SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME								
CLASS	4			REGISTER NUMBER				
CENTRE NUMBER					INDEX NUMBER			

CHEMISTRY

5073/01

Paper 1 Multiple Choice

12 August 2016

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 Question Paper and Answer Sheet in the spaces provided.

There are **forty** questions in 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 a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 2.
The use of an approved scientific calculator is expected, where appropriate.

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 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	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

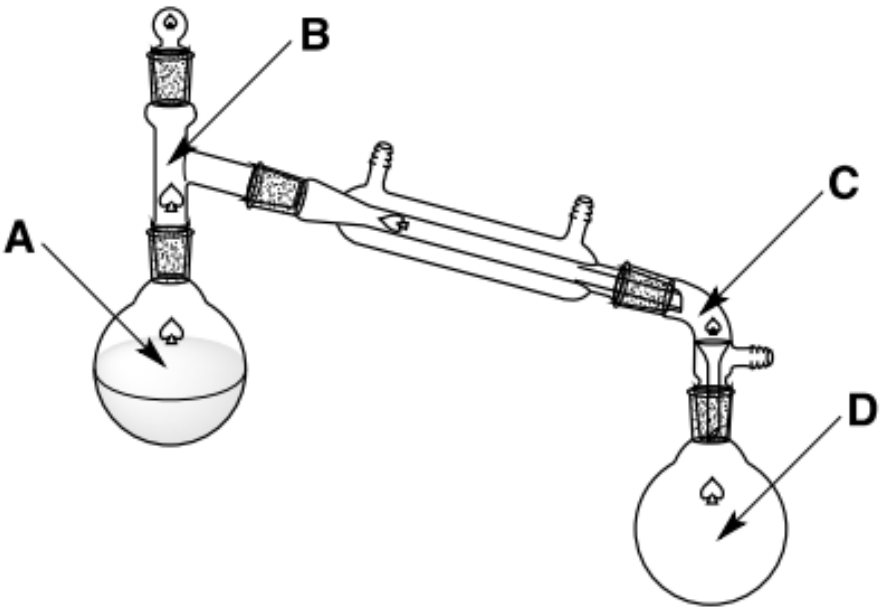
*58-71 Lanthanoid series
†90-103 Actinoid series

Key

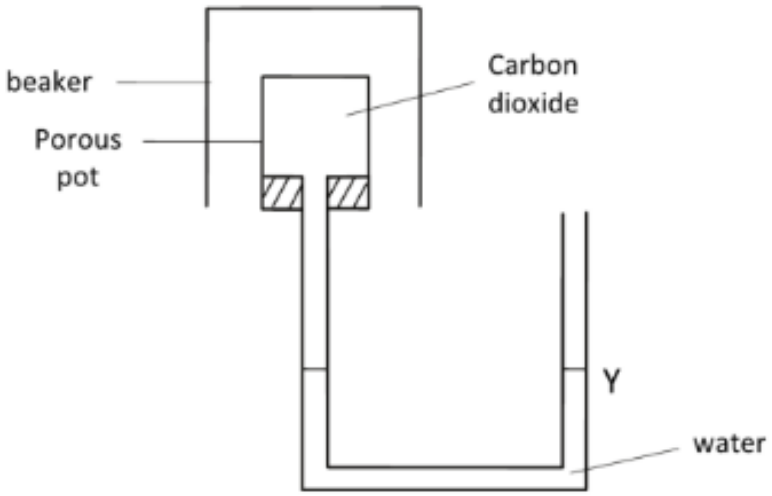
a	a = relative atomic mass
X	X = atomic symbol
b	b = proton (atomic) number

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

1 A student is distilling a mixture of iodine in ethanol (boiling point of ethanol= 78°C). She has just begun to collect the distillate in the receiving flask. At which position in the experimental set-up will the temperature be 78 °C?



2 A beaker containing gas **X** is placed over a porous pot filled with carbon dioxide gas as shown. The level of water at Y rises after a short time. What is a possible identity of gas **X**?



A Chlorine
B Oxygen
C Nitrogen dioxide
D Sulfur dioxide

3 The atomic number of element **X** is 16. Which statement(s) concerning **X** is/are correct?

I. X can react with calcium to form an ionic compound.
II. The oxide of X dissolves in water to form an acidic solution.
III. X can conduct electricity in its molten state.

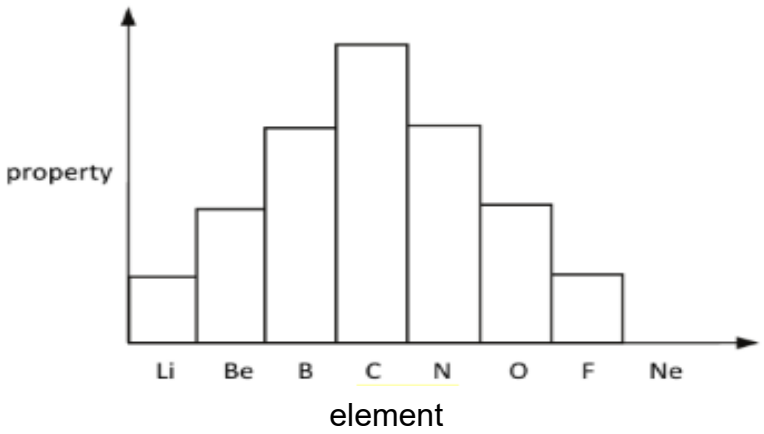
A I and II only
B I and III only
C II and III only
D I, II and III

4 **T** is an element. It can form a cation $\mathbf{T^{2+}}$, which has an electronic arrangement 2.8.8. Which statements about T are correct?

I. T is a strong oxidising agent.
II. T is in Period 4 of the Periodic Table.
III. T burns in oxygen to form a white solid.

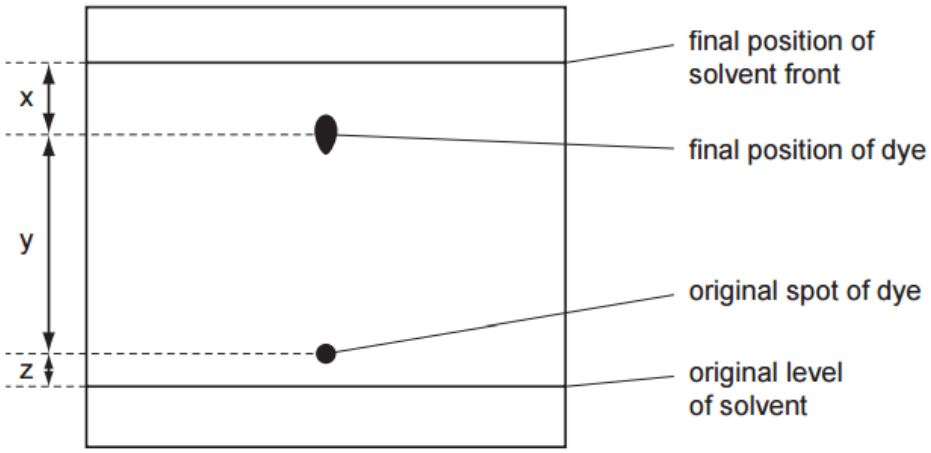
A I and II only
B I and III only
C II and III only
D I, II and III

5 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 number of electrons used in bonding
B The number of shells holding electrons
C The melting point
D The atomic radius

6 The diagram shows the chromatogram obtained by analysis of a single dye. Three measurements are shown.



How is the R_f value of the dye calculated?

A $\frac{x}{x+y}$

B $\frac{y}{x+y}$

C $\frac{x}{x+y+z}$

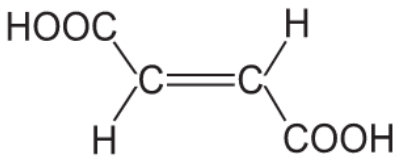
D $\frac{y}{x+y+z}$

7 Silicon carbide, SiC, has a structure similar to diamond. Boron nitride, BN, has a structure similar to graphite. Bronze is an alloy of copper and tin. Which statements about silicon carbide, boron nitride and bronze are correct?

I. All are bonded covalently.
II. All except silicon carbide conduct electricity when solid.
III. All have high melting points.

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

8 The diagram shows the structure an organic compound.



Which of the following statements is **false** for the compound?

A It is immiscible in water.
B It reacts with alcohol under suitable conditions.
C It decolorises aqueous bromine rapidly.
D It reacts with steam.

9 The atmosphere of Venus contains mainly oxygen, argon and nitrogen. The melting and boiling points of these gases are shown in the table below.

Gas	Melting point/ ^{o}C	Boiling point/ ^{o}C
Oxygen	-219	-183
Argon	-189	-186
Nitrogen	-210	-196

If only liquid oxygen is to be obtained, what temperature should the sample of air be decreased to?

A -180^{o}C
B -185^{o}C
C -187^{o}C
D -198^{o}C

10 In an experiment, 4.0 cm^3 of 1.0 mol/dm^3 aqueous copper(II) sulfate was mixed with 8.0 cm^3 of 1.0 mol/dm^3 aqueous sodium carbonate. The equation for the reaction is as shown below.

$$CuSO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + CuCO_3$$

What did the reaction vessel contain when the reaction was completed?

A A blue solution only
B A green precipitate and a blue solution
C A green precipitate and a colourless solution
D A white precipitate and a blue solution

11 A 10.00 g sample of a compound containing only carbon, hydrogen and oxygen forms 23.98 g CO_2 and 4.91 g H_2O upon complete combustion. What is the empirical formula of the compound?

A C_2HO
B C_3H_3O
C $C_6H_3O_2$
D C_6H_6O

12 Carbon monoxide reacts with oxygen according to the equation shown below.

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$$

If all volumes of gases are measured at the same temperature and pressure, what is the total volume of the resulting gas(es), after 50 cm^3 of carbon monoxide reacts with 50 cm^3 of oxygen?

A 100 cm^3
B 75 cm^3
C 50 cm^3
D 25 cm^3

13 Silver ions react with chloride ions as follows:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

It is found that 5 cm^3 of a 0.1 mol/dm^3 solution of the chloride of metal X needs 10 cm^3 of 0.1 mol/dm^3 silver nitrate for complete reaction. What is the formula of the chloride?

A XCl_4
B XCl_2
C XCl
D X_2Cl

14 An aqueous solution of the organic compound methylamine has a pH greater than 7. Which one of the following statements about methylamine is correct?

A It neutralises an aqueous solution of sodium hydroxide.
B It reacts with copper(II) carbonate to give carbon dioxide.
C It reacts with hydrochloric acid to form a salt.
D It turns blue litmus red.

15 Which equation describes the most suitable reaction for making lead(II) sulfate?

A $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$
B $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + CO_2 + H_2O$
C $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
D $Pb(OH)_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

16 The table below shows the properties of some elements, **W**, **X**, **Y** and **Z** in Period 3.

	W	**X**	**Y**	**Z**
Appearance at room temperature	Silvery grey solid	Yellow solid	Silvery grey solid	Yellowish-green gas
Reaction with cold water	Extremely violent reaction	No reaction	No reaction	Slow reaction
Nature of oxide	Reacts with acids	Reacts with bases	Reacts with acids and bases	Reacts with bases

Which of the following shows the arrangement of these elements in the Periodic Table in **increasing** order of group number, from the smallest to the largest?

A W, X, Y, Z
B W, Y, X, Z
C Y, W, X, Z
D Z, X, Y, W

17 Three experiments are carried out to determine the reactivity of three unknown halogens. The ionic equations of the three experiments are shown below.

$Z^-(aq) + Y_2(aq) \rightarrow$ no reaction

$X^-(aq) + Z_2(aq) \rightarrow$ no reaction

$2Y^-(aq) + X_2(aq) \rightarrow 2X^-(aq) + Y_2(aq)$

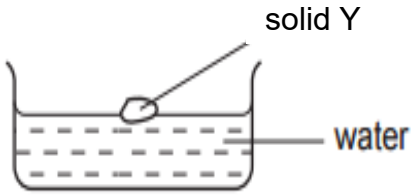
Predict the reactivity of the halogens in **decreasing** order.

A X, Y, Z
B X, Z, Y
C Z, Y, X
D Z, X, Y

18 When heated, solid X gives off gas. When this gas is bubbled through limewater, a white precipitate is formed. The residue after heating solid X reacts with dilute acid and also with aqueous alkali. What is X?

A Magnesium carbonate
B Aluminium oxide
C Calcium hydroxide
D Zinc carbonate

19 When solid Y reacts with water, a solution and a gas are produced.



The universal indicator changed from green to purple and the gas extinguished a lighted splint with a 'pop' sound.

What is the identity of solid Y and the explanation for the test for the gas formed?

	Identity of solid Y	**Is gas flammable?**
A	Calcium	Yes
B	Calcium	No
C	Sodium	No
D	Sodium	Yes

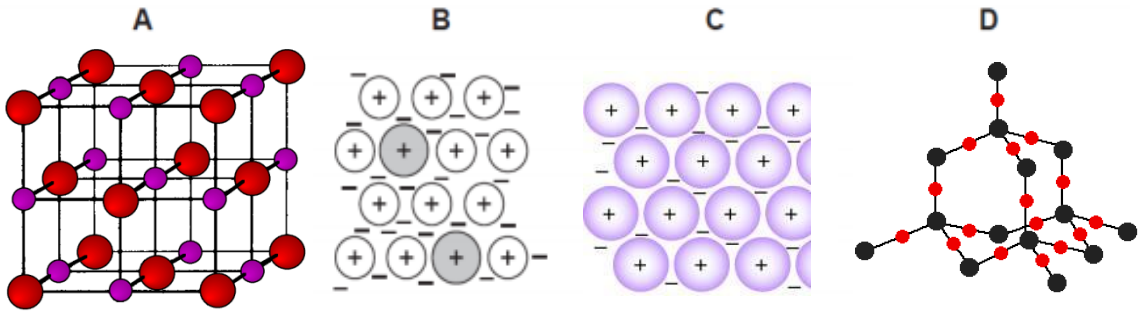
20 The red colour in some pottery glazes may be formed as a result of the reactions shown.

$$CuCO_3 \xrightarrow{\text{heat}} CuO + CO_2$$
$$CuO + SnO \longrightarrow Cu + SnO_2$$

These equations show that …….**1**…… is oxidised and …….**2**…… is reduced.
Which substances correctly complete gaps **1** and **2** in the above sentence?

	1	**2**
A	CO_2	SnO_2
B	$CuCO_3$	CuO
C	CuO	SnO
D	SnO	CuO

21 Which diagram represents the structure of an alloy?



22 An element has the following properties.

- It forms coloured compounds.
- It acts as a catalyst.
- It melts at 1539°C.

In which Period is the element likely to be found?

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

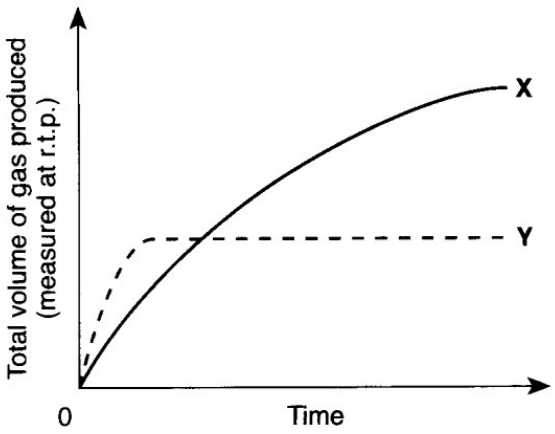
23 Calcium carbonate reacts with dilute hydrochloric acid as shown:

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

Which option shows the correct effect on the rate of the reaction when a factor is changed?

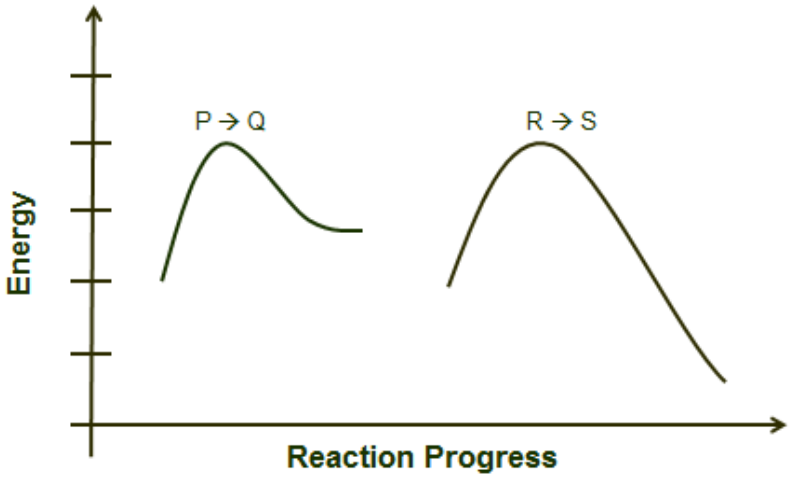
	Factor changed	**Rate of reaction**
A	Particle size of calcium carbonate increased	Increased
B	Concentration of hydrochloric acid increase	Increased
C	Pressure of carbon dioxide increased	Increased
D	Temperature increased	Decreased

24 In the graph shown below, curve **X** represents the results of the reaction between 2g of zinc granules and excess acid at 25°C. Which of the following changes would produce curve **Y**?



A Using 1 g of zinc powder at 25°C
B Using 2 g of zinc powder at 30°C
C Using 1 g of zinc granules at 25°C
D Using 2 g of zinc granules at 30°C

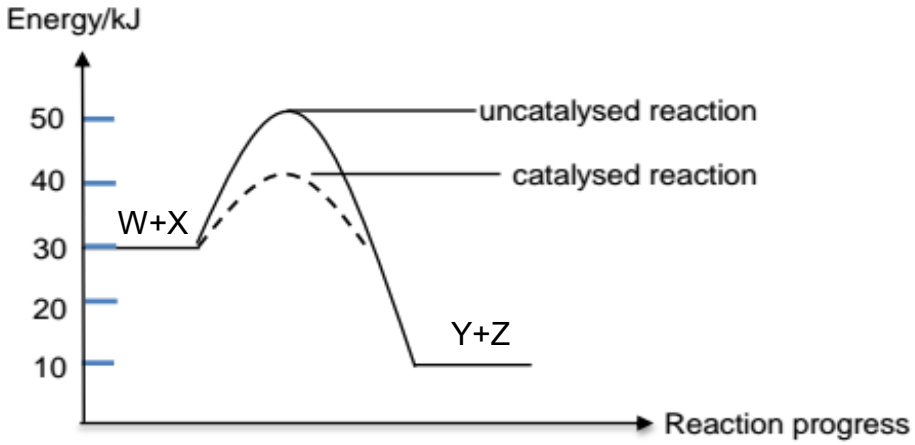
25 From the energy profiles for the two reactions below, how will the rates of the two reactions compare if the temperature of each reaction is increased from 25°C to 75°C?



A The rate of reaction P → Q will increase more than the rate of R → S.
B The rate of P → Q will decrease but the rate of R → S will increase.
C The rate of reaction R → S will increase more than the rate of P → Q.
D The rates of the two reactions will increase by the same amount.

26 A reversible reaction is represented by the equation W + X $\rightleftharpoons$ Y +Z.

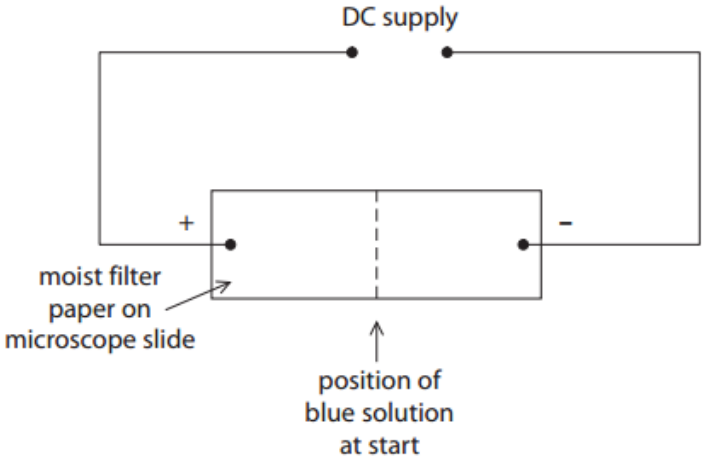
The energy profiles for the reversible reaction under catalysed and uncatalysed conditions are shown below.



What is the activation energy of the reverse reaction that is catalysed?

A -40kJ
B -10kJ
C +30kJ
D +40kJ

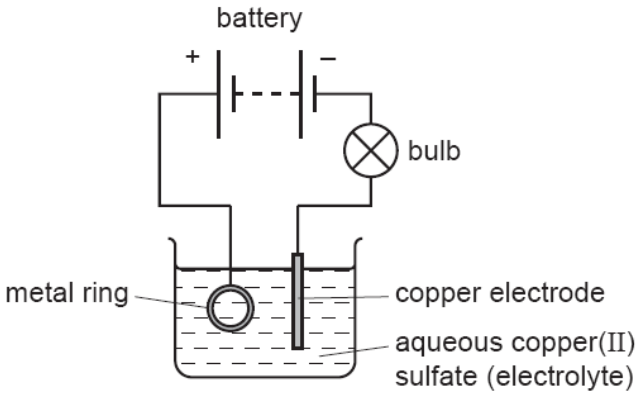
27 A spot of blue solution was placed in the centre of a piece of moist filter paper supported on a microscope slide and a DC voltage applied across the filter paper.



After some time, a blue colour moved towards the negative terminal and no change was visible in the region of the positive terminal. What statement best describes this observation?

A The negative ions in the solution were colourless and the positive ions were blue.
B The positive ions in the solution were colourless and the negative ions were blue.
C The negative ions in the solution had not moved but the positive ions had moved.
D The positive ions in the solution had not moved but the negative ions had moved.

28 The diagram shows the apparatus used in an attempt to electroplate a metal ring with copper.



The experiment did not work.
Which change is needed in the experiment to make it work?

A Add solid copper(II) sulfate to the electrolyte.
B Increase the temperature of the electrolyte.
C Replace the copper electrode with a carbon electrode.
D Reverse the connection to the battery.

29 Metal **X** reacts with dilute hydrochloric acid. It is used in the building of bridges and beams in buildings.

Metal **Y** does not corrode easily. It can be used for jewellery.

Metal **Z** reacts rapidly with water to form hydrogen.

Which method of extraction of the metals from their ores is most likely to be used?

	Electrolysis of molten ore	**Heating with carbon**
A	X and Y	Z
B	X and Z	Y
C	Y	X and Z
D	Z	X and Y

30 Three electrochemical cells are set up using copper metal as one electrode and one of three unknown metals, U, V and W as the second electrode, immersed in aqueous sodium nitrate of the same concentration.

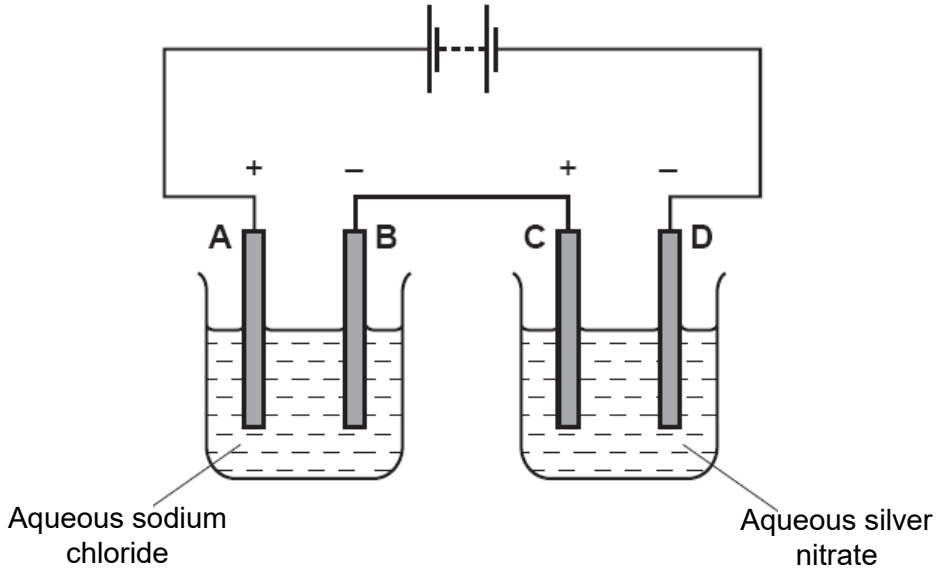
The potential differences between the metals are given in the table below.

Electrochemical cell	Metals used	Voltage/ V	Negative electrode
1	Cu, U	-0.45	Cu
2	Cu, V	+1.11	V
3	Cu, W	+2.71	W

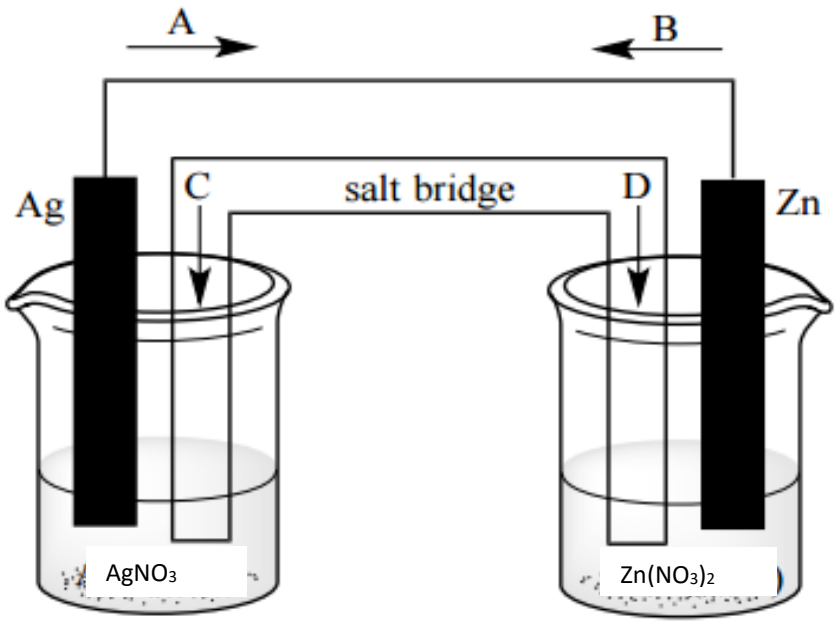
Which of the following correctly lists the metals in order of **increasing** reactivity?

A U V Cu W
B U Cu V W
C W V Cu U
D W Cu V U

31 The diagram shows an electrolysis circuit. At which electrode is hydrogen formed?



32 In an electrochemical cell shown below, which arrow indicates the spontaneous electron flow?



33 Hydrazine has the formula H_2NNH_2 and has similar properties to ammonia. Which statement correctly describes the property of hydrazine?

A It reacts with hydrogen chloride to form a compound with the chemical formula ClH_3NNH_3Cl.
B It reacts with sodium hydroxide to form a compound with the chemical formula NaHNNHNa.
C It is an ionic compound.
D It dissolves in water to form hydrogen ions.

34 To reduce atmospheric pollution, the following waste gases are passed through powdered calcium carbonate.

Carbon monoxide	Carbon dioxide	Nitrogen monoxide
Nitrogen dioxide	Sulphur dioxide	Phosphorus (V) oxide

How many waste gases will **not** be removed by the powdered calcium carbonate?

A 1
B 2
C 3
D 4

35 What environmental effects do chlorofluorocarbons, methane and nitrogen dioxide result in?

	chlorofluorocarbons	**methane**	**nitrogen dioxide**
A	Acid rain	Depletion of the ozone layer	Global warming
B	Depletion of the ozone layer	Acid rain	Global warming
C	Depletion of the ozone layer	Global warming	Acid rain
D	Global warming	Depletion of the ozone layer	Acid rain

36 The table below shows some data about the composition of the mixtures of exhaust gases from two cars, one fitted with a catalytic converter and one without.

	% by volume of nitrogen monoxide	% by volume of carbon dioxide	% by volume of water vapour
Car without catalytic converter	67.60	12.00	11.00
Car with catalytic converter	23.60	32.35	41.10

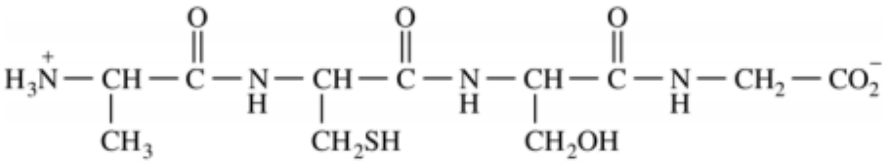
Which statement does **not** explain the above data?

A The percentage of nitrogen monoxide decreases as it is oxidised to form harmless nitrates, carbon dioxide and water in the catalytic converter.
B The percentage of nitrogen monoxide decreases as it is reduced to form nitrogen in the catalytic converter.
C The percentage of carbon dioxide increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.
D The percentage of water vapour increases as unburnt hydrocarbons undergo complete combustion in the catalytic converter.

37 Ammonia is produced by the Haber process. Which statement is **not** correct?

A A catalyst of iron(II) oxide is used.
B Each nitrogen molecule reacts with three hydrogen molecules to form two molecules of ammonia.
C Hydrogen for the process can be obtained by cracking of some fractions of crude oil.
D Two ammonia molecules decompose to form one nitrogen molecule and three hydrogen molecules.

38 What is the total number of amide linkages in the structure shown below?



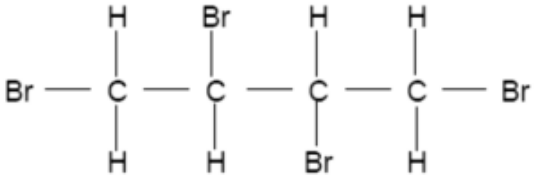
A 1
B 2
C 3
D 4

39 An ester is made by reacting alcohol **P** with a carboxylic acid **Q**. Alcohol **P** can be oxidised to form **Q** by warming with acidified potassium manganate(VII), under reflux.

What might be the structural formula for the ester made?

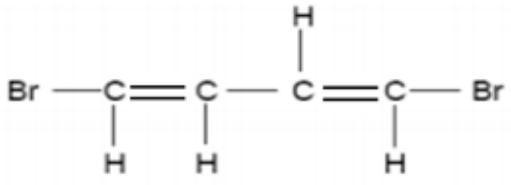
A CH_3OOCH_3
B $CH_3COOCH_2CH_3$
C $CH_3CH_2COOCH_2CH_3$
D $CH_3CH_2CH_2COOCH_2CH_3$

40 When an organic compound **R** reacts with aqueous bromine, the product formed is shown below.

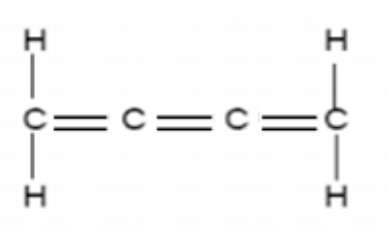


Which of the following structures is the organic compound **R** most likely to be?

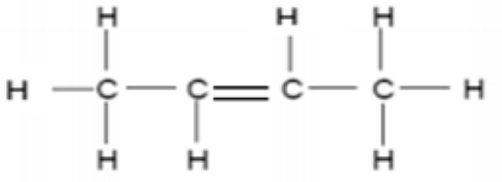
A



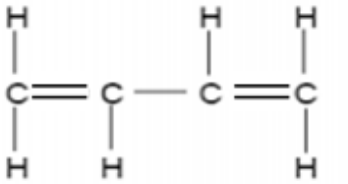
B



C



D



SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination 2016

CHEMISTRY 5073/01

PAPER 1 Multiple Choice ANSWER

Friday **12 AUGUST 2016**

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

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME							
CLASS	4			REGISTER NUMBER			
CENTRE NUMBER					INDEX NUMBER			

Chemistry

5073/02

Paper 2 Theory

Thursday **4 August 2016** **1 hour 45 minutes**

Candidates answer on the Question Paper.
No Additional materials are required.
READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer **all** 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 20.

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

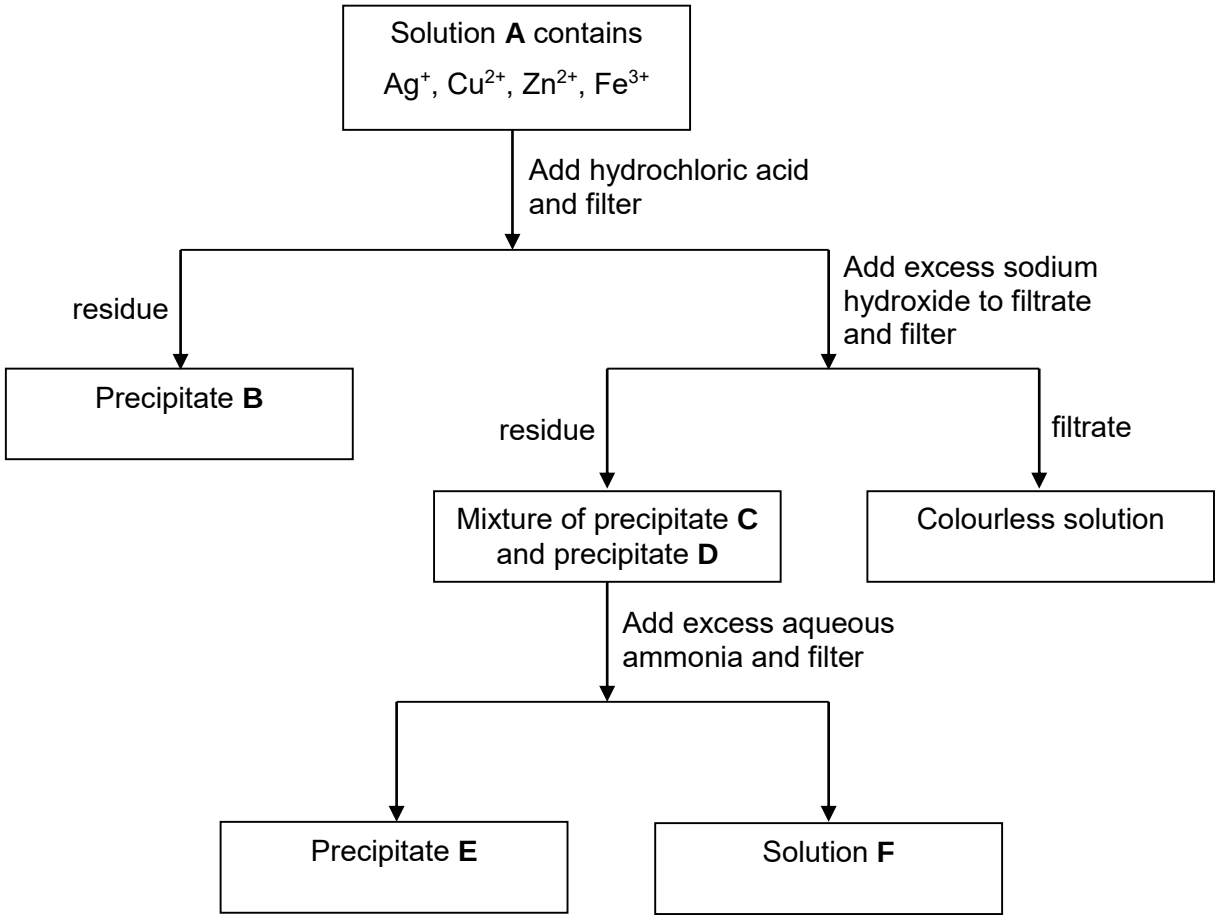
For Examiner's Use	
Section A	/50
B8	/12
B9	/8
B10	/10
Total	/80

This question paper consists of **20** printed pages.

Section A

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

A1 The flowchart below shows how the ions present in solution **A** are separated.



(a) It is known that solution **A** contains 1 anion. Suggest the identity of this anion. Give a reason for your answer.

Identity of anion : ……

Reason : …….. [2]

(b) Describe a test to confirm the anion you named in part (a).

……

……

…… [2]

(c) Name the precipitates **B**, **C** and **D**.

B : ……..

C : ……..

D : …….. [3]

(d) What are the colours of precipitate **E** and Solution **F**?

Precipitate **E** : ……

Solution **F** : …… [2]

[Total: 9]

A2 The level of dissolved oxygen is used as an indicator to gauge the health of a water body. Generally, the higher the concentration of dissolved oxygen, the less polluted the water and the more likely it is able to support living organisms. To measure the level of oxygen in a sample of water, the Winkler Method is used. This technique makes use of redox reactions and is carried out in the 3 steps shown below.

Reaction 1 : $2Mn^{2+}(aq) + O_2(g) + 4OH^-(aq) \rightarrow 2MnO_2(s) + 2H_2O(l)$

Reaction 2 : $MnO_2(s) + 2I^-(aq) + 4H^+(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2H_2O(l)$

Reaction 3 : $2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

(a) Define a redox reaction.

……

……

…… [1]

(b) Choose any **one** of the above reactions and explain why it is a redox reaction, making reference to oxidation states.

Reaction ……

Explanation : ……

……

……

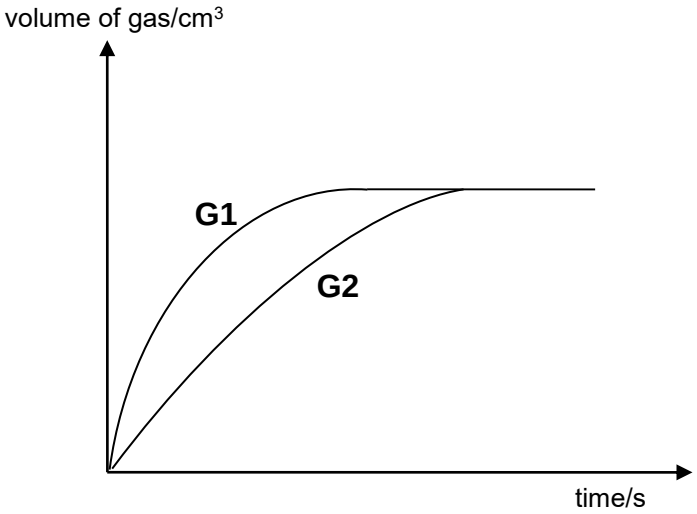
…… [2]

(c) 100 cm^3 of water was taken from the school's koi pond and analysed using this method. It was found that 0.0008 mole of iodide ions was formed in step 3. Calculate the mass of oxygen dissolved in this sample of pond water.

[2]

[Total: 5]

A3 A sample of 3.36 g of magnesium carbonate powder was divided equally into two portions. One portion was added into hydrochloric acid and the other portion was added into sulfuric acid. The volume and concentration of acids used were both 25.0 cm^3 and 5.00 mol/dm^3 respectively. The graphs below (**G1** and **G2**) show the volume of the gas collected over time.



(a) Which graph represents the results for hydrochloric acid? Explain your answer in terms of particle collision.

Graph ……

Explanation : ……

……

……

……

……

……

……

…… [4]

(b) Another experiment was carried out by adding 2.00 g calcium carbonate powder into 25.0 cm^3 of sulfuric acid of concentration 5.00 mol/dm^3. On the same axes, sketch the graph you will expect to obtain and label it **C**. [1]

(c) Explain the shape of your graph.

.....

.....

.....

.....

..... [2]

[Total: 7]

A4 Astatine, At, is an element in Group VII of the Periodic Table. It exists as diatomic molecules similar to the other elements in the same Group. 2 isotopes of astatine are known to exist : astatine-210 and astatine-211. It reacts with strontium (Sr) to form the compound strontium astatide.

symbol	number of protons	number of electrons	number of neutrons
$^{210}_{85}At$	.....	.....	.....
$^{211}_{85}At$	.....	.....	.....

(a) Complete the table above. [1]

(b) What are isotopes?

.....

.....

..... [1]

(c) Draw the 'dot-and-cross' diagram for an astatine molecule, showing only the outer shell electrons.

[1]

(d) Draw the "dot-and-cross" diagram of strontium astatide, showing only the outer shell electrons. Hence write the chemical formula of this compound.

Formula of strontium astatide : …….. [3]

(e) Predict 2 properties of strontium astatide. Give a reason for each of the properties which you state.

Property 1 : ……

Reason : ……

……. [2]

Property 2 : ……

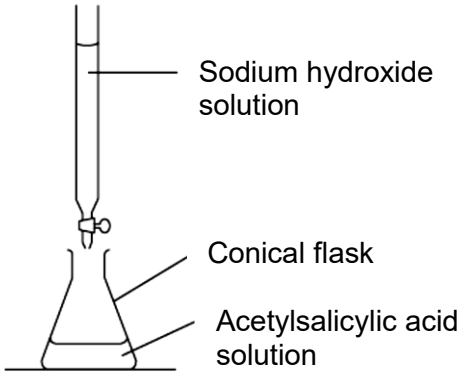
Reason : ……

……. [2]

[Total: 10]

A5 The drug aspirin is used to relieve pain, fever and inflammation. However, if taken in high doses, it can cause gastric ulcers and bleeding in the stomach. The active ingredient is acetylsalicylic acid which a monobasic acid. The formula of the acid can be represented by HA and its relative molecular mass is 180.

A student was interested in determining the percentage of the acid in an aspirin tablet. An aspirin tablet was first weighed and then dissolved in water to make a solution in a conical flask. A few drops of indicator were then added and dilute sodium hydroxide solution was run in from a burette until the indicator changed colour.



The results were as follows :

Mass of aspirin tablet taken	0.50 g
Volume of dilute sodium hydroxide added	23.0 cm^3
Concentration of the dilute sodium hydroxide added	0.01 mol/dm^3

(a) Acetylsalicylic acid is a weak acid. Explain what is a *weak* acid.

……

…… [1]

(b) Explain why it is **not** important to know the volume of the aspirin solution originally taken.

……

…… [1]

(c) Calculate the number of moles of sodium hydroxide solution added. Hence, calculate the percentage of acetylsalicylic acid in the aspirin tablet.

[3]

(d) The student wanted to make a crystalline sample of sodium acetylsalicylate, the salt formed in the reaction. This salt decomposes on strong heating. Describe briefly how this might be carried out using a solution of pure acetylsalicylic acid.

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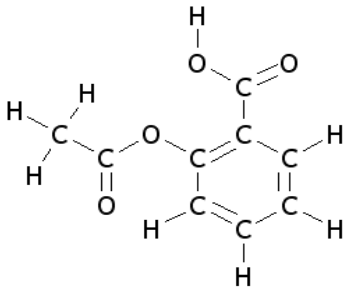
..... [3]

(e) The structure of acetylsalicylic acid is given below.



Draw the structure of sodium acetylsalicylate.

[1]

[Total: 9]

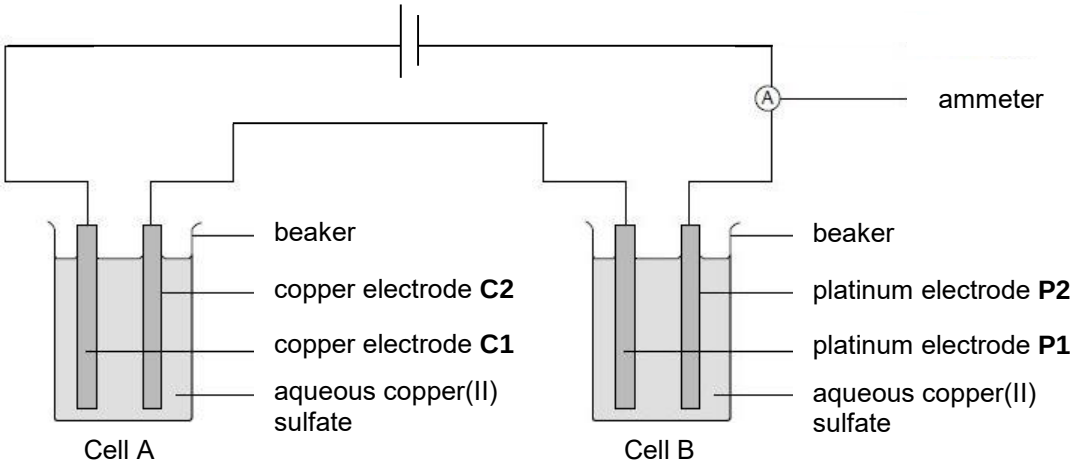
A6 A student carried out electrolysis of dilute potassium chloride and molten potassium chloride using platinum electrodes to determine what products are formed.

(a) Complete the table below.

Electrolyte	Ions in Electrolyte	Product at anode	Product at cathode
Dilute potassium chloride		oxygen	
Molten potassium chloride	K^+, Cl^-		

[2]

In another investigation, the electrolysis of aqueous copper(II) sulfate was carried out using the apparatus shown in the diagram below.



(b) **Briefly** describe the change(s), if any, which take place at the electrodes and electrolytes at the end of the experiment in the table below.

	Change(s), if any
Electrode **C1**	
Electrode **C2**	
Electrolyte (Cell A)	

	Change(s), if any
Electrode **P1**	
Electrode **P2**	
Electrolyte (Cell B)	

[3]

[Total: 5]

A7 Hydrazine (N_2H_4) is often used as a rocket fuel. It can react with oxygen or fluorine to release large amounts of heat. The equations for the 2 reactions are shown below.

$$N_2H_4\ (g) + O_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g) \qquad \Delta H = -622kJ$$

$$N_2H_4\ (g) + 2F_2\ (g) \rightarrow N_2\ (g) + 4HF\ (g) \qquad \Delta H = -1166kJ$$

The ΔH values represent the energy change per mole of hydrazine reacted.

(a) Draw the energy profile diagram for the reaction between hydrazine and oxygen, showing the activation energy and the enthalpy change clearly.

[2]

(b) Based only on the information provided above, which other reactant (oxygen or fluorine) would have made a better choice for usage as a rocket fuel together with hydrazine? Briefly explain your answer.

……

……

……

……

……

…… [2]

(c) State 1 other factor that should be taken into consideration when deciding which fuel to use.

…… [1]

[Total: 5]

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 The table below gives the current estimated percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's Crust		**Earth's Core**	
Element	% by Mass	Element	% by Mass
Oxygen	40.6	Iron	31.0
Silicon	24.7	Oxygen	24.0
Nickel	8.1	Magnesium	16.0
Aluminium	8.1	Silicon	13.0
Iron	5.0	Nickel	11.7
Calcium	3.6	Aluminium	0.1
Sodium	2.8	Sodium	0.1
Potassium	2.6	Hydrogen	0.05
Magnesium	2.1	Potassium	0.04
Zinc	0.0078	Calcium	0.04
Copper	0.0068		
Tin	0.00022		

(a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

…… [1]

(b) Suggest a reason why oxygen is the most abundant element in the earth's crust.

……

……

…… [1]

(c) The estimated mass of the earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^{9} tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out. (1 tonne = 1000 kg)

[2]

(d) **Briefly** describe **one** advantage and **one** disadvantage of recycling metals.

Advantage : …….

……

Disadvantage : ……

…… [2]

(e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these 2 metals that accounts for this.

Iron : …….

……

Aluminium : …….

…… [2]

A student studied the action of heat on 4 different substances (**A**, **B**, **C** and **D**). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

Solid	Appearance		Mass/g	
	Before	**After**	**Before**	**After**
A	Brown	Black	5.00	6.25
B	Green	Black	5.00	3.22
C	White	White	5.00	5.00
D	Silvery	White	5.00	6.73

(f) Based on the data given above, suggest which 2 were the metals and which 2 were the metal carbonates. Explain your answers.

Metals : Solid …… and Solid ……

Metal carbonates : Solid …… and Solid …… [1]

Explanation : …….

……

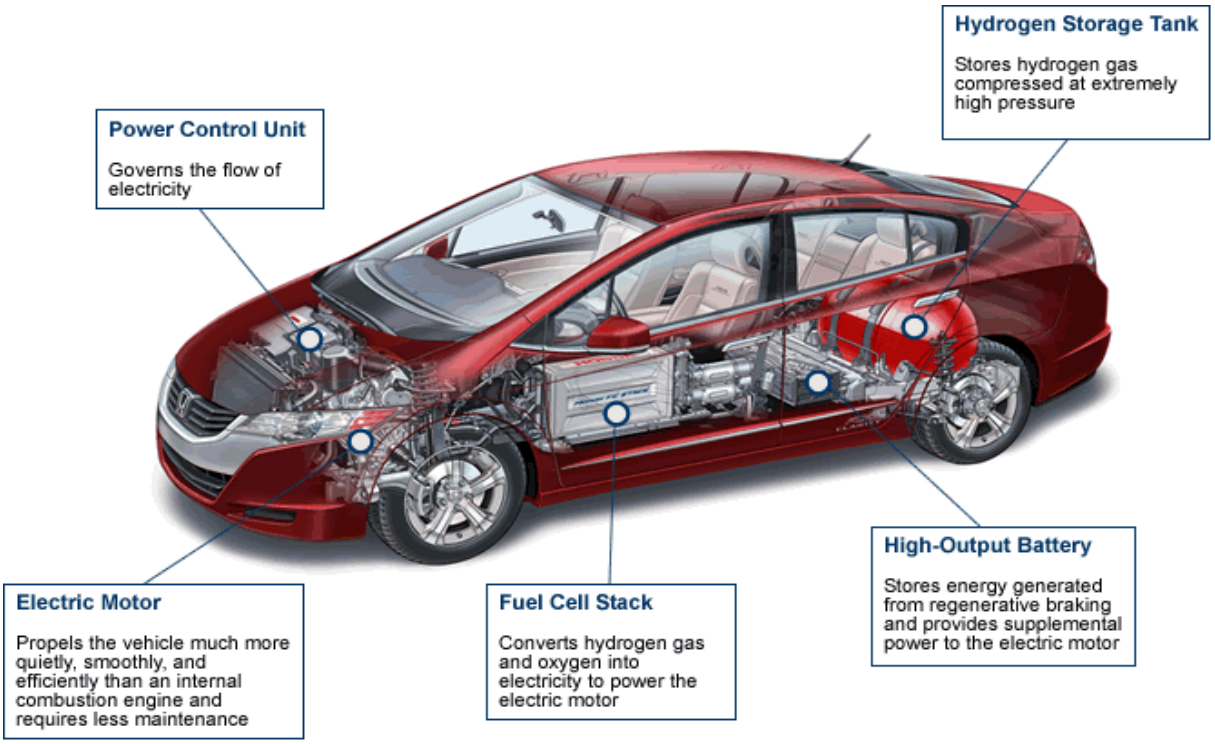
……

……

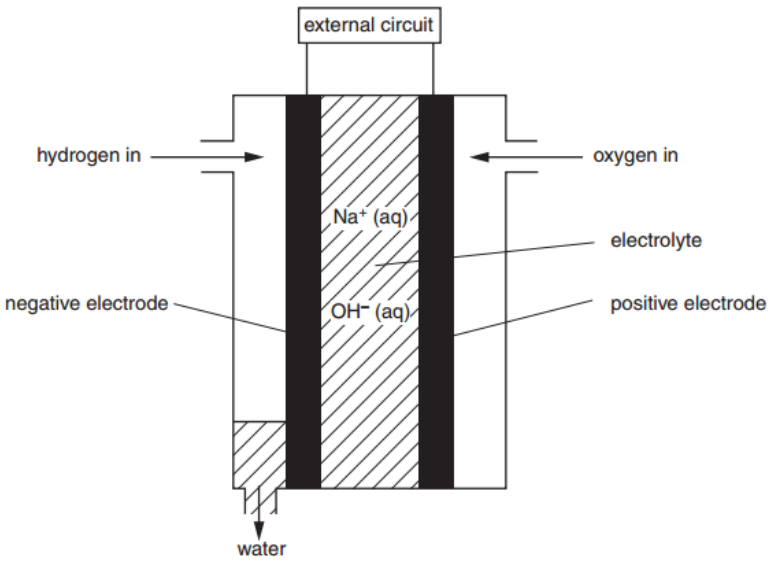
…… [3]

[Total 12]

B9 The diagram below shows the internal setup of a modern eco-friendly car powered by hydrogen-oxygen fuel cells. The main advantages of the use of fuels cells is that hydrogen is an efficient source of energy and it does not cause pollution at the point of use.



The diagram below shows the hydrogen-oxygen fuel cell used in such a car.



At the positive electrode, the reaction which takes place is :

$$O_2\,(g) \;+\; 2H_2O\,(l) \;+\; 4\,e \;\rightarrow\; 4OH^-\,(aq)$$

At the negative electrode, the reaction which takes place is :

$$2H_2\,(g) \;+\; 4OH^-\,(aq) \;\rightarrow\; 4H_2O\,(l) \;+\; 4\,e$$

(a) Write the overall equation for the reaction in the fuel cell.

…….. [1]

(b) Briefly explain why the use of fuel cells does not cause pollution at the point of use.

…….. [1]

(c) Suggest why the use of fuel cells may still generate pollution.

……..

…….. [1]

(d) Manufacturers claim that hydrogen is a renewable fuel. Do you agree? Explain your answer.

……..

…….. [1]

(e) Give a source of oxygen.

…….. [1]

(f) Suggest why the hydrogen and oxygen must be kept apart.

……

…… [1]

(g) Briefly describe one advantage and one disadvantage of compressing hydrogen fuel at high pressure.

Advantage : …….

……

Disadvantage : ……

…… [2]

[Total 8]

EITHER

B10 One of the components in crude oil is undecane, $C_{11}H_{24}$. This molecule may be broken down into butene and one other product. The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

…… [1]

(b) Write the equation for this reaction.

…… [1]

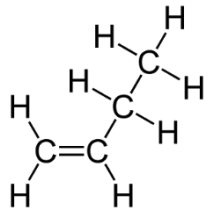
(c) Suggest **2** conditions required for this reaction to take place

…… [1]

(d) When the reaction is carried out, 1.00 mol of undecane gives 25.2 g of butene. Calculate the percentage yield of butene.

[2]

Butene can exist as 3 isomers. One of the isomers, but-1-ene, is shown in the diagram below.



(e) Draw the structures of the other 2 isomers of butene.

[2]

(f) The isomers of butene can undergo addition polymerization. Draw the structure of the polymer formed by any **1** of the isomers in part (e), showing **3** repeating units.

[1]

Butan-2-ol is manufactured by the reaction between steam and butene. An isomer of butan-2-ol is also formed at the same time. The 2 isomers are miscible.

(g) Suggest, with reason, a method suitable for separating the components of the mixture of products.

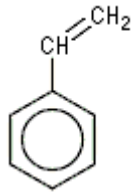
Method : ……

Reason : …… [2]

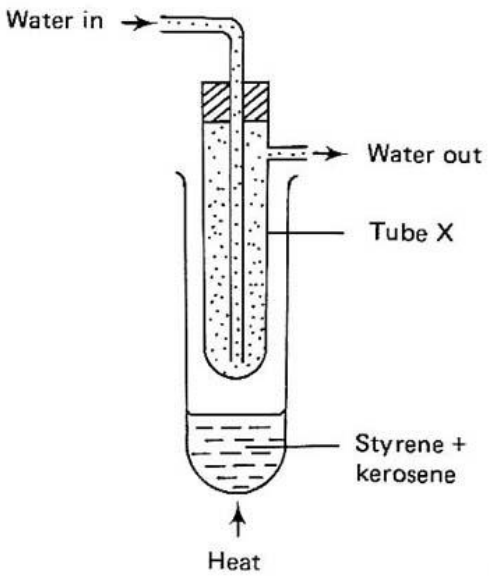
[Total 10]

OR

B10 The compound styrene (chemical formula C_8H_8) has the following structure



It can undergo addition polymerisation to form polystyrene, a non-biodegradable thermoplastic polymer used for making disposable utensils such as styrofoam cups and plates. The polymerisation process is carried out by mixing styrene and kerosene and refluxing the mixture at about 150°C using the setup shown below.



After cooling, the reaction mixture is poured into methanol. Polystyrene, which appears as a waxy white solid will then form under the surface of the methanol.

(a) Suggest the function of

(i) tube **X** and

…… [1]

(ii) kerosene**.**

…… [1]

(b) Draw the structural formula of polystyrene formed, showing 3 repeating units.

[1]

(c) What is meant by the term “non-biodegradable”?

……

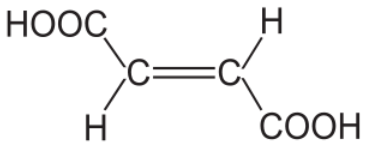
…… [1]

(d) Suggest a reason why polystyrene produces a lot of soot when burnt.

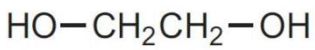
……

…… [1]

The structural formulae of two organic compounds, butenedioic acid and ethane- 1,2-diol are shown below.



butenedioic acid



ethane- 1,2- diol

(e) Butenedioic acid reacts with aqueous bromine and also with aqueous sodium carbonate. State an observation for each reaction and briefly explain why it is observed.

Reactant	Observation	Explanation
Aqueous bromine		
Aqueous sodium carbonate		

[4]

(f) Butenedioic acid and ethane-1,2-diol can polymerize under the right conditions to form a polymer W. Draw the repeating unit of this polymer.

[1]

[Total 10]

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 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	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.).

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME							
CLASS	4			REGISTER NUMBER			
CENTRE NUMBER					INDEX NUMBER			

Chemistry

5073/02

Paper 2 Theory

Thursday **4 August 2016** **1 hour 45 minutes**

Candidates answer on the Question Paper.
No Additional materials are required.
READ THESE INSTRUCTIONS FIRST

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

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

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

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 20.

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

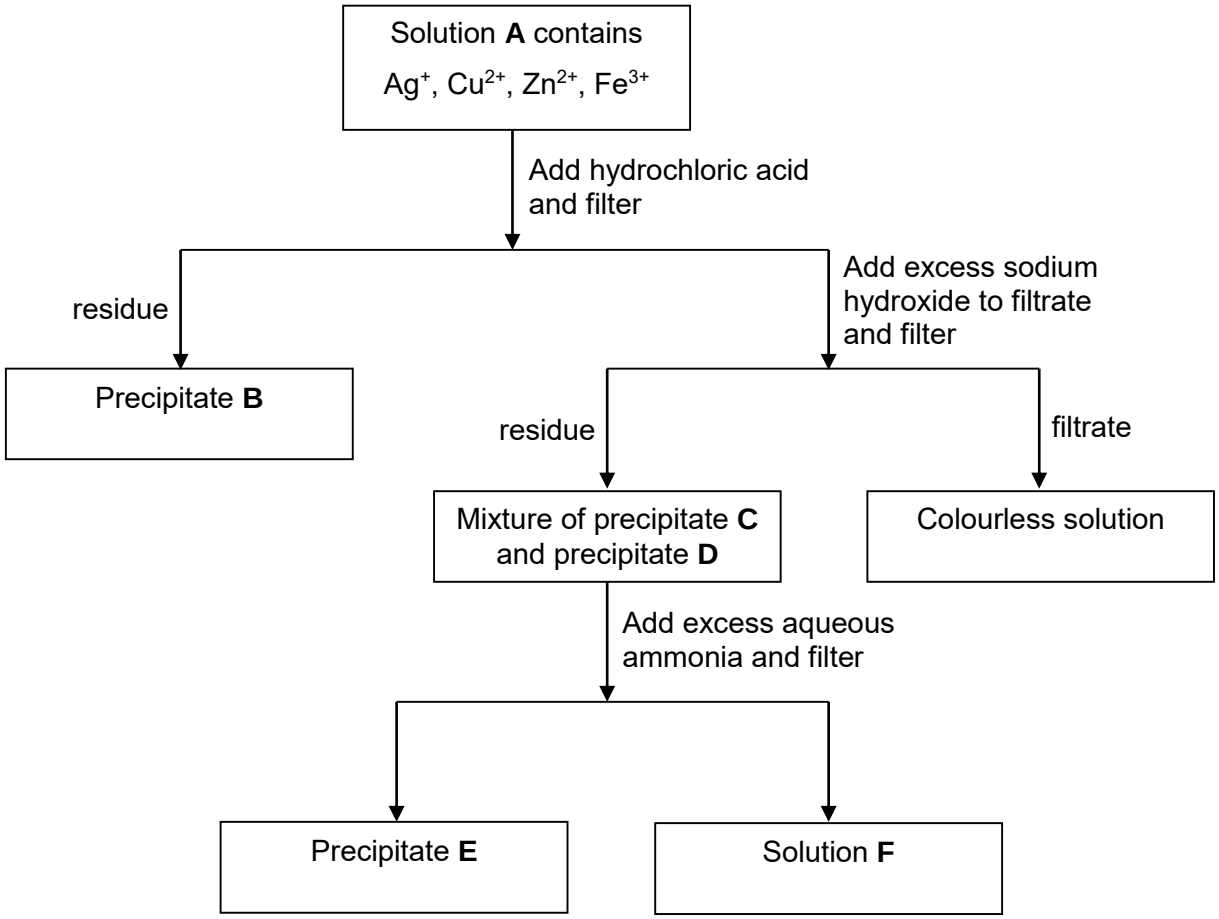
Answers

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

Section A

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

A1 The flowchart below shows how the ions present in solution **A** are separated.



(a) It is known that solution **A** contains 1 anion. Suggest the identity of this anion. Give a reason for your answer.

Identity of anion : Nitrate **1m**

Reason : All nitrates are soluble **1m** [2]

(b) Describe a test to confirm the anion you named in part (a).

Add aqueous sodium hydroxide, Devarda's alloy/aluminium and warm; **1m**

Gas given off turns moist red litmus paper blue **1m**

…… [2]

(c) Name the precipitates **B**, **C** and **D**.

B : silver chloride **1m**

C : copper(II) hydroxide **1m**

D : iron(III) hydroxide **1m**

Answers to C and D interchangeable

[3]

(d) What are the colours of precipitate **E** and Solution **F**?

Precipitate **E** : reddish brown **1m**

Solution **F** : dark blue **1m** [2]

[Total: 9]

A2 The level of dissolved oxygen is used as an indicator to gauge the health of a water body. Generally, the higher the concentration of dissolved oxygen, the less polluted the water and the more likely it is able to support living organisms. To measure the level of oxygen in a sample of water, the Winkler Method is used. This technique makes use of redox reactions and is carried out in the 3 steps shown below.

Reaction 1 : $2Mn^{2+}(aq) + O_2(g) + 4OH^-(aq) \rightarrow 2MnO_2(s) + 2H_2O(l)$

Reaction 2 : $MnO_2(s) + 2I^-(aq) + 4H^+(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2H_2O(l)$

Reaction 3 : $2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

(a) Define a redox reaction.

Reaction which involves oxidation and reduction simultaneously **1m**

……

…… [1]

(b) Choose any **one** of the above reactions and explain why it is a redox reaction, making reference to oxidation states.

Reaction 1 : Oxidation state of Mn increases from +2 in Mn^{2+} to +4 in MnO_2 **1m**
Oxidation state of O decreases from 0 in O_2 to -2 in MnO_2/H_2O **1m**

Reaction 2 : Oxidation state of Mn decreases from +4 in MnO_2 to +2 in Mn^{2+} **1m**
Oxidation state of I increases from -1 in I^- to 0 in I_2 1m

Reaction 3 : Oxidation state of S increases from +2 in $S_2O_3^{2-}$ to +2.5 in $S_4O_6^{2-}$ **1m**
Oxidation state of I decreases from 0 in I_2 to -1 in I^- **1m**

[2]

Any 1 of above

(c) 100 cm^3 of water was taken from the school's koi pond and analysed using this method. It was found that 0.0008 mole of iodide ions was formed in step 3. Calculate the mass of oxygen dissolved in this sample of pond water.

0.0008 moles of I^- is produced by 0.0004 mole of I_2
0.0004 moles of I_2 is produced by 0.0004 mole of MnO_2
0.0004 moles of MnO_2 is produced by 0.0002 mole of O_2

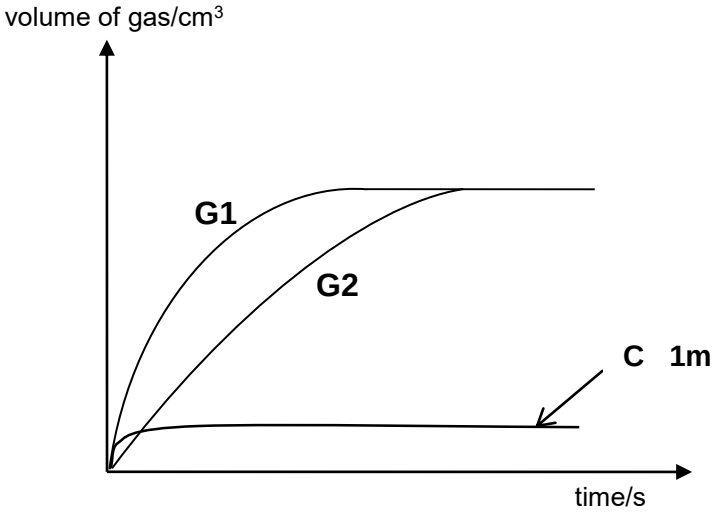
} Explanation **1m**

Mass of oxygen dissolved = 0.0002 x 32 = 0.0064 g **1m**

[2]

[Total: 5]

A3 A sample of 3.36 g of magnesium carbonate powder was divided equally into two portions. One portion was added into hydrochloric acid and the other portion was added into sulfuric acid. The volume and concentration of acids used were both 25.0 cm^3 and 5.00 mol/dm^3 respectively. The graphs below (**G1** and **G2**) show the volume of the gas collected over time.



(a) Which graph represents the results for hydrochloric acid? Explain your answer in terms of particle collision.

Graph G2 **1m**

Explanation : sulfuric acid is dibasic while hydrochloric acid is monobasic acid,

concentration of hydrogen ions in HCl is half that of H_2SO_4 ; **1m**

frequency of collisions is lower and hence number of effective collisions per

unit time is less in HCl compared to H_2SO_4; **1m**

rate of reaction is slower, graph is less steep; **1m**

MgCO3 is the same limiting reactant **1m**

Any 4 out of 5 points **4m**

…… [4]

(b) Another experiment was carried out by adding 2.00 g calcium carbonate powder into 25.0 cm^3 of sulfuric acid of concentration 5.00 mol/dm^3. On the same axes, sketch the graph you will expect to obtain and label it **C**. [1]

(c) Explain the shape of your graph.

Calcium carbonate reacts with sulfuric acid to form calcium sulfate which is insoluble ; **1m**

layer of calcium sulfate around calcium carbonate prevents further reaction with the acid **1m**

..... [2]

[Total: 7]

A4 Astatine, At, is an element in Group VII of the Periodic Table. It exists as diatomic molecules similar to the other elements in the same Group. 2 isotopes of astatine are known to exist : astatine-210 and astatine-211. It reacts with strontium (Sr) to form the compound strontium astatide.

symbol	number of protons	number of electrons	number of neutrons
$^{210}_{85}At$	..... 85	..... 85	..... 125 .....
$^{211}_{85}At$	..... 85	..... 85	..... 126 .....

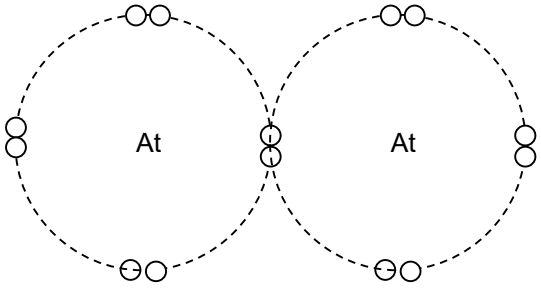
(a) Complete the table above. All correct **1m** [1]

(b) What are isotopes?

Atoms of same element with same number of protons but different number of neutrons **1m**

..... [1]

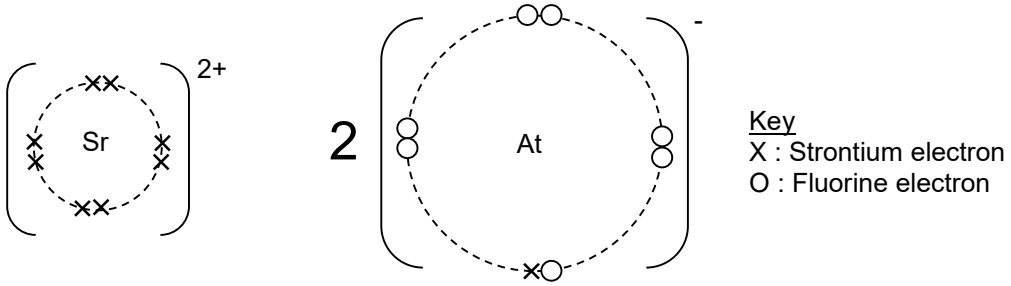
(c) Draw the 'dot-and-cross' diagram for an astatine molecule, showing only the outer shell electrons.



Correct number of electrons and 1 pair of shared electrons **1m**

[1]

(d) Draw the "dot-and-cross" diagram of strontium astatide, showing only the outer shell electrons. Hence write the chemical formula of this compound.



1m **1m**

Formula of strontium astatide : $\underline{SrAt_2}$ **1m** [3]

(e) Predict 2 properties of strontium astatide. Give a reason for each of the properties which you state.

Property 1 : high melting/boiling point **1m**

Reason : strong electrostatic forces of attraction between ions, a lot of energy required to overcome them **1m** [2]

Property 2 : can conduct electricity in the molten/aqueous state **1m**

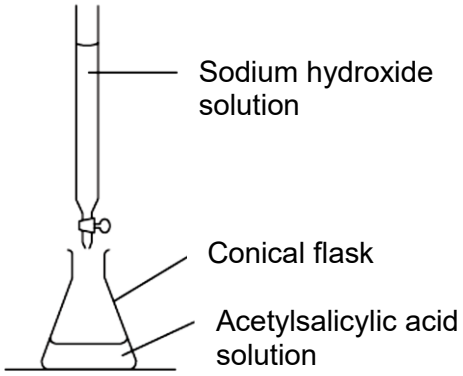
Reason : mobile ions in the molten/aqueous state **1m**

[2]

[Total: 10]

A5 The drug aspirin is used to relieve pain, fever and inflammation. However, if taken in high doses, it can cause gastric ulcers and bleeding in the stomach. The active ingredient is acetylsalicylic acid which a monobasic acid. The formula of the acid can be represented by HA and its relative molecular mass is 180.

A student was interested in determining the percentage of the acid in an aspirin tablet. An aspirin tablet was first weighed and then dissolved in water to make a solution in a conical flask. A few drops of indicator were then added and dilute sodium hydroxide solution was run in from a burette until the indicator changed colour.



The results were as follows :

Mass of aspirin tablet taken	0.50 g
Volume of dilute sodium hydroxide added	23.0 cm^3
Concentration of the dilute sodium hydroxide added	0.01 mol/dm^3

(a) Acetylsalicylic acid is a weak acid. Explain what is a *weak* acid.

Acid undergoes partial ionization in water **1m**

…… [1]

(b) Explain why it is **not** important to know the volume of the aspirin solution originally taken.

All the acetylsalicylic acid is dissolved in the water regardless of its volume **1m**

…… [1]

(c) Calculate the number of moles of sodium hydroxide solution added. Hence, calculate the percentage of acetylsalicylic acid in the aspirin tablet.

No of moles of NaOH = (23.0/1000) x 0.01 = 0.00023
Hence, no of moles of acid present = 0.00023 **1m**
Mass of acetylsalicylic acid present = 0.00023 x 180 = 0.0414 g **1m**

Hence, percentage of acetylsalicylic acid in tablet = (0.0414/0.50) x 100%
= 8.28% **1m**

[3]

(d) The student wanted to make a crystalline sample of sodium acetylsalicylate, the salt formed in the reaction. This salt decomposes on strong heating. Describe briefly how this might be carried out using a solution of pure acetylsalicylic acid.

Determine the exact volume of sodium hydroxide required to neutralize a fixed volume of acetylsalicylic acid by titration using a suitable indicator. Repeat a few times to obtain accurate result ;

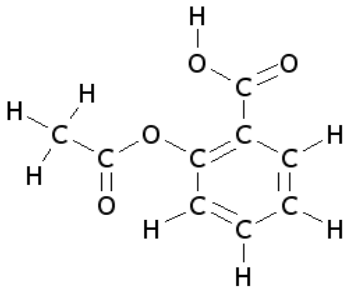
Add exact volume of sodium hydroxide into fixed volume of acetylsalicylic acid but do not add indicator, **1m** heat to obtain saturated solution and cool solution to allow crystallization to take place; **1m** filter to obtain crystals and dry between pieces of filter paper. **1m**

……

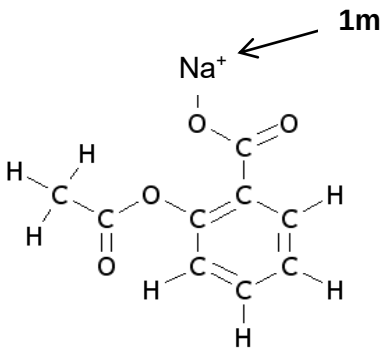
……

…… [3]

(e) The structure of acetylsalicylic acid is given below.



Draw the structure of sodium acetylsalicylate.



[1]

[Total: 9]

A6 A student carried out electrolysis of dilute potassium chloride and molten potassium chloride using platinum electrodes to determine what products are formed.

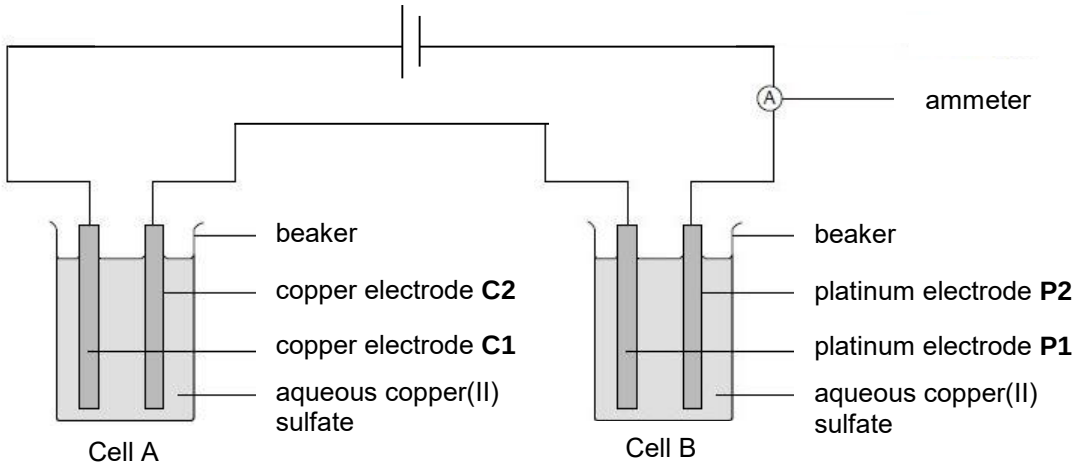
(a) Complete the table below.

Electrolyte	Ions in Electrolyte	Product at anode	Product at cathode
Dilute potassium chloride	$\underline{H^+}$, $\underline{OH^-}$, $\underline{K^+}$, $\underline{Cl^-}$	oxygen	<u>hydrogen</u>
Molten potassium chloride	K^+, Cl^-	<u>chlorine</u>	<u>potassium</u>

All correct **2m**, 2-3 correct **1m,** 0-1 correct **0m**

[2]

In another investigation, the electrolysis of aqueous copper(II) sulfate was carried out using the apparatus shown in the diagram below.



(b) **Briefly** describe the change(s), if any, which take place at the electrodes and electrolytes at the end of the experiment in the table below.

	Change(s), if any
Electrode **C1**	Copper electrode becomes <u>thinner/smaller</u>
Electrode **C2**	Copper electrode becomes <u>thicker/bigger</u>
Electrolyte (Cell A)	<u>No visible change</u>, solution remains blue

	Change(s), if any
Electrode **P1**	<u>Bubbles of gas observed</u>, colourless gas given off
Electrode **P2**	<u>Brown solid</u> appears on the electrode
Electrolyte (Cell B)	<u>Blue solution becomes pale blue/colourless</u>

All correct **3m**, 4-5 correct **2m,** 2-3 correct **1m,** 0-1 correct **0m**

[3]

[Total: 5]

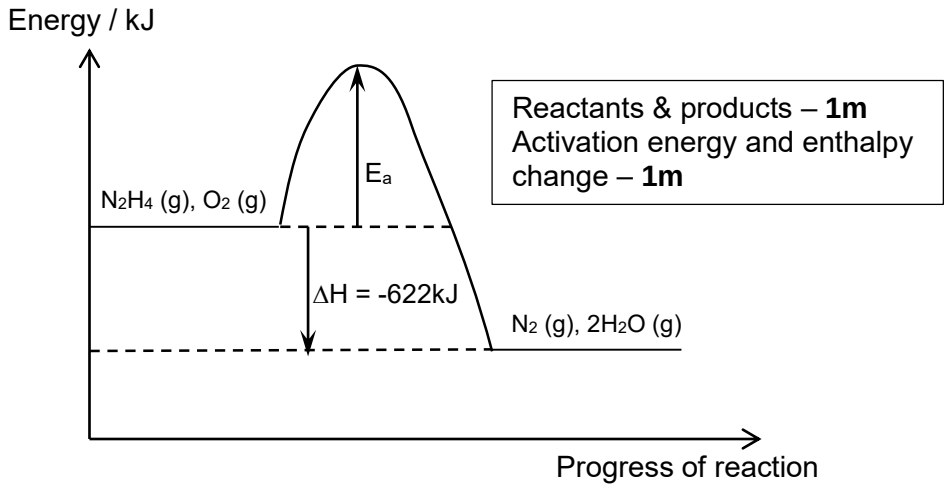
A7 Hydrazine (N_2H_4) is often used as a rocket fuel. It can react with oxygen or fluorine to release large amounts of heat. The equations for the 2 reactions are shown below.

$$N_2H_4\ (g) + O_2\ (g) \rightarrow N_2\ (g) + 2H_2O\ (g) \qquad \Delta H = -622kJ$$

$$N_2H_4\ (g) + 2F_2\ (g) \rightarrow N_2\ (g) + 4HF\ (g) \qquad \Delta H = -1166kJ$$

The ΔH values represent the energy change per mole of hydrazine reacted.

(a) Draw the energy profile diagram for the reaction between hydrazine and oxygen, showing the activation energy and the enthalpy change clearly.



Reactants & products – **1m**
Activation energy and enthalpy change – **1m**

[2]

(b) Based only on the information provided above, which other reactant (oxygen or fluorine) would have made a better choice for usage as a rocket fuel together with hydrazine? Briefly explain your answer.

Fluorine would be a better choice ;

Reaction with fluorine is more exothermic/releases more energy compared **1m**

to reaction with oxygen, enabling the rocket to travel further **1m**

……

……

…… [2]

(c) State 1 other factor that should be taken into consideration when deciding which fuel to use.

Cost/availability of gas/how "clean" reaction is/toxicity of gas/mass of gas [1]

Any 1 of above **1m**

[Total: 5]

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 The table below gives the current estimated percentage by mass of some of the elements found in the Earth's crust and the Earth's core.

Earth's Crust		**Earth's Core**	
Element	% by Mass	Element	% by Mass
Oxygen	40.6	Iron	31.0
Silicon	24.7	Oxygen	24.0
Nickel	8.1	Magnesium	16.0
Aluminium	8.1	Silicon	13.0
Iron	5.0	Nickel	11.7
Calcium	3.6	Aluminium	0.1
Sodium	2.8	Sodium	0.1
Potassium	2.6	Hydrogen	0.05
Magnesium	2.1	Potassium	0.04
Zinc	0.0078	Calcium	0.04
Copper	0.0068		
Tin	0.00022		

(a) Which metallic elements are more abundant in the Earth's crust compared to the Earth's core?

Aluminium, calcium, sodium, potassium (can include zinc, copper, tin) **1m** [1]

(b) Suggest a reason why oxygen is the most abundant element in the earth's crust.

Oxygen, though a gas, is combined with other elements such as metals and

silicon in the form of oxides **1m**

…… [1]

(c) The estimated mass of the earth's crust is 2.125×10^{16} kg. The annual production of iron is 3.32×10^{9} tonnes. Assuming that the demand for this metal is the same each year, determine the number of years before the supply of iron from the Earth's crust runs out. (1 tonne = 1000 kg)

Mass of iron in Earth's crust = (5/100) x 2.125×10^{16} = 1.0625×10^{15}kg **1m**

3.32×10^{9} tonnes = 3.32×10^{12} kg

Hence no. of years Earth's crust can supply iron = 1.0625×10^{15}kg ÷ 3.32×10^{12}

= 320 years **1m**

[2]

(d) **Briefly** describe **one** advantage and **one** disadvantage of recycling metals.

Advantage : conserve natural resources/reduce environmental problems

related to mining of land/ save cost of extracting metals from ores Any 1, **1m**

Disadvantage : High costs related to get people to do recycling/ environmental

issues related to release of harmful substances into environment Any 1, **1m** [2]

(e) Globally, iron and aluminium are the most recycled metals because of the ease of recycling them. Suggest a property of each of these 2 metals that accounts for the ease of recycling them.

Iron : magnetic property of iron enables it to be separated easily using

electromagnets **1m**

Aluminium : not easily corroded due to the layer of oxide **1m**

…… [2]

A student studied the action of heat on 4 different substances (**A**, **B**, **C** and **D**). He knew that two of them were metals, and the other two were carbonates of the same two metals. He weighed out 5.00 g of each of the four solids and heated them in separate crucibles.

The table below shows the appearances and masses of the four solids before and after strong heating for some time.

Solid	Appearance		Mass/g	
	Before	**After**	**Before**	**After**
A	Brown	Black	5.00	6.25
B	Green	Black	5.00	3.22
C	White	White	5.00	5.00
D	Silvery	White	5.00	6.73

(f) Based on the data given above, suggest which 2 were the metals and which 2 were the metal carbonates. Explain your answers.

Metals : Solid **A** and Solid **D**

Metal carbonates : Solid **B** and Solid **C** ALL 4 correct, **1m** [1]

Explanation : A and D has increased in mass due to reaction with oxygen in

the air to form metal oxide ; **1m** **B** has decreased in mass as carbonate

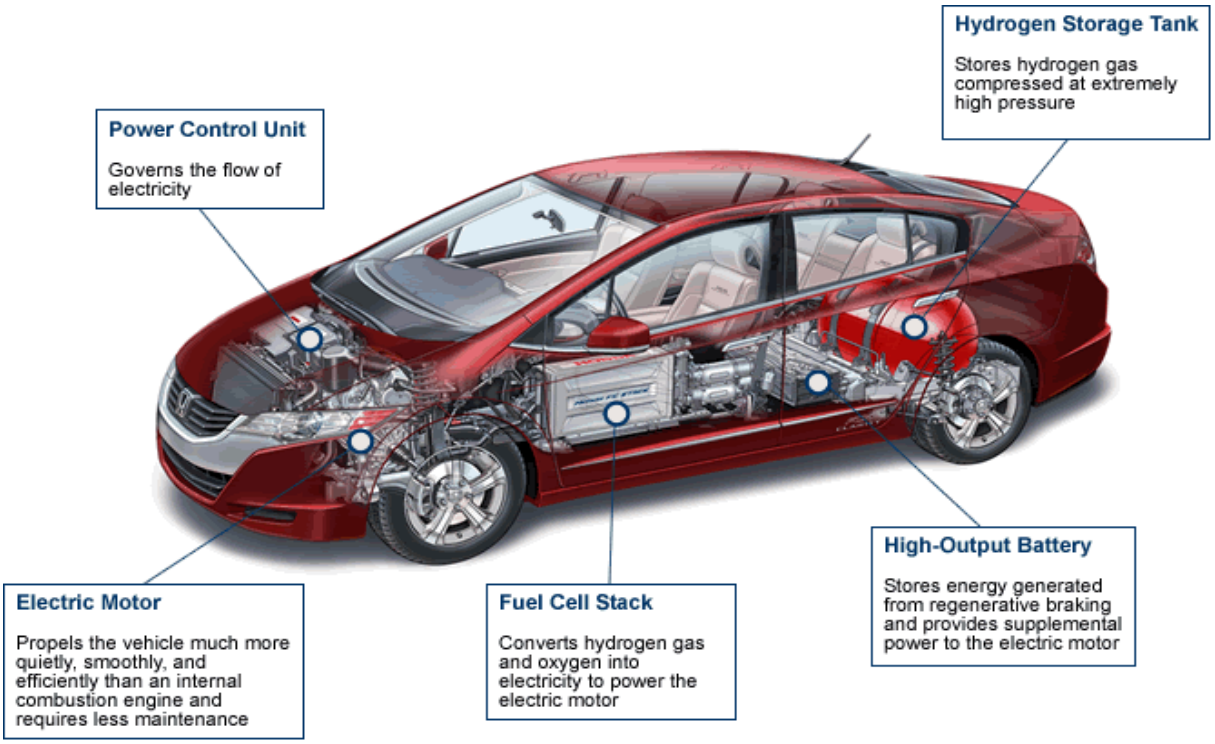
decompose on heating to form metal oxide and carbon dioxide; **1m**

C is carbonate of reactive metal as it is stable and does not decompose on

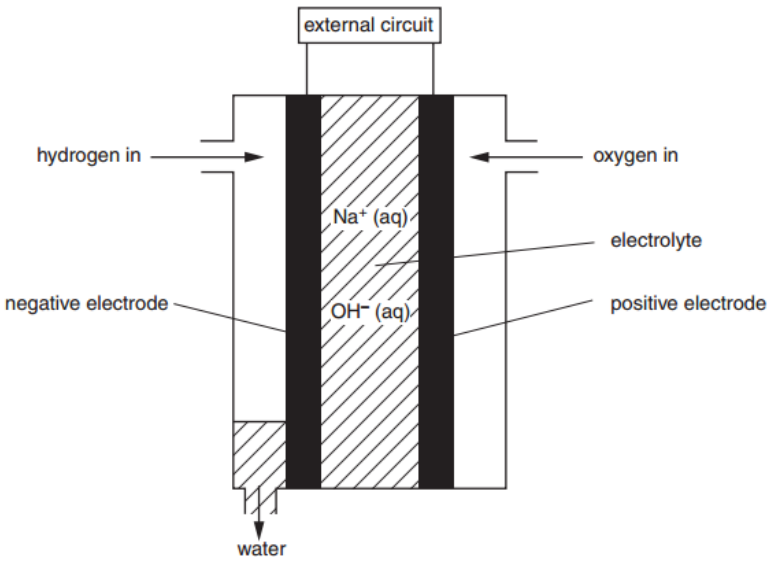
heating **1m** [3]

[Total 12]

B9 The diagram below shows the internal setup of a modern eco-friendly car powered by hydrogen-oxygen fuel cells. The main advantages of the use of fuels cells is that hydrogen is an efficient source of energy and it does not cause pollution at the point of use.



The diagram below shows the hydrogen-oxygen fuel cell used in such a car.



At the positive electrode, the reaction which takes place is :

$$O_2\,(g) \;+\; 2H_2O\,(l) \;+\; 4\,e \;\rightarrow\; 4OH^-\,(aq)$$

At the negative electrode, the reaction which takes place is :

$$2H_2\,(g) \;+\; 4OH^-\,(aq) \;\rightarrow\; 4H_2O\,(l) \;+\; 4\,e$$

(a) Write the overall equation for the reaction in the fuel cell.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ **1m** [1]

(b) Briefly explain why the use of fuel cells does not cause pollution at the point of use.

Only product of reaction is water which is harmless **1m** [1]

(c) Suggest why the use of fuel cells may still generate pollution.

Hydrogen obtained from cracking/electrolysis still requires a lot of heat/electricity which comes from burning of fossil fuels **1m** [1]

(d) Manufacturers claim that hydrogen is a renewable fuel. Do you agree? Explain your answer.

No, hydrogen is not renewable. It is obtained from cracking of long-chained alkanes which is not renewable. **1m** [1]

(e) Give a source of oxygen.

oxygen from the air/fractional distillation of liquid air **1m** [1]

(f) Suggest why the hydrogen and oxygen must be kept apart.

Hydrogen and oxygen can react explosively if a spark is present **1m**

…… [1]

(g) Briefly describe one advantage and one disadvantage of compressing hydrogen fuel at high pressure.

Advantage : Hydrogen is a gas, compression will allow a greater mass to be carried in the tank so travel longer distances **1m**

Disadvantage : Hydrogen needs highly pressurized containers which are heavy hence difficult to transport **1m** [2]

[Total 8]

EITHER

B10 One of the components in crude oil is undecane, $C_{11}H_{24}$. This molecule may be broken down into butene and one other product. The reaction is carried out in the oil refinery.

(a) What is the name of this type of reaction?

Cracking **1m** [1]

(b) Write the equation for this reaction.

$C_{11}H_{24} \rightarrow C_4H_8 + C_7H_{16}$ **1m** [1]

(c) Suggest **2** conditions required for this reaction to take place

Catalyst, high temperature Both points **1m** [1]

(d) When the reaction is carried out, 1.00 mol of undecane gives 25.2 g of butene. Calculate the percentage yield of butane.

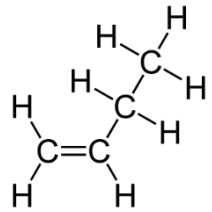
1 mole of undecane gives 1 mole of butene

Molar mass of butene is 56 g **1m**

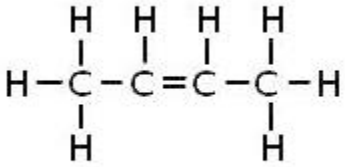
Hence percentage yield = (25.2/56) x 100% = 45.0% **1m**

[2]

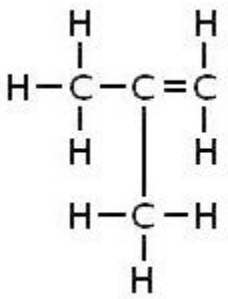
Butene can exist as 3 isomers. One of the isomers, but-1-ene, is shown in the diagram below.



(e) Draw the structures of the other 2 isomers of butene.



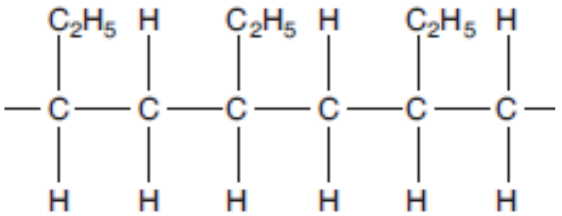
1m



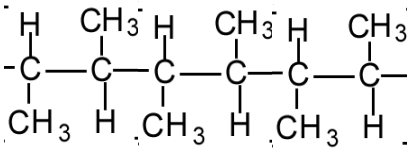
1m

[2]

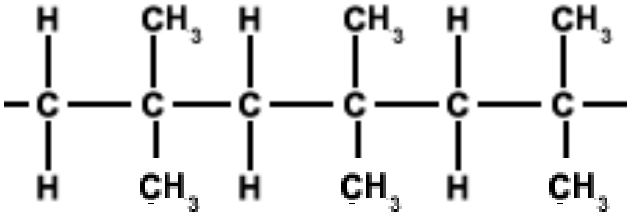
(f) The isomers of butene can undergo addition polymerization. Draw the structure of the polymers formed by any **1** of the isomers in part (e), showing **3** repeating units.



or



or



1m [1]

[1]

Butan-2-ol is manufactured by the reaction between steam and butene. An isomer of butan-2-ol is also formed at the same time. The 2 isomers are miscible.

(g) Suggest, with reason, a method suitable for separating the components of the mixture of products.

Method : <u>Fractional distillation</u> **1m**

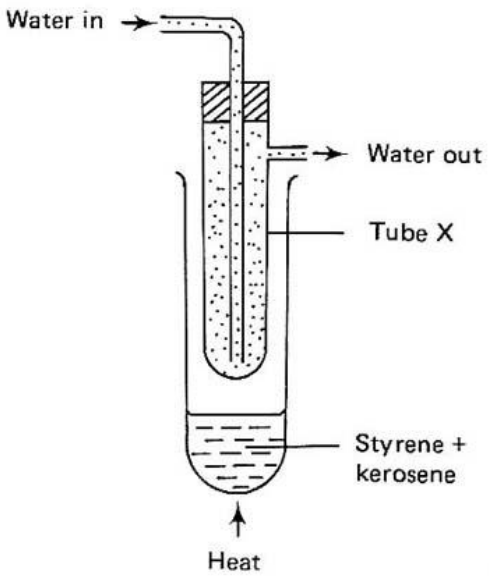
Reason : They have <u>different boiling points</u> **1m** [2]

[Total 10]

OR

B10 The compound styrene (chemical formula C_8H_8) has the following structure

It can undergo addition polymerisation to form polystyrene, a non-biodegradable thermoplastic polymer used for making disposable utensils such as styrofoam cups and plates. The polymerisation process is carried out by mixing styrene and kerosene and refluxing the mixture at about 150°C using the setup shown below.



After cooling, the reaction mixture is poured into methanol. Polystyrene, which appears as a waxy white solid will then form under the surface of the methanol.

(a) Suggest the function of

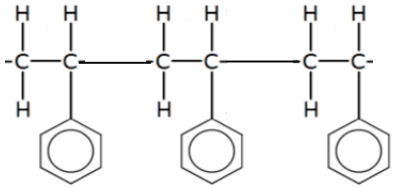
(i) tube **X** and

Provide cool surface to allow styrene/kerosene to condense **1m** [1]

(ii) kerosene**.**

Solvent. catalyst (Any 1, **1m)** [1]

(b) Draw the structural formula of polystyrene formed, showing 3 repeating units.



1m

[1]

(c) What is meant by the term “non-biodegradable”?

Cannot be broken down by bacteria **1m**

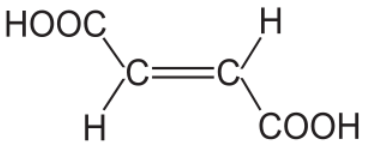
…… [1]

(d) Suggest a reason why polystyrene produces a lot of soot when burnt.

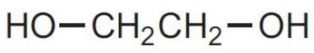
High percentage of carbon in the compound **1m**

…… [1]

The structural formulae of two organic compounds, butenedioic acid and ethane- 1,2-diol are shown below.



butenedioic acid



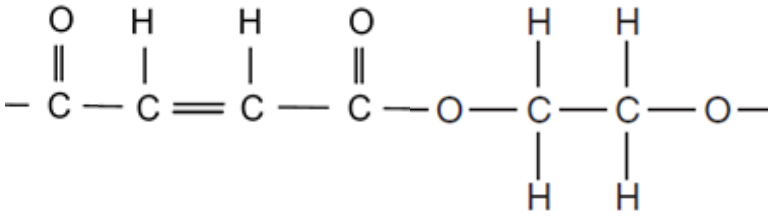
ethane- 1,2- diol

(e) Butenedioic acid reacts with aqueous bromine and also with aqueous sodium carbonate. State an observation for each reaction and briefly explain why it is observed.

Reactant	Observation	Explanation
Aqueous bromine	Reddish brown bromine decolourised **1m**	Addition reaction takes place to form colourless products **1m**
Aqueous sodium carbonate	Effervescence **1m**	Acid reacts with carbonates to form carbon dioxide gas which appear as bubbles **1m**

[4]

(f) Butenedioic acid and ethane-1,2-diol can polymerize under the right conditions to form a polymer W. Draw the repeating unit of this polymer.



1m

[1]

[Total 10]

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 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	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.).