometer by the use of negatively-charged plates.

Step 3: Deflection and detection – the ions are deflected by a magnetic field and are detected electrically.

Step 4: Mass spectrum – the mass spectrometer records the m/z value and relative abundance of all ions in the form of a histogram, called a mass spectrum.

Fig. 8.1 shows the mass spectrum of a pure sample of lithium.



additional information
It is known that all ions analysed in this sample have a charge of 1+.

Fig. 8.1

Fig. 8.2 shows the mass spectrum of a pure sample of chlorine.

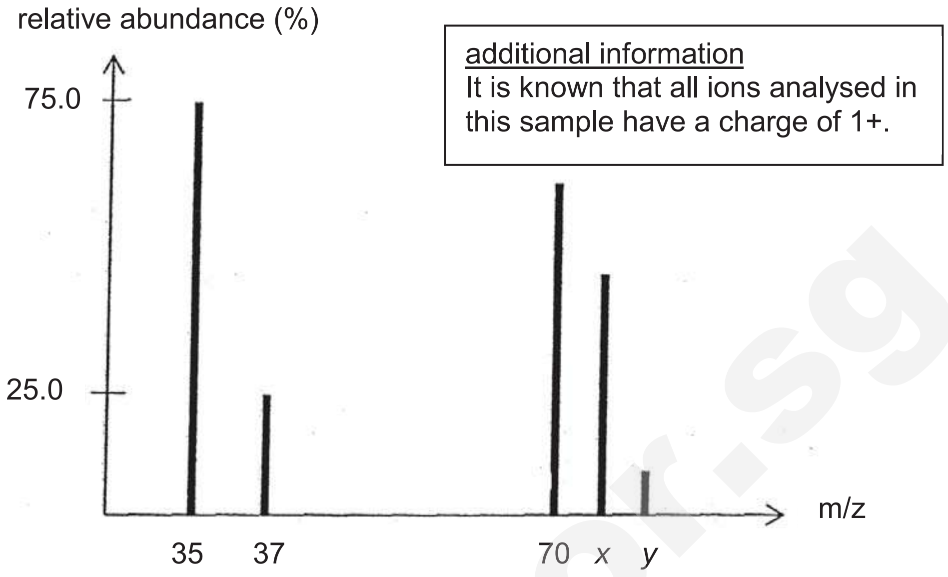


Fig. 8.2

Fig. 8.3 shows the mass spectrum of a pure sample of an unknown hydrocarbon.

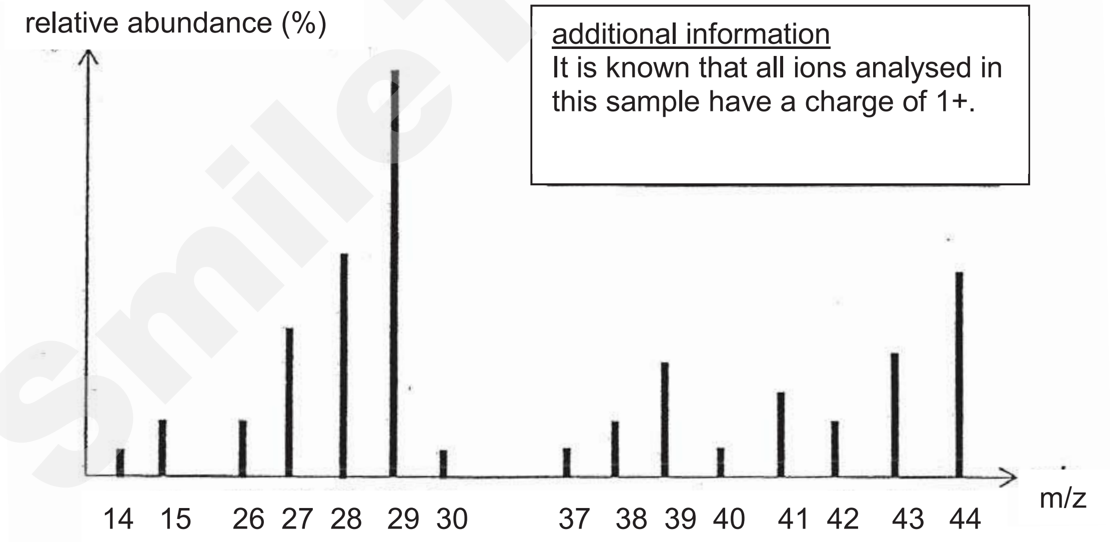


Fig. 8.3

(a) **(i)** Explain how the data in Fig. 8.1 shows that there are two isotopes of lithium.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(ii) With appropriate calculation, show that the average relative atomic mass of lithium is 6.96, correct to 3 significant figures.

[1]

(b) **(i)** With reference to Fig. 8.2, calculate the values of *x* and *y*.

[2]

(ii) Chlorine-35 and chlorine-37 are the only two known isotopes of chlorine. Use the data in Fig. 8.2 to suggest why there were three additional peaks of 70, *x* and *y* on the mass spectrum of chlorine.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(c) **(i)** A student comments that the unknown hydrocarbon is propane.

Explain how the data in Fig. 8.3 shows that this is true.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [2]

(ii) Suggest the formula of the **ion** which has a m/z value of 14.

……………………………………………………………………………………… [1]

(iii) Another mass spectrometry analysis was carried out on a sample of butane.

Suggest how the results of the mass spectrum of butane would differ from that of propane.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [2]

[Total: 12]

9 Besides its use in food products, vinegar is also commonly used as a household cleaner. The chemical name of vinegar is ethanoic acid.

(a) Name the elements that are present in ethanoic acid.

………………………………………………………………………………………… [1]

(b) Showing only the outermost electrons, draw a 'dot-and-cross' diagram of ethanoic acid.

[2]

(c) Will ethanoic acid have a high or low boiling point?
With reference to your knowledge of chemical bonding, give a reason for your answer.

…………………………………………………………………………………………

…………………………………………………………………………………………

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

(d) **(i)** Name the **two** products that are formed when magnesium reacts with ethanoic acid.

……………………………………………………………………………………... [1]

(ii) Construct a chemical equation, with state symbols, for the reaction of magnesium with ethanoic acid.

……………………………………………………………………………………. [2]

[Total: 8]

EITHER

10 Table 10.1 shows some information on four organic compounds.

Table 10.1

compound	molecular formula	Does it decolourise aqueous bromine?	effect on blue litmus paper
A	C_2F_4	yes	remains blue
B	$C_3H_6O_2$	no	turns red
C	$C_3H_6O_2$	yes	remains blue
D	$HO_2C\text{-}C_2H_4\text{-}CO_2H$	no	turns red

(a) **(i)** Compound **A** can be polymerised to make poly(tetrafluoroethylene) also known as poly(tetrafluoroethene). It is also commonly known as PTFE.

Name the type of polymerisation that is present in PTFE.

.... [1]

(ii) Showing **two** repeat units, draw the displayed formula of PTFE.

[1]

(iii) There are high and low grades of PTFE.
Molecules of high-grade PTFE typically have a relative molecular mass of 1.2×10^6.

By showing your working clearly, calculate how many repeat units are present in a typical molecule of high-grade PTFE.

[1]

(iv) Low-grade PTFE molecules typically have a relative molecular mass of 1.4×10^4.

Explain why low-grade PTFE has a lower melting point than high-grade PTFE.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(v) Describe and explain a pollution problem caused by getting rid of substances made of PTFE.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(b) Compound **B** can react with another organic compound to form ethyl propanoate.

(i) Draw the full structural formula of the organic compound which can react with compound **B** to form ethyl propanoate.

[1]

(ii) Draw the full structural formula of ethyl propanoate.

[1]

(c) Compound **C** can be polymerised with compound **D**.
During this polymerisation process, small molecules of water are eliminated.

Showing **two** repeat units, draw the structure of the polymer that is formed when compound **C** is polymerised with compound **D**.

[2]

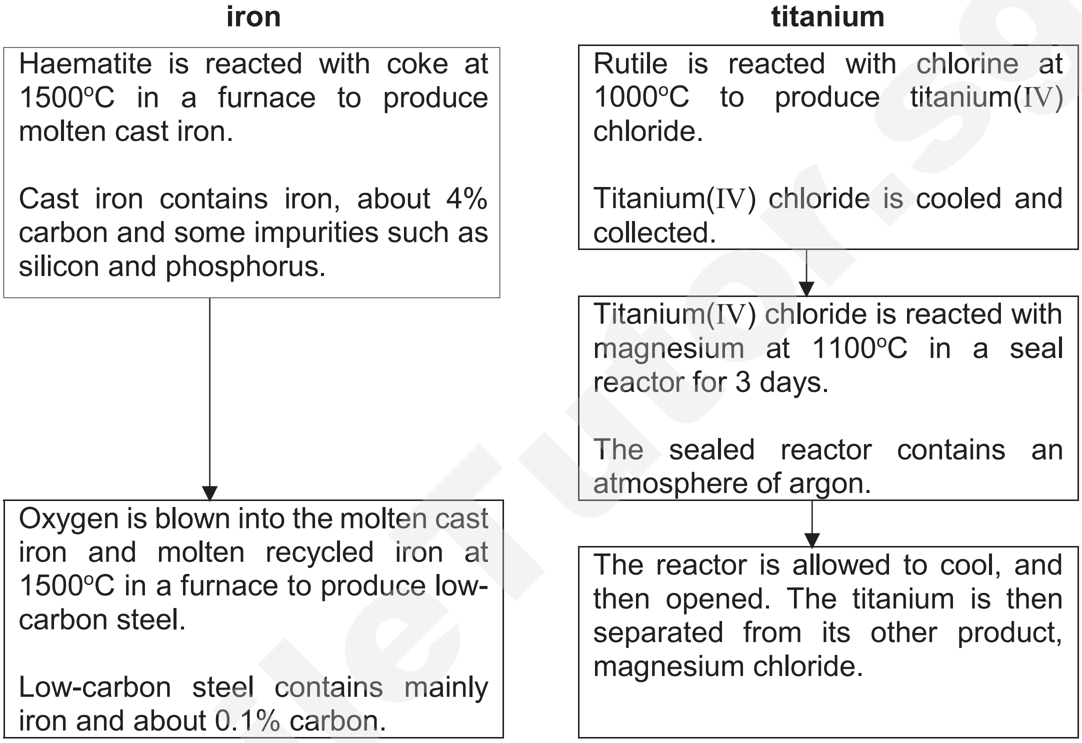
[Total: 10]

OR

10 Iron is produced in the blast furnace using the ore, haematite (melting point 1566°C), as one of the raw materials.

Titanium is produced from the ore, rutile. The chemical name for rutile is titanium dioxide (melting point 1843°C). Rutile cannot be reduced by coke and hence, it requires a different method of extraction.

Fig. 10.1 shows a quick summary of the extraction methods for iron and titanium.



iron

Haematite is reacted with coke at 1500°C in a furnace to produce molten cast iron.

Cast iron contains iron, about 4% carbon and some impurities such as silicon and phosphorus.

Oxygen is blown into the molten cast iron and molten recycled iron at 1500°C in a furnace to produce low-carbon steel.

Low-carbon steel contains mainly iron and about 0.1% carbon.

titanium

Rutile is reacted with chlorine at 1000°C to produce titanium(IV) chloride.

Titanium(IV) chloride is cooled and collected.

Titanium(IV) chloride is reacted with magnesium at 1100°C in a seal reactor for 3 days.

The sealed reactor contains an atmosphere of argon.

The reactor is allowed to cool, and then opened. The titanium is then separated from its other product, magnesium chloride.

Fig. 10.1

Titanium reactors produce about 1 tonne of the metal per day.
Iron blast furnace produce about 20 000 tonnes of the metal per hour.

(a) Explain why the production of low-carbon steel uses oxygen but the production of titanium requires 'an atmosphere of argon'.

....

....

....

....

.... [3]

(b) The melting point of haematite is higher than the temperature in the blast furnace.

(i) What is the chemical name for haematite?

.... [1]

(ii) Explain why haematite could remain in the molten state in the blast furnace.

....

.... [1]

(c) There is less titanium than iron in the Earth's crust.

Other than titanium's scarcity, use the information to explain why titanium costs much more than iron.

....

....

....

....

.... [2]

(d) Suggest why water is used to flush the titanium at the last stage.

....

.... [1]

(e) Suggest the position of titanium in the Reactivity Series of Metals.
Explain your answer.

....

....

.... [2]

[Total: 10]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
			Key				1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		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 –

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

4E Pure SKSS Chemistry Prelim Exam 2019 Paper 1– Answers

1	D
2	D
3	D
4	D
5	D
6	A
7	C
8	C
9	B
10	C

11	C
12	B
13	C
14	D
15	A
16	D
17	C
18	B
19	B
20	A

21	D
22	C
23	A
24	B
25	C
26	B
27	A
28	D
29	A
30	C

31	C
32	C
33	B
34	B
35	D
36	B
37	A
38	D
39	B
40	D

Setter: Mrs S Yap

4E Pure SKSS Chemistry Prelim Exam 2019 Paper 2– Answers

1 (a) E (b) B (c) A (d) E (e) C — 5

2 (a)

element	most common oxidation states	metal or non-metal?
A	−2	**non-metal**
B	+2, +3, +4, +6, +7	**metal**
C	+1	non-metal
D	+3	**metal**
E	−1	**non-metal**

1 all correct entries

(b) (i) C (ii) A (iii) B — 3

(c) Elements in Group 0 have a full valence shell (allow: stable noble gas configuration), they are electronically stable and do not form ions as they are chemically unreactive. (allow: do not need to gain or lose electrons) — 1, 1
(**not accepted**: electronically stable alone / chemically unreactive alone / noble gas alone / full electron shell)

3 (a) Neutralisation occur, a salt and water is produced. (**no mark**: mention neutralisation alone) — 1

(b) Dilute ethanoic acid is a weak acid and is partially ionised into hydrogen ions (H^+) in solution. Hydrochloric acid is strong acid and it is completely ionised into hydrogen ions (H^+) in solution. (**no mark**: mention of strong acid or weak acid alone) — 1

There are more hydrogen ions (H^+) ions per unit volume in hydrochloric acid, hence there are more frequent effective collisions between the reactants and thus rate of reaction of hydrochloric acid with metal oxides is faster than that of ethanoic acid with metal oxides. — 1

(c)

solutions that are mixed	formula of precipitate	colour of precipitate
aqueous copper(II) sulfate and aqueous sodium hydroxide	**$Cu(OH)_2$**	**blue**
aqueous potassium iodide and aqueous silver nitrate	**AgI**	**yellow**
dilute sulfuric acid and aqueous barium chloride	**$BaSO_4$**	**white**

1m for each formula, **max 3**

1m - all correct colours of ppt

Total: [4]

4 (a) Any **2** of the following: 2

chromium is more attractive / shiny than steel /
to improve the appearance of steel /
to resist corrosion / rusting of steel

(**reject:** make it harder / serves as protective layer)

(b) $Cr_2(SO_4)_3$ 1

(c) $Cr^{3+}(aq) + 3e \rightarrow Cr(s)$

correct equation with correct balancing 1

correct state sym (this mark is only awarded if all the formula are correct) 1

(d) oxygen 1

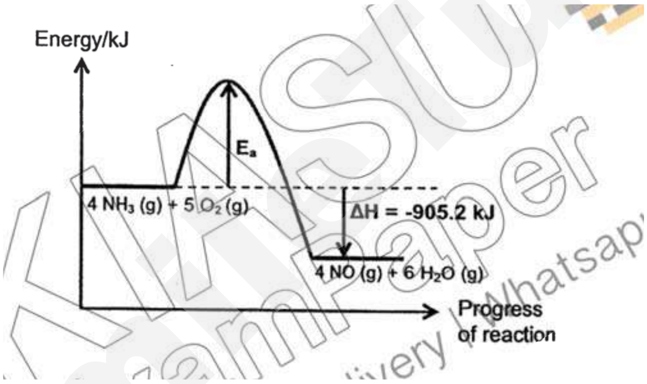
gas <u>relights / rekindles</u> a <u>glowing splint</u> 1

(**no mark**: glowing splint alone)

(e) to replace chromium ions that are used to plate the steel / chromium ions are used up; 1

copper(II) ions are continually being replaced from copper anode (active electrode) 1

5 (a)



Correct exothermic profile **and** correct labels for axes , reactants and products 1

Correct E_a and ΔH indicated on diagram, and correct direction of arrows 1

(**no mark**: use of double-headed arrows; wrong symbols for E_a or ΔH)

(b) <u>Oxidation</u> occurs in NH_3, <u>oxidation state of N increases from −3 to +2</u> 1

<u>Reduction</u> occurs in O_2, <u>oxidation state of O decreases from 0 to −2</u> 1

(**no mark**: if oxidation state changes are mentioned but did not state oxidation or reduction)

(c) (i) $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$ 1

(ii) distillation 1

(**reject:** fractional distillation / heating / evaporation)

6 (a) (i) bromine and potassium chloride 1
(**reject:** bromine gas)

(ii) <u>colourless</u> solution becomes <u>red-brown</u> 1
(**no mark**: solution becomes red-brown)

(b) **No. of moles of C*l***
$= \frac{(0.366-0.224)}{35.5}$
=0.004

No. of moles of O
$= \frac{0.224}{16}$
= 0.014

} 1

NOTE: This mark is only awarded if the above working is shown

whole no. ratio of C*l* : O = 1 : 3.5
= <u>2 : 7</u> 1

Empirical formula is $\mathbf{Cl_2O_7}$ 1

7 (a) calcium oxide (**reject**: CaO) 1

(b) thermal decomposition (**reject**: decomposition) 1

(c) carbon dioxide comes from the thermal decomposition of limestone / 1
carbon dioxide is a product of the reaction
(**no mark:** carbon dioxide is produced from combustion)

(d) neutralising <u>acidic</u> soils / treating <u>acidic</u> lakes / flue gas desulfurisation / drying agent for ammonia gas 1
(**no mark**: neutralise soil / drying agent alone)

(e) **Answers need to be accompanied with specific scientific terms** 1
temperature of Bunsen / temperature of heat source / distance of Bunsen burner from the tube / mass of carbonate used / duration of heating

(**no mark**: amount of carbonate / amount of heat / temperature alone / strength of heat)

(f) (i) calcium carbonate 1

(ii) 27 **<u>cm³</u>** (mark is **only** awarded when this answer is **<u>indicated on the graph, and with correct units</u>**) 1

(iii) <u>Calcium carbonate</u> produces carbon dioxide at the highest rate, followed by <u>strontium carbonate</u>, and lastly <u>barium carbonate</u>. 1
(**no mark:** calcium produces highest amount, followed by strontium, and lastly barium ➔ wrong concept , it is not the metal that produces the gas!)

State the trend: <u>less rapid</u> reaction the further <u>down the Group</u> / down Group II 1
(accept reverse argument)

7 (g) add hydrochloric acid to carbonate 1

bubble gas (carbon dioxide) through limewater,
gas produced white precipitate (accept – ppt) in limewater } 1

carbon dioxide is produced / evolved / given out, carbonate is present 1
(**no mark**: carbon dioxide is present)

8 (a) (i) In Fig. 8.1, there are **2 ions** (accept particles) / **2 peaks** which have **different m/z values** of **6 and 7**. 1

This shows that these two ions have **different number of neutrons**. 1

(ii) $$\left(\frac{3.75}{100}\times 6\right)+\left(\frac{96.25}{100}\times 7\right)= 6.9625 \approx \mathbf{6.96} \text{ (3sf)}$$ 1

(b) (i) $x = 35 + 37 = 72$ 1
$y = 37 + 37 = 74$ 1
NOTE: No mark will be awarded if no working is shown

(ii) Chlorine exists as diatomic molecules. 1
There are 3 possible combinations as follow:
2 atoms of Chlorine – 35
1 atom of Chlorine – 35 and 1 atom of Chlorine – 37 } 1
2 atoms of Chlorine – 37

NOTE: if student **did not list out the combinations** ➔ **no marks** awarded

(c) (i) Propane has a relative molecular mass of 44 / molar mass of 44 g/mol) 1
(**no mark**: wrong use of terms e.g. mass = 44; molecular mass = 44)

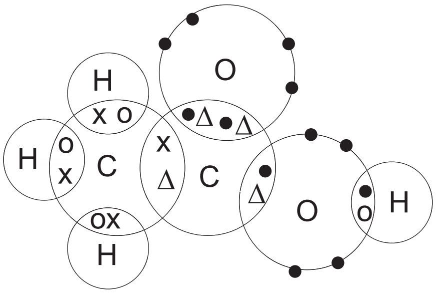
The largest m/z value is 44, which belong to the ion formed by the **largest molecule**. This molecule would be that of the unknown hydrocarbon as it is **unbroken**. 1

(ii) CH_2^{+} 1

(iii) The **highest m/z value** recorded would be **58**. 1
There would also be **more peaks** on the mass spectrum of butane. 1
(**no mark:** vague phrases e.g. should be higher than propane)

9 (a) carbon, oxygen, hydrogen 1

(b)



Covalent bonding shown + Correct number of shared electrons in all the atoms 1

Correct number of valence electrons on 2 oxygen atoms that are not involved in bonding 1

(c) It will have a **<u>low boiling point</u>**. 1
Not much energy is required to overcome the weak intermolecular forces between the ethanoic acid molecules. 1
(**zero mark**: high boiling point)

(d) (i) magnesium ethanoate and hydrogen 1

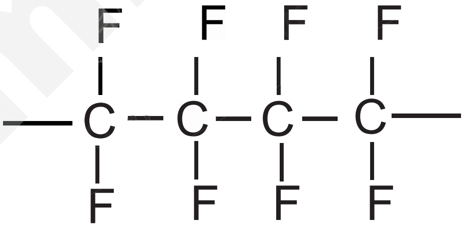
(ii) $Mg(s) + 2CH_3COOH(aq) \rightarrow (CH_3COO)_2Mg(aq) + H_2(g)$

correct formula, equation correctly balanced 1

correct state sym (this mark is only awarded if all the formula are correct 1

E10 (a) (i) addition polymerisation (**reject**: additional polymerisation) 1

(ii) 1



$$-\overset{\overset{F}{|}}{\underset{\underset{F}{|}}{C}}-\overset{\overset{F}{|}}{\underset{\underset{F}{|}}{C}}-\overset{\overset{F}{|}}{\underset{\underset{F}{|}}{C}}-\overset{\overset{F}{|}}{\underset{\underset{F}{|}}{C}}-$$

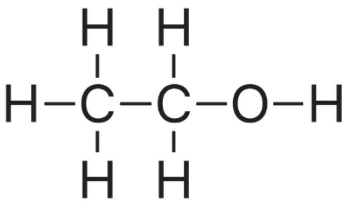
No mark awarded if the end bonds are not drawn / if brackets are drawn

(iii) M_r of one repeat unit = (12 x 2) + (19 x 4) = 100
No. of repeat units = (1.2 x 10^6) / 100 = **12 000** 1

(iv) Low-grade PTFE molecules are smaller in size, hence the force of attraction between the molecules is weaker (accept : weaker intermolecular forces) than that of high-grade PTFE molecules, hence lesser energy is needed to overcome the low-grade PTFE molecules. 1
NOTE: all underlined words must be stated before mark is awarded

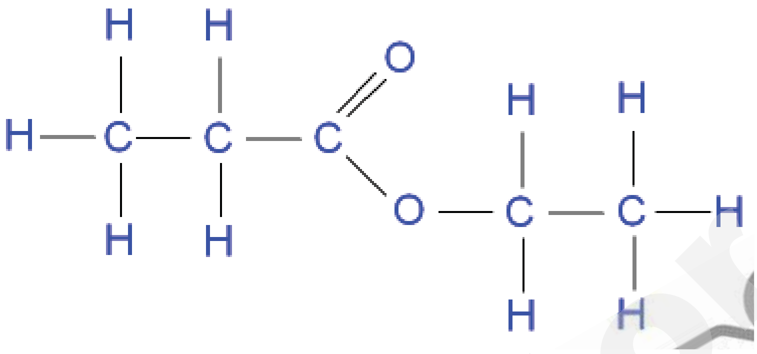
(v) Substances made of PTFE are non-biodegradable. 1
If they are disposed by burning, toxic gases are released / 1
if they are disposed by burying, valuable land space is used up as landfills.
(**reject**: greenhouse gases / pollute land and sea)

E10 (b) (i) 1

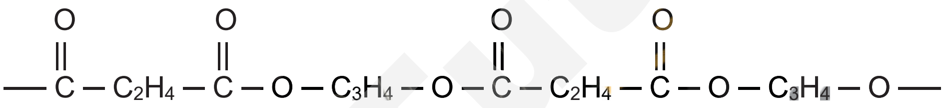


$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & O-H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

(ii) 1



(c)



$$-\overset{O}{\overset{\|}{C}}-C_2H_4-\overset{O}{\overset{\|}{C}}-O-C_3H_4-O-\overset{O}{\overset{\|}{C}}-C_2H_4-\overset{O}{\overset{\|}{C}}-O-C_3H_4-O-$$

1 repeat unit shown 1

2 repeat units shown 2

OR
10 (a) (i) Oxygen is needed to react with / oxidise carbon to reduce the carbon content and produce low-carbon steel. 1

To produce titanium, argon is used to create an inert / unreactive atmosphere, 1
as the presence of oxygen would cause a reaction / oxidation to occur with titanium 1

(b) (i) iron(III) oxide (**reject:** Fe_2O_3) 1

(ii) The presence of impurities such as silicon dioxide / sand lower the melting point of iron(III) oxide / haematite. 1

OR The energy released from the combustion of carbon / coke results in a higher temperature in the blast furnace for the iron(III) oxide / haematite to melt.

(c) As seen from the summary flowchart, there are more stages to manufacture titanium, hence more energy is needed. 1

In one day, blast furnace could produce 24 x 20 000 = 480 000 tonnes of metal while the reactor can only produce 1 tonne of metal, hence the **rate of production** is slower. 1

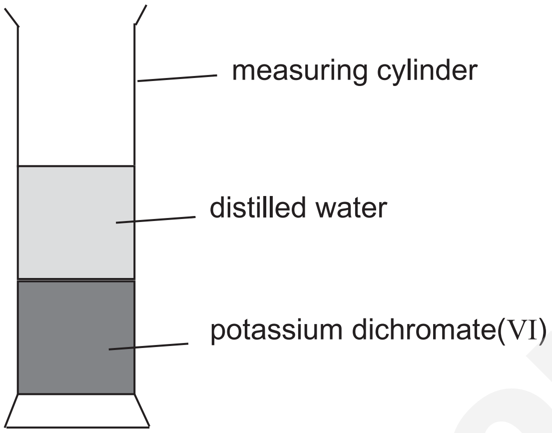
NOTE: relevant data from the information given must be used to support the answers

(d) To remove soluble magnesium chloride from titanium (**reject:** remove impurities) 1

(e) Titanium is below magnesium **AND** above zinc in the reactivity series. 1
(**no mark**: below magnesium alone / middle position)

Magnesium can displace titanium from titanium(IV) chloride, hence magnesium is more reactive than titanium. Titanium dioxide cannot be reduced by coke, but iron(III) oxide can be reduced by coke. Thus, titanium is more reactive than iron. 1

1 Potassium dichromate(VI) contains potassium ions (colourless) and dichromate(VI) ions (orange). An experiment was set up as shown below.

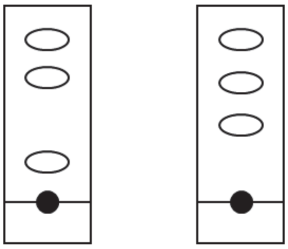


After a few days, a uniformly orange solution was obtained in the measuring cylinder.

The phenomenon was caused by the movement of ________________________.

A dichromate(VI) ions only.
B dichromate(VI) ions and water molecules only.
C potassium ions and dichromate(VI) ions only.
D potassium ions, dichromate(VI) ions and water molecules.

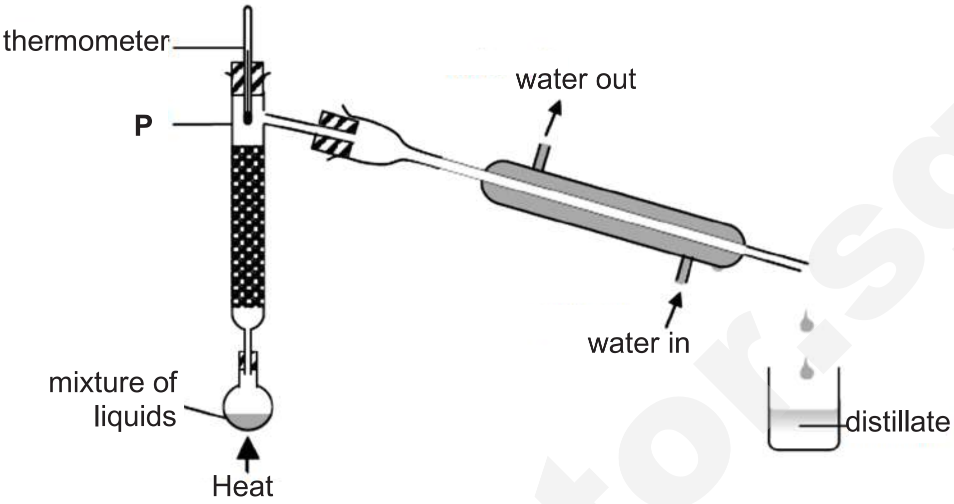
2 Two students were investigating the type of pigments found in flower petals. After obtaining a solution from the petals, the separation of the pigments was performed using chromatography. The chromatograms obtained are shown below.



If both students used flowers from the same plant, why were the chromatograms different?

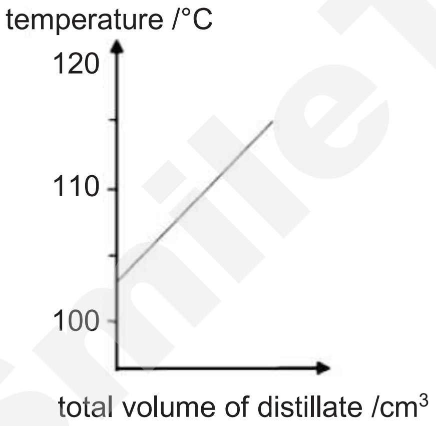
A One student did not use enough solvent.
B The solvent travelled up the paper at different speeds.
C The two students used different solvents.
D The solvent in one of the separation did not reach the top of the paper.

3 The diagram below shows the apparatus used to separate a mixture of two liquids with boiling points 102.5°C and 115°C.

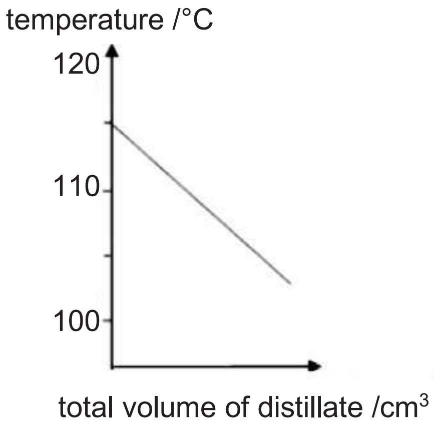


Which graph would be obtained if the temperature at point **P** was plotted against the total volume of distillate produced?

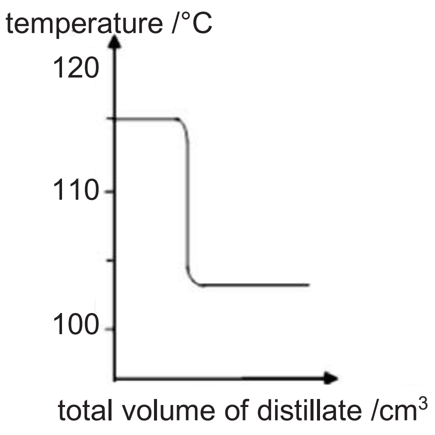
A



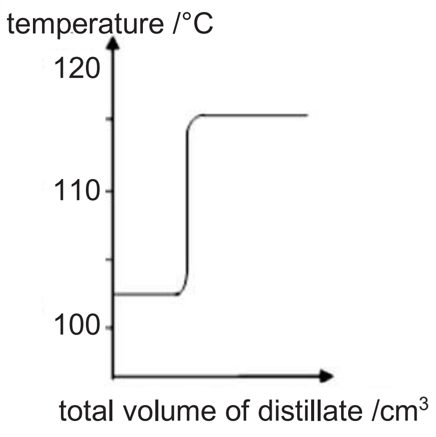
B



C

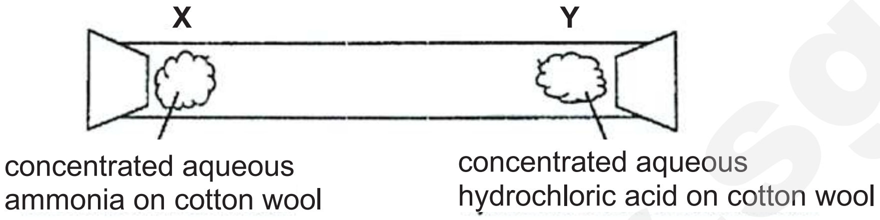


D



4 The apparatus below was set up with two cotton wool plugs soaked in concentrated aqueous ammonia and concentrated aqueous hydrochloric acid respectively.

These plugs were secured at opposite ends of a long glass tube as shown. After some time, a white solid formed within the tube.



The experiment was then repeated by placing the tube vertically, where the cotton wool soaked in concentrated aqueous hydrochloric acid is at the top.

Which of the following is true of the repeated experiment?

A The white solid forms even closer to **X** compared to the first experiment but at the same rate.
B The white solid forms even closer to **Y** compared to the first experiment but at the same rate.
C The white solid forms even closer to **X** and at a much faster rate compared to the first experiment.
D The white solid forms even closer to **Y** and at a much faster rate compared to the first experiment.

5 Which of the following list of substances contains an element, a compound and a mixture?

A crude oil, stainless steel, graphite
B diamond, ethanol, dry air
C petrol, neon, oxygen
D methane, carbon dioxide, air

6 An ion $\mathbf{X}^{3-}$ has a mass number of **m** and **n** electrons.

What does the nucleus of an atom of **X** contain?

	number of protons	number of neutrons
A	**n** - 3	**m** – **n**
B	**n** – 3	**m** – (**n** -3)
C	**n** + 3	**m** – (**n** – 3)
D	**n** + 3	**m** – (**n** + 3)

7 An element **Z** exists in three isotopic forms as shown below.

isotope	^{86}Z	^{87}Z	^{88}Z
isotopic abundance (%)	10	**p**	**q**

If the relative atomic mass of element **Z** is 87.7, what is the value of **p**?

A 10
B 20
C 70
D 80

8 Hydrogen can form both H^+ and H^- ions.

Which statement about these two ions is correct?

A H^+ ion has 1 more proton than a H^- ion.
B H^+ ion has 2 more protons than a H^- ion.
C H^- ion has 1 more electron than a H^+ ion.
D H^- ion has 2 more electrons than a H^+ ion.

9 Which substance consists of both ionic and covalent bonds in their structures?

A ethanol
B magnesium chloride
C potassium nitrate
D ethyl ethanoate

10 When dry ice is left at room temperature, it sublimes.

Which of the following statements correctly describes this process?

A Energy is absorbed to overcome the ionic bonds between the ions.
B Energy is absorbed to overcome the covalent bonds between the atoms.
C Energy is absorbed to overcome the van der Waals forces between the atoms.
D Energy is absorbed to overcome the van der Waals forces between the molecules.

11 In the lattice structure of ionic compounds, coordination number is the number of nearest neighbouring ions of the opposite charge. For instance, in sodium chloride, each sodium ions is surrounded by 6 chloride ions and each chloride ion is surrounded by six sodium ions. Hence, coordination number of sodium ions and chloride ions is 6.

The table below shows the ions present and the coordination number of the ions in some ionic compounds.

compound	ions present		coordination number of		formula
	cation	anion	cation	anion	
sodium chloride	Na^+	Cl^-	6	6	$NaCl$
titanium(IV) oxide	Ti^{4+}	O^{2-}	6	3	TiO_2
P	**Q**	**R**	4	8	?

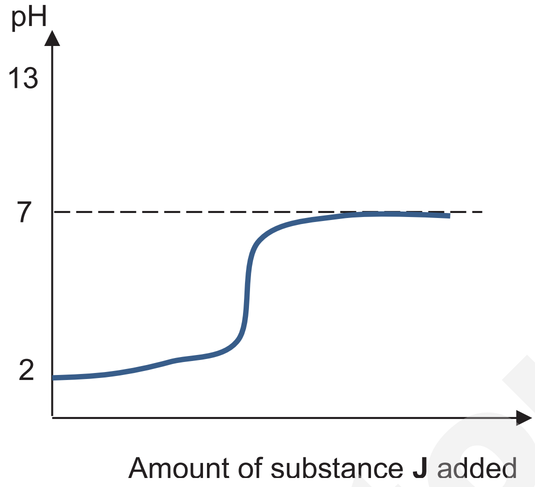
What is the formula of compound **P**?

A **QR_2**
B **Q_2R**
C **QR_4**
D **Q_4R**

12 Which of the following equations suggests that the underlined oxide has amphoteric properties?

A $\underline{K_2O} + H_2O \rightarrow 2\,KOH$
B $\underline{P_2O_5} + 6\,NaOH \rightarrow 2\,Na_3PO_4 + 3\,H_2O$
C $\underline{Cl_2O} + 2\,LiOH \rightarrow 2\,LiClO + H_2O$
D $\underline{Ga_2O_3} + 2\,KOH \rightarrow 2\,KGaO_2 + H_2O$

13 An excess of substance **J** was added bit by bit, with stirring, to aqueous solution **M**. The changes in the pH of the mixture are shown in the graph below.



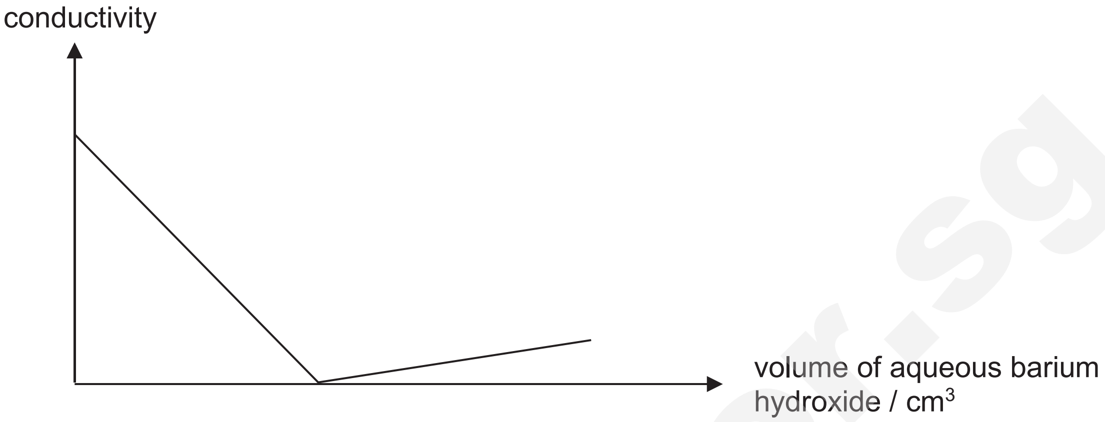
What could substance **J** and solution **M** be?

	substance **J**	solution **M**
A	aqueous ammonia	sulfuric acid
B	magnesium oxide	nitric acid
C	potassium oxide	hydrochloric acid
D	zinc oxide	ethanoic acid

14 Which pair of reagents is most suitable in preparing the following salts?

	salt	reagents
A	copper(II) chloride	copper + hydrochloric acid
B	iron(II) sulfate	iron(II) chloride + sulfuric acid
C	lead(II) chloride	lead(II) nitrate + ammonium chloride
D	potassium nitrate	potassium + nitric acid

15 The diagram below shows the change in electrical conductivity when aqueous barium hydroxide is added to a fixed volume of substance **X**.



Which of the following is a possible identity for substance **X**?

A aqueous zinc sulfate
B aqueous iron(III) nitrate
C aqueous sodium hydroxide
D aqueous copper(II) chloride

16 Which of the following does **not** represent 0.25 mol of nitrogen gas?

A 0.5 mol of atoms
B 3×10^{23} atoms
C 1.5×10^{23} molecules
D 14 g of nitrogen

17 Sodium reacts with water in a violent reaction to give an alkaline solution. A small piece of sodium of mass 0.400 g was added to excess water. When the reaction was complete, the resulting alkaline solution required 35.0 cm^3 of 0.200 mol/dm^3 dilute hydrochloric acid for complete neutralization.

What is the percentage purity of the sodium added?

A 24.8%
B 40.3%
C 60.0%
D 80.5%

18 When skunks are threatened, they release a foul smell that contains a group of compounds known as thiols.

An example of a thiol is methanethiol, CH_3SH, which burns as follows:

$$CH_3SH + 3\ O_2 \rightarrow CO_2 + SO_2 + 2\ H_2O$$

A sample of 10 cm^3 of methanethiol was burnt in 60 cm^3 of oxygen. What would be the final volume of the resultant mixture of gases when cooled to room temperature and pressure?

A 20 cm^3
B 40 cm^3
C 50 cm^3
D 70 cm^3

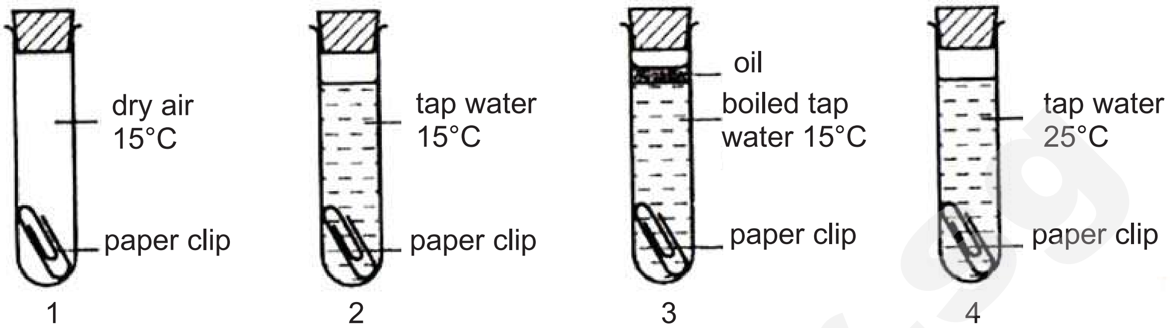
19 The atomic radius of some Group I elements of the Periodic Table is given.

element	atomic radius / pm
K	231
L	152
M	248
N	186

Which of the following shows the correct ascending order of melting point for the elements?

	lowest → highest			
A	**L**	**K**	**N**	**M**
B	**L**	**N**	**K**	**M**
C	**M**	**K**	**L**	**N**
D	**M**	**K**	**N**	**L**

20 Four experiments on rusting are shown.



Which two experiments can be used to show that air is needed for iron to rust?

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

21 Solid carbonates of three metals **W**, **X** and **Y** are heated.

	result
carbonate of **W**	carbon dioxide given off solid changes colour from green to black
carbonate of **X**	carbon dioxide given off solid does not change colour
carbonate of **Y**	carbon dioxide not given off solid does not change colour

Which of the following statements is/are correct?

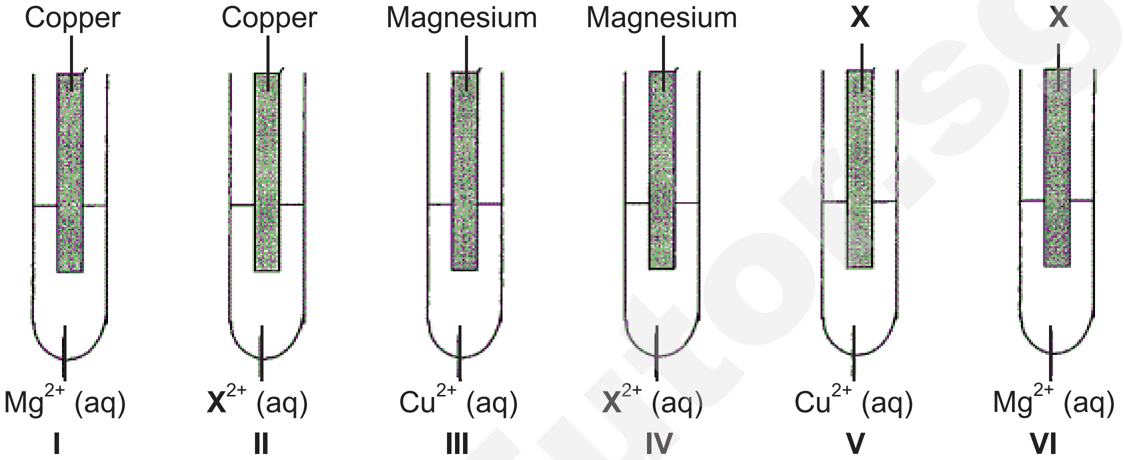
I Metal **Y** is a stronger reducing agent than metal **X**.
II Metal **W** can displace metal **Y** from its solution.
III Only the carbonate of **W** gives off carbon dioxide when added to dilute nitric acid.

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

22 **X** is an unknown metal.

A student did the following experiments to compare the reactivity of magnesium, copper and metal **X**.

Six tubes were arranged as shown in the diagrams below. Each tube contained a piece of metal half immersed in an aqueous solution containing ions of one of the other two metals.



The following observations were made:

- There was a deposit seen in only three tubes including tube **V**.
- There was no deposit in tube **VI**.

Besides tube **V**, which two other tubes contain a deposit?

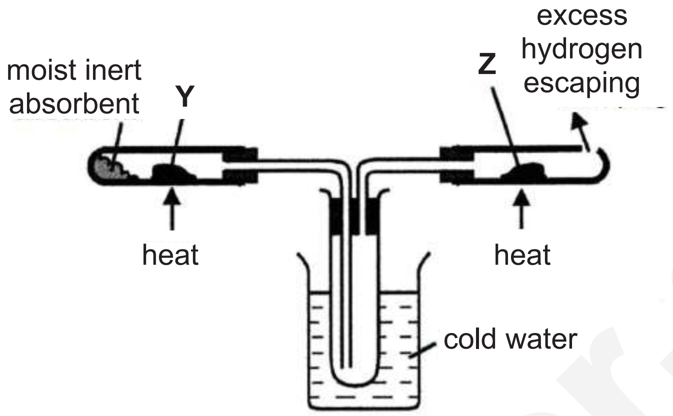
A **I** and **II**

B **II** and **III**

C **II** and **IV**

D **III** and **IV**

23 The diagram shows an apparatus used to demonstrate the reduction of a metallic oxide **Z** by hydrogen, which is produced by the action of steam on metal **Y**.



Which of the following could be **Y** and **Z**?

	Y	**Z**
A	copper	iron(II) oxide
B	iron	copper(II) oxide
C	lead	lead(II) oxide
D	magnesium	zinc oxide

24 Nitric acid, HNO_3, is a strong oxidizing agent.

Which of the following **cannot** be a product of nitric acid in its reaction with other substances?

A N_2
B NO
C NO_2
D N_2O_5

25 The equations below show the properties of sulfur dioxide.

$SO_2 + Cl_2 \rightarrow SO_2Cl_2$
$SO_2 + 2\ H_2S \rightarrow 3\ S + 2\ H_2O$

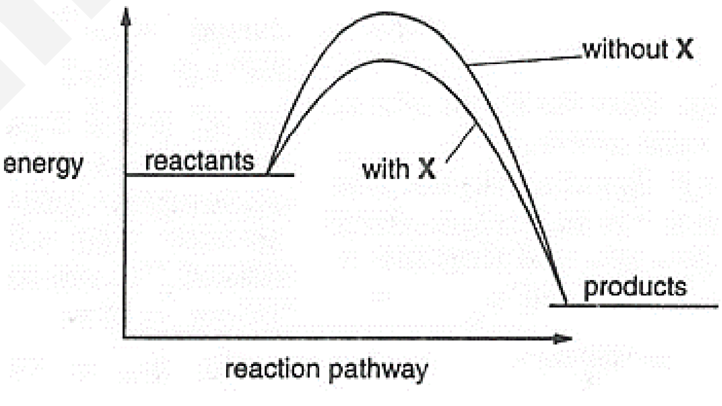
In two different experiments, sulfur dioxide was bubbled into acidified aqueous potassium manganate(VII) and aqueous potassium iodide. Which of the following correctly describes the observations seen in these experiments?

	acidified aqueous potassium manganate(VII)	aqueous potassium iodide
A	colourless to purple	remains brown
B	purple to colourless	remains colourless
C	purple to colourless	colourless to brown
D	colourless to purple	brown to colourless

26 Which of the following chemicals can be used to distinguish between aqueous calcium chloride and lead(II) nitrate?

A ammonium sulfate
B iron(II) sulfate
C sodium hydroxide
D potassium carbonate

27 The energy profile diagram of a reaction, where **X** is a catalyst, is shown.



Which of the following statements is correct?

A The addition of **X** increases the yield of the products.
B As the reaction proceeds, the amount of **X** present decreases.
C The enthalpy change of the reaction is decreased by the addition of **X**.
D Less heat is absorbed in bond breaking than is released in bond forming.

28 Which of the following reactions is an exothermic reaction?

A photosynthesis
B boiling of water
C condensation of steam
D thermal decomposition of metal carbonates

29 Methane and sulfur dioxide are gases which affect the atmosphere and the environment.

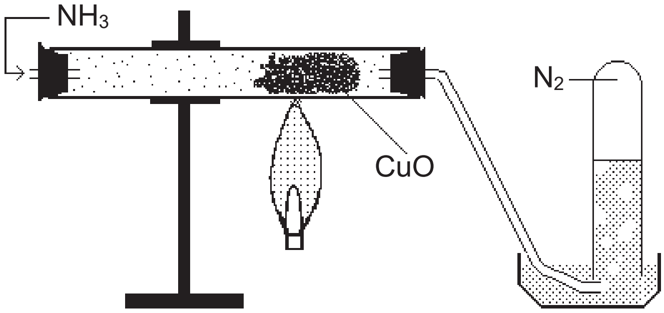
In what way do these gases affect the environment?

	methane	sulfur dioxide
A	depletion of the ozone layer	acid rain
B	global warming	photochemical smog
C	photochemical smog	global warming
D	global warming	acid rain

30 During the Haber process, ammonia that is produced is separated from the reaction mixture by ______________________.

A cooling the mixture
B dissolving the other two gases
C passing the gaseous mixture through fused calcium oxide
D filtering out the other two gases by passing through cotton wool

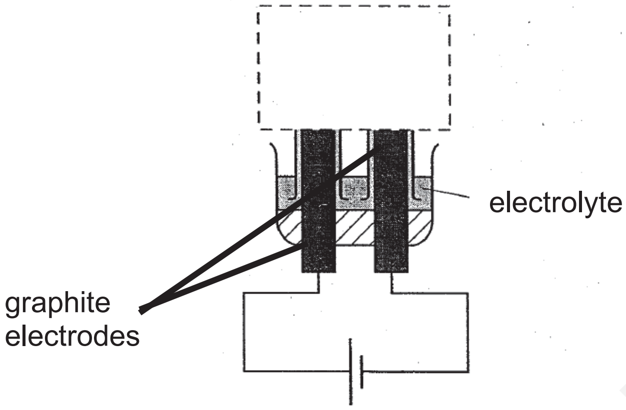
31 The diagram below shows an experiment involving ammonia.



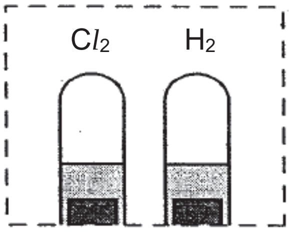
In this experiment, copper(II) oxide functions as ______________________________.

A a basic oxide
B a catalyst
C a reducing agent
D an oxidising agent

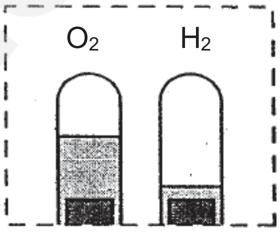
32 The diagram below is an incomplete diagram of an electrolysis experiment.



A student carries out the experiment above and obtains two different results **I** and **II** as shown below.



result **I**



result **II**

Which of the following correctly identifies the electrolyte used in the experiment to obtain results **I** and **II**?

	electrolyte used to obtain result **I**	electrolyte used to obtain result **II**
A	dilute hydrochloric acid	dilute sodium chloride
B	concentrated hydrochloric acid	dilute nitric acid
C	concentrated sodium chloride	concentrated hydrochloric acid
D	dilute sodium chloride	dilute nitric acid

33 In an electrolysis experiment, the same amount of charge deposited 32 g of copper and 13 g of chromium.

What is the charge of the chromium ion?

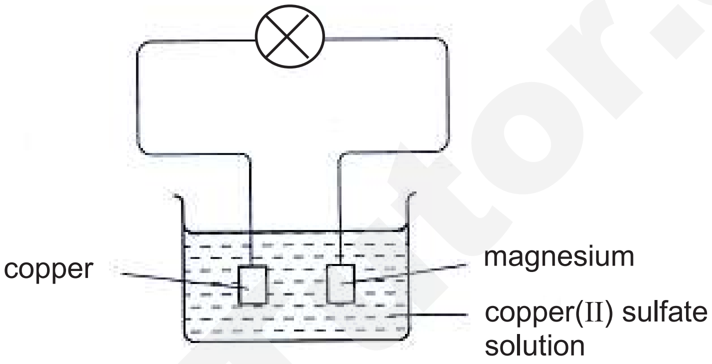
A +1
B +2
C +3
D +4

34 When electroplating an orchid with gold, a coating of carbon particles is painted onto the orchid first.

Why is this coating applied?

A It allows the orchid to act as the negative electrode.
B It provides a rough surface for the gold plating to stick to.
C It allows the gold to form a tough alloy on the orchid's surface.
D It pre`vents the pigments on the orchid from dissolving into the electrolyte.

35 Consider the simple cell below.



What would be observed in the simple cell after the bulb has been lighted for some time?

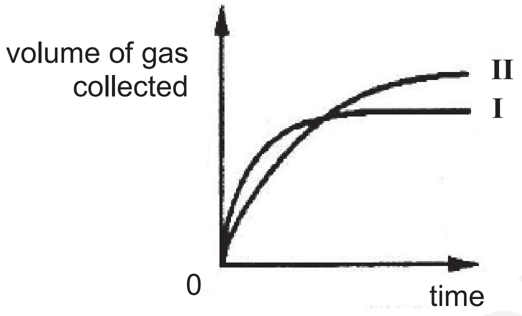
A Oxygen gas was produced at the copper electrode.
B The solution of copper(II) sulfate turned dark blue.
C Oxygen gas was produced at the magnesium electrode.
D The copper electrode was coated with a layer of pink solid.

36 A sawmill is a facility where logs are cut into lumber. Sawmills with a large amount of sawdust face a greater danger of explosions with a naked flame than sawmills with a large amount of wood shavings.

What is the most likely reason for this?

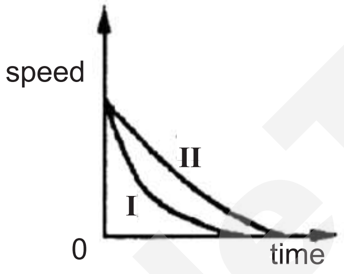
A Sawdust is more flammable than wood shavings.
B Sawdust has a larger surface area than wood shavings.
C Wood in powdered form acts as a catalyst for combustion.
D Sawmills produce methane which combine with the sawdust to form an explosive mixture.

37 In two separate experiments, a substance was decomposed and the gas evolved was collected. The graph below shows the total volume of gas collected against time for each experiment.

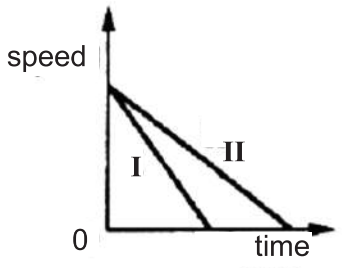


Which of the following graphs shows how the speed of the reaction varied with time in each experiment?

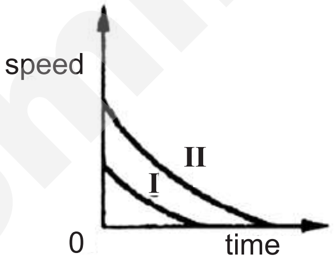
A



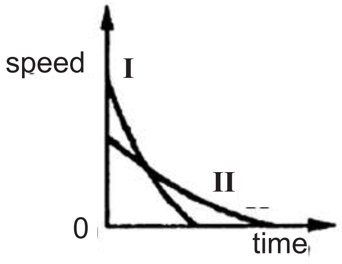
B



C



D



38 Useful fractions are obtained by the fractional distillation of petroleum.

Which of the following petroleum fractions is correctly matched with its use?

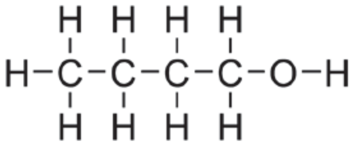
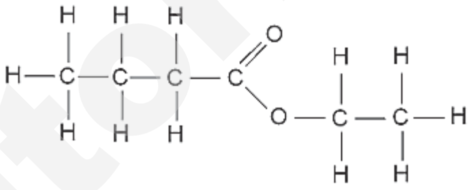
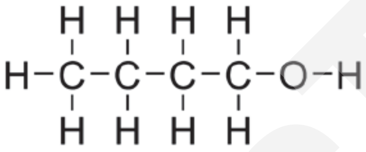
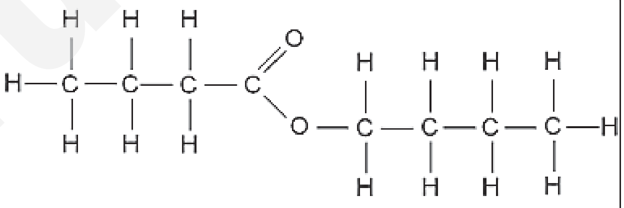
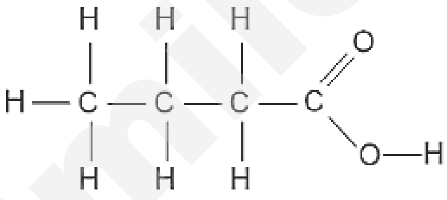
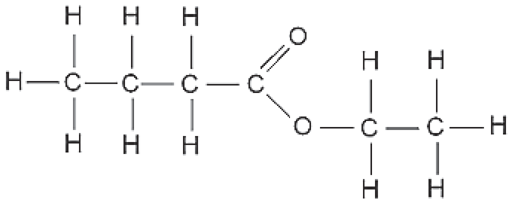
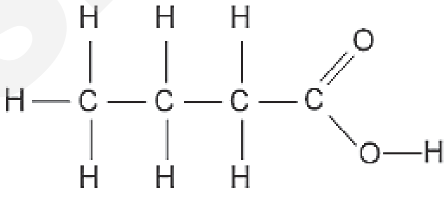
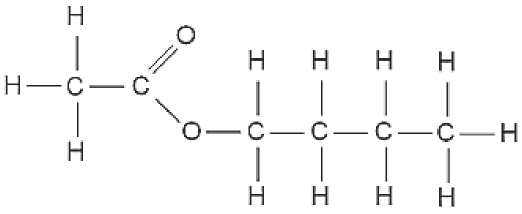
	fraction	use
A	bitumen	fuel in cars
B	kerosene	fuel for cars
C	naphtha	petrochemical feedstock

D	diesel	fuel for aircraft engines

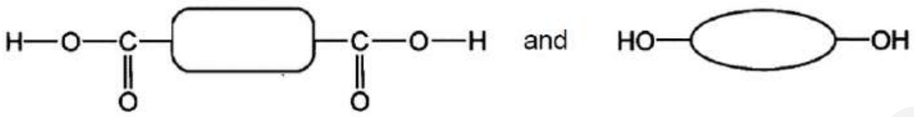
39 The following shows some descriptions about different organic compounds **P** – **T**.

I **P** (C_4H_8) can undergo hydration to form **Q**
II **Q** can be oxidised to form **R**.
III **R** and magnesium react together to form bubbles of gas.
IV **S** is formed from the fermentation of sugar.
V **R** and **S** react together to form a sweet smelling product **T**.

Which of the following correct shows the full structural formula of **R** and **T**?

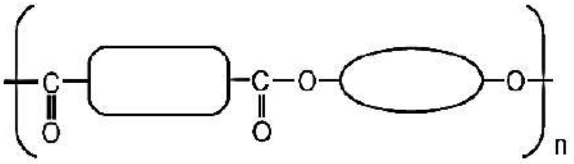
	R	**T**
A		
B		
C		
D		

40 Terylene is made by the condensation polymerisation of the two monomers shown.

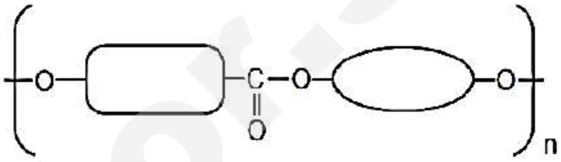


Which diagram represents the structure of the polymer formed?

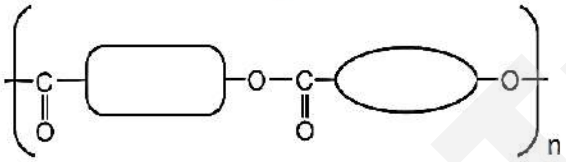
A



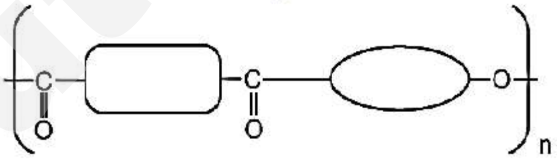
B



C



D



- End of Paper -

COVER PAGE

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.).

Section A [50 marks]

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

A1 Choose from the following substances to answer the questions below.

CF_3Cl	O_3	Ni	NaCl
Mg	CO	Al_2O_3	Cu

Each substance can be used once, more than once or not at all.

(a) State the substance which

(i) is responsible for ozone depletion.

……………………………………………………………………………………..[1]

(ii) dissolves in rainwater and speeds up rusting.

……………………………………………………………………………………..[1]

(iii) must be used in order to convert naptha to ethene.

……………………………………………………………………………………..[1]

(iv) reacts with aqueous iron(II) chloride and causes the solution to decolourise.

……………………………………………………………………………………..[1]

(b) Is the reaction in **(a)(iv)** a redox reaction? Explain your answer in terms of electron gain or loss.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………..[2]

[Total: 6]

A2 An oxyacid is an acid that contains an oxygen atom bonded to a hydrogen atom and at least one other element. Sulfuric acid (H_2SO_4), phosphoric acid (H_3PO_4) and nitric acid (HNO_3) are all oxyacids.

Chlorine forms several types of oxyacids. The table below shows some properties of oxyacids of chlorine that have the same concentration.

name of acid	chemical formula	reaction with magnesium	oxidation state of chlorine
perchloric acid	$HClO_4$	very vigorous	+7
hypochlorous acid	$HOCl$	only a few bubbles seen	
chloric acid	$HClO_3$	vigorous	
chlorous acid	$HClO_2$	reacts readily	+3

(a) Complete the table by filling in the oxidation state of chlorine. [1]

(b) **(i)** Arrange, in ascending order, the strength of these acids.

…………………………………………………………………………………………..

……………………………………………………………………………………[1]

(ii) Hence, deduce the trend in the strength of the acid with reference to the information in the table.

…………………………………………………………………………………………..

……………………………………………………………………………………[1]

(c) Carboxylic acids are also a type of oxyacid.

In another experiment, a solution containing 0.172 g of an unknown carboxylic acid, $C_xH_yCO_2H$, is titrated with 0.100 mol/dm^3 aqueous sodium hydroxide. The volume of sodium hydroxide solution needed to exactly neutralize the acid is 23.20 cm^3.

$$C_xH_yCO_2H + NaOH \rightarrow C_xH_yCO_2Na + H_2O$$

Calculate the relative formula mass of the carboxylic acid and suggest its identity.

relative formula mass: …………………….

identity: ……………………………… [3]

[Total: 6]

A3 Ammonia is manufactured on a large scale by the Haber Process. **Fig. 3** below shows the effect of pressure on the amount of ammonia in the equilibrium mixture at five different temperatures.

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$$

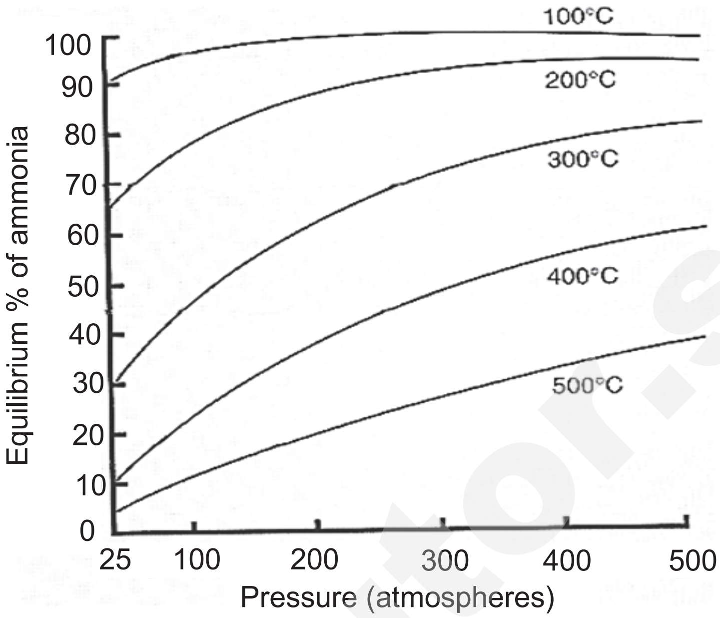


Fig. 3

(a) Using data from **Fig. 3**, describe the effect of pressure on the percentage of ammonia at equilibrium.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(b) State the actual conditions used in industry for the manufacture of ammonia in the Haber Process.

……………………………………………………………………………………………..[1]

(c) **(i)** Based on the information in **Fig. 3**, state the temperature of the reaction that would give 80% ammonia at equilibrium when the pressure is at 100 atm.

……………………………………………………………………………………..[1]

(ii) By comparing the temperature in **(c)(i)** with the actual temperature stated in **(b)**, explain why the temperature in **(c)(i)** is not used in practice.

…………………………………………………………………………………….

…………………………………………………………………………………….[1]

(d) Ammonia is used to make ammonium nitrate fertilisers.
To ensure that crops grow well at a suitable pH, farmers add fertilisers and slaked lime to the soil.

Explain why slaked lime and ammonium nitrate fertilisers should not be added together.

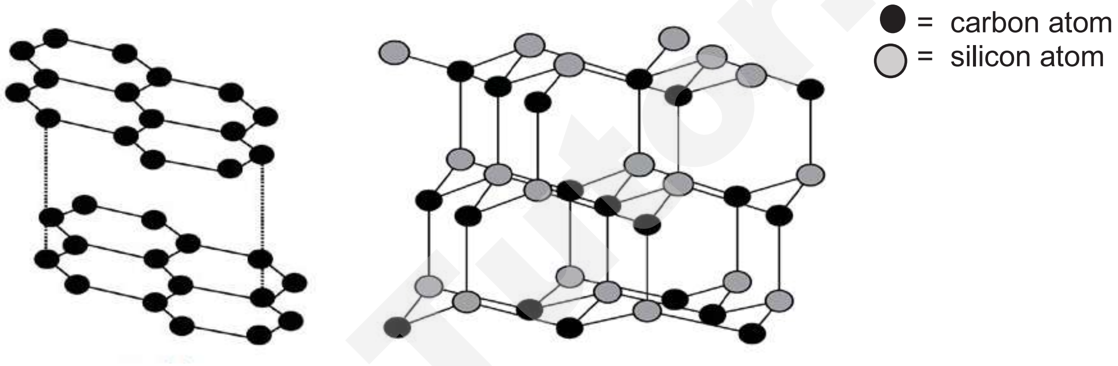
………………………………………………………………………………………………

………………………………………………………………………………………………

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

[Total: 7]

A4 The structure of graphite and silicon carbide are shown in **Fig. 4**.



graphite silicon carbide

Fig. 4

With reference to the bonding present in the substances,

(a) state and explain which substance is able to conduct electricity.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………[3]

(b) state and explain which substance is more suitable to be used as drill bits.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………[3]

[Total: 6]

A5 An electrical circuit is set up as shown. **A** and **B** are the poles of the battery. Electrodes **P** and **Q** are both made of platinum. 0.2025 g of silver metal was deposited on electrode **P**.

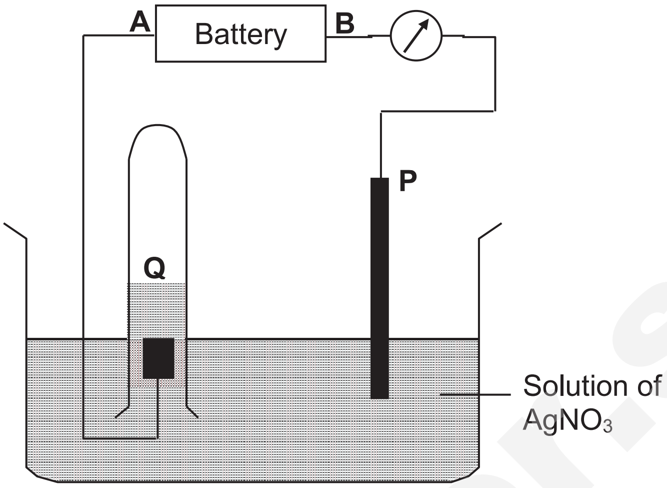


Fig. 5

(a) **(i)** State whether electrode **Q** is the positive or negative electrode.

……………………………………………………………………………………….[1]

(ii) Write an ionic equation for the reaction occurring at electrode **Q**.

……………………………………………………………………………………….[1]

(iii) Calculate the volume of gas collected, at room temperature and pressure, in the tube.

volume of gas collected: ……………………… [3]

(b) If the experiment was repeated using molten zinc chloride as the electrolyte, describe and explain the observations seen in the set-up.

………………………………………………………………………………………………......

………………………………………………………………………………………………......

………………………………………………………………………………………………......

………………………………………………………………………………………………......

………………………………………………………………………………………………..[3]

[Total: 8]

A6 The Periodic Table shows trends down each group and across each period.

(a) Which trends are only true down a group, across a period, true for both or not true for both?

Put a tick(✓) in the appropriate box for each trend. [2]

trend	only true down a group	only true across a period	true for both	not true for both
The mass number increases.				
The atomic radius decreases.				
The melting point increases.				
The character of the oxides changes from basic to amphoteric to acidic.				

(b) Chlorine gas was bubbled into a solution of potassium iodide.

(i) Describe the expected observation of this reaction.

…………………………………………………………………………………………[1]

(ii) With reference to the atomic radii of relevant elements, explain why the reaction in **(b)(i)** occurs.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

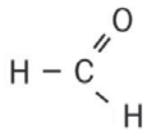
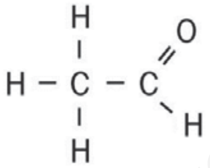
…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………[3]

[Total: 6]

A7 The table shows some information about the homologous series of organic compounds called aldehydes.

name	condensed formula	full structural formula
methanal	HCHO	
ethanal	CH_3CHO	
propanal		

(a) **(i)** Complete the table to show the name, condensed formula and structural formula of propanal. [1]

(ii) With reference to the structural formula, explain how you can deduce that these molecules are from the same homologous series.

……………………………………………………………………………………

……………………………………………………………………………………[1]

(b) Suggest and explain the trend in the boiling points of the aldehydes down the series.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

………..……………………………………………………………………………[3]

[Total: 5]

A8 Acrylamide is an organic compound that is classified as a hazardous substance as it is a potential carcinogen and is easily absorbed by the skin. It is used to manufacture polymers that are highly water absorbent and are used as thickeners. Acrylamide has the following structure.

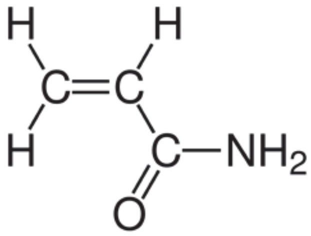


Fig. 8

(a) Draw the structure of the polymer formed from acrylamide, showing three repeating units. [1]

(b) Name the polymer drawn in **(a)**.

………...………………………………………………………………………………[1]

(c) Describe one difference and one similarity between acrylamide and its polymer.

………………………………………………………………………………….........

………………………………………………………………………………….........

………………………………………………………………………………….........

…………………………………………………………………………………………[2]

(d) The polymer from acrylamide is *non-biodegradable*.
Explain the term '*non-biodegradable'* and describe a problem caused by the disposal of non-biodegradable polymers.

………………………………………………………………………………….........

………………………………………………………………………………….........

………………………………………………………………………………….........

…………………………………………………………………………………………[2]

[Total: 6]

Section B [30 marks]

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

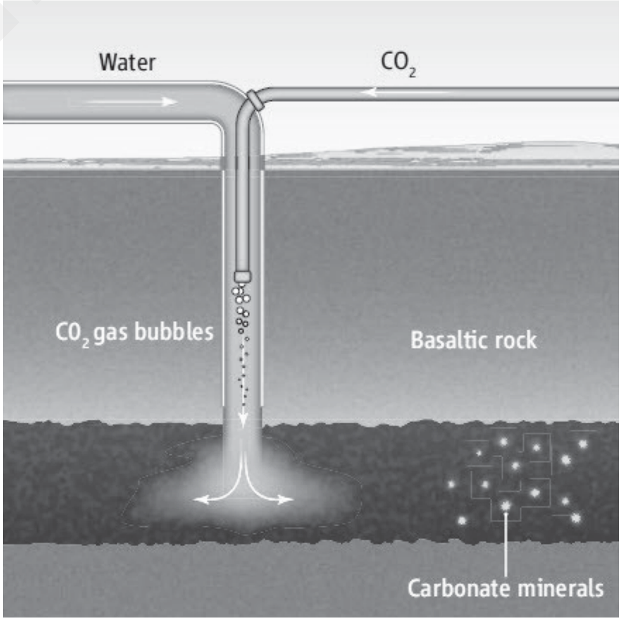
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.

B9 Heat waves and carbon emissions

The recent spell of heat waves that are sweeping across Europe and the United States have led to an increase in global awareness about the need to control carbon emissions. Extreme heat refers to temperatures that are exceptionally high relative to typical local conditions or reach levels that may be harmful to human health or infrastructure. When extreme daytime temperatures persist over a prolonged period (usually at least two days), it is often referred to as a heat wave.

In order to control carbon emissions, scientists have found ways to 'lock away' carbon dioxide. The article below was adapted from The Straits Times dated June 11, 2016.

> Scientists say they may have found a radical breakthrough to tackling climate change – by pumping heat-trapping carbon dioxide gas into the ground and turning it into stone.
>
> The research, called the *CarbFix* project and led by Columbia University, was published in American journal *Science* on Thursday (June 9).
>
> The approach involves dissolving carbon dioxide gas with water and pumping the resulting mixture – essentially soda water – down into certain kinds of rocks. Soda water then accelerates the release of metal ions from the rocks, such as calcium and magnesium, which react with the soda water to form minerals such as calcite ($CaCO_3$) and magnesite ($MgCO_3$). Acidic ions also produced in this reaction, which then further promotes the release of metal ions from the rocks, hence speeding up the reaction of soda water with metal ions. By turning the carbon dioxide gas into calcite and magnesite, scientists can then lock it away permanently.



One key to the approach is to find the right kind of rocks. Volcanic rocks called basalts are excellent for the process, because basalts are rich in calcium and magnesium.

The research was conducted for years in Iceland, a volcanic island made up mainly of basalt. Scientists found that the conversion yield is about 95%; meaning that 95% of the carbon dioxide was converted into calcite. More importantly, the conversion happened relatively quickly – in less than two years, instead of ten years as previously predicted by scientists.

Fig. 9

(a) Explain how high levels of carbon emissions cause heat waves.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

…………………………………………………………………………………………[2]

(b) **(i)** 'Soda water' mentioned in the article is weak carbonic acid (H_2CO_3). Explain what is meant by the term weak acid.

………………………………………………………………………………………

……………………………………………………………………………………[1]

(ii) Write an equation for the formation of magnesite.

……………………………………………………………………………………[1]

(c) Other than calcite, name another mineral that also contains calcium carbonate.

…………………………………………………………………………………………[1]

(d) Suggest a reason why

(i) the conversion of carbon dioxide gas into calcite happened relatively quickly around volcanic areas in Iceland.

………………………………………………………………………………………

……………………………………………………………………………………[1]

(ii) conversion yield of carbon dioxide gas into calcite may not reach 100%.

………………………………………………………………………………………

……………………………………………………………………………………[1]

(e) Other than the process described above, describe two other natural process that traps and stores carbon dioxide in the atmosphere.

……………………………………………………………………………………………..........

……………………………………………………………………………………………........

……………………………………………………………………………………………........

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

(f) As vehicles are a major source of air pollution, governments have introduced regulations to ensure that all vehicles install catalytic converters.

Describe briefly how catalytic converters work and explain why they are not useful in lowering carbon emissions.

……………………………………………………………………………………………........

……………………………………………………………………………………………........

……………………………………………………………………………………………........

……………………………………………………………………………………………........

………………………………………………………………………………………………[3]

[Total: 12]

B10 A growing concern for the environment has promoted a shift towards the use of cleaner sources of energy such as hydrogen fuel. Currently, the dominant technology for the production of hydrogen is through steam reforming of hydrocarbons.

Steam-methane reforming is a method used for producing hydrogen from natural gas. In the process, methane reacts with steam to produce carbon monoxide and hydrogen.

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

The carbon monoxide produced is transferred into another reaction vessel, where it is further reacted with more steam to produce more hydrogen in the water-gas shift reaction.

$$CO\ (g) + H_2O\ (g) \rightleftharpoons CO_2\ (g) + H_2\ (g)$$

(a) The bond energies of various bonds are shown in the table.

bond	bond energy (kJ/mol)
C─O	358
C≡O	1080
O─H	464
H─H	436

Given that the enthalpy change of the steam-methane reforming reaction is +200 kJ/mol, calculate the bond energy of the C─H bond.

bond energy: …..………………[2]

(b) Explain, in terms of bond breaking and bond forming, whether the reaction above is endothermic or exothermic.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………..[2]

(c) Both reactions described above are *reversible* reactions.

Explain the term '*reversible* reaction'.

…………………………………………………………………………………………………

…………………………………………………………………………………………...[1]

(d) If 1 kg of methane and 1.6 kg of steam are used in the steam-methane reforming reaction, what is the maximum mass of hydrogen that can be produced from 1 kg of methane?

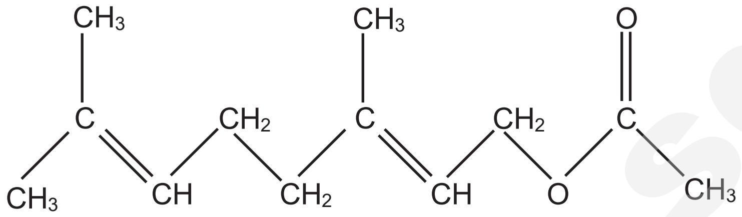
mass of hydrogen: ………………………. [3]

[Total: 8]

EITHER

B11 Perfumes usually contain three groups of components called the top note, middle note and end note.

(a) The top note compounds vapourise most readily. An example of a top note compound is geranyl acetate. The structure of geranyl acetate is shown below.



(i) Explain why geranyl acetate is suitable to be used as a top note for perfumes.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………….[2]

(ii) Draw the full structural formula of the carboxylic acid and alcohol used to synthesize geranyl acetate.

carboxylic acid

alcohol

(iii) State the name of the carboxylic acid drawn in **(a)(ii)**.

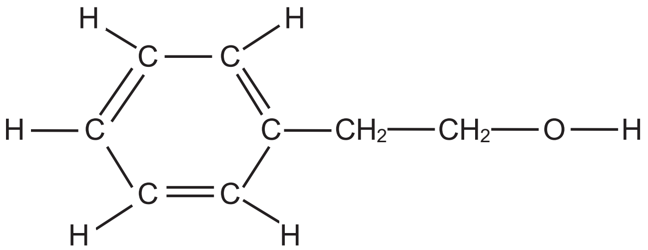
………………………………………………………………………………….[1]

(iv) Using the following percentage composition data, calculate the empirical formula for geranyl acetate.

element	percentage by mass (%)
carbon	73.47
hydrogen	10.20
oxygen	16.33

empirical formula: ……………………….. [2]

(b) The middle note compounds vapourise less readily. A typical middle note is 2-phenylethanol. The structure of 2-phenylethanol is shown below.



Describe a chemical test which can be carried out to distinguish between the top note (geranyl acetate) and middle note (2-phenylethanol) compounds.

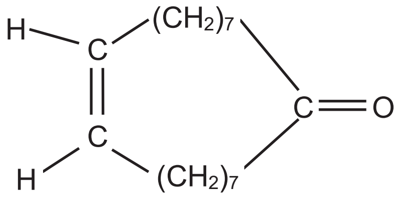
…………………………………………………………………………………………..........

…………………………………………………………………………………………..........

…………………………………………………………………………………………..........

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

(c) The end note of a perfume has a long lasting odour which stays with the user. An example of an end note compound is shown below.



Draw the structure of the compound formed when the end note compound above reacts with steam in the presence of a catalyst. [1]

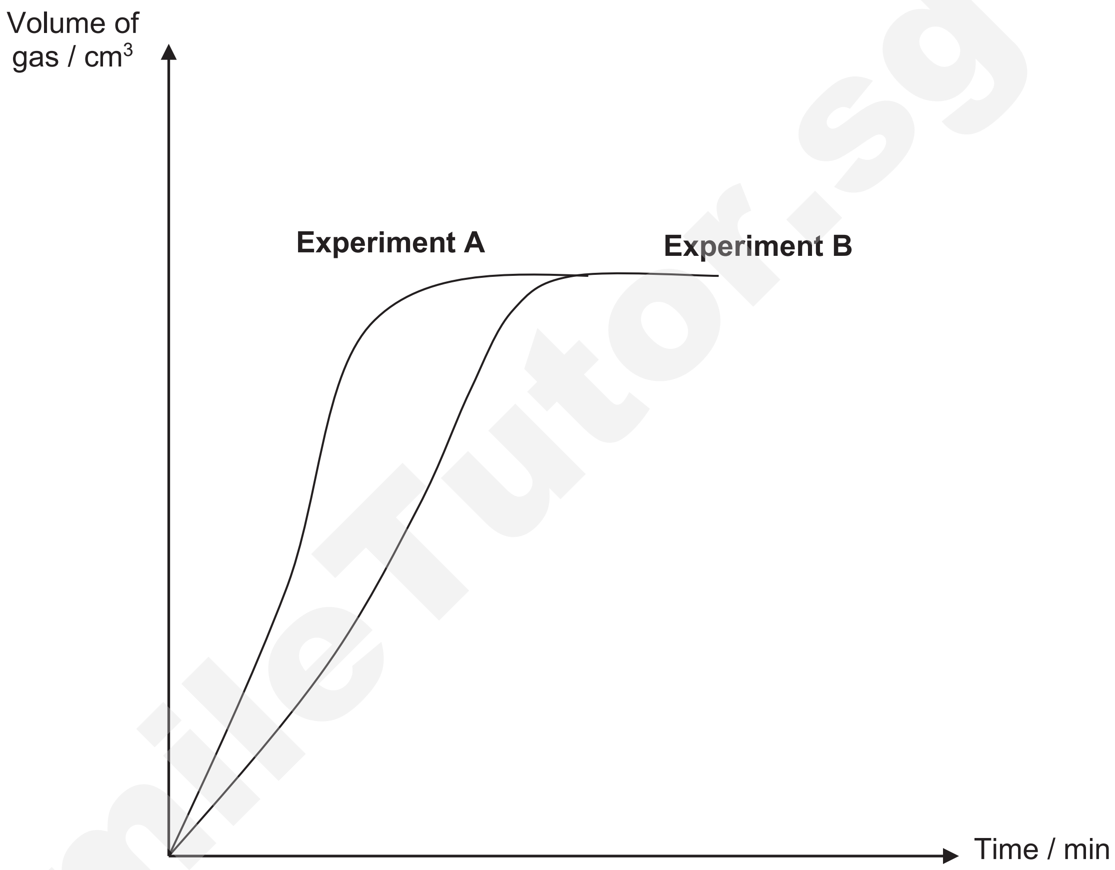
[Total: 10]

OR

B11 Lead(II) carbonate reacts with dilute nitric acid as shown by the equation below:

$$PbCO_3(s) + 2\,HNO_3\,(aq) \rightarrow CO_2(g) + Pb(NO_3)_2(aq) + H_2O(l)$$

Two experiments are carried out using lumps or granules of lead(II) carbonate of the same mass, with other conditions kept the same. The results are shown in the graph below.



(a) With reference to the graph, which experiment, **A** or **B**, was carried out using granules of lead(II) carbonate?
Explain your answer in terms of collisions between particles.

……………………………………………………………………………………………..........

……………………………………………………………………………………………..........

……………………………………………………………………………………………..........

……………………………………………………………………………………………[3]

(b) Experiment **A** is repeated using the same mass of calcium carbonate in place of lead(II) carbonate. All other conditions are kept constant.

Will the total volume of gas produced be more, less, or the same, as compared to Experiment **A**? Explain your answer.

....

....

....

....[2]

(c) Experiment **A** is repeated using excess sulfuric acid in place of nitric acid. All other conditions are kept constant.

(i) On the graph above, sketch the results you would expect to obtain. [1]

(ii) Explain the shape of your graph.

....

....

....

....

....

....

....

....

....[4]

[Total: 10]

- End of Paper -

4 Exp 6092 Chemistry Prelim 2019: Answer Scheme

Paper 1

Qn	**Ans**	**Qn**	**Ans**	**Qn**	**Ans**	**Qn**	**Ans**
1	D	**6**	B	**11**	B	**16**	D
2	C	**7**	A	**12**	D	**17**	B
3	D	**8**	D	**13**	B	**18**	C
4	C	**9**	C	**14**	C	**19**	D
5	B	**10**	D	**15**	A	**20**	C

Qn	**Ans**	**Qn**	**Ans**	**Qn**	**Ans**	**Qn**	**Ans**
21	A	**26**	C	**31**	D	**36**	B
22	D	**27**	D	**32**	B	**37**	D
23	B	**28**	C	**33**	D	**38**	C
24	D	**29**	D	**34**	A	**39**	C
25	C	**30**	A	**35**	D	**40**	A

Paper 2

Section A

A1 (a) (i) CF_3Cl

(ii) $NaCl$

(iii) Al_2O_3

(iv) Mg

(b) Mg loses two electrons and is oxidised to form Mg^{2+} [1] while Fe^{2+} gains two electrons and is reduced to Fe. [1] Since oxidation and reduction occurs at the same time, it is a redox reaction.

A2 (a)

chemical formula	oxidation state of chlorine
$HClO_4$	+7
$HOCl$	**+1**
$HClO_3$	**+5**
$HClO_2$	+3

(2 correct answers, 1 mark. No 0.5 mark)

(b) (i) hypochlorous acid, chlorous acid, chloric acid, perchloric acid

OR $HOCl$, $HClO_2$, $HClO_3$, $HClO_4$

(ii) The stronger the acid, the higher the number of oxygen atoms in each unit of the acid.

OR The stronger the acid, the higher the oxidation state of chlorine in the acid.

(c) No. of mol of NaOH = 0.1 x 23.2/1000 = 0.00232 mol [0.5]

By mol ratio, NaOH : acid
1 : 1
0.00232 mol : 0.00232 mol [0.5]
Relative formula mass of acid = 0.172 / 0.00232 = 74.138 (to 5 s.f.)
= 74.1 (to 3 s.f.) [1]

Identity of acid = propanoic acid OR $C_2H_5CO_2H$ [1]

A3 (a) The higher the pressure, the larger the percentage of ammonia present at equilibrium. [1]

[1 mark - student quotes data from the graph, stating the percentage of ammonia at different pressures but at the same temperature.]

(b) 450°C, 250 atm, iron catalyst [1]

(c) (i) 200°C

(ii) This temperature is lower than the actual temperature and thus the rate of the reaction to be slower, hence the process of manufacturing ammonia will not be cost-effective.[1]

(d) When ammonium nitrate fertilisers and slaked lime are added together, they react to release ammonia gas [1] which escapes from the soil, thus reducing the amount of nitrogen available in the soil that is needed for plant growth. [1]

A4 (a) Graphite. [1] In graphite, each carbon atom is covalently bonded to three other carbon atoms and has one valence electron that is not used in bonding. [1] These electrons are delocalised and act as charge carriers to enable graphite to conduct electricity. [1]

(b) Silicon carbide. [1] In silicon carbide, each atom is covalently bonded to 4 other atoms to form a repeated network of tetrahedral structures. [1] It takes a large amount of energy to overcome the strong covalent bonds between the atoms, hence it is hard [1] and more suitable to be used as drill bits.

A5 (a) (i) Positive electrode [1]

(ii) 4 OH- (aq) → 2 H_2O (*l*) + O_2 (g) + 4 e^-

(iii) No. of mol of silver = 0.2025 / 108 = 0.001875 mol [1]

At P: Ag^+ (aq) + e^- → Ag (s)

By mol ratio, Ag : e^-

1 : 1

0.001875 mol : 0.001875 mol [0.5]

4 OH- (aq) → 2 H_2O (*l*) + O_2 (g) + 4 e^-

By mol ratio, O_2 : e^-

1 : 4

0.00046875 mol : 0.001875 mol [0.5]

Vol of oxygen gas produced = 0.00046875 x 24 = 0.01125 dm^3

= 0.0113 dm^3 [1]

(b) If molten zinc chloride was used, grey metal deposits will be seen at P and a yellow-green gas will be obtained at Q. [1]

When molten zinc chloride is used, zinc ions are discharged at P to form molten zinc metal [1], chloride ions are discharged at Q to form chlorine gas. [1]

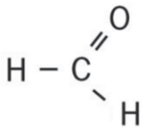
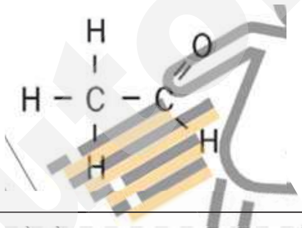
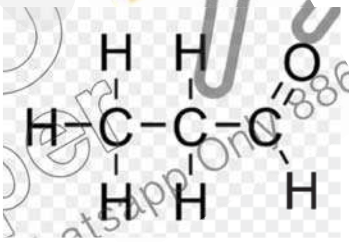
A6 (a)

trend	only true down a group	only true across a period	true for both	not true for both
The mass number increases.	✓			
The atomic radius decreases.		✓		
The melting point increases.				✓
The character of the oxides changes from basic to amphoteric to acidic.		✓		

(b) (i) Colourless potassium iodide solution turns brown. [1]

(ii) The reaction occurs as chlorine is more reactive than iodine, hence chlorine is able to displace iodine from its solution. [1] Chlorine has a <u>smaller atomic radii</u> compared to iodine, and the distance between the <u>positively charged nucleus</u> and the valence electron shell is smaller. [1] Thus when chlorine reacts, its nucleus is able to <u>attract the electrons more strongly</u> [1], and thus chlorine is more reactive than iodine.

A7 (a) (i)

name	condensed formula	full structural formula
methanal	HCHO	
ethanal	CH_3CHO	
propanal	**CH_3CH_2CHO OR C_2H_5CHO [0.5]**	 [0.5]

(ii) They have the same functional group – CHO, hence they belong to the same homologous series. [1]

OR They have the same general formula, $C_{n-1}H_{2n-1}CHO$, hence they belong to the same homologous series. [1]

(b) The boiling points of the aldehydes increases down the series. [1] Going down the series, as the molecules increase in size, there will be stronger intermolecular forces of attraction between the molecules [1], thus more energy is needed to overcome these intermolecular forces [1] and hence the boiling point will increase.

A8 (a)

(b) polyacrylamide [1]

(c) Both of them have the same empirical formula / contain the amide functional group. [1]

Polyacrylamide has a higher melting and boiling point than acrylamide

OR polyacrylamide has a giant molecular structure while acrylamide has a simple molecular structure. [1]

(Accept any other logical difference and similarity)

(d) ‘Non-biodegradable’ means that the polymer cannot be broken down by bacteria in the soil. [1]

Disposal of the polymer by burning releases toxic gases such as CO and thus contributes to air pollution.

OR Disposal of the polymer by burying results in the filling up of landfill sites and reduces the amount of land available for other uses such as agriculture and development. [1]

Section B

B9 (a) Carbon dioxide is a greenhouse gas that traps infrared radiation from the earth’s surface and prevents it from escaping into space. [1] This thus causes the earth’s temperature to rise, and causes heat waves. [1]

(b) (i) Weak acids dissociate partially in water to form hydrogen ions. [1]

(ii) $Mg^{2+} + H_2CO_3 \rightarrow MgCO_3 + 2\ H^+$

(c) Limestone

(d) (i) The higher temperature due to volcanoes around Iceland increases the speed of the reaction. [1]

(ii) The calcite decomposes at high temperatures, hence 100% conversion may not be possible.

OR Carbonic acid is a weak acid, hence lesser amounts of soda water may have reacted and hence the yield is lower. [1]

(e) Plants carry out photosynthesis by taking in carbon dioxide from the atmosphere and converting it into glucose, which is used by plants for energy. [1]

Carbon dioxide dissolves in the oceans, and is subsequently used by plants for photosynthesis or converted into calcium carbonate in the form of shells and skeletons of marine organisms. [1]

(f) Catalytic converters contain rhodium and platinum catalysts [1] that convert harmful gases such as CO and NO into harmless gases such as N_2 and H_2O. [1]

It does not help to lower carbon emissions, as CO is converted into CO_2, and thus causes an increase in the amount of CO_2 present in the atmosphere. [1]

B10 (a) Let the bond energy for C-H bond be x

Energy absorbed for bond breaking = 4(+x) + 2 (+464)

Energy released for bond forming = -1080 + 3 (-436) = - 2388 kJ/mol

Enthalpy change = Energy absorbed for bond breaking + Energy released for bond forming

+200 = 4(+x) + 2 (+464) + (-2388) [1]

1660 = 4 x

X = 415

Bond energy = 415 kJ/mol [1]

(b) More energy is absorbed to break C-H and O-H bonds and less energy is released to form C≡O and H-H bonds. [1] Thus the reaction is endothermic. [1]

(c) Reversible reactions are reactions where reactants are converted into products, and products are converted back into reactants at the same time. [1]

(d) No. of mol of steam = 1600 / (16 + 1 + 1) = 88.889 mol [0.5]

No. of mol of methane = 1000 / (12 + 1 x 4) = 62.5 mol [0.5]

By mol ratio of the steam-methane reaction,
CH_3 : H_2O
1 : 1
62.5 mol : 62.5 mol (reaction is possible as there is sufficient H_2O)
88.889 mol : 88.889 mol (reaction is not possible as there is insufficient methane)

Hence, as all methane is used up, methane is the limiting reagent. [0.5]

From the seam-methane reaction,

By mol ratio, CH_4 : H_2 : CO
1 : 3 : 1
62.5 mol : 187.5 mol : 62.5 mol [0.5]

From the water-gas shift reaction,

By mol ratio, CO : H_2
1 : 1
62.5 mol : 62.5 mol [0.5]

Total amount of H_2 formed = 187.5 + 62.5 = 250 mol
Mass of H_2 formed = 250 x (1 + 1) = 500 g [0.5]

EITHER

B11 (a) (i) Geranyl acetate is a covalent compound with a low boiling point. [1] Only a small amount of energy is needed to overcome the weak intermolecular forces between the molecules, [1] thus it evaporates readily and is suitable to be used as a top note for perfumes.

(ii)

(iii) ethanoic acid [1]

(iv)

	C	H	O
% by mass / %	73.47	10.20	16.33
Mass in 100 g / g	73.47	10.20	16.33
No. of mol / mol	73.47 / 12 = 6.1225	10.20 / 1 = 10.20	16.33 / 16 = 1.0206
Mol ratio	6.1225 / 1.0206 = 5.9989	10.20 / 1.0206 = 9.9941	1.0206 / 1.0206 = 1
	6	10	1

(Calculation of number of mol for all elements – [1])
Empirical formula = $C_6H_{10}O$ [1]

(b) Add the two compounds to 2 separate test tubes containing acidified potassium manganate(VII) and heat. [1]
If the test tube contains the middle note, purple acidified potassium manganate(VII) solution will turn from purple to colourless.

If the test tube contains the top note, purple acidified potassium manganate(VII) will remain. [1]

(c)

OR

B11 (a) Experiment A. Granules has a smaller particle size compared to lumps, thus it has more surface area exposed for collisions. [1] Hence the reaction that uses granules of lead(II) carbonate will have a higher frequency of effective collisions between reactant particles and thus have a faster rate of reaction. [1] Since the gradient of the graph for experiment A is steeper, it shows that experiment A has a faster rate of reaction, [1] and thus it used granules of lead(II) carbonate.

(b) The total volume of gas produced will be higher. Although the same mass of carbonates are used, the experiment using $CaCO_3$ will have a larger amount of carbonate present compared to $PbCO_3$, as $CaCO_3$ has a smaller molar mass. [1] Thus, more CO_2 will be produced in the reaction that uses $CaCO_3$ [1].

(c) (i) Graph drawn should have the highest loss in mass initially, but quickly remains constant. Volume of gas produced should be small. – [1]

(ii) The rate of reaction is fast initially as sulfuric acid is a dibasic acid and hence the reaction has a twice the number of H+ per unit volume / twice the concentration of H+ compared to experiment A [1] , thus frequency of effective collisions between reactant particles is higher. [1]
The volume of gas produced quickly remains constant as $PbCO_3$ reacts with sulfuric acid to form insoluble $PbSO_4$ [1] which forms a protective layer around the carbonate and prevents further reaction from taking place. [1]

Name	Class	Index Number

UNITY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2019

SECONDARY FOUR EXPRESS

CHEMISTRY 6092/01 **19 SEP 2019**

PAPER 1 **1 HOUR**

Additional Materials : **Optical Answer Sheet**

READ THESE INSTRUCTIONS FIRST

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

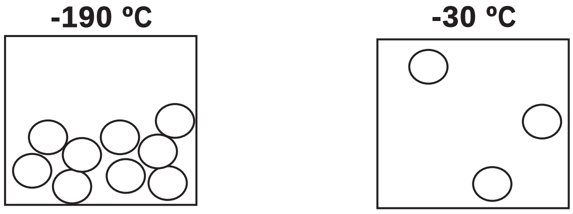
There are **forty** questions on this paper. Answer all questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Answer Sheet.

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 15.
The total mark for this paper is 40 marks.

This paper consists of **15** printed pages, including this cover page.

1 The following diagrams show the arrangement of particles of a substance at two different temperatures.

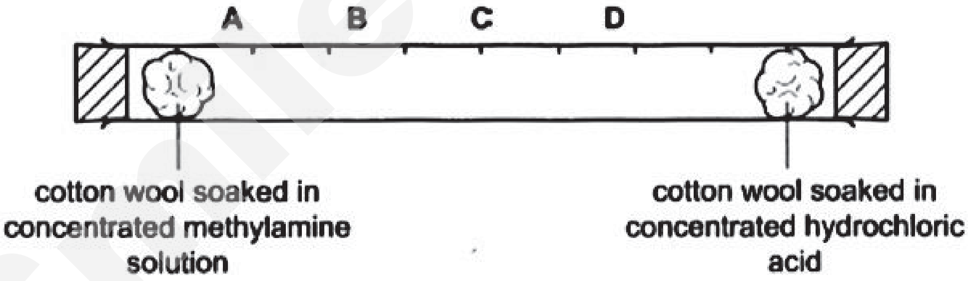


Which substance could the diagrams represent?

Substance	Melting point / ^{0}C	Boiling point / ^{0}C
A	−210	−50
B	−210	−10
C	−100	−50
D	−100	−10

2 When concentrated aqueous methylamine, CH_3NH_2 (*Mr* = 31) and concentrated hydrochloric acid, HCl (*Mr* = 36.5) are placed at opposite ends of a tube, a white ring of solid, methyl ammonium chloride, CH_3NH_3Cl is formed.

At which position **A**, **B**, **C** or **D**, will the white ring be found?



3 Which two gases each change the colour of damp red litmus paper?

A ammonia and chlorine
B ammonia and hydrogen chloride
C carbon dioxide and chlorine
D carbon dioxide and sulfur dioxide

4 Four students were asked to test a solution for the presence of a cation by using various anions. The students obtained these results.

Student	**chlorides**	**sulfates**	**carbonates**
A	No precipitate	No precipitate	Precipitate
B	Precipitate	Precipitate	No precipitate
C	Precipitate	Precipitate	Precipitate
D	No precipitate	Precipitate	No precipitate

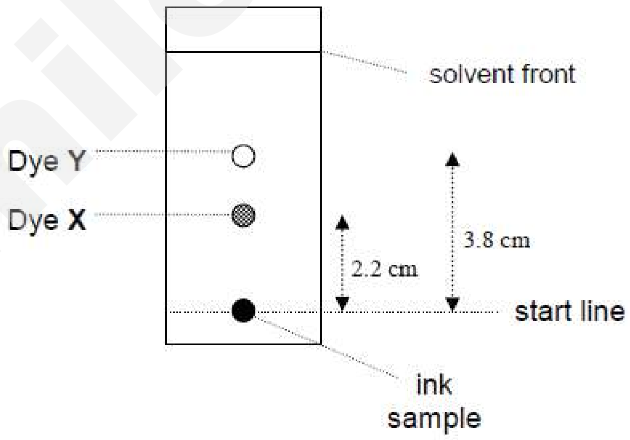
Each student concluded that Pb^{2+} was present.

Which student had results consistent with this conclusion?

5 Solid samples of ammonium chloride, silver chloride and sodium chloride were accidentally mixed together. Which of the following sequences outlines the best method to obtain the pure dry sample for each substance?

A dissolving, filtration, sublimation, crystallisation
B dissolving, fractional distillation, filtration, evaporation
C sublimation, filtration, evaporation, crystallisation
D sublimation, dissolving, filtration, evaporation

6 The results of a paper chromatography experiment carried out on an ink sample are shown below.



Given that the R_f value of Dye X is 0.40, what is the R_f value of Dye Y?

A 0.50
B 0.57
C 0.69
D 1.73

7 An imaginary element Unitium (Um) has a proton number of 113 and a nucleon number of 237. Which of the following indicates the number of sub-atomic particles in the Unitium ion, Um^{3+}?

	Number of electrons	**Number of neutrons**	**Number of protons**
A	110	124	110
B	110	124	113
C	113	237	113
D	113	124	110

8 The relative atomic mass of naturally occurring chlorine on planet Jupiter is found to be exactly 36.0. What **cannot** be a reason for this?

A All the chlorine atoms on Jupiter have 19 neutrons.
B Half the chlorine atoms on Jupiter have 18 neutrons and the rest have 20 neutrons.
C There is only one type of chlorine atom found on Jupiter.
D The chlorine atoms on Jupiter have different number of protons but same number of neutrons.

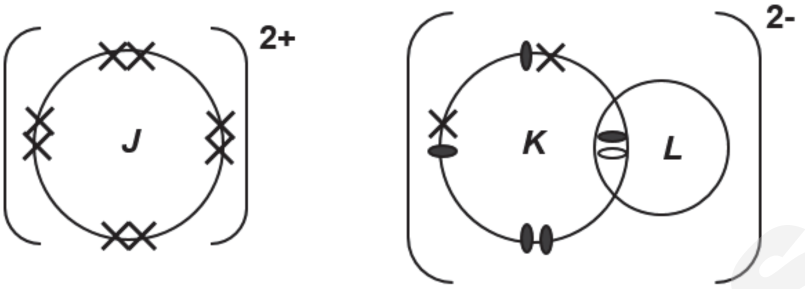
9 How many covalent bonds are there in the molecule with the formula CH_2CHCH_3?

A 7
B 8
C 9
D 10

10 The proton numbers of elements, Q, R and Z are 4, 6 and 8 respectively. Which of the following lists give the correct formulae of the compounds formed between them?

A	QZ	RZ_2	QRZ_3
B	QZ	RZ_2	QRZ_4
C	Q_2Z	RZ	QRZ_3
D	Q_2Z	RZ	QRZ_4

11 ***J***, ***K*** and ***L*** are three different elements in the Periodic Table. The electronic diagram (showing only the valence electrons) of the compound formed between ***J***, ***K*** and ***L*** is shown below:



Which of the following statements are correct?

I Element ***K*** could be nitrogen.
II Element ***J*** belongs to Group II of the Periodic Table.
III Element ***K*** and element ***L*** are bonded together by covalent bond.
IV Element ***L*** is a metal.

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

12 A pure compound contains 24 g of carbon, 4 g of hydrogen and 32 g of oxygen. What is the empirical formula of the compound?

A CHO
B CH_2O
C CH_4O
D C_2H_2O

13 When solid sodium hydrogencarbonate (Mr = 84) is heated strongly, the following reaction occurs.

$$2NaHCO_3\ (s) \rightarrow Na_2CO_3\ (s) + H_2O\ (g) + CO_2\ (g)$$

What is the loss in mass when 25.2 g of solid sodium hydrogencarbonate is heated?

A 2.7 g
B 9.3 g
C 15.9 g
D 18.6 g

14 In an experiment, 4.0 cm^3 of 1.0 mol/dm^3 copper(II) sulfate solution are mixed with 8.0 cm^3 of 1.0 mol/dm^3 sodium carbonate solution.

What does the reaction vessel contain?

A a green precipitate and a blue solution
B a colourless solution only
C a white precipitate and a colourless solution
D a green precipitate and a colourless solution

15 Concentrated aqueous iron (II) iodide is electrolysed using platinum electrode. Which of the following correctly describes the reactions at each electrode?

	Ions attracted to cathode	**Observations at anode**
A	I^- and OH^-	Colourless gas evolved
B	I^- and OH^-	Grey deposit formed
C	Fe^{2+} and H^+	Brown solution formed
D	Fe^{2+} and H^+	Colourless gas evolved

16 Four electrolytes are listed. Each is electrolysed using inert electrodes.

1 aqueous copper(II) chloride
2 concentrated aqueous sodium chloride
3 dilute aqueous sodium chloride
4 molten aluminium oxide

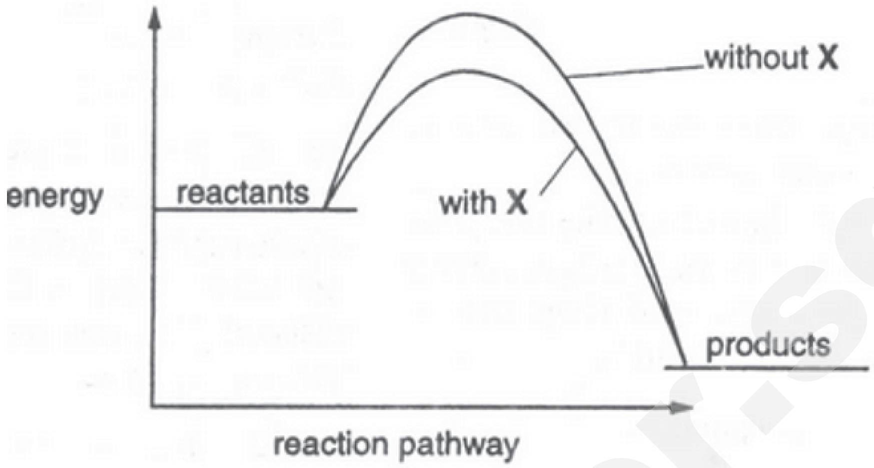
Which two of the electrolytes will result in a metal forming at the cathode?

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

17 Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

A Electricity is generated directly.
B Electricity is used to produce water.
C Hydrogen is burned to form steam.
D Hydrogen reacts to form a hydrocarbon fuel.

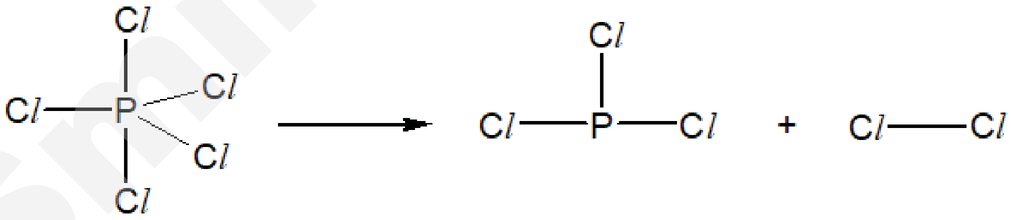
18 The energy profile diagram of a certain reaction is shown below. ***X*** is a catalyst.



Which one of the following statements is correct?

- **A** More heat is absorbed in bond-breaking than is released in bond-making.
- **B** The addition of ***X*** increases the yield of the products.
- **C** The enthalpy change is decreased by the addition of ***X***.
- **D** The frequency of effective collisions is increased by the addition of ***X***.

19 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating.



Given that the bond energy of P-Cl is 330 kJ/mol and Cl-Cl is 240 kJ/mol, calculate the enthalpy change for the reaction.

- **A** −420 kJ/mol
- **B** −90 kJ/mol
- **C** +90 kJ/mol
- **D** +420 kJ/mol

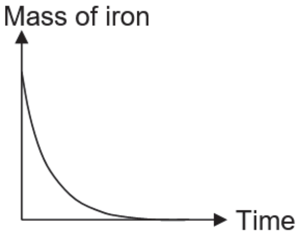
20 When excess calcium carbonate pieces are added to dilute hydrochloric acid, the reaction gradually becomes slower and finally stops.

Which statement best explains why the rate of reaction becomes slower?

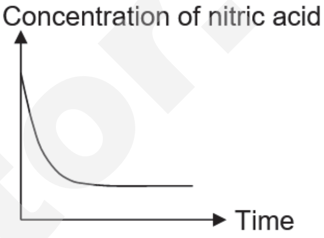
A An insoluble layer of calcium chloride is formed on calcium carbonate.
B The concentration of hydrochloric acid gradually reduces to zero.
C The mass of calcium carbonate decreases throughout the reaction.
D The pieces of calcium carbonate gradually become smaller.

21 Which of the following graphs shows the correct change with time when nitric acid reacts with excess iron filings?

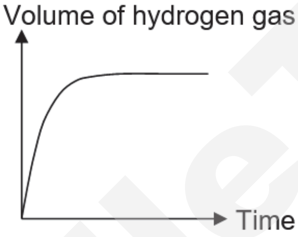
A



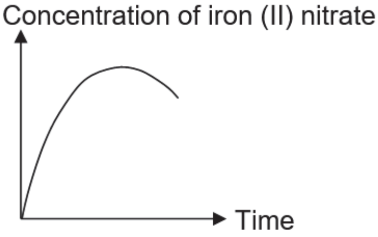
B



C



D



22 A textbook writes 'Nitric acid, HNO_3, is a strong oxidising agent'.

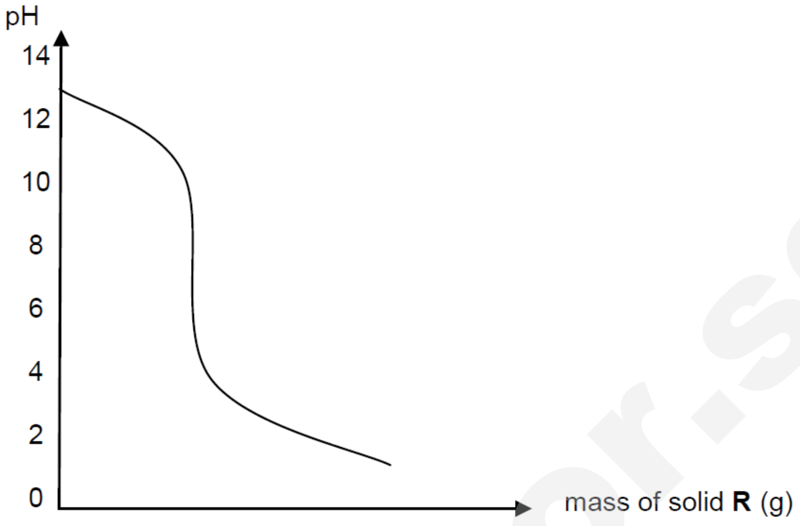
Which of the following **cannot** be a product of nitric acid in its reaction with a reducing agent?

A N_2O_5
B N_2
C NO
D NO_2

23 Which of the following pairs of reactants will **not** give a neutral solution when they are mixed together in equal number of moles?

A Sodium hydroxide and nitric acid
B Calcium hydroxide and sulfuric acid
C Potassium hydroxide and hydrochloric acid
D Barium hydroxide and nitric acid

24 Solid **R** is gradually added to aqueous solution **S**. The changes in pH are shown on the graph.



What are substances **R** and **S**?

	Substance **R**	Substance **S**
A	insoluble metal oxide	nitric acid
B	soluble metal oxide	hydrochloric acid
C	soluble non-metal oxide	aqueous ammonia
D	soluble non-metal oxide	sodium hydroxide

25 A new indicator has just been produced in the laboratory. It changes colour according to the table below:

pH	**Colour**
0 - 3	Red
4 - 7	Green
8 - 14	Dark blue

This indicator will be suitable to distinguish between

A aqueous ammonia and sodium hydroxide.
B aqueous sodium chloride and water.
C aqueous sodium nitrate and sodium hydroxide.
D dilute hydrochloric acid and dilute sulfuric acid.

26 Which of these statements are true in Haber Process?

I The hydrogen needed can be obtained by cracking of petroleum.
II The reaction chamber is pressurized to speed up the reaction.
III The ammonia formed is removed by condensation.

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

27 Many properties of an element and its compounds can be predicted from the position of the element in the Periodic Table.

Which property could **not** be predicted in this way?

A the acidic or basic nature of its oxide
B the formula of its oxide
C the number of isotopes it has
D its metallic or non-metallic properties

28 A large volume of copper(II) sulfate solution is left in an iron container overnight.

Which statement describes what happens?

A The solution evaporates completely and some copper(II) sulfate crystals are left behind.
B The part of the container in contact with the solution is coated with copper.
C Some fine iron particles are formed in the solution.
D Atmospheric oxygen reacts with the copper(II) sulfate to give black copper(II) oxide.

29 The Apple® Watch (Sport) is made up of an alloy comprising aluminium and tightly controlled amounts of magnesium and zinc.

Which of the following is **not** a good reason for alloying metals?

A It is cheaper to use alloys than pure metals.
B The use of alloys enhances the appearances of the product.
C The use of alloys enhances the strength of the product.
D The use of alloys makes the product less susceptible to corrosion.

30 The haemoglobin molecule in our blood contains 0.33% by mass of iron. If the molar mass of haemoglobin is 68 000 g, how many iron atoms are there in one mole of haemoglobin?

A 4
B 8
C 224
D 401

31 Petrol and diesel are two common fuels used by cars and buses respectively. The combustion of these fuels produces air pollutants.

The table shows the mass of pollutants found in exhaust fumes when 1 kg of each fuel is burnt.

pollutant produced	mass of pollutant after petrol is burnt / g	mass of pollutant after diesel is burnt / g
carbon monoxide	240	10
oxides of nitrogen	30	60
sulfur dioxide	1	4
unburnt hydrocarbons	25	20

Which of the following statements can be inferred using the data in the table?

A All the pollutants listed can be removed by installing a catalytic converter.
B Carbon monoxide is produced by complete combustion of the fuels.
C Petrol contributes more towards the formation of acid rain.
D The temperature in petrol engine is lower than that in diesel engine.

32 Which of the following changes does **not** happen in a catalytic converter?

A carbon monoxide → carbon dioxide
B nitrogen dioxide → nitrogen
C nitrogen monoxide → nitrogen dioxide
D unburnt hydrocarbons → carbon dioxide and water

33 Four alkanes, **H**, **I**, **J** and **K** were extracted from a fractional distillation sample of crude oil.

K is more viscous compared to **I**.
J burns with a less sooty flame compared to **I** and **K**.
H is less flammable than **K**.

Which of the following shows the sequence in which the alkanes were collected, in order of increasing boiling point?

A **J, H, K, I**
B **H, I, K, J**
C **K, H, J, I**
D **J, I, K, H**

34 A molecule of $C_{17}H_{36}$ undergoes catalytic cracking. The products of the reaction are one butane molecule, one propene molecule and some ethene molecules. How many ethene molecules are produced during the reaction?

A 5
B 6
C 7
D 8

35 200 cm^3 of methane is burned in 300 cm^3 of oxygen.

When cooled to room temperature, what could be the resulting mixture of gases?

A CH_4, CO, CO_2
B CH_4, CO, H_2O
C CH_4, CO_2, O_2
D CO_2, H_2, O_2

36 Some cooking oils contain a mixture of water with molecules of saturated and unsaturated fats. A pure fat molecule has a relative molecular mass of 300.

75 g of the fat reacts with 120 g aqueous bromine.

How many double bonds are there in each molecule of the fat?

A 2
B 3
C 4
D 6

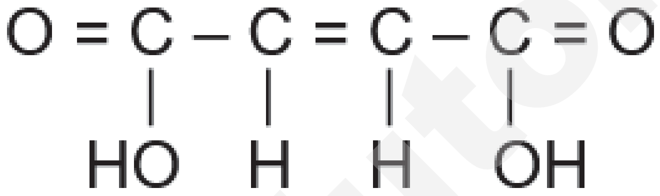
37 A compound ***X*** has all of the following properties:

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not decolourise acidified potassium manganate (VII).

What could **X** be?

A ethane
B ethanoic acid
C ethanol
D ethyl ethanoate

38 Which prediction about the compound below is **not** likely to be true?



$$\begin{array}{ccccccccccc} O & = & C & - & C & = & C & - & C & = & O \\ & & | & & | & & | & & | & & \\ & & HO & & H & & H & & OH & & \end{array}$$

A It forms salts with bases.
B It reacts with ethanol.
C It reacts with hydrogen to form a saturated compound.
D It can be oxidised by acidified potassium manganate (VII).

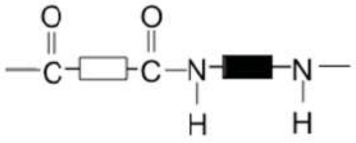
39 The reaction between a carboxylic acid, $C_xH_yCO_2H$, and an alcohol, $C_nH_{2n+1}OH$, produces an ester.

How many hydrogen atoms does one molecule of the ester contain?

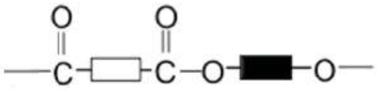
A y + 2n
B y + 2n + 1
C y + 2n + 2
D y + 2n + 3

40 Which of the following shows the repeating unit of terylene?

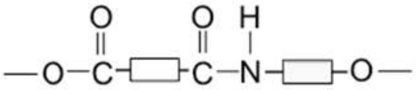
A



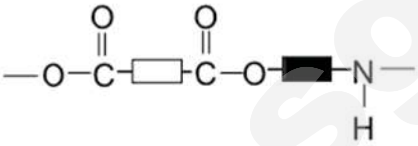
B



C



D



End of Paper 1

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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	Class	Index Number

UNITY SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2019

SECONDARY FOUR EXPRESS

CHEMISTRY 6092/02 **20 SEP 2019**

PAPER 2 **1 HOUR 45 MINUTES**

READ THESE INSTRUCTIONS FIRST

Write your name and index number 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 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.
Answer **all** questions in the spaces provided.

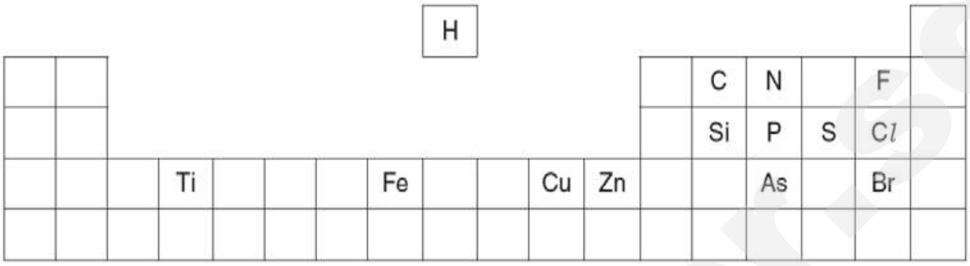
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.
The total mark for this paper is 80 marks.

This paper consists of **21** printed pages, including this cover page.

Section A

Answer all 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.



(a) Answer each of the following questions using only the elements shown in the diagram.
Each element may be used once, more than once or not at all.
State one element which

(i) has a melting point below room temperature but a boiling point above room temperature [1]

……………………………..

(ii) has an atom with three occupied electron shells, the outer of which has only five electrons. [1]

……………………………..

(iii) is colourless, diatomic gas [1]

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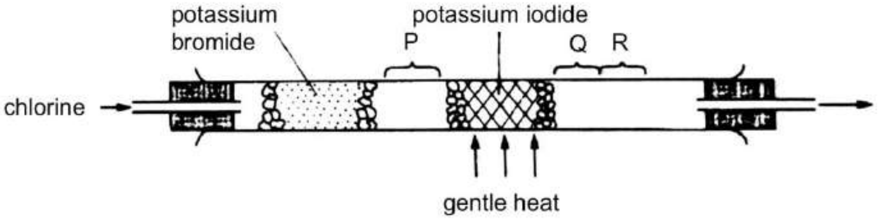
(b) Chlorine was passed through a tube as shown below. After some time, coloured substances were seen at **P**, **Q** and **R**.



State the observations seen at each of the region.

[3]

Region	Observations
P	
Q	
R	

(c) Arsenic reacts with oxygen to form arsenic(III) oxide, As_2O_3.
Arsenic(III) oxide is slightly soluble in water. A weak acid, arsenous acid, H_3AsO_3, is formed.

Use the kinetic particle theory to explain why a 0.05 mol/dm^3 solution of arsenous acid reacts much more slowly with magnesium ribbon than a 0.05 mol/dm^3 solution of hydrochloric acid. [2]

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A2 The chemical equation for the thermal decomposition of calcium nitrate is shown below.

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

(a) What is the total volume of gases produced at room temperature and pressure when 49.2 g of calcium nitrate undergoes thermal decomposition? [2]

(b) State the oxidation state of nitrogen in calcium nitrate. [1]

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(c) Explain, using oxidation state, whether the nitrogen in calcium nitrate is oxidized or reduced during the reaction. [2]

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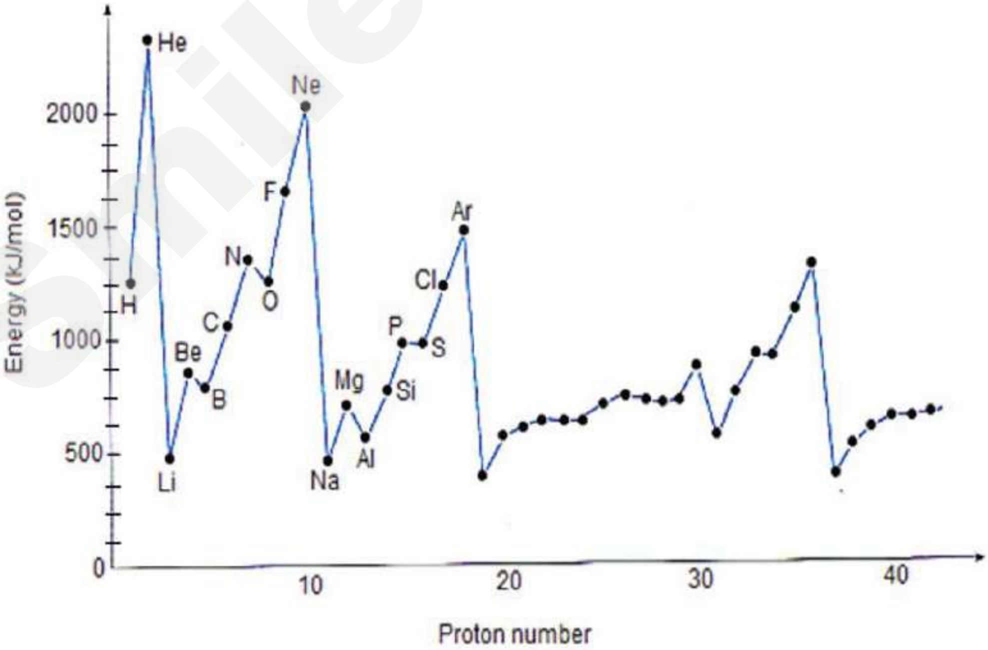
A3 The graph below shows the first ionisation energy of the atoms of elements in the Periodic Table. The first ionisation energy is the amount of energy needed to remove the most loosely held electron in the atom to form a positive ion.

Example of the first two elements is given as follows:

$H \rightarrow H^+ + e$ First ionisation energy = 1250 kJ/mol

$He \rightarrow He^+ + e$ First ionisation energy = 2300 kJ/mol



(a) Based on the graph,

(i) which element is the least reactive between the proton number of 10 to 20? [1]

…………………………

(ii) estimate the first ionization energy of Krypton. [1]

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(iii) suggest an explanation for the difference in the first ionization energy between beryllium and magnesium. [2]

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(b) Oxygen contains two isotopes, **O-16** and **O-18**. Do you think that the first ionization energy of both the isotopes is the same? Give a reason for your answer. [1]

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A4 Sodium phosphate is a soluble salt used as a water softener in detergents. It can be prepared by reacting phosphoric acid, H_3PO_4, with sodium hydroxide in a neutralization reaction.

(a) Give the formula of sodium phosphate. [1]

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(b) Write a chemical equation for the reaction between phosphoric acid and sodium hydroxide. [1]

……………………………………………………………………………………..

(c) 50.0 cm^3 of 1.0 mol/dm^3 phosphoric acid reacted completely with sodium hydroxide to form sodium phosphate solution.

(i) Calculate the mass of sodium phosphate formed. [2]

(ii) Describe how you would obtain pure, dry crystals of sodium phosphate from the salt solution. [3]

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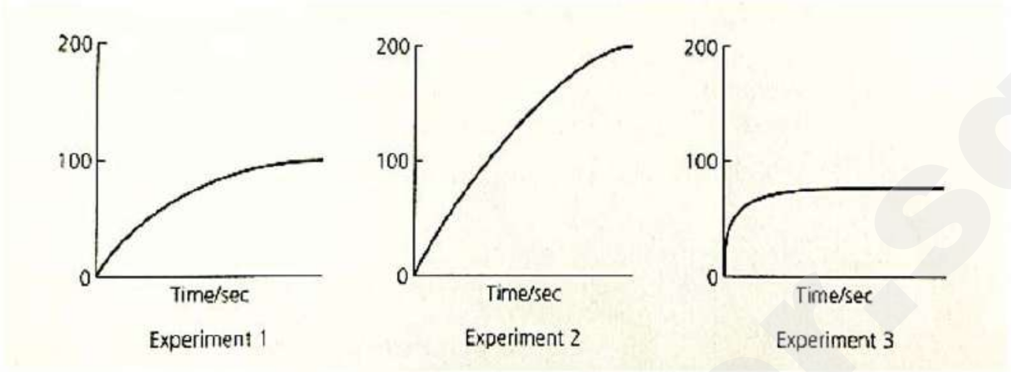
A5 Experiments were carried out on the rate of reaction of zinc with dilute sulfuric acid. In each experiment, excess sulfuric acid was used. The results are shown in the following graphs.
In **Experiment 1**, 0.26 g of powdered zinc were used. All three experiments were carried out at room temperature.



(a) The x-axis has been labelled for you. Suggest the label for the y-axis. [1]

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(b) Suggest, with a reason, how the condition might have been altered to produce the results for **Experiment 2**. [2]

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(c) In **Experiment 3**, some copper(II) sulfate was added. Suggest **two** reasons for the results obtained for this experiment. [2]

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(d) Explain why attaching a piece of zinc to an iron pipe prevents the pipe from rusting. [1]

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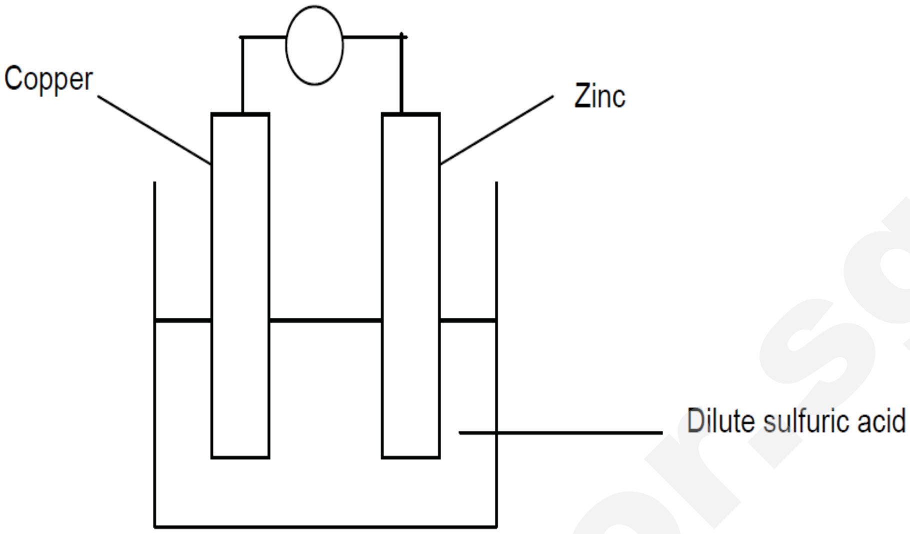
A6 The diagram shows an electric cell.



(a) **(i)** Draw an arrow on the diagram to show the direction of the flow of electrons in the wire. [1]

(ii) Write a half-equation with state symbols for the reaction taking place at the negative electrode. Explain why it happens that way. [2]

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(b) The zinc electrode is now replaced by iron.

(i) State and explain the change in the ammeter reading obtained. [2]

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(ii) State one other observation that will be different from the original set-up. [1]

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A7 The table below shows the enthalpy of combustion of three fuels.

fuel	**enthalpy change of combustion (kJ/mol)**
ethanol	−1370
hydrogen	−256
octane	−5510

(a) Using ideas about bond-breaking and bond-forming, explain why the enthalpy change of combustion for ethanol is negative. [2]

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(b) Ethanol and octane both undergo combustion to produce carbon dioxide. The equation for the combustion of ethanol and octane are given below.

combustion of ethanol: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

combustion of octane: $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

(i) Calculate the volume of carbon dioxide that will be produced when ethanol undergoes combustion to produce 200 kJ of energy. [2]

(ii) Calculate the volume of carbon dioxide that will be produced when octane undergoes combustion to produce 200 kJ of energy. [2]

(iii) Green fuel is a fuel that produces lesser carbon dioxide when burnt. An example of green fuel is biogas. [1]

Is ethanol "necessarily" a greener fuel? Explain.

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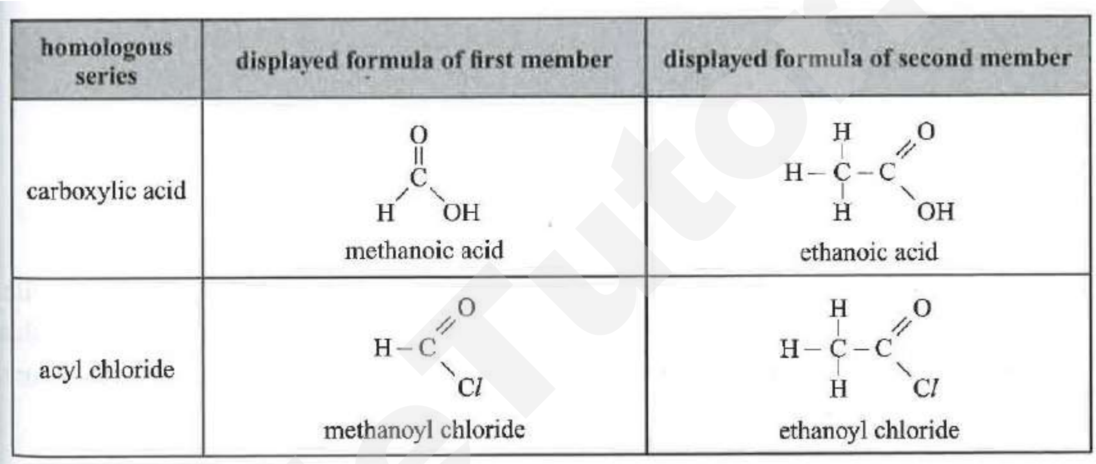
A8 Acyl chlorides belong to a class of organic compounds that are analogous to carboxylic acids. Methanoyl chloride and ethanoyl chloride are the first two members of the acyl chloride homologous series.



homologous series	**displayed formula of first member**	**displayed formula of second member**
carboxylic acid	methanoic acid	ethanoic acid
acyl chloride	methanoyl chloride	ethanoyl chloride

(a) **(i)** Define the term *homologous series*. [1]

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(ii) Describe and explain how the boiling point of ethanoyl chloride compares with that of methanoyl chloride. [2]

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(iii) Draw the full structural formula of the fourth member of the acyl chloride homologous series. [1]

(b) Acyl chlorides undergo the same type of reaction with alcohols as their carboxylic acid counterparts to form the same ester.

For example, methanoic acid and ethanol react to form ethyl methanoate. Methanoyl chloride reacts with ethanol to also form ethyl methanoate.

Using your answer from **(a)(iii)**, draw the full structural formula of the ester formed between the fourth member of the acyl chloride homologous series and methanol. Name this ester.

[2]

Name of ester: ………………………………………………………..

Full structural formula of ester:

Section B

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

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

B9 Glass is a mixture of oxides, made up of three components: *formers*, *fluxes* and *stabilizers*.

- *Formers* make up the largest percentage of the mixture to be melted to produce the glass.
- *Fluxes* lower the temperature at which the formers will melt.
- *Stabilizers* make the glass strong and weather resistant.

The composition of a type of glass (percentage by mass of their components) is shown in the table below.

chemical present	**soda lime silica glass**
silica, SiO_2	73.6%
soda, Na_2O	16.0%
potash, K_2O	0.6%
alumina, Al_2O_3	1.0%

Note: not all the components of glass are shown in the table above

(a) **(i)** Identify the chemical that serves as the *former*. [1]

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(ii) Explain, based on structure and bonding, why the chemical in **(a)(i)** can withstand high temperatures. [2]

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(b) Soda and potash are commonly used as *fluxes*. These *fluxes* have to be thermally stable.

Which flux, soda or potash is more thermally stable? Explain your answer. [2]

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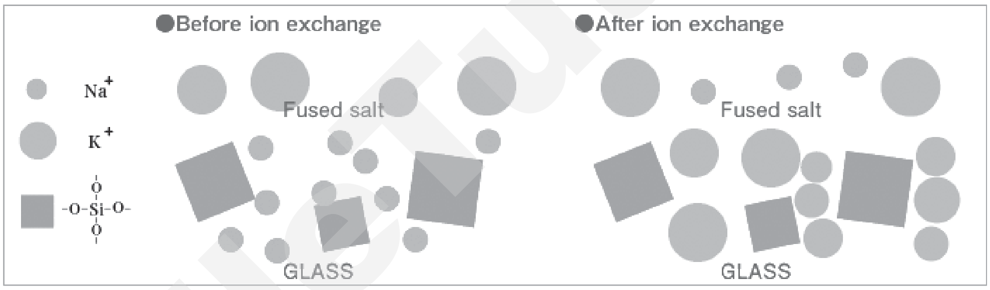
(c) The Gorilla Glass is a type of scratch-resistant glass made by the company, Corning. Glass sheets are dipped into a molten potassium salt bath at about 400 ºC, where the potassium ions undergo an exchange with the sodium ions (see diagram below).

The larger potassium ions now present in the glass structure exert a "compressive effect" on the glass (similar to what happens in an alloy) that strengthens it.



particle	ionic radii / 10^{-12} m
sodium ion	116
potassium ion	142

(i) Explain why the molten potassium salt bath has to be at 400 ºC. [2]

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(ii) Explain, using data, how the ion-exchange process strengthens the glass through the "compressive effect". [2]

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(iii) As part of the quality control process, a sample of Gorilla Glass was immersed in two solvents and the weight loss per unit surface area was measured after some time. [1]

	time / hours	**weight loss / mg cm^{-2}**
HC*l*	24	0.12
NaOH	6	1.42

Explain the results in the table above.

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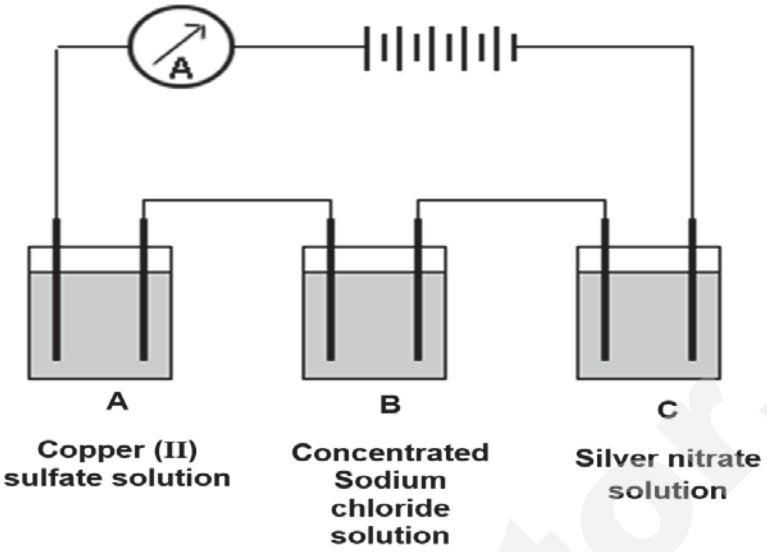
B10 The diagram shows the electrolysis of three different solutions using inert electrodes.



(a) **(i)** Write equations for the reactions that happen at each electrode in cell **B** during electrolysis. Include state symbols. [2]

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(ii) Describe **two** observations that take place at cell **B**.
Explain your observations. [4]

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(b) 6.0 dm^3 of oxygen is liberated from cell **A**, at room temperature and pressure.

(i) Calculate the increase in mass of the cathodes in cells **A** and **C**. [2]

(ii) What is another observation in cell **A**?
Explain your observation. [2]

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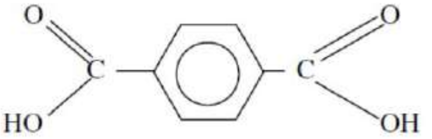
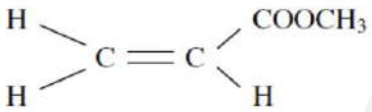
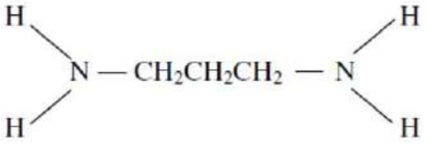
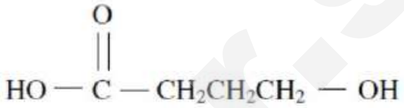
B11 EITHER

The diagram shows four monomers.

Monomer **A** 	Monomer **B** 
Monomer **C** 	Monomer **D** 

(a) Monomer **B** was formed by reacting propenoic acid, $CH_2CHCOOH$ with another compound, **X**. State the conditions of the reaction and name compound **X**. [2]

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(b) **(i)** Which of these monomers can be used to produce a polymer through condensation polymerisation by itself? [1]

…………………………………………………………………………………

(ii) Which of these monomers will undergo polymerisation without a change in percentage composition? Explain your answer. [1]

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(c) **(i)** Using two monomers above, draw a repeat unit of the polymer formed, which has the same linkages as found in nylon. [1]

(ii) Explain why the polymer formed in **(c)(i)** should not be disposed by burning. [2]

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(d) A student has four solutions containing monomers **A** to **D** each. Describe chemical tests the student could do to identify the four solutions. [3]

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B11 OR

Haematite and coke are used to make iron in the blast furnace. A series of chemical reaction occurs within the furnace before molten iron is collected. Iron from the blast furnace contains carbon and silicon as impurities.

(a) Explain, with the help of equations, why coke is essential to the process of making iron from haematite. [4]

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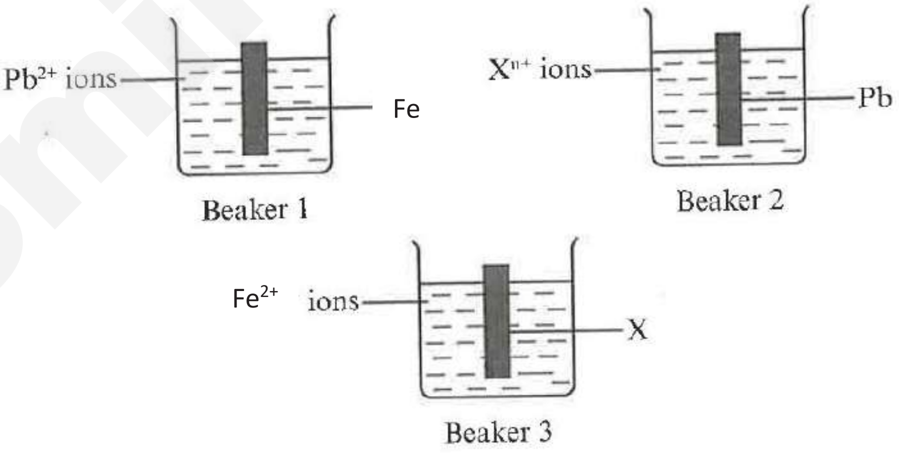
(b) Three beakers were set up to study the reactivities of iron, lead and an unknown metal **X**.



After some time, it was observed that the metal pieces in beakers 1 and 3 decreased in size. However, the metal piece in beaker 2 remained the same.

Deduce the order of the reactivities of iron, lead and metal **X**, starting with the least reactive metal. Explain your answer. [3]

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(c) Iron was reacted with dilute sulfuric acid to obtain a solution. Adding some aqueous ammonia to the solution in a test-tube resulted in a green precipitate. After some time, the green precipitate started to turn reddish-brown.

(i) Write an ionic equation for the formation of the green precipitate. [1]

………………………………………………………………………………

(ii) Name the brown solid and explain how it was formed. [2]

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End of Paper 2

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		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.).

UNITY SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY 4 CHEMISTRY

Paper 1

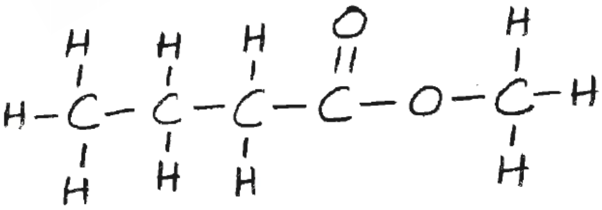
1	A	11	A	21	C	31	D
2	D	12	B	22	A	32	C
3	A	13	B	23	D	33	D
4	C	14	D	24	D	34	A
5	D	15	C	25	C	35	A
6	C	16	B	26	D	36	B
7	B	17	A	27	C	37	D
8	D	18	D	28	B	38	D
9	C	19	D	29	A	39	B
10	A	20	B	30	A	40	B

Paper 2

A1	ai	Br	1
	ii	P	1
	iii	N or H	1
	b	P – brown gas is seen	1
		Q – purple fumes/vapour seen	1
		R – purple-black solid condensed on surface of tube	1
	c	Arsenic acid being a weak acid ionises to form a few hydrogen ions only. At any time, there are only a few hydrogen ions colliding with the magnesium ribbon causing little reaction. Lesser number of colissions result in a lower proabability of effective colissions with magnesium. Thus rate of reaction is slow.	1 1
A2	a	49.2 g of calcium nitrate Number of mol = 49.2/164 = 0.3 0.3 mol of calcium nitrate produces 0.6 mol of NO_2 and 0.15 mol of O_2. Total volume of gases = (0.6 + 0.15) x 24 dm^3 = **18 dm^3**	1 1
	b	+5	1

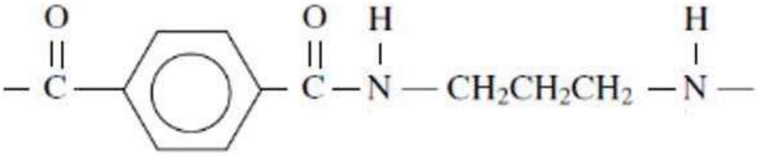
	c	Oxidation state of nitrogen in calcium nitrate (+5) decreased to +4 nitrogen dioxide; decrease in oxidation state; so reduced	1 1
A3	ai	Argon	1
	ii	1375 kJ/mol [Range: 1300 – 1400 kJ accepted]	1
	iii	The two valence electrons of magnesium is in the third shell that is <u>further away from nucleus</u> as compared to beryllium's valence electron in second shell which is <u>nearer to the nucleus.</u> Hence, attraction between the valence electron and the positively charged nucleus is **less strong in magnesium** and needs lesser ionization energy.	1 1
	b	Should be the same; as the difference between the two isotopes is only the number of neutrons. The number of protons is the same and hence the attractive force will be the same.	1
A4	a	Na_3PO_4	1
	b	$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$	1
	ci	Number of mol of H_3PO_4 = 0.05 x 1 = 0.05 mol 0.05 mol acid → 0.05 mol of sodium phosphate Mass of sodium phosphate = 0.05 x 164 = **8.2 g**	1 1
	ii	Pour the solution into an evaporating dish and heat it till the saturation point. Let the hot saturated solution to cool for crystals to form. Filter to get the crystals, rinse with distilled water and dry by pressing between filter papers.	1 1 1
A5	a	y-axis : Volume of hydrogen gas/ cm^3	1
	b	The volume of hydrogen gas produced is double that of expt 1. Since zinc is the limiting reactant, they used double the mass of zinc; 0.52 g of zinc was used	1 1
	c		1

		Copper(II) sulfate could have acted as a catalyst; which makes the rate of reaction faster as indicated by a steeper gradient. Some zinc could have reacted with the copper(II) sulfate in displacement reaction; thus less zinc reacted with the acid. Hence the volume of hydrogen is lesser.	1
	d	Zinc being more reactive than iron, provides sacrificial protection to iron. It corrodes by reacting with the oxygen and protects the iron.	1
A6	ai	Electron flow from zinc to copper in the wire	1
	ii	Zn (s) → Zn^{2+} (aq) + $2e^-$ Zinc is more reactive than copper so it loses electrons easily to form zinc ions.	1 1
	bi	Ammeter will record a lower reading than that for zinc. This is because iron is closer to copper in the reactivity series as compared to zinc and copper.	1 1
	ii	The container will have a light green solution whereas it was colourless when zinc was used.	1
A7	a	Ethanol burns in oxygen to form carbon dioxide and water. In this combustion reaction, the energy needed to break the bonds (C-C, O-H, C-H,) in ethanol and oxygen molecules (O=O) is **much lower than** the energy released in forming the bonds (C=O) in carbon dioxide and (O-H) bonds in water; hence the enthalpy change is negative.	1 1
	bi	From the table, 1 mol of ethanol gives out 1370 kJ of energy. 1370 kJ of energy from 1 mole 200 kJ of energy will come from = 1/1370 x 200 = 0.146 mol of ethanol No of mol of CO_2 produced = 0.146 x 2 =0.292 Volume of CO_2 = 0.292 x 24 dm^3 = **7.01 dm^3**	1 1
	bii	1 mol of octane gives out 5510 kJ of energy. 5510 kJ of energy from 1 mole	1

		200 kJ of energy will come from = 1/5510 x 200 = 0.0363 mol of octane No of mol of CO_2 produced = 0.0363 x 8 = 0.290 Volume of CO_2 = 0.290 x 24 dm^3 = **6.97 dm^3**	1
	c	Ethanol is **not necessarily a greener fuel** because it produces slightly more carbon dioxide than octane in combustion when the same amount of energy is released.	1
A8	ai	It refers to a group of organic compounds having similar chemical properties and the same functional group.	1
	ii	Ethanoyl chloride will have a higher boiling point than methanoyl chloride. This is because ethanoyl chloride is a bigger molecule and there are stronger forces of attraction between the molecules as compared to that in methanoyl chloride.(smaller molecule)	1 1
	iii		
	b	Name of ester: **methyl butanoate** Structure: 	

B9	ai	Silica / SiO_2 ;	1
	ii	Silica has a giant molecular structure where all the silicon and oxygen atoms are held together by a network of strong covalent bonds.; A lot of energy is required to overcome these bonds, hence, it can withstand high heat.;	1 1
	b	Potash is more thermally stable ; because K is a more reactive metal than Na and forms a more stable compound with oxygen.	1 1
	ci	Potassium salt is an ionic compound and ions are held by strong electrostatic forces of attraction. ; Only in the molten state will the ions be free to move / mobile. ; hence the temperature is high	1 1
	ii	The potassium ions have a larger ionic radii of 142×10^{-12} m while the sodium ions only have an ionic radii of 116×10^{-12} m. ; potassium ions fills up the structure and prevents the atoms (and ions) in the glass from moving/sliding easily, hence increasing its strength. ; Accept: - K^+ ions were larger / larger ionic radii than Na^+ ions - Reduces the empty spaces between particles / limits movement between particles.	1 1
	iii	Silicon dioxide is the main component in the Gorilla glass and is an acidic oxide that reacts with an alkali. ;	1
B10	ai	Anode: $2Cl^- (aq) \rightarrow Cl_2 (g) + 2e^-$ Cathode: $2H^+ (aq) + 2e^- \rightarrow H_2 (g)$	1 1
	ii	Bubbles of gases (yellow-green) will be seen at anode	1 1

		This is because although both chloride and hydroxide ions are attracted to the anode, it is the chloride ions that are preferentially discharged due to its higher concentration Bubbles of gas (colourless) also formed at cathode This is because although hydrogen ions and sodium ions are attracted to the cathode, due to the ease of discharge, hydrogen ions are preferentially discharged.	1 1
	bi	Number of mol of oxygen gas = 6/24 = 0.25 mol $4OH^{-}$ (aq) → $2H_2O$ + O_2 + $4e^{-}$ When 1 mol of oxygen is formed at anode, 4 mol of e are lost. Since only ¼ mol of oxygen is formed, only 1 mol of e are lost. Cu^{2+} (aq) + $2e^{-}$ → Cu (s) From this, 1 mol of e can only produce ½ mol of Cu Mass of copper formed = ½ x 64 g = 32 g Ag^{+} (aq) + e^{-} → Ag (s) 1 mol of e can produce 1 mol of silver Mass of silver formed = 108 g	1 1
	ii	The blue solution turned colourless when all the copper ions had been discharged from the solution. Or Reddish-brown solid is formed at cathode as copper ions are being discharged to form copper metal.	1 1
B11		**Either**	
	a	The compound X is methanol. Concentrated sulfuric acid is needed as a catalyst and the mixture must be heated.	1 1
	bi	Monomer D	1
	ii	Monomer B which has C=C bonds in it. It undergoes addition polymerisation where atoms are not lost.	1
	ci	Monomer A and C	

			1
	ii	It has amide group in it with nitrogen atoms; on burning it may form the harmful gases, nitrogen monoxide and nitrogen dioxide. These nitrogen oxides may give rise to the formation of acid rain that corrodes buildings and affects vegetation.	1 1
	d	Adding some **bromine solution** separately into all the four solutions. Only **monomer B, having the C=C bond, will decolourise** the red-brown iodine solution. Add **acidified potassium manganite(VII)** solution to the three remaining solutions and heat. **Monomer D**, having the hydroxyl group, will get oxidised and there will be a colour change in the solution. **Purple solution will turn colourless**. In the remaining two solutions, add a piece of **magnesium ribbon**. The one which **produces bubbles of gas** will be **monomer A** as it is an acid. The monomer which does not react in all the three reactions above is monomer C.	1 1 1
B11		**OR**	
	a	Coke is essential in the blast furnace for the following two reactions. Firstly, coke is needed to burn in oxygen to form carbon dioxide. $C + O_2 \rightarrow CO_2$ Secondly, it is needed to reduce carbon dioxide to carbon monoxide. $CO_2 + C \rightarrow 2CO$ We need this carbon monoxide because, carbon monoxide will reduce the iron(III) oxide in haematite to produce iron. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$	1 1 1 1
	b	Order of reactivity: lead, iron, metal X (least reactive to most reactive) In beaker 1, iron displaces lead; iron is more reactive. In beaker 3, X displaces iron, metal X is more reactive than iron.	1 1 1

		In beaker 2, lead cannot displace X; as X is most reactive	
	ci	Fe^{2+} (aq) + 2OH^{-} (aq) → $Fe(OH)_2$ (s)	1
	ii	The brown solid is iron(III) hydroxide. It is formed when green iron(II) hydroxide gets oxidised to brown iron(III) hydroxide by the atmospheric oxygen.	1 1

YISHUN SECONDARY SCHOOL

We Seek, We Strive, We Soar

PRELIMINARY EXAMINATION

Name: ______________________________ **Reg. No:** _______ **Class:** ______________

Secondary 4 Express

Date: 29 August 2019

CHEMISTRY (6092/02)

PAPER 2

Duration: 1 hour 45 minutes

MAX MARKS: 80

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A

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

Section B

Answer all **three** questions in this section, the last question is in the form either/or.

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

At the end of the examination, fasten all your work securely together.

The number of marks is given in bracket [ ] at the end of each question or part question.

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

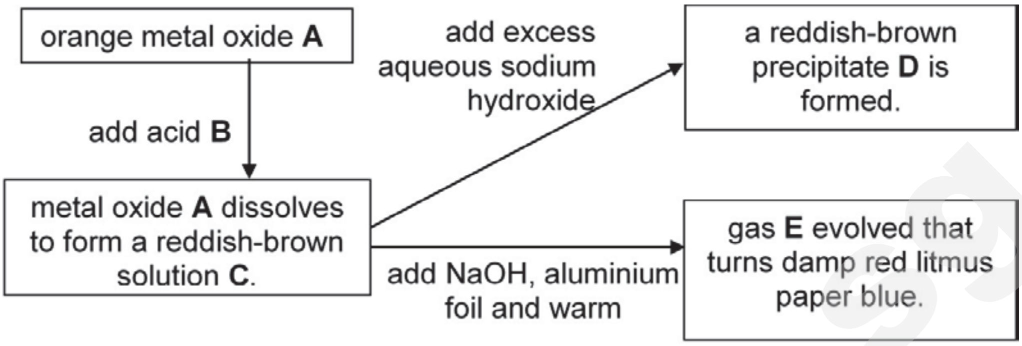
The Periodic Table is on page 17.

For Examiner's Use Only		
PAPER TWO		
A		**50**
B8		**10**
B9		**10**
B10		**10**
Total		**80**

This document consists of **17** printed pages including the cover page.

Section A: Structured Questions [50 marks]
Answer ALL questions in the spaces provided.

A1 The figure below shows the reaction scheme of an orange metal oxide, **A**, which undergoes a series of reactions.



Name the following

(a) metal oxide **A**, ……………………………………………..[1]

(b) acid **B**, ……………………………………………..[1]

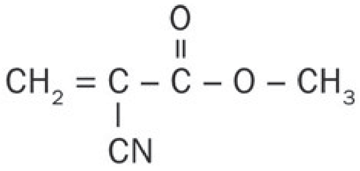
(c) solution **C**, ……………………………………………..[1]

(d) precipitate **D**, ……………………………………………..[1]

(e) gas **E**. ……………………………………………..[1]

[total: 5]

A2 Superglue is a very strong adhesive used to fasten materials, such as wood, together.
The active ingredient in superglue is methyl cyanopropenoate, commonly known as methyl cyanoacrylate. The structure of methyl cyanopropenoate is shown below.



$$CH_2=C(CN)-C(=O)-O-CH_3$$

methyl cyanopropenoate

Superglue polymerises when exposed to moisture in the air. This causes the glue to set.

(a) Draw the structural formulae of the two functional groups present in methyl cyanopropenoate. Name these two functional groups.

[2]

(b) What type of polymerisation does methyl cyanopropenoate undergo when it forms superglue?

……………………………………………………………………………………………..[1]

(c) Draw the structural formula of the polymer formed, showing two repeat units.

[1]

(d) Other than superglue, suggest another name for the polymer formed in **(c)**.

……………………………………………………………………………………………………..[1]

(e) **(i)** A sample of methyl cyanopropenoate is shaken with bromine water.

Describe what you would observe.

……………………………………………………………………………………………………

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

(ii) What type of reaction has occurred in **(e)(i)**?

……………………………………………………………………………………………………[1]

[total: 8]

A3 People with kidney problems are advised against eating starfruit as it contains a significant amount of oxalic acid.

The concentration of oxalic acid in starfruit is estimated to be at 0.020 mol/dm^3.

The acid concentration in starfruit can be determined by performing an acid-base titration with sodium hydroxide solution.

Assume that the oxalic acid found in starfruit is dibasic and can be represented by H_2A.

(a) Write a balanced chemical equation, with state symbols, for the reaction between oxalic acid and sodium hydroxide.

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

(b) A student suggested that 25.0 cm^3 of starfruit juice should be pipetted into a conical flask and titrated against 0.050 mol/dm^3 sodium hydroxide solution.

Based on the information provided, calculate the maximum volume of sodium hydroxide solution required for complete neutralisation.

maximum volume of sodium hydroxide solution required = ……………….. cm^3 [2]

(c) Oxalic acid is made up of carbon, oxygen and hydrogen and it contains 26.7 % carbon and 2.20 % hydrogen by mass.

(i) Determine the empirical formula of oxalic acid.

empirical formula: …………….. [2]

(ii) The relative molecular mass of oxalic acid is 90.
Determine the molecular formula of oxalic acid.

molecular formula: …………….. [1]

(d) A patient was advised by the doctor to consume not more than 0.05 g of oxalic acid per day. If a typical serving of starfruit contains 0.00011 mol of oxalic acid, calculate the maximum number of servings of starfruit the patient can eat in a day.

maximum number of servings = …………… [1]

[total: 8]

A4 (a) The table shows some information about two homologous series of alcohol and ether.

name of alcohol	**formula of alcohol**	**number of C atoms**	**formula of ether**	**name of ether**
ethanol	C_2H_5OH	2	CH_3OCH_3	methoxymethane
propanol	C_3H_7OH	3	$CH_3OC_2H_5$	methoxyethane
butanol	C_4H_9OH	4	$CH_3OC_3H_7$	methoxypropane
pentanol	$C_5H_{11}OH$	5		

(i) Deduce the name and formula of the ether that contains 5 carbon atoms.

name: ………………………………………………………………………………………………

formula: ……………………………………………………………………………………………[2]

(ii) Suggest a **relationship** between alcohols and ethers by comparing the chemical formulae with the same number of carbon atoms.

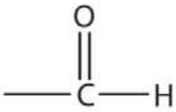
……

……[1]

(iii) Hence, calculate the relative molecular mass of the ether that contains 20 carbon atoms.

M_r of ether = ………… [1]

(b) The table below shows some information about another homologous series of organic compounds called aldehydes. The functional group of the aldehydes is:



name	**molecular formula**	**boiling point /°C**
methanal	HCHO	– 19
ethanal	CH_3CHO	20
propanal	C_2H_5CHO	49
pentanal	C_4H_9CHO	103

(i) Use the information in the table to give two pieces of evidence that suggest that the aldehydes are a homologous series.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

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

(ii) Deduce the name of the aldehyde that contains 4 carbon atoms and predict its boiling point.

name: ……………………………………………………………………………………………

predicted boiling point: ……………………………………………………………………[2]

[total: 8]

A5 The relative positions of the elements rubidium (Rb), beryllium (Be) and bismuth (Bi) in the reactivity series are shown in the table below.

Position in the reactivity series (highest to lowest)
Rubidium
Sodium
Magnesium
Beryllium
Iron
Hydrogen
Bismuth
Copper
Silver

You may assume that these elements do not show variable valencies.

(a) An unknown photograph showing specks of silvery deposits with the caption

"Pure rubidium found on a tiny island in the Pacific Ocean"

was posted in the early morning of August 16, 2016, on social media. The post has since gone viral. Using the information above and your knowledge, discuss the validity of this post.

………

………

………[2]

(b) Predict, with reasons, the reactions of beryllium with cold water and steam.

………

………

………[3]

(c) Suggest a suitable method to extract bismuth from its ore.

………[1]

[total: 6]

A6 One important property of a rocket fuel mixture is the large volume of gaseous products formed which provide thrust. Hydrazine, N_2H_4, is often used as a rocket fuel. The combination of hydrazine with oxygen is represented by the equation:

$$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -585 \text{ kJ/mol}$$

(a) Explain if the reaction is a redox reaction.

………

………

………[2]

(b) Hydrazine can also react with fluorine to produce gaseous nitrogen and hydrogen fluoride. The amount of energy produced is 1179 kJ/mol. Write a balanced equation for this reaction, including the state symbols and the enthalpy change.

………[2]

(c) Suggest, giving **two** reasons based on the information given, whether a mixture of hydrazine and oxygen is a better rocket fuel than a mixture of hydrazine and fluorine.

………

………

………

………[2]

(d) The local government promotes the use of hydrazine with oxygen due to the environmental safety of the products. Explain why this is so.

………

………

………[2]

[total: 8]

A7 Isotopes are variants of a particular chemical element and most elements have several naturally-occurring isotopes.

(a) Define the term 'isotopes'.

………

………[1]

(b) Hydrogen, deuterium and tritium are isotopes of one another.

Using this information, complete the table below.

name	**formula**	**number of protons**	**number of neutrons**	**number of electrons**
hydrogen atom	${}^{1}_{1}H$	1		1
deuterium ion	${}^{2}_{1}H^{+}$			0
tritium ion			2	2

[3]

(c) The table below gives the relative abundance of each isotope in a mass spectrum of sample of germanium, Ge.

mass	70	72	74
relative abundance (%)	24.4	32.4	43.2

Use the data in the table to calculate the relative atomic mass (A_r) of this sample of germanium.

A_r of germanium = …………………. [2]

(d) A student commented, "Isotopes of an element should all have the same chemical properties." Do you agree with the student? Give a reason for your answer.

………

………[1]

[total: 7]

End of Section A

Section B: Essay Questions [30 marks]

Question B8 and B9 are compulsory. Question B10 is an Either/Or.

B8 Changing of variables in reversible reactions

Most chemical reactions only proceed in one direction. But some reactions can be reversed. They are known as reversible reactions.

In reversible reactions, the forward and backward reactions take place at the same time. At the end of the reaction, a mixture of reactants and products is present.

When the forward and backward reactions become equal in speed, the mixture is said to be in equilibrium. At equilibrium, the forward and backward reactions do not stop.

To alter the yield of products in a reversible reaction, we can change the experimental conditions such as temperature and pressure. The change in the yield of products in a reversible reaction follows the *Le Chatelier's Principle*.

According to *Le Chatelier's Principle*, the reaction will shift either to the left towards the backward reaction or to the right towards the forward reaction to reduce the effect of the new condition.

Changing temperature

When hydrogen iodide, HI, is heated in a closed tube, the following equilibrium is established.

Reaction 1 $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $\Delta H = +9.6$ kJ/mol

The equation shows the forward reaction producing hydrogen and iodine is endothermic. An increase in temperature shifts the reaction to the right to reduce the temperature. This increase the yield of hydrogen and iodine.

The table shows the concentrations of $HI(g)$ and $I_2(g)$ in the equilibrium mixture at 2 different temperatures when the same concentration of $HI(g)$ was injected into the tube at the start of the experiment.

substance	concentration in mol/dm^3 at 25 °C	concentration in mol/dm^3 at 450 °C
$HI(g)$	0.94	0.79
$H_2(g)$	0.033	0.11
$I_2(g)$	0.033	0.11

Changing pressure

Changing pressure affects reactions involving gases. However, there must be different number of gas molecules on either side of the equation.

The greater the number of gas molecules in the same volume, the greater the pressure the gas exerts.

Reaction 2 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -197$ kJ/mol

The equation shows a reaction used to change sulfur dioxide into sulfur trioxide. An increase in pressure shifts the reaction to the right. As there are more molecules on the left side of the equation, the reaction shifts to the right side with lesser number of molecules to reduce the pressure.

The conditions for reaction 2 are:

Pressure:	atmospheric pressure
Catalyst:	vanadium(V) oxide
Temperature:	450 °C

The conditions chosen are a compromise between speed of reaction and yield of SO_3. Using these conditions, the yield of SO_3 is 95%.

(a) A change in temperature or pressure does not affect the yield for the reaction between sodium hydroxide and hydrochloric acid to form sodium chloride.
Suggest why.

……………………………………………………………………………………………………..[1]

(b) Explain the differences in the concentrations of reactant and products at 25 °C and 450 °C in reaction 1.

……………………………………………………………………………………………………...

……………………………………………………………………………………………………...

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

(c) With reference to the table, state the concentration of HI(g) injected into the tube at the start of the experiment, giving your answer to 3 significant figures.

……………………………………………………………………………………………………..[1]

(d) Suggest why reaction 2 is carried out at 450 °C, and not at a higher or lower temperature.

……………………………………………………………………………………………………...

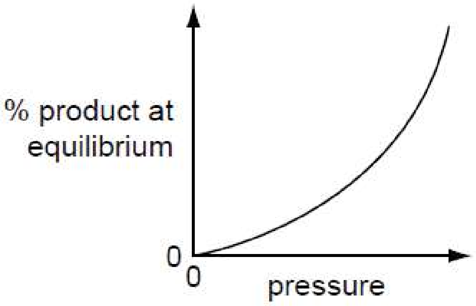
……………………………………………………………………………………………………...

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

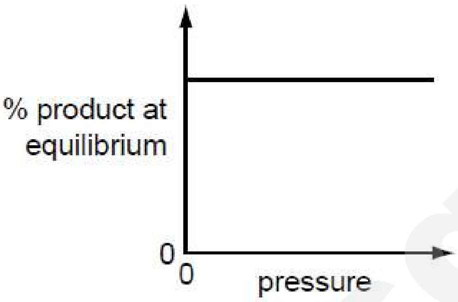
(e) Explain why reaction 2 is carried out at atmospheric pressure even though an increase in pressure shifts the position of the equilibrium further to the right.

……………………………………………………………………………………………………..[1]

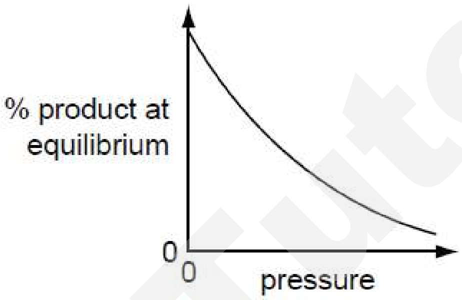
(f) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.
Match reaction 1 and reaction 2 to a graph each. Give a reason for your choice.



Graph A



Graph B



Graph C

………..

………..[3]

[total: 10]

B9 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulfide, NiS.

Stage 1 – nickel(II) sulfide is heated in air to form nickel(II) oxide and sulfur dioxide
Stage 2 – nickel(II) oxide is heated with carbon to give impure nickel
Stage 3 – impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, $Ni(CO)_4$
Stage 4 – nickel tetracarbonyl is decomposed to give pure nickel

(a) (i) Construct the balanced equation for the reaction in stage 1.

....[1]

(ii) Calculate the mass of sulfur dioxide that is formed when 182 kg of nickel(II) sulfide is heated in air.

mass of sulfur dioxide = ... kg [2]

(b) Nickel tetracarbonyl is a liquid with a boiling point of 43 °C.

Suggest, with a reason, the type of structure and bonding in nickel tetracarbonyl.

....

....

....[2]

(c) In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions. The results are shown in the table.

	aqueous zinc nitrate	**aqueous nickel(II) nitrate**	**aqueous copper(II) nitrate**
zinc	no reaction	green solution turn colourless and zinc coated with a grey solid	blue solution turn colourless and zinc coated with a pink solid
nickel		no reaction	
copper	no reaction	no reaction	no reaction

Predict the observations when nickel is added to separate solutions of zinc nitrate and copper(II) nitrate.

with zinc nitrate ....

....

with copper(II) nitrate ....

....

[3]

(d) Explain why this 4-stage process cannot be used to manufacture magnesium.

……………………………………………………………………………………………………..…..

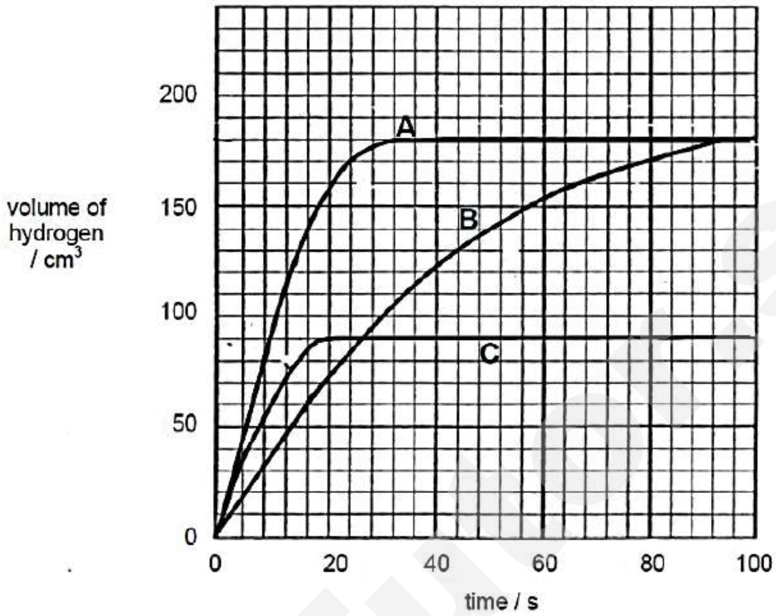
……………………………………………………………………………………………………...[2]

[total: 10]

Either

B10

A student carried out two separate reactions between 0.488 g of zinc and two acids, hydrochloric acid and sulfuric acid. The volume and concentration of the acids used were both 20.0 cm^3 and 2.00 mol/dm^3. The curves **A** and **B** shown in the graph below show the results of the reactions.



He carried out a third reaction with **C** with 20.0 cm^3 of a 2.00 mol/dm^3 acid, but forgot to weigh the mass of zinc as well as take note of which acid, hydrochloric acid or sulfuric acid, was used.

(a) Explain, with relevant calculations, why the same volume of gas was produced for both curves **A** and **B**.

………

………

………

………

………[3]

(b) Between curves **A** and **B**, identify the curve for the reaction that used sulfuric acid. Explain your choice.

………

………

………[2]

(c) In experiment **C**, identify the acid used and calculate the mass of zinc the student had used.

………

………

………[2]

(d) The student repeated experiment **C** using the same mass of zinc and the same volume and concentration of the acid, but this time, he added in a small amount of copper(II) sulfate crystals to the reaction mixture.

He noted that the effervescence was more vigourous and a brown deposit was formed. The volume of hydrogen collected was slightly less than in experiment **C**.

(i) Explain why less hydrogen was collected.

....

....

....[2]

(ii) The student concluded that copper(II) sulfate acted as a catalyst.

Comment, with a reason, whether the student's conclusion was right or wrong.

....

....[1]

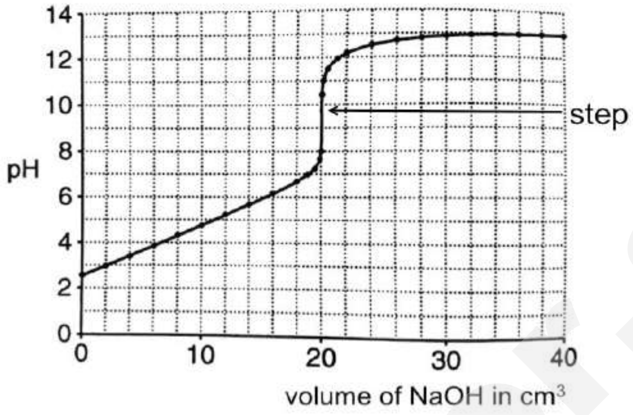
[total: 10]

Or

B10

Graph 1 shows the changes in pH level when 20.0 cm^3 of ethanoic acid (CH_3COOH) is titrated with 0.1 mol/dm^3 of sodium hydroxide.

Graph 1



The endpoint of a titration is reached when a 'step' occurs. At this point, all the acid has been fully neutralised.

(a) What is the name and formula of the salt formed in the titration?

……………………………………………………………………………………………………..[1]

(b) Using information from **Graph 1**, calculate the concentration of the ethanoic acid used in the reaction.

concentration of ethanoic acid = ……………………….. [2]

(c) An indicator changes colour when the endpoint of a titration is reached. The table below shows the colours of some indicators at different pH values. The best indicator for a titration gives a distinct colour change when a 'step' occurs.

indicator	low pH	pH range where indicator changes colour	high pH
methyl orange	red	3.1 to 4.4	yellow
thymolphthalein	colourless	9.3 to 10.5	blue
phenolphthalein	colourless	8.3 to 10.0	pink

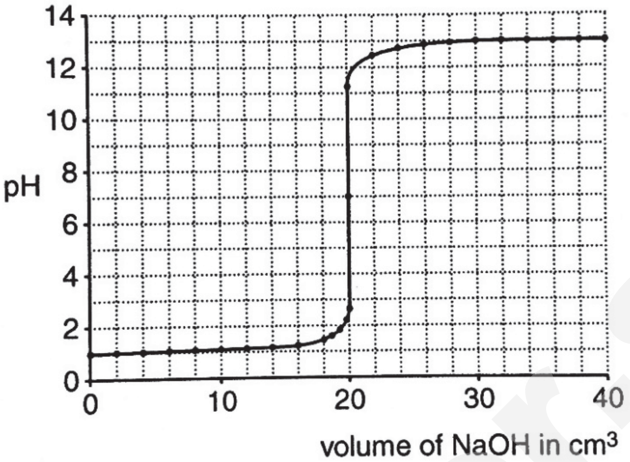
Using information from **Graph 1** and the table, explain which indicator will **not** be suitable for use when titrating ethanoic acid with sodium hydroxide.

……………………………………………………………………………………………………..

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

(d) The titration was repeated using the same concentration and volume of hydrochloric acid instead of ethanoic acid, with all other variables remaining constant. **Graph 2** shows the changes in pH level for this reaction.

Graph 2



(i) Explain how and why the time taken for the endpoint to be reached is different from that in the experiment using ethanoic acid.

……

……

……

……

……

……[4]

(ii) Sketch on **Graph 2**, the graph you would obtain if dilute sulfuric acid of the same concentration and volume is used instead.

[1]

[total: 10]

End of Section B

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanium 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 +															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

*58-71 Lanthanoid series
+90-103 Actinoid series

Key
a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

YISHUN SECONDARY SCHOOL

We Seek, We Strive, We Soar

PRELIMINARY EXAMINATION

Name: ________________________________ **Reg. No:** ________ **Class:** ___________

Secondary 4 Express Date: 20 September 2019

CHEMISTRY (6092/01)

PAPER 1 Duration: 1 hour

MAX MARKS: 40

Additional Materials: OTAS Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name and register number on the OTAS Sheet provided.

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 separate 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.

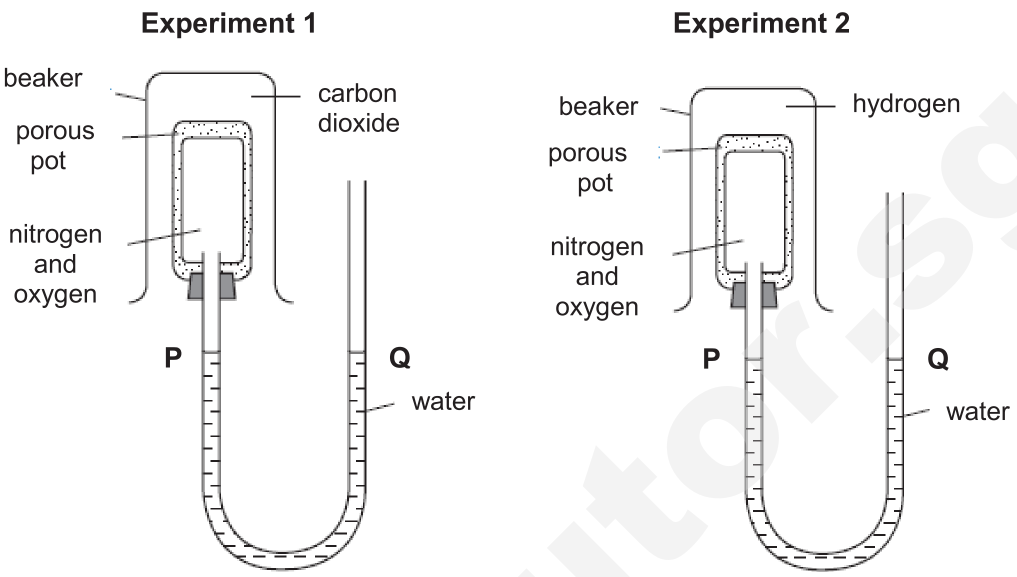
A copy of the Periodic Table is printed on page 15.

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

This document consists of __15__ printed pages including the cover page.

Paper 1 [40 marks]
Shade your answers in the OTAS sheet provided.

1 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagrams below. Each porous pot contains a mixture of nitrogen and oxygen.



In the first experiment, the gas introduced into the beaker is carbon dioxide while in the second experiment, it is hydrogen.

What changes, if any, to the water levels **P** and **Q**, would you expect to see in both experiments?

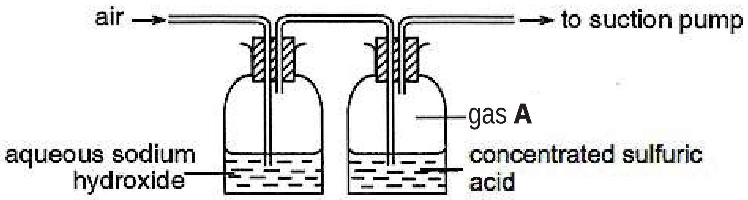
	Experiment 1	**Experiment 2**
A	**P** and **Q** remain the same	**P** and **Q** remain the same
B	**P** and **Q** remain the same	**Q** is higher than **P**
C	**P** is higher than **Q**	**Q** is higher than **P**
D	**Q** is higher than **P**	**Q** is higher than **P**

2 A substance dissolves in water to form a colourless solution. This solution reacts with aqueous silver nitrate in the presence of dilute nitric acid to give a yellow precipitate.

What is the possible identity of the substance?

A calcium iodide
B copper(II) chloride
C iron(II) iodide
D sodium chloride

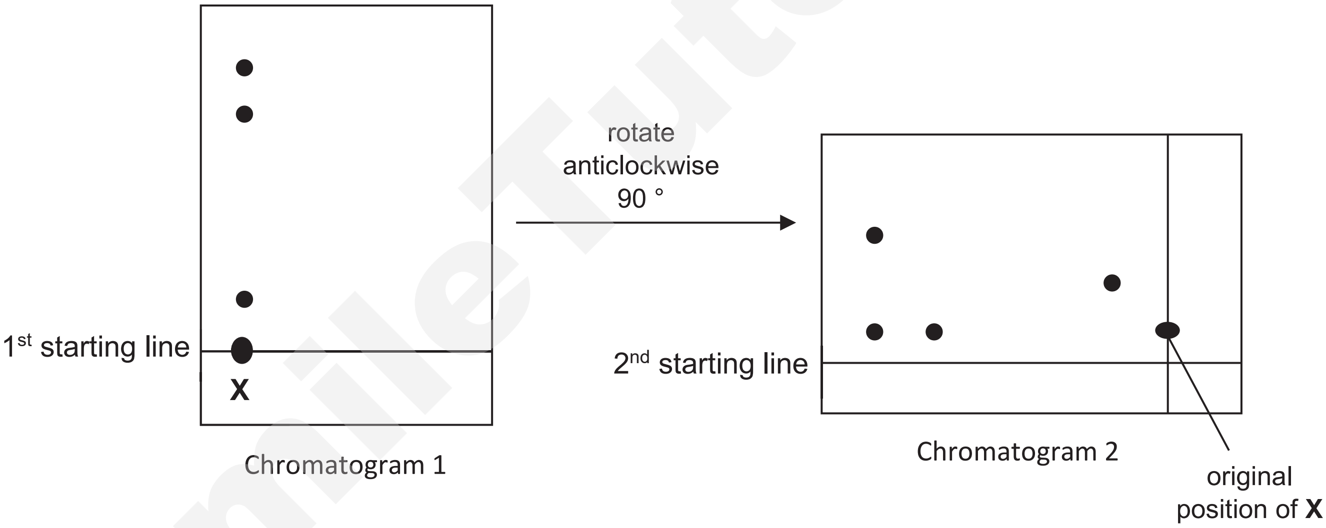
3 A sample of air is passed through the apparatus shown below.



What would be the composition of gas **A** after passing air through aqueous sodium hydroxide and then concentrated sulfuric acid?

A noble gases only
B oxygen, carbon dioxide, nitrogen
C oxygen, nitrogen, water vapour
D noble gases, oxygen, nitrogen

4 Chromatogram 1 below shows the separation of coloured inks in mixture **X**, using solvent **A**. Chromatogram 2 shows the separation using the same piece of paper after it has been rotated anti-clockwise 90 ° in another solvent, **B**.



How many different types of ink are present in mixture **X**?

A 3
B 4
C 5
D 7

5 A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance **cannot** be an element?

A It has a fixed boiling point.
B It dissolves in water to form a yellow-green solution.
C When heated strongly, a brown solid and a yellow gas are produced.
D When heated in air, it can form oxides with two different chemical formulae.

6 Which substance is **wrongly** matched with the type of particles it contains?

	substance	**type of particles**
A	HC*l* (g)	ions
B	I_2 (s)	molecules
C	LiBr (s)	ions
D	graphite	atoms

7 A student is given the nucleon number of an atom as well as its position in the Periodic Table.

What can be deduced about the structure of the atom?

A number of protons only
B number of neutrons only
C number of neutrons and protons
D number of neutrons, protons and electrons

8 Two elements, **P** and **Q**, have the electronic configuration 2,8,1 and 2,6 respectively. A student describes the compound formed by **P** and **Q** using the following statements.

1 It is insoluble in water.
2 It has a high melting and boiling point.
3 It has a crystal lattice structure similar to that of sodium sulfide.
4 The elements in it can be separated by electrolysis.

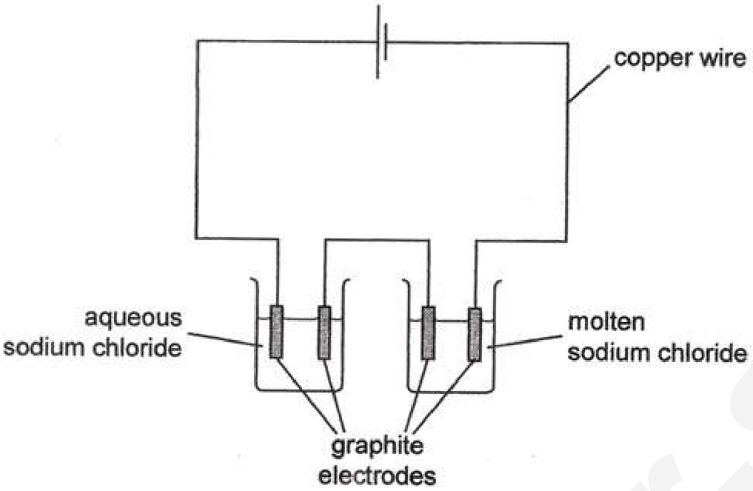
Which of the above statements correctly describe the compound formed by **P** and **Q**?

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

9 Titanium tetrachloride has a structure similar to tetrachloromethane. What is the property of titanium tetrachloride?

A Titanium tetrachloride conducts electricity in all states.
B Titanium tetrachloride is insoluble in organic solvent.
C Titanium tetrachloride has a high melting point.
D Titanium tetrachloride has a high volatility.

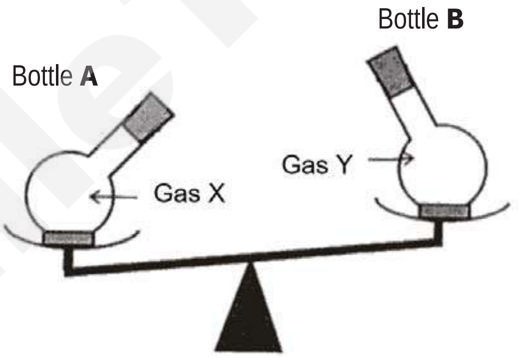
10 The diagram shows an electrolysis set-up involving two electrolytes.



Which substance contains both positive ions and mobile electrons?

A aqueous sodium chloride
B copper wire
C graphite electrodes
D molten sodium chloride

11 At room temperature and pressure, two identical flasks which have been filled up with gas X and Y were put on a balance. The result is shown below.



Which statement is correct?

A The number of gas particles in bottle **A** is greater than the number of gas particles in bottle **B**.

B The number of moles of gas particles in bottle **A** is greater than the number of moles of gas particles in bottle **B**.

C The molar mass of gas particles in bottle **A** is greater than the molar mass of gas particles in bottle **B**.

D The molar volume of gas particles in bottle **A** is greater than the molar volume of gas particles in bottle **B**.

12 To identify an oxide of nitrogen, 0.1 mol of the oxide is mixed with an excess of hydrogen and passed over a catalyst at a suitable temperature.

$$N_xO_y \xrightarrow[\text{catalyst}]{H_2\text{ (g)}} xNH_3 + yH_2O$$

The water produced weighs 7.20 g. The ammonia produced is neutralised by 200 cm^3 of 1.0 mol/dm^3 HC*l*.

What is the formula of the oxide of nitrogen?

A NO
B NO_2
C N_2O
D N_2O_4

13 A 10 cm^3 sample of a gaseous hydrocarbon is completely burnt in oxygen. The total volume of the products is 70 cm^3.

All gas volumes are measured at room temperature and pressure.

Which equation represents the combustion of the hydrocarbon?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
B $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$
C $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$
D $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$

14 Elements X, Y and Z are in the same period of the Periodic Table.

Oxides of X reacts with both alkali and acid.
Oxides of Y dissolves in water to form solution with pH < 7.
Solid Z conducts electricity.

In which order do the elements appear in the Periodic Table.

A X → Y → Z
B Y → X → Z
C Z → X → Y
D Z → Y → X

15 Excess bromine is bubbled through three different solutions.

What are the observations in the respective solutions when the reactions are completed?

	potassium iodide solution	**potassium chloride solution**	**acidified potassium manganate(VII)**
A	brown	colourless	purple
B	colourless	colourless	colourless
C	brown	greenish yellow	colourless
D	colourless	greenish yellow	purple

16 Which of the following, when added to water, makes a solution that is a good conductor of electricity?

A calcium sulfate
B copper
C ethanol
D sodium hydroxide

17 A black powder is burned in air.

The gas produced dissolves in water to form solution **R**. The pH of **R** is close to 7.

The gas is readily absorbed in aqueous sodium hydroxide.

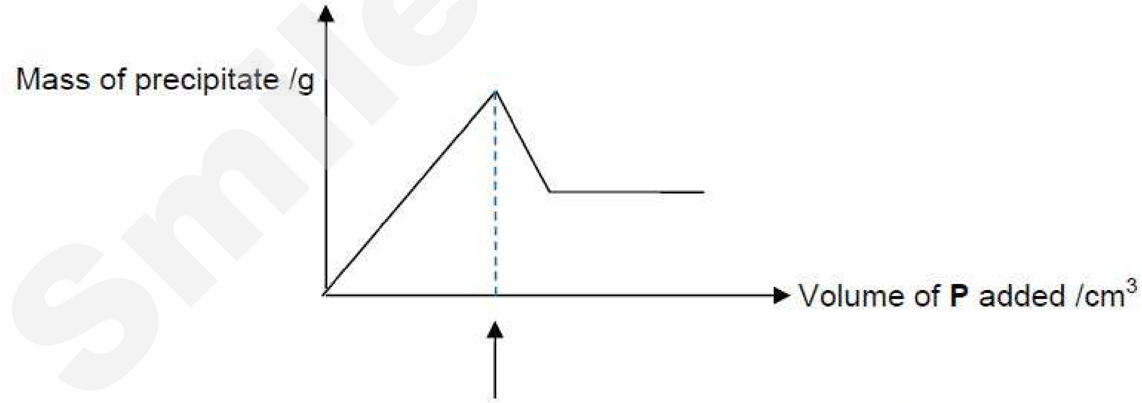
What type of substance is present in solution **R**?

A strong acid
B strong base
C weak acid
D weak base

18 Which test is best used to distinguish between calcium chloride and calcium carbonate?

A adding aqueous sodium hydroxide
B adding dilute hydrochloric acid
C using damp litmus paper
D using silver nitrate solution

19 In a qualitative analysis, reagent **P** is added gradually to solution **Q**, followed by the addition of a dilute acid **R**.

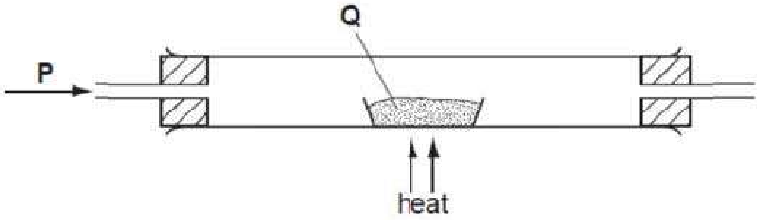


The graph shows how the mass of the precipitate changes as the reagents are added.

Which of the following entries is correct?

	P	Anions in Q	R
A	aqueous silver nitrate	Cl^- and CO_3^{2-}	dilute nitric acid
B	aqueous silver nitrate	Cl^-	dilute nitric acid
C	aqueous barium chloride	Cl^- and CO_3^{2-}	dilute hydrochloric acid
D	aqueous barium chloride	CO_3^{2-}	dilute hydrochloric acid

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



No reaction occurs if **P** and **Q** are

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

21 Given the following reactivity series,

Al
Mn
C
Zn

↑ increasing reactivity

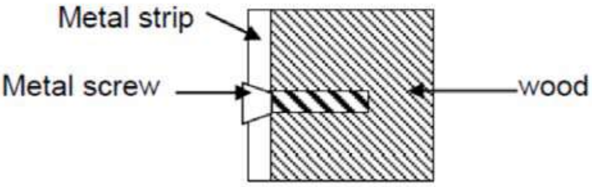
Which action would **not** result in a chemical reaction?

A adding dilute hydrochloric acid to manganese
B heating manganese(II) carbonate strongly
C heating manganese(IV) oxide with carbon
D mixing zinc sulfate solution with manganese powder

22 One of the raw materials used in the extraction of iron in the blast furnace is calcium carbonate. Which statement best explains the use of calcium carbonate?

A To produce slag as a by-product.
B To oxidise haematite to iron.
C To remove the basic impurities in the ore.
D To speed up the rate of reaction.

23 Metal strips are secured on the outside of the wooden box by means of screws. After a few weeks of being exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



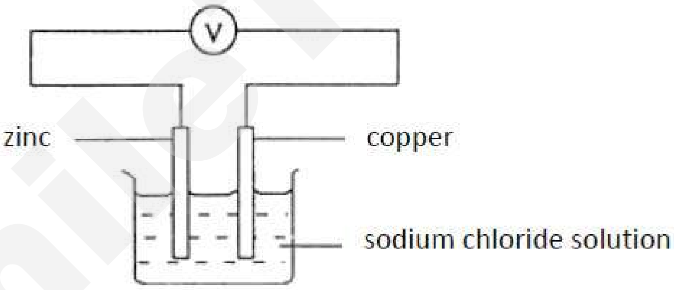
Which statement best explains the observation?

A The metal screw loses electrons less readily than the metal strip.
B The metal screw stops oxygen in the air from getting to the metal strip.
C The metal strip has a protective oxide layer but not the metal screw.
D The metal screw is a pure metal and the metal strip is an alloy.

24 In an electrolysis experiment, the same amount of electrical charge deposited 65 g of zinc and 394 g of gold. What was the charge on the gold ion?

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

25 Consider the following chemical cell:



Which of the following changes would lead to an increase in the voltage of the cell?

1 The copper electrode is replaced with an iron electrode.
2 The sodium chloride solution is replaced with a sugar solution.
3 The zinc electrode is replaced with a magnesium electrode.

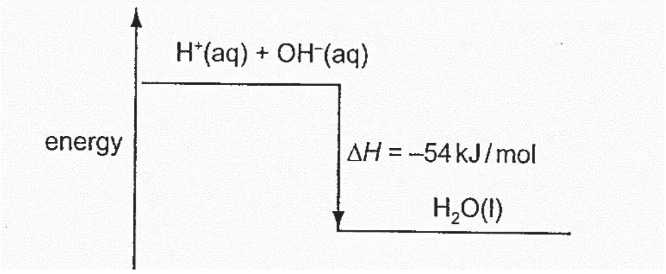
A 1 and 2
B 1 and 3
C 2 only
D 3 only

26 When one mole of ethanol (CH_3CH_2OH) undergoes complete combustion, 1370 kJ of energy are released. When one mole of dimethyl ether (CH_3OCH_3) undergoes complete combustion, 1460 kJ of energy are released.

What causes this difference in the amount of energy released?

A The two compounds have different boiling points.
B The two compounds have different relative molecular masses.
C The two compounds have different bonds within the molecules.
D The two compounds have different products of combustion.

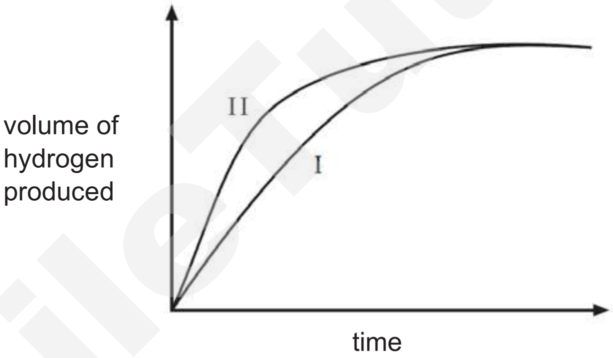
27 The energy level diagram for the reaction between sodium hydroxide and hydrochloric acid is shown below.



What can be deduced from the diagram?

A The reaction is rapid.
B Heat is needed to start the reaction.
C The OH^- ions have more energy than the H^+ ions.
D The products contain less energy than the reactants.

28 Excess zinc was added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid and was represented by Graph I.



Which condition could Graph II be representing?

A Excess zinc reacting with 100 cm^3 of 2.0 mol/dm^3 hydrochloric acid.
B Excess zinc reacting with 100 cm^3 of 1.0 mol.dm^3 sulfuric acid.
C Excess zinc reacting with 100 cm^3 of 1.0 mol/dm^3 ethanoic acid.
D Excess magnesium reacting with 100 cm^3 of 1.0 mo/dm^3 hydrochloric acid.

29 Nitrogen and hydrogen react to form ammonia in the Haber process. Which statement is correct about this process?

A A high yield of ammonia is favoured by high temperature.
B Increasing the pressure speeds up the reaction.
C Nickel catalyst is used to increase the production of ammonia.
D The reaction between nitrogen and hydrogen is irreversible.

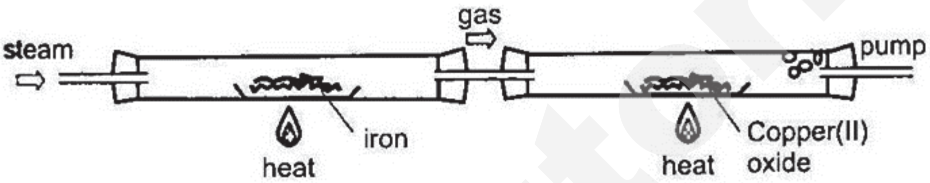
30 Sodium hypochlorite undergoes decomposition according to the following equation.

$$3NaClO \rightarrow 2NaCl + NaClO_3$$

Which option shows the correct oxidation states of chlorine respectively?

	NaClO	**NaCl**	**$NaClO_3$**
A	-1	-1	+5
B	+1	-1	+5
C	+1	-1	+7
D	+2	+1	+7

31 Which of the following is **not** a product of the reaction sequence shown below?



A copper
B iron(III) oxide
C oxygen
D water vapour

32 Which two gases do **not** damage limestone buildings?

A nitrogen and carbon monoxide
B nitrogen dioxide and carbon monoxide
C nitrogen dioxide and carbon dioxide
D sulfur dioxide and carbon dioxide

33 Chlorine atoms are involved in the decomposition of ozone by reacting with ozone in a two-step reaction.

$$Cl + O_3 \rightarrow ClO + O_2 \quad \textbf{step 1}$$
$$ClO + O_3 \rightarrow Cl + 2O_2 \quad \textbf{step 2}$$

Which observation is true for the reaction?

A The reaction is reversible.
B Chlorine atoms are reduced in step 1.
C Chlorine atoms act as catalysts in the reaction.
D Each chlorine atom causes one ozone molecule to decompose.

34 The fractions obtained from the fractional distillation of petroleum mainly contain alkanes.

Which of the following molecules are most likely to be found in kerosene, naphtha and diesel oil respectively?

	kerosene	**naphtha**	**diesel oil**
A	C_8H_{18}	$C_{13}H_{28}$	$C_{20}H_{42}$
B	C_8H_{18}	$C_{20}H_{42}$	$C_{13}H_{28}$
C	$C_{13}H_{28}$	C_8H_{18}	$C_{20}H_{42}$
D	$C_{20}H_{42}$	C_8H_{18}	$C_{13}H_{28}$

35 The general formula of alkanes is C_nH_{2n+2}.

Which property decreases as n increases?

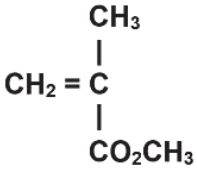
- **A** boiling point
- **B** flammability
- **C** melting point
- **D** viscosity

36 Linoleic acid is found in sunflower oil. The molecular formula of linoleic acid is $C_{18}H_{32}O_2$.

How many double bonds between carbon atoms are present in one molecule of linoleic acid?

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

37 In an artificial hip joint, bone cement is used to attach the poly(ethane) cup for the joint to the pelvic girdle. Bone cement is formed by the polymerisation of methyl 2-methylpropenoate and the process is highly exothermic.



$$\begin{array}{rl} & CH_3 \\ & | \\ CH_2 = & C \\ & | \\ & CO_2CH_3 \end{array}$$

methyl 2-methylpropenoate

Which statement is true about bone cement?

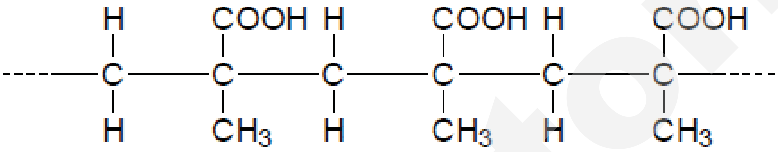
- **A** Aqueous bromine is decolourised by bone cement.
- **B** Less energy is released in the formation of C-C bond than the energy absorbed in the breaking of C=C bond.
- **C** The empirical formula of bone cement is $C_5H_8O_2$.
- **D** Water is formed in the polymerisation of methyl 2-methylpropenoate.

38 An ester is formed from a carboxylic acid and an alcohol.

How does the number of carbon, hydrogen and oxygen atoms in an ester differ from the total number of these atoms in the carboxylic acid and alcohol from which the ester is formed?

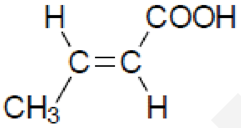
	carbon atoms	hydrogen atoms	oxygen atoms
A	fewer	fewer	fewer
B	fewer	same	fewer
C	same	fewer	fewer
D	same	same	same

39 The structure below shows a section of a polymer.

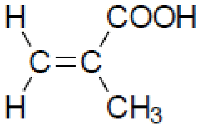


Which monomer was used to make the polymer?

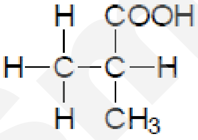
A



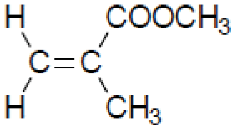
B



C

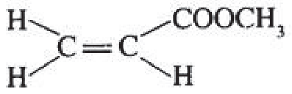


D

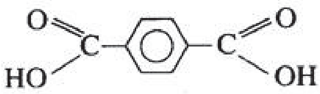


40 The following are monomers of a few compounds. Which of them can be used to produce a polymer via condensation polymerisation?

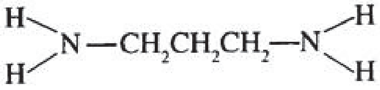
I



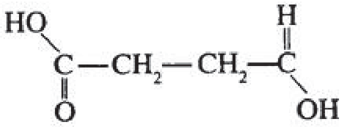
II



III



IV



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

End of paper 1

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanium 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 +															
			140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
			232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

*58-71 Lanthanoid series
+90-103 Actinoid series

Key

a **X** b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

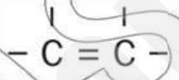
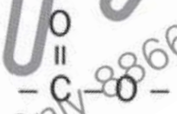
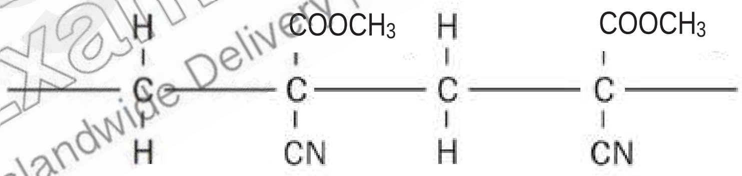
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Yishun Secondary School
Preliminary Examination 2019
Secondary 4 Express Chemistry (6092)
Mark Scheme

Paper 1

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

Paper 2

Qn no.	**Key marking points**	**Remarks**
A1a	iron(III) oxide;	
b	nitric acid;	
c	iron(III) nitrate;	
d	iron(III) hydroxide;	
e	ammonia;	
A2a	 carbon-carbon double bond;  ester;	
b	Addition polymerisation;	
c		
d	Poly(methyl cyanopropenoate);	
ei	Red brown; aqueous bromine turns colourless;	
ii	Addition reaction / addition of aqueous bromine / bromination;	
A3a	H_2A (aq) + 2 NaOH (aq) → Na_2A (aq) + 2 H_2O (*l*) Correct equation; Correct state symbols;	
b	$\frac{(25/1000)\ X\ 0.02}{V\ X\ 0.05} = \frac{1}{2}$; $V = 20\ cm^3$;	

<table>
<tr><td>ci</td><td><table><tr><td></td><td>carbon</td><td>hydrogen</td><td>oxygen</td></tr><tr><td>mass (in 100g)</td><td>26.7</td><td>2.2</td><td>71.1</td></tr><tr><td>no of moles</td><td>2.225</td><td>2.2/1 = 2.2</td><td>4.44</td></tr><tr><td>lowest ratio</td><td>1</td><td>1</td><td>2</td></tr></table>working;
Empirical formula of oxalic acid = CHO_2 ;</td><td></td></tr>
<tr><td>ii</td><td>n (12 + 1 + 32) = 90
n = 2
molecular formula of oxalic acid = $C_2H_2O_4$;</td><td></td></tr>
<tr><td>d</td><td>mass of oxalic acid in one star fruit = 0.00011 X 90 = 0.0099 g
maximum amount of serving = 0.05 g/0.0099 g = 5;</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A4ai</td><td>methoxybutane ;
$CH_3OC_4H_9$;</td><td></td></tr>
<tr><td>ii</td><td>isomers

with the same number of carbon, both the alcohol and ether has the same molecular formula ;</td><td>no marks given without comparison</td></tr>
<tr><td>iii</td><td>298;</td><td></td></tr>
<tr><td>bi</td><td>same general formula of $C_nH_{2n}O$ / $C_nH_{2n+1}CHO$;
same functional group of –CHO;</td><td>must make ref to the table</td></tr>
<tr><td>ii</td><td>butanal ;
any temp between 70 – 80°C (midpoint of 49°C & 103°C);</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A5a</td><td>the photograph is unlikely to show deposits of pure rubidium / hoax

Rubidium is a highly reactive metal /more reactive than sodium ;
so will react violently when exposed to air / water ;</td><td>no mark without explanation</td></tr>
<tr><td>b</td><td>Beryllium is less reactive than magnesium ;
no reaction with cold water / reacts very much slower than magnesium with water ;
react with steam to form beryllium oxide and hydrogen gas ;</td><td></td></tr>
<tr><td>c</td><td>reduction by carbon / carbon monoxide ;</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A6a</td><td>Oxidation state(O.S) of N increases from -2 in N_2H_4 to 0 in N_2, and O.S of O decreases from 0 in O_2 to -2 in H_2O ;
N_2H_4 is oxidised while O_2 is reduced ;</td><td>or using any definition of [O] or [R]</td></tr>
<tr><td>b</td><td>$N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$;
ΔH = -1179 kJ/mol ;</td><td>ΔH must be negative</td></tr>
<tr><td>c</td><td>hydrazine and fluorine is a better rocket fuel

any 2 of the following reasons:
(produces larger volume of gases and more thrust, 5 moles of gases compared to hydrazine and oxygen which produces 3 moles of gases ;)
amount of energy produced per mole by the fluorine mixture is more / is a more energy efficient fuel ;
does not use oxygen as a reactant;
more energy release, causing a larger increase in the volume of gases;</td><td>no mark without reasons</td></tr>
<tr><td>d</td><td>reaction of hydrazine with fluorine produces HF which is acidic compared to water which is neutral ;
HF is likely to cause acid rain which is harmful to the environment and aquatic life ;</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

<table>
<tr><td>A7a</td><td>atoms of the same element with the same number of protons but different number of neutrons / nucleon number ;</td><td></td></tr>
<tr><td>b</td><td>
<table>
<tr><th>Name</th><th>Formula</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th></tr>
<tr><td>Hydrogen atom</td><td>$^{1}_{1}H$</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>Deuterium ion</td><td>$^{2}_{1}H^{+}$</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>Tritium ion</td><td>$^{3}_{1}H^{-}$</td><td>1</td><td>2</td><td>2</td></tr>
</table>

3m – all correct; 2m – 3 to 4 correct; 1m – 1-2 correct;</td><td></td></tr>
<tr><td>c</td><td>Ar of Ge = ((24.4/100) x 70) + ((32.4/100) x 72) +((43.2/100) x 74) ;
= 72.4 (3sf) ;</td><td></td></tr>
<tr><td>d</td><td>Agree
all isotopes of the same element have same number of valence electrons ;</td><td>no mark if no reason given</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>B8a</td><td>reaction is not reversible ;</td><td></td></tr>
<tr><td>b</td><td>endothermic reaction causes the temperature to decrease ;
at a higher temperature of 450 °C, the reaction shifts to the right to increase the concentration of products and decrease concentration of reactants; ;</td><td></td></tr>
<tr><td>c</td><td>1.01 mol/dm^{3};</td><td>3 s.f.</td></tr>
<tr><td>d</td><td>higher temperatures would shift reaction in favour of forming the reactants, lowering yield;
at lower temperatures rate of reaction is slower;</td><td>accept: high cost to maintain high temperature</td></tr>
<tr><td>e</td><td>high yield of sulfur trioxide without increasing pressure /
increase in pressure would be expensive (for marginal increased yield) ;</td><td></td></tr>
<tr><td>f</td><td>Reaction 1 – graph B
Vr = Vp ;
Reaction 2 – graph A
Vr > Vp ;</td><td>both graphs must be correct
accept: moles of gas / molecules of gas as an alternative to volume</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>B9</td><td>$2NiS + 3O_2 \rightarrow 2NiO + 2SO_2$;</td><td></td></tr>
<tr><td></td><td>no. of moles of NiS= $\frac{182000}{59+32}$ =2000 mol ;
2000 x (32 +16x2) = 128 kg ;</td><td></td></tr>
<tr><td>b</td><td>simple covalent molecule/ simple molecular structure with weak intermolecular bonds/FOA ;
low boiling point;</td><td></td></tr>
<tr><td>c</td><td>with zinc nitrate - no reaction;
with copper(II) nitrate - blue solution turned green;
nickel coated with pink solid;</td><td></td></tr>
<tr><td>d</td><td>magnesium is more reactive than carbon ;
thus manufacture by electrolysis (of its ore);</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Either</td><td>$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$</td><td></td></tr>
</table>

B10a	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ Mol of zinc = 0.488/65 = 0.00751 ; Mol of acid = 2.0 x 20.0/1000 = 0.04mol ; Zinc is the limiting reagent and will produce the same volume (180 cm^3) of hydrogen ;	
b	A – sulfuric acid, dibasic → due to twice the concentration of H^+ and higher rate; B – hydrochloric acid, due to lower concentration of H^+ and lower rate;	
c	C – sulfuric acid, as same gradient as A ; mol of hydrogen = 90/24000 = 0.00375 mass of zinc = 0.00375 x 65 = 0.244 g ; Or half the volume of hydrogen, therefore half the mass of zinc so 0.488/2 = 0.244 g ;	no mark if no calculation presented
di	zinc displaces copper from copper(II) sulfate to produce brown copper deposit ; less zinc reacts with acid to produce less hydrogen ;	
ii	Wrong copper(II) sulfate forms copper, but a catalyst should remain chemically unchanged after the reaction ;	no mark given without reason
Or B10a	sodium ethanoate + CH_3COONa ;	
b	From graph, volume of NaOH used = 20 cm^3 mole of NaOH = 20/1000 X 0.1 = 0.002mol ; 1 mole of CH_3COOH = 1 mole of NaOH conc of CH_3COOH = mole / vol = 0.002 / (20/1000) = 0.1 mol/dm^3 ;	
c	Methyl orange ; 'Step' occurs at pH 9, but methyl orange only changes colour between 3.1 to 4.4 / does not change colour at pH 9 ;	accept OWTTE
di	hydrochloric acid ionises/ dissociate completely while ethanoic acid ionises/ dissociate partially / hydrochloric acid is a strong / stronger acid while ethanoic acid is a weak / weaker acid ; so hydrochloric acid has a higher concentration / no of moles per unit volume of H^+ ions so frequency of effective collision increases ; thus time taken is shorter ;	
ii	Volume of NaOH = 10cm^3 and same shape ;	

ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY 4E

Candidate's Name	Class	Register Number

CHEMISTRY **6092/01**

23 September 2019
1 hour

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

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

Read the instructions on the Answer Sheet very carefully.

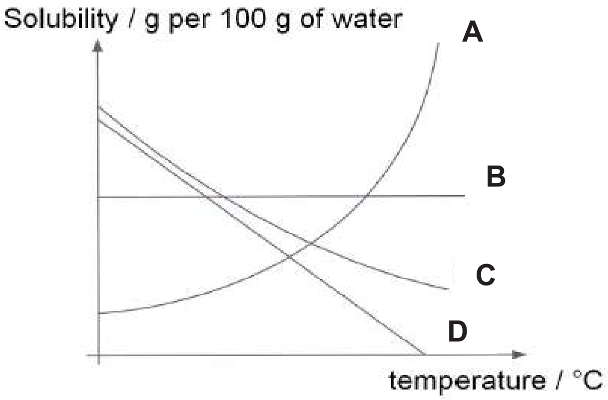
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 17.

Setter: Ms Ong Lay Hong
Vetter: Mrs Maybrie Ang and Ms Julia Yeo

This document consists of **17** printed pages, including this cover page.

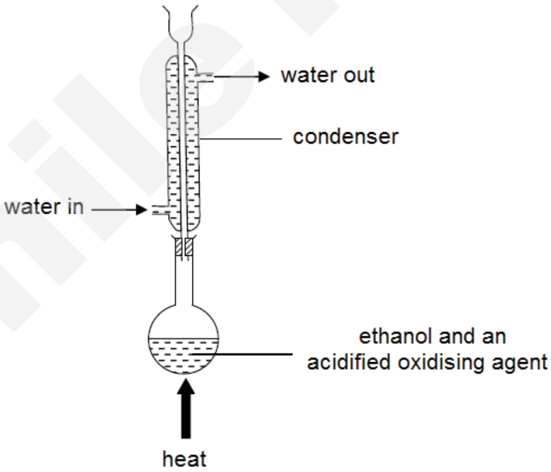
[Turn over

1 The solubility curves of four different substances **A** to **D** in water are shown below.
The solubility of a substance refers to the mass of substance that can dissolve completely in 100 g of water at a specific temperature to form a saturated solution.



Which substance is the most suitable to be collected by crystallisation from cooling its hot saturated aqueous solution?

2 The following apparatus is commonly used to oxidise ethanol to ethanoic acid



What is the purpose of the condenser?

A prevent air from oxidizing ethanoic acid formed

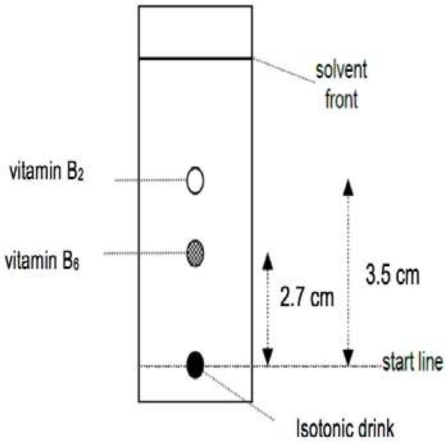
B prevent ethanoic acid from reforming back to ethanol

C prevent ethanol from being converted to ethene

D prevent the escape of any unreacted ethanol.

[Turn over

3 A sample of isotonic drink containing two water soluble vitamins was analysed using the method of chromatography with water as a solvent. The following chromatogram (*not drawn to* scale) was obtained.



Given that the R_f value of vitamin B_2 is 0.35, which of the following statements can be deduced from the chromatogram?

1 Isotonic drink is a mixture.
2 The solvent front is at 10 cm from the start line.
3 The R_f value of vitamin B_6 is 0.27
4 Vitamin B_6 is more soluble in ethanol than vitamin B_2.

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

4 Two elements, **X** and **Y**, have the electronic configurations 2.8.2 and 2.8.7 respectively. Which of the following statements describe the compound formed by **X** and **Y**?

1 It is soluble in water.
2 It has high melting and boiling point.
3 It has a crystal lattice structure similar to that of sodium chloride.
4 The elements in it can be separated by electrolysis of the aqueous mixture.

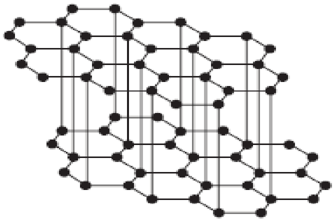
A 1 and 2
B 3 and 4
C 2, 3 and 4
D 1, 2, 3 and 4

[Turn over

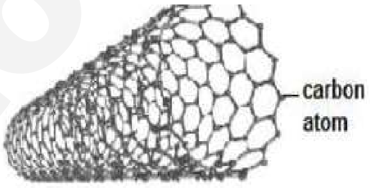
5 Element **A** forms an acidic, covalent oxide
Which row shows the possible number of electrons that could be present in the outer shell of an atom of **A**?

	1	2	6	7
A	√	√	x	x
B	√	x	√	x
C	x	x	√	√
D	x	√	x	√

6 Carbon can form different structures as shown in the diagram below. Which of these structures are able to conduct electricity?



1



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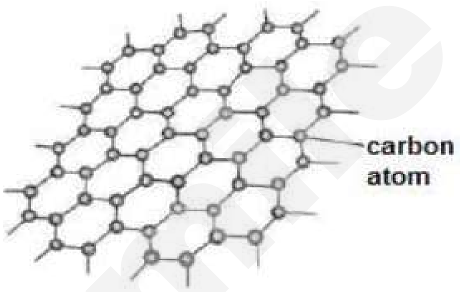

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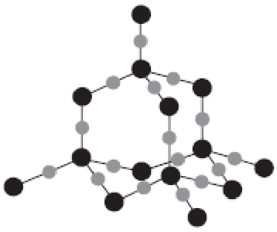


4

A 1 and 4

B 2 and 3

C 3 amd 4

D 1, 2 and 3

7 The formation of metallic chlorides involves the transfer of electrons from a metal atom to chlorine atoms.
Which of the metal atom in the metallic chloride below do not transfer exactly two moles of electrons to form the metallic chloride?

A barium chloride

B iron (II) chloride

C magnesium chloride

D sodium chloride

8 Hardness in tap water can be determined by titrating a sample of water against a reagent which reacts with dissolved metals ions. The indicator for this titration requires the pH to be maintained at about 10.

Which substances, in aqueous solution, could be used to maintain the pH at about 10?

A ammonia and ammonium chloride

B ammonia and sodium hydroxide

C sodium hydroxide and sodium ethanoate

D sodium hydroxide only

9 Gas **Y** is soluble in water. Its solution turns red litmus paper blue.

Which statement is not correct?

A A green precipitate is obtained when an aqueous solution of **Y** is added one drop at a time to aqueous iron(III) nitrate.

B A white precipitate is produced, which is soluble when an aqueous solution of **Y** is added one drop at a time to aqueous zinc nitrate.

C Gas **Y** could be made by warming ammonium nitrate with aqueous sodium hydroxide.

D Gas **Y** could be made by warming calcium nitrate with aqueous sodium hydroxide and powdered aluminium.

10 Barium sulfate which is used as a medical tracer is prepared by mixing two substances, **X** and **Y.**

Which row shows the best way to prepare pure barium sulfate?

	substance **X**	substance **Y**
A	aqueous barium nitrate	lead(II) sulfate
B	aqueous barium chloride	aqueous sodium sulfate
C	barium carbonate	dilute sulfuric acid
D	barium oxide	dilute sulfuric acid

11 A student added 12.5 cm^3 of 0.0500 mol/dm^3 sodium hydroxide to 25.0 cm^3 of 0.100 mol/dm^3 hydrochloric acid.

What is the concentration of hydrochloric acid remaining in the reaction mixture?

A 0.0333 mol/dm^3

B 0.0500 mol/dm^3

C 0.0667 mol/dm^3

D 0.0750 mol/dm^3

12 Iron(II) sulfate is a common nutritional supplement used in treating patient with iron-deficiency anaemia. The percentage of iron(II) sulfate present in one tablet of this supplement can be determined by dissolving 5.00 g tablet containing iron(II) sulfate in water with excess barium chloride solution.

After mixing, 2.89 g of barium sulfate is precipitated out, what is the percentage of iron(II) sulfate in the tablet?

A	18.9 %	**B**	37.7 %
C	42.2 %	**D**	57.8 %

13 In an experiment, 8.0 cm^3 of 1.0 mol/dm^3 aqueous copper(II) sulfate and 4.0 cm^3 of 1.0 mol/dm^3 aqueous sodium carbonate are mixed.

What does the reaction vessel contain once the reaction is completed?

A a colourless solution only

B a green precipitate and a blue solution

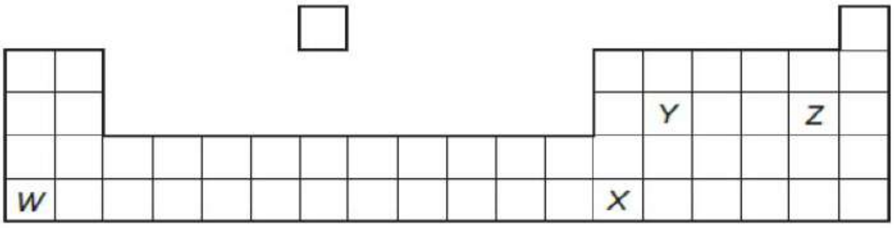
C a green precipitate and a colourless solution

D a white precipitate and a colourless solution

14 Metal **R** is more reactive than metal **S** which is more reactive than metal **T**.
The sulfates of **R** and **T** are colourless; the sulfate of **S** is blue.
Which observation is correct when a metal is added to a solution of sulfate?

	metal added	solution of sulfate	colour change
A	**R**	**S**	blue to colourless
B	**S**	**R**	colourless to blue
C	**S**	**T**	blue to colourless
D	**T**	**S**	blue to colourless

15 The diagram shows the positions of elements **W**, **X**, **Y** and **Z** in the Periodic Table. These letters are not the chemical symbols of the elements.



Which statement is not correct?

A **W** and **Z** could react together and form a compound, **WZ**

B **W** has a melting point that is lower than that of **Z**.

C **X** could form an oxide, $\mathbf{X_2O_3}$

D **Y** could form an oxide, $\mathbf{YO_2}$.

16 Which statement about metals and their compounds is not correct?

A Unreactive metals are likely to be found as elements in soil or rocks.

B Metals low in the reactivity series are generally extracted from their oxides by heating with carbon.

C Heating magnesium with iron(III) oxide produces iron and a white ash containing magnesium oxide.

D Higher temperature are needed to reduce copper(II) oxide to copper than are needed to reduce zinc oxide to zinc by hydrogen.

17 An underground water tank made of iron is joined to a copper pipe. Which of the following will occur?

A The corrosion of copper is faster.

B Electrons will flow from the iron to copper.

C Copper atoms will be oxidised to form copper(II) ions.

D A chemical cell will be formed with the copper pipe acting as the negative terminal.

[Turn over

18 **P**, **Q** and **R** are elements found in Group VII of the Periodic Table. Three experiments were carried out to determine the reactivity of **P**, **Q** and **R**.
The three reactions are represented by the three equations shown below.

1 $\mathbf{R}^-(aq) + \mathbf{Q}_2(aq) \rightarrow$ no reaction
2 $\mathbf{P}^-(aq) + \mathbf{R}_2(aq) \rightarrow$ no reaction
3 $2\mathbf{Q}^-(aq) + \mathbf{P}_2(aq) \rightarrow \mathbf{Q}_2(aq) + 2\mathbf{P}^-(aq)$

Which statement about **P**, **Q** and **R** is correct?

A $\mathbf{P}_2$ is a solid at room temperature.

B $\mathbf{R}_2$ is a stronger oxidising agent than $\mathbf{Q}_2$.

C Aqueous H**Q** turns red litmus paper blue.

D $\mathbf{P}_2$ is a reducing agent for reaction 3.

19 In which equation(s) is nitrogen being reduced?

1 $HNO_3\ (aq) + NH_4OH\ (aq) \rightarrow NH_4NO_3\ (aq) + H_2O\ (l)$
2 $4NO_3^-\ (aq) + 5CH_2O\ (l) + 4H^+\ (aq) \rightarrow 2N_2\ (g) + 5CO_2\ (g) + 7H_2O\ (l)$
3 $2NO_3^-\ (aq) + 4H^+\ (aq) + Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2NO\ (g) + 2H_2O\ (l)$

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

20 In which reactions are reduction taking place?

1 the formation of iron from hematite in the blast furnace
2 the manufacture of ammonium sulfate from aqueous ammonia and sulfuric acid.
3 the manufacture of margarine from vegetable oil
4 a reaction of acidified potassium dichromate(vi) in which colour changes from orange to green

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

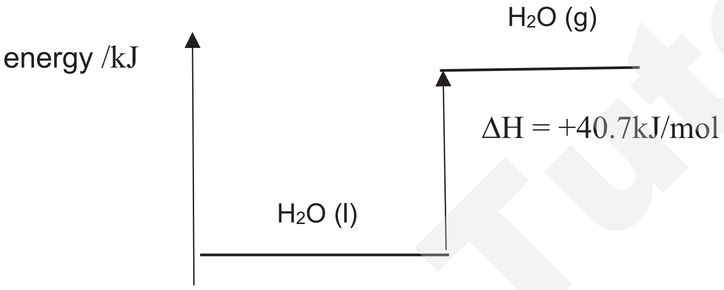
21 Bismuth(III) oxychloride is dissolved in concentrated hydrochloric acid to give a colourless solution of bismuth(III) chloride.

$BiOCl(s) + 2HCl(aq) \rightarrow BiCl_3(aq) + H_2O(l)$; $\Delta H = -132$ kJ/mol
The activation energy for the forward reaction is 45 kJ/mol.

Addition of water re-forms the bismuth(III) oxychloride as a white precipitate.
What is the activation energy for the reverse reaction?

A -45 kJ/ mol
B 87 kJ/ mol
C -87 kJ/mol
D 177 kJ/mol

22 The following diagram shows the energy changes associated with one stage of the heating of water under atmospheric pressure.



Which of the following statements about this system are correct?

1 The conversion $H_2O(l)$ to $H_2O(g)$ is exothermic.
2 When 18 g of steam at 100°C condense to water at 100°C, 40.7 kJ of energy is given out.
3 Water at 100°C has particles further apart than steam at 100°C.
4 Steam at 100°C contains more energy than the same mass of water at 100°C.

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

23 When aqueous potassium iodide is added to hydrogen peroxide, the following reactions are observed.

$$H_2O_2(aq) + I^-(aq) \rightarrow IO^-(aq) + H_2O(l)$$
$$H_2O_2(aq) + IO^-(aq) \rightarrow I^-(aq) + H_2O(l) + O_2(g)$$

There is a vigorous reaction and energy is liberated very rapidly, leading to a rise in temperature of the reaction mixture.
What is the role of aqueous potassium iodide in the overall reaction?

A as a base
B as a catalyst
C as a reducing agent
D as an oxidising agent

[Turn over

24 Aqueous hydrogen peroxide decomposes according to the following equation.

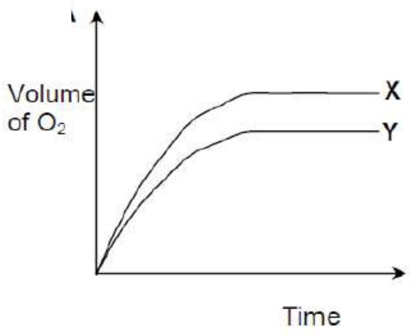
$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Two experiments were carried out to measure the rate of production of oxygen from aqueous hydrogen peroxide. The results are given below.

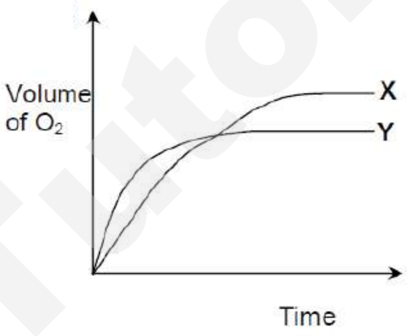
experiment	solution used
X	100 cm^3 of 2 mol/dm^3 H_2O_2
Y	mixture of 100 cm^3 of 2 mol/dm^3 of H_2O_2 and 50 cm^3 of 0.5 mol/dm^3 H_2O_2

Which graph best shows the results of the two experiments?

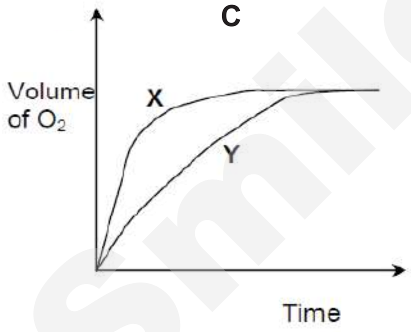
A



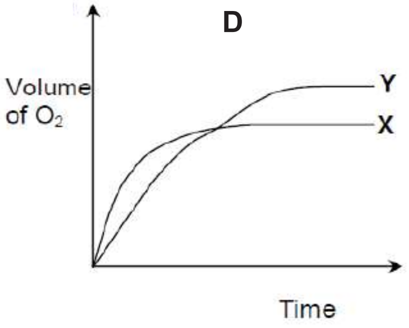
B



C



D

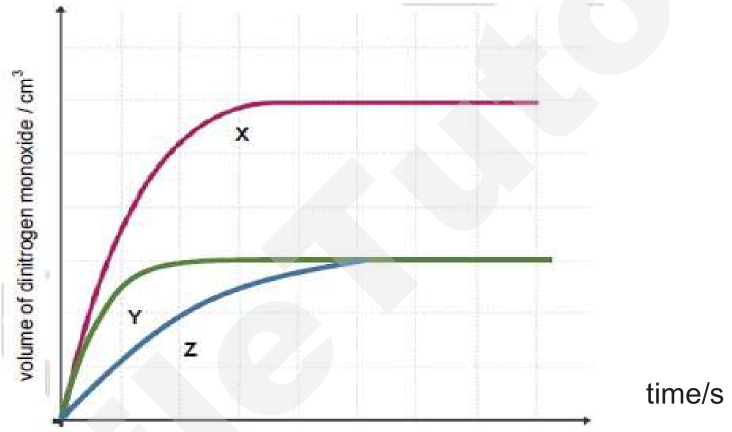


25 Sulfamic acid, H_2NSO_3H, is used as an acidic cleaning agent. It reacts with dilute nitric acid to produce the gas dinitrogen monoxide, N_2O.

$$H_2NSO_3H + HNO_3 \rightarrow N_2O + H_2O + H_2SO_4$$

Three experiments were performed using a fixed concentration and volume of sulfamic acid but with varying concentrations and volumes of dilute nitric acid. The total volume of the dinitrogen monoxide evolved was recorded against time.

experiment	concentration of HNO_3/ mol/dm^3	volume of HNO_3 /cm^3
1	2.0	50
2	1.0	100
3	2.0	100



Assuming that sulfamic acid is in excess, which of the curves **X**, **Y** and **Z** in the graph above relate to experiment 1, 2, and 3?

	1	**2**	**3**
A	**X**	**Y**	**Z**
B	**X**	**Z**	**Y**
C	**Z**	**X**	**Y**
D	**Y**	**Z**	**X**

26 In an experiment, 2 moles of aluminium ions, Al^{3+} were discharged in the electrolysis of molten aluminium oxide.

Which amount of metal ions would be discharged by an equal amount of electricity in the following experiments?

A 2 mol of Cu^{2+}, in the electrolysis of aqueous copper(II) nitrate.

B 3 mol of Pb^{2+}, in the electrolysis of molten lead(II) bromide

C 3 mol of Ag^{+}, in the electrolysis of aqueous silver nitrate

D 6 mol of Zn^{2+}, in the electrolysis of aqueous zinc sulfate

27 Metal **P** can be obtained from its oxide by heating with carbon, and from its aqueous chloride by electrolysis.

Which metal is **P**?

A lead **B** copper

C silver **D** sodium

28 Three electrolytic cells are set up using inert electrodes.
The electrolytes used are listed below.

cell 1: concentrated aqueous potassium chloride
cell 2: dilute sulfuric acid
cell 3: molten magnesium oxide

In which of these cell(s) is/are gases formed at both electrodes?

A 2 only **B** 3 only

C 1 and 2 **D** 2 and 3

29 During the electrolysis of an aqueous solution of a molybdenum salt, 24 g of molybdenum (Ar of Mo = 96) is deposited at the cathode by 1.5 moles of electrons.

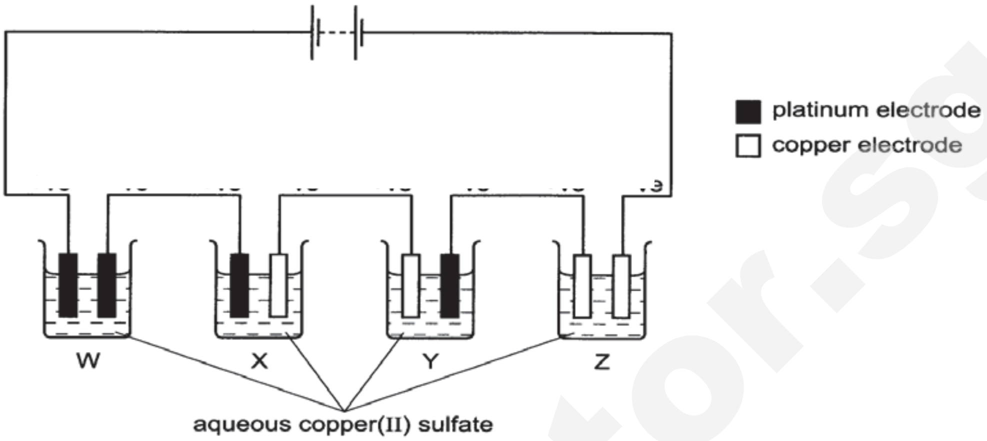
What is the formula of the molybdenum ion?

A Mo^{+} **B** Mo^{3+}

C Mo^{4+} **D** Mo^{6+}

[Turn over

30 The circuit shown is set up and an electric current is passed through the four cells in series.
In which cells are the intensity of the blue colouration of the solution unchanged?



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

C X and Z **D** Y and Z

31 Which of the following reaction(s) produces greenhouse gases?

1 Cracking of C_9H_{20} to form 4 moles of ethene and another organic compound.
2 Heating potassium carbonate over a strong flame.
3 Passing of unburnt hydrocarbons through the catalytic converters.

A 2 only **B** 1 and 3

C 2 and 3 **D** 1, 2 and 3

32 A car burning lead-free fuel has a catalytic converter fitted to its exhaust. On analysis, its exhaust gases are shown to contain small quantities of nitrogen oxides.
What modifications would results in lower exhaust concentrations of nitrogen oxides?

1 An increase in the surface area of the catalyst in the converter.
2 An increase in the air-fuel ratio through the engine of the car.
3 A much higher temperature of combustion in the engine.

A 1 only **B** 2 and 3

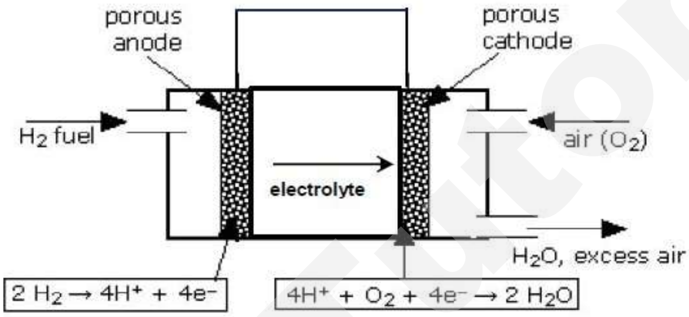
C 1 and 2 **D** 1, 2 and 3

33 Which of the following are true of the Haber Process?

1 Nitrogen is oxidised to form ammonia
2 The hydrogen is obtained from cracking of petroleum fractions.
3 Ammonia formed is condensed and obtained as liquid.
4 A high temperature will increase the yield of ammonia.

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

34 A diagram of the hydrogen-oxygen fuel cell is shown below.

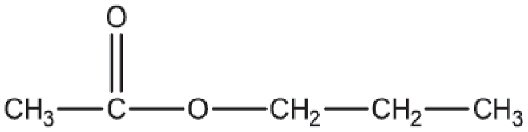


Which of the following are correct statements about the fuel cell?

1 Electricity is used to generate hydrogen and oxygen.
2 Electrons flow from the anode to the cathode in the electrolyte.
3 Hydrogen and oxygen undergo redox reactions to generate electricity.
4 The anode and cathode are the negative and positive electrodes respectively

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

35 Esters are sweet smelling substances found in fruits and flowers.
The following is the ester from pear.



$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-O-CH_2-CH_2-CH_3$$

Which of the following react together to form the above ester?

A	methanol and butanoic acid	**B**	propanoic acid and ethanol
C	ethanoic acid and propanol	**D**	methanoic acid and butanol

36 When iodine, I_2, reacts with an unsaturated compound, one molecule of iodine adds across each double bond.
Unsaturated fatty acids react similarly with iodine. 0.150 mol of a particular fatty acid reacts with exactly 0.300 mol of I_2.

What could the fatty acid be?

A	lauric acid	$CH_3(CH_2)_{10}COOH$
B	linoleic acid	$CH_3(CH_2CH{=}CH)_2(CH_2)_{10}COOH$
C	palmitoleic acid	$CH_3(CH_2)_5CH{=}CH(CH_2)_7COOH$
D	arachidonic acid	$CH_3(CH_2CH{=}CH)_4(CH_2)_6COOH$

37 The chemical formulae of four organic compounds are listed below.

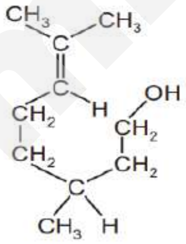
1 $H_2C{=}CH(COOCH_3)$
2 $HOOC(CH_2)_3COOH$
3 $NH_2CH_2CH_2CH_2COOH$
4 $H_2NCHClCHClNH_2$

Which two compounds can undergo self-polymerisation to form a polymer?

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

38 A student carried out some test on citronella, a compound which is found in rose oil.

The structure formula of citronella is shown below.



Which of the following statements about citronella are correct?

1 Aqueous bromine was decolourised when citronella was added to it.
2 Effervescence observed when sodium carbonate was reacted with citronella.
3 Citronella turns aqueous acidified potassium manganate(VII) from purple to colourless.
4 A sweet smelling smell was detected when citronella was heated with a mixture of methanoic acid and concentrated sulfuric acid.

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

39 Petroleum can be separated into fractions by fractional distillation.
Which statement about this process is not correct?

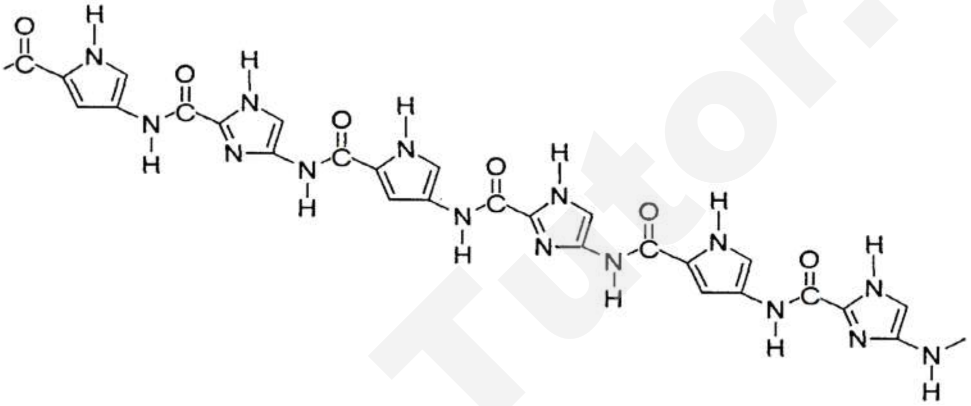
A The lubricating oil fraction is a source of polishes and waxes.

B The fraction obtained at the top of the fractionating column has the highest boiling point.

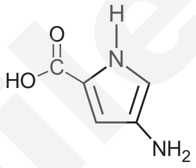
C In a fractionating column, the bitumen fraction is obtained below the kerosene fraction.

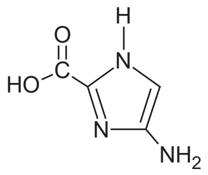
D The molecules reaching the top of the column have the smallest relative molecular mass.

40 The structure below shows part of a polymer.
Which one of the following show the correct monomers?



A





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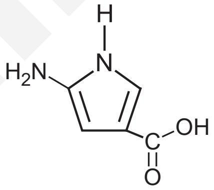
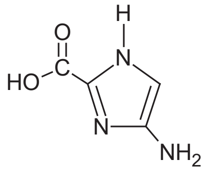
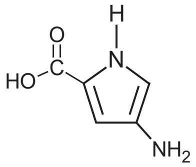
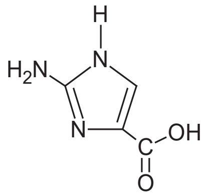


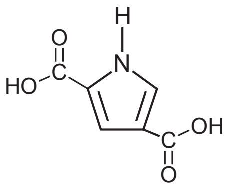


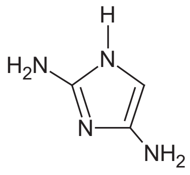
C





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		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 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* 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 T*l* 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 F*l* 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.).

ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY 4E

Candidate's Name	Class	Register Number

CHEMISTRY

6092 /02

16 September 2019
1 hour 45 minutes

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper

Section B

Answer all **three** questions, the last question is in the form either/or.

Write your answers in the spaces provided.

You are advised to spend no longer than one hour on **Section A** and no longer than 45 minutes on **Section B**.

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.

All essential working must be shown clearly.

A copy of the Periodic Table is printed on page 22.

For Examiner's Use	
Section A	**50**
B8	**10**
B9	**10**
B10	**10**
Total	**80**

Setter: Ms Julia Yeo
Vetter: Ms Ong Lay Hong & Mrs Maybrie Ang

This document consists of **22** printed pages, including this cover page.

Section A

Answer **all** questions in the spaces provided below.

The total marks for this section is 50.

A1 Choose from the following solutions to answer the questions below.

$CuSO_4$	KCl	$K_2Cr_2O_7$	KI
$KMnO_4$	$MgSO_4$	NH_3	$ZnSO_4$
$Al(NO_3)_3$	$AgNO_3$	NH_4NO_3	$NaNO_3$

Each solution can be used once, more than once, or not at all.

Write the formula for a solution which

(a) reacts with an acid to produce a fertiliser.

.... [1]

(b) turns colourless when sulfur dioxide is bubbled through it.

.... [1]

(c) is used to test for an oxidising agent.

.... [1]

(d) reacts with magnesium strips to give a pink-brown solid.

.... [1]

(e) gives a white precipitate that dissolves in excess of sodium hydroxide and aqueous ammonia.

.... [1]

(f) reacts with lead(II) nitrate to give a bright yellow precipitate.

.... [1]

[Total: 6]

A2 Ammonia, NH_3, is a colourless, pungent-smelling gas which has been known to man from the beginning of record time. It is given off from urine such as that on a wet soiled nappy used by a baby.

The nitrogen-containing substance in urine is urea, $CO(NH_2)_2$ which reacts with water and decomposes by hydrolysis into ammonia and another colourless gas.

(a) Construct a balanced chemical equation for the hydrolysis of aqueous urea.

.... [1]

(b) Ammonia burns in pure oxygen to produce nitrogen and steam.

$4\ NH_3(g) + 3\ O_2(g) \rightarrow 2\ N_2(g) + 6\ H_2O(g)$

Explain in terms of oxidation state, whether the reaction is a redox reaction.

....

....

.... [2]

(c) The Haber process makes use of hydrogen and nitrogen to manufacture large scale amount of ammonia, NH_3 in the industry. Calculate the maximum mass of ammonia formed when 6 dm^3 of hydrogen reacts with 10 dm^3 of nitrogen if the percentage yield is 88%.

mass of ammonia = ... [3]

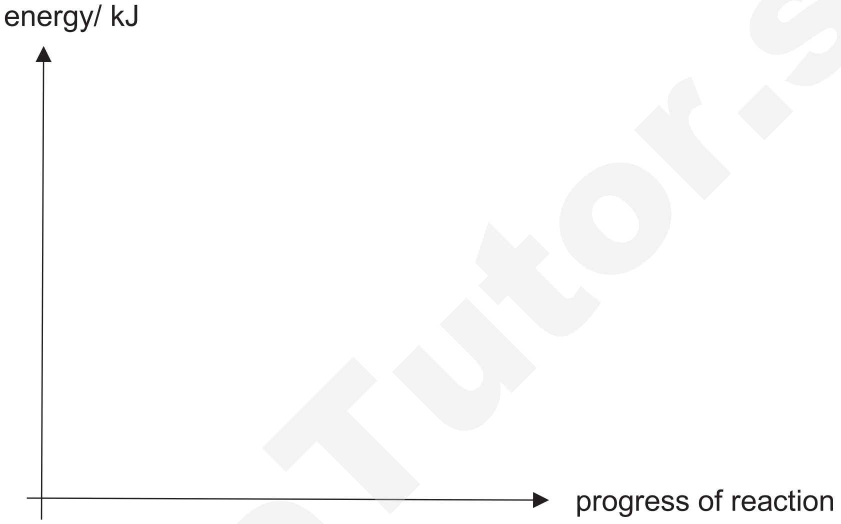
(d) When ammonia dissolves in water, the water feels cold.

$NH_3(g) + H_2O(aq) \rightleftharpoons NH_4OH\ (aq)$

Complete the energy profile diagram for this reaction.

Your diagram should include:

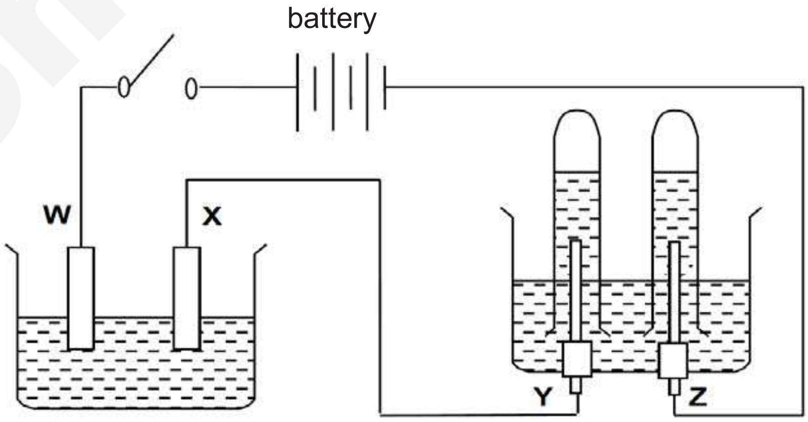
(i) the formulae of reactants and products.
(ii) labels to show activation energy and enthalpy change of the reaction.



[3]

[Total: 9]

A3 An experiment is carried out to electrolyse copper(II) sulfate solution and concentrated potassium chloride solution at the same time using inert electrodes.



Cell 1

copper(II) sulfate solution

Cell 2

concentrated potassium chloride solution + universal indicator

(a) State one visible change that can be observed on electrode **X**.

.... [1]

(b) Student **A** commented that the colour intensity of the blue copper(II) sulfate solution will start to fade away throughout the experiment in **Cell 1**.

Student **B** commented that there will be no changes in the colour intensity of the blue copper(II) sulfate solution throughout the experiment in **Cell 1**.

Which student is correct? Explain with the help of ionic half equations to support your answer.

....

....

....

.... [3]

(c) **(i)** Describe the colour change of the Universal Indicator during electrolysis of the concentrated potassium chloride solution in **Cell 2**.

.... [1]

(ii) Explain your observation in **(c)(i)**.

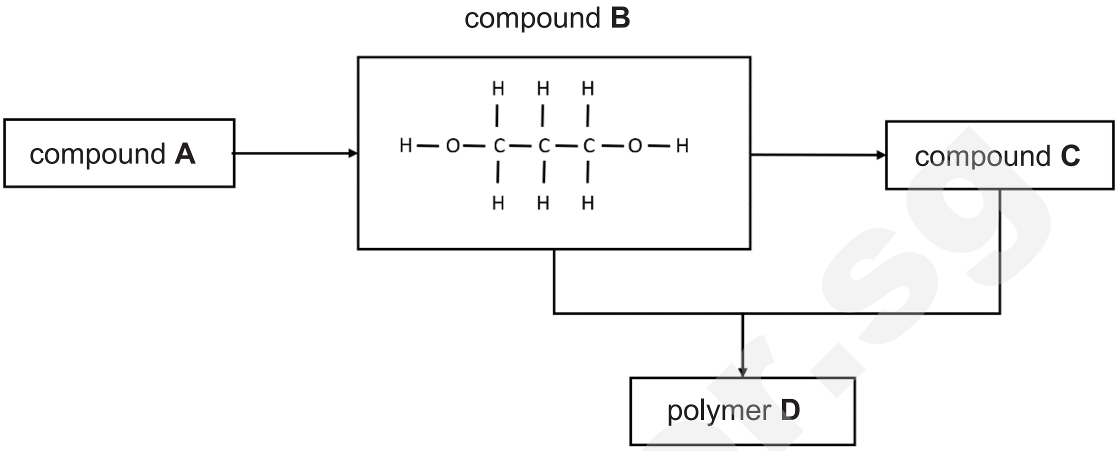
....

....

.... [2]

[Total: 7]

A4 The reaction scheme below shows compound **A** converted into compound **B**.



(a) One mole of compound **A** reacts with one mole of steam to form compound **B** at high temperature and pressure in the presence of a catalyst.

Draw the full structural formula of compound **A**.

[1]

(b) Compound **A** is an unsaturated organic compound. Describe a chemical test to show that it is unsaturated.

....

.... [1]

(c) Compound **A** can form an addition polymer. Draw two repeat units of this addition polymer.

[1]

(d) Compound **B** can be oxidised by acidified aqueous potassium manganate(VII) to form compound **C**. Draw the full structural formula of compound **C**.

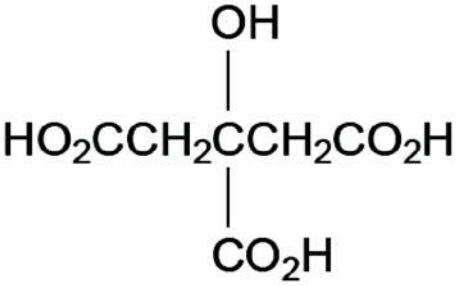
[1]

(e) Compound **B** and compound **C** can undergo condensation polymerisation to form polymer **D**. Draw a repeat unit of polymer **D**.

[1]

[Total: 5]

A5 **(a)** Unripe fruit often contains polycarboxylic acids, that is acids with more than one carboxylic acid functional group in their molecule. A citric acid organic molecule is shown below.



$$HO_2CCH_2\overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle CO_2H}{|}}{C}}CH_2CO_2H$$

Draw the full structural formula of the organic compound produced when citric acid is reacted with an excess of Na_2CO_3.

[1]

(b) Another polycarboxylic acid present in unripe fruit is a colourless crystalline solid, **W**, which has the following composition by mass:

C, 40.7%; H, 5.1%; O, 54.2%.

(i) Show that the empirical formula of **W** is $C_2H_3O_2$. Present your working clearly in a table.

[3]

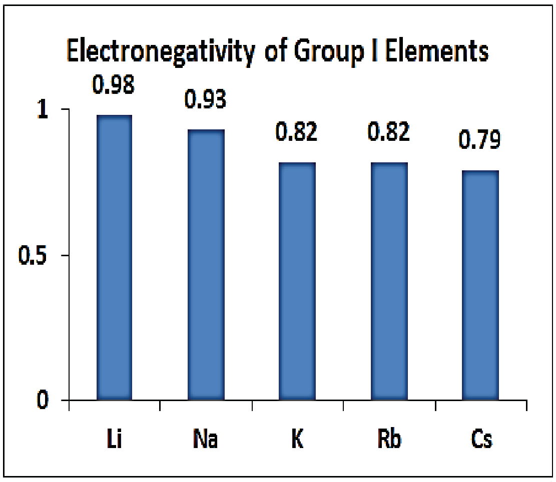
(ii) A sample of a compound **W** of mass 1.73 g and relative molecular mass of 118 was dissolved in water and the resulting solution was titrated with 1.00 mol/dm^3 NaOH. 29.40 cm^3 of NaOH was required for complete neutralisation.

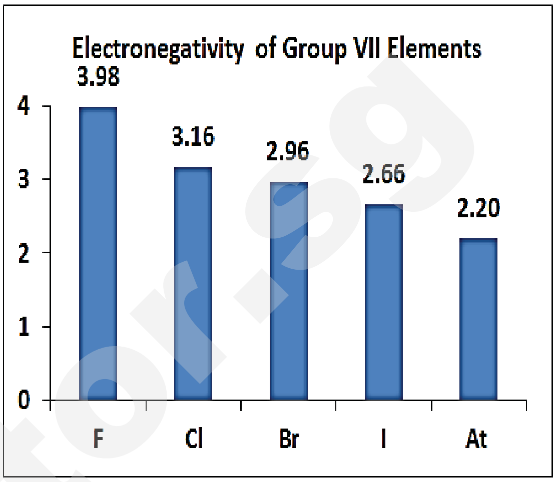
Deduce the number of carboxyl functional groups that are present in one molecule of compound **W**. Show your working clearly.

[2]

[Total: 6]

A6 Electronegativity refers to the ability of an atom to attract electrons and is otherwise known as ‘electron attracting’ power. The greater the electronegativity value of an atom, the greater is its ability to attract electrons and vice versa.
The diagram below shows the electronegativity of Group I and VII elements.





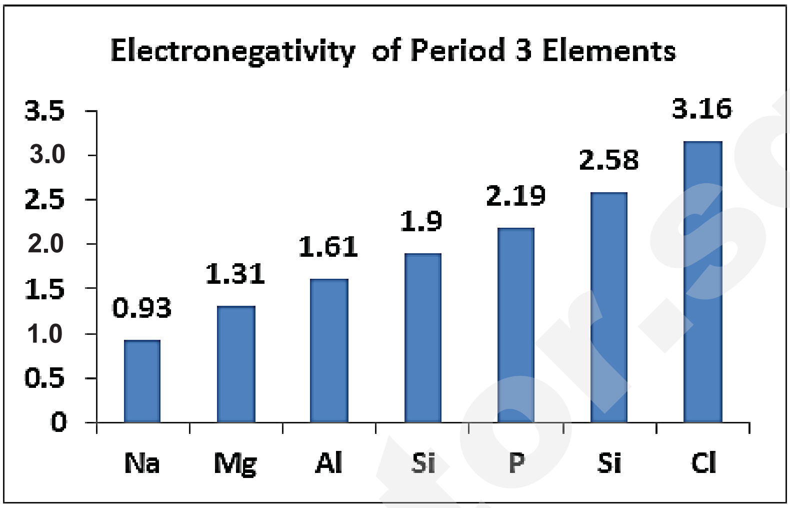
(a) Suggest why the electronegativity of fluorine is the highest among Group VII elements?

[2]

(b) Suggest why the electronegativity of Group I elements are very low.

[1]

(c) The diagram below shows the electronegativity across Period 3 elements with argon (Ar) being excluded. In addition, it is observed that the electronegativity increases across the period.



Explain why argon is excluded in illustrating the electronegativity across Period 3.

....

.... [2]

(d) With reference to all the diagrams above and the Periodic Table, state an element other than the noble gases, that is most likely to have the lowest electronegativity. Predict the value of electronegativity for the element that you have stated.

.... [2]

[Total: 7]

A7 In a series of experiments, different types of acid were added to powdered sodium carbonate. The acids added were hydrochloric acid (HCl), sulfuric acid (H_2SO_4) and phosphoric acid (H_3PO_4).

(a) Phosphoric acid is a weak acid. Define '*weak acid*'.

....

.... [1]

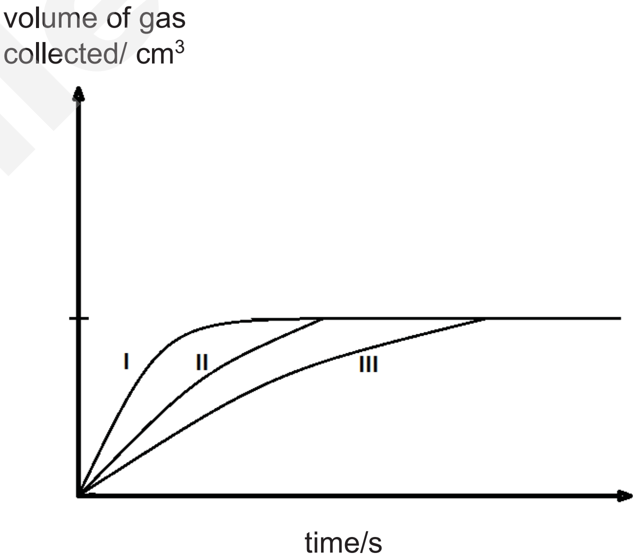
(b) Phosphoric acid is a weak tribasic acid. Write an ionic equation to show the ionisation of phosphoric acid.

.... [1]

(c) Different sodium salts can be formed by reacting sodium carbonate and phosphoric acid. Other than Na_3PO_4, suggest the chemical formula of two other salts formed from phosphoric acid and sodium carbonate.

.... [1]

(d) The graph below shows the volume of gas collected over a fixed period of time when the three different acids were added to powdered sodium carbonate. In all the experiments, three different acids of the same concentration and volume were added in excess to the same mass of sodium carbonate.



(i) In the table below, match the acids used to the curves labelled **I**, **II** and **III** obtained in the graph.

acid used	**curve**
HCl	
H_2SO_4	
H_3PO_4	

[1]

(ii) Using the collision theory, explain how the types of acid chosen in **(d)(i)** affect the rate of reaction as seen in the different curves.

....

....

....

....

....

....

.... [3]

(e) On the graph shown on the previous page, sketch the curve obtained when

(i) the mass of sodium carbonate added to sulfuric acid is doubled but in lump form. Label this curve as **IV**. [1]

(ii) sodium carbonate added to sulfuric acid is replaced with calcium carbonate of the same mass. Label this curve as **V**. [1]

(f) Describe briefly another method that can be used to monitor the rate of reaction.

....

.... [1]

[Total: 10]

Section B

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

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

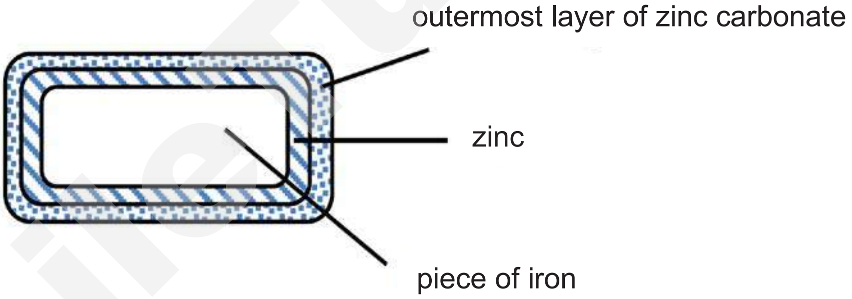
B8 Galvanisation is the process of coating the entire surface of a piece of iron with zinc to prevent it from rusting. The information below shows two common ways of galvanising iron. Either through hot-dip galvanisation or electro-galvanisation (electroplating an object with zinc).

Hot-dip galvanisation

The piece of iron to be galvanised is dipped into a molten bath of zinc at a temperature of around 460°C. The piece of iron is then cooled and exposed to the air. The outermost layer of zinc then reacts with oxygen and carbon dioxide in air as follows:

Reaction 1: Zinc reacts with oxygen to form zinc oxide
Reaction 2: Zinc oxide reacts with carbon dioxide to form zinc carbonate

The resulting iron piece looks like this:



Electro-galvanisation (electroplating an object with zinc)

The piece of iron to be galvanised and a piece of zinc are used as electrodes and dipped into an electrolyte containing a mixture of aqueous zinc cyanide [$Zn(CN)_2$] and aqueous sodium hydroxide at room temperature and pressure. An external electrical power supply is used. Zinc ions are discharged to form zinc atoms, which are coated onto the piece of iron.

Other facts about both types of galvanisation

Hot-dip galvanised iron	Electro-galvanised iron
Layer of zinc is coarse and thick.	Layer of zinc is smooth and thin.
Used to make alloy sheets for roofs.	Used to make bolts and nuts.

(a) A student made the following comment on galvanisation:

"Galvanising a piece of iron is more effective in preventing it from rusting than painting or greasing it." Use the information given and your knowledge to explain whether this comment is true.

[2]

(b) **In hot-dip galvanisation,**

(i) use the information given to write balanced chemical equations for reaction **1** and reaction **2.**

[2]

(ii) if 12.5 g of zinc carbonate were found on a piece of galvanised iron, calculate the mass of zinc which reacted to form this mass of zinc carbonate.

[2]

(c) **In electro-galvanisation,**

(i) use the information given to draw a clearly-labelled diagram of the experimental setup. In your diagram, label the piece of iron, the piece of zinc and the electrolyte.

[1]

(ii) some older processes of electro-galvanisation employ the use of dilute acids in the electrolyte instead of aqueous sodium hydroxide.

Explain what problem this could pose.

....

.... [1]

(d) From the information given, suggest one advantage and one disadvantage that hot-dip galvanisation has over electro-galvanisation.

....

....

....

.... [2]

[Total: 10]

B9 Read the following article on using artificial leaves to make hydrogen.

Gasoline comes mostly from fossil fuels which cause air pollution when they are processed.

Scientists are trying to find an alternative to gasoline that is cost-efficient and sustainable. Materials that work like leaves, called synthetic leaves, could be such an alternative. Plant leaves use sunlight to make their own food, which is glucose, a type of carbohydrate.

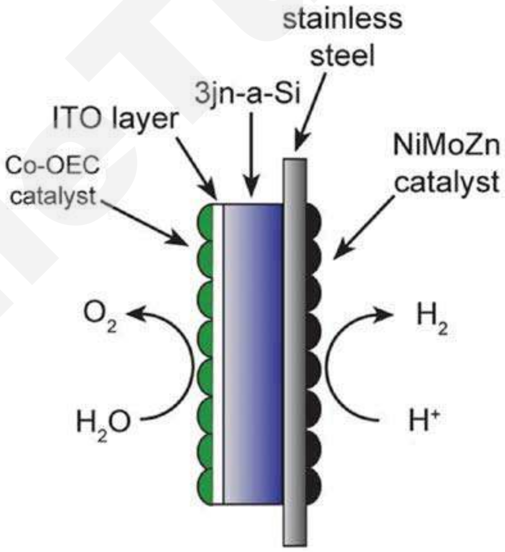
An artificial leaf would also use sunlight and water to create hydrogen and oxygen. The hydrogen created through this process could serve as a source of energy that would ultimately replace gasoline. When used as a car fuel, hydrogen combines with the oxygen in the air and releases energy along with water. The reaction is more exothermic compared to burning gasoline.

The artificial leaf below that Nate Lewis, a chemist at California Institute of Technology in Pasadena, and colleagues have developed consists of a membrane that produces hydrogen in two steps.

Step 1: Catalysts in the membrane help to form oxygen from water, releasing hydrogen ions and electrons.

Step 2: The electrons combine with hydrogen ions to form hydrogen gas as shown in the diagram below.

Artificial Leaf



The artificial leaf produced in Lewis' laboratory looks more like a small spherical structure than a leaf. Such small structures look like bubble wrap on the rooftop of a house.

The artificial leaf absorbs sunlight and water from the air. This material would generate hydrogen that could be collected into a tank and converted later into a fuel.

~ Sherry Karabin

Adapted and modified from ChemMatters, December 2012

(a) Processing crude oil often releases methane into the environment. State two effects that methane has on the environment.

....

....

.... [2]

(b) Describe with the help of a balanced chemical equation, how plant leaves make food for themselves.

chemical equation: ....

....

.... [2]

(c) Artificial leaves can be used to produce hydrogen gas for hydrogen fuel cell in the future. Describe how the current source of hydrogen gas is obtained and explain why it is unsustainable.

....

.... [2]

(d) Suggest two other advantages, other than cost, of using hydrogen as a fuel instead of gasoline.

....

....

.... [2]

(e) The artificial leaf functions as an electrolytic cell. Using information given, write the anode half equation and the overall cell equation.

anode half equation: ....

overall cell equation: .... [2]

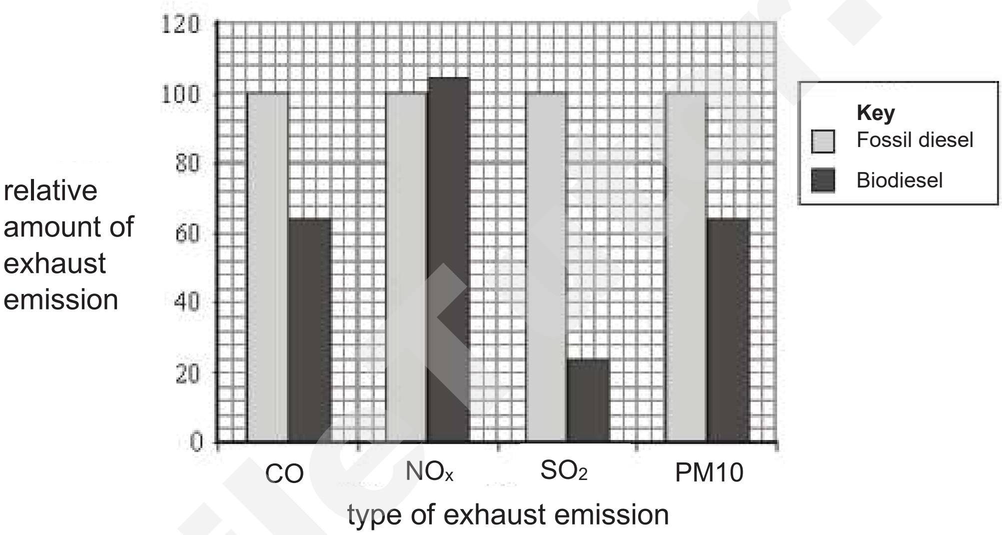
[Total: 10]

Either

B10 **(a)** Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.

Tiny particles of solids are produced when the fuel does not burn completely. This increases the level of particulates (PM10) in the atmosphere. These particles are small enough to pass through the throat and nose and enter the lungs.

One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels. Some of the relative amounts of these exhaust emissions are shown in the bar chart.



(i) Using the data given, compare the exhaust emission between fossil diesel and biodiesel.

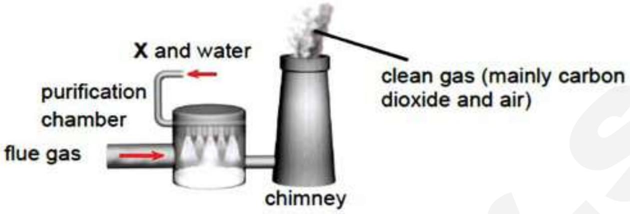
[2]

(ii) Explain why exhaust emissions from fossil diesel cause more harm to human health than those from biodiesel.

[2]

(b) Coal-burning power stations generate large amount of heat from the combustion of coal to convert water into steam which in turn drives turbine generators to produce electricity. Flue gas that is produced contains sulfur dioxide and oxides of nitrogen. These two gases cause acid rain.

Sulfur dioxide can be removed from the flue gases by several methods. One method uses a 'scrubber' that contains wet compound **X**.



(i) Identify compound **X** that is added to the purification chamber to remove sulfur dioxide. Write a balanced chemical equation to show how compound **X** removes sulfur dioxide.

.... [2]

(ii) Oxides of nitrogen generally consist of a mixture of nitrogen monoxide and nitrogen dioxide. In flue gas, nitrogen monoxide is the main component in the oxides of nitrogen produced. Explain how nitrogen monoxide cause acid rain even though it is a neutral oxide.

....

....

.... [2]

(iii) Acid rain impacts farming greatly as it often causes the soil to be overly acidic and results in the leaching of nutrients. In order to alleviate the effects of acid rain, a farmer has been advised to treat the soil to reduce the acidity.
The table below gives the solubility of some calcium compounds.

	calcium hydroxide	**calcium oxide**	**calcium carbonate**
Solubility in water (g per 100ml of water)	**0.173**	immediately reacts with water on contact to form an alkaline solution	**6.17 x 10^{-4}**

Using the information given in the table, suggest and explain why calcium carbonate is less effective at reducing acidity than calcium hydroxide and calcium oxide.

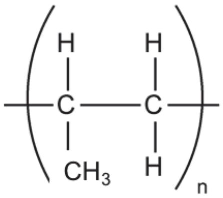
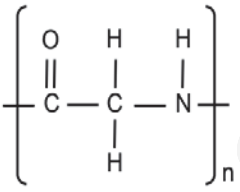
....

.... [2]

[Total: 10]

OR

B10 **(a)** Polymers have several uses, and can be found almost everywhere. Some information about two polymers are shown below.

name of polymer	**polypropene**	**polyglycine**
structural formula		
name of monomer	propene	glycine
average M_r	2000 – 4000	2000 - 5000

(i) Polyglycine is a polyamide, which is made by the condensation polymerization of the amino acid monomer, glycine. Draw the full structural formula of the monomer, glycine.

[1]

(ii) Describe one similarity and one difference between the structures of the addition polymer, polypropene, and the condensation polymer, polyglycine.

[2]

(iii) The condensation polymerisation of glycine to produce one molecule of polyglycine eliminates 990 g of water.

Calculate the relative molecular mass of this molecule of polyglycine, showing all your working (M_r of glycine is 75).

[2]

(b) When compound **A** (C_2H_6O), an alcohol, was heated with acidified potassium manganate (VII), an organic compound **B** was formed. When a mixture of **A** and **B** was heated in the presence of a catalyst, a sweet smelling liquid **C** was obtained.

(i) Draw the full structural equation for the reaction that occurs between **A** and **B**. Identify compound **A**, **B** and **C** and write their respective names next to their structural formula in the equation.

[3]

(ii) Compound **A** can be used as a car fuel. In some countries it is produced from the sugars in sugar cane.

An environmentalist makes a comment about using compound **A** as a fuel.

> Compound **A** as a fuel is 'carbon neutral' because using it does not add to the amount of carbon dioxide in the atmosphere.

Do you agree with the comment? Explain your reasoning.

....

.... [2]

[Total: 10]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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 –
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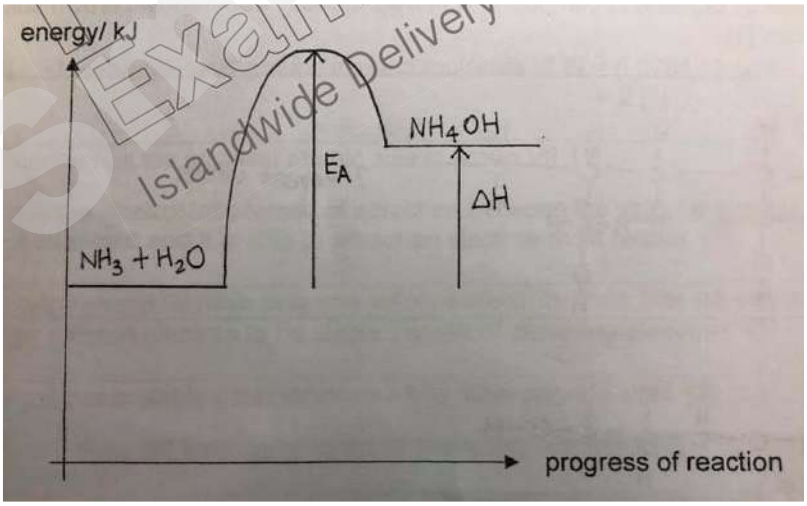
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
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 –

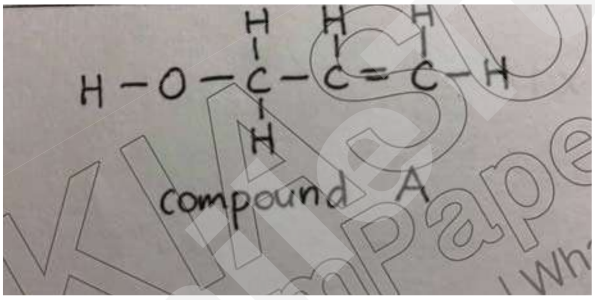
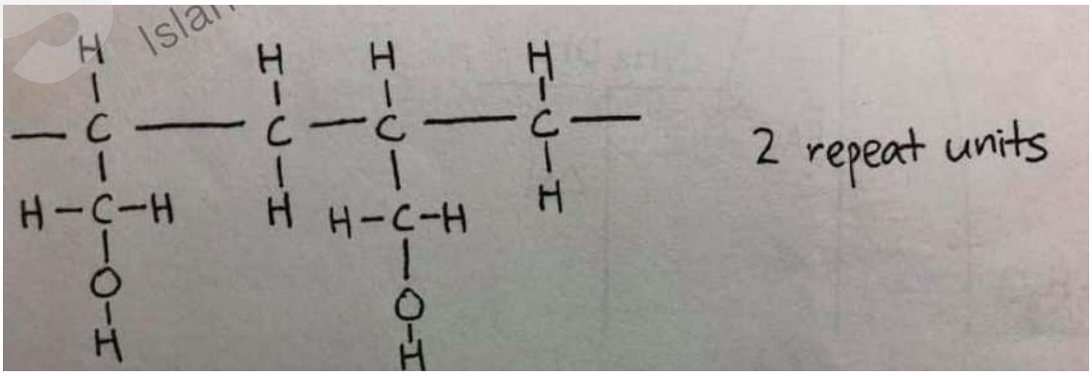
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Zhonghua Secondary School

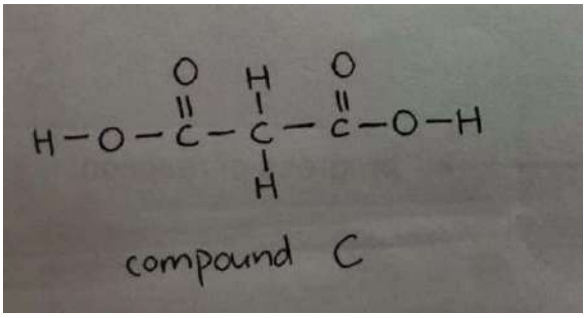
2019 Prelim 6092 Examination- Chemistry

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

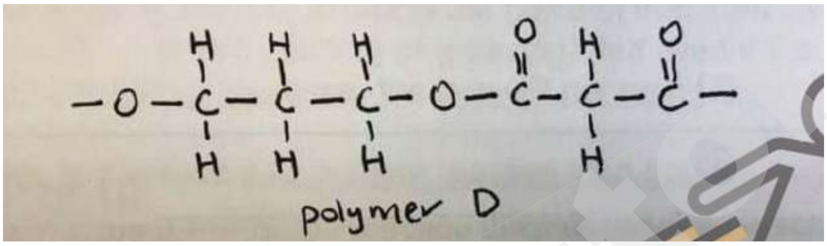
A1(a)	NH_3 [1]
(b)	$KMnO_4$ [1]
(c)	KI [1]
(d)	$CuSO_4$ [1]
(e)	$ZnSO_4$ [1]
(f)	KI [1]
A2 (a)	$CO(NH_2)_2 + H_2O \rightarrow 2NH_3 + CO_2$ [1]
(b)	Ammonia is oxidized to form nitrogen gas. Oxidation state of nitrogen increases from -3 in NH_3 to 0 in N_2. [1] Oxygen gas is reduced to form steam. Oxidation state of oxygen decreases from 0 in O_2 to -2 in H_2O. [1] Since oxidation and reduction take place, it is a redox reaction.
(c)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$ No of moles of $N_2 : H_2$ 1 : 3 2 : 6 Nitrogen is in excess, hydrogen is the limiting reactant. [1] Theoretical mass of ammonia = 6/24 x 2/3 x 17 = 2.83 g [1] Maximum mass of ammonia = 2.83 x 88% = 2.49 g [1] (3sf)
(d)	 [1] for E_A [1] for ΔH [1] for reactants and products

A3(a)	Reddish brown solid will be formed on X. [1]
(b)	Student A is correct. Cu^{2+} ions will be preferentially discharged at the cathode and reduced to form Cu. [1] Cu^{2+} (aq) + 2e $\rightarrow$ Cu(s) [1] Blue colour intensity fades away due to Cu^{2+} ions being removed from the electrolyte. [1]
(c)(i)	Green to violet/blue [1]
(ii)	Initially concentrated potassium chloride solution is neutral and universal indicator is green. Hydrogen ions will be preferentially discharged at the cathode to form hydrogen gas. Chloride ions will be preferentially discharged at the anode to form chlorine gas. [1] Thus the remaining electrolyte is potassium hydroxide, which is alkaline. Universal indicatior turns violet in the presence of an alkaline solution. [1]
A4(a)	
(b)	Add aqueous bromine to compound **A**. It decolourises from reddish brown solution to colourless. [1]
(c)	

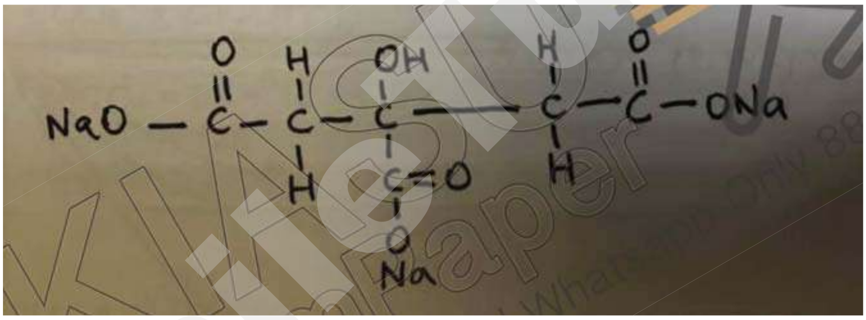
(d)



(e)



A5
(a)



(b)(i)

Element	C	H	O
Percentage	40.7	5.1	54.2
No. of moles	40.7/12 ≈ 3.39	5.1/1 =5.1	54.2/16 = 3.39
Simplest ratio	3.39/3.39 =1	5.1/3.39 =1.5	3.39/3.39 =1
	2	3	2

Correct table with values [2] marks

Empirical formula is $C_2H_3O_2$. [1]

(ii)

No. of moles of NaOH = 1 x (29.40/1000)
= 0.0294 mol
No. of moles of **W** reacted = 1.73/118
= 0.0146 mol [1]

No. of carboxylic acid groups in each molecule of **W** = 0.0294 / 0.0146
= 2 [1]

<table>
<tr><td>**A6**
(a)</td><td>Fluorine has the smallest atomic size in group VII. [1]

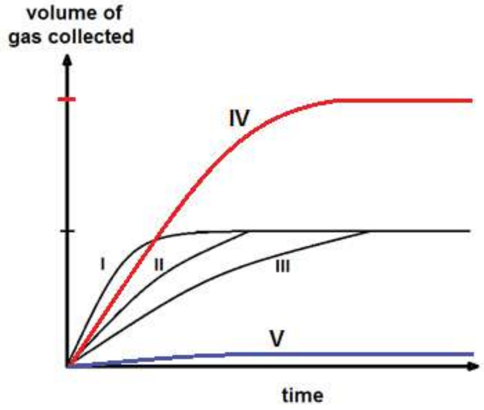
Thus the electrostatic forces of attraction between the valence electron and nucleus is the strongest and it is able to attract an electron most readily. [1]</td></tr>
<tr><td>(b)</td><td>Group I elements have only one valence electron. Thus they have tendency to lose their valence electron to be stable instead of attracting electrons. [1]</td></tr>
<tr><td>(c)</td><td>Argon has a stable octet structure / fully filled valence shell. [1]

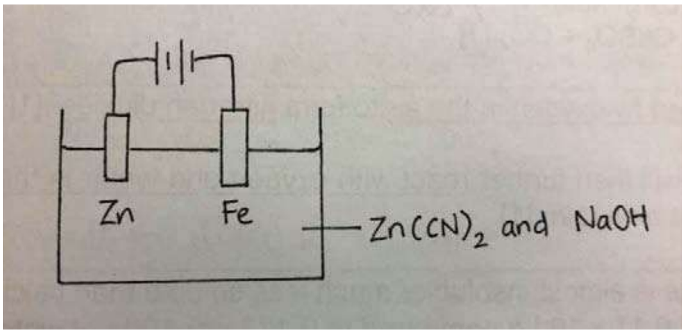
Thus it does not lose, gain/attract or share any electrons.[1]</td></tr>
<tr><td>(d)</td><td>Francium [1]

Range of value = 0.50 – 0.79 [1]</td></tr>
<tr><td>**A7**
(a)</td><td>Weak acids partially ionize to produce lower concentration of H^+ ions. [1]</td></tr>
<tr><td>(b)</td><td>$H_3PO_4\ (aq) \rightleftharpoons 3H^+\ (aq) + PO_4^{3-}\ (aq)$ /
$H_3PO_4\ (aq) \rightleftharpoons 2H^+\ (aq) + HPO_4^{2-}\ (aq)$/
$H_3PO_4\ (aq) \rightleftharpoons H^+\ (aq) + H_2PO_4^-\ (aq)$ [1]</td></tr>
<tr><td>(c)</td><td>NaH_2PO_4 and Na_2HPO_4 [1]</td></tr>
<tr><td>(d)(i)</td><td>
<table>
<tr><th>Acid used</th><th>Curve</th></tr>
<tr><td>HCl</td><td>II</td></tr>
<tr><td>H_2SO_4</td><td>I</td></tr>
<tr><td>H_3PO_4</td><td>III</td></tr>
</table>
All correct for [1] mark</td></tr>
<tr><td>(ii)</td><td>Both sulfuric acid and hydrochloric acid are strong acids. Sulfuric acid is a dibasic acid while hydrochloric acid is a monobasic acid. Thus, the experiment using sulfuric acid has a faster rate of reaction as compared to hydrochloric acid since the concentration of hydrogen ions is doubled compared to hydrochloric acid. [1]

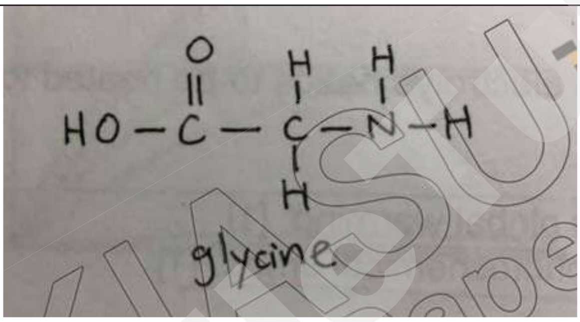
The experiment using phosphoric acid will have the lowest rate of reaction because the concentration of hydrogen ions in phosphoric acid is lowest among the three acids. [1]

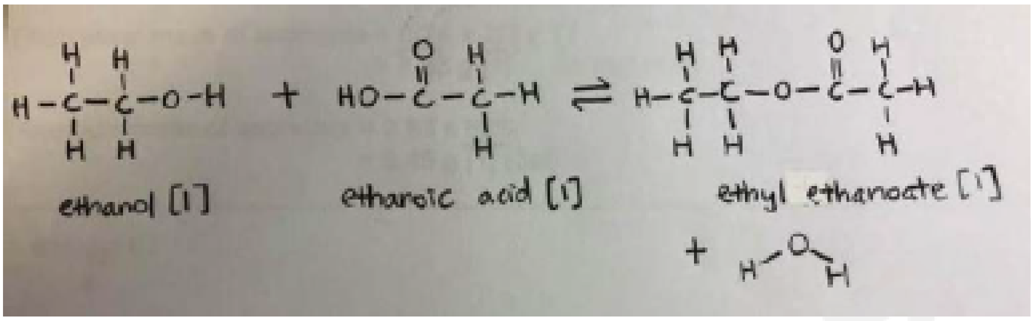
The higher the concentration of hydrogen ions per unit volume, the higher the frequency of effective collisions and the faster the rate of reaction. [1]</td></tr>
</table>

(e)	
(f)	Measure the mass of the reaction mixture using an electronic balance at fixed time intervals. [1]

B8 (a)	Galvanising not only protects the piece of iron from coming into contact with oxygen or water (just like painting or greasing), but even if the surface is scratched and the iron beneath is exposed, the iron will not rust. [1] This is because zinc is more reactive than iron and will corrode in place of iron. [1]
(b)(i)	$2Zn + O_2 \rightarrow 2ZnO$ [1] $ZnO + CO_2 \rightarrow ZnCO_3$ [1]
(ii)	Mr of $ZnCO_3$ = 65 + 12 + (16 x 3) = 125 No. of mol of $ZnCO_3$ = 12.5/125 = 0.1 mol [1] No. of mol of ZnO = 0.1 x 1 = 0.1 mol Mass of Zn = 0.1 x 65 = 6.5 g [1]
(c)(i)	

(ii)	The acids in the electrolyte may react with the iron and zinc electrodes. / H^+ ions from the electrolyte can be preferentially discharged to form H_2 gas. [1]
(d)	A piece of iron galvanised by hot-dip galvanisation is more durable / less likely to rust, as the layer of zinc is thicker. [1] However, it is more expensive/ more energy is needed as the electrolyte needs to be heated to 460°C to carry out galvanisation. [1]
B9 (a)	Methane is a greenhouse gas. It causes global warming. [1] Methane also leads to the formation of photochemical smog. [1]
(b)	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ [1] Plants take in carbon dioxide and water in the presence of sunlight to manufacture glucose. [1]
(c)	Hydrogen is currently obtained from cracking of petroleum. [1] Petroleum is a non-renewable source / depleting finite resource. [1]
(d)	Any 2 answers: Burning hydrogen does not produce any pollutants, it produces only water. [1] The reaction between hydrogen and oxygen is more exothermic, thus producing more energy than that of gasoline. [1] Hydrogen is a renewable resource. [1]
(e)	Anode equation: $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ [1] Overall equation: $2H_2O(l) \rightarrow O_2(g) + 2H_2(g)$ [1]
B10(a) (i) Either	The amounts of CO, SO_2 and PM10 emissions are lower when using biodiesel than fossil diesel. [1] On the contrary, the amount of NO_x exhaust emission is higher when burning biodiesel than fossil diesel. [1]
(ii)	There is more amount of CO produced. CO is a pollutant which binds with haemoglobin in red blood cells, reducing its ability to transport oxygen. This causes breathing difficulties and may even result in death. [1] There is more SO_2 produced. SO_2 irritate the eyes and lungs and causes breathing difficulties [1]

(b)(i)	CaO/ calcium oxide [1] $CaO + SO_2 \rightarrow CaSO_3$ [1] OR $CaCO_3$/ calcium carbonate [1] $CaCO_3 + SO_2 \rightarrow CaSO_3 + CO_2$ [1]
(ii)	NO will be oxidised by oxygen in the air to form nitrogen dioxide. [1] Nitrogen dioxide will then further react with oxygen and water in the air to form nitric acid which causes acid rain. [1]
(iii)	Calcium carbonate is almost insoluble/ much less soluble than calcium hydroxide, with a solubility of 6.17×10^{-4} g compared to 0.173 per 100g of water. [1] Thus $CaCO_3$ reacts slowly with acid/effective only in reducing acidity on the surface of the soil/ cannot penetrate the soil to neutralise acid deeper down. [1]
B10 (a)(i) Or	
(ii)	Similarity: Both polymers only require one type of monomer / both polymers have giant molecular structures. [1] Difference: Polypropene is a hydrocarbon while polyglycine is a non-hydrocarbon / polyglycine has amide linkage while polypropene is held together by C-C single bonds. [1]
(iii)	No of monomers = 990/18 = 55 [1] Mr of polyglycine = 55 x [75 – 16 – 2(1)] = 3135 [1]

(b)(i)	Compound A is ethanol, B is ethanoic acid and C is ethyl ethanoate. 
(ii)	The amount of carbon dioxide emitted during the combustion of ethanol [1] is balanced by the taking in of carbon dioxide by sugar cane during photosynthesis [1]. As there is no net gain in carbon dioxide, the environmentalist is correct.