Name: .....( ) Class: Sec .....

St. Gabriel's Secondary School

2017 'O' Preliminary Examination

Subject	:	**Chemistry**
Paper No	:	**5073/1**
Level/Stream	:	**4 Express**
Duration	:	**1 hour**
Date	:	**29 August 2017**

Additional material: *Multiple Choice Answer Sheet*

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

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

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 in soft pencil on the separate Answer Sheet provided.

Read the instructions on the Answer Sheet 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.

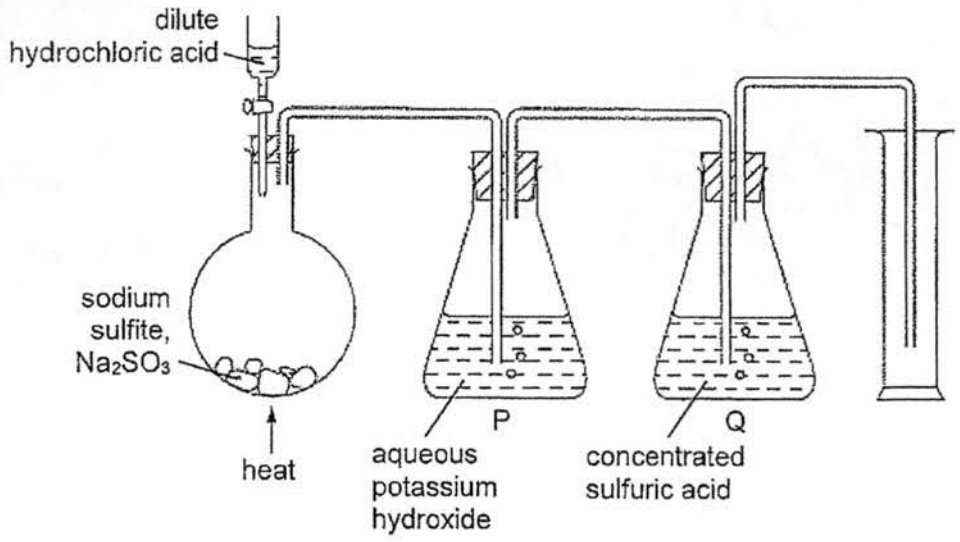
At the end of the examination, submit the Answer Sheet.

A copy of the Periodic Table is printed on page 17.

This question paper consists of **17** printed pages including this cover page.

[Turn over

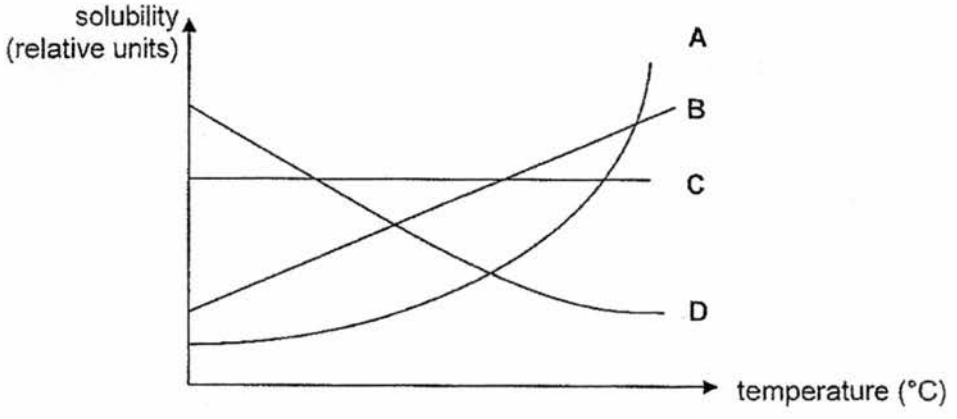
1 The apparatus shows an unsuccessful attempt to prepare and collect dry sulfur dioxide.



Which change would make the experiment successful?

A removing flask P containing aqueous potassium hydroxide
B removing flask Q containing concentrated sulfuric acid
C using upward delivery instead of downward delivery of gas
D using calcium oxide instead of concentrated sulfuric acid

2 The solubility curves for four solids, **A**, **B**, **C** and **D**, in water are shown below. Which solid is most suitable to be prepared by crystallisation from its aqueous salt?



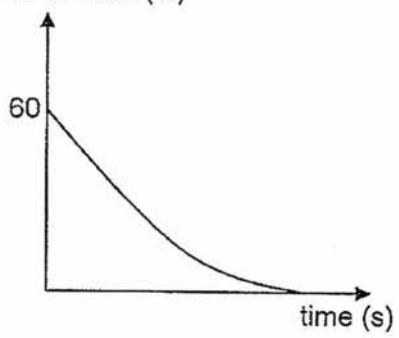
3 The table below shows the properties of some substances. Which substance has been wrongly classified as an element, compound or mixture?

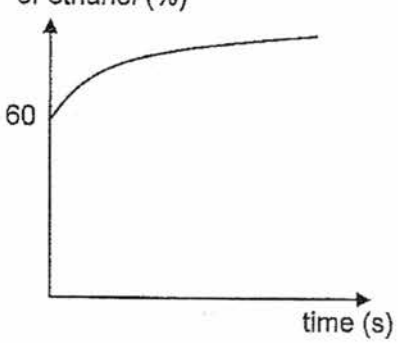
	property	classification
A	A white solid is formed when a silvery metal is burnt in air.	compound
B	Black powder burns in air to form a colourless gas.	element
C	Green powder on heating leaves a black residue and a colourless gas is evolved.	element
D	White solid melts over 45 °C to 50 °C.	mixture

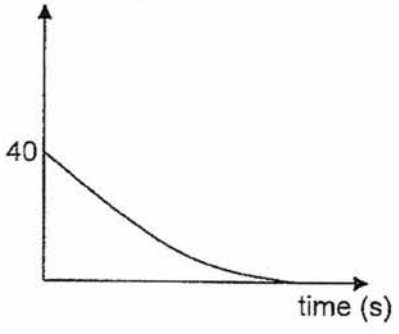
4 Most alcoholic drinks are composed primarily of water and ethanol, with some traces of impurities and flavourings. Alcoholic drink **X** is made up of 40% by volume of ethanol.

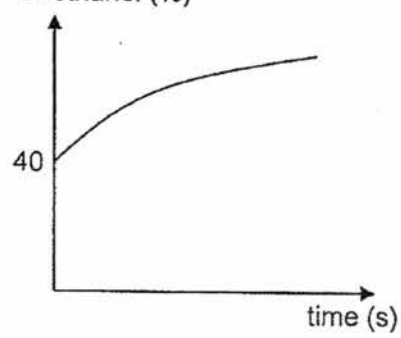
A sample of alcoholic drink **X** is distilled using fractional distillation. Boiling points of ethanol and water are 78 °C and 100 °C respectively.

Which graph shows the change in concentration of ethanol in the round-bottomed flask as the distillation proceeds?

A


B


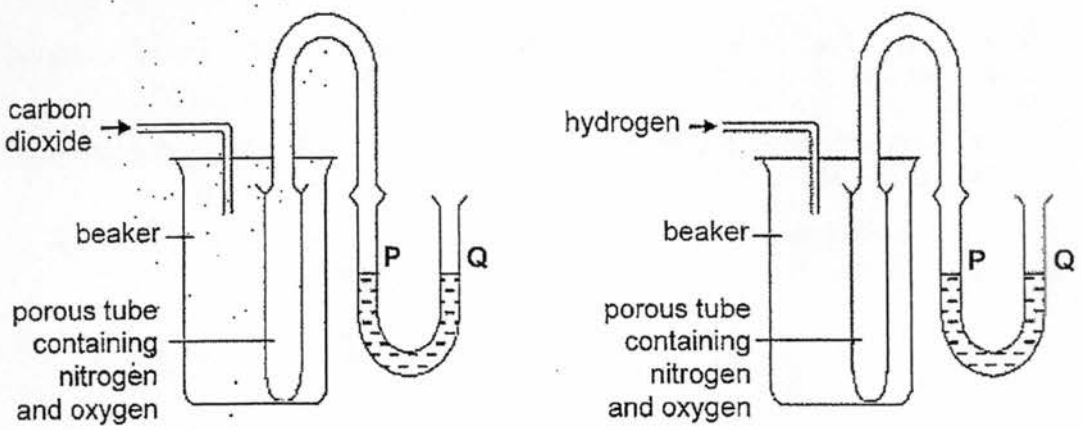
C


D


5 20 cm^3 of ethene diffused through a porous pot in 40 seconds. How long will it take for 40 cm^3 of carbon monoxide to diffuse under the same conditions of temperature and pressure?

A 10 seconds
B 20 seconds
C 40 seconds
D 80 seconds

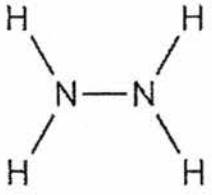
6 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagram below. What changes, if any, to the water levels at **P** and **Q** would you expect to see in both experiments?



experiment 1 experiment 2

	experiment 1	experiment 2
A	**P** is higher than **Q**	**Q** is higher than **P**
B	**Q** is higher than **P**	**Q** is higher than **P**
C	**P** and **Q** remain the same	**P** and **Q** remain the same
D	**P** and **Q** remain the same	**Q** is higher than **P**

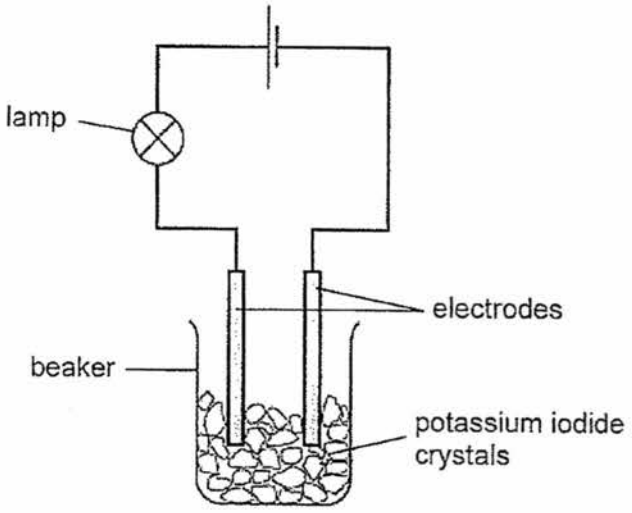
7 The diagram shows the structural formula of the covalent molecule hydrazine, N_2H_4.



Consider all the electrons in a molecule of hydrazine.
Which description fits the arrangement of these electrons in the molecule?

	total number of electrons involved in bonding	total number of electrons not involved in bonding
A	5	4
B	5	8
C	10	4
D	10	8

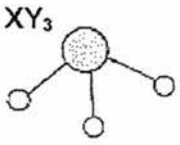
8 The experiment shown is used to test the electrical conductivity of potassium iodide crystals.

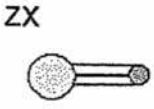


The lamp does not light up.
Distilled water is then added to the beaker and the lamp lights.
Which statement explains these results?

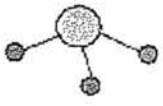
A Metal ions are free to move when potassium iodide melts.
B Metal ions are free to move when potassium reacts with water.
C Electrons are free to move in the solution when potassium iodide dissolves.
D Oppositely charged ions are free to move in the solution when potassium iodide dissolves.

9 The models and formulae for some molecules are shown below.





Which of the following, A, B, C or D, is the correct model for a molecule of the compound between Y and Z?

A 

B 

C 

D 

10 A piece of magnesium does not react when put into a solution of hydrogen chloride in chloroform. Which of the following changes will cause a reaction to occur?

A adding a catalyst
B adding water and stirring
C increasing the temperature
D increasing the concentration of hydrogen chloride in chloroform

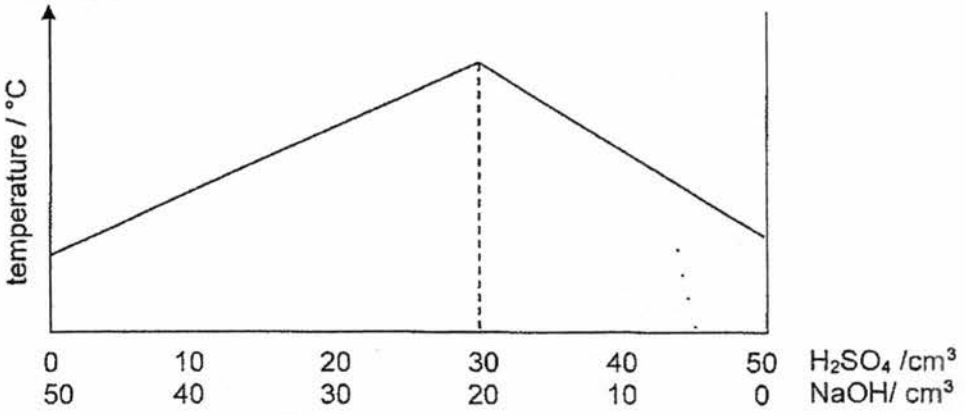
11 32 g of copper contains x atoms. How many atoms are there in 44 g of carbon dioxide?

A 0.5x
B x
C 2x
D 4x

12 40 cm^3 of 1.0 mol/dm^3 solution of a magnesium salt contains 4.8 g of the dissolved compound. The salt is a _____.

A carbonate
B sulfate
C nitrate
D chloride

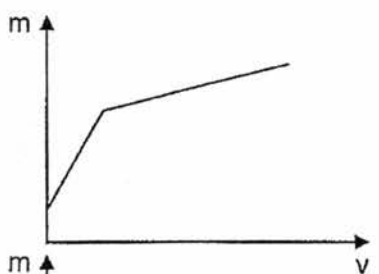
13 A solution of sulfuric acid has a concentration of 1 mol/dm^3.
Different volumes of the acid are added to different volumes of aqueous sodium hydroxide. The maximum temperature of each mixture is measured. The graph below shows the results.

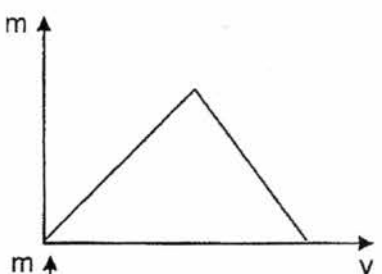


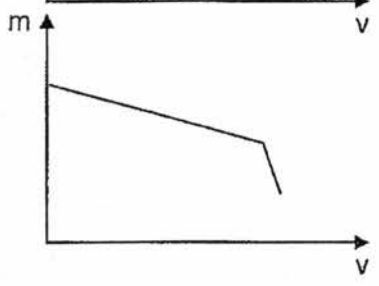
What is the concentration of the aqueous sodium hydroxide?

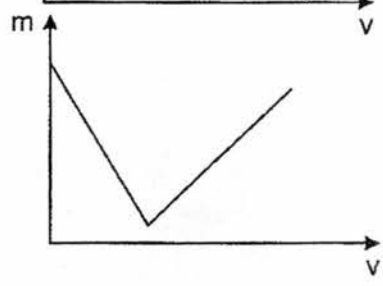
A 0.67 mol/dm^3
B 1.3 mol/dm^3
C 1.5 mol/dm^3
D 3.0 mol/dm^3

14 In a test for the presence of lead(II) ions in a solution, aqueous sodium hydroxide is added slowly till excess. Which of the following diagrams shows how the mass (m) of the precipitate varies with the volume (v) of the aqueous sodium hydroxide added?

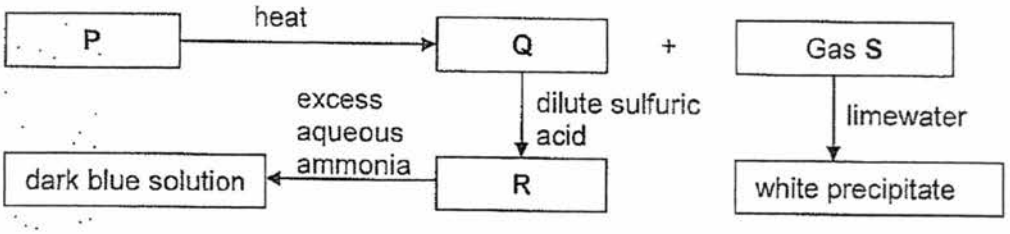
A


B


C


D


15 The diagram below shows a series of tests starting with **P**.



Which of the following statement(s) is/are true?

i. **P** can react directly with sulfuric acid to produce **R**.
ii. **Q** dissolves readily in water to form a blue solution.
iii. **R** forms a blue precipitate which remains insoluble in excess aqueous sodium hydroxide.

A i only
B iii only
C i and ii only
D i and iii only

16 Gabriel was given four bottles containing colourless solutions of four compounds, labelled **X**, **W**, **Y** and **Z**. He mixed two different solutions together and obtained the following results.

solution	observations
X and **W**	no visible reaction
X and **Z**	white precipitate
W and **Y**	white precipitate
W and **Z**	white precipitate
Y and **Z**	effervescence

Which of the following correctly identifies each solution?

	solution **X**	solution **W**	solution **Y**	solution **Z**
A	calcium nitrate	potassium carbonate	sulfuric acid	barium nitrate
B	barium nitrate	calcium nitrate	potassium carbonate	sulfuric acid
C	sulfuric acid	barium nitrate	calcium nitrate	potassium carbonate
D	potassium carbonate	sulfuric acid	barium nitrate	calcium nitrate

17 Two elements, **S** and **T** have proton numbers between 1 and 12. The atom **S** has two electrons less than a noble gas while the atom **T** has five electrons more than a noble gas. Which of the following compounds **cannot** be formed between **S** and **T**?

A TS
B TS_6
C TS_2
D TS_3^-

18 The reaction of manganate(VII) ions with hydrogen peroxide in acid solution may be represented by the following equation.

$$2MnO_4^-(aq) + 6H^+(aq) + 5H_2O_2(aq) \rightarrow 2Mn^{2+}(aq) + 5O_2(g) + 8H_2O(l)$$

The rate of reaction can be determined by measuring changes in different variables of the reaction.

Which of the following methods of monitoring the rate of reaction are suitable?

I. volume of gas produced
II. pH of the reaction mixture
III. mass of the reaction mixture
IV. amount of precipitate obtained
V. intensity of the purple colour of the reaction mixture

A I, II and III
B I, II and IV
C I, II, IV and V
D I, II, III and V

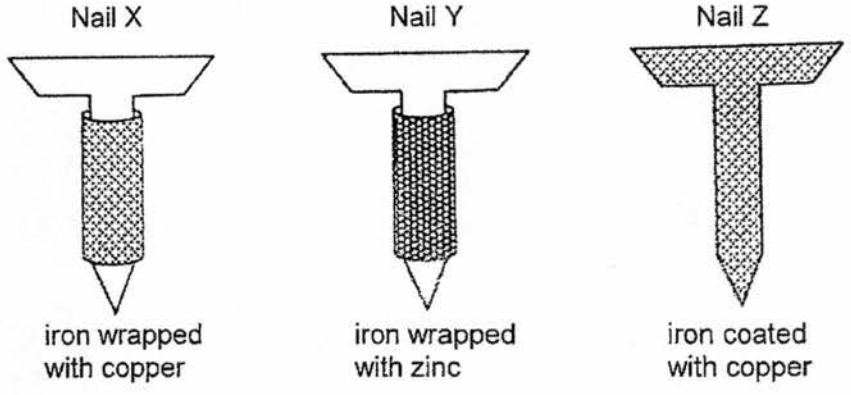
19 Titanium reacts with acid and cannot be extracted from its ore by heating with carbon. Where should titanium be placed in the reactivity series?

A below copper
B between zinc and iron
C between iron and copper
D between magnesium and zinc

20 Which statement about the extraction of iron from its ore is correct?

A Iron is more difficult to extract than zinc.
B Iron is more difficult to extract than copper.
C Iron is easy to extract because it is a transition metal.
D Iron cannot be extracted by reduction with carbon.

21 The diagram below shows the experiment of investigating rusting of iron nails.



Which of the nail(s) above shows(s) rusting?

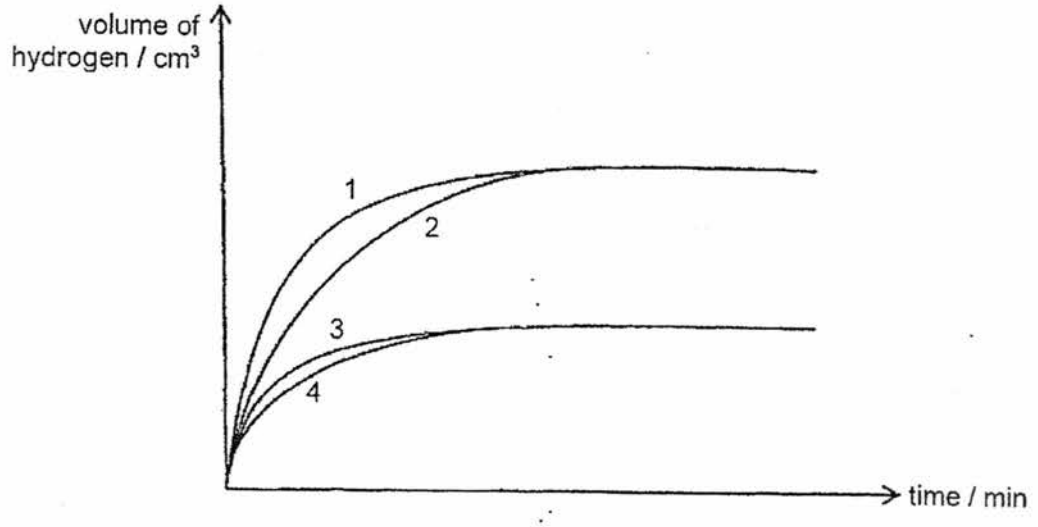
A X only
B X and Y only
C X and Z only
D Y and Z only

22 Four experiments were carried out by adding samples of zinc of different size and mass to excess 1.0 mol/dm^3 hydrochloric acid in four separate conical flasks. The volume of hydrogen gas evolved was collected and measured at regular time interval for each experiment.

The set of conditions for the four experiments are shown in the table below.

set of conditions	particle size of zinc	mass of zinc / g
W	granular	5.0
X	granular	10.0
Y	powder	5.0
Z	powder	10.0

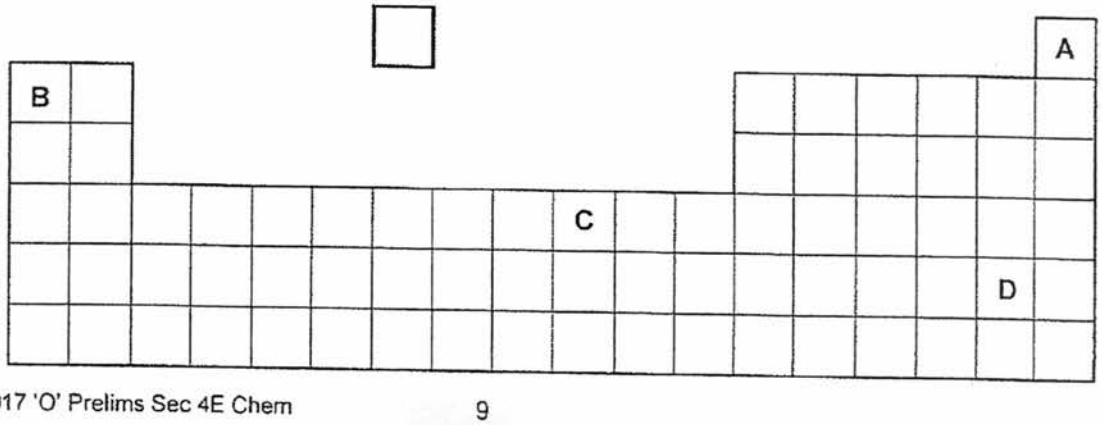
The graph of the results from the four experiments are labelled 1, 2, 3 and 4 as shown below.



Which of the following correctly matches the graphs of experiments 1, 2, 3 and 4 with the set of conditions W, X, Y and Z?

	W	X	Y	Z
A	3	2	1	4
B	3	2	4	1
C	4	1	3	2
D	4	2	3	1

23 An element melts at 1455 °C, has a density of 8.90 g/cm^3 and forms a green chloride. Where in the Periodic Table is this element found?



24 Sulfur and selenium, Se, are in the same group of the Periodic Table. From this, we would expect selenium to form compounds having the formulae _____.

A Se_2O, Na_2Se and $NaSeO_4$
B SeO_2, Na_2Se and $NaSeO_4$
C SeO_2, Na_2Se and Na_2SeO_4
D SeO_3, $NaSe$ and $NaSeO_4$

25 The reaction scheme represents the process for obtaining pure silicon.

SiO_2 —(I: heat with carbon)→ Si (impure) —(II: react with chlorine)→ $SiCl_4$ (impure) —(III: distill)→ $SiCl_4$ (pure) —(IV: heat with hydrogen)→ Si (pure)

In which stages is silicon reduced?

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

26 In which of the following experiments will a redox reaction occur?

A adding zinc granule to silver nitrate solution
B adding calcium oxide powder to aqueous sulfuric acid
C adding aqueous sodium hydroxide to aqueous nitric acid
D adding calcium(II) chloride solution to copper(II) sulfate solution

27 After adding acidified potassium manganate(VII) solution to a sample of solution X, the potassium manganate(VII) solution was decolourised and the resulting solution was brown. When starch solution was added to a fresh sample of solution X, the solution turned dark blue. What conclusion can be drawn about solution X?

A It is a reducing agent and it contains iodide ions.
B It is a reducing agent and it contains bromide ions.
C It is an oxidising agent and it contains iodide ions.
D It is an oxidising agent and it contains bromide ions.

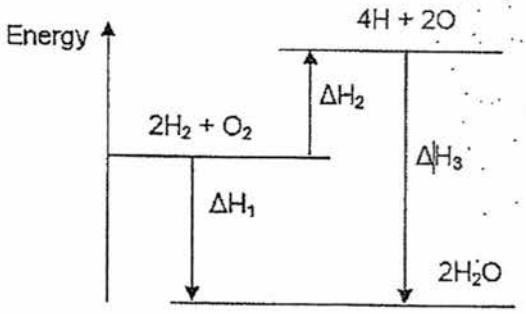
28 Which row shows the correct enthalpy change for its process?

	process	enthalpy change, ΔH
A	$CO_2(g) \rightarrow C(g) + 2O(g)$	negative
B	$PbCl_2 \rightarrow Pb(s) + Cl_2(g)$	positive
C	$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$	positive
D	$N_2(l) \rightarrow N_2(g)$	negative

29 Hydrogen and oxygen react to form steam as shown in the equation below.

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

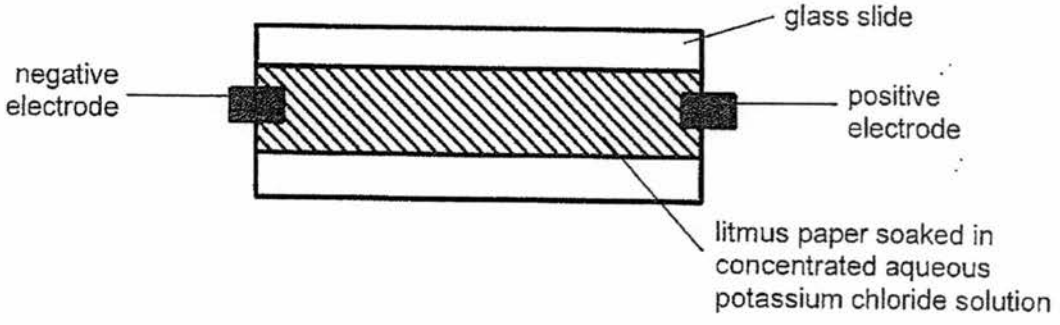
The following energy level diagram represents this reaction.



Which symbols represent the energy involved in the 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

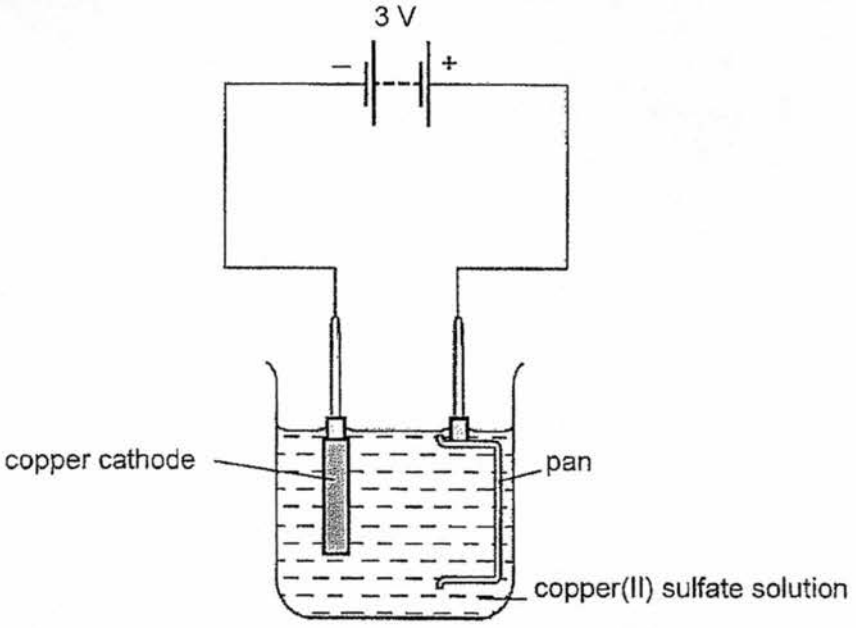
30 A piece of litmus paper soaked in concentrated aqueous potassium chloride solution was placed on a glass slide. The paper was connected to a battery.



Which of the following shows the correct observations near the negative electrode and positive electrode after the current had flowed for some time?

	at negative electrode	at positive electrode
A	red	blue
B	red	bleached
C	bleached	blue
D	blue	bleached

31 The diagram shows a failed attempt to copper-plate a pan.



Which action will plate the pan with copper?

A increasing the voltage from 3 V to 6 V
B making the pan the cathode and the copper the anode
C cooling the copper(II) sulfate solution in an ice bath
D heating the copper(II) sulfate solution to boiling point

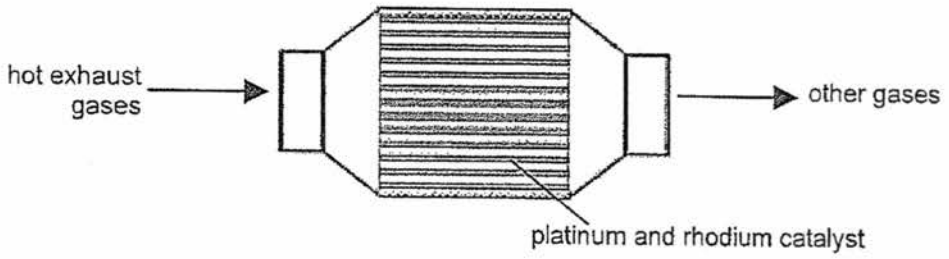
32 Which of the following statements concerning the Haber process is incorrect?

A A catalyst of finely divided iron is used.
B Nitrogen and hydrogen are fed into the reactor in the volume ratio of 1:3.
C The cost of high pressure technology means that the reaction is carried out at the more economical pressure of 4 atm.
D The equilibrium yield of ammonia is favoured by the use of low temperatures, although temperatures of around 450 °C are actually used.

33 To produce ammonia gas, which of the following methods below cannot be used?

A heating concentrated aqueous ammonia
B heating ammonium chloride with calcium hydroxide
C heating ammonium sulfate with sodium hydroxide
D heating ammonium sulfate with dilute hydrochloric acid

34 The diagram below represents a section of a catalytic converter in the exhaust system of a car.

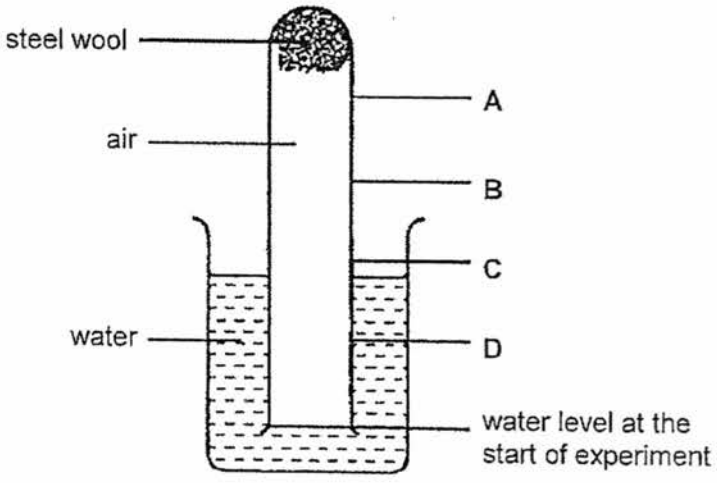


Which processes take place in this catalytic converter?

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

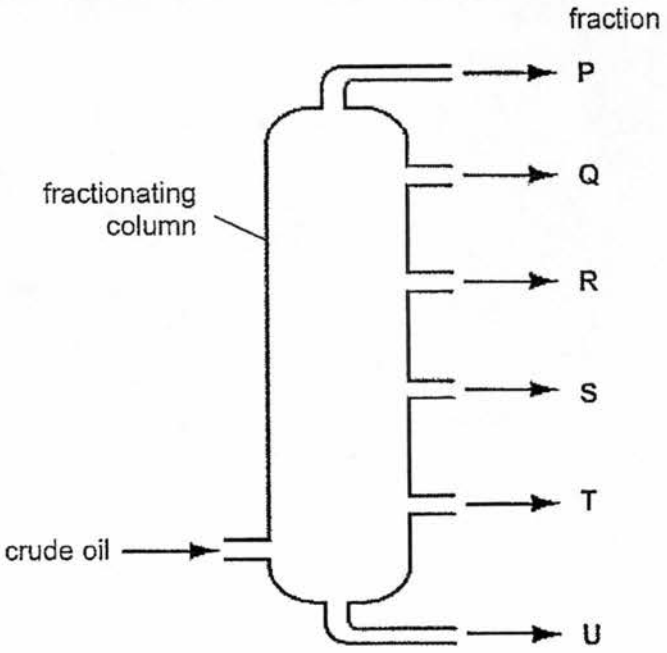
A I and II
B I and III
C II and III
D I, II and III

35 The diagram shows a ball of steel wool placed inside the end of a test tube. The test tube is inverted in a beaker of water, trapping air inside.



What is the level of water after several days?

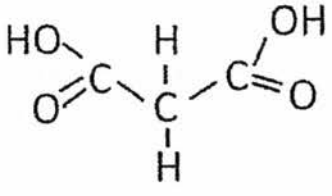
36 The diagram shows the fractional distillation of crude oil.



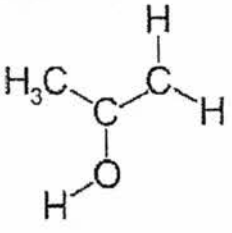
Which row explains why fraction **Q** is collected above fraction **S**?

	boiling point of **Q**	average molecular mass of **Q**	enthalpy change of combustion of **Q** (kJ/mol)
A	lower than **S**	smaller than **S**	less than **S**
B	lower than **S**	greater than **S**	less than **S**
C	higher than **S**	smaller than **S**	more than **S**
D	higher than **S**	greater than **S**	more than **S**

37 The structure of propanedioic acid and propanol are shown below.



propanedioic acid



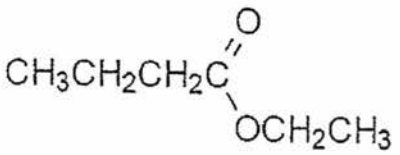
propanol

How many of the following substances can be used to distinguish between the two compounds?

I. aqueous bromine
II. zinc carbonate
III. acidified potassium manganate(VII) solution

A 0 **B** 1
C 2 **D** 3

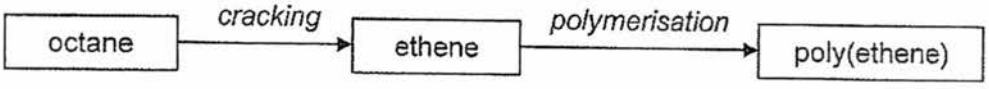
38 Rum flavouring is based on the compound with the formula shown below.



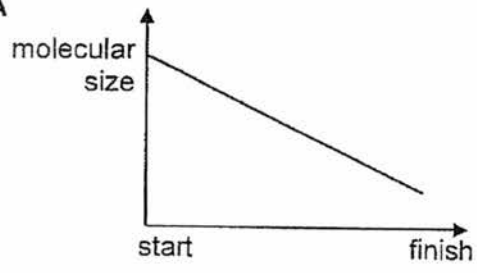
The compound can be made from _____.

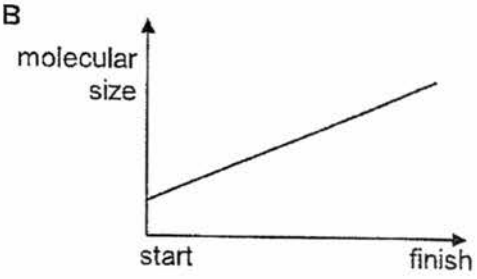
A propanol and methanoic acid
B ethanol and butanoic acid
C butanol and ethanoic acid
D propanol and propanoic acid

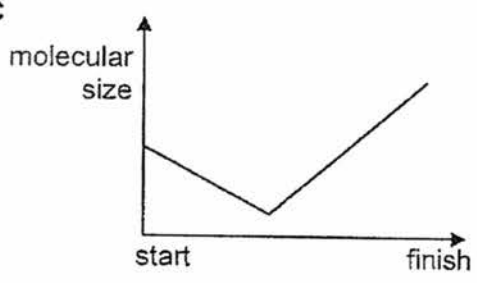
39 Poly(ethene) can be manufactured by the process below.

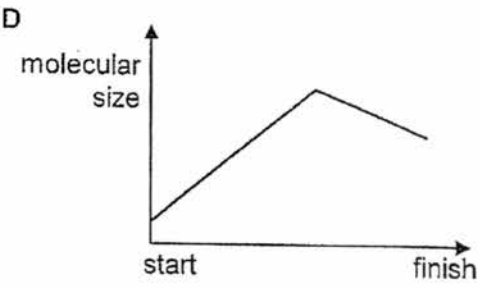


Which diagram shows the change in molecular size during this process?

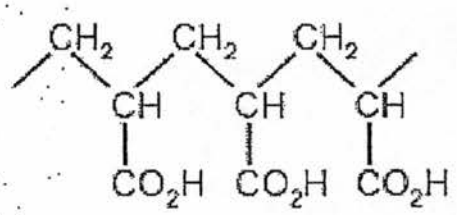
A


B


C


D


40 The absorbent material in babies' disposable nappies is made from the polymer shown below.



From which monomer could this polymer be obtained?

A $H_2C=CHCO_2H$
B $HO_2CCH=CHCO_2H$
C $HOCH_2CH_2CO_2H$
D $CH_3CH_2CH_2CO_2H$

End of Paper 1

The Periodic Table of the Elements

Group																	
I	II											III					
							1 H Hydrogen 1										
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5					
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13					
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					
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					
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 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					
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

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						
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						

Key: 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

Name: .....( ) Class: Sec .....

St. Gabriel's Secondary School

2017 'O' Preliminary Examination

Subject : Chemistry
Paper No : 5073/2
Level/Stream : 4 Express
Duration : 1 hour 45 mins
Date : 24 August 2017

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces above.
Write in dark blue or black pen.
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. Write your answers on the spaces provided.

Section B
Answer **all three** questions, the last question is in the form **either/or**.
Write your answers on 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 17.

FOR EXAMINER'S USE	
Section A [50 marks]	
B9	
B10	
B11 [EITHER / OR]	
Total	/80

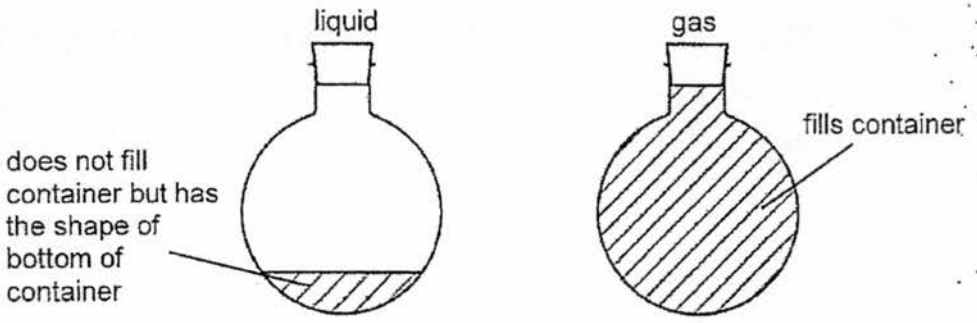
This question paper consists of **17** printed pages including this cover page.

[Turn over

Section A [50 marks]

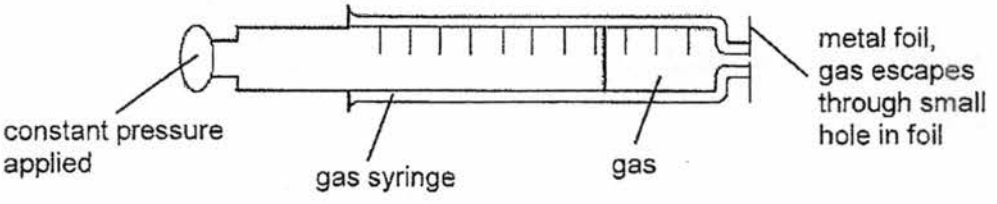
Answer **all** questions in the spaces provided.

A1 **(a)** Using the Kinetic Particle Theory, explain why liquids and gases both take the shape of the container but a gas always fills the container.



[3]

(b) The following apparatus can be used to measure the rate of diffusion of a gas.



(i) What measurements would need to be taken to calculate the rate of diffusion of a gas?

[2]

(ii) Which gas, nitrogen dioxide or sulfur dioxide, would diffuse faster? Explain your choice.

[2]

[Total: 7 marks]

A2 Use the information in the table below to answer the questions.

element	formula(e) of oxide(s)	density of element at r.t.p (g/cm^3)	volume of 1 mole of atoms at r.t.p (cm^3)
A	A_2O, A_2O_2	0.00008	12 000
B	None formed	0.00346	24 000
C	C_2O	0.53	13.20
D	D_2O	0.97	23.71
E	EO_2, EO_3	2.07	15.46
F	F_2O_3	3.00	15.00
G	GO, G_2O_3	7.86	7.11

(r.t.p refers to room temperature and pressure)

(a) Which two elements are in the same group of the Periodic Table.
Explain your answer.

_____

_____

_____ [2]

(b) Which element could be argon? Explain your answer.

_____

_____

_____ [2]

(c) Using information in the third and fourth columns, calculate the mass of 1 mole of **F** and identify **F**.

[2]

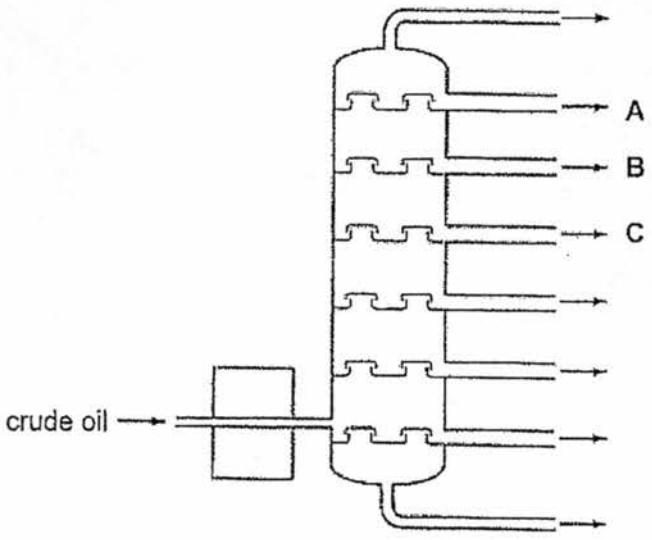
(d) Write down two observations you would expect to see when element **G** is added to dilute nitric acid.

_____

_____ [2]

[Total: 8 marks]

A3 The diagram below shows a fractionating column for the separation of crude oil.



(a) The properties of three fractions in crude oil are given in the table below.
Complete the table below by identifying the fractions at **A**, **B** and **C** in the diagram.

	number of carbon atoms per molecule	boiling point (°C)	fraction
A	5 to 11	50 to 80	
B	7 to 14	90 to 150	
C	9 to 16	150 to 240	

[1]

(b) Give two pieces of evidence to show why the fractions identified in **(a)** are classified as mixtures.

_____

_____

_____ [2]

(c) Describe the process of separating the fractions **A** and **C** by this method.

_____

_____

_____

_____ [2]

(d) Cracking is carried out on **B** to produce other useful products. The table below shows some information on the percentage yield of the products from a cracking plant.

product	percentage yield (%)
methane	15
ethene	32
propene	16
C_4 hydrocarbons	11
C_5 to C_8 hydrocarbons	25

(i) Cracking is often described as a key source of alkenes.
Use the information given to support the above statement.

_____

_____ [1]

(ii) Suggest a reason why the data for C_4 hydrocarbons and C_5 to C_8 hydrocarbons are grouped together, whereas the data for the first few products are classified individually.

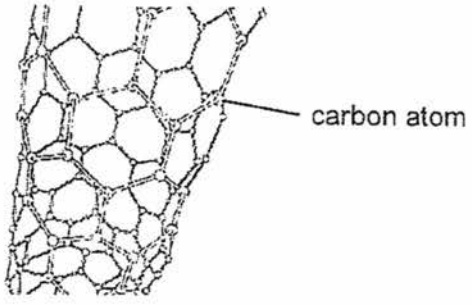
_____

_____

_____ [2]

[Total: 8 marks]

A4 An airplane contains many miles of electrical wiring made of copper. This adds to the mass of the airplane. It has been suggested that the electrical wiring made of copper could be replaced by lighter carbon nanotubes. The diagram shows the structure of a carbon nanotube. Like graphite, each carbon atom is joined to three other carbon atoms.



(a) Explain why the carbon nanotube can conduct electricity.

_____

_____

_____ [2]

(b) Another reason why copper is replaced by the carbon nanotubes is that the copper wiring will react eventually with atmospheric oxygen to form copper(II) oxide, decreasing its electrical conductivity.

Explain in terms of its structure and bonding why the metal oxide has a poor electrical conductivity.

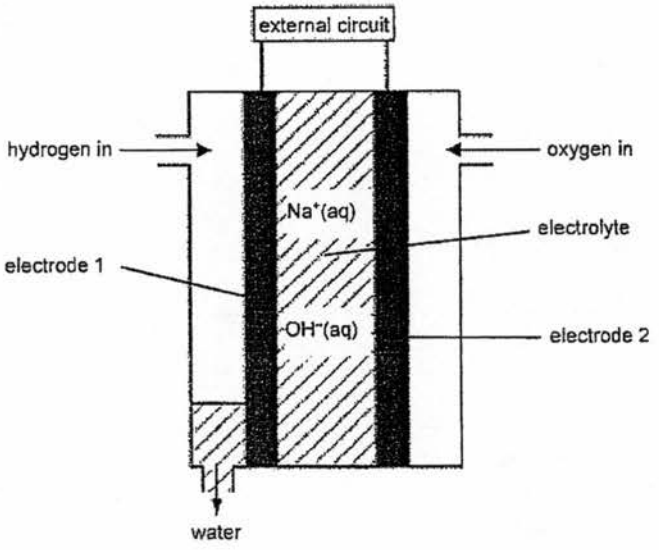
_____

_____

_____ [2]

[Total: 4 marks]

A5 The NASA space shuttle uses fuel cells to generate electricity. The diagram shows a hydrogen-oxygen fuel cell.



(a) Identify which electrode above is an anode, and which is a cathode.

_____ [1]

(b) Describe how electricity is generated in the fuel cell.

_____

_____

_____

_____ [3]

(c) Give one source for hydrogen for use in a fuel cell.

_____

_____ [1]

[Total: 5 marks]

A6 30 cm^3 of 1 mol/dm^3 dilute hydrochloric acid is added to two different test tubes containing substances **A** and **B**. The results are recorded in the table below.

substance	appearance of substance	gas produced	colour of solution formed
A	green solid	gas formed white precipitate with limewater	pale blue
B	black solid	no gas produced	pale blue

(a) Suggest the name of substance **A** and write down a balanced chemical equation for the reaction between **A** and dilute hydrochloric acid.

[2]

(b) Substance **B** is impure copper(II) oxide. The mass of **B** in the test tube is 3 g. To test for the purity of substance **B**, the following is carried out. It is assumed that the impurities do not react with dilute hydrochloric acid.

(i) The excess hydrochloric acid that did not react with **B** was titrated with 1 mol/dm^3 of dilute sodium hydroxide. The average volume of sodium hydroxide required for the titration was 10.0 cm^3.

Calculate the number of moles of excess hydrochloric acid and hence, calculate the number of moles of hydrochloric acid that has reacted with substance **B**.

[3]

(ii) The reaction between copper(II) oxide and hydrochloric acid is given by the equation below.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

Calculate the percentage purity of **B** in the test tube.

[2]

[Total: 7 marks]

A7 The table below shows the time taken for the same mass of zinc to react completely with sulfuric acid of various concentrations at room temperature and pressure.

concentration (mol/dm^3)	0.5	1.0	2.0	4.0
time taken (s)	450	45	22	5

(a) Explain, using collision theory, how the rate of reaction change when the concentration of sulfuric acid used increases from 0.5 mol/dm^3 to 4.0 mol/dm^3.

_____

_____

_____ [2]

(b) Suggest a reason why very little hydrogen gas is produced when the concentration of sulfuric acid used is increased to 10.0 mol/dm^3.

_____

_____

_____ [2]

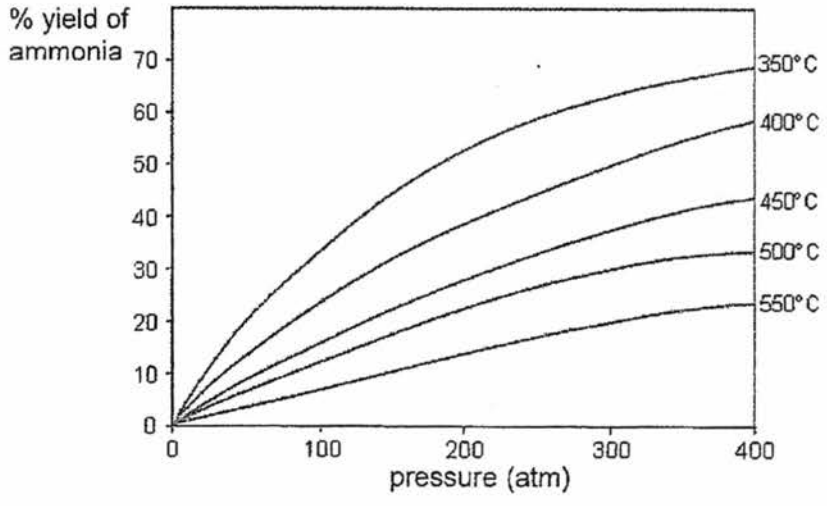
(c) A student repeated the above experiments using calcium while keeping all the other conditions the same. However, it was observed that the reaction stopped shortly. Explain why.

_____

_____ [1]

[Total: 5 marks]

A8 Ammonia is manufactured from nitrogen and hydrogen via the Haber process, using iron as catalyst. The graph below shows how the amount of ammonia produced (percentage yield) varies with both temperature and pressure.



(a) (i) From the graph, suggest whether a higher or lower temperature would result in more ammonia being formed from the Haber Process.

_____ [1]

(ii) Suggest why this temperature is not used in the Haber Process?

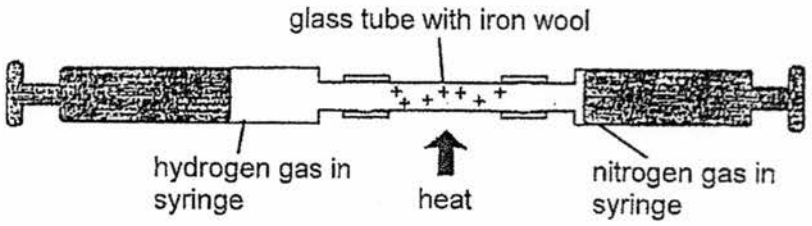
_____ [1]

(b) Explain how using a catalyst in the Haber process has an economic advantage.

_____

_____ [1]

(c) The Haber Process can be demonstrated in the laboratory by the method shown below.



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

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

_____

_____ [1]

(d) The equation below shows the reaction for the conversion of ammonia to nitrogen(II) oxide.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta H = -950 \text{ kJ/mol}$$

Is the reaction exothermic or endothermic? Explain your answer, in terms of the energy changes that take place during bond breaking and bond making, why the reaction is exothermic or endothermic.

_____

_____

_____

_____ [2]

[Total: 6 marks]

End of Section A

Section B [30 marks]

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

Question **B11** is in the form of an either/or and only one of the alternatives should be attempted.

B9 The information below is about the extraction of zinc.

The method of extraction of zinc has changed, as different ores containing the element have been discovered, and as technology has improved.

Extraction Process 1

In the earliest process, calamine (impure zinc carbonate) was heated with charcoal in earthenware pots. This two-stage process gives a low yield of zinc.

$$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$$

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$$

Extraction Process 2

A new two-stage process was developed using zinc sulfide ores. All of the waste gases from this process were released into the atmosphere.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$$

Extraction Process 3

This uses the electrolysis of aqueous solutions of very pure zinc sulfate. The first step in this process is the same as the first step in Extraction Process 2. The second step uses sulfuric acid made from SO_2 collected in the first step. The third step involves the electrolysis of zinc sulfate solution to form pure zinc.

$$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$$

$$ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(g)$$

$$ZnSO_4(aq) \rightarrow Zn(s) \quad \text{[electrolysis]}$$

The electrolysis of zinc sulfate solution can be carried out by using graphite or zinc as anode. When zinc is used, the anode needs to be replaced frequently.

(a) (i) Identify one equation that represents a redox equation.

_____ [1]

(ii) Explain, in terms of oxidation states, why the equation identified in (a)(i) is a redox reaction.

_____

_____

_____ [2]

(b) Suggest which of the three extraction processes is the most environmentally friendly. Give a reason for your answer.

_____

_____

_____

_____

_____

_____ [3]

(c) Zinc sulfate solution is electroysed in Extraction Process 3.

(i) If zinc is used as the anode, write the ionic half-equations, including state symbols, for the reaction occurring at each electrode.

Anode: _____

Cathode: _____ [2]

(ii) Explain why the zinc anode needs to be replaced periodically?

_____

_____

_____ [2]

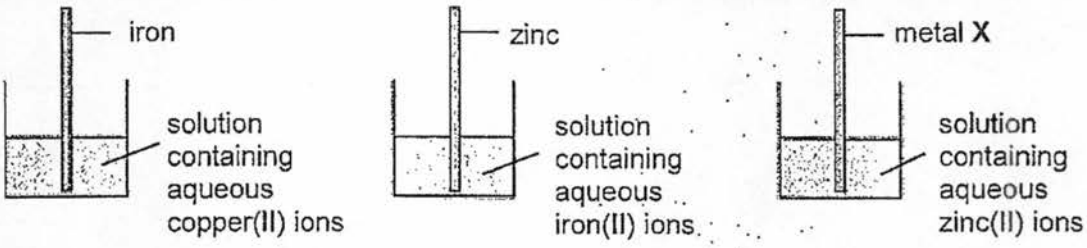
(d) A factory replaced zinc sulfate solution with molten zinc chloride.
Suggest why molten zinc chloride may not be a good choice to replace zinc sulfate solution.

_____

_____ [1]

[Total: 11 marks]

B10 A student investigate the reactivity of four metals, iron, copper, zinc and metal **X**.



experiment 1 **experiment 2** **experiment 3**

(a) In **experiment 1**, the student sees changes happen to both the iron and the solution. Describe the changes that the student sees and explain why these changes occur.

_____

_____

_____

_____ [3]

(b) Write an ionic equation, including state symbols, for the reaction that happens in **experiment 2**.

_____ [1]

(c) The student observes that a reaction happens in all three experiments.

(i) Arrange the four metals in order of **increasing** reactivity. Explain your answer.

_____

_____

_____ [2]

(ii) Suggest the name of metal **X**.

_____ [1]

(d) At the end of **experiment 3**, the student wanted to check if there are any zinc ions left in the solution. What can the student do to confirm this?

_____

_____

_____

_____ [2]

[Total: 9 marks]

Either

B11 Alkenes are unsaturated organic compounds consisting of a carbon-carbon double bond.

Table **1** lists the boiling points of some straight chain alkenes.

alkene	boiling point (°C)
ethene	–104
propene	–47
butene	–6
pentene	30
hexene	63

Table **1**

Table **2** shows the properties of branched isomers of some of the alkenes.

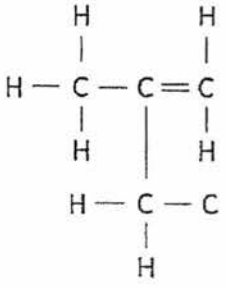
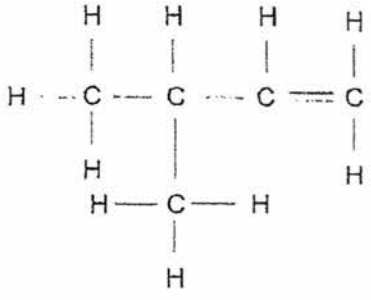
	number of carbon atoms in molecule	formula	boiling point (°C)
branched alkene 1	4		–7
branched alkene 2	5		20

Table **2**

(a) What trend is shown by the data in Table **1**?

_____

_____ [1]

(b) Using evidence from Tables **1** and **2**, explain how the boiling point of a straight chain alkene is affected by branching in isomerism.

_____

_____

_____

[3]

(c) **Q** is a gaseous hydrocarbon which can decolourise a solution of bromine and has a density of 1.75 g/dm^3 at room temperature and temperature.

(i) Calculate the relative molecular mass of **Q**.

[1]

(ii) Hence, identify **Q**. Explain your reasoning.

_____

_____

_____

_____ [2]

(iii) Hence, write a chemical equation for the reaction between **Q** and bromine solution.

_____ [1]

(d) Both ethane and ethene can react with chlorine.
Give one similarity and one difference between the two reactions.

_____

_____

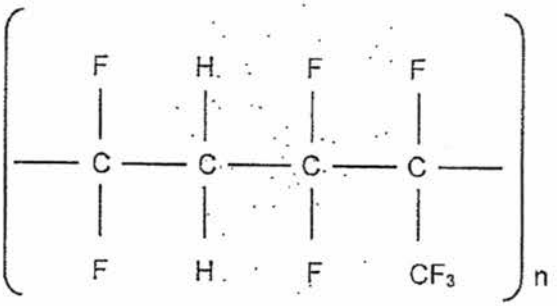
_____

_____ [2]

[Total: 10 marks]

OR

B11 A *copolymer* is formed from more than one type of monomer unit.
Viton elastomer is a copolymer used in fuel injection seals. The following shows the structure of a *copolymer*, *Viton*, showing one repeat unit. There is **no** by-product formed.



(a) **(i)** What type of polymerisation does it undergo?

_____ [1]

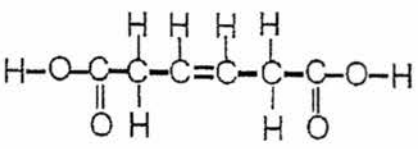
(ii) Draw the structures of the monomers that react to form this polymer.

[2]

(iii) The relative molecular mass of the *Viton* molecule is about 500 000.
Calculate the minimum number of monomers in one *Viton* molecule.

[2]

(b) Polyesters are polymers used in the manufacture of numerous products such as fabrics and eyeglass lenses. The starting material of one such polyester is compound **P** which has the structural formula shown below:



compound **P**

(i) State the observation when compound **P** reacts with aqueous bromine and with aqueous sodium carbonate

_____

_____

_____ [2]

(ii) Draw the full structural formula when compound **P** reacts with excess ethanol.

[2]

(iii) State the condition for the reaction in **(ii)** above.

_____ [1]

[Total: 10 marks]

End of Section B

The Periodic Table of the Elements

Group I	Group II											Group III	
							1 H Hydrogen 1						
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	
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	
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	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 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	
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †											

*58-71 Lanthanoid series

†90-103 Actinoid series

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	
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	

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

St Gabriel's Secondary School
2017 'O' Preliminary Examination
Sec 4E Chemistry
Marking Scheme

Paper 1

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

Paper 2 Section A

Question			Answer	Marks
A1	(a)		In liquid, the particles are close together; the strong forces of attraction between the particles do not allow them to move apart. Hence, liquid cannot fills up the container.	1
			However, liquid particles can slide over each other to take up the shape of the container.	1
			In gas, the forces are much weaker and the particles can move in all directions /freely to fill the container.	1
	(b)	(i)	Measure the volume of gas left in the gas syringe (or volume of gas that escapes) at regular intervals of time	1 1
		(ii)	Nitrogen dioxide	1
			It has lower relative molecular mass / molar mass / mass.	1
A2	(a)		C and D.	1
			Both elements form oxides of the same chemical formulae, C_2O and D_2O. This shows that the elements formed ions that have a charge of +1 and they both belong in Group I of the Periodic Table as they have the same number of valence electron.	1
	(b)		B.	1
			Its volume of 1 mole of atoms is 24 000 cm^3, indicating that B is monoatomic. (Reject: it does not form any oxide or reacts with oxygen)	1
	(c)		Mass of 1 mole of F = 3 x 15 = 45 g	1
			F is scandium.	1
	(d)		Effervescence / Bubbles is seen,	1
			pale green solution is formed.	1

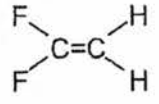
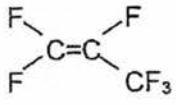
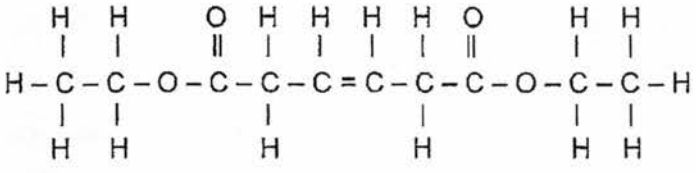
A3	(a)	Petrol; Naptha; Kerosene/Paraffin		1
	(b)	There is no fixed boiling point for each fraction. / Each fraction boils over a range of temperatures. There is a range in the number of carbon atoms in each fraction.		1 1
	(c)	Crude oil is heated and the vapour rises and enters the fractionating column. Fraction **A** (petrol) is condensed and collected at higher outlet as it has a lower boiling point than fraction **C** (kerosene). Fraction **C** (kerosene) is condensed and collected at the lower outlet of the fractionating column.		1 1
	(d)	(i)	For both processes, the yield of ethene and propene alone (excluding the alkenes in the C_4 to C_8 hydrocarbons), accounts for 48%.	1
		(ii)	From C_4 onwards, there are isomers for both the alkanes and alkenes. Hence there are many compounds with the same number of carbon atoms. The smaller hydrocarbons have no isomers, so they are classified individually.	1 1
A4	(a)	Each carbon atom uses 3 out of 4 valence electrons for bonding and has 1 unbonded/free valence electron which is mobile to act as charge carrier. (Reject: 'sea of delocalised electrons' without explaining where these electrons come from)		1 1
	(b)	The metal oxide has a giant ionic lattice structure with strong electrostatic forces of attraction between the metal ions and the negative oxide ions. In the solid state, the ions are held in fixed arrangement/positions and will not be able to carry electrical charges.		1 1
A5	(a)	Anode: electrode 1 Cathode: electrode 2		1
	(b)	Hydrogen gas is oxidised and releases electrons and water. These electrons flow from the anode to the cathode. Oxygen is then reduced to form hydroxide ions. The movement of electron flow from hydrogen to oxygen in the cell generates electricity.		1 1 1
	(c)	Cracking of crude oil / petroleum / large alkane, alkene, hydrocarbon OR Electrolysis of water		1

A6	(a)	Copper(II) carbonate		1
		$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$ (allow e.c.f. if candidate gives the wrong substance)		1
	(b)	(i)	NaOH + HCl → NaCl + H2O	
			Mol of NaOH = 10/1000 x 1 = 0.01 mol	
			Mol of excess HCl = <u>0.01 mol</u>	1
			Mol of HCl added initially = 30/1000 x 1 = 0.03 mol	1
			Mol of HCl that react with $CuCO_3$ = 0.03 – 0.01 = <u>0.02mol</u>	1
		(ii)	Mol of CuO = 0.02/2 = 0.01 mol	
			Mass of CuO = 0.01 x 80 = 0.8 g	1
			% purity = 0.8/3*100 = 26.7%	1
A7	(a)	As the concentration increases, there are <u>more H^+ ions</u> in the same volume of solution.		1
		This <u>increases the frequency of the successful collisions</u> between the reacting particles and hence <u>increases the rate of the reaction</u>		1
	(b)	When concentration of sulfuric acid is increased to 10 mol/dm^3, there is <u>very little water present</u>.		1
		Most of the acid molecules <u>do not dissociate to form H^+ ions</u>.		1
	(c)	<u>Insoluble calcium sulfate</u> is formed on the calcium carbonate. This prevent the remaining calcium from reacting.		1
A8	(a)	(i)	<u>Lower</u> temperature	1
		(ii)	Lower temperature results in a <u>slower rate of reaction</u>.	1
	(b)	speeds up the reaction / lowers the activation energy		1
		lowers energy costs / less energy used/only a small amount is needed (Reject: Catalyst can be re-used and hence save cost as this is not a significant contributing economic advantage)		
	(c)	This to prevent hydrogen from <u>reacting with oxygen</u> in the air.		1
	(d)	<u>Exothermic</u>		1
		<u>More heat energy is given out</u> when bonds <u>between N–O and H–O</u> are formed <u>than is taken in</u> for breaking the <u>N–H bonds and O=O bonds</u>.		1

Paper 2 Section B

Question			Answer	Marks
B9	(a)	(i)	$ZnO\ (s) + C\ (s) \rightarrow Zn\ (s) + CO\ (g)$ **or** $2ZnS\ (s) + 3O_2\ (g) \rightarrow 2ZnO(s) + 2SO_2\ (g)$	1
		(ii)	$ZnO\ (s) + C\ (s) \rightarrow Zn\ (s) + CO\ (g)$ Oxidation state of zinc decreases from +2 in ZnO to 0 in Zn. Hence, ZnO is reduced: Oxidation state of carbon increases from 0 in carbon to + 2 in CO. Hence, C is oxidised. (Accept 2+ or +2) OR $2ZnS\ (s) + 3O_2\ (g) \rightarrow 2ZnO(s) + 2SO_2\ (g)$ Oxidation state of sulfur increases from -2 in ZnS to +4 in SO_2. Hence, ZnS is oxidised. Oxidation state of oxygen deceases from 0 in O_2 to -2 in ZnO (or SO_2). Hence, oxygen is reduced.	1 1 1 1
	(b)		Process 3. (with at least one reason) SO_2 is used to make sulfuric acid. *(Any answer)* No CO is produced, unlike processes 1 and 2. CO causes headaches / fatigue /breathing difficulties / death / Reduces ability of haemoglobin to transport oxygen SO_2 from process 2 may irritate the eyes / lungs / Cause breathing difficulties / inflammation of the lungs (bronchitis) / Reacts with water in the atmosphere to form acid rain, which corrodes buildings and harms aquatic life and plants (R: no air pollutant is released to the environment.)	1 1 1
	(c)	(i)	Anode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ Cathode: $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	1 1
		(ii)	Zinc is the reactive anode and will be oxidised / ionised to from Zn^{2+} ions (don't accept zinc oxide is formed, without stating the oxidation of zinc) and hence needs to be replaced	1 1
	(d)		A high amount of energy is required to maintain the molten zinc chloride, increasing the cost of production of zinc.	1

B10	**(a)**		Pink copper metal formed on iron rod; as it is displaced out of the solution by iron. Blue solution turns pale green; as the Cu^{2+} ions are being replaced by Fe^{2+} ions. Iron is more reactive than copper, iron displaces copper out from its salt solution to form copper and Fe^{2+}.	1 1 1
	(b)		$Zn(s) + Fe^{2+}(aq) \rightarrow Zn^{2+}(aq) + Fe(s)$	1
	(c)	**(i)**	Copper, iron, zinc, **X**. Metal X is more reactive than zinc as there is a reaction in experiment 3. The rest of the arrangement follows the reactivity series.	1 1
		(ii)	Magnesium or aluminium or calcium	1
	(d)		Add aqueous ammonia / ammonium hydroxide solution till excess; (Reject: addition of sodium hydroxide) If zinc(II) ions are left in the solution, a white precipitate will be formed which will dissolve in excess of aqueous ammonia to form a colourless solution.	1 1
B11	**Either**			
	(a)		The greater the number of C atoms/ the larger the molecule/ down the series, the higher the boiling point;	1
	(b)		Branching in isomerism decreases the boiling point of straight chain alkenes; From the data, the boiling point of straight chain butene (-6 °C) is higher than the branched butene (-7 °C); The boiling point of straight chain pentene (30 °C) is also higher than the branched pentene (20 °C);	1 1 1
	(c)	**(i)**	Volume of Q = no. of mol of Q × 24 dm^3 (Mass/density) = (mass/Mr) × 24 dm^3 Mr = density × 24 dm^3 = 1.75 × 24 = 42 (no unit)	 1
		(ii)	Q is propene/ C_3H_6; with Mr of propene = (12×3) + (1×6) = 42; As Q decolourises aqueous bromine, it is unsaturated/ an alkene with general formula C_nH_{2n};	1 1
		(iii)	$C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$ (allow e.c.f)	1

	(d)		*Similarity* (any one) • both reactions can form dichloroethane (Accept: chloroethane) • both reactions involve formation of C-C*l* bond *Difference* (any one) • substitution in ethane requires UV light whereas addition in ethene does not require. • substitution in ethane involve breaking of C-H bond whereas addition in ethene does not. • substitution in ethane produces many products whereas addition in ethene produces only one product (dichloroethane). • substitution in ethane produces a byproduct (HC*l* or H_2) whereas addition in ethene does not. or any reasonable answers which include comparison of both reactions.	1 1
B11	**OR**			
	(a)	**(i)**	Addition polymerization	1
		(ii)	 	1 1
		(iii)	Mr of repeating unit = 214 No. of repeating units = 500 000 ÷ 214 = 2336 No. of monomers = 2336 × 2 = 4672 (or 4673)	1 1
	(b)	**(i)**	Aq bromine: Reddish brown aqueous bromine is rapidly decolourised/turned colourless. Aq sodium carbonate: Effervescence occurs/ colourless gas produced/ bubbling.	1 1
		(ii)		1: 1 ethyl on left 1: 1 ethyl on right
		(iii)	Warming with concentrated sulfuric acid	1