中正中学 (义顺)
CHUNG CHENG HIGH SCHOOL (YISHUN)

Preliminary Examinations (2016)
Secondary Four Express

Candidate			
	Name	Register No.	Class

CHEMISTRY

5073/02

Paper 2 Section A

Date: 24 August 2016
Duration: 1 hour 45 min

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.
Write in dark blue or black pen.
You are to use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue, correction fluid or correction tape.

Section A (50 marks)
Answer **all** questions in the spaces provided.

At the end of the paper, 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 2.

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

For Examiner's Use	
Section A	

Setter: Mr Lim Wee Keong

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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	– Ra radium 88	– Ac actinium 89 †															

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

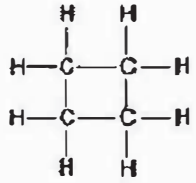
140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 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

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

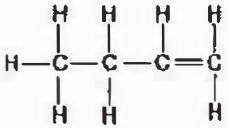
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Section A (50 marks)

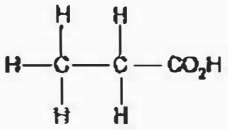
1 Structures of six organic compounds are shown below.



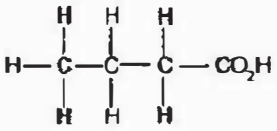
compound A



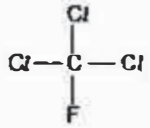
compound B



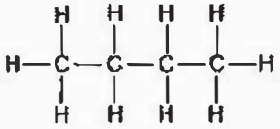
compound C



compound D



compound E



compound F

(a) Choose from the above compounds to answer the following questions. Each compound can be used once, more than once or none at all.

(i) Which compound(s) can react with metal carbonates to produce effervescence?

.....[1]

(ii) Which compound(s) decolourise(s) aqueous bromine?

.....[1]

(iii) Which compound(s) will undergo hydration and oxidation to form butanoic acid?

.....[1]

(b) Explain whether compound A and compound B are isomers.

.....

..... [1]

(c) Draw an isomer of compound D.

[1]
[Total: 5]

2 Seawater contains many dissolved ions. The table shows the concentration of some of these ions in a typical sample of seawater.

ion	concentration g/dm^3
chloride	19.00
sodium	10.56
sulfate	2.65
magnesium	1.26
calcium	0.40
potassium	0.38

(a) (i) State what you would **see** if three drops of acidified aqueous silver nitrate is added to 5 cm^3 of seawater.

.....[1]

(ii) Hence, construct an ionic equation for the reaction in **(a)(i)**.

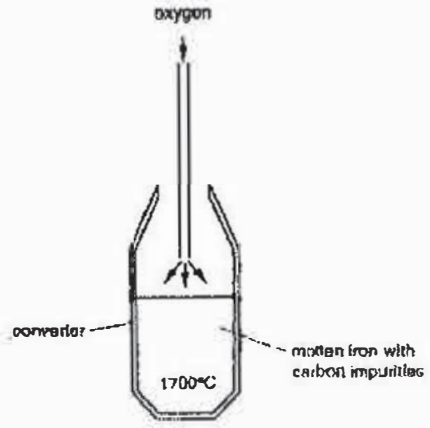
.....[1]

(b) Calculate the mass of sulfate ions which can be precipitated when excess acidified barium nitrate is added to 20 cm^3 of seawater.

[1]

[Total: 3]

3 Iron from the Blast Furnace contains carbon as an impurity. To remove the carbon, oxygen is blown on the molten iron in a large vessel known as a converter.

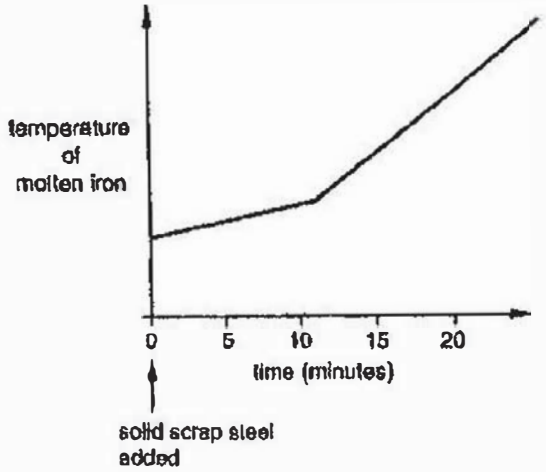


(a) The temperature of the molten iron increases as the oxygen is blown onto it. Explain why.

.....

..... [1]

(b) Scrap steel is recycled by being added, as a solid, to the molten iron, before the oxygen blow. The graph shows how the temperature of the molten iron changes during the oxygen below.



(i) Describe and explain how the solid scrap steel affects the temperature change during the oxygen blow.

.....

.....

.....[2]

(ii) State a reason why it is important to recycle steel.

.....[1]

(c) Using ideas about the arrangement of atoms, explain why high carbon steel is preferred over pure iron to be used as cutting tool.

.....

.....

.....[2]

[Total: 6]

4 Hydrogen peroxide is a colourless liquid.

An aqueous solution of hydrogen peroxide reacts with the iodide ions in acidified potassium iodide to form water and iodine according to the equation shown below.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$$

(a) (i) Explain, in terms of electrons, whether the iodide ions are acting as the oxidising agent or reducing agent in this reaction.

.....

.....[1]

(ii) Describe the colour change for the above reaction.

.....[1]

(b) The table shows how the speed of this reaction changes when different concentrations of aqueous potassium iodide and dilute sulfuric acid are used. The hydrogen peroxide is always added in excess and the temperature remains constant.

experiment	concentration of aqueous potassium iodide in mol/dm^3	concentration of dilute sulfuric acid in mol/dm^3	speed of reaction in mol/dm^3/s
1	0.1	0.1	0.00017
2	0.2	0.1	0.00034
3	0.1	0.2	0.00017
4	0.3	0.1	0.00051
5	0.1	0.3	0.00017

"The speed of this reaction is more dependent on the concentration of aqueous potassium iodide than aqueous sulfuric acid."

Using the information in the table, justify whether you agree with the above statement.

.....

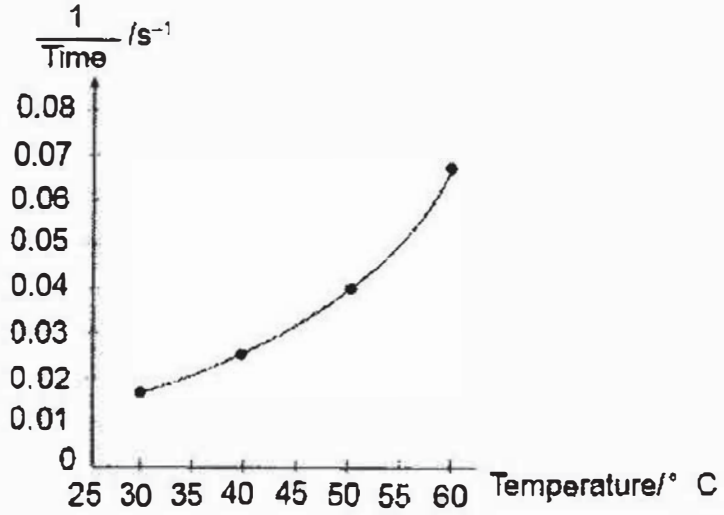
.....

.....

.....

.....[2]

(c) The experiment was repeated by varying the temperature of aqueous potassium iodide, with other variables being kept constant. The results of the experiment were represented by the graph shown below.



Use ideas about collision between particles to explain the trend in the results.

.....

.....

.....[2]

(d) A student thinks that iron(III) oxide acts as catalyst in this reaction.

Describe what the student should do and what information he should collect to test his hypothesis.

.....

.....

.....

.....[3]

[Total: 9]

5 (a) Carbon dioxide is a greenhouse gas and is given a greenhouse factor of 1.

Other gases are given a greenhouse factor that compares their effects with carbon dioxide. The greenhouse effect increases as the factor value increases.

Table 1 below gives information about the greenhouse factor and the composition of four different gases in the Earth's atmosphere.

gas	greenhouse factor	percentage of gas in the atmosphere
CO_2	1	0.036
CH_4	30	0.0017
N_2O	160	3.0×10^{-4}
CCl_3F	21000	2.8×10^{-8}

Table 1

Using the information above, explain whether scientists should be more worried about the percentage increase of methane in the Earth's atmosphere as compared to the percentage increase of carbon dioxide.

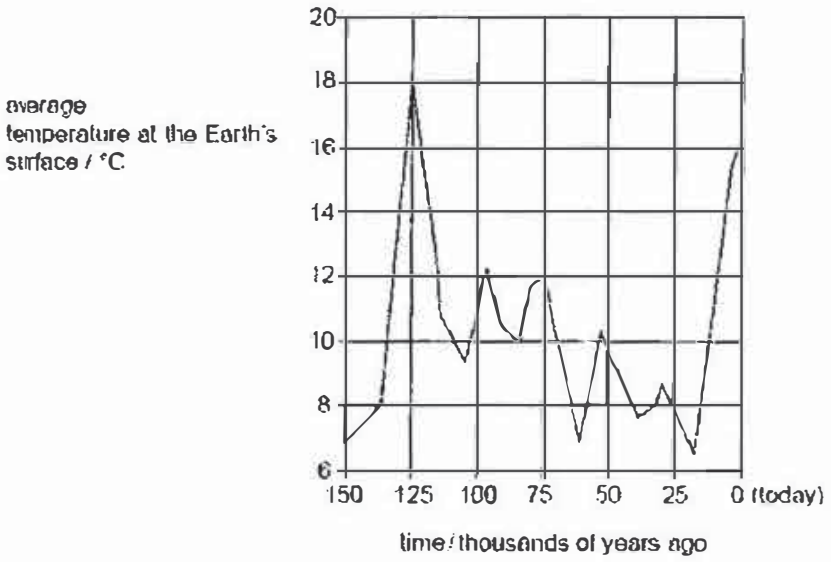
.....

.....

.....[2]

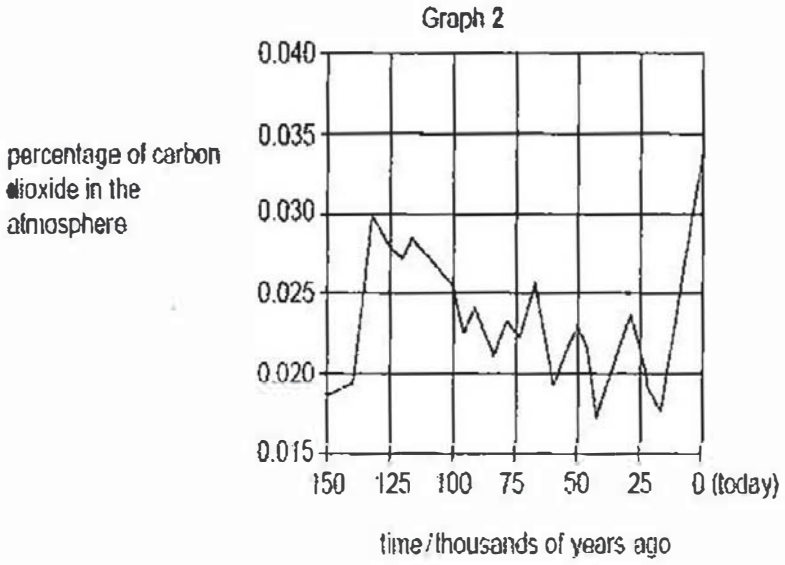
(b) **Graph 1** below shows how the average temperature at the Earth's surface may have changed over the last 150 thousand years.

Graph 1



Graph 2 below shows how the percentage of carbon dioxide in the atmosphere may have changed over the last 150 thousand years.

Graph 2



(i) Scientists think that an increase in the amount of carbon dioxide will result in global warming.

Explain how **Graph 1** and **2** support this statement.

.....

.....[1]

(ii) "Increase in amount of carbon dioxide is not the only factor which contributes to global warming."

Using the information from **Table 1**, **Graph 1** and **2**, explain how these information can be used to support the above statement.

.....

.....

.....

.....[2]

(iii) Describe one possible consequence of global warming.

.....

.....[1]

(iv) Showing only the outer shell electrons, draw a "dot-and-cross" diagram to show the bonding present in CCl_3F.

[2]

(v) Explain how the presence of CCl_3F in the atmosphere contributes to health problems like skin cancer.

.....

.....

.....[2]

[Total: 10]

6 Small pieces of a silver coloured metal, **X**, were added to concentrated nitric acid. A brown acidic gas, **Z**, and a colourless solution containing salt **Y** were formed.

Analysis of 0.0914 mole sample of **Z** showed it contained 1.28 g of nitrogen and 2.93 g of oxygen.

The small sample of the colourless solution was diluted with water and then divided into two portions.

To the first portion

Aqueous sodium hydroxide was added drop by drop until it was in excess. A white precipitate, **W**, was formed that redissolved in the excess aqueous sodium hydroxide.

To the second portion

Aqueous ammonia was added drop by drop until it was in excess. A white precipitate, **W** was formed and remained insoluble in the excess aqueous ammonia.

(a) With the means of chemical calculation, determine the empirical formula of **Z**.

[2]

(b) **(i)** Suggest the identities of precipitate **W**.

.....[1]

(ii) Construct one possible ionic equation, with state symbols, for the forming of **W** from the first portion.

.....[2]

(c) **(i)** Suggest the identities of **X**.

.....[1]

(ii) Describe a chemical test to determine the anion present in **Y**.

.....

.....[2]

[Total: 8]

7 **(a)** Four isomers of butanol are shown in the table below.

Isomer	1	2	3	4
	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2\underset{\displaystyle OH}{\underset{\vert}{C}}H\text{-}CH_3$	$CH_3\text{-}\underset{\displaystyle CH_3}{\underset{\vert}{C}}H\text{-}CH_2OH$	$CH_3\text{-}\underset{\displaystyle OH}{\underset{\vert}{\overset{\displaystyle CH_3}{\overset{\vert}{C}}}}\text{-}CH_3$
Name	Butan-1-ol	Butan-2-ol	2-methylpropanol	2-methyl propan-2-ol

(i) Name the organic product when butan-1-ol is added to acidified potassium managante (VII).

.....[1]

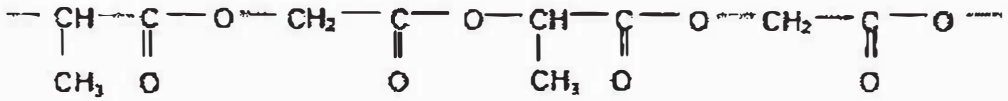
(ii) A student would like to prepare a sweet-smelling compound **X**. He added 2-methyl propanol to a beaker containing aqueous propanoic acid, with warming. Concentrated sulfuric acid was also added to the mixture.

Show the full structural formula of compound **X** and name compound **X**.

[1]

Name of compound **X**: .....[1]

(b) Lactomer is a trade name of synthetic material that is used to make surgical stitches. Part of this polymer is shown below.



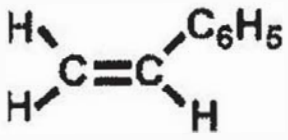
Draw the two possible monomers which are used to form the above polymer.

monomer 1

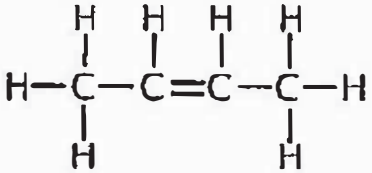
monomer 2

[2]

(c) Styrene-butylene rubber is a synthetic rubber. It is made by polymerising a mixture of the monomers styrene and butylene.



Styrene



butylene

Onepossible structure for the polymer is shown below.

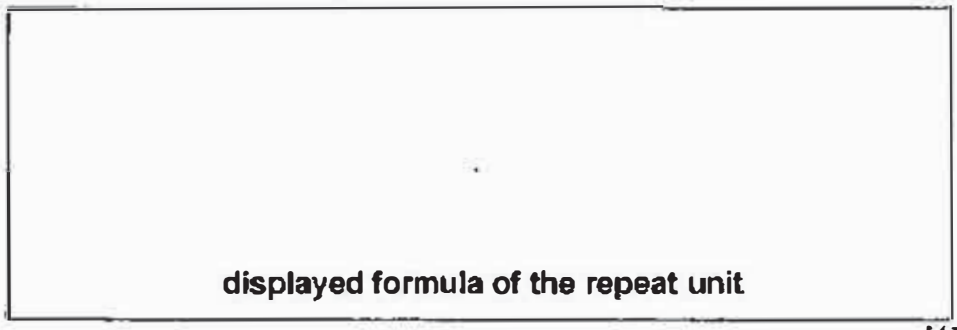
(i) Styrene is processed by cracking of crude oil in an oil refinery.

Explain why cracking of styrene is an important process in the oil refinery industry.

.....

.....[1]

(ii) Draw the displayed formula of the repeat unit in this polymer structure.



[1]

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

.....

.....[1]

(iv) Describe one difference between the reactions to form styrene-butylene polymer and lactomer.

.....

.....

.....

.....[1]

[Total:9]

End of Section A

中正中学 (义顺)
CHUNG CHENG HIGH SCHOOL (YISHUN)

Preliminary Examinations (2016)
Secondary Four Express

Candidate			
	Name	**Register No.**	**Class**

CHEMISTRY 5073/02

Paper 2 Section B

Date: 24 August 2016

Duration: 1 hour 45 min

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.
Write in dark blue or black pen.
You are to use a soft pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue, correction fluid or correction tape.

Section B (30 marks)
Answer all **three** questions in the spaces provided.
The last question is in the form either/or.

At the end of the paper, 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 2 of Section A.

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

For Examiner's Use	
Section B	

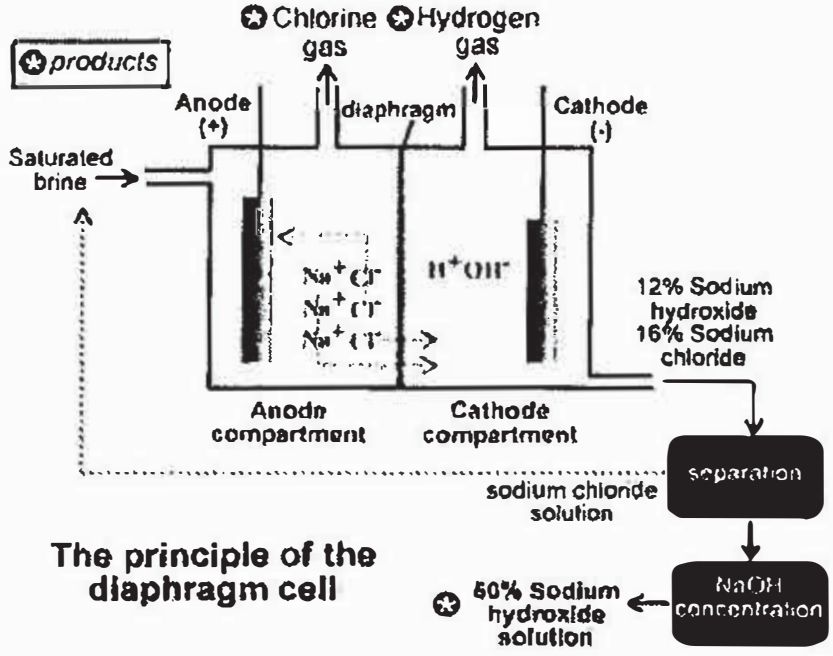
Setter: Mr Lim Wee Keong

Section B (30 marks)

1 Electrolysis reactions are the basic foundations of today's modern industry. There are various elements, chemical compounds and organic compounds that can only be produced by electrolysis. For example, chlorine and sodium hydroxide.

Brine is a saturated solution of sodium chloride, containing about 25 % by mass of sodium chloride. Industrial electrolysis of brine can be carried out in a **diaphragm** cell and a **membrane** cell.

The diagram below shows how the **diaphragm** cell works.



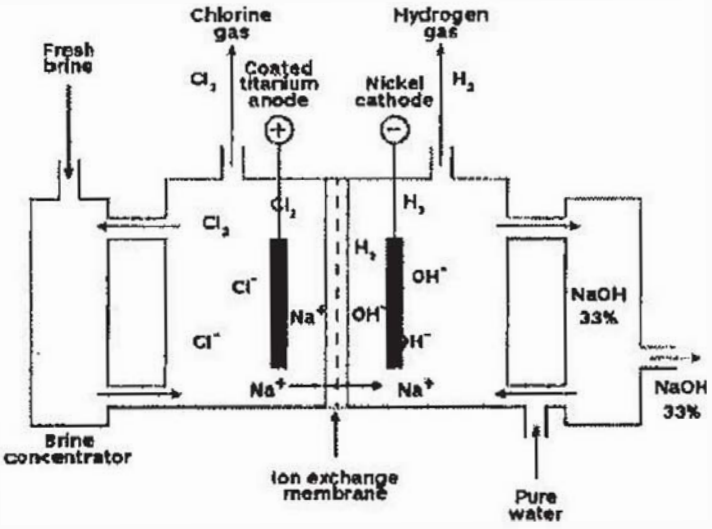
The principle of the diaphragm cell

The brine is contained in the anode compartment and the electrode which is used can either be made up of graphite or titanium. However, graphite is commonly preferred over titanium.

On the cathode side, the hydroxide ions and hydrogen gas are formed due to the reduction of water. Due to the difference in the solution level between the anode and the cathode, there will be a gradual flow of sodium chloride from the anode into the cathode. However, there will not be any backflow of sodium ions into the anode. If chlorine and sodium hydroxide come into contact, chlorine turns into ClO^-, ClO_3^- and Cl^- ions.

To ensure that a pure sodium hydroxide can be collected, purification of sodium chloride out of the sodium hydroxide will have to be carried out. After purification, the industry is able to get a solution of 50% of aqueous sodium hydroxide and about 1% of sodium chloride.

The diagram below shows how the **membrane** cell works.



In the **membrane** cell, the brine is fed to the brine concentrator and current passing through will result in the aqueous sodium chloride to split into sodium ions and chloride ions. The sodium ions will flow through the ion exchange membrane and react with the hydroxide ions that are produced through the reduction of water to form aqueous sodium hydroxide. Without the ion exchange membrane, the sodium hydroxide would not be pure because it would contain chloride ions.

The table shows some information about the two types of cells.

cell type	construction	operation of cell	quality of NaOH produced
diaphragm cell	Relatively simple and inexpensive.	Frequent replacement of diaphragm. Operates at 3.8 V.	Must be evaporated to concentrate from 12% to 50% and to crystallise out the salt.
membrane cell	Cheap to construct and install.	Requires high purity brine. Operates at 3.3 V. Membrane changes every 2 to 3 years.	High purity. Must be evaporated to concentrate from 33% to 50%.

(a) **(i)** Construct a half ionic equation for the reaction that happens at the cathode of the diaphragm cell.

..... [1]

(ii) Suggest a reason why graphite is commonly preferred over titanium to be used as electrode in the diaphragm cell.

..... [1]

(b) When chlorine and sodium hydroxide comes into contact, a disproportionation reaction happens. Disproportionation happens when the oxidation state of the same element both increases and decreases in the reaction.

Use ideas about oxidation state to explain why the reaction of chlorine and sodium hydroxide is a disproportionation reaction.

.....

.....[2]

(c) **(i)** Write an equation for the overall reaction that happens in the membrane cell.

..... [1]

(ii) Calculate the volume of hydrogen gas that can be produced from two tonnes of saturated brine in membrane cell at r.t.p.

[3]

(d) "Industries should adopt using membrane cell to produce sodium hydroxide instead of diaphragm cell."

Using the relevant information, explain one reason why such statement was made.

.....

.....[1]

(e) A student made the following comment.

"In school laboratory, I can obtain aqueous sodium hydroxide by just using concentrated sodium bromide solution with graphite electrodes."

Explain whether you agree with the student.

.....

.....[1]

[Total:10]

2 Many carbonates thermally decompose to form a metal oxide and a gas.

Six 2.00 g of samples of carbonates are heated strongly until there is no further change in the mass. The table shows the mass of solid remaining at the end of the heating.

carbonate	mass before heating / g	mass after heating / g
calcium carbonate	2.00	1.12
copper(II) carbonate	2.00	1.29
iron(II) carbonate	2.00	1.24
magnesium carbonate	2.00	0.95
sodium carbonate	2.00	2.00
zinc carbonate	2.00	1.30

(a) Two students made the following conclusions based on the table above.

Student 1: The thermal stability of the metal carbonate is dependent on the charge of the metal ion.

Student 2: The more reactive the metal, the more thermal stable the metal carbonate is.

Which student's conclusion is correct? Use the information from the table to support your reasoning.

.....

.....

.....

.....

.....

.....

.....[3]

(b) One of the metal oxides formed from the decomposition of the metal carbonate can be used to treat excess acidity of soils in agriculture.

(i) Using a 'dot-and-cross' diagram, show the bonding present in this metal oxide. Only outer-shell electrons need to be shown.

[2]

(ii) Plants thrive well on fertilisers such as ammonium chloride because of the nitrogen content.

Explain, with an equation, why it is not advisable for farmers to add this metal oxide together with ammonium chloride to the soil.

.....

..... [1]

(iii) The molten state of this metal oxide is suitable to be used as an electrolyte to extract the metal.

Explain in terms of structure and bonding, why this metal oxide has to be in molten state in order to be used as an electrolyte.

.....

.....

..... [2]

(iv) Write down the half ionic equations, including state symbols, for the reaction which takes place at the respective electrodes when this molten metal oxide is electrolysed using carbon electrodes.

positive electrode: .....[1]

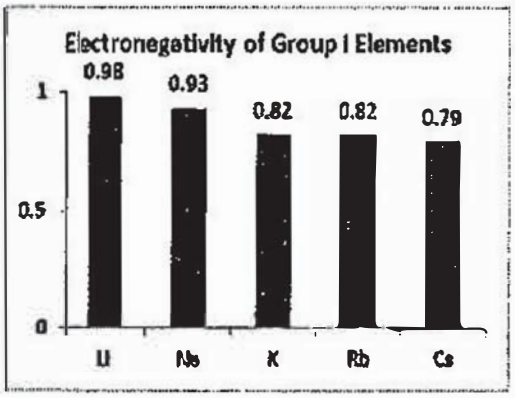
negative electrode: ..... [1]

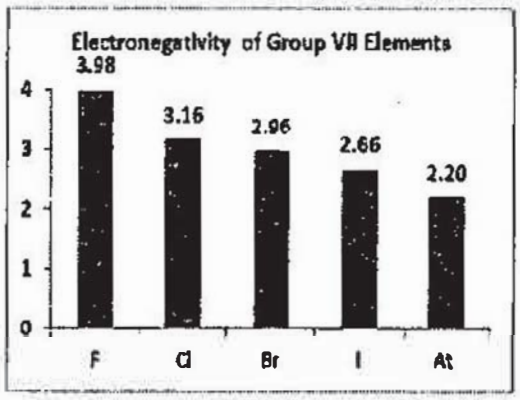
[Total: 10]

Either

3 (a) Electronegativity refers to the ability of an atom to attract electrons and is otherwise known as 'electron attracting' power. The greater the electronegativity value of an atom, the greater its ability to attract electrons and vice versa.

The diagrams below show the electronegativity of Group I and VII elements.





(i) Based on the data above, suggest a reason why the electronegativity for Group VII elements is generally higher than the electronegativity for Group I elements.

.....

..... [1]

(ii) Based on the electronegativity of Group VII elements, suggest and explain the trend of the oxidising power of Group VII elements when moving down the group.

.....

.....

..... [2]

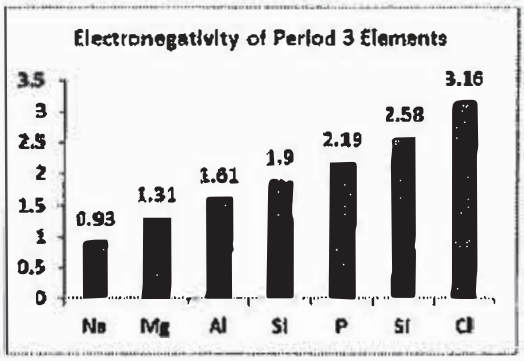
(iii) Aqueous chlorine is bubbled into a solution of potassium bromide. Explain, with the use of an ionic equation, what will be observed.

.....

.....

..... [2]

The following diagram shows the electronegativity across Period 3 elements with argon (Ar) being excluded.



(iv) Describe the general trend of electronegativity across Period 3 elements.

.....

..... [1]

(v) The electronegativity of the Period 3 elements is dependent on the number of electron shells the elements have.

Justify whether you agree or disagree with the statement.

.....

..... [1]

(b) Other than electronegativity, Group I and VII elements also show trends in their melting points.

	element	melting point / °C
Group I	lithium	180
	sodium	97.8
	potassium	64
Group VII	chlorine	-101
	bromine	-7
	iodine	114

Using the information provided, describe and explain the trend of melting points of Group I and Group VII elements.

.....

.....

.....[3]

[Total:10]

Or

3 (a) Researchers have been investigating the use of ethanol for replacing hydrogen as a liquid fuel for space craft intended for low Earth orbit. Its major advantage is that, unlike hydrogen, ethanol can be used as a liquid fuel without the need for storage at extremely low temperatures.

The table shows some information about ethanol and hydrogen.

compound	enthalpy change of combustion/ kJ per mol
hydrogen	-236
ethanol	-1367

(i) Given that the enthalpy change of combustion of hydrogen is -118 kJ/g, determine which fuel, hydrogen or ethanol, gives a greater energy output per gram of fuel used. Show your workings clearly, leaving your final answer to 3 significant figures.

[2]

(ii) Explain, in terms of bond breaking and bond making, why is combustion of hydrogen an exothermic reaction.

.....

..... [2]

(iii) In some countries, ethanol is produced from sugars in sugar cane.

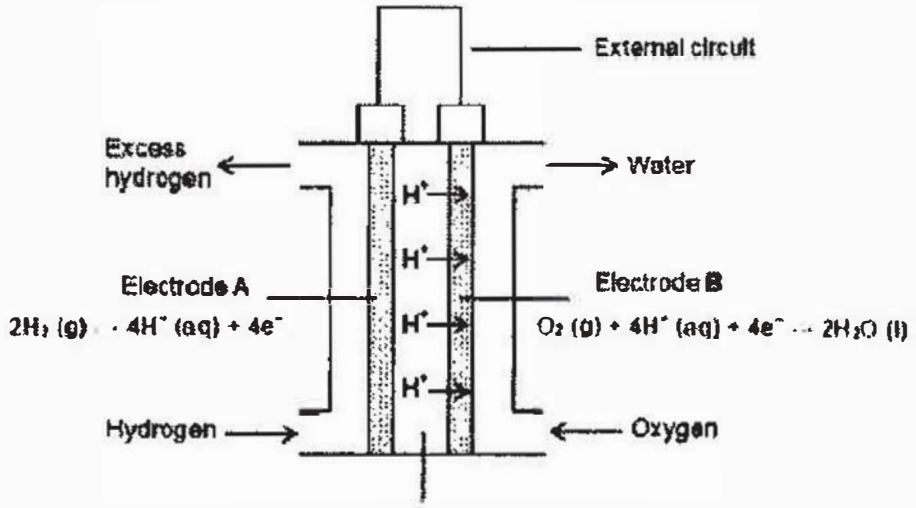
An environmentalist claims that ethanol as a fuel is 'carbon neutral' because using it does not add to the amount of carbon dioxide in the atmosphere.

Explain why this is true.

.....

..... [1]

(b) One other use of hydrogen is using it as a fuel in the Proton Exchange membrane (PEM) fuel cell as shown in the diagram below.



Proton Exchange Membrane or Polymer Electrolyte Membrane: hydrogen ions move across the electrolyte

Proton Exchange Membrane fuel cells use a polymer membrane (a thin plastic film which is semi permeable) as the electrolyte. Thus, they are also commonly known as Polymer Electrolyte Membrane (PEM) fuel cells.

(i) Hydrogen ions move across Proton Exchange Membrane.

With reference to a hydrogen ion, explain why it is considered as the "proton" in the Proton Exchange Membrane.

.....

..... [1]

(ii) With reference to the electrodes A and B, state the direction of the flow of electrons in the external circuit.

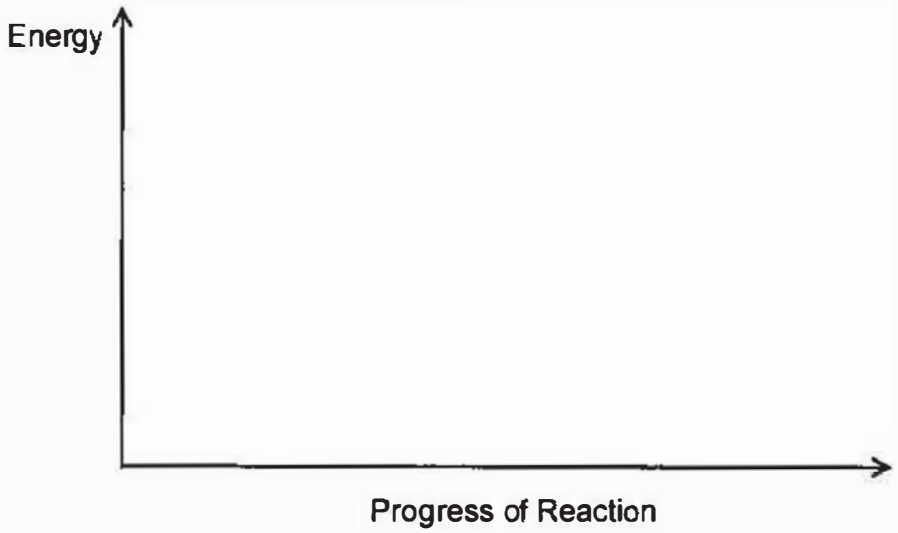
..... [1]

(iii) Construct an equation for the overall reaction that occurred in the Proton Exchange Membrane fuel cell.

..... [1]

(iv) Complete the energy profile diagram to illustrate the energy changes for the overall reaction. Your diagram should include

- The formula of the reactants and the products
- The label for the enthalpy change and the activation energy of the reaction.



[2]

[Total:10]

End of Section B

Marking Scheme
Secondary 4 Express Pure Chemistry Prelim 2016

Section A (40 marks)

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

39. D
40. C

Marking Scheme
Secondary 4 Pure Chemistry Prelims 2016

Section A Answers

Q/No.	Answer	Marks	Remarks/ Markers Comments
1(ai)	C,D	[1]	
(ii)	B	[1]	A few candidates missundertood that unsaturation includes C=O and included C and D as their answers.
(iii)	B	[1]	
(b)	Yes. Both compounds have the same molecular formula but different structural formula.	[1]	general formula is not credited. link back to the definition for isomers: same molecular formula but different structural formula.
(c)		[1]	
2(a)(i)	White precipitate.	[1]	
(ii)	$Ag^+ + Cl^- \rightarrow AgCl$	[1]	
(b)	(2.65/1000) x 20 = 0.053g	[1]	check table header, concentration is given in g/dm3
3(a)	The reaction between carbon/iron and oxygen is exothermic / heat energy is being released.	[1]	not enough to simply state that O2 reacted with iron/carbon as the reaction can be endothermic if not stated. Keyword to be mentioned is exothermic.

(b)(i)	Between 0 to 10min, the solid scrap steel results in the temperature to **increase gently**. After 10 min, the solid scrap steel results in the temperature to **increase sharply**. When the solid scrap steel is added to the molten Fe, it begins to **melt for 10 minutes** and the **sudden rise** of temperature is due to **combustion of carbon**. *Examiners Report 2004:* *Vague answers such as 'temperature increases' did not score.* ***The simplest statement to score two marks was: 'temperature increases slowly at first then faster'.***	[1] [1]	process the data and put down your understanding of the data. understanding of temperature rise has to be mentioned. rej: temperature change Many students were not able to highlight the different in the rate of temperature rise for the two portions. Explanation was also pretty weak.
(ii)	Iron Ore is finite / recycling steel is cheaper than extracting iron / reduce environmental problem arising from extraction of iron. *Examiners Report 2004:* In giving an advantage of recycling steel, many candidates gave answers that were too vague for credit, for example 'less pollution', 'less waste' or 'saves resources'. Better answers were more specific, for example discussing landfill area, saving finite metal resources or finite energy sources.	[1]	Any logical answer. Rej: steel has finite resource, because the keywords: **finite metal** resources
(c)	As carbon atom is of different size compared to iron atoms, the introduction of **carbon atom/ different sized atoms disrupt the orderly layer** of iron atoms. The **layer of atoms** in high carbon steel is	[2]	The link to property such as hardness has to be mentioned. 3 pt: 2m 1-2pt:1m

	unable to slide over one another <u>easily.</u> Hence, high carbon steel is **harder** and more suitable to be used as a cutting tool compared to pure iron.		Some students mentioned about steel being strong, however failed to mentioned it being hard.
4(a)(i)	Reducing agent. Iodide ions donate electrons.	[1]	Students incorrectly mentioned H was reduced. However, it was ignored. Lose electrons to ..... was accepted VS lose electrons (because the understanding is vague whether losing electrons means iodide ions is oxidised and thus is the reducing agent.)
(ii)	Colourless to brown.	[1]	original and final colour must be mentioned.
(b)	Do not agree. Expt 1,2: When concentration of KI increases by two times from 0.1 to 0.2 mol/dm^3, the speed of reaction increases by two times from 0.00017 to 0.00034 mol/dm^3/s. Expt 1,3: When concentration of H_2SO_4 increases by two times from 0.1 to 0.2 mol/dm^3, the speed of reaction remains unchanged at 0.00017 mol/dm^3/s. Hence rate of reaction more dependent on concentration of KI.	[1] [1]	Data has to be quoted and be interpreted for the marks to be awarded. Many students lacked clarity in linking data because it is important to link back to the experiment that is referred to as point of reference compared to just stating all the experiment data.

(c)	Higher the temperature, faster the rate of reaction. Higher the temperature, more particles have **higher kinetic energy equal to or greater than (sufficient) activation** energy. **Higher frequency of effective collisions** and hence, faster rate of reaction.	[1] [1]	Many students failed to highlight the full explanation.
(d)	1. Carry out two experiments – one with iron (III) oxide and the other without iron(III) oxide. 2. All other key variables such as temperature to be kept constant. 3. Record the time taken for the reaction to be completed.	[1] [1] [1]	Repeat the experiment was accepted as long as understanding was shown
5(a)	More worried about the increase in percentage of methane. With 0.00017 % of methane present in the atmosphere, the **greenhouse factor is 30**, which is 30 times than that of carbon dioxide. With more increase in methane, the **impact** on the environment will be at least **30 times bigger** than that of carbon dioxide.	[1] [1]	

(bi)	Graphs are roughly similar / high percentage of carbon dioxide shows there's high percentage of average temperature. *(quoted from Jun 2006)*	[1]	
(ii)	**Other gases** such as methane, N_2O and CCl_3F are present in the atmosphere. Gas such as methane has a **greenhouse factor** of 30 which implied that their effects on the Earth's average temperature is at least 30 times. Between **125 to 100 / 100 to 75 thousand years** ago, there was a period of time when there's a **decline in percentage of carbon dioxide** in the atmosphere but the **average temperature** of the Earth's surface actually **rise.**	[1] [1]	
(iii)	melting of polar ice/ rise in sea level/ desertification/extreme climate changes/ effect on animal/plant habitats *(quoted from Jun 2006)*	[1]	
(iv)	Valence electrons of the halogens must be shown correctly.	[2]	No key: minus [1] overall Any mistake minus [1]
(v)	Results in **depletion of ozone layer** which	[2]	

<table>
<tr><td></td><td>results in more harmful UV radiation entering the Earth's surface.</td><td></td><td></td></tr>
<tr><td>6(a)</td><td><table><tr><td></td><td>N</td><td>O</td></tr><tr><td>Number of moles</td><td>(1.28/14) = 0.091429</td><td>(2.93/16) 0.183125</td></tr><tr><td>Ratio</td><td>(0.091429/0.91429) = 1</td><td>(0.18312 = 2</td></tr></table>Hence empirical formula is NO_2</td><td>[1]
[1]</td><td>Working has to be shown.</td></tr>
<tr><td>b(i)</td><td>Lead(II) hydroxide and aluminium hydroxide</td><td>[1]</td><td>Both correct [1]</td></tr>
<tr><td>(ii)</td><td>$Pb^{2+}(aq) + 2OH^-(aq)\ Pb(OH)_2(s)$

$Al^{3+}(aq) + 3OH^-(aq)\ Al(OH)_3(s)$</td><td>[2]</td><td>[1] eqn
[1] state symbols</td></tr>
<tr><td>(b)(i)</td><td>Lead / Pb or Alumnium / Al</td><td>[1]</td><td>Both correct [1]</td></tr>
<tr><td>(ii)</td><td>Add a piece of Al foil to the solution and add 2 to 3 drops of aqueous sodium hydroxide. Warm. Test the gas evolved with moist red litmus paper.

Moist red litmus paper turns blue.</td><td>[1]

[1]</td><td>Always to mention results of the experiment and to provide evidence to support the identity of the gas</td></tr>
<tr><td>7(a)(i)</td><td>butan-1-oic acid</td><td>[1]</td><td>butanoic acid accepted</td></tr>
<tr><td>(ii)</td><td>2-methyl propyl propanoate</td><td>[1]

[1]</td><td></td></tr>
<tr><td>(b)</td><td></td><td>[2]</td><td>[1] for each</td></tr>
</table>

(c)(i)	To match the demand for fractions containing smaller and more useful molecules from refinery process.	[1]	
(ii)		[1]	
(iii)	Both contain **C=C** which can polymerise at **random.**	[1]	
(iv)	**Addition Polymerisation reaction** Double bond/ alkene/ unsaturated / only one type of monomer Only 1 product obtained high temperature and pressure same empirical formula as monomer / same composition by mass of monomer **Condensation Polymerisation** 2 type monomers / 2 type functional group / functional group on each end of member small molecule , H2O, given out Does not require high temperature and pressure Does not have the same empirical formula as	[1]	Any 1

	the monomers/ different composition by mass of monomer		

Section B Answers

Q/No.	Answer	Marks	Remarks/ Markers Comments
1(a)(i)	$2H_2O + 2e \quad 2OH^- + H_2$	[1]	Many candidates failed to extract the relevant information from the text which states that reduction of water happens in the cathode.
(ii)	Graphite is cheaper than titanium. OR Graphite is easier to obtain than titanium	[1]	Common mistake is "Graphite is inert". This answer is not acceptable as Ti is relatively inert too. *To consider 1. cost, 2 safety, 3 environment*
(b)	Oxidation state of Cl increases from 0 in Cl_2 to +1 in ClO^- / +5 in ClO_3^- Cl_2 is oxidised.	[1]	Candidates need to be mindful that they have to know how to calculate the oxidation states. Some candidates are still unable to calculate to determine the correct oxidation states.

	Oxidation state of Cl decreases from 0 in Cl_2 to -1 in Cl^-. Cl_2 is reduced.	[1]	
(c)(i)	$2NaCl + 2H_2O \rightarrow Cl_2 + 2NaOH + H_2$	[1]	Only few candidates manage to get this correct. Candidates need to be mindful of extracting relevant data.
(ii)	Number of moles of NaCl = 2 000 000 x 0.25 / (23 + 35.5) = 8547.00855 moles Number of moles of H_2 = 4273.5 moles Volume of H_2 = 4273.5 x 24 = 102 564 = 103 000 dm^3	[1] [1] [1]	Candidates need to be mindful of extracting relevant data as most candidates failed to read that only 25% of brine consists NaCl. Allow ECF from here.
(d)	Membrane cell operates at a **lower voltage** as compared to diaphragm cell, hence **cheaper to operate.**	[1]	Accepted answers include: 1. lesser electricity 2. higher purity higher concentration 3. 2 to 3 years of replacement of membrane vs frequent replacement Reject answers: 1. Cheap to construct (unless candidates mention that it is due to lower voltage) 2. Inexpensive = cheap and hence, elaboration has to be made

			otherwise, no marks will be awarded.
(e)	Agree. **Bromide ions are discharged** in preference to hydroxide ions due to concentration effect and **hydrogen ions are discharged** in preference to sodium ions. Sodium ions and hydroxide ions remain behind. OR The NaOH collected will be contaminated by the Br- ions.	[1]	Some candidates only mention that hydrogen and bromine gas are formed without any details on discharging of the ions.
2(a)	Student 2 is correct and student 1 is incorrect. When the metal ion has a charge of 2+ in carbonate such as calcium carbonate, the mass loss is 0.70g. When the metal ion has a charge of 1+ in carbonate such as sodium carbonate, there is no mass loss. However, it was also shown that when the metal ion has a charge of 2+ in carbonate such as copper (II) carbonate, the mass loss was 1.05g. Thus, it cannot be concluded that the thermal stability is dependent on the charge of the metal ion. Sodium being more reactive than calcium which is more reactive than copper, shows that there is a greater	[1] [1] [1]	Marks are awarded when candidates talk about both student 1 and student 2. [2m] The last 1m is given when candidates quote data. Many candidates had a poor explanation. Example, " calcium more reactive than zinc and hence, it / calcium is more thermal stable.." / "Calcium carbonate is more reactive than zinc carbonate". Candidates need to take note that thermal stability is referring to the metal carbonate and not the metal. Vague explanation or ambiguous explanation will not score.

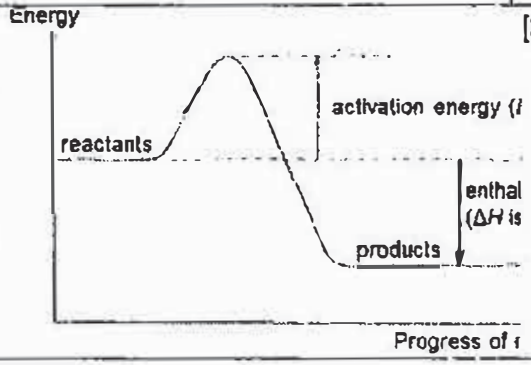
	mass loss in metal carbonate which contains a less reactive metal. Example: No mass loss for sodium carbonate but a mass loss of 0.70g for calcium carbonate and 1.05g for copper(II) carbonate. Hence, student 2's conclusion is correct. **Alternative 1** Student 1 is correct but student 2 is incorrect. Na ion has a charge of +1 and its carbonate did not decompose. Other carbonates in the table consists metal ions of charge +2 and its carbonate decompose, as shown by the decrease in mass loss. Eg: Zinc carbonate has a decrease in 0.70 g as zinc carbonate decompose to form zinc oxide and carbon dioxide. This shows that thermal stability of metal carbonate is dependent on the charge of the metal ion. Calcium more reactive than zinc but calcium carbonate has a higher mass loss of 0.88 g when being heated as compared to zinc carbonate with mass loss of 0.70 g. This shows that more reactive the metal, the metal carbonate is not more thermal stable. **Alternative 2** Both students are incorrect.		

	When the metal ion has a charge of 2+ in carbonate such as calcium carbonate, the mass loss is 0.70g. When the metal ion has a charge of 1+ in carbonate such as sodium carbonate, there is no mass loss. However, it was also shown that when the metal ion has a charge of 2+ in carbonate such as copper (II) carbonate, the mass loss was 1.05g. Thus, it cannot be concluded that the thermal stability is dependent on the charge of the metal ion. (**Student 1 is incorrect**) Calcium more reactive than zinc but calcium carbonate has a higher mass loss of 0.88 g when being heated as compared to zinc carbonate with mass loss of 0.70 g. This shows that more reactive the metal, the metal carbonate is not more thermal stable. (**Student 2 is incorrect**)		
(b)(i)		[2]	No key: minus [1] overall
(ii)	$2NH_4Cl + CaO \rightarrow CaCl_2 + 2NH_3 + H_2O$ **Ammonia** is formed and is released to	[1]	Eqn link to statement Candidates failed to include balanced equation. Some candidates faced

	the surrounding. Hence, **nitrogen** content in the soil is **decreased**.		difficulty in writing the correct products.
(iii)	In molten state, the **giant ionic lattice** of calcium oxide **breaks down**. The oppositely charged / Ca^{2+} and O^{2-} are **no longer held in fixed positions** and **move relatively freely** to carry the electric current. Hence, suitable to be used as electrolyte.	[1] [1]	
(iv)	Positive electrode: $2O^{2-}(l) \rightarrow O_2(g) + 4e$ Negative electrode: $Ca^{2+}(l) + 2e \rightarrow Ca(l)$ Note: for overall equation, the number of electrons must be first balanced: $2CaO \rightarrow 2Ca + O_2$	[1] [1]	With correct state symbols. Candidates have problem with writing the correct state symbols and balancing the equation for the positive electrode. Some candidates mention hydroxide ions are discharged.
Either 3(a)(i)	Group VII elements are **non metals** which **gain electrons** to achieve noble gas configuration while Group I elements are **metals** which **lose valence electrons** to achieve octet configuration.	[1]	No marks are awarded if candidates just mention about gaining or losing of electrons. Marks will be awarded if candidates link gaining/losing due to the metallic or non metallic character or the idea of achieving noble gas configuraton. Some candidates did not talk about Group I.
(ii)	Down the group, the **oxidising power decreases** because the elements	[1]	

	down the group has **lower tendency to gain** electrons. *Recall, reactive of the halogens decreases down the group because the attraction power for electron of the atom decreases down the group as the atomic size increases.	[1]	
(iii)	Colourless solution turns reddish-brown. $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Chlorine **more reactive than bromine** **displace bromine** from **aqueous** potassium bromide to form a reddish brown bromine solution.	[1] [1]	the original colour and the final colour must be mentioned. Ionic equation to be supported by explanation. Candidates are still facing difficulty in constructing the correct ionic equation. Some candidates are unable to write the correct observation.
(iv)	Across the period, the electronegativity increases (from 0.93 to 3.16).	[1]	Candidates need to pay attention to the command word of the question - "describe the trend", hence data should be quoted. However, since the trend is obvious and it was only a 1 mark question, credit is given to all candidate.
(v)	Disagree. Across the period, the number of electron shell **remains as 3** but **electronegativity increases**.	[1]	change is rejected: direction of change e.g. increase/decrease/lower/larger etc. must be specified.
(b)	Down Group I, melting point of elements **decreases from 180°C to 64°C** while down Group VII, melting	[1]	Candidates need to pay attention to the command word of the question - "Using information provided", hence data should be quoted.

	point increase **from -101°C to 114°C.** Down Group I, the **metallic bond** becomes **weaker**. Thus, **lesser energy** needed to overcome the bond. Down Group VII, the **intermolecular** forces of attraction becomes **stronger** *(because the molecular size becomes bigger)*. Thus, **more energy** needed to overcome the intermolecular forces of attraction.	[1] [1]	As the atomic size increases, the valence electrons are further away from the positive metal nucleus, hence the attraction force becomes weaker and thus the metallic bond becomes weaker. *bond is different from force. eg. no BOND is present between molecules. ONLY forces of attraction are present before molecules.
Or 3(a)(i)	Number of moles of ethanol = (1/46) = 0.021739 mol Enthalpy change of combustion of ethanol = 0.021739 x -1367 = - 29.7kJ/g Thus, hydrogen gives greater output.	[1] [1] [1]	Allow ecf Surprisingly, some candidates do not know how to solve such question despite such question has appeared in O level many times. Some candidates failed to cite the units or forgot the negative sign. Marks are awarded if students did include negative sign but clear statement such as "Energy output", "Energy released" is used.
(ii)	More energy is released during the formation of bonds in water than the total energy absorbed during bond		[1]: idea of more energy released than absorbed

	breaking in hydrogen and oxygen.		[1]: reactants & products mentioned / specific bonds mentioned. Many candidates forgot that oxygen is one of the reactants. Some candidates talked about formation of carbon dioxide.
(iii)	During **photosynthesis, sugar cane takes in the carbon dioxide**. Hence, carbon dioxide produced from burning of fuel will not result in increase in amount of carbon dioxide being added.	[1]	This question was generally well attempted.
(b)(i)	Hydrogen ion has **one single proton** in its nucleus but **no electrons at all.**	[1]	No marks are awarded if candidates just mention because hydrogen ion has +1 charge, like a proton. Clear explaination is expected from candidates to mention idea about protons and electrons.
(ii)	A to B	[1]	This question was generally well attempted.
(iii)	$2H_2 + O_2 \quad 2H_2O$	[1]	This question was generally well attempted.
(iv)		[2]	[1] Formula of reactants and products, label for enthalpy change [1] showing an exothermic energy profile diagram with correct axis.