Secondary 4 Express
SA1 & SA2 Examination Papers
2014

Chemistry

SA1

Gan Eng Seng School	**P1**	**P2**
Hai Sing Catholic School	**P1**	**P2**
Nanyang Girls' High School	**P1**	**P2**
Victoria School	**P1**	**P2**

SA2

Anderson Secondary School	**P1**	**P2**
Catholic High School	**P1**	**P2**
Crescent Girls' School	**P1**	**P2**
Geylang Methodist School	**P1**	**P2**
Methodist Girls School	**P1**	**P2**
Paya Lebar Methodist Girls' School	**P1**	**P2**
Singapore Chinese Girls' School	**P1**	**P2**
St. Joseph's Institution	**P1**	**P2**
Swiss Cottage Secondary School	**P1**	**P2**

O	GAN ENG SENG SCHOOL Preliminary Examination 2014

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

5073/01
9 May 2014
1 hour

Secondary 4 Express

Paper 1 Multiple Choice

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

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

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

Read the instructions on the OTAS very carefully.

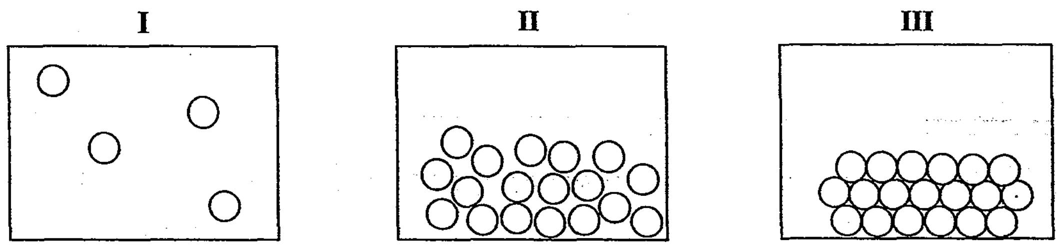
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is on page 13.

Total Marks
40

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



In which of the following are the substances corresponding to the diagram correctly?

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

2 A student attempts to dry ammonia gas by using a drying agent. Which of the following is most suitable for use as a drying agent?

A calcium oxide
B concentrated sulfuric acid
C dilute sulfuric acid
D fused calcium chloride

3 A dye **X** melts at 50°C and boils at 105°C. It does not dissolve in water nor react with water. Which method is **most** suitable for separating **X** from a mixture of **X** and water?

A chromatography
B Filtration
C fractional distillation
D separating funnel

4 Which of the following statements about $^{32}_{15}P$ and $^{32}_{16}S$ are correct?

I The phosphorus atom has more neutrons than the sulfur atom.

II If a neutron is added to the nucleus of $^{32}_{15}P$, $^{32}_{16}S$ is produced.

III Both contain 32 electrons.

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

5 Strontium is used in fireworks to produce crimson flames. Naturally occurring strontium has three isotopes:

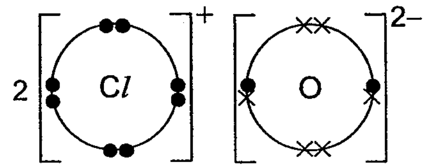
$$^{86}_{38}Sr\ (10\%);\ ^{87}_{38}Sr\ (7\%);\text{and}\ ^{88}_{38}Sr$$

What is the relative atomic mass of naturally occurring strontium?

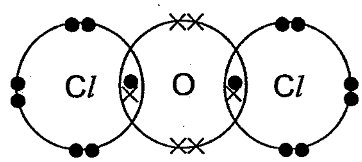
A 38.0 **B** 87.0
C 87.7 **D** 88.0

6 Which one of the following best represents the bonding in the yellow-red gas of chlorine(I) oxide, Cl_2O?

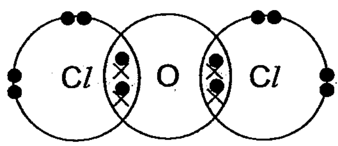
A



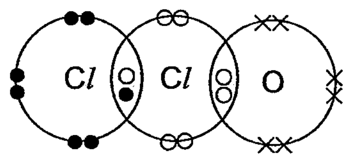
B



C



D



7 In 'dry ice' (solid carbon dioxide), what does the solid structure consist of?

A simple ions **B** atoms
C simple molecules **D** giant molecules

8 Four elements identified only as **W**, **X**, **Y** and **Z** are all found in the third period of the Periodic Table. Use the following information to determine the most likely order of arrangement of these elements from left to right in the third period.

- **I** The atomic size of **Z** is less than that of **X**.
- **II** The energy to remove the first electron from the atom of **Y** is greater than that from the atom of **Z**.
- **III** **W** forms an ion which has a larger size than an atom of **W**.
- **IV** **X**, **Y** and **Z** form ions which are smaller than their parent atoms.

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

9 Which pair of molecules has the same number of protons?

A O_2 and N_2 **B** SO_2 and CO_2
C CH_4 and NH_3 **D** NO_2 and Br_2

10 Which one of the following substances will cause a redox reaction with aqueous iron(II) sulfate?

A acidified aqueous potassium iodide **B** aqueous ammonia
C aqueous barium nitrate **D** oxygen

11 Which of the following is an example of a redox reaction?

A $2K_2CrO_4 + H_2SO_4 \rightarrow K_2Cr_2O_7 + K_2SO_4 + H_2O$
B $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$
C $2Na + Cl_2 \rightarrow 2NaCl$
D $BaSO_3 + 2HCl \rightarrow BaCl_2 + H_2O + SO_2$

12 The equation for the reaction between manganate(VII) ions and sulfite ions in acid solution is as follow:

$$2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$$

Which one of the following statements is **not** true?

A The manganate(VII) ion is acting as the oxidising agent in this reaction.
B As the reaction proceeds, the pH of the solution decreases.
C The hydrogen ions are neither reduced nor oxidised during the reaction.
D The sulfite ions are oxidised during the reaction.

13 Haemoglobin of the red blood corpuscles contains approximately 0.33% of iron by mass. Given the relative molecular mass of haemoglobin is approximately 68 000, what is the number of iron atom(s) per molecule of haemoglobin?

A 1 **B** 4
C 220 **D** 400

14 The equation for the burning of hydrogen in oxygen is shown below.

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

Which information does this equation give about the reaction?

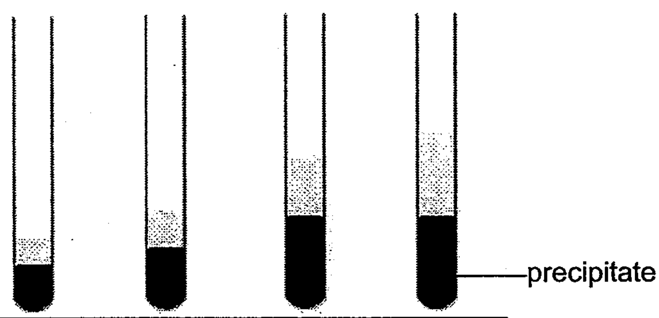
A 2 atoms of hydrogen combine with 2 atoms of oxygen
B 2 moles of steam can be obtained from 1 mole of oxygen
C 2 g of hydrogen combine with 1 g of oxygen
D 36 g of steam can be obtained from 16 g of oxygen

15 35.0 cm^3 of 0.500 mol/dm^3 hydrochloric acid were added to 1.41 g of a sample of sodium carbonate containing some sodium chloride as impurity. The excess acid was neutralised by 15.0 cm^3 of 0.400 mol/dm^3 sodium hydroxide solution.

What is the percentage purity of the sodium carbonate in the sample?

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

16 A 3 cm^3 sample of a solution of the nitrate of metal **Q**, concentration 1.0 mol/dm^3, was added to 2 cm^3 of potassium fluoride, concentration 1.0 mol/dm^3. When the precipitate had settled, its height was measured. The experiment was then repeated using different volumes of potassium fluoride solution. The results are shown in the diagram below.



Volume of potassium fluoride solution added / cm^3	2	4	6	8

What is the formula of the fluoride of metals **Q**?

A Q_2F **B** QF
C QF_2 **D** QF_3

17 A piece of magnesium ribbon does not react when placed in a solution of hydrogen chloride which is dissolved in methylbenzene. Which of the following changes will cause a reaction?

A Add water and stir well.
B Bubble more hydrogen chloride gas into the solution to increase its concentration.
C Remove the layer of oxide on magnesium ribbon before placing it in the solution.
D Using magnesium powder instead of magnesium ribbon as rate will be faster.

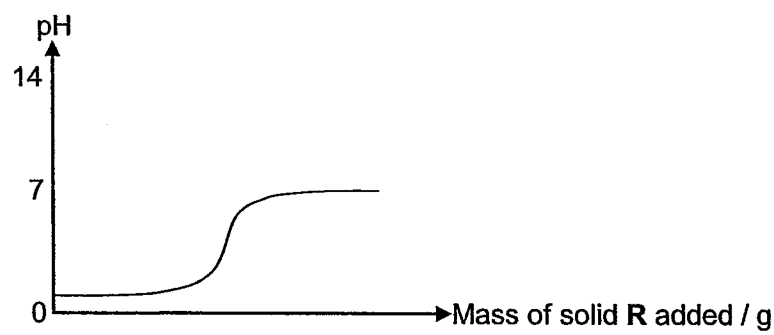
18 Which of the following salts is best prepared using a burette and pipette?

A iron(II) sulfate **B** potassium nitrate
C magnesium nitrate **D** calcium sulfate

19 How can barium sulfate be best prepared from barium carbonate?

A by adding dilute sulfuric acid
B by adding dilute hydrochloric acid followed by dilute sulfuric acid
C by adding sodium chloride solution followed by dilute sulfuric acid
D by heating until there is no further change followed by dilute sulfuric acid

20 Solid **R** is gradually added to aqueous solution **S**. The changes in pH are shown on the graph.



What are **R** and **S**?

	R	S
A	Sodium oxide	Hydrochloric acid
B	Ethanoic acid	Sodium hydroxide
C	Zinc oxide	Hydrochloric acid
D	Dry ice	Sodium hydroxide

21 **X** is a white powder which on heating gives off a colourless gas readily. The gas is moderately soluble in water and could produce a solution with a pH less than 7. The residue is soluble in aqueous solutions of sodium hydroxide, ammonia and hydrogen chloride.

Which of the following substances is most likely **X**?

A aluminium carbonate **B** aluminium hydroxide
C zinc carbonate **D** zinc nitrate

22 Solution **Y** contains a mixture of two salts. The scheme below shows some reactions of solution **Y**.

$$\begin{tikzcd}
\text{Solution Y} \arrow[r, "+\text{ dilute } HNO_3"] & \text{Colourless solution} \arrow[r, "+\ Ba(NO_3)_2(aq)"] \arrow[d, "+\ AgNO_3(aq)"] & \text{White precipitate} \\
& \text{White precipitate} &
\end{tikzcd}$$

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

A copper(II) sulfate and sodium chloride
B lead(II) chloride and sodium sulfate
C magnesium sulfate and zinc chloride
D potassium nitrate and calcium chloride

23 Which of the following reagents, when mixed and heated with ammonium sulfate, liberates ammonia?

A limewater **B** aqueous bromine
C dilute hydrochloric acid **D** acidified potassium dichromate(VI)

24 Hydrated sodium tungstate has the formula $Na_2WO_4.2H_2O$. What is the oxidation number of tungsten in the tungstate ion?

A –2 **B** +2
C +4 **D** +6

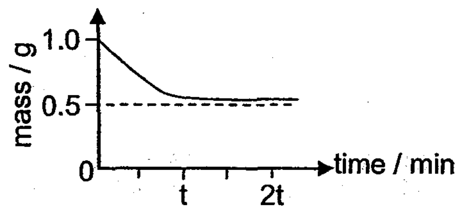
25 Dilute sulfuric acid reacts with copper(II) oxide and copper(II) carbonate. In what way are these two reactions alike?

A Water is a product.
B An insoluble salt is precipitated.
C An acid is neutralised by an alkali.
D Sulfuric acid is reacting as an oxidising agent.

26 Which substance in the fumes from car exhausts is **not** a pollutant?

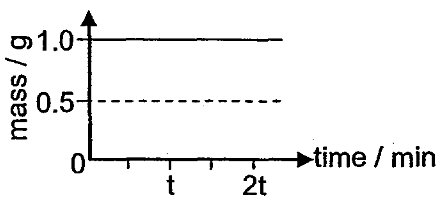
A	carbon monoxide	**B**	nitrogen
C	nitrogen dioxide	**D**	lead compounds

27 The graph represents the change in mass that occurs when 1.0 g of powdered calcium carbonate, $CaCO_3$, is heated at a temperature, T°C.

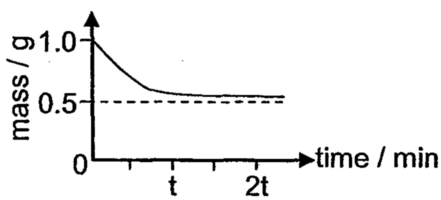


Which graph would be obtained by heating 1.0 g of powdered magnesium carbonate, $MgCO_3$, at T°C?

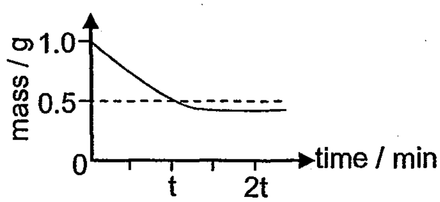
A



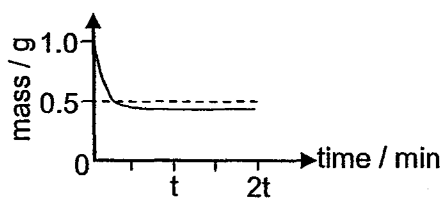
B



C



D



28 Calcium reacts slowly with cold water. If dropped into hot water, the reaction is much more vigorous. Which of the following statements best explains the observed increase in the rate of reaction?

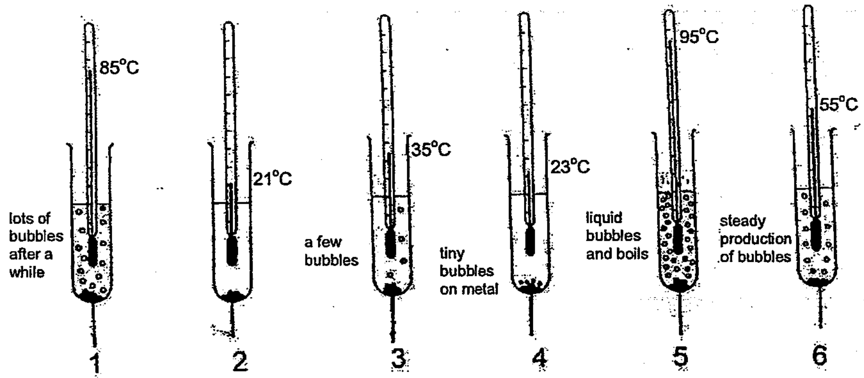
A At the higher temperature, the number of collisions per second increases. This increases the rate of the reaction.

B The activation energy is lower at the higher temperature. More particles thus have enough energy to react.

C The metal expands at the higher temperature. This increases its surface area and the rate of reaction.

D The number of particles with energy greater than the activation energy is much greater at the higher temperature. This increases the rate of reaction.

29 Different metals 1 to 6 are reacted with hydrochloric acid at 20 °C. The thermometers show the highest temperatures reached for the reactions. Study the diagrams below to determine the relative reactivity of the metals used.



Which of the following combinations would show a positive reaction?

I Metal 5 and aqueous salt of metal 1
II Metal 6 and aqueous salt of metal 2
III Metal 4 and aqueous salt of metal 3

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

30 Which of the following statements is **not** true about the reaction between zinc and excess dilute sulfuric acid?

A As the reaction proceeds, it becomes slower.
B The mass of the reaction vessel and contents decreases.
C The rate of reaction is constant.
D The reaction stops when all the zinc is used up.

31 The equation below represents the solution of sodium thiosulfate in excess water.

$$Na_2S_2O_3(aq) \rightarrow 2Na^+(aq) + S_2O_3^{2-}(aq) \qquad \Delta H = +7.15 \text{ kJ/mol}$$

When 0.010 mol of sodium thiosulfate is dissolved in 100 cm^3 of pure water in a thermally insulated container, the water will ....

A become warmer due to the reaction
B remain at the same temperature but heat will be given off to the surroundings
C become colder due to the reaction
D remain at the same temperature but heat will be absorbed from the surroundings

32 The energy released by the following reaction is 564 kJ/mol.

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

How much energy is released when 1 mole (28 g) of CO is burnt?

A $\frac{564}{2}$ kJ

B 564 × 28 kJ

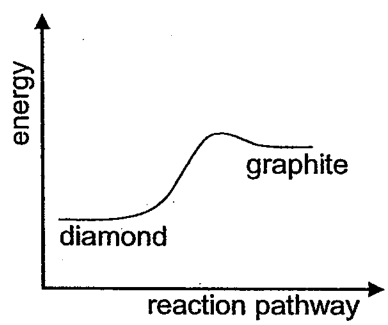
C 564 kJ

D 564 × 2 kJ

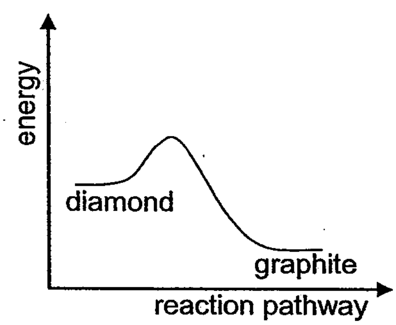
33 The conversion of diamond into graphite is exothermic by 2 kJ/mol. Diamond does not readily change into graphite.

Which energy diagram best represents this conversion?

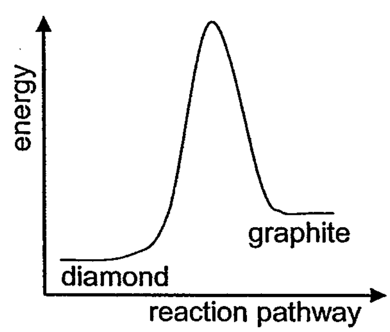
A



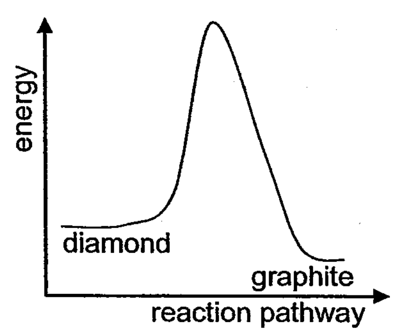
B



C



D

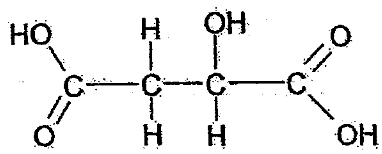


34 Carbon burns in air to give carbon dioxide and heat.

Which of the following describes this reaction correctly?

A catalytic and exothermic
B catalytic and oxidation
C exothermic and oxidation
D catalytic, exothermic and oxidation

35 The diagram shows the structure of a molecule that is commonly found in apples.



How can this molecule be classified?

A	alkene and alcohol	**B**	alkene and organic acid
C	alcohol and organic acid	**D**	alkene, alcohol and organic acid

36 A compound **X** has the properties below:

I It is a liquid at room temperature and pressure.
II It does not mix completely with water.
III It does not decolourise acidified potassium manganate(VII).

What could **X** be?

A	ethane	**B**	ethanol
C	ethanoic acid	**D**	ethyl ethanoate

37 Bread can be prepared from a mixture of flour, yeast and sugar. Carbon dioxide produced by a reaction within the mixture causes the dough to rise.

Which of the following could be the other main product from this reaction?

A	CH_3COOH	**B**	CH_3CH_2OH
C	$C_6H_{12}O_6$	**D**	H_2O

38 An organic liquid **Y** is tested with some reagents and the results are given in the table below.

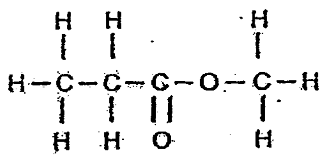
Reagent	**Observation**
sodium	effervescence produced
aqueous bromine	aqueous bromine decolourised
Acidified aqueous potassium dichromate(VI)	no visible reaction

Which structural formula best fits liquid **Y**?

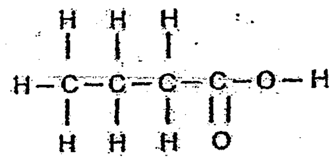
A	$CH_2 = CHCOOH$	**B**	$CH_3 - \overset{\overset{O}{\parallel}}{C} - CH = CH_2$
C	CH_3CH_2COOH	**D**	$CH_3CH_2CH_2OH$

39 The structures of three compounds **P**, **Q** and **R** are shown below.

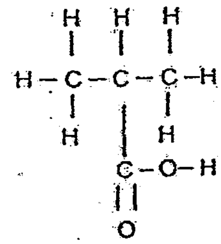
P



Q



R



Which compounds are isomers of each other?

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

40 An ester with an odour of banana has the following formula:

$$\begin{array}{l} CH_3CO_2CH_2\overset{}{C}HCH_2CH_3 \\ | \\ CH_3 \end{array}$$

Which of the following substances will react together to produce this ester?

A $\begin{array}{l} CH_3CH_2CHCH_2CO_2H \\ | \\ CH_3 \end{array}$ + CH_3OH

B $\begin{array}{l} CH_3CH_2CHCH_2COCl \\ | \\ CH_3 \end{array}$ + CH_3OH

C CH_3CO_2H + $\begin{array}{l} CH_3CH_2CHCH_2OH \\ | \\ CH_3 \end{array}$

D CH_3CH_2OH + $\begin{array}{l} CH_3CH_2CHCO_2H \\ | \\ CH_3 \end{array}$

END OF PAPER

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 †															

*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 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.).

Answers

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

O

GAN ENG SENG SCHOOL
Preliminary 1 Examination 2014

GESS ONWARD FOUNDED A.D.1885

CANDIDATE NAME	
CLASS	
INDEX NUMBER	

CHEMISTRY

5073/02

Paper 2

12 May 2014
1 hour 45 minutes

Secondary 4 Express

Candidates answer on the Question Paper.
Calculators are allowed in the examination

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 on both sides of the paper.
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 **three** questions, the last question is in the form either/or.
Write your answers on the lined paper 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 on page 21.

	For Examiner's Use
Section A	....
Section B	
B10	....
B11	....
B12 *Either / OR *Circle where appropriate*	....
Total	80

This paper consists of **21** printed pages including the cover page.

[Turn over

Section A (50 marks)

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

A1 The table below shows a list of substances, **A** to **E** and some information about them. Use the letters in the table to answer the following questions. A substance may be used once, more than once or not at all.

Substance	Melting Point/°C	Boiling Point/°C	Electrical Conductivity	
			Solid	Aqueous
A	-189	-186	None	None
B	327	1613	Good	Good
C	852	Decomposes at very high temperature	None	Good
D	-73	-10	None	Good
E	17	118	None	Good

Using the list of substances, **A** to **E**, answer the following questions.

(a) Which is a gas at room temperature and pressure? .... [1]

(b) Which is a metal? .... [1]

(c) Which is likely to be sodium carbonate? .... [1]

(d) Which is likely to be ethanoic acid? .... [1]

[Total: 4]

A2 A student made crystals of sodium sulfate from sodium hydroxide solution and dilute sulfuric acid using the following procedure.

Some sodium hydroxide solution was placed in an evaporating dish and a few drops of litmus solution added. The dilute sulfuric acid was then added slowly from a measuring cylinder until the litmus solution changed colour.
The solution in the evaporating dish was then heated strongly until all the water has evaporated.

(a) State the colour change of the litmus solution.

.... [1]

(b) Why is litmus solution needed?

....

[1]

(c) **(i)** Identify any *two* key errors or poor techniques in this procedure.

....

....

....

....

.... [2]

(ii) For one of the errors or poor techniques you identified in (c)(i), state how this part of the experiment should be carried out. Explain how your method improves on the result.

....

....

....

....

.... [2]

[Total: 6]

A3 The following is an account of how an English physicist, Rayleigh, performed a series of experiments to determine with great accuracy, how much a litre of nitrogen weighs, i.e. its density:

It is not hard to get pure nitrogen from the air. Ever since the time of Scheele and Lavoisier everyone knew that air was four parts nitrogen to one part oxygen.
All that was necessary was to get rid of the oxygen, and a little carbonic acid gas and water vapour, and you have pure nitrogen.
Rayleigh proceeded in this way. He passed the air through a series of chemical traps: in one the carbonic acid gas was absorbed, another took out all the oxygen; a third absorbed the water vapour.
In this way, Rayleigh drew out all the oxygen, carbonic acid gas, and moisture. This left him with pure nitrogen and Rayleigh weighed it.

(a) **(i)** What is the "carbonic acid gas" commonly known as now?

.... [1]

(ii) Suggest how the "carbonic acid gas" could be removed from the air.

....

[1]

(b) Rayleigh removed oxygen from the air by passing it over heated copper.
Explain why this method works.

....

.... [1]

As a check on his results Rayleigh decided to try obtaining nitrogen by another method instead of from the air. If the density of both agreed, then it would mean his results were correct. Rayleigh proceeded to extract nitrogen from ammonia. He purified it according to all the rules, then weighed it.
To his dismay the weights of the two gases, both nitrogen, did not agree. A litre of nitrogen from the air weighed 1.2572 grams. A litre of nitrogen obtained from ammonia weighed 1.2560 gram – that is 1/1000 of a gram less.

[Adapted from "The Chemical Elements"by Nechaev & Jenkins]

(c) **(i)** Nitrogen can be obtained from ammonia by heating with copper(II) oxide.
Write the chemical equation for this reaction.

.... [1]

(ii) From the extract above, suggest an explanation why the nitrogen from the air was heavier than the nitrogen obtained from ammonia (assuming that it was not due to experimental error).

....

....

.... [1]

[Total: 5]

A4 The table below shows the properties of the different types of oxides formed by the Group IV elements.

Element	**Formula of oxides formed**	**Stability of oxide**	**Nature of oxide**
Carbon	CO	Readily oxidised to dioxide	React with neither acids nor alkalis
	CO_2	Stable even at high temperatures	Acidic
Silicon	SiO	Readily oxidised to dioxide	React with neither acids nor alkalis
	SiO_2	Stable even at high temperatures	Acidic
Germanium	GeO	Readily oxidised to dioxide	Amphoteric
	GeO_2	Stable even at high temperatures	Amphoteric
Lead	PbO	Stable	Amphoteric
	PbO_2	Decomposes to PbO on warming	Amphoteric

(a) Elements in the same group of the Periodic Table have similar chemical properties. From the data given in the table, state **one** similarity in the oxides formed from the elements in Group IV of the Periodic Table.

....

....

....

....

....

.... [2]

(b) Using information from the table, state **two** trends in terms of the properties of the oxides down Group IV.

....

....

....

....

....

.... [2]

(c) What does the trend in the nature of the oxides suggest about the metallic character of the elements in Group IV?

.... [1]

(d) Lead(IV) oxide, PbO_2, is a strong oxidising agent.
Lead(IV) oxide reacts with hydrochloric acid to form chlorine and lead(II) chloride.

$$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$$

Explain how lead(IV) ions in lead(IV) oxide act as an oxidising agent in this reaction.

....

....

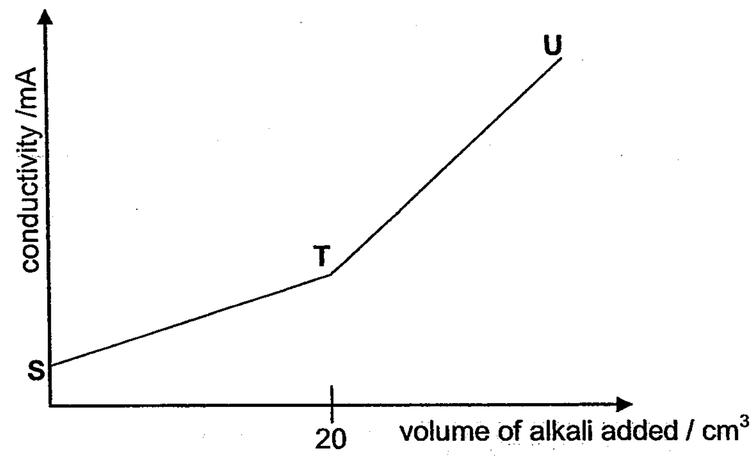
....

....

.... [2]

[Total: 7]

A5 The graph shows conductivity changes when sodium hydroxide solution is added to aqueous ethanoic acid.



(a) Explain the low conductivity value at **S**.

....

....

.... [1]

(b) Write an equation, including state symbols for the reaction between aqueous ethanoic acid and sodium hydroxide solution.

.... [2]

(c) Explain why the conductivity increases as sodium hydroxide solution is added to aqueous ethanoic acid?

....

....

....

....

....

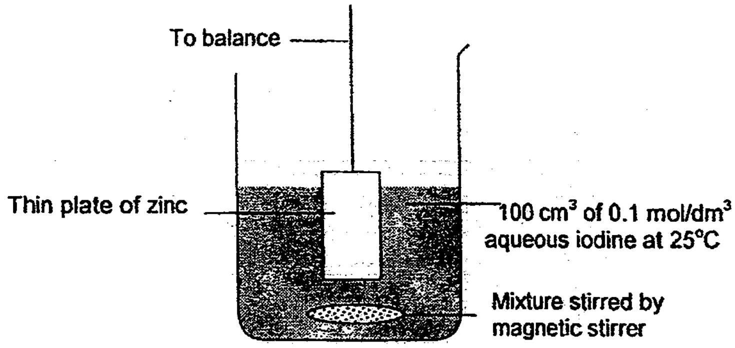
.... [2]

(d) If the concentration of the acid is half the concentration of the alkali solution, state the volume of acid used in the flask at the start of the reaction.

.... [1]

[Total: 6]

A6 The following apparatus was used to measure the rate of the reaction between zinc and iodine.

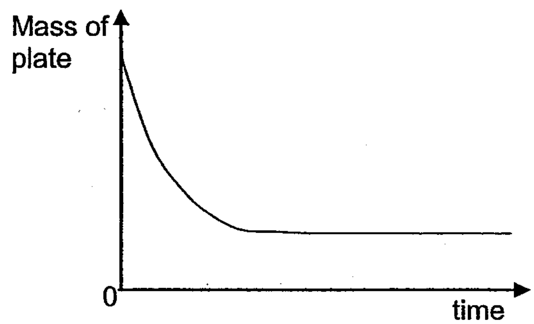


The mass of the zinc plate was measured every minute until the reaction was complete.

(a) Write a chemical equation, including state symbols, for the redox reaction that occurred between zinc and iodine.

.... [1]

(b) From the results of the experiment, the following graph was plotted.



(i) Which reagent, iodine or zinc is in excess? Give a reason for your answer.

....

.... [1]

(ii) Sketch on the graph if 100 cm^3 of 0.05 mol/dm^3 iodine had been used instead and label this graph **G**. [1]

(c) Describe how you would show that an aqueous solution contains zinc ions.

....

....

....

.... [2]

[Total: 5]

A7 Some information about four metals, **W**, **X**, **Y** and **Z** is shown in the table.

Element	**W**	**X**	**Y**	**Z**
number of electrons in outer shell	4	1	1	1
density in g/cm^3	2.22	8.9	0.9	11.3
melting point / °C	3720	1083	64	328
atomic radius / pm	77	135	203	154
ions formed	W^{4+}	X^{+} and X^{2+}	Y^{+}	Z^{2+} and Z^{4+}
formulae and appearance of chlorides	WCl_4 – a colourless liquid	XCl – a white solid XCl_2 – a green solid	YCl – a white solid	ZCl_2 – a white solid ZCl_4 – a colourless liquid

(a) Which one of the elements would react most vigorously with dilute sulfuric acid? Using the information from the table, explain your answer.

....

....

....

....

.... [2]

(b) Which one of the elements is a transition metal? Give **three** evidence from the table to support your answer.

....

....

....

....

....

.... [3]

[Total: 5]

A8 Some hydrated ionic solids when heated release their water of crystallization and dissolve in this water. When the solution is cooled the solid recrystallises and heat is released. One example is calcium chloride hexahydrate ($CaCl_2.6H_2O$) and the process is described by the equation:

$$CaCl_2.6H_2O\ (s) \rightleftharpoons CaCl_2.2H_2O(l) + 4H_2O(l) \qquad \Delta H = +37.2\ kJ$$

This process can be repeated many times and can be used to store solar energy. Energy from the sun heats the solid calcium chloride hexahydrate and its temperature increases. At 29°C the solid melts and the energy required for the chemical change described above is absorbed from the solar radiation. At night as the solution cools, it solidifies and heat is given back to the surroundings.

(a) **(i)** Is the reaction taking place at night an endothermic or exothermic reaction? Give a reason for your answer.

....

.... [1]

(ii) Describe the changes in the movement and arrangement of particles as the solution cools and solidifies at night.

....

....

....

....

....

.... [2]

(b) Draw a fully labelled energy level diagram for the above (forward i.e. left to right) reaction.

[2]

(c) Calculate the energy absorbed when 100kg of calcium chloride hexahydrate undergoes the above reaction. Leave your answer to the nearest kJ.

[2]

[Total: 7]

A9 The table below gives information about car exhaust emissions.

Pollutant	**Petrol car (without catalytic converter)**	**Petrol car (with catalytic converter)**	**Diesel car (without catalytic converter)**	**Diesel car (with catalytic converter)**
Nitrogen oxides	xxx	x	xx	xx
Carbon monoxide	xxx	xx	xx	x
Hydrocarbons	xxx	xx	xx	x
Particulates	xx	x	xxx	xx
Carbon dioxide	xx	xxx	x	xx

Key:

Highest emissions: xxx
Intermediate: xx
Lowest emissions: x

(a) Particulates are very small particles of a black solid. Suggest the name of this black solid.

.... [1]

(b) Explain how the oxides of nitrogen are formed in car engines.

....

....

....

.... [2]

(c) Based on the data given, describe the effect of installing a catalytic converter on car exhaust emissions.

....

....

....

.... [2]

[Total: 5]

Section B (30 marks)
Answer all **three** questions. The last question is in the form **either/or.**
Write your answers on the lined paper provided provided.

B10 Below is a table of data corresponding to the following balanced equation:

$$2ClO_2\,(aq) + 2OH^-\,(aq) \rightarrow ClO_3^-\,(aq) + ClO_2^-\,(aq) + H_2O\,(l)$$

Six experiments were carried out with differing concentrations of ClO_2 and OH^- in each experiment.
The measurement of how quickly ClO_2 disappears is given in the table for each of the six experiments. How quickly a reactant disappears is a good measurement of how fast a reaction takes place.

Expt	**Concentration of ClO_2 / mol dm^{-3}**	**Concentration of OH^- / mol dm^{-3}**	**Initial rate of disappearance of ClO_2 / mol dm^{-3} s^{-1}**
1	0.020	0.030	0.00276
2	0.040	0.030	0.01104
3	0.020	0.060	0.00552
4	0.040	0.060	0.02208
5	0.040	0.090	0.03312
6	0.120	0.030	0.09936

(a) What is the relationship between the concentrations of the reactants and the rate of reaction? Justify your answer using the results in the table, stating clearly the experimental data you are using.

....

....

....

....

....

....

.... [3]

(b) Explain the effect of concentration on the rate of reaction in terms of collisions between particles.

....

....

....

[2]

(c) Does the reaction rate depend on the concentration of ClO_2 and OH^- *equally*? Explain your answer using results from the table. State which experimental data you are using, and show how you arrived at your answer clearly.

....

....

....

....

....

....

....

.... [4]

(d) Predict the initial rate of disappearance of ClO_2 if the experiment was conducted using 0.040 mol/dm^3 of ClO_2 and 0.120 mol/dm^3 of OH^-.

.... [1]

(e) In the reaction between ClO_2 and OH^-, chlorine in ClO_2 is said to be both oxidised and reduced simultaneously. Explain why.

....

....

....

....

.... [2]

[Total: 12]

B11 In Shakespearean time, actors in theatre were literally "in the limelight". This was because limestone was heated strongly in front of the stage illuminating the actors.
Limestone, containing a natural occurring form of calcium carbonate, decomposed on heating to produce two products and emitting a bright light at the same time.

(a) Write a balanced chemical equation, including the state symbols, for the thermal decomposition of limestone.

.... [1]

(b) Describe two **other** industrial uses of calcium carbonate.

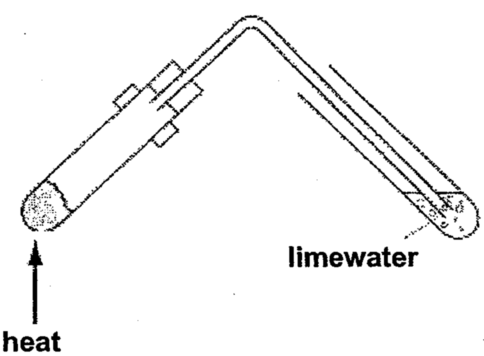
....

....

.... [2]

(c) Dolomite proved to be less effective as stage lighting. This is because dolomite contains both calcium and magnesium carbonate.
Magnesium carbonate does not emit light when it decomposes.

A student carried out the following experiment to determine which of the two carbonates decomposes readily.



(i) Describe the change you would see in limewater, if the carbonate decomposes on heating.

.... [1]

(ii) The student used the same number of moles of carbonate rather than the same mass of carbonate to get a fair comparison. Explain why.

....

....

....

....

.... [2]

(iii) Describe how you could use the above experiment to show that magnesium carbonate decomposes more readily than calcium carbonate.

Hence, explain why magnesium carbonate decomposes more readily than calcium carbonate.

....

....

....

....

.... [2]

[Total: 8]

EITHER

B12 **(a)** Ethanol is an important industrial chemical with about 200,000 tonnes manufactured in the UK each year. The usual method of manufacture is by the hydration of ethene with steam in the presence of a catalyst at 300°C and high pressure. The reaction occurs as shown in the following equation:

$$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g) \qquad \Delta H = -46 \text{ kJ/mol}$$

(i) The boiling points of the three chemicals involved in this reaction are shown in the table below:

Compound	C_2H_4	H_2O	C_2H_5OH
Boiling point / °C	−104	100	78

Suggest how the ethanol could be separated from the mixture.

....

....

....

....

.... [2]

Alcohols such as ethanol can be used as alternative fuels to petrol. The combustion of ethanol tends to be more complete than the combustion of the alkanes in petrol, partly because less oxygen is required for combustion.

(ii) With the aid of chemical equations, calculate the amount (number of moles) of oxygen required per gram of each fuel burned. [Use octane, C_8H_{18}, as the typical alkane in petrol for your equation.]

....

....

....

....

....

....

....

....

.... [4]

(iii) Suggest why there is this difference between the amounts of oxygen required per gram for these two fuels.

....

....

.... [1]

(b) The structure of the silkworm moth sex attractant, bombykol, is

$$H_3C{-}(CH_2)_2{-}CH{=}CH{-}CH{=}CH{-}(CH_2)_8{-}CH_2OH$$

Predict, with reasons,

(i) the solubility of bombykol in water;

....

....

....

....

.... [2]

(ii) what you will observe if aqueous bromine is added to bombykol.

....

.... [1]

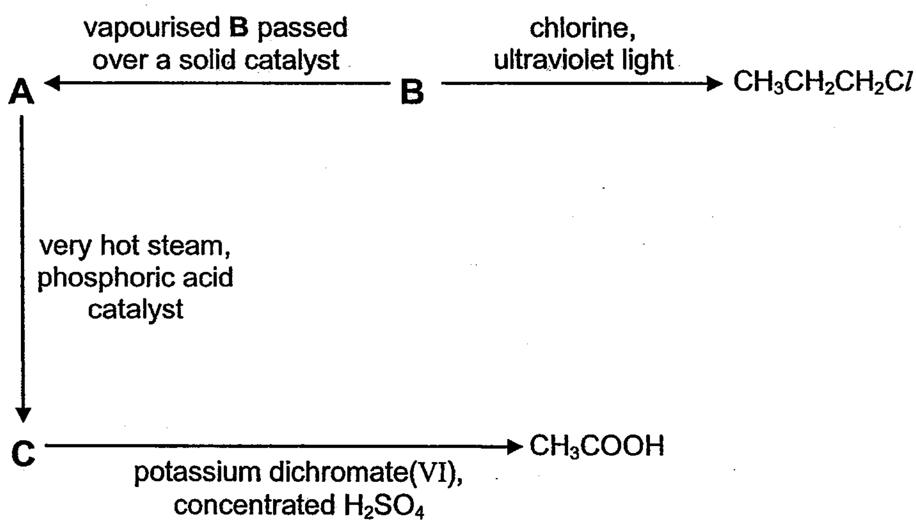
[Total: 10]

OR

B12 **(a)** Draw a dot-and-cross diagram to represent the bonding in trichloromethane, $CHCl_3$.

[2]

(b)



It is known that compound **B** is a hydrocarbon.

(i) State the molecular formula of compound **B**.

.... [1]

(ii) State the type of reaction that **A** undergoes to form **C**.

.... [1]

(iii) Name and draw the structure of the organic product that is formed when **C** is reacted with propanoic acid.

Name: ....

[2]

(iv) State the formula of the product, other than **A**, which is formed when vapourised **B** is passed over a solid catalyst.

.... [1]

(c) The aldehydes are a group of organic compounds which contain hydrogen, carbon and oxygen. The table below shows some information about aldehydes and alkanes:

Alkanes	**Aldehydes**	
formula	*name*	*formula*
C_2H_6	ethanal	CH_3CHO
C_3H_8	propanal	C_2H_5CHO
C_4H_{10}	butanal	C_3H_7CHO
C_5H_{12}	pentanal	C_4H_9CHO

(i) Deduce the general formula for the aldehydes.

.... [1]

(ii) Would you expect pentanal to have a higher boiling point than butanal? Explain your answer.

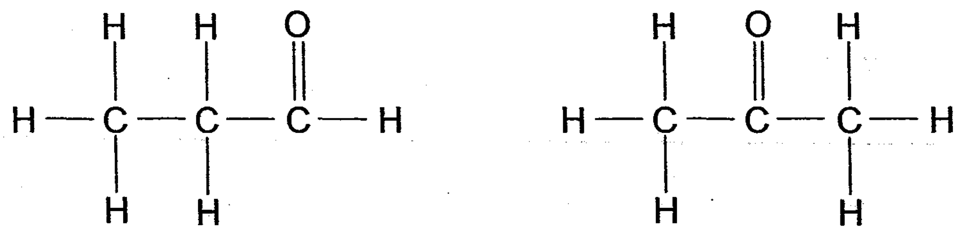
....

....

....

.... [1]

(d) The functional group of the aldehydes is the – **CHO** group. The structural formulae of propanal, $\mathbf{C_2H_5CHO}$, and one of its isomers with a different functional group are given below:



propanal

isomer of propanal with a different functional group

Draw the structure of another isomer of propanal which has a different functional group from the above two compounds.

[1]

[Total: 10]

END OF PAPER

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	226 Ra Radium 88	227 Ac actinium 89 †															

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

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	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

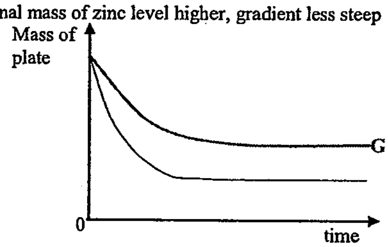
Key: a above, X, b below

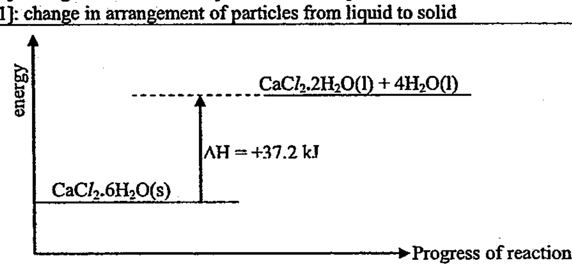
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

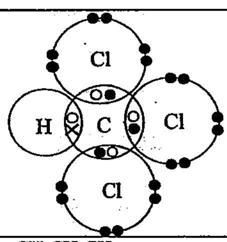
Marking Scheme for Paper 2

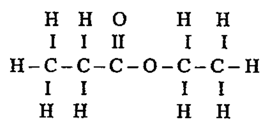
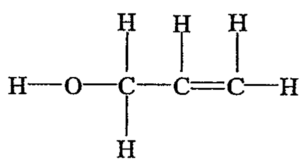
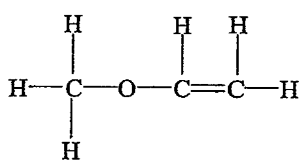
Qn	**Possible answers**
A1(a)	**A** or **D**
(b)	**B**
(c)	**C**
(d)	**E**
A2(a)	The litmus changes from blue to red.
(b)	Litmus is needed to indicate when the sodium hydroxide solution has been completely neutralised.
(c)(i)	Error 1: - A measuring cylinder should not have been used to add the acid. Error 2: - The procedure was not repeated without the indicator. OR - The solution should not have been heated strongly until all the water has evaporated.
(ii)	Error 1: - The acid should have been added drop by drop / dropwise from a burette instead of a measuring cylinder. - This would improve accuracy, ensuring that the alkali is exactly neutralised by the acid. Error 2: - The volume of acid needed to neutralise the alkali is noted and the procedure should be repeated without the use of indicator. - This would prevent the salt from being contaminated by the indicator. OR -The solution should be heated until saturated and then leave to cool to crystallise the salt out of the solution.
A3(a)(i)	Carbon dioxide / CO_2
(ii)	By passing the gas through calcium hydroxide/ sodium hydroxide/ potassium hydroxide. **Reject: calcium oxide** as answer must be a soluble / slightly soluble base
(b)	Copper will react with the oxygen present in the air to form copper(II) oxide.
(c)(i)	$2NH_3 + 3CuO \rightarrow N_2 + 3Cu + 3H_2O$

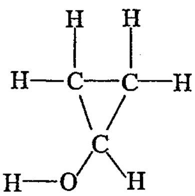
(ii)	The nitrogen from the air still contained the noble gases such as argon. Hence it is heavier than the one obtained from ammonia.
A4 (a)	All of the elements form two types of oxides – one in which the oxidation state of the Group IV is +2 and the other in which the oxidation state is +4 OR oxides with one and two oxygen atoms respectively
(b)	1. Going down the group, the dioxide becomes less stable while the monoxide becomes more stable 2. Going down the group, the dioxides change from acidic to amphoteric OR monoxides change from neutral to amphoteric.
(c)	The metallic character increases down the group.
(d)	Lead(IV) ions accepts electron from chloride ions in hydrochloric acid, thus oxidising chloride ions to chlorine gas.
A5 (a)	ic acid is a weak acid with / partially dissociates/ionises in water to form a low concentration of ions that are available to could conduct electricity.
(b)	$CH_3COOH\,(aq) + NaOH\,(aq) \rightarrow CH_3COONa\,(aq) + H_2O\,(l)$ [1]: correct formulae and balanced chemical equation [1]: state symbols *Marks for state symbols will only be awarded if all chemical formulae of the substances are correct*
(c)	As NaOH is added to ethanoic acid, the salt / sodium ethanoate / CH_3COONa formed is soluble/fully ionizes in water. After T, ethanoic acid is fully used up and NaOH is in excess. NaOH is a strong alkali /fully ionises, so there is an even much higher concentration of mobile ions present to conduct electricity.
(d)	40 cm^3
A6(a)	$Zn\,(s) + I_2\,(aq) \rightarrow ZnI_2\,(aq)$
(b)(i)	Zinc because the final mass of zinc is greater than 0.
(ii)	Final mass of zinc level higher, gradient less steep 

(c)	n of aqueous ammonia to the sample. White ppt, soluble in excess aq. ammonia and form a colourless solution.
A7 (a)	Element Y It has a much lower density and melting point than other metals and thus Y is most likely a Group I metal which is very reactive.
(b)	X is a transition metal. The three pieces of evidence are : 1. X has variable oxidation states of +1 and +2 / variable valencies. 2. X forms coloured compounds e.g. XCl_2 is a green solid. 3. X has a high density of 8.9 g/cm^3 and high melting point of 1083°C.
A8(a)(i)	An exothermic reaction takes place at night as energy is lost to the surroundings.
(ii)	Initially, in the liquid state, the particles are able to slide past each other and are randomly arranged. As the liquid cools, the particles lose energy and move more slowly. Eventually the particles no longer have enough energy to move freely, only vibrating about fixed positions, and are now regularly/orderly arranged. [1]: change in movement of particles from liquid to solid [1]: change in arrangement of particles from liquid to solid
(b)	
(c)	Mr $CaCl_2.6H_2O$ = 40+(35.5×2)+12+(16×6) = 219 Therefore 219 g of calcium chloride hexahydrate absorbs 37.2 kJ energy 100 kg of calcium chloride hexahydrate thus absorbs [(100×1000)÷219]× 37.2 kJ = 16 986 kJ of energy

A9(a)	Carbon/soot
(b)	The high temperature in the car engine causes nitrogen **in the air** to react with oxygen **in the air** producing oxides of nitrogen.
(c)	Installing a catalytic converter decreases the emissions of nitrogen oxides, carbon monoxide, hydrocarbons and particulates but increases the emission of carbon dioxide.
B10 (a)	Comparing Expts 1, 2 and 6 – As the concentration of ClO_2 increases while concentration of OH^- is kept constant, rate of reaction increases. Comparing Expts 2, 4 and 5 – an increase in the concentration of OH^- increases the rate of reaction. Hence the rate of reaction increases as the concentrations of reactants increase.
(b)	The higher the concentration, the greater the number of particles for the same volume / per unit volume. Hence, the particles are closer together and frequency of effective collisions increases, leading to an increase in the rate of reaction.
(c)	Comparing Expts 1 and 2, doubling the concentration of ClO_2 increases the rate of reaction by 4 times $\left[\frac{0.01104}{0.00276}=4\right]$. Comparing Expts 2 and 4 (or 1 and 3), doubling the concentration of OH^- increases the rate of reaction by 2 times $\left[\frac{0.02208}{0.01104}=2\right]$. Hence the rate is more dependent on the concentration of ClO_2.
(d)	0.04416 mol dm^{-3} s^{-1}
(e)	Oxidation state of chlorine increases from +4 in ClO_2 to +5 in ClO_3^-, hence chlorine in ClO_2 is oxidised. Oxidation state of chlorine decreases from +4 in ClO_2 to +3 in ClO_2^- hence chlorine in ClO_2 is reduced.
B11(a)	$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
(b)	It is used in the extraction of iron to remove acidic impurities such as sand / silicon dioxide from molten iron in the form of molten slag. It is used in flue gas desulfurisation to remove sulfur dioxide from the waste gases when fossil fuels undergo combustion.
(c)(i)	White precipitate is formed in limewater.
(ii)	Same mass of carbonate contains different number of moles of carbonate due to different relative molecular mass of the metal carbonate. Since the amount of carbonate ions affect the volume of carbon dioxide gas produced, the same number of moles of carbonate had to be used in order to ensure that the only changing variable is due to the different stability of the carbonates that causes the different volumes of gas produced per unit time.
(iii)	Magnesium carbonate should take a shorter time to decompose and form white precipitate in limewater. Magnesium is less reactive than calcium and hence form a less stable metal carbonate than calcium carbonate.

Either B12 (a)(i)	The mixture can be cooled to about 50°C (or below 78°C). Water and ethanol will condense as a mixture of liquids. Ethanol can then be separated from the mixture by fractional distillation.
(ii)	Using octane as a typical alkane in petrol, $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ Mr C8H18 = (8×12)+18 = 114 ⇒ (114×2) = 228 g C_8H_{18} requires 25 mol oxygen ⇒ 1g C_8H_{18} requires (1/228)×25 = 0.110 mol oxygen (to 3sf) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ M_r C_2H_5OH = 24+6+16 = 46 ⇒ 46 g C_2H_5OH requires 3 mol oxygen ⇒1 g C_2H_5OH requires (1/46)×3 = 0.0652 mol oxygen (to 3 sf)
(iii)	Unlike octane, ethanol contains oxygen atoms in its molecules, hence it requires less oxygen from the air per gram compared to octane. OR Octane has higher carbon content, hence it requires more oxygen from the air per gram compared to ethanol.
(b)(i)	Bombykol should be slightly soluble in water .As it is an alcohol/ as it has a hydroxyl group, bombykol should be soluble in water but because of the relatively long carbon chain it became only be slightly soluble.
(ii)	Reddish-brown/Orange-red aqueous bromine will decolourise/turn colourless because of the presence of carbon-carbon double bond/ C=C bonds / as the molecule is unsaturated.
OR B12a	 Key X electron of H O electron of C ● electron of Cl
b(i)	C_3H_8 or $CH_3CH_2CH_3$

(ii)	Addition
(iii)	 Ethyl propanoate
(iv)	CH_4
(c)(i)	$C_nH_{2n+1}CHO$ or $C_{n-1}H_{2n-1}CHO$
(ii)	Yes. A pentanal molecule has more atoms and hence **size of molecules increases**. The **intermolecular forces are stronger** and **more energy is required to overcome these stronger intermolecular forces**.
(d)	 OR  OR

Class:	Index No.:	Name:	Date:

海星天主教中学
HAI SING CATHOLIC SCHOOL
9 Pasir Ris Drive 6, Singapore 519421 Tel: 5827864 Fax: 5822543

2014 PRELIMINARY EXAMINATION 1

Secondary Four Express

CHEMISTRY **5073/1**

Paper 1 Multiple Choice

12 May 2014

1 hour

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

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

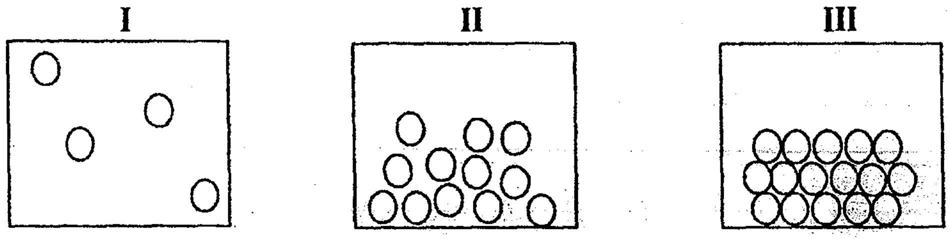
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

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

This question paper consists of **15** printed pages, including the cover page.

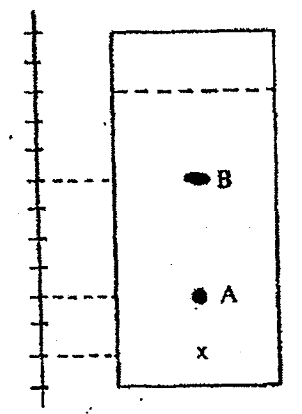
1 Diagrams **I**, **II** and **III** show the particles of three substances at room temperature.



In which of the following are the substances correctly named?

	I	II	III
A	Argon	Water	Mercury
B	Helium	Mercury	Copper
C	Hydrogen chloride	Molten zinc chloride	Sugar solution
D	Methane	Sodium chloride	Copper

2 The diagram represents a chromatogram which has been developed by standing the paper in a trough of solvent. Spots of a sample containing components A and B, were originally placed at x.



Compared to component A, component B is

A less soluble and has a smaller R_f value.
B less soluble and has a larger R_f value.
C more soluble and has a smaller R_f value.
D more soluble and has a larger R_f value.

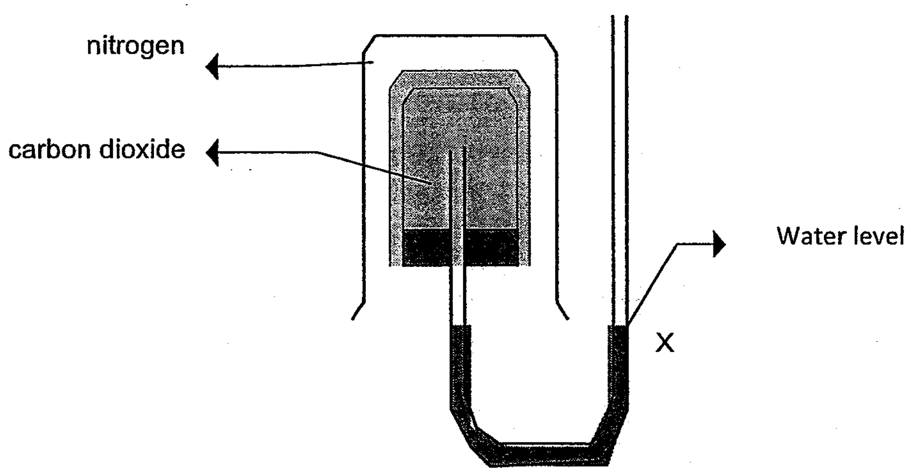
3 An element **Y,** has two isotopes of 16 and 18. Its relative atomic mass is 16.4. The proportion of each isotope will be

A	50% of Y-16	50% of Y-18
B	60% of Y-16	40% of Y-18
C	70% of Y-16	30% of Y-18
D	80% of Y-16	20% of Y-18

4 What are the operating conditions in the Haber process for the manufacture of ammonia?

	Pressure	temperature	catalyst
	1 atm	450°C	iron
B	200 atm	450°C	iron
C	200 atm	500°C	vanadium (V) oxide
D	200 atm	2000°C	vanadium (V) oxide

5 When a large beaker full of nitrogen is inverted over a porous pot containing carbon dioxide in the apparatus below, the water level at X



A falls as carbon dioxide is denser than nitrogen.
B falls as nitrogen is denser than carbon dioxide
C rises as carbon dioxide is denser than nitrogen.
D rises as nitrogen is denser than carbon dioxide.

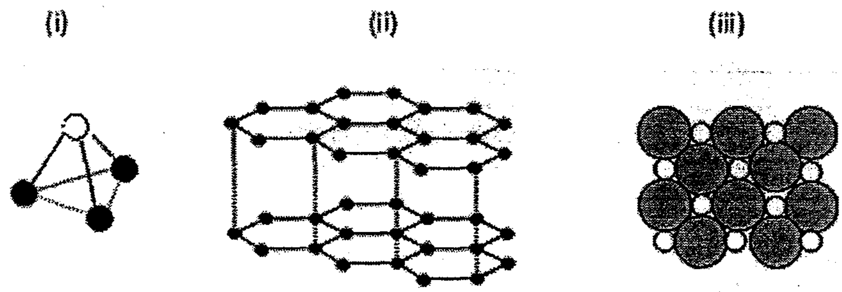
6 The atoms of element X have the electronic configuration 2.8.2.
Which statement about X is correct?

A It forms an ion of charge 2 -.
B It forms an ionic compound with oxygen.
C It has two protons in the outer shell of an atom.
D It only reacts with metals.

7 How many electrons are present in one ion of ${}^{31}_{15}X^{3-}$?

A 12
B 18
C 29
D 34

8 Which of the following correctly identifies the structures shown?



	(i)	(ii)	(iii)
A	ammonia	diamond	silicon
B	ammonia	graphite	sodium chloride
C	methane	diamond	silicon
D	methane	graphite	sodium chloride

9 What volume of 1.5 mol/dm^3 NaOH is needed to provide 0.75 mol of NaOH?

A 500 cm^3
B 0.75 dm^3
C 5.0 dm^3
D 500 dm^3

10 The reaction between bromine and iodide ions is shown in the equation:

$$Br_2 + 2\,I^- \longrightarrow 2\,Br^- + I_2.$$

What happens during the reaction?

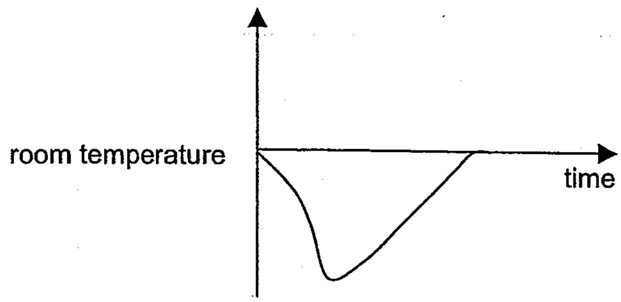
A Bromine molecules are the oxidising agent.
B Bromine molecules are oxidised into bromide ions.
C Iodide ions are reduced to iodine molecules.
D Iodide ions gain electrons.

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

Which statement is **not** correct?

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

12 The following graph was obtained when potassium iodide was dissolved in water.



Which of the following statements about the reaction is correct?

A Ice is formed and has melted.
B The potassium iodide has sublimed.
C The reaction is endothermic.
D The reaction is exothermic.

13 A salt has the chemical formula $\mathbf{(NH_4)_2Fe(SO_4)_2.12\ H_2O}$
Excess aqueous sodium hydroxide was added slowly, with shaking to a hot solution of the salt in a boiling tube until there is no further reaction. The boiling tube was then left to stand for some time. Which one of the following observation would **not** be made?

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

14 When a mixture of barium nitrate, sodium sulfate and potassium chloride is shaken up with water, a solid remains insoluble after shaking. The solid is most likely to be

A $BaSO_4$
B $BaCl_2$
C K_2SO_4
D $NaNO_3$

15 Selenium has proton number 34 on the Periodic Table. Selenium forms

A a covalent hydride
B a giant covalent chloride
C a fluoride of formula SeF_5
D an ionic oxide

16 The table below shows the colour of bromophenol blue and phenolpthalein in acid and alkali, as well as the pH at which the colour changes take place.

Indicator	Colour in strongly acidic solution	Colour in strongly alkaline solution	pH at which colour changes
bromophenol blue	yellow	blue	4
phenolpthalein	colourless	red	9

What is the colour of a mixture of bromophenol blue and phenolpthalein in a solution with pH 2?

A blue
B colourless
C red
D yellow

17 Which of the following statement is true for both graphite and diamond?

	Graphite	Diamond
A	Good conductor of electricity	Good insulator
B	Hard and transparent	Soft and opaque
C	Low boiling point	High boiling point
D	three ionic bonds between each carbon atom	four covalent bonds between each carbon atom

18 An excess of silver nitrate is added to aqueous barium chloride, and the precipitate is removed by filtration. What are the main ions in the filtrate?

A Ag^+ and NO_3^-

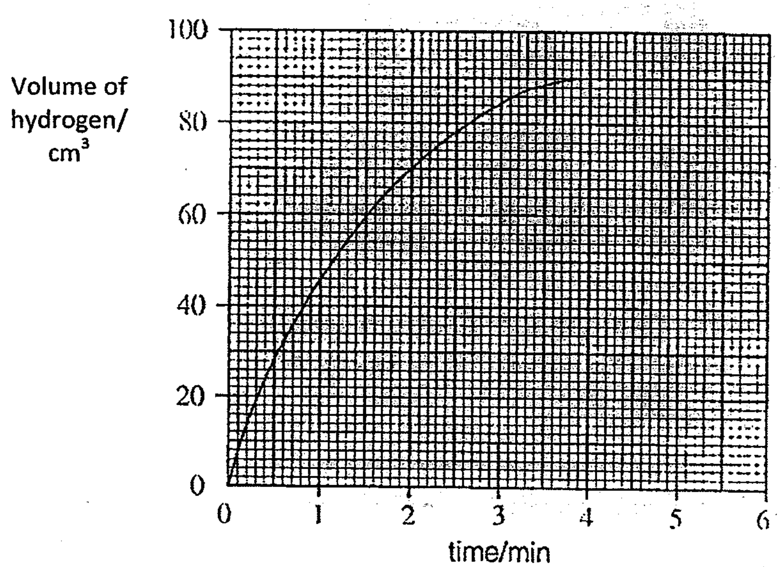
B Ag^+, Ba^{2+} and NO_3^-

C Ba^{2+} and NO_3^-

D Ba^{2+}, Cl^- and NO_3^-

For questions **19** and **20**, refer to the information below:

0.10 g of magnesium ribbon was allowed to react at 18°C with 20 cm^3 of 1mol/dm^3 hydrochloric acid at atmospheric pressure. The total volume of hydrogen collected was noted at half minute intervals and the graph below was plotted.



19 Which one of the following factors would **not** result in an increase in the initial rate of reaction?

A adding 10 cm^3 of water to the hydrochloric acid
B carrying out the reaction at 30°C
C using 0.2 g of magnesium
D using 20 cm^3 of 2 mol/dm^3 hydrochloric acid

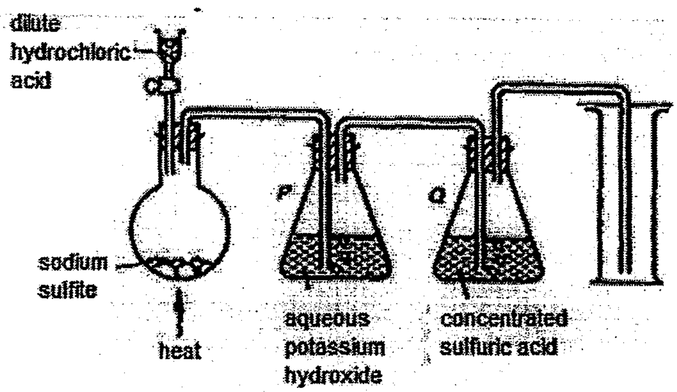
20 What time was required for half the magnesium to react?

A 0.95 min
B 1.5 min
C 2.0 min
D 3.0 min

21 Which pair would react most violently together?

A caesium and chlorine
B caesium and fluorine
C sodium and chlorine
D sodium and fluorine

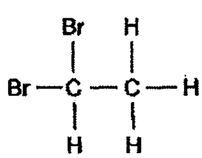
22 The diagram represents an unsuccessful attempt to collect sulfur dioxide.



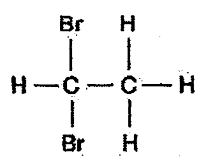
Which modification would make the experiment successful?

A collect the gas using upward delivery
B remove flask P
C remove flask Q
D using water in flask P instead of aqueous potassium hydroxide

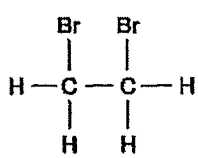
23 Which of these molecules are isomers?



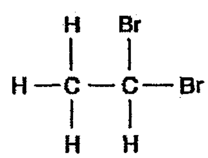
I



II



III



IV

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

24 In which of the following substances does sulfur exhibit its highest oxidation state?

A S_8

B SO_2

C SO_2Cl_2

D $Na_2S_2O_3$

25 A sample of 10 dm^3 of polluted air is passed through limewater so that all the carbon dioxide present is precipitated as calcium carbonate. The mass of calcium carbonate formed is 0.05g. What is the percentage, by volume, of carbon dioxide in the air sample?

A 0.03%

B 0.05%

C 0.12%

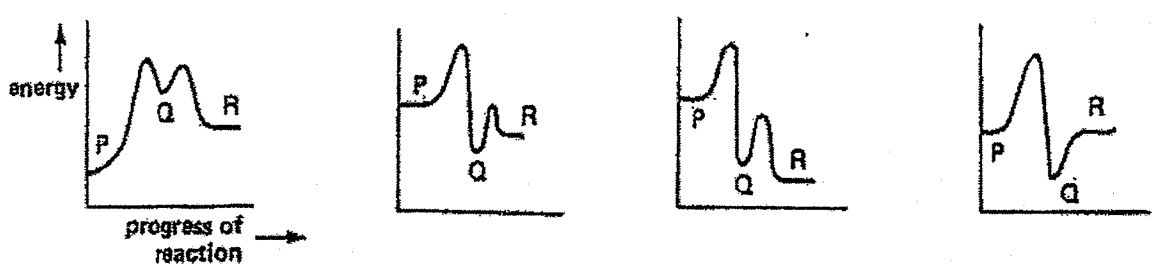
D 0.30%

26 In the conversion of compound **P** into compound **R**, it was found that the reaction proceeded by way of compound **Q**, which could be isolated.
The steps involved were

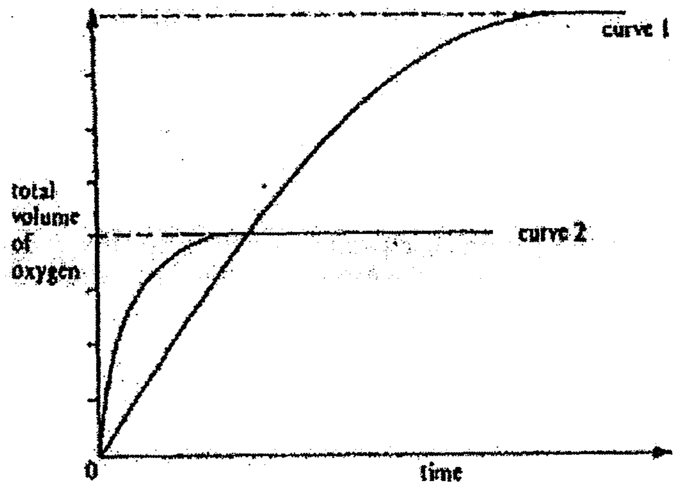
$$\mathbf{P \rightarrow Q} \qquad \Delta H = \text{negative}$$
$$\mathbf{Q \rightarrow R} \qquad \Delta H = \text{positive}$$

Which one of the following reaction profiles agrees with the data?

A. B. C. D.



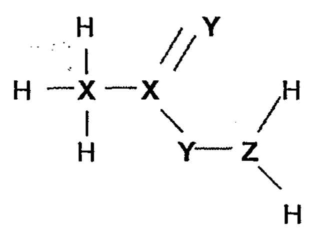
27 Manganese(IV) oxide catalyses the decomposition of aqueous hydrogen peroxide into water and oxygen. In order to follow the rates of this reaction for two different solutions of hydrogen peroxide, the total volumes of oxygen evolved were recorded at regular time intervals and the results were plotted. In each experiment, the same mass of catalysts was used and the temperature was the same.



If curve 1 corresponds to 20 cm^3 of a 4.0 mol/dm^3 solution, curve 2 would correspond to

A 5 cm^3 of a 8.0 mol/dm^3 solution
B 20 cm^3 of a 8.0 mol/dm^3 solution
C 10 cm^3 of a 4.0 mol/dm^3 solution
D 20 cm^3 of a 2.0 mol/dm^3 solution

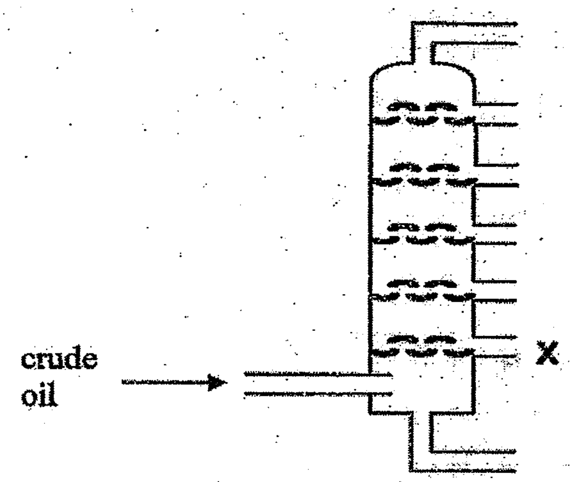
28 The diagram shows the structure of a covalent compound containing the element hydrogen, H, and the unknown elements **X**, **Y** and **Z**



To which groups of the Periodic Table do these three elements, X, Y and Z belong?

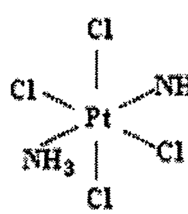
	X	Y	Z
A	I	V	VI
B	IV	V	I
C	IV	VI	V
D	V	I	IV

29 The diagram below shows the fractional distillation of crude oil. What is the main use of the fraction that comes out from **X**?



A as a fuel for cooking and heating
B as a fuel for aeroplanes
C as a lubricant
D for making roads

30 Platinum is a very expensive but unreactive metal. It has catalytic properties and certain platinum compounds are used to treat cancer.
The structure of one such drug, diamminetetrachloroplatinum (IV), is shown in the diagram.
What is the percentage by mass of the metal platinum in this molecule?



A less than 25%
B between 25% and 50%
C between 50% and 75%
D above 75%

31 Which compound is manufactured by reacting ethene with steam in the presence of a heated catalyst?

A C_2H_6
B C_2H_5OH
C C_4H_8
D C_4H_9OH

32 Which equation shows a reaction that would actually take place?

A $2MgO + C \rightarrow CO_2 + Mg$
B $MgO + Cu \rightarrow CuO + Mg$
C $PbO + Zn \rightarrow ZnO + Pb$
D $ZnO + H_2 \rightarrow H_2O + Zn$

33 Which gas **cannot** be removed from the exhaust gases of a petrol-powered car by its catalytic converter?

A carbon dioxide
B carbon monoxide
C hydrocarbons
D nitrogen dioxide

34 A hydride is a compound containing only two elements, one of which is hydrogen.
Which element forms the most hydrides?

A carbon
B chlorine
C nitrogen
D oxygen

35 The combustion of methane is exothermic. The equation is given below.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

What can be deduced from the fact that the reaction is exothermic?

A Fewer bonds are broken than are made.
B Less energy is involved in breaking bonds than is involved in making bonds.
C More bonds are broken than are made.
D More energy is involved in breaking bonds than is involved in making bonds.

36 Which method of preparation of a pure salt solution requires the use of a pipette and burette?

A $BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$

B $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

C $KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$

D $MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l) + CO_2(g)$

37 The data gives the concentration, in parts of pollutant per billion parts of air, of polluting gases in four different industrialised cities.

In which city are limestone buildings under greatest threat from pollution?

City	Sulfur dioxide	Nitrogen dioxide	ozone
A	17	46	23
B	32	33	30
C	38	40	11
D	45	14	21

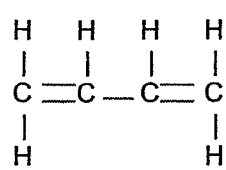
38 A coin is analysed by dissolving it in nitric acid. To the resulting solution an excess of aqueous ammonia is added and the mixture is filtered.

A brown precipitate remains in the filter paper and a deep blue solution is obtained as the filtrate.

Which metals does the coin contain?

A aluminium and copper
B copper and iron
C iron and lead
D lead and zinc

39 The diagram shows the structure of the compound 1,3-butadiene.



How many molecules of hydrogen are needed to saturate one molecule of 1,3-butadiene?

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

40 A student investigated the reaction of different vegetable oils with hydrogen. 100 cm^3 of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst.

The volume of hydrogen remaining after each reaction was recorded as shown in the table below.

Vegetable	Volume of hydrogen remaining /cm^3
P	100
Q	87
R	63
S	0

Which vegetable oils are unsaturated?

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

2014 Midyr
4E Pure Chemistry 5073 P1

Question number	1	2	3	4	5	6	7	8	9	10
Answer	**B**	**D**	**D**	**B**	**C**	**B**	**B**	**B**	**A**	**A**

Question number	11	12	13	14	15	16	17	18	19	20
Answer	**C**	**C**	**D**	**A**	**A**	**D**	**A**	**B**	**A**	**A**

Question number	21	22	23	24	25	26	27	28	29	30
Answer	**B**	**B**	**C**	**C**	**C**	**B**	**A**	**C**	**C**	**C**

Question number	31	32	33	34	35	36	37	38	39	40
Answer	**B**	**C**	**A**	**A**	**B**	**C**	**C**	**B**	**B**	**C**

The Periodic Table of the Elements

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	– 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 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.).

Class:	Index No.:	Name:	Date:

海星天主教中学
HAI SING CATHOLIC SCHOOL
9 Pasir Ris Drive 6, Singapore 519421 Tel: 5827864 Fax: 5822543

2014 PRELIMINARY EXAMINATION 1
Secondary Four Express

CHEMISTRY **5073/2**
Paper 2 12 May 2014

1 hour 45 min

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer all **three** questions, the last question is in the form either/or.
Write your answers on the lined paper provided and, if necessary, continue on separate answer paper.

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 16.

FOR EXAMINER'S USE	
Section A	/50
B8	/10
B9	/10
B10	/10

Parent's Signature

Section A

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

A1 The table gives some information about the melting and boiling points of substances, **A, B, C, D** and **E.**

Substance	Melting point / °C	Boiling point / °C	Electrical conductivity	
			Solid	Liquid
A	1083	3570	Yes	Yes
B	98	881	Yes	Yes
C	716	1412	No	Yes
D	-182	- 161	No	No
E	1610	2230	No	No

(a) Which substance could be magnesium chloride?
Use the structure of magnesium chloride to explain its electrical conductivity when solid.

....

....

....

.... [2]

(b) Explain, in terms of its structure, how substance **A** conducts electricity.

....

....

....

....

.... [2]

(c) Explain, using ideas about bonding, why substance **D** and substance **E** have different melting points.

....

....

....

....

.... [3]

(d) Which substance is most likely to be found in Group I of the Periodic Table? Explain your answer.

....

.... [2]

A2

(a) Barium reacts with water in a redox reaction.

$$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$$

(i) Explain in terms of electrons, what is meant by oxidation.

....

.... [1]

(ii) Which element has been oxidized in this reaction? Deduce its change in its oxidation number.

element ....

oxidation number changes from .... to .... [2]

(b) Sulfuric acid was added to aqueous barium hydroxide until the solution was just neutralized, forming insoluble barium sulfate and water.
The electrical conductivity of the solution steadily decreased as sulfuric acid was added.

(i) Write down a chemical equation with state symbols for the reaction.

.... [2]

(ii) Explain why the electrical conductivity decreases.

....

....

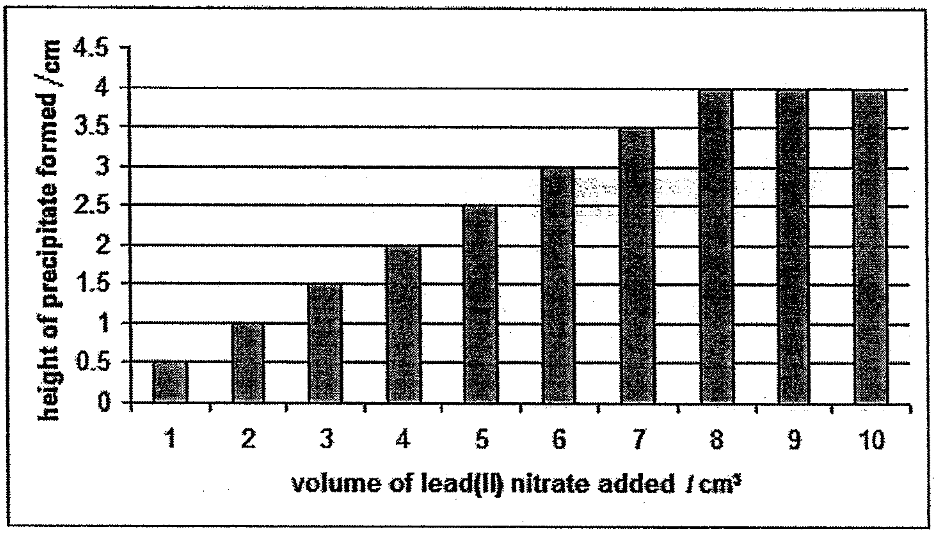
....

.... [2]

A3 An experiment was carried out to study the reaction between aqueous lead(II) nitrate and aqueous potassium iodide solutions. This reaction proceeds as follows:

$$Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$$

10 cm^3 volume of 0.4 mol/dm^3 potassium iodide was placed in each of 10 different boiling tubes. Different volumes of lead(II) nitrate solution of unknown concentration were added to each tube. The mixtures were then shaken and left to stand. In each case, a yellow precipitate was formed and the height of the precipitate in the test tube was measured.
The following graph shows the relationship between the height of the precipitate and the volume of lead(II) nitrate that had been added.



(a) Name the yellow precipitate formed.

.... [1]

(b) State the volume of lead(II) nitrate solution required to react completely with 10 cm^3 of the potassium iodide solution.

.... [1]

(c) Explain why the height of precipitate formed does not increase after the volume of lead (II) nitrate solution stated in **(b)** has been added.

....

.... [1]

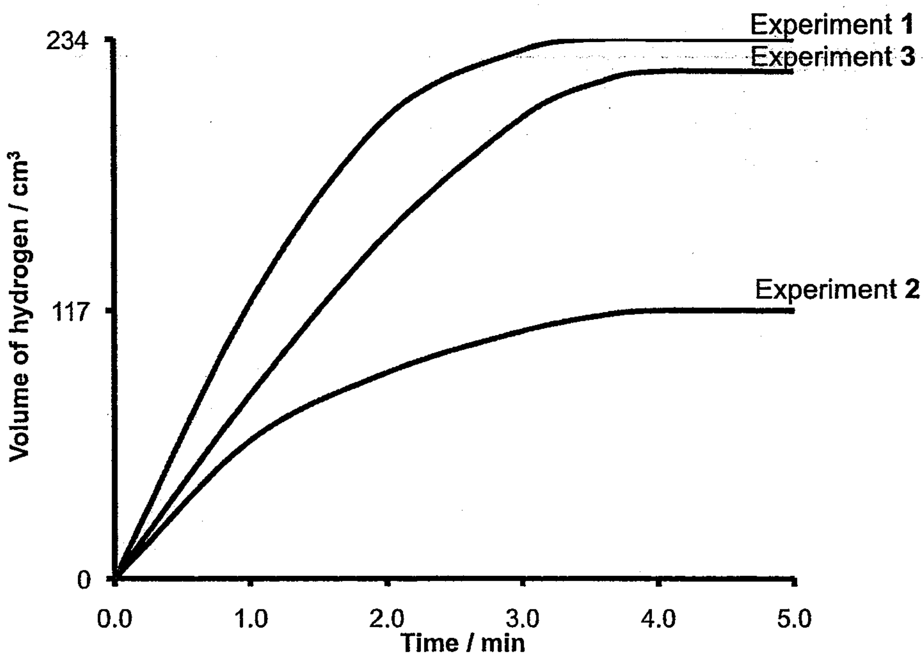
(d) Using your answer from **(b)** above, calculate the concentration of the aqueous lead (II) nitrate solution in mol/dm^3.

[1]

A4 Three experiments were carried out to investigate the rate of reaction between zinc and dilute hydrochloric acid. The chemical equation is:

$$Zn\,(s) + 2\,HCl\,(aq) \rightarrow ZnCl_2\,(aq) + H_2\,(g)$$

All three experiments were carried out at room temperature (25 °C), using excess hydrochloric acid. The results are shown on the graph below.



In Experiment 1, 0.78 g of powdered zinc was added.

(a) Calculate the percentage purity of powdered zinc used in Experiment 1. [3]

(b) Suggest how you can alter one condition to produce the results for Experiment 2. [1]

....

....

(c) In Experiment 3, some copper (II) chloride solution was added. Suggest reasons for the results obtained for this experiment. [2]

....

....

....

....

(d) If Experiment 1 was repeated using powdered magnesium instead of powdered zinc, how would the rate of reaction change? Give a reason for your answer. [2]

....

....

A5 Many inks contain salts of the metals potassium, iron, cobalt and nickel in addition to ethanoic acid and gallic acid.

(a)(i) State **two** differences in the physical properties of the metals potassium and iron. [2]

....

....

(ii) State **one** difference in the chemical properties of potassium and iron. [1]

....

....

(b) Gallic acid can be used as a photographic developer. It reduces silver ions to silver.

(i) Write an equation for the reduction of silver ions to silver. [1]

....

(ii) Explain why this is a reduction reaction. [1]

....

(c) The blue colour of ink is due to the reaction between gallic acid and iron(III) ions. Describe a standard test for iron(III) ions. [2]

test...

result ....

A6 Phosphine, PH_3, is a gas which has a smell of garlic. It is formed when white phosphorus is warmed with aqueous sodium hydroxide.

$$P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$$

(a) Draw a 'dot-and-cross' diagram for phosphine. Show only the outer electrons. [1]

(b) Phosphine decomposes into its elements on warming. Write an equation for this reaction. [2]

....

(c) Phosphine reacts with hydrogen iodide to form the salt phosphonium iodide, PH_4I. Phosphonium salts react in a similar way to ammonium salts when warmed with aqueous sodium hydroxide.

(i) Write an equation for the reaction of phosphonium iodide with aqueous sodium hydroxide. [1]

....

(ii) What should you notice when sodium hydroxide is warmed with phosphonium iodide? [1]

....

(d) Phosphine is formed when water reacts with calcium phosphide, Ca_3P_2.
Calcium phosphide is an ionic compound.

(i) Write the formula for the phosphide ion. [1]

....

(ii) Predict one physical property of calcium phosphide. [1]

....

A7 Iron(II) sulfate, $FeSO_4$, is a green salt.

(a) A sample of iron(II) sulfate is dissolved in water. Describe a test to show the presence of sulfate ions in this solution. [2]

Reagents ....

....

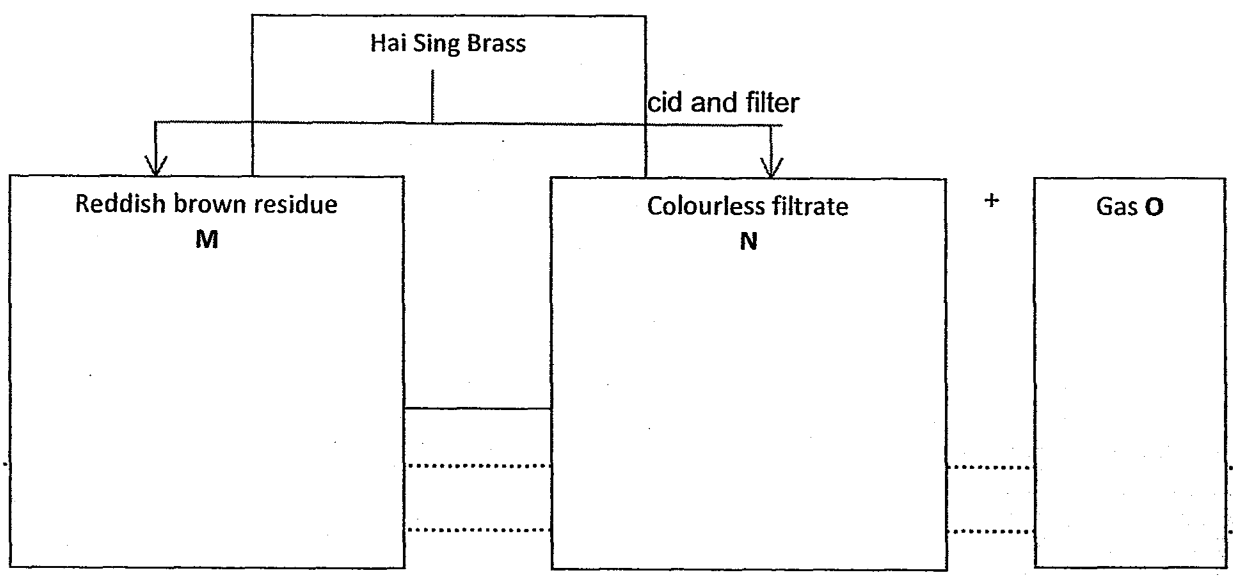
Observation ....

(b) An impure sample of iron (II) sulfate was analysed by titration.
The sample was dissolved in 25.0 cm^3 of dilute sulfuric acid and then titrated against 0.0400 mol/dm^3 potassium dichromate (VI) solution.
19.0 cm^3 of potassium dichromate (VI) solution was required to reach the end-point.

(i) Calculate the number of moles of potassium dichromate (VI) used in the titration. [1]

(ii) One mole of potassium dichromate (VI) reacts with six moles of iron (II) ions.
Calculate the mass, in grams, of iron (II) ions in the sample analysed. [2]

A8 The diagram below shows the reaction of an alloy, Hai Sing Brass.



[3]

....

Section B

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

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

The total mark for this section is 30.

B9(a)

Read carefully the information about Group I elements and use them to answer the questions below.

The atomic radius of an element is a measure of the size of its atoms, usually the mean distance from the nucleus to the boundary of the surrounding cloud of electrons. The unit of measurement is in nanometer, nm (or 1×10^{-9} m).

Table 9.1 below shows some information regarding some Group I elements.

Element	Li	Na	K	Rb
Atomic radius/ nm	0.16	0.19	0.24	0.25
Melting point/ °C	181	98	63	39
Boiling point/ °C	1342	883	760	686

(i) Explain why the atomic radius of Group I elements increases down the group. [1]

(ii) Group I elements are all metals with metallic bonding. Explain what is meant by 'metallic bonding'. [1]

(iii) In the context of metallic bonding, suggest why the melting point of the elements decreases down the group. [2]

(iv) Group I elements are good reducing agents. Explain why. [2]

(b) The ionization energy is the energy required to remove one electron from each atom to form a positive ion.
The first ionization energy is therefore the energy required to remove the first electron from the atom; the second ionization energy is the energy required to remove the second subsequent electron, and so on.

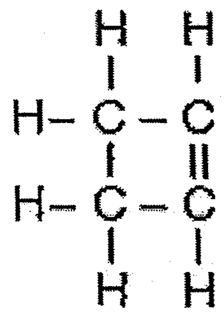
Table 9.2 below shows the ionization energies of sodium and magnesium.

Element	Na	Mg
First Ionization energy/ kJ	496	738
Second Ionization energy/ kJ	4562	1451
Third Ionization energy/ kJ	6910	7733

(i) The electronic configuration of sodium is 2.8.1.
Write down the electronic configuration for magnesium. [1]

(ii) From their electronic configuration, suggest why there is a large increase from the 1st to the 2nd ionization energy for sodium, but a similar increase is only observed from the 2nd to the 3rd ionization energies for magnesium. [3]

B10 Cyclobutene is a hydrocarbon and has the following structural formula.



(a) Cyclobutene reacts with hydrogen to form cyclobutane.

(i) Draw the full structure of cyclobutane. [1]

(ii) By means of their structural formulae, write an equation to represent the reaction between cyclobutene and hydrogen. [2]

(iii) State the conditions required for the above reaction. [2]

(b) The table below gives the bond energies of some chemical bonds.

Bond	Bond energy (kJ/mol)
C - C	350
C = C	600
C - H	410
H - H	440

(i) Calculate the enthalpy change, ΔH, of the reaction between cyclobutene and hydrogen. [2]

(ii) Using the enthalpy change you have calculated, draw an energy profile diagram of the reaction between cyclobutene and hydrogen.
On your diagram, show clearly the activation energy and enthalpy change. [3]

EITHER

B11 Chlorine, bromine and iodine are elements in Group VII of the Periodic Table.

(a) Describe the trend in colour and physical state at room temperature and pressure as the atomic number increases. [2]

(b) Aqueous chlorine is an oxidising agent.

(i) Name the products formed and write an ionic equation for the reaction between aqueous chlorine and aqueous potassium bromide. [2]

(ii) Name the product formed when aqueous chlorine reacts with aqueous iron (II) chloride. [1]

(c) An oxide of chlorine was analysed. A 0.366g sample was found to contain 0.224g of oxygen. Calculate the empirical formula of this oxide. [3]

(d) Chlorine (IV) oxide, ClO_2, is a powerful oxidising agent.

(i) Construct an equation to show the decomposition of chlorine (IV) oxide into its elements. [1]

(ii) Chlorine (IV) oxide reacts explosively with powdered sulfur. Suggest the name or formula of one of the products of the reaction between sulfur and chlorine (IV) oxide. [1]

OR

B12 In the experiment to find how atmospheric pollutants affect the rate at which metals corrode, strips of four different metals were left in contact with contaminated moist air.

After two weeks, the appearance of the surface of each of the metal strips was as shown in the table below.

Metal	Moist air alone	Moist air polluted with Ammonia	Moist air polluted with Carbon monoxide	Moist air polluted with Sulfur dioxide
Aluminium	Still shiny	Still shiny	Still shiny	Still shiny
Copper	Small patch of green solid	Coating of blue-green solid	Small patch of green solid	Coating of a black and blue solid
Iron	Coating of red-brown solid	Thin coating of red-brown solid	Coating of red-brown solid	Thin coating of red-brown solid
Lead	Still shiny	Still shiny	Still shiny	Coating of black solid

(a) Which atmospheric pollutant gave the greatest increase in the rate of corrosion? Explain your answer. [2]

(b) Describe briefly how sulfur dioxide and carbon monoxide enter the atmosphere. [2]

(c) Explain which metal would be most suitable for storing an acidic gas. [2]

(d) The student repeated the experiments with iron but this time fixed pieces of magnesium ribbon to the iron strips. What changes in the observations would you expect? Explain your answer. [2]

(e) Describe a test for sulfur dioxide and state the observation obtained. [2]

The End

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	– 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
X
b

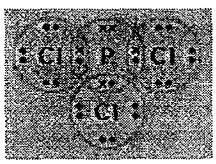
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

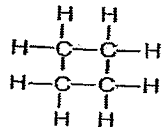
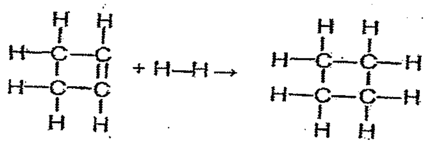
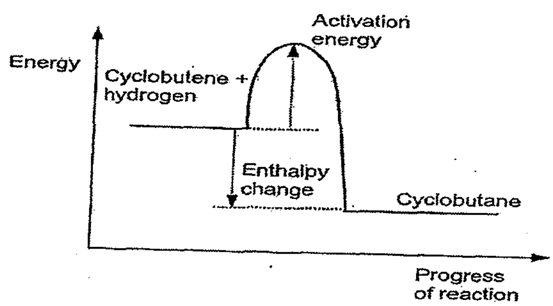
2014 Mid Year
4E Pure Chemistry 5073
Paper 2

Qn	Answer	Mark
	Section A	
1(a)	C. The Mg^{2+} and Cl^- ions in the ionic crystal lattice are not mobile as they are held in fixed positions so they are not able to conduct electricity.	1 1
(b)	Substance A has a giant metallic structure of positive metal ions in a sea of mobile electrons. The mobile electrons can move to carry electrical charges to conduct electricity.	1 1
(c)	Substance D has (a simple molecular structure with) **weak intermolecular forces** of attraction between the molecules. Substance E has(a giant covalent structure with) **strong covalent bonds between the atoms.** Mention of simple molecular structure for D and giant covalent structure for E will score additional mark.	1 1 1
(d)	Substance B. It is a group 1 metal with a low melting point and boiling point and (it conducts electricity in both solid and liquid states- optional)	1 1
2(a) (i)	Oxidation is the loss of electrons from a substance.	1
(ii)	Barium 0 to +2	1 1
2(b)(i)	H_2SO_4 (aq) + $Ba(OH)_2$ (aq) → $BaSO_4$ (s) + 2 H_2O (l) Balanced Correct state symbol	 1 1
(ii)	Insoluble barium sulfate salt is formed. The concentration of mobile ions in the solution to conduct electricity reduces.	1 1
3(a)	Lead (II) iodide.	1
(b)	8 cm^3	1

(c)	The limiting reactant is potassium iodide which determines the yield of lead (II) iodide formed. OR All the potassium iodide reacted.	1
(d)	(0.002x1000)/8 = 0.25mol/dm^3	1
4(a)	No. of moles of H_2 = 0.234 / 24 = **0.00975 mol** No. of moles of zinc = 0.00975 mol mass of zinc used = 0.00975 x 65 = 0.63375g **= 0.6338g** % purity = mass of pure zinc/ mass of impure zinc x 100 % = 0.663375/0.78 x 100 = **81.3 %** (3 sf)	1 1 1
(b)	A lower concentration of dilute hydrochloric acid could have been used. Or The final volume of hydrogen produced is halved, so the mass of zinc used is halved (0.39 g of zinc has been used)	1
(c)	Zinc reacts with copper (II) chloride to form copper and zinc chloride. **This results in less mass of zinc that react with dilute hydrochloric acid** in Experiment 1. **The concentration of dilute hydrochloric acid reacting with zinc is lowered,** so the initial rate of reaction is slightly lower than that in Experiment 1.	1 1
(d)	Rate of reaction would be faster. **Magnesium is more reactive than zinc,** so it would react more readily with dilute hydrochloric acid.	1 1
5(a)(i)	· potassium soft but iron hard [ALLOW: iron is harder] · potassium low melting point but iron high melting point [ALLOW: iron has a higher melting point] · potassium not very dense but iron (very) dense [ALLOW: iron is more dense]	any two differences 2
5(a)(ii)	· variable oxidation states · potassium is more reactive than iron · potassium reacts with cold water but iron does not · potassium tarnishes iron does not · potassium reacts with air at room temperature iron does not	any one difference 1

(b)(i)	$Ag^{+} + e^{-} \rightarrow Ag$	1
(b)(ii)	Silver ion(s) gains electrons OR oxidation state of silver changes from +1 to 0 Not accepted :[because Q asked to explain why **this** is a reduction reaction] - It gains electrons -Silver gains electrons -Reduction is addition of electrons	1
(c)	add aqueous sodium hydroxide / add aqueous ammonia red brown precipitate [both red brown and ppt needed]	1 1
6 (a)	 correct electronic structure of three bonding pairs and a lone pair	1
6(b)	$2PH_3 \rightarrow 2P + 3H_2$ Correct chemical formulae Balanced equation	1 1
(c)(i)	$PH_4I + NaOH \rightarrow PH_3 + NaI + H_2O$	1
(c)(ii)	fumes of phosphine / bubbles seen / effervescence is seen / smell of garlic	1
(d)(i)	P^{3-}	1
(d)(ii)	high melting point and high boiling point OR conducts electricity when it dissolves or when molten OR soluble in water OR insoluble in organic solvent	1
7a	Add dilute nitric acid and barium nitrate OR dilute hydrochloric acid and barium chloride White precipitate is seen	1 1

7(b)(i)	0.04 / 1000 X 19 = 0.00076 mol OR 7.6 × 10-4 mol	1
(ii)	No of mol of Fe^{2+} = 0.00076 X 6 = 0.00456 mol Mass of Fe^{2+} = 0.00456 X 56 = 0.256 g (3sf)	 1 1
8	M : copper N : zinc sulfate O : hydrogen	1 1 1
	Section B	
B9 (a)(i)	The **number of electron shells increases down the group**, therefore the atomic radius increases.	1
(ii)	Metallic bonding is the (electrostatic) force of attraction between the delocalized electrons and the positive metal ions.	1
(iii)	The atomic radius / size increases down the group so **the valence electron is further away from the positive nucleus.** Hence **the force of attraction is weaker.**	1 1
(iv)	Group I elements have only one valence electron in its outermost shell. Hence it loses/donates this valence electron readily, and are thus good reducing agents.	1 1
b(i)	Mg : 2.8.2	1
b(ii)	Sodium has only **1 electron in its valence shell.** The **second ionization energy for sodium involves removing an electron from a full electron shell**. This results in a large increase in the ionization energy. Similarly since **magnesium has 2 valence electrons, their 3rd ionization energies involve removing an electron from a full electron shell** resulting in a large increase in ionization energies.	1 1 1

B10 (a)(i)		1
(ii)	 Cyclobutene Cyclobutane **[1m correct formula of reactants]** **[1m for correct formula of products]**	2
(iii)	200 °C, nickel catalyst	1, 1
b(i)	$\Delta H = 600 + 440 - (350 + 410 \times 2)$ $= -130 kJ$	1 1
(ii)	Allow ecf  **[1m for Ea]** **[1m for ΔH]** **[1m for reactants higher than products and shape of energy profile diagram]**	3
B11(a)	The colour darkens. The element changes from gas to liquid to solid states.	1 1
(b)(i)	Aqueous potassium chloride and bromine. $Cl_2(aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$	1 1
(ii)	Iron (III) chloride	1

(c)	Mass of Cl = 0.366 – 0.224 = 0.142 g No of mol of Cl = 0.142 / 35.5 = 0.004 mol No of mol of O = 0.224 / 16 = 0.014 mol Simplest ratio of Cl : O = 0.004 / 0.004 : 0.014 / 0.004 = 1 : 3.5 = 2 : 7 Empirical formula is Cl_2O_7	1 1 1
(d)(i)	$2ClO_2 \rightarrow Cl_2 + 2O_2$	1
(ii)	Sulfur dioxide SO_2 Or sulfur trioxide SO_3	1
B12 (a)	Sulfur dioxide. Three out of four metals were corroded by it.	1 1
(b)	Sulfur dioxide enters the atmosphere from **combustion of fuels containing sulfur.** Carbon monoxide enters the atmosphere from **incomplete combustion of fuels.**	1 1
(c)	Aluminium. It is not affected by the gasses and moist air.	1 1
(d)	The iron remains shiny while a layer of oxide forms on magnesium. Magnesium corrodes in place of iron in sacrificial protection.	1 1
(e)	Dip a piece of filter paper into acidified potassium manganate(VII) solution. The purple colour of potassium manganate (VII) solution turns colourless.	1 1

Class	Register Number	Name

南洋女子中学校

NANYANG GIRLS' HIGH SCHOOL

Mid-Year Examination 2014
Secondary Four

CHEMISTRY — **45 minutes**

Paper 1 Multiple Choice — **1030 – 1115 hrs**

Wednesday **7 May 2014**

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

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

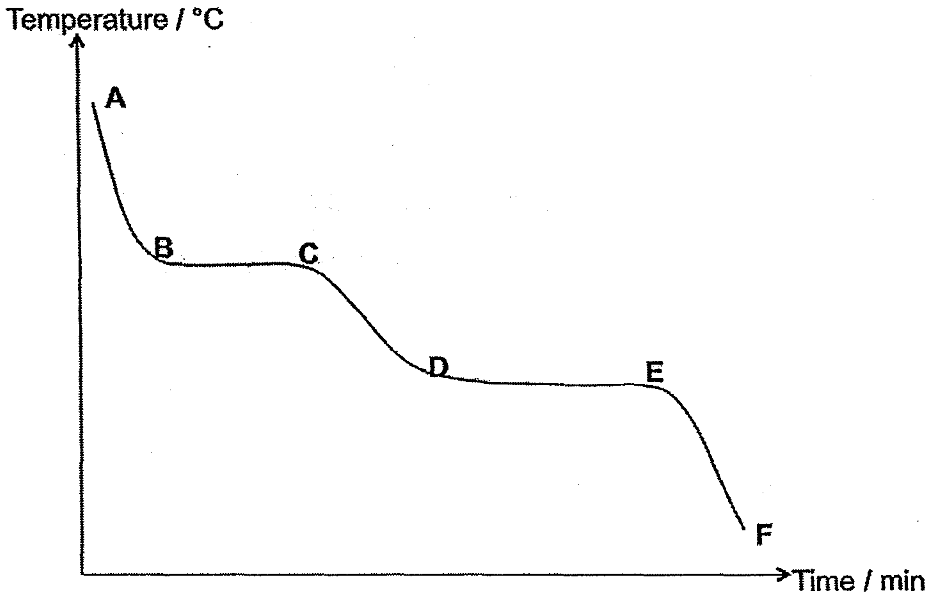
There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A, B, C** and **D.** Choose the **one** you consider correct and record your choice in **soft pencil** on the answer sheet.

INFORMATION FOR CANDIDATES

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.

This document consists of 13 printed pages.

1 The diagram below shows the **cooling** curve of a substance.

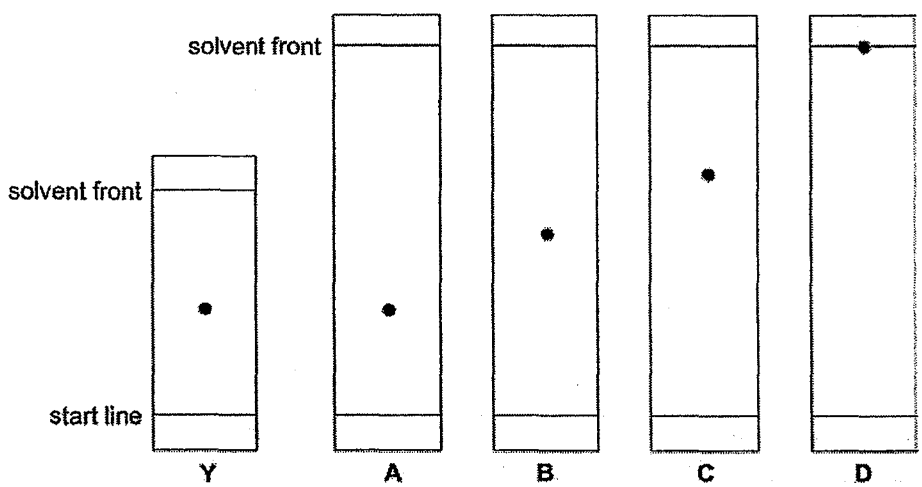


Which of the following describes the state(s) of the substance for the given segment of the curve?

	Segment of curve	States(s) of substance
A	**A** to **B**	Solid only
B	**C** to **D**	Gas and liquid
C	**D** to **E**	Solid and liquid
D	**E** to **F**	Liquid only

2 A dye was dissolved in acetone and its paper chromatogram **Y** was obtained as shown below. A second chromatogram was run using a longer piece of paper and the same solvent.

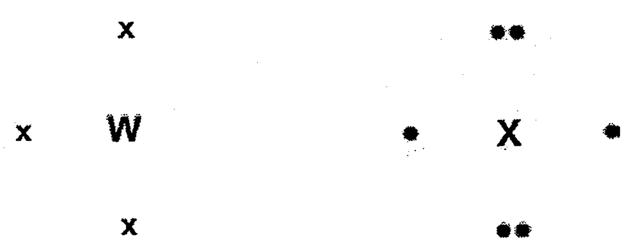
Which of the following shows the second chromatogram that was obtained?



3 What happens when a hydrogen atom becomes a H^+ ion?

A The hydrogen atom gains an electron.
B The hydrogen atom gains a positive charge.
C The atomic mass of the hydrogen atom increases.
D The proton number of the hydrogen atom does not change.

4 The diagram below shows the valence electrons of 2 elements, **W** and **X**.



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

	Type of bonds	Chemical formula
A	Ionic	**WX**
B	Covalent	**WX_2**
C	Ionic	**W_2X_3**
D	Ionic	**W_3X_2**

5 Ethanol boils at 78°C while water boils at 100°C.

Which of the following best explains the difference in boiling points between ethanol (C_2H_5OH) and water (H_2O)?

A The O–H bonds in water molecules are stronger than the O–H and C–H bonds in ethanol molecules.

B The intermolecular forces of attraction between water molecules are stronger than those between ethanol molecules.

C The ionic bonds between H^+ and OH^- ions in water are stronger than the covalent bonds within ethanol molecules.

D The ionic bonds between H^+ and OH^- ions in water are stronger than the ionic bonds between the H^+ and $C_2H_5O^-$ ions in ethanol.

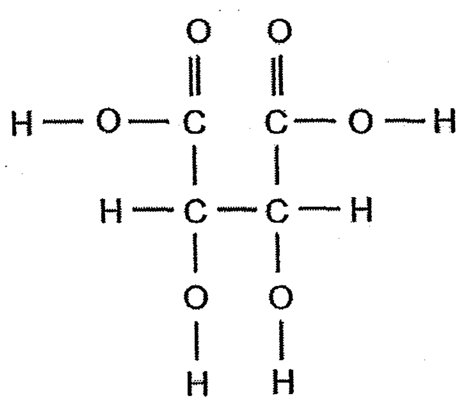
6 Which of the following compounds contains an atom that does **not** have a noble gas electronic configuration?

A BF_3
B CCl_4
C PH_3
D SO

7 Which of the following is **true** of oxides?

A All metallic oxides are basic oxides.
B All oxides react with acids to produce a salt.
C Water and carbon monoxide are neutral oxides.
D Acidic oxides react with acids to produce a salt.

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



tartaric acid

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

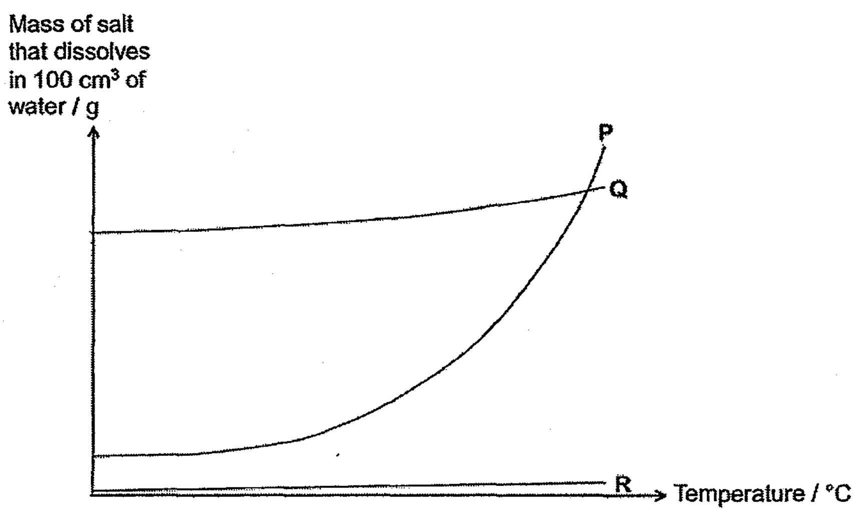
I $C_4H_5O_6K$
II $C_4H_4O_6K_2$
III $C_4H_3O_6K_3$
IV $C_4H_2O_6K_4$

A **II** only
B **I** and **II** only
C **II** and **III** only
D All of the above

9 Which of the following correctly shows the appropriate method and starting reagents to prepare a pure sample of copper(II) chloride?

	Method	Starting reagents
A	Titration	copper(II) carbonate and hydrochloric acid
B	Titration	copper(II) sulfate and hydrochloric acid
C	Acid and excess insoluble base	copper(II) oxide and hydrochloric acid
D	Ionic precipitation	copper(II) nitrate and sodium chloride

10 The diagram below shows the solubility curves of 3 salts, **P**, **Q** and **R** over a range of temperatures.



Which of the following shows the correct method of recovery for the 3 salts?

	Salt P	Salt Q	Salt R
A	Crystallisation	Ionic precipitation	Evaporation to dryness
B	Evaporation to dryness	Evaporation to dryness	Ionic precipitation
C	Evaporation to dryness	Crystallisation	Evaporation to dryness
D	Crystallisation	Evaporation to dryness	Ionic precipitation

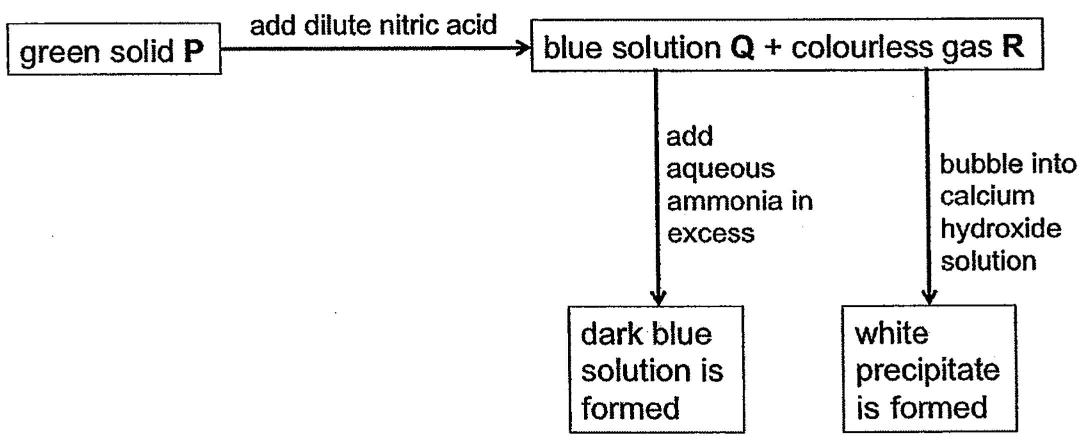
11 Alexis wanted to make calcium sulfate salt. Which one of the following steps would she be taking in the procedure?

A Heat the pure salt solution until saturation point and then cool
B Filter to separate calcium sulfate salt from the starting reagents
C Add excess calcium carbonate to sulfuric acid until solid stops dissolving
D Repeat the addition of calcium hydroxide to sulfuric acid without an indicator

12 Which of the following correctly shows the ionic equation for the preparation of potassium sulfate from the corresponding starting reagents?

	Starting reagents	Ionic equation
A	K_2CO_3 and H_2SO_4	$2K^+(aq) + SO_4^{2-}(aq) \rightarrow K_2SO_4(aq)$
B	K_2CO_3 and H_2SO_4	$K_2CO_3(s) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l) + 2K^+$
C	KOH and H_2SO_4	$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$
D	KOH and H_2SO_4	$2KOH(s) + 2H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2H_2O(l) + K_2SO_4(aq)$

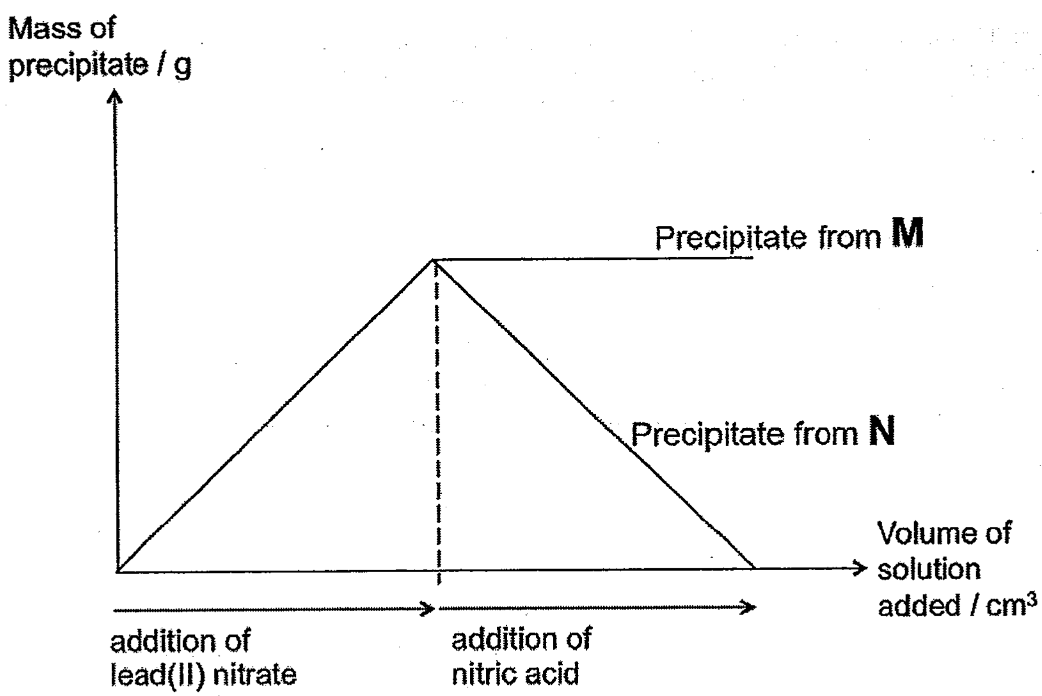
13 The diagram below shows a reaction scheme for an unknown green solid **P**.



What is the identity of the unknown **P**?

A Cu
B $CuCO_3$
C $FeCO_3$
D $Fe_2(CO_3)_3$

14 The graph below shows the mass of precipitate formed when lead(II) nitrate and nitric acid are added successively to 2 solutions **M** and **N**.



What are the possible identities of the precipitates formed from solutions **M** and **N**?

	Precipitate from solution M	Precipitate from solution N
A	$PbCl_2$	$PbCO_3$
B	$PbCO_3$	$PbCl_2$
C	$Pb(OH)_2$	$PbCO_3$
D	$PbSO_4$	$PbCl_2$

15 Melamine ($C_3H_6N_6$) is sometimes illegally added to food products to increase their nitrogen content.

What is the percentage by mass of nitrogen in melamine by mass?

A 11.1%
B 51.9%
C 66.7%
D 84.0%

16 Chloride ions react with silver ions according to the following equation:

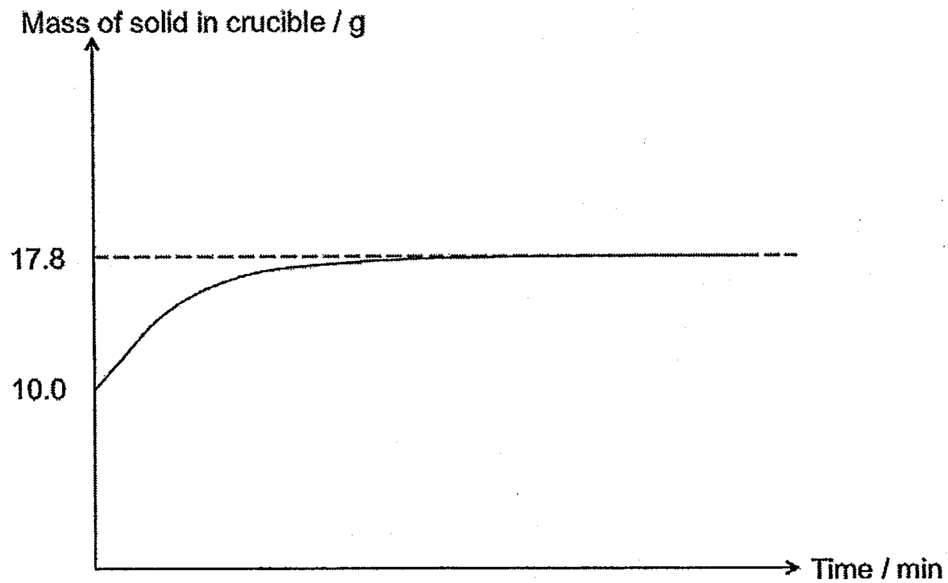
$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

It was found that 20 cm^3 of a 0.1 mol/dm^3 solution of a chloride of a metal **X** needed 15 cm^3 of 0.4 mol/dm^3 of silver nitrate solution for complete reaction.

What is the formula of the chloride?

A XCl
B XCl_2
C XCl_3
D X_2Cl_3

17 10.0 g of vanadium was placed in a crucible and heated strongly in excess oxygen to produce an oxide of vanadium of unknown chemical formula. The mass of the sample in the crucible was recorded over time as shown in the graph below.



What is the formula of the oxide obtained?

A VO
B VO_2
C V_2O_3
D V_2O_5

18 Which of the following is **not** a reaction involving oxidation and reduction?

A Rusting of an iron nail
B Neutralisation of ammonia by sulfuric acid
C Conversion of an alcohol to a carboxylic acid
D Hydrogenation of vegetable oil to form saturated fat

19 Which of the following statements **incorrectly** describes the reaction below?

$$2K_2S_2O_3 + I_2 \rightarrow K_2S_4O_6 + 2KI$$

A Sulfur is oxidised during the reaction.
B $K_2S_2O_3$ is the reducing agent in the reaction.
C The solution changes from reddish-brown to colourless.
D The oxidation state of iodine remains unchanged after the reaction.

20 What is the change in oxidation state of manganese before and after the reaction shown below?

$$MnO_4^-(aq) + PH_3(aq) + H^+(aq) \rightarrow MnO_2(s) + P(s) + 2H_2O(l)$$

A +6 to +2
B +7 to +2
C +7 to +4
D +8 to +4

21 In some redox reactions, some substances can be both reduced and oxidised at the same time, a process known as disproportionation. Which of the following reactions shows disproportionation occurring?

A $C_2H_6 \rightarrow C_2H_4 + H_2$
B $CaCO_3 \rightarrow CaO + O_2$
C $Hg_2Cl_2 \rightarrow Hg + HgCl_2$
D $2SO_2 + O_2 \rightarrow 2SO_3$

22 Which of the pollutants below **cannot** be cut down by catalytic converters in vehicles?

A Sulfur dioxide
B Nitrogen oxide
C Carbon monoxide
D Unburnt hydrocarbons

23 Zinc reacts with sulfuric acid to produce zinc sulfate and hydrogen gas.

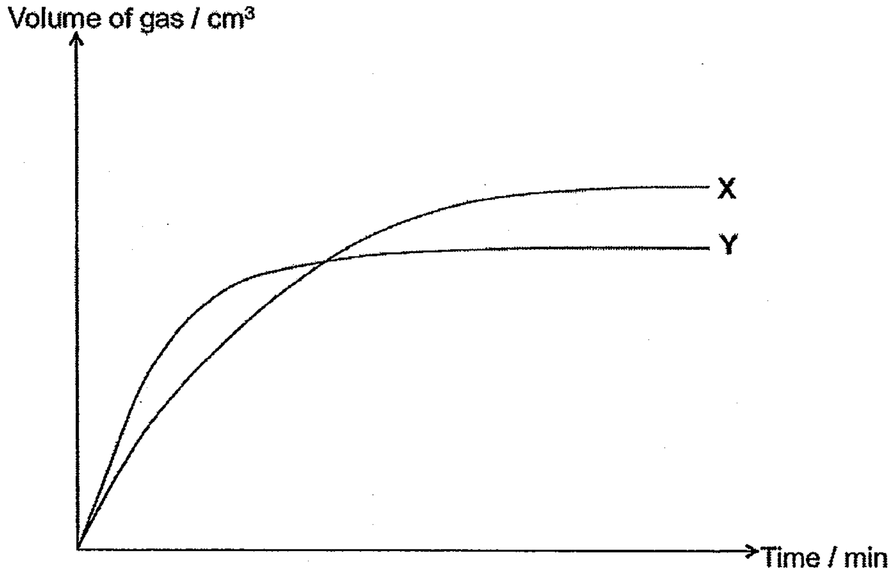
Which of the following would result in the highest rate of reaction?

A Zinc ribbon with 100cm^3 of 0.1 mol/dm^3 sulfuric acid at 30°C
B Zinc powder with 100cm^3 of 0.1 mol/dm^3 sulfuric acid at 30°C
C Zinc ribbon with 100cm^3 of 2.0 mol/dm^3 sulfuric acid at 60°C
D Zinc powder with 100cm^3 of 2.0 mol/dm^3 sulfuric acid at 60°C

24 Hydrogen peroxide decomposes according to the following equation:

$$2H_2O_2 \rightarrow O_2 + 2H_2O$$

100 cm^3 of 0.10 mol/dm^3 hydrogen peroxide was allowed to decompose until there was no change in the volume of oxygen gas collected. The graph **X** below was obtained by measuring the volume of oxygen gas during the decomposition.



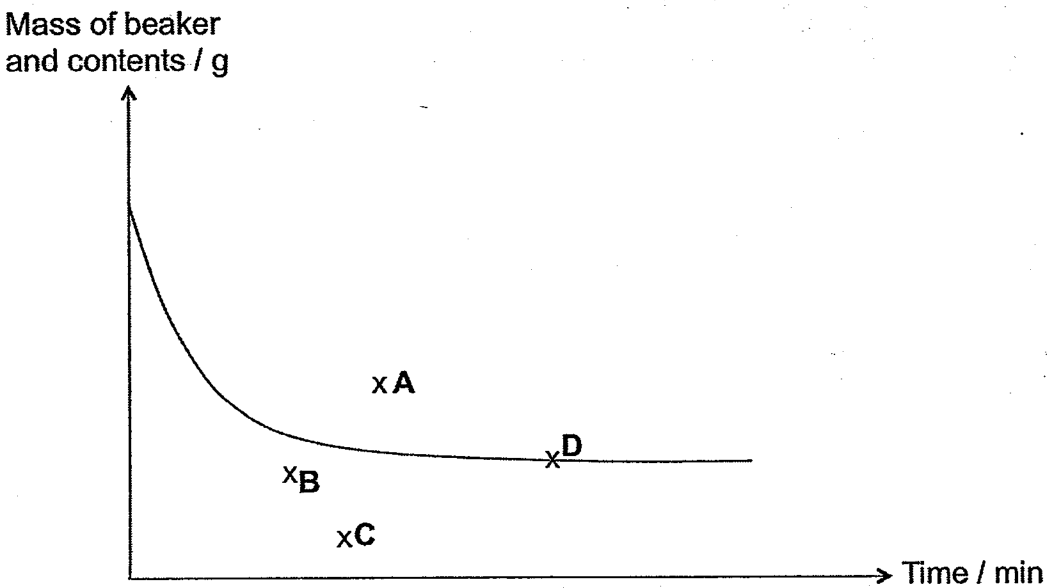
Which of the following changes to the experiment would produce the graph **Y**?

A Adding manganese(IV) oxide as a catalyst
B Increasing the temperature of the reactants
C Using 90 cm^3 of 0.10 mol/dm^3 hydrogen peroxide
D Using 60 cm^3 of 0.15 mol/dm^3 hydrogen peroxide

25 In which of the following reactions is the rate of reaction **not** affected by a change in surface area of the reactants?

A Reaction between aluminium oxide and hydrochloric acid
B Reaction between aqueous sodium hydroxide and nitric acid
C Production of sodium chloride from sodium and chlorine gas
D Decomposition of hydrogen peroxide solution with solid catalyst

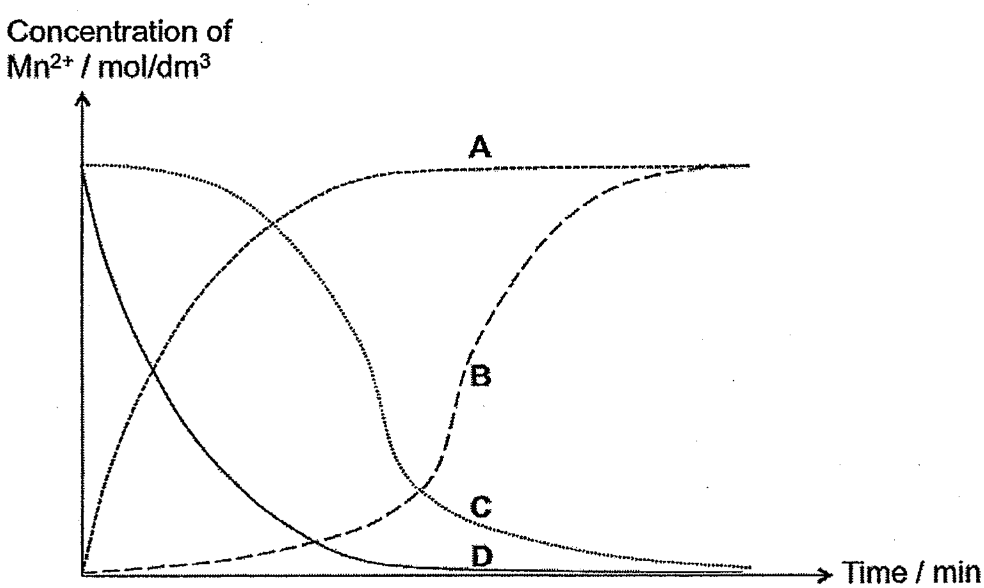
26 In an experiment 1, excess zinc carbonate was added to 100 cm^3 of 1.0 mol/dm^3 sulfuric acid in a beaker. The mass of the beaker and its contents was recorded at regular time intervals, and a graph was plotted as shown below.



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

27 Some reactions form products that are themselves catalysts of the reaction. These products are known as autocatalysts.

In an experiment, manganese(II) ion Mn^{2+} is formed and is an autocatalyst. Which of the following graphs shows how the concentration of Mn^{2+} varies as the reaction progresses?



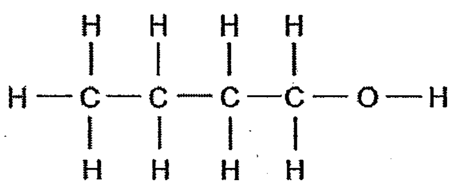
28 Which of the following is **not true** of alkanes?

- **A** Their general formula is C_nH_{2n+2}.
- **B** They can be produced in the cracking of larger hydrocarbons.
- **C** They undergo combustion in excess oxygen to give carbon dioxide and water.
- **D** They can be converted from an alkene by mixing with hydrogen gas at room temperature.

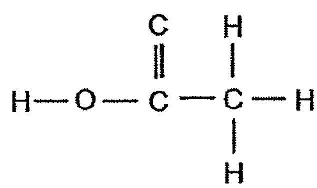
29 Which of the following occurs during the reduction of ethene by hydrogen gas?

- **A** Breaking of carbon-carbon single bond
- **B** Breaking of carbon-carbon double bond
- **C** Breaking of carbon-hydrogen single bond
- **D** Breaking of hydrogen-hydrogen single bond

30 The diagram below shows the structures of an alcohol and a carboxylic acid that are reacted under suitable conditions.

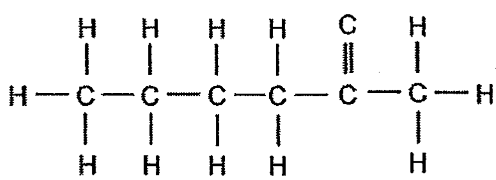


Alcohol

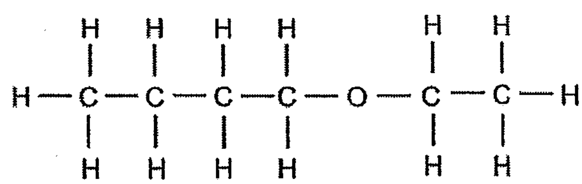


Carboxylic acid

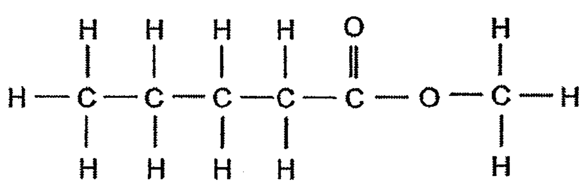
Which of the following shows the product that is formed?



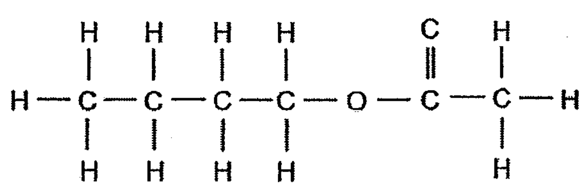
A



B



C



D

The Periodic Table of the Elements

Key

relative atomic mass
atomic symbol
name
atomic number

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	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid 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
†90-103 Actinoid series	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

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

2014 Sec 4 Mid-Year Chemistry Answers

Paper 1

1	C	2	B	3	D	4	C	5	B
6	A	7	C	8	B	9	C	10	D
11	B	12	C	13	B	14	A	15	C
16	C	17	D	18	B	19	D	20	C
21	C	22	A	23	D	24	D	25	B
26	D	27	B	28	D	29	B / D	30	D

Class	Register Number	Name

南洋女子中学校

NANYANG GIRLS' HIGH SCHOOL

Mid-Year Examination 2014
Secondary Four

CHEMISTRY — **1 hour 15 minutes**

Paper 2 Theory Paper — **1145-1300**

Wednesday **7 May 2014**

Additional materials: Writing papers

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, register number and class in the spaces at the top of this page and on any separate answer paper used.

Section A (40 marks)
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B (10 marks)
Answer **all** questions.
Write your answers on the separate writing paper provided.
At the end of the examination,
1. fasten all your work securely together;
2. hand in Section A and Section B separately

INFORMATION FOR CANDIDATES

The intended number of marks is given in the brackets [ ] at the end of each question or part question. You are advised to spend no longer than one hour on Section A and no longer than 15 minutes on Section B.

Use of scientific calculators is allowed.

A copy of the periodic table is found on page 10.

Examiner's Use	
Section A	
Section B	
Total	

Section A

Answer **all** questions.

Write your answers in the spaces provided.

A1 Dieticians recommend that saturated fats in our diet be replaced by polyunsaturated vegetable oils. Vegetable oils can often be converted by reacting with hydrogen through a process called hydrogenation.

(a) Explain the meaning of the term '*polyunsaturated*'. [1]

____

(b) What type of a reaction is hydrogenation? [1]

____

(c) Name a catalyst needed for the reaction in **(b)**. [1]

____

(d) 10.0 g of an oil ($Mr = 800$) is completely reacted with 1.80 dm^3 of hydrogen measured at r.t.p. Calculate the number of moles of hydrogen that will react with one mole of the oil. Hence deduce how many C=C bonds there are in one molecule of this oil. [3]

Total [6]

A2 An unlabelled solution is identified as either aqueous aluminium nitrate or aqueous lead(II) nitrate.

(a) Describe what you would see when aqueous ammonia is added dropwise to the solution until in excess. [1]

____

(b) Suggest a reagent to determine the identity of the solution. [1]

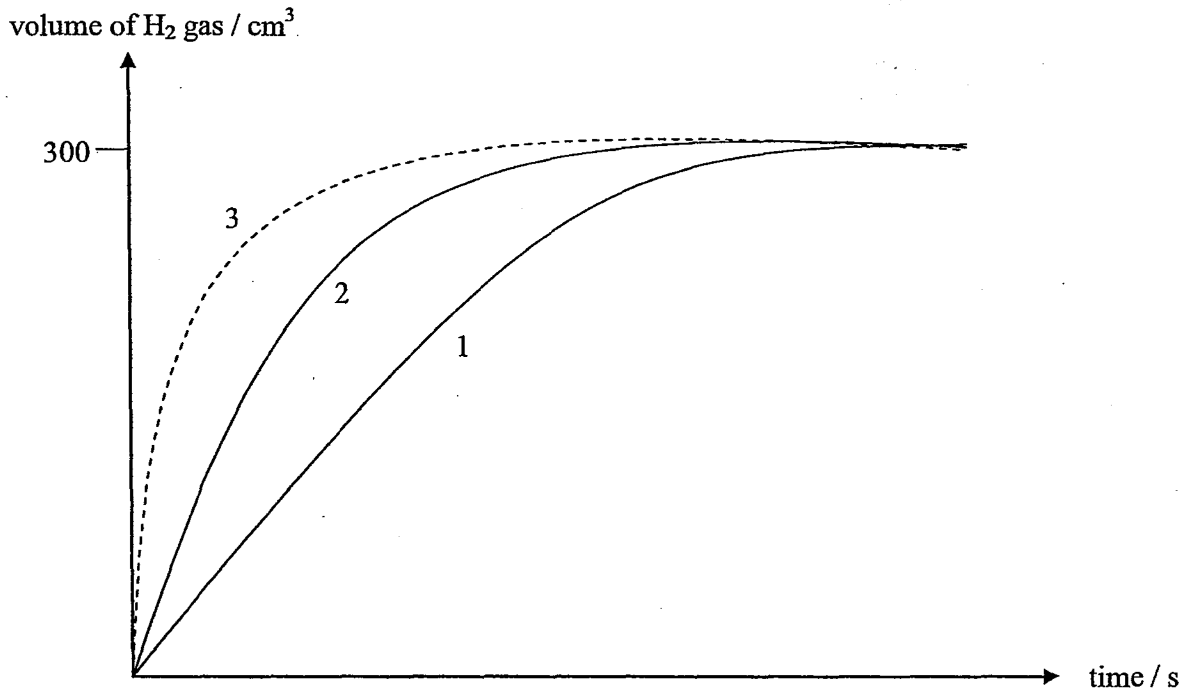
____

Total [2]

A3 A student placed 0.50 g of metal **X** into a conical flask containing 80 cm^3 of 1.00 mol/dm^3 HCl. The volume of hydrogen gas was measured at regular intervals at 25°C. The whole experiment was repeated using 0.50 g of metal **X** and 50 cm^3 of 2.00 mol/dm^3 HCl. Metal **X** belongs to Group II of the Periodic Table.

Experiment	Mass of Metal **X**	Volume and concentration of HCl
1	0.50 g	80 cm^3, 1.00 mol/dm^3
2	0.50 g	50 cm^3, 2.00 mol/dm^3

The results obtained are shown on the following graphs:



Graph **1**: Result from Experiment **1**
Graph **2**: Result from Experiment **2**

(a) Which reagent is in excess, metal **X** or HCl in Experiment **1**? Explain your answer without utilizing any calculation. [2]

(b) Suggest a method for measuring the volume of hydrogen gas liberated. [1]

____

____

(c) Experiment **2** was repeated by changing one of the conditions. Suggest three different ways of changing the condition of the experiment, without changing the concentration of the HC*l*, that might lead to the same result shown by graph **3**. [3]

____

____

____

____

(d) Draw a graph that would be obtained if experiment **1** was repeated using **0.25 g** of metal **X** on the same axes as graphs **1**, **2** and **3**. All other conditions remain unchanged. Label the graph as **4**. [1]

(e) Calculate the relative atomic mass of metal **X** and hence identify metal **X**. [3]

(f) Draw a graph on the same axes as graphs **1**, **2** and **3** which would be obtained if experiment **1** was repeated using 80 cm^3 of 1.00 mol/dm^3 sulfuric acid keeping all other conditions unchanged. Label the graph as **5**. [1]

[Total:11]

A4 Hex-3-ene undergoes reactions as shown below.

$$CH_3-CH_2-CH{=}CH-CH_2-CH_3$$

Reaction **1**: liquid bromine → Compound **X**

Reaction **2**: H_2O, 300°C, 65atm, H_3PO_4 catalyst → Compound **Y**

(a) Draw the full structural formula of compound **X** and give its IUPAC name. [2]

(b) Draw the full structural formula of compound **Y** and give its IUPAC name. [2]

(c) Explain the consequence of carrying out Reaction **1** in the presence of sunlight. [1]

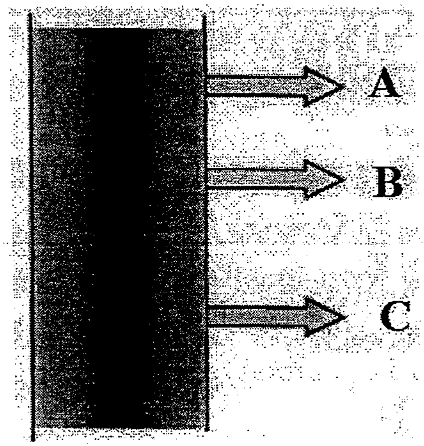
____

(d) Give the IUPAC name of an isomer of the product of Reaction **2**. [1]

____

Total [6]

A5



In the figure below, three consecutive fractions **A, B** and **C** of petroleum are extracted from a fractionating column.

(a) If **B** is petrol, what are fractions **A** and **C**? [2]

Fraction **A** is ______________________________

Fraction **C** is ______________________________

(b) State the difference in molecular size and boiling point between the three fractions, **A, B** and **C**. [1]

____

____

____

____

Total [3]

A6 **(a)** The catalytic cracking process is used to break up decane, $C_{10}H_{22}$, into smaller alkane and alkene molecules. One possible reaction during the cracking process is given by the equation below:

$$C_{10}H_{22}\ (l) \rightarrow C_2H_4\ (g) + C_3H_6\ (g) + C_5H_{12}\ (l)$$

(i) State the conditions required for the cracking process. [2]

Conditions: ______________________________

____

____

(ii) Name the process used to separate the three different products. [1]

Name of process: ______________________________

(iii) State two possible reasons for carrying out catalytic cracking of crude oil. [2]

____

____

____

____

____

____

(iv) Calculate the mass of ethene that can be produced from cracking 12.0 dm^3 of decane, assuming a 20% yield. [2]

(b) When an alkane, **$CH_3CH_2CH(CH_3)CH_2CH(C_2H_5)CH_2CH(CH_3)_2$** was subjected to catalytic cracking, three products were identified. Of these, two of the products decolourised liquid bromine in the dark while one product did not.

(i) The mass spectrum of the mixture showed molecular ion peaks at mass-to-charge ratio (m/e) values of **42, 56** and **72,** indicating the relative molecular masses of the three products. Deduce and hence draw the full-displayed structures of the three molecules in the cracking process. [3]

m/e=42

m/e=56

m/e=72

(ii) Name two other possible products from **(bi)** above that did not decolourise liquid bromine in the dark. [2]

Total [12]

Section B

Answer **all** questions.

B7 Organic compounds **A** and **B** are colourless liquids. The structural formulae of the compounds are shown.

$CH_3{-}CH_2{-}CH_2{-}CH_2{-}O{-}H$

Compound **A**

$CH_3{-}CH_2{-}CH_2{-}CH_2{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}O{-}H$

Compound **B**

(a) Name a reagent which can distinguish the two compounds. Describe clearly all observations that would be made. Write chemical equation(s) to show the reaction(s) that have taken place. State symbols are **not** required. [3]

(b) Compound **A** can be converted into compound **B**.

(i) Assuming that both compounds are soluble in water and have similar densities, explain how would you separate compound **B** from the reaction mixture containing compound **B** and compound **A**. [2]

(ii) Name the type of reaction that has taken place in the process of converting compound **A** to compound **B.** [1]

(c) Compound **A** can also react with compound **B** to form an ester.

(i) Draw the full structural formula of the ester, and name the ester. [2]

(ii) A student prepared the ester using 22.0 g of Compound **A** and excess compound **B**. It was found that 38.1 g of the ester was obtained. Calculate the percentage yield of this reaction. [2]

Total [10]

End of paper

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	– 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 over X over b

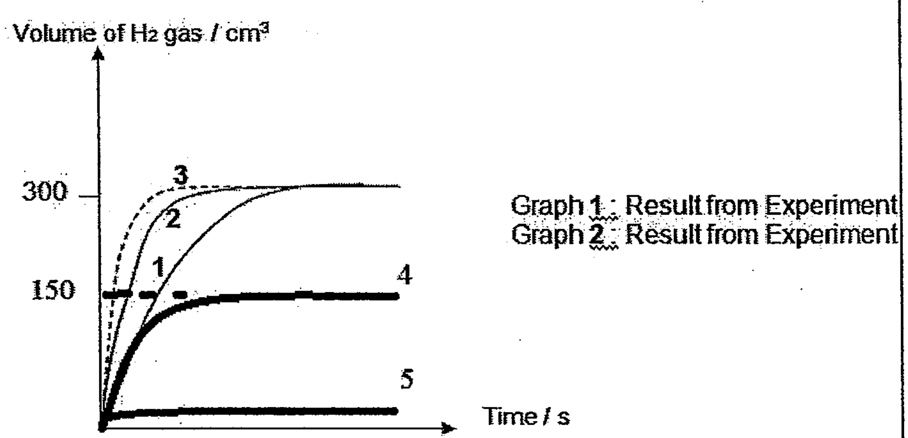
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and

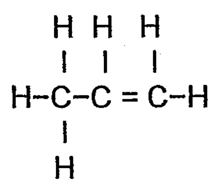
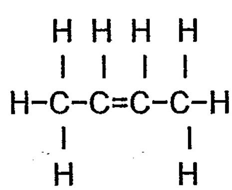
2014 Sec 4 Mid-Year Chemistry Answers

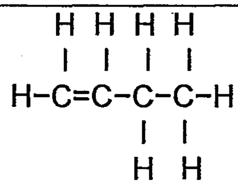
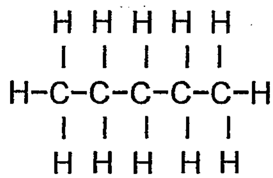
Paper 2

No	Answers	Marks
A1 a)	The term polyunsaturated refers to the presence of **more than one carbon to carbon double (C=C) or triple bonds** in a molecule. [reject : double bonds]	[1]
b)	Addition [accept: redox reaction]	[1]
c)	Nickel	[1]
d)	No of moles of oil = 0.0125 No of moles of hydrogen gas used = 0.075 mol 0.0125 mol of oil needed 0.075 mol of hydrogen gas 1 mol of oil will need 0.075/0.0125 = 6 mol of hydrogen gas Therefore, the oil has 6 double bonds.	[1] [1] [1]
A2 a)	A white precipitate insoluble in excess aqueous ammonia is observed. [reject : insoluble white precipitate]	[1]

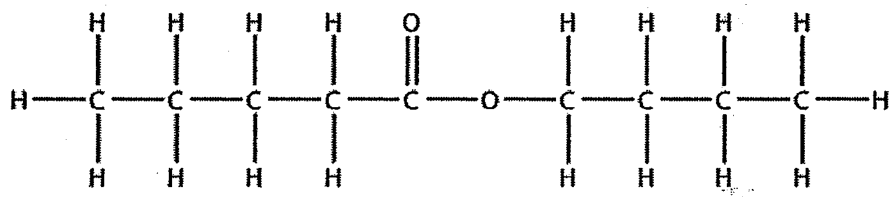
No	Answers	Marks
b)	Any aqueous halide or sulfate	[1]
A3 a)	**<u>HC*l*</u>** is present in excess in experiment **I**. Same volume of gas produced when mass of metal used is the same but different no. of moles of HC*l* used. OR Despite the different number of moles of HC*l* used, the volume of gas produced is the same. Reject: There is more HC*l* than metal X.	[1] [1]
b)	Connect the conical flask containing the reaction mixture to a gas syringe.	[1]
c)	Any three of the following: addition of catalyst; using (finely) powdered form of metal **X;** higher temperature	[3]
d)	Same gradient (rate) as graph **1** and volume of H_2 = 150 cm^3  	[1]
e)	No. of mol of $H_2(g)$ = $\frac{300}{24000}$ = 0.0125 Since **X** is a group **II** element, **X**(s) + 2HC*l* → **X**Cl_2(aq) + H_2(g) OR	[1]

No	Answers	Marks
	Mole ratio of X to H_2 is 1:1 No of moles of X = 0.0125 $\therefore$ A_r of **X** = $\frac{0.50}{0.0125}$ = 40 **X** is calcium.	[1] [1]
f)	volume of H_2 lower than graph **4** (and steeper gradient than graph **1)** refer to graph in part (d)	[1]
A4 a)	H H H H H H I I I I I I H–C–C–C–C–C–C–H I I I I I I H H Br Br H H 3,4-dibromohexane	[1] [1]
b)	H H H H H H I I I I I I H–C–C–C–C–C–C–H I I I I I I H H H O H H I H hexan-3-ol	[1] [1]
c)	Substitution will occur as well, resulting in multiple organic products 1 mark for either **substitution** or **multiple organic products** being mentioned	[1]
d)	hexan-1-ol or any other valid isomer	[1]
A5 a)	A is petroleum gas. B is naphtha.	[2]
b)	The molecular size and boiling points **increase** from A to C.	[1]
A6 a) i)	Conditions for catalytic cracking: 600°C, with use of catalysts such as aluminium oxide or silicon(IV)	[2]

No	Answers	Marks
	oxide. [temperature = [1], name of catalyst = [1]]	
ii)	Fractional Distillation	[1]
iii)	To produce fuels such as petrol; To produce hydrogen gas; To produce short-chain alkenes such as ethene and propene which are used in the petrochemical industries [any 2 of the above]	[2]
iv)	12 dm^3 of decane will produce 12 dm^3 of ethane OR 0.5mole of ethane is formed. 20% yield would mean that only 2.4 dm^3 of ethene is produced. Mass of 2.4dm^3 of ethene = (28/24) x 2.4 = **2.8 g**	 [1] [1]
b) i)	2 fractions were able to react with liquid bromine in the dark. The 2 fractions are alkenes. Relative molecular mass of **<u>42 is likely to be propene.</u>**  Relative molecular mass of **<u>56 is likely to be butene</u>** (either but-1-ene or but-2-ene will be accepted)  OR	 [1]

No	Answers	Marks
	 $C_nH_{2n+2} = 72$ $12n + 2n + 2 = 72$ $14n = 70$ $\mathbf{n = 5}$  **<u>Relative molecular mass of 72 is likely to be pentane or any isomer of pentane will be accepted.</u>** **All 3 full structures must be correct. [names only = 0 marks]**	[1]
ii)	Pentane or 2-methylbutane or 2,2-dimethylpropane [depends on what the student has drawn for b(i)] The answer of the 2 isomers here **<u>must be different</u>** from the full structure that the student has drawn for b)(i).	[2]
B7 a)	Reagent: **sodium carbonate** (accept any suitable carbonate or magnesium, zinc, iron) **Observations:** Compound B – **Effervescence** / bubbles of gas / gas evolved produces a white precipitate with aqueous calcium hydroxide or gas extinguishes a lighted splint with a 'pop' sound. Compound A - no effervescence / no visible change. **[1 for <u>both</u> observations]**	[1]

No	Answers	Marks
	Equation: **$2C_4H_9COOH + Na_2CO_3 \rightarrow 2C_4H_9COONa + CO_2 + H_2O$ [1] OR** **$2C_4H_9COOH + Mg \rightarrow (C_4H_9COO)_2Mg + H_2$** Reject: Metals from Group I and Aluminium. Aluminium generally has a layer of aluminium oxide over it and is not likely to react if the oxide layer was not removed. Equation given NO mark once proposed method is wrong. **OR** Reagent: **Acidified** aqueous **potassium manganate(VII)** **Observations:** Compound B – Acidified aqueous potassium manganate(VII) remains purple when it is **warmed** with compound B. **Compound A** - Acidified aqueous potassium manganate(VII) changes from purple to colourless when **warmed** with compound A. 1 for both observations Equation: **$C_4H_9OH + 2[O] \rightarrow C_3H_7COOH + H_2O$ OR** **$5\ C_4H_9OH + 4\ KMnO_4 + 6H_2SO_4 \rightarrow 5\ C_3H_7COOH + 4MnSO_4$** **$+\ 2K_2SO4 + 11H_2O$** comments: zero marks awarded if the mixture is not warmed	**[1]** **[1]**
b) i)	Fractional distillation Compounds A and B are separated on basis of their **difference in their boiling points.** Boiling point of compound A is 117.4 °C while compound B is 185°C.	[1] [1]

No	Answers	Marks
	reject: distillation or simple distillation	
ii)	oxidation (Accept redox reaction) reject: incorrect spelling of oxidation. This is a chemical term. You need to be able to get the spelling correct to be awarded the marks	[1]
c) i)	 Name of ester: butyl pentanoate [Marks awarded only for FULL structural formula because that is what is asked for. No marks awarded for wrong spelling of the ester]	[1] [1]
ii)	No of moles of alcohol: 22/74 = 0.2973 mol No of moles of ester: 0.2973 mol Theoretical mass of ester: 0.2973 x 158 = 46.97g % yield of reaction: 38.1 / 46.97= 80.1% (3sf)	[1] [1]

Name	Class	Register Number

5073/01 (with SPA) **14/4P1/CH/1**

CHEMISTRY
Paper 1

Friday **16 May 2014** **1 hour**

VICTORIA SCHOOL

FIRST PRELIMINARY EXAMINATION (SECONDARY FOUR)

Additional Material: Optical Answer Sheet

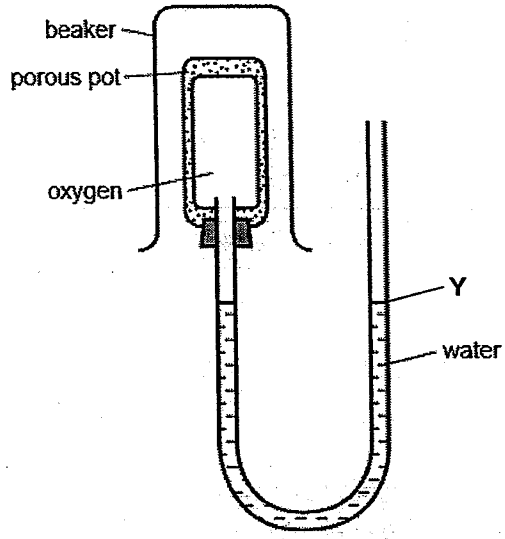
READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, class and register number in the spaces provided at the top of this page.
There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B C, and D.**
Choose the one you consider correct and record your choice in **soft pencil** on the separate answer sheet.

Read the instructions on the Answer Sheet very carefully.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 14.

This question paper consists of 14 printed pages including the cover page.

1 The diagram shows a diffusion experiment.



Which gas, when present in the beaker over the porous pot, will cause the water level at **Y** to drop the most?

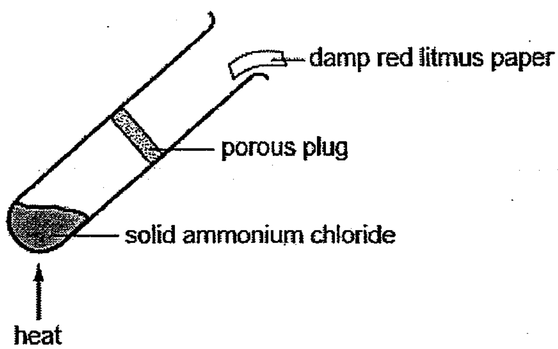
A hydrogen

B carbon dioxide

C helium

D methane

2 Solid ammonium chloride decomposes upon heating to give ammonia gas and hydrogen chloride gas.



Which change occurs to the damp red litmus paper in the experiment above?

A damp red litmus paper is bleached

B damp red litmus paper remains red

C damp red litmus paper turns blue and then turns red

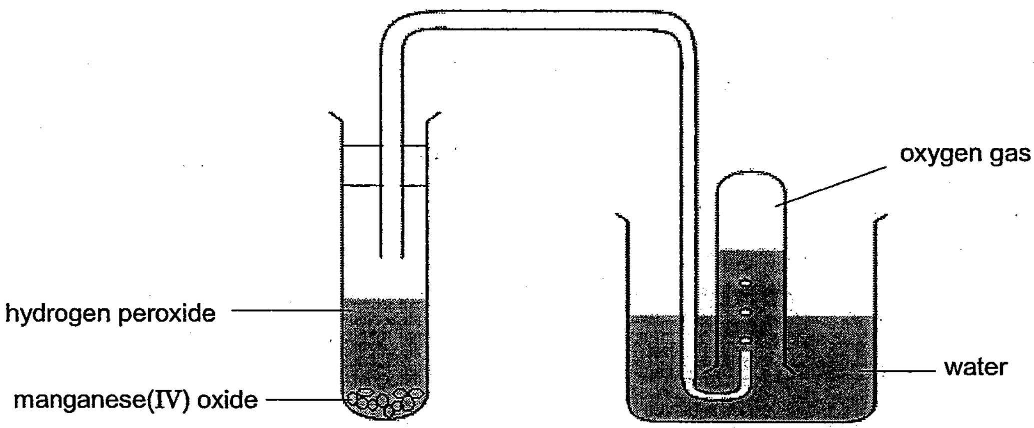
D damp red litmus paper turns blue, then turns red and eventually is bleached

3 An unknown substance **X** melts at –166°C and boils at –138°C.

Describe the arrangement and movment of the particles of substance **X** at –125°C.

	arrangement of particles	movement of particles
A	very closely packed in orderly manner	vibrate about fixed positions
B	loosely packed in orderly manner	slide over one another easily
C	loosely packed in random manner	slide over one another easily
D	spread very far apart in random manner	moves in all directions at high speeds

4 Oxygen was prepared and collected using the apparatus as shown in the diagram below.



The first tube of gas collected was rejected because the gas was contaminated by

A hydrogen.

B hydrogen peroxide.

C manganese(IV) oxide.

D nitrogen.

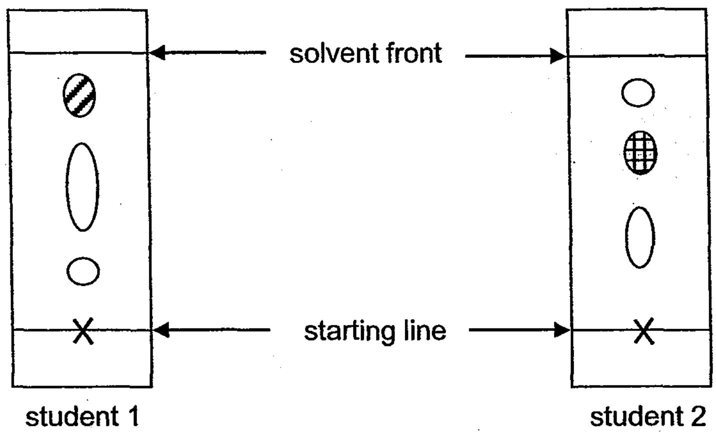
5 A flask contains a mixture of benzene and aqueous sodium chloride. Benzene boils at 80°C and is immiscible with water.

Which of the following methods are suitable to obtain samples of benzene and dry sodium chloride?

	first method	second method
A	fractional distillation	evaporation
B	filtration	crystallisation
C	crystallisation	use a separating funnel
D	use a separating funnel	evaporation

6 Two students each carried out a chromatography experiment to see what dyes are present in the brown food colouring from a candy.

Their chromatograms are shown below.



Which of the following statements best explains the difference in their chromatograms?

A Student 1 used a lesser volume of the same solvent than student 2.

B Student 2 used a different solvent from student 1.

C Student 1 started the chromatography later than student 2.

D The concentrations of the food colouring used by students 1 and 2 are different.

7 The table shows the number of sub-atomic particles in four different ions.

Which ion has the correct number of sub-atomic particles shown?

	ion	number of sub-atomic particles		
		protons	neutrons	electrons
A	$^{14}_{7}N^{3-}$	7	14	10
B	$^{37}_{17}Cl^{-}$	17	20	18
C	$^{7}_{3}Li^{+}$	4	4	2
D	$^{64}_{29}Cu^{2+}$	29	64	27

8 Oxygen has two isotopes, namely oxygen-16 and oxygen-18.

Which statement correctly describes the two isotopes of oxygen?

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

B Oxygen-16 has a smaller proton number than oxygen-18.

C Both oxygen-16 and oxygen-18 have the same relative atomic masses.

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

9 Which of the following statements correctly describe sodium chloride?

A A sodium ion is bonded to the chloride ion which it donated its outermost electron to.

B A sodium atom with one outermost electron forms a single covalent bond with one chlorine atom, producing sodium chloride molecule.

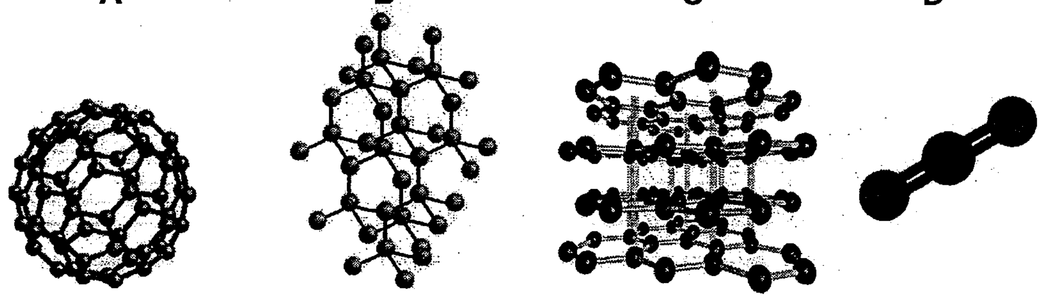
C The attraction between oppositely charged sodium and chloride ions results in the charges being neutralised, forming neutral molecules.

D The sodium chloride lattice consists of sodium ions and chloride ions, in which every chloride ion is bonded to one sodium ion.

10 The diagram below shows the structures of four substances **A**, **B**, **C** and **D**.

Which of the substance can be used as a lubricant?

A B C D



11 Which of the following gases will not result in a change of pH value when dissolved in water?

A CO_2 B HBr C NH_3 D O_2

12 25.0 cm^3 of two separate acid **HX** and acid **HY** of the same concentration 1.0 mol/dm^3 reacted with 0.5 g of calcium carbonate to form 14.5 cm^3 and 30.0 cm^3 of carbon dioxide respectively in two minutes.

What deductions can be made from the above statement?

A The volume of carbon dioxide produced at the end of the reaction is not the same.

B The solution of acid **HY** has a lower pH than the solution of acid **HX**.

C Acid **HX** contains higher number of H^+ ions per unit volume as compared to acid **HY**.

D Reaction between **HY** and calcium carbonate produces a salt which reacts with more calcium carbonate to produce a larger volume of carbon dioxide.

13 Which one of the following produces an amphoteric oxide on heating?

A silver carbonate

B sodium carbonate

C lead(II) carbonate

D copper(II) carbonate

14 Which of the following describes a step in the preparation of barium sulfate?

A Add excess barium carbonate into dilute sulfuric acid, filter, wash and collect residue

B Add excess barium hydroxide into dilute sulfuric acid, filter, wash and collect residue

C Add barium carbonate into dilute nitric acid followed by ammonium sulfate before collecting the precipitate

D Heat the filtrate to saturation, and then cool it till crystallisation occurs

15 The nature of the following gases may be tested using litmus paper.

sulfur dioxide   ammonia   nitrogen dioxide   chlorine

For how many of the gases must damp litmus paper be used?

A 1   B 2   C 3   D 4

16 The labels on three separate bottles of zinc powder, magnesium powder and iron powder have dropped off.

Which of the following experiments will enable one to identify all three bottles of metal?

A heat some metal powder in air

B place some metal powder in dilute nitric acid

C place some metal in aqueous copper(II) sulfate

D weigh equal heap size of the metal powder

17 Methane, oxides of nitrogen and sulfur dioxide are gases which have an adverse impact on the environment.

Which of the following correctly show the sources of these gases?

	methane	oxides of nitrogen	sulfur dioxide
A	bacterial decay of organic matter	car engines	volcanic eruptions
B	bacterial decay of organic matter	lightning activity	car engines
C	bacterial decay of organic matter	lightning activity	acid rain
D	belching of cattles	lightning activity	car engines

18 Which of the following are true of greenhouse gases?

I Methane and carbon dioxide are examples of greenhouse gases.

II They are solely the result of human activities such as burning fossil fuels.

III Increasing their concentrations will lead to an increase in Earth's temperature.

A I and II only

B I and III only

C II and III only

D All of the above

19 In moving across Period 3 from Group I to Group VII, the elements

I show a gradual transition in properties from metallic to non-metallic.

II have oxides whose property change from acidic to basic.

III have mass numbers differing by one unit from the previous element.

A I only

B I and III only

C II only

D II and III only

20 The table below shows the atomic number of four elements.

element	W	X	Y	Z
atomic number	9	11	17	19

Which statement about the elements stated above is correct?

A **W** is a metal.

B **X** is more reactive than **Z**.

C **W** is more reactive than **Y**.

D **X** and **Z** are in the same period.

21 20 cm^3 of oxygen is reacted with 20 cm^3 of hydrogen.

What are the volumes of gases remaining at the end of the reaction?

	volume of oxygen / cm^3	volume of hydrogen / cm^3	volume of product / cm^3
A	0	0	20
B	0	0	40
C	10	0	20
D	10	10	20

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

mass of test tube = 21.28 g

mass of test tube + lead oxide = 29.84 g

mass of test tube + lead = 29.04 g

What is the empirical formula of this oxide of lead?

A PbO B Pb_2O_3 C PbO_2 D Pb_3O_4

23 How many moles of hydrogen atoms does 4.8 g of methane contain?

A 1.20 **B** 0.900 **C** 0.300 **D** 0.120

24 Which of the following is an example of a redox reaction?

A $H_2 \rightarrow 2H^+ + 2e^-$

B $N_2 + 3H_2 \rightarrow 2NH_3$

C $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

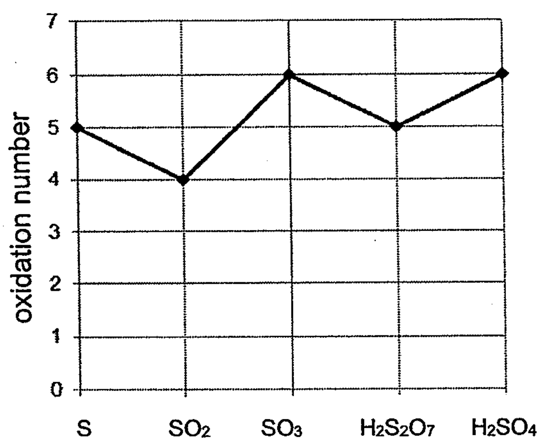
D $Mg(NO_3)_2 + Na_2CO_3 \rightarrow MgCO_3 + 2NaNO_3$

25 In an industrial scale, sulfuric acid can be prepared by Contact or Lead Chamber Process. The reaction for the manufacturing of sulfuric acid can be represented as follows.

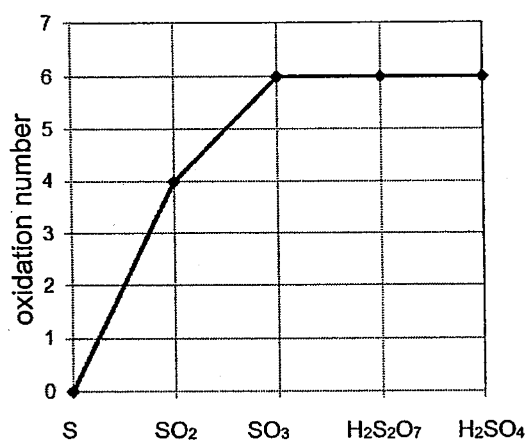
$$S \rightarrow SO_2 \rightarrow SO_3 \rightarrow H_2S_2O_7 \rightarrow H_2SO_4$$

Which of the following graphs correctly shows the oxidation number of sulfur at each stage of the process?

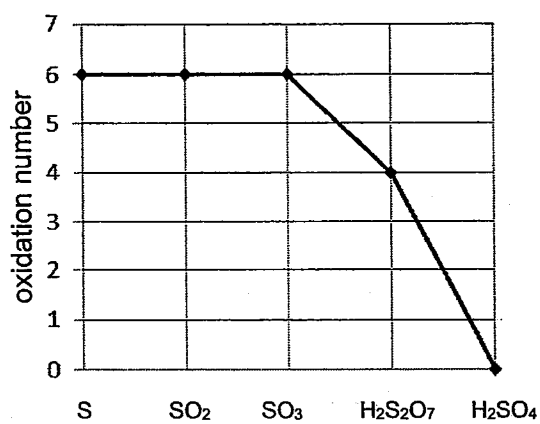
A



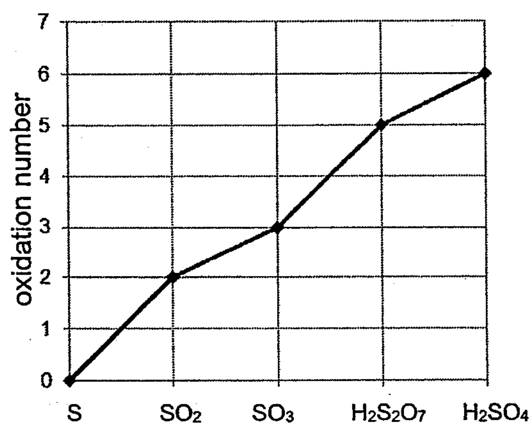
B



C



D



26 Chromium is a transition metal used in flash bulbs. When the filament inside the bulb gets hot, chromium burns with a white light to form a mixture of chromium(II) oxide and chromium(III) oxide. These oxides can react with both acids and bases. Chromium has no reaction with water or steam.

Which statement shows that chromium is a transition metal?

A Chromium is unreactive.

B The oxides of chromium are amphoteric.

C Chromium oxide can react with acid to form a salt and water only.

D Chromium can form two different oxides.

27 Strips of metal **E** were dipped into solutions of zinc nitrate and lead(II) nitrate. A metallic deposit appeared on both strips.

What could metal **E** be?

A potassium **B** magnesium **C** iron **D** copper

28 The information below concerns three metals, **F**, **G** and **H**.

I the oxide of **F** is decomposed by heat to the element **F**

II the carbonate of **G** is not decomposed by heat

III the oxide of **H** is not decomposed by heat, but its carbonate decomposes

In order of decreasing reactivity, the three elements should be arranged as

A F, G, H. **B** G, F, H. **C** G, H, F. **D** F, H, G.

29 Which substance could be added to remove the sand impurities during the extraction of metal from its ore?

A slag

B hot air

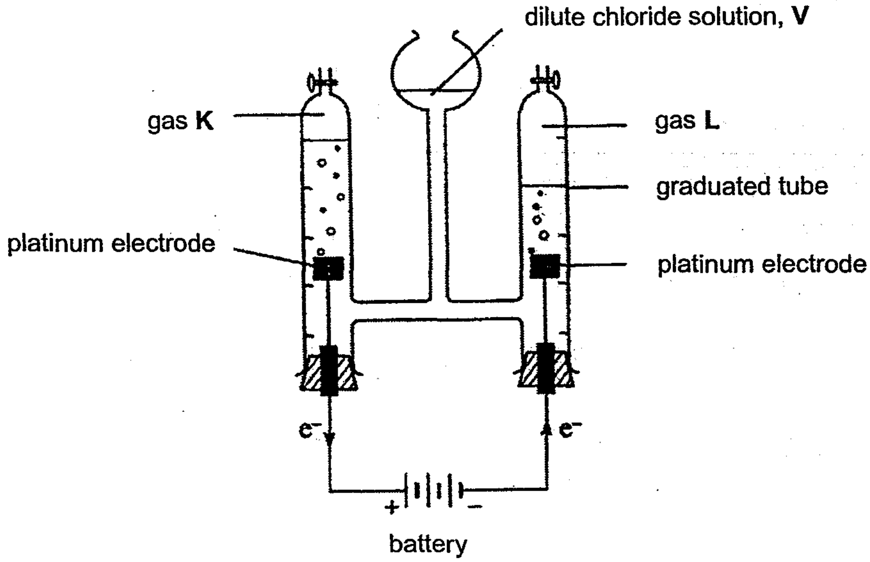
C carbon

D calcium oxide

30 In the electrolysis of concentrated potassium iodide solution using inert electrode, the products formed are

	cathode	anode
A	silvery metal	violet solution
B	silvery metal	black solid
C	colourless gas	violet solution
D	colourless gas	black solid

31 Gases **K** and **L** were two colourless gases produced during the electrolysis of a very dilute chloride solution, **V**. The electrolysis diagram of solution **V** is shown and some conclusions were made by a student at the end of the electrolysis.



Which of the following conclusions is correct?

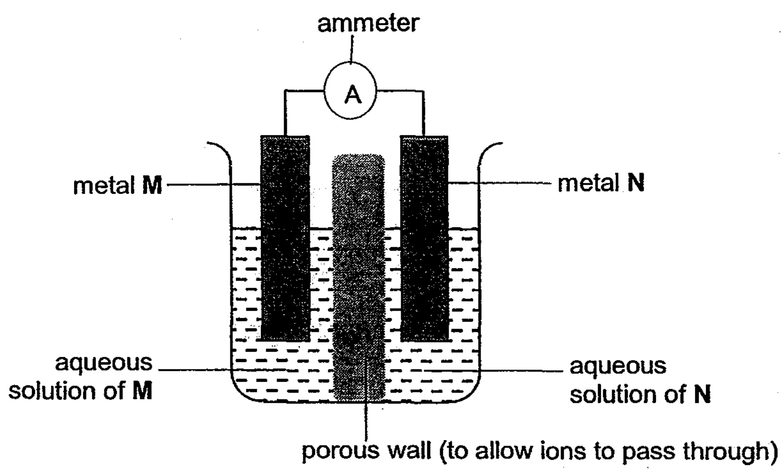
A gas **L** will extinguish a lighted splint with a 'pop' sound

B gas **K** is very soluble and some of it has dissolved into the solution

C gas **L** will turn moist blue litmus paper red

D electrolyte solution after electrolysis turned red litmus paper blue

32 A simple cell was set up as shown in the diagram.



Which pair of metals will give rise to the highest ammeter reading?

	metal **M**	metal **N**
A	copper	silver
B	magnesium	aluminium
C	aluminium	iron
D	silver	zinc

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

A Hydrogen ions are reduced at the cathode.

B Hydroxide ions are oxidised at the anode.

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

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

34 An enclosed container containing only ammonia gas was slowly heated from room temperature to 450°C.

What are the gas(es) which may be found in the enclosed container at 450°C?

A ammonia only

B nitrogen and hydrogen only

C nitrogen and ammonia only

D nitrogen, hydrogen and ammonia

35 Below are four statements about endothermic reactions.

I The temperature of the surroundings decreases.

II The temperature of reactants increases.

III The products always have more energy than the reactants.

IV The products formed are unstable and explosive.

Which of these statements are true?

A I and III only

B I, II and III only

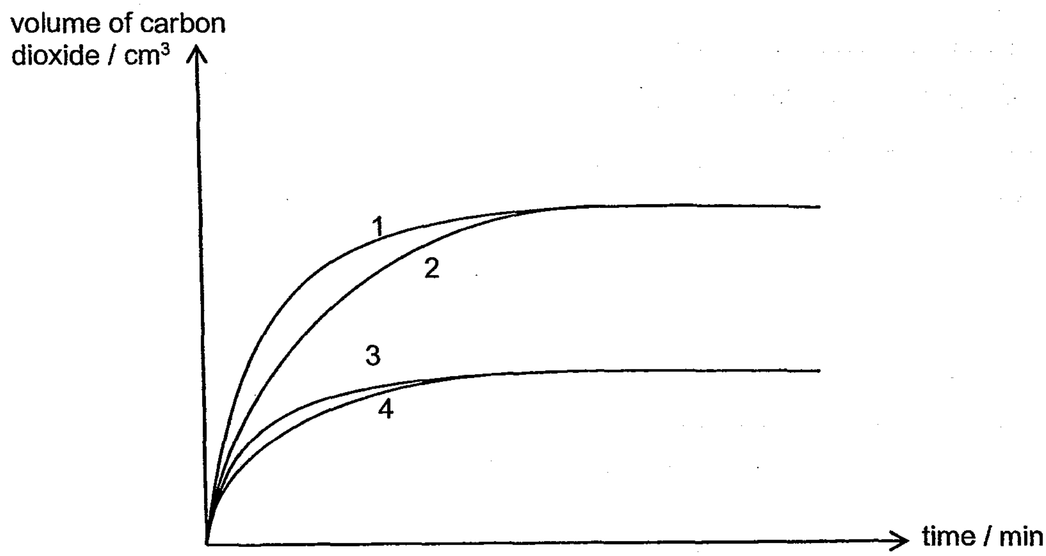
C I, II and IV only

D II and IV only

36 Which of the following correctly describe the effects which increasing temperature and using catalyst have on ΔH and E_a?

	increasing temperature		using catalyst	
	ΔH	E_a	ΔH	E_a
A	unchange	decrease	unchange	decrease
B	unchange	unchange	unchange	decrease
C	decrease	decrease	unchange	decrease
D	increase	increase	decrease	decrease

37 Four experiments were carried out by adding calcium carbonate to excess 1.00 mol/dm^3 hydrochloric acid in four separate beakers. The total volume of carbon dioxide gas evolved was collected and measured at various times for each experiment. The graphs of the results from the four experiments labelled 1, 2, 3 and 4 are shown.



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

set of conditions	type of calcium carbonate	mass of calcium carbonate / g
R	granular	5.0
S	granular	10.0
T	powder	5.0
U	powder	10.0

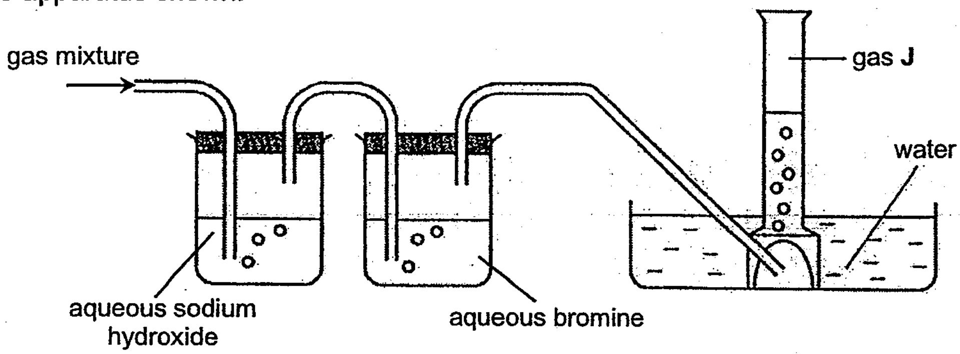
Which of the following matches the graphs of experiments 1, 2, 3 and 4 correctly with the set of conditions **R**, **S**, **T** and **U**?

	R	**S**	**T**	**U**
A	3	2	1	4
B	4	1	3	2
C	3	2	4	1
D	4	2	3	1

38 Which of the following is not a correct use for the petroleum fraction?

	fraction	use
A	naphtha	make drugs
B	kerosene	fuel for cooking
C	diesel oil	make plastic
D	lubricating oil	make shoe polish

39 A gaseous mixture of carbon dioxide, ethane, ethene and sulfur dioxide is passed through the apparatus shown.



What is a property of the gas **J** collected?

A turns moist blue litmus paper red

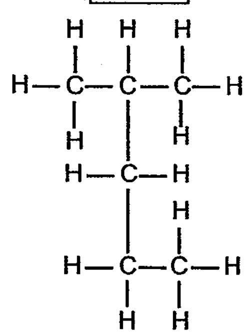
B turns limewater chalky

C turns acidified potassium dichromate(VI) green

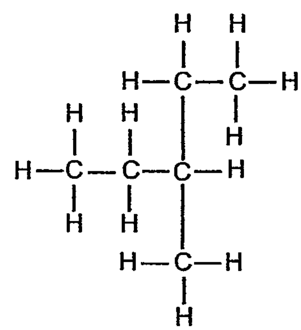
D burns in air

40 The structures of four alkanes are shown below.

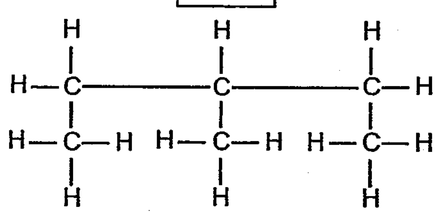
I



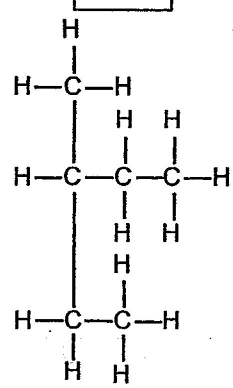
II



III



IV



Which structures are the same hydrocarbons?

A **I** and **IV** only

B **II**, **III** and **IV** only

C **I**, **III** and **IV** only

D all of them

End of paper

DATA SHEET
The Periodic Table of the Elements

I	II	Group										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.).

Victoria School

Secondary 4 First Preliminary Examination 2014
Chemistry Paper 1 Answer Key

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

Name	Class	Register Number

5073/02(with SPA) **14/4P1/CH/2**

CHEMISTRY
Paper 2

Friday **09 May 2014** **1 hour 45 minutes**

NIL SINE LABORE

V S

VICTORIA SCHOOL

FIRST PRELIMINARY EXAMINATION
(SECONDARY FOUR)

Candidates answer on the Question Paper and writing papers
Additional Materials: Writing Papers

READ THESE INSTRUCTIONS FIRST
Do not open this booklet until you are told to do so.

Write your name, class and register number in the spaces provided at the top of this page and on any separate answer paper used.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.

Section A
Answer **all** questions.

Section B
Answer all **three** questions, the last question is in the form either/or.
Write your answers on the lined papers 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 15.

For Examiner's Use	
Section	**Marks**
A	**/ 50**
B	**/ 30**
Total	**/ 80**

This question paper consists of 15 printed pages including the cover page.

Section A

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

1 **(a)** The table below shows the electronic configurations of 3 different atoms of elements and one corresponding property of the element. Give an explanation for each of the following properties.

electronic configuration of atom	property	explanation
2.8.3	easily hammered into thin sheets	
2.8.8	to preserve paint and varnish after opening	
2.7	a strong oxidising agent commonly used in bleaches	

[3]

(b) The table below shows a portion of Charles Janet's Periodic Table.

																1 H	2 He
																3 Li	4 Be
										5 B	6 C	7 N	8 O	9 F	10 Ne	11 Na	12 Mg
										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	19 K	20 Ca
21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	37 Rb	38 Sr

Give two differences in the arrangement of the elements between this Periodic Table and the modern Periodic Table.

....

....

....[2]

(c) The table below shows some properties of 5 metals, **P**, **Q**, **R**, **S** and **T**.

element	able to catalyse reactions	number of electrons that can be lost during reactions	melting point °C	density g cm^{-3}	atomic radius m
P	no	2	842	1.55	1.97×10^{-10}
Q	yes	2, 3, 4 or 5	1910	5.80	1.34×10^{-10}
R	yes	1	97.0	0.97	1.86×10^{-10}
S	yes	1, 2 or 4	-39.0	13.50	1.51×10^{-10}
T	no	2	777	2.64	2.15×10^{-10}

(i) Identify which is/are the transition metal(s).

....[1]

(ii) Can metal **R** be an alkali metal? Give a reason for your answer.

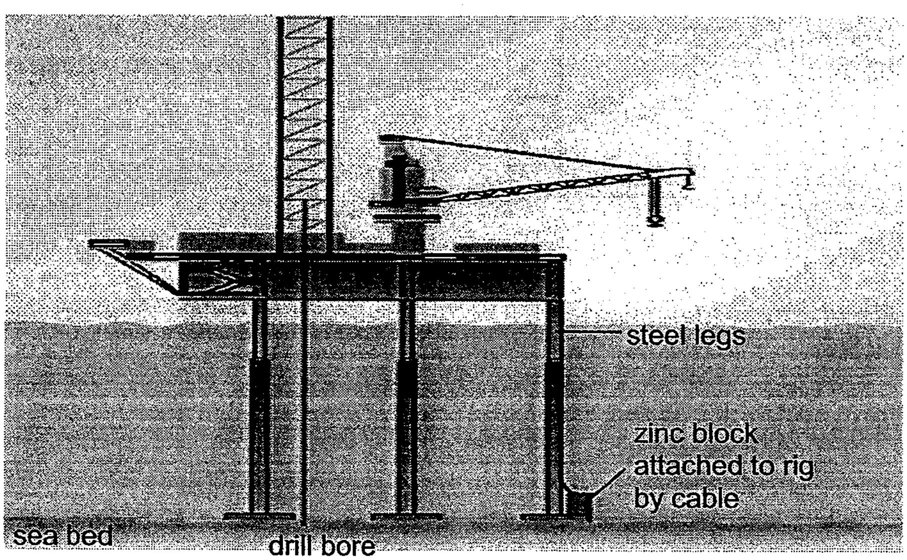
....[1]

(iii) Explain why metal **P** has a higher melting point than metal **T**.

....

....[1]

(d) Zinc is a moderately reactive metal used as sacrificial anodes in oil rigs. For large structures like oil rigs, completely covering the steel with zinc is not practical. Instead, blocks of zinc can be bolted to the steel leg of oil rig as shown in the diagram below.



Explain why it is better for the steel leg of the oil rig to be bolted with zinc rather than an unreactive metal like copper.

....

....[2]

[Total: 10]

2 Coconut oil is an edible oil that has been consumed in tropical countries for many years. Traditionally, coconut oil is produced by the fermentation method, where dried kernel or fresh coconut meat is crushed to extract the coconut milk first, then left to ferment overnight. During this period, the oil phase gets separated from the aqueous phase.

(a) Explain why it is easier to extract coconut milk from grated coconut and not big pieces of coconut meat.

....[1]

(b) A simple method of extracting the coconut milk can be performed by washing the coconut gratings with some water and then strained in a cloth to extract the milk.

How does this method acts as a filtration process?

....[1]

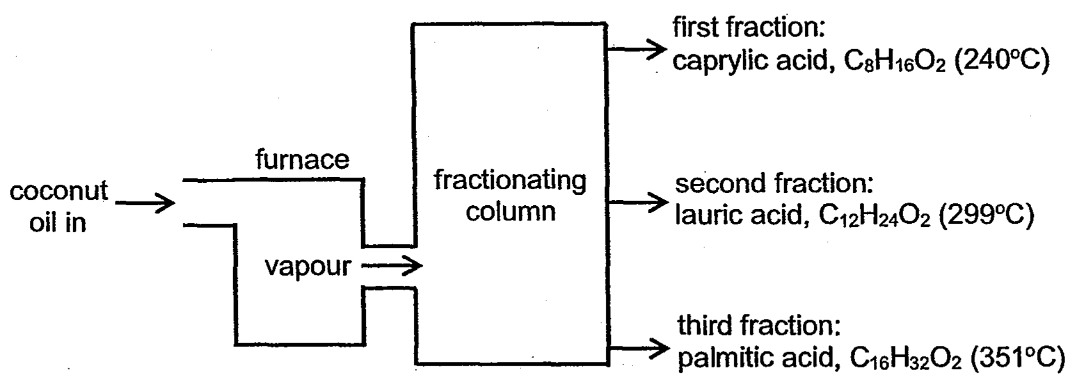
(c) The coconut milk is further processed to produce an intermediate product.

Describe an experiment to show how this intermediate product is actually a mixture.

....

....[1]

(d) Coconut oil can be further separated into different components through fractional distillation. The three fractions are obtained from the process as shown.



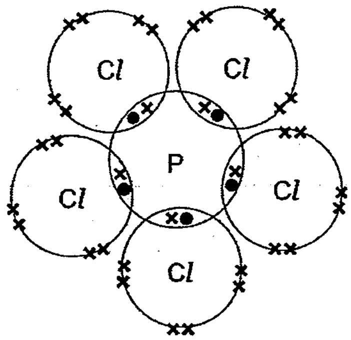
Describe two **other** differences in the physical properties between the first and third fraction.

....

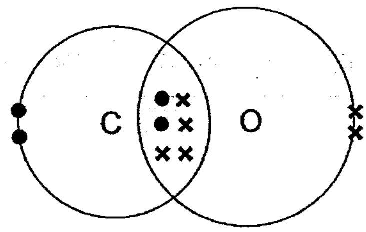
....[2]

[Total: 5]

3 Covalent molecules such as phosphorus pentachloride and carbon monoxide are formed when the atoms are bonded together by covalent bond.



phosphorus pentachloride



carbon monoxide

(a) What is a covalent bond?

....

....[1]

(b) Suggest how the structure of phosphorus pentachloride is different from other 'normal' covalent molecules?

....[1]

(c) Carbon monoxide is a good reducing agent and is used for that purpose in industries.

(i) State how the structure of carbon monoxide is unusual.

....[1]

(ii) Carbon monoxide burns with a blue flame in air.

Explain how this shows that carbon monoxide is a reducing agent.

....[1]

(iii) With the help of a balanced chemical equation, explain briefly how carbon monoxide is used as a reducing agent in industries.

....

....

....[2]

(d) A textbook wrote "*Hydrogen chloride exist as a gas at r.t.p and does not conduct electricity under any conditions.*"

Do you agree with the above statement? Explain your answer.

....

....

....[2]

[Total: 8]

4 (a) The presence of excess nitrate and lead(II) ions in food and drinks may pose health threats to human beings.

(i) Explain why it is difficult to remove nitrates from water.

....[1]

(ii) Describe a chemical test to identify the presence of nitrate ions.

....

....[2]

(iii) Explain why adding aqueous sodium iodide into the water sample will enable one to identify the presence of lead(II) ions.

....[1]

(b) The temperature inside waste incinerators can typically go up to 850°C. A lot of water is required to cool the furnace and water mists are also periodically sprayed into the fire to lower the temperature of the fire.

(i) Suggest why the water mists can help to reduce the amount of oxides of nitrogen formed inside the incinerators.

....[1]

(ii) Explain why it is important to control the emission of oxides of nitrogen from the incineration plants into the environment.

....

....

....[2]

(iii) Another pollutant from waste incinerators is sulfur dioxide.

Name a reagent used to test for the presence of sulfur dioxide.

....[1]

[Total: 8]

5 Hydrated nickel(II) chloride, $NiCl_2 \bullet 6H_2O$ can be produced by reacting excess nickel(II) carbonate with dilute hydrochloric acid followed by addition of water. The chemical equation is shown.

$$NiCO_3 + 2HCl + 5H_2O \rightarrow NiCl_2 \bullet 6H_2O + CO_2$$

The mixture is then filtered and the filtrate partially evaporated to obtain green crystals upon cooling.

(a) (i) Explain why nickel(II) carbonate is used in excess but not the acid.

....

....

....[2]

(ii) Explain why the filtrate is partially evaporated instead of evaporated to dryness.

....

....[1]

(b) (i) 25.0 cm^3 of 1.00 mol/dm^3 dilute hydrochloric acid was reacted with excess nickel(II) carbonate in an experiment to produce hydrated nickel(II) chloride.

Calculate the percentage yield if 2.50 g of hydrated nickel(II) chloride was obtained at the end of the reaction.

[3]

(ii) Suggest why the yield of hydrated nickel(II) chloride is expected to be lower than 100%.

....

....[1]

[Total: 7]

6 (a) Potassium is the seventh most abundant element on earth and occurs in mineral deposits, mainly as potassium chloride.

Molten potassium chloride can be reacted with sodium vapour to produce potassium and sodium chloride. The potassium is boiled off and is therefore obtained in a reasonably pure state by distillation.

The equation is given.

$$Na + KCl \rightarrow NaCl + K$$

(i) Explain why this reaction is unusual.

....

....[1]

(ii) Explain, in terms of electron transfer, why this is a redox reaction.

....

....

....[2]

(b) In one of the processes in the industrial electrolysis of brine (sodium chloride) solution, sodium-mercury almagam was passed into water where sodium will react with water in the vessel. The mercury does not react and is recycled.

(i) Give the chemical formula of the product for the reaction below and balance the equation.

$$Na \quad + \quad H_2O \rightarrow \qquad\qquad + \quad H_2$$ [1]

(ii) During one run, the sodium-mercury almagam was poured into a tank of water which measured 200 dm wide, 200 dm long and 200 dm high. After passing the amalgam into the water for 2 hours, the product formed in **(b)(i)** has a concentration of 0.0100 mol/dm^3.

Calculate the mass of sodium reacted in tonnes. [1 tonne = 1000 kg]

[3]

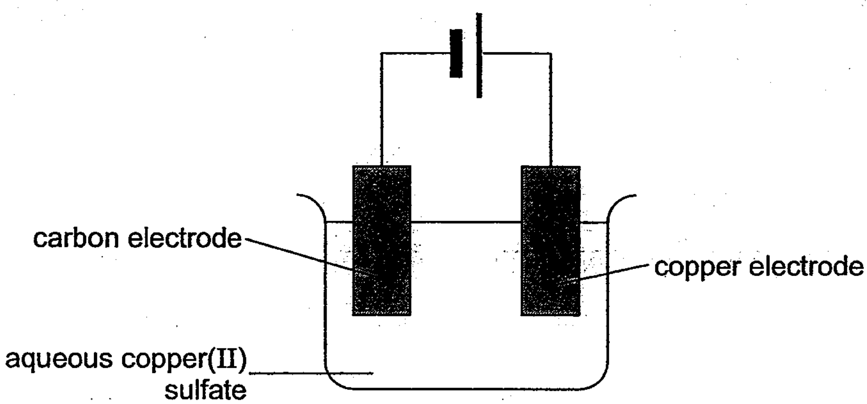
[Total: 7]

7 (a) When copper is extracted from its ore, it contains carbon impurities.

Suggest how the carbon impurities get into the copper.

....[1]

(b) A sample of aqueous copper(II) sulfate was electrolysed using copper and carbon electrodes as shown in the diagram.



(i) Write an ionic equation, with state symbols, for the reaction that take place at the anode.

....[1]

(ii) Describe what will be observed at the cathode after some time.

....[1]

(b) Electroplating is one of the main uses of electrolysis industrially.

Draw a labelled diagram of an apparatus used to plate silver on a round object.

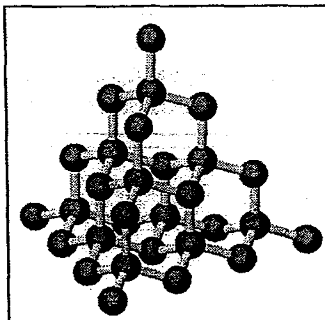
[2]

[Total: 5]

Section B

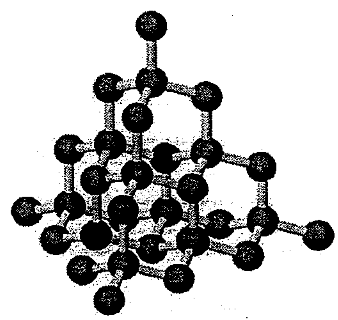
Answer all **three** questions from this section.
The last question is in the form of either/or and only **one** alternative should be attempted.

8 "Diamonds are a girl's best friend", a song made famous by Marilyn Monroe, clearly reflects many women's obsession with this tiny little shiny thing over the centuries.


structure of diamond

Natural diamonds are made of carbon that crystallised under crushing pressures and intense heat 150 to 190 km in the Earth's mantle. It is the hardest mineral we know of and can only be cut by another diamond.

Diamonds are weighed in carats. 1 carat is equivalent to 0.200 g. It should be noted that the weight of the diamond does not correlate to its size. A 2-carat diamond does not necessary appears to be twice the size of a 1-carat diamond when viewed from the top.


structure of a boron-doped diamond

Each carbon atom in diamond is bonded to four other carbon atoms to form a tetrahedral unit. The angle between two adjacent bonds is 109.5°. Diamond is a very bad conductor of electricity except natural blue diamond which is a semiconductor due to the boron impurities. Phosphorus-doped diamonds are made by changing some carbon atoms with phosphorus atoms. Generally, diamond doped with Group III (such as boron-doped diamond) or Group V elements will form a semiconductor.

The bonding at the edge and corner of a diamond has intrigued many. Because there are carbon atoms at one side but no carbon atoms at the other side, it seems that these carbon atoms have "dangling bonds". Researches and experiments have shown that the "dangling bonds" at the edges and corners normally pick up hydrogen or hydroxyl groups (–OH). As what the Nobel Prize winner for Chemistry Professor Richard Errett Smalley aptly describe, "when you touch a diamond, you're not touching carbon. You're touching a monatomic layer of hydrogen formed at its surface".

(a) Explain why substances with structure similar to that of diamond are expected to be very hard and have very high melting points. [3]

(b) Explain why phosphorus-doped diamonds have free electrons to conduct electricity. [2]

(c) Explain why the "dangling bonds" at the edges and corners of the diamond must pick up other atoms and cannot exist on their own. [1]

(d) A 3.5 carat diamond was burnt in limited amount of oxygen to form carbon monoxide. Calculate the maximum volume of carbon monoxide produced. [3]

(e) A student made the comment that "diamond is actually a compound and not an element". Explain why he is justified in his statement. [1]

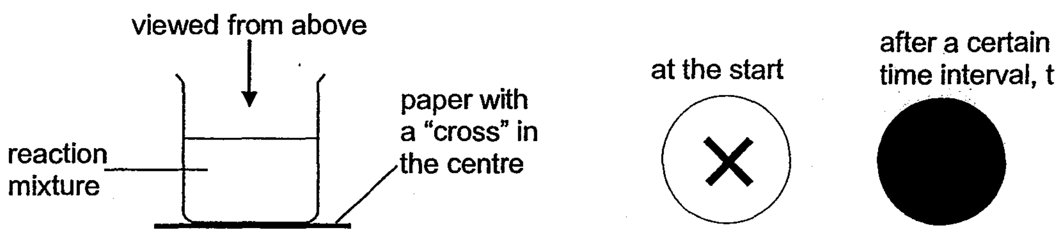
[Total: 10]

9 (a) Sodium thiosulfate reacts with an acid to form yellow solid sulfur in a colloidal suspension as shown in the equation below.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(g) + H_2O(l)$$

The table below shows how the speed of this reaction changes when different concentrations of sodium thiosulfate solution and dilute hydrochloric acid are used. The rate of the above reaction is inversely proportional to the time taken for sufficient sulfur to form and obscure a black "cross" drawn on a white piece of paper.

experiment	concentration of sodium thiosulfate solution / mol dm^{-3}	concentration of dilute hydrochloric acid / mol dm^{-3}	time taken for the "cross" to be obscured, t / s
1	0.100	0.100	54
2	0.200	0.100	27
3	0.100	0.200	54
4	0.300	0.100	18
5	0.300	0.300	18
6	0.600	0.200	9



(i) With reference from the experimental data, describe the effect of increasing concentration of sodium thiosulfate solution on the time taken for the "cross" to be obscured. [1]

(ii) Explain the effect of concentration of sodium thiosulfate solution on the rate of reaction using collision theory. [2]

(iii) Predict the time taken for the "cross" to be obscured if the concentration of sodium thiosulfate solution is halved for experiment 1. [1]

(iv) What effect does increasing concentration of the dilute hydrochloric acid have on the rate of reaction? [1]

(b) The Haber-Bosch process is an industrial process to produce ammonia from nitrogen and hydrogen. The chemical reaction is a reversible reaction and it is typically carried out at a temperature of 450°C and 250 atm with the use of iron as catalyst. The equation is shown.

$$N_2\,(g) + 3H_2\,(g) \leftrightharpoons 2NH_3\,(g) \qquad \Delta H = -87\ \text{kJ/mol}$$

(i) What is a reversible reaction? [1]

(ii) Explain why, in terms of collision theory, increasing pressure will increase the yield per unit time in the Haber-Bosch process. [2]

(iii) Explain why increasing the temperature of a reaction need not always increase the yield per unit time. [1]

(iv) Calculate the overall energy change when 17.0 g of nitrogen was completely reacted to form ammonia. [1]

[Total: 10]

EITHER

10 **(a)** An amateur chemistry website stated the following.

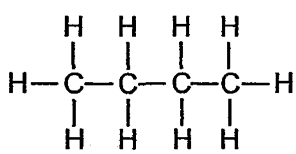
> Because all the members of the same homologous series have the same general formula, it follows that they have the same empirical formula.

(i) Define the term *homologous series.* [1]

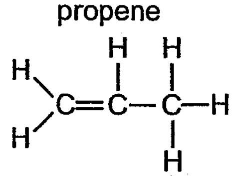
(ii) By using appropriate examples, explain why the above statement is true for the alkene homologous series but not for the alkane homologous series. [2]

(b) The structures of butane and propene are shown below.

butane



propene



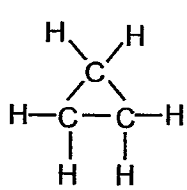
(i) Name a method to make propene from butane. [1]

(ii) State the conditions for the hydration of propene to propanol. [2]

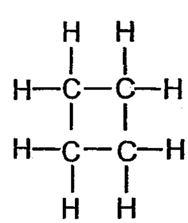
(iii) The hydration of ethene produces only one product.
The hydration of propene may produce two products.

Explain the above observations. [2]

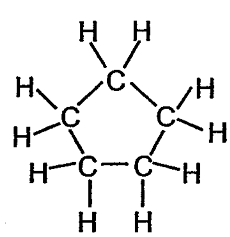
(c) Cycloalkanes are a class of saturated hydrocarbons that have at least one ring of carbon atoms in the structure of their molecules. The structures of the first three members in the cycloalkane homologous series are shown below.



cyclopropane



cyclobutane



cyclopentane

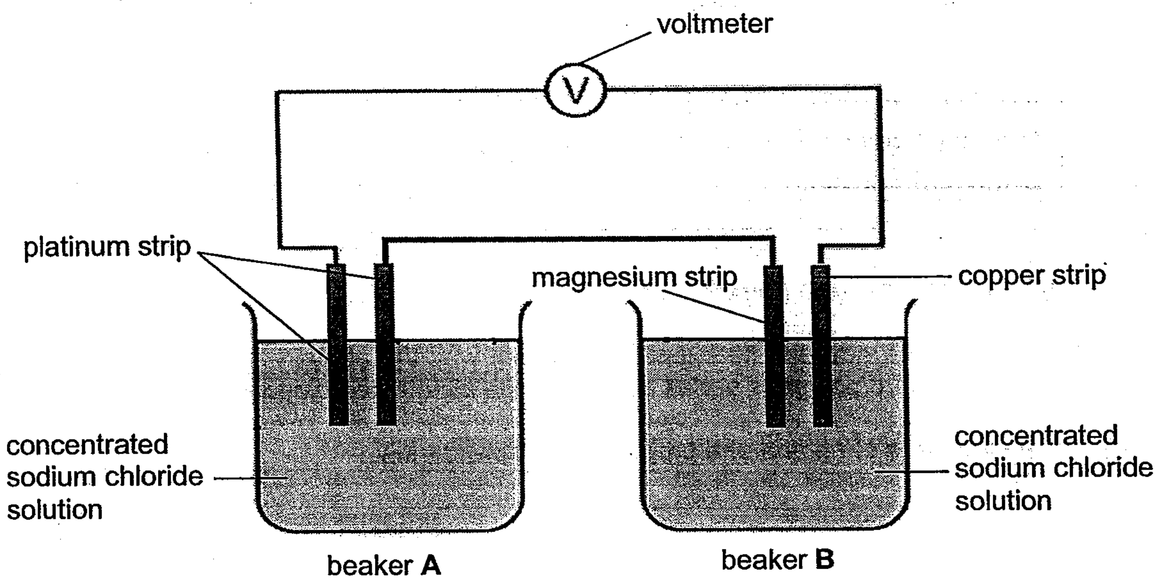
(i) Write the general formula of cycloalkanes. [1]

(ii) Explain why cycloalkanes are saturated compounds. [1]

[Total: 10]

OR

10 The diagram below shows an electric cell.



(a) Describe a difference in observations between the reactions in beaker **A** and **B**. [2]

(b) Describe how the electrons flow in this setup. [1]

(c) Describe the reactions occurring at both electrodes in beaker **B**. [2]

(d) Name the products formed in beaker **A**. [2]

(e) Write the ionic equation, with state symbols, for the reaction which takes place at the cathode in beaker **A**. [1]

(f) After some time, both beakers feel hot.

Draw the energy profile for any one of the beakers and indicate the ΔH. [2]

[Total: 10]

End of Paper

Setters: Chua KW, G Tan, J Wong, Ricca Jasin

DATA SHEET
The Periodic Table of the Elements

I	II						Group					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	Ui 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

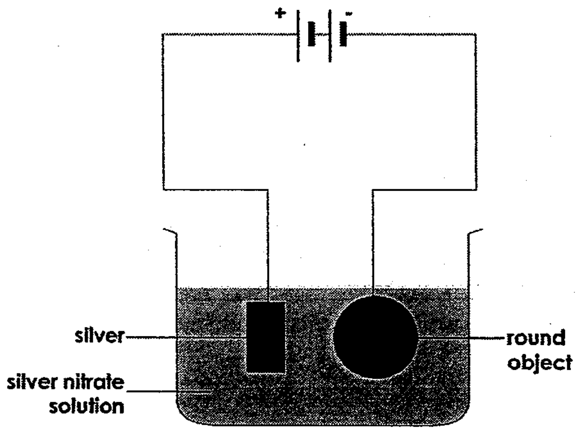
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

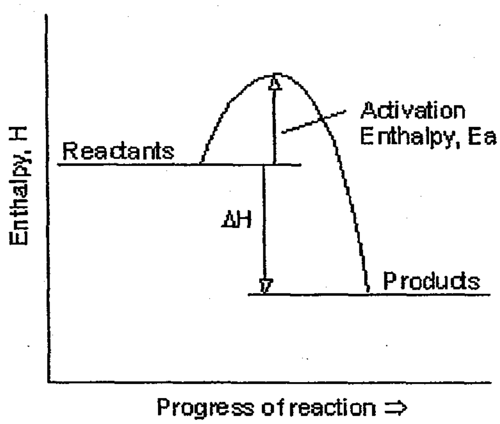
The volume of one ɟf any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Victoria School Sec 4 First Preliminary Examination 2014 – Answer Key

Qn No	Suggested answers
1(a)	(i) layers/rows of metal atoms/ions can slide over one another easily (without breaking the metallic bonds) [1] (ii) noble gas is unreactive due to fully filled outermost electron shell hence protecting paint from tarnishing [1] (iii) able to gain an (outermost) electron easily/readily [1]
1(b)	Hydrogen, a non-metal, is placed in the same vertical group as the group I metals, whereas in the modern Periodic Table, hydrogen does not belong to a group. Helium is a noble gas and it is placed in the same group as group II metals. Lithium and beryllium are not placed in the same period 2 as in the modern Periodic Table. Any 2 – [2m]
1(c)(i)	Metal Q and S. [1]
1(b)(ii)	No. Metal R has a low density. [1] [R: only forms ions of +1 / low m.p.]
1(b)(iii)	Metal P has a <u>smaller atomic radius</u> compared to metal T, hence there is <u>stronger electrostatic forces of attraction</u> between the ions and delocalised mobile electrons in P/ <u>stronger metallic bonds</u>. [1]
1(d)	Zinc is a more reactive metal than iron and so zinc will corrode in place of iron. [1] Copper is a less reactive metal than iron and so iron will corrode in place of copper. [1]
2(a)	Grated coconut has a <u>larger total surface area</u> to volume ratio thus allowing the coconut milk to be extracted faster. [1]
2(b)	The holes in the cloth are small enough to allow coconut milk to pass through but not the coconut gratings. [1]
2(c)	Heat the intermediate product and measure its temperature. The intermediate product is a mixture if it melts/boils over a range of temperatures. [1]
2(d)	First fraction is less flammable as compared to the third fraction. First fraction is less viscous as compared to the third fraction. First fraction has a lighter colour compared to third fraction. First fraction burns with a less sooty flame compared to third fraction. Molecular mass of the first fraction is lower than molecular mass of third fraction. Any 2 - [2m]
3(a)	A covalent bond is a pair of electrons which are shared between two atoms. [1]
3(b)	In phosphorus pentachloride, the <u>phosphorus atom has 10 outermost electrons</u> after bonding with chlorine atom. [1]
3(c)(i)	Oxygen atom shared two extra electrons to form bond with carbon atom / one pair of the shared electrons comes from oxygen atom only (dative covalent bonding). [1]
3(c)(ii)	Carbon monoxide can <u>burn in / react with oxygen</u> and itself become <u>oxidised</u>. [1]
3(c)(iii)	Carbon monoxide is used to reduce iron(III)oxide (to molten iron) in the extraction of iron process in the blast furnace while itself is oxidised (to carbon dioxide). reduction: $Fe_2O_3 \rightarrow 2Fe$ $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$ oxidation: $3CO \rightarrow 3CO_2$ Equation [1] Explanation [1]
3(d)	No. Hydrogen chloride <u>dissolves in water</u> [1] and <u>dissociates to form</u> mobile ions to conduct electricity in aqueous state. [1]
4(a)(i)	All nitrates are soluble in water so there are no physical means to remove it from water. [1]

Qn No	Suggested answers
4(a)(ii)	To a portion of the sample, add a spatula of aluminium powder/Devarda's alloy, excess aqueous sodium hydroxide and then warm the mixture. [1] If colourless, pungent gas evolved which turns moist red litmus paper blue, ammonia gas is produced which means that nitrates are present. [1]
4(a)(iii)	Yellow precipitate is formed if lead(II) ions are present. [1] [R: ppt]
4(b)(i)	The water mists help to lower the temperature and reduce the amount of heat energy needed for the oxygen molecules and nitrogen molecules to react. [1]
4(b)(ii)	Oxides of nitrogen is oxidised by oxygen in air and dissolve in rainwater to form acid rain [1] which corrodes limestone buildings / metal infrastructures / destroys crops and damage forests. [1]
4(b)(iii)	acidified potassium manganate(VII)/dichromate(VI) solution [1]
5(a)(i)	Nickel(II) carbonate is used in excess so that all the (hydrogen ions in the) acid will completely react away. [1] Acid is not used in excess so as to prevent any unreacted acid to be present in the filtrate which will cause contamination to the eventual crystal formed. [1] or Nickel(II) carbonate is insoluble in water and can be removed by filtration. [1] The acid is soluble in water and cannot be removed by filtration. [1]
5(a)(ii)	To prevent the loss of water of crystallisation from nickel(II) chloride crystals which will otherwise form the powder instead of crystals. [1]
5(b)(i)	No. of moles of hydrochloric acid = 25.0/1000 × 1.00 = 0.02500 moles No. of moles of hydrated nickel(II) chloride = 0.02500 ÷ 2 = 0.01250 moles [1] Theoretical mass of hydrated nickel(II) chloride = 0.01250 × [59 + 35.5×2 + 6×(1+1+16)] = 2.975 g [1] Percentage yield of the reaction = 2.50/2.975 × 100% =84.0% (3 s.f.) [1]
5(b)(ii)	Not all the nickel(II) chloride crystals have precipitated out / Some of the product may be lost when transferred from one apparatus to another / some of the water molecules in the hydrated nickel(II) chloride crystals may have been lost.
6(a)(i)	Sodium is less reactive than potassium in the reactivity series hence it should not be able to displace potassium from molten potassium chloride. [1]
6(a)(ii)	Sodium atom is oxidised as it loses one valence electron to form sodium ion. [1] Potassium ion is reduced as it gains one electron to form potassium atom. Since oxidation and reduction occurs simultaneously / at the same time, this is a redox reaction. [1]
6(b)(i)	2 Na + 2 H_2O → 2 NaOH + H_2 [1]
6(b)(ii)	Volume of water = 200 x 200 x 200 = 8000000 dm^3 No. of moles of sodium hydroxide = 0.0100 x 8000000 = 80 000 [1] No. of moles of sodium = 80 000 Mass of sodium = 80 000 x 23 = 1840000g = 1.84 tonnes [1]
7(a)	The copper was extracted from its ore by heating / reducing / reacting its oxide with carbon. Excess carbon is dissolved into the molten copper. [1]
7(b)(i)	Cu (s) → Cu^{2+} (aq) + $2e^-$ [1]
7(b)(ii)	Reddish-brown / pinkish-brown / pink solid deposited at the cathode / The cathode increases in size. [1]

Qn No	Suggested answers
7(c)	
8(a)	giant covalent structure with extensive strong covalent bonding [1] Rigid 3-dimensional network which requires a lot of energy to move atom, so hard [1] A lot of energy to overcome / break all covalent bonds, so high melting point. [1]
8(b)	Every phosphorus atom has 5 outermost electrons [1] Only 4 of the outermost electron is used in covalent bonding (with carbon atoms) leaving one electron free to be delocalised to conduct electricity. [1]
8(c)	otherwise the atom will not have full outermost shell of electrons [1]
8(d)	mass of diamond = 3.5 x 0.200 = 0.700 g [1] number of mole of carbon monoxide = $\frac{0.700}{12}$ = 0.0583 mol [1] maximum volume of carbon monoxide produced = 0.0583 x 24 = 1.40 dm^3 [1]
8(e)	contains more than one kind atom or contains carbon, oxygen and hydrogen chemically combined / bonded together [1]
9(a)(i)	When the concentration of sodium thiosulfate is doubled, the time taken for the "cross" to be obscured is halved. [1]
9(a)(ii)	As the concentration of thiosulfate ions increases, the number of thiosulfate ions per unit volume increases. [1] This increases the frequency of effective collisions between thiosulfate ions and hydrogen ions. Hence the rate of reaction increase as concentration increases. [1]
9(a)(iii)	108 s [1]
9(a)(iv)	No effect on the rate of reaction. [1]
9(b)(i)	A reaction which can go both forwards and backwards until a dynamic equilibrium is reached. [1]
9(b)(ii)	Increasing the pressure will increase the number of nitrogen and hydrogen molecules per unit volume [1] thereby increasing the number of effective collisions between the nitrogen and hydrogen molecules, increasing the yield per unit time. [1]
9(b)(iii)	Increasing the temperature will cause the ammonia to be decomposed to form nitrogen and hydrogen. [1]
9(b)(iv)	Overall energy change $= \frac{17.0}{(14\times2)} \times (-87)$ = −52.8 kJ [R: kJ/mol as units]
Either 10(a)(i)	A homologous series is a set of organic compounds with the same general formula and rather similar chemical properties. Each member of the series differs from the next by a $-CH_2-$ unit. [1]
10(a)(ii)	Ethene and propene (any alkene) has empirical formula of CH_2 [1]. Methane has empirical formula CH_4 but ethane has CH_3 (or any alkane) [1]
10(b)(i)	(catalytic) cracking [1]
10(b)(ii)	300°C, 70 atm [1]

Qn No	Suggested answers
	phosphoric(V) acid catalyst [1]
10(b)(iii)	Hydration of ethene produces only ethanol [1]. Hydration of propene produces propan-1-ol and propan-2-ol (allow structure) [1]
10(c)(i)	C_nH_{2n} [1]
10(b)(v)	All the carbon atoms in cycloalkanes are bonded together by single covalent bonds only. [1]
Or 10(a)	Effervescence of pale green gas and colourless gas observed in beaker A [1] while only effervescence of colourless gas observed in beaker B. [1]
10(b)	Electrons flow from magnesium strip to platinum strip and from platinum strip to copper strip. [1]
10(c)	Magnesium atoms in the magnesium strip oxidises / lose electrons to form magnesium ions. [1] Hydrogen ions gain electrons / reduce to form hydrogen gas at the copper strip. [1]
10(d)	hydrogen gas chlorine gas aqueous sodium hydroxide [3 correct – 2 marks; 2 correct – 1 mark]
10(e)	$2H^+ (aq) + 2e \rightarrow H_2 (g)$ [1]
10(f)	

ANDERSON SECONDARY SCHOOL
SCIENCE DEPARTMENT
PRELIMINARY EXAMINATION 2014

CANDIDATE NAME	

CLASS	4	/		INDEX NUMBER		

CHEMISTRY **5073/01**

Paper 1 Multiple Choice

28th August 2014

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and register number on the Question Paper and Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions.

For each question there are four possible answers **A**, **B**, **C**, and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate **Answer Sheet**.

Read the instructions on the answer sheet very carefully.

Each correct answer will score one mark.

A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

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

This document consists of 17 printed pages including this cover page.

1 Which of the following statements can be used to explain why the volume of a fixed mass of gas is inversely proportional to the pressure at a constant temperature?

A Forces between the particles are overcome at higher pressure.

B Particles collide harder and move farther apart at higher pressure.

C Particles move closer to one another at higher pressure.

D Particles move faster and more randomly at higher pressure.

2 The melting point and boiling point of some gases in air is shown below:

Gas	Melting point / °C	Boiling point / °C
Oxygen	-219	-183
Argon	-189	-186
Nitrogen	-210	-196

To obtain only liquid oxygen, the temperature of a sample of air should be decreased to ____________.

A - 180°C

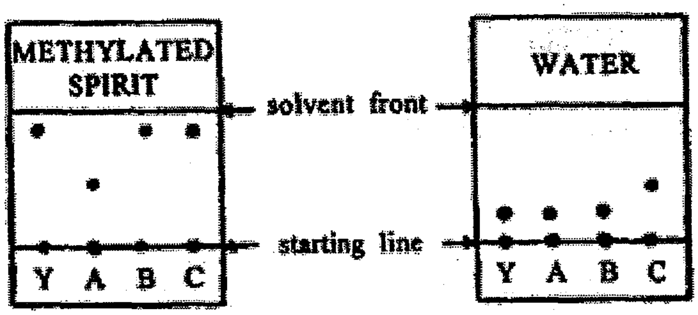
B - 182°C

C - 185°C

D - 195°C

3 It was suspected that an illegal drug **Y** contained one or more of three poisonous compounds, **A**, **B** or **C**.

Spots of each poisonous compound were put on the starting line of two chromatograms. The first chromatogram was developed with methylated spirit, and the second with water. The results were shown below.



From these chromatograms, we can deduce that drug **Y** contains ___________.

A compound **A** only

B compound **B** only

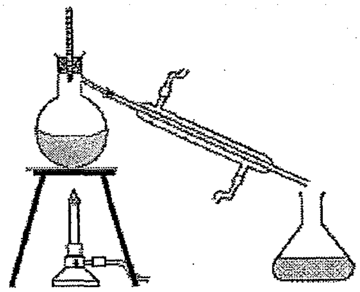
C compound **C** only

D compounds **B** and **C** only

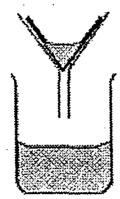
4 In the laboratory experiment, a student prepares an ester, ethyl ethanoate by heating ethanoic acid with ethanol for thirty minutes. It is necessary to separate the ester from the reaction mixture.

Which of the following apparatus is correct for carrying out this separation?

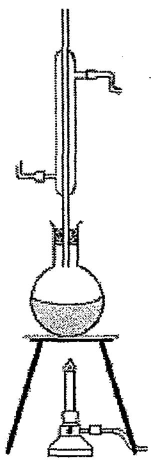
A



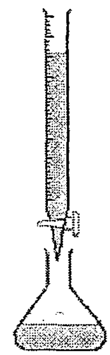
B



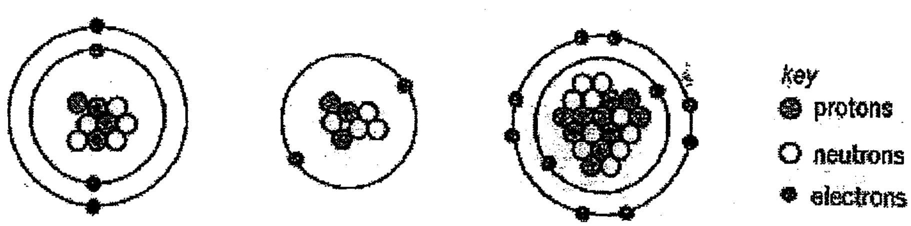
C



D



5 The diagrams below show the structure of three particles, **P**, **Q** and **R**.



P Q R

Which of the statements about **P**, **Q** and **R** is correct?

A **P** and **Q** are isotopes of the same element.

B The atoms of **P**, **Q** and **R** have the same number of electron shells.

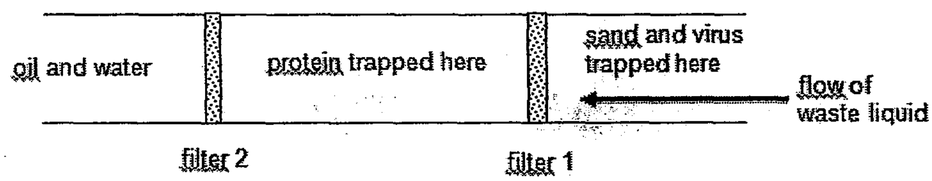
C They all have noble gas electronic configurations.

D They are all electrically neutral.

6 The diameters of some particles are shown in the table below.

Particle	Size in nanometre (nm)
water molecule	0.2
oil molecule	1.0
protein molecule	10.0
virus particle	50.0

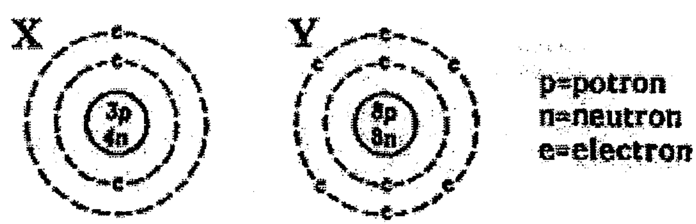
An aqueous waste liquid contains a suspension of visible sand particles mixed with oil, protein and a virus.
By using two filters with holes of different sizes, it is intended to separate the protein and oil as shown in the diagram below.



Filter 1 removes sand and the virus and filter 2 separates the oil from the protein. Which of the following are suitable diameters for the holes in the filters?

	Filter 1	Filter 2
A	0.1 nm	5.0 nm
B	20.0 nm	5.0 nm
C	20.0 nm	0.1 nm
D	100.0 nm	5.0 nm

7 The diagram below illustrates the structure of the atoms of two elements, **X** and **Y**.



When these two elements combine together to form a compound, what will be the mass of one mole of this compound?

A 11 g

B 14 g

C 23 g

D 30 g

8 The properties of four stubstances, **P**, **Q**, **R** and **S** are given below.

Compounds	Properties
P	low melting point; not able to conduct electricity in solid state; made up of two elements
Q	high melting point, not able to conduct electricity in solid state; made up of two elements
R	high melting point; able to conduct electricity in solid state; made up of one element
S	high melting point; not able to conduct electricity in solid state; made up of one element

Which of the following could be **P**, **Q**, **R** and **S**?

	P	Q	R	S
A	ammonia	sodium chloride	graphite	diamond
B	ammonia	sodium chloride	diamond	graphite
C	bromine	magnesium chloride	argon	silicon dioxide
D	bromine	carbon tetrachloride	neon	silicon dioxide

9 Why is graphite a good lubricant for the door lock?

A Graphite has a very high melting point.

B Graphite has very strong covalent bonds.

C The free electrons of graphite can conduct electricity.

D The layers of atoms easily slip over each other.

10 In which reaction is dilute sulfuric acid **not** behaving as an acid?

A $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

B $H_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2HCl$

C $H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

D $H_2SO_4 + Mg \rightarrow MgSO_4 + H_2$

11 Which of the following substance is **not** appropriate for use in the reaction with dilute sulfuric acid to prepare zinc sulfate?

A zinc

B zinc carbonate

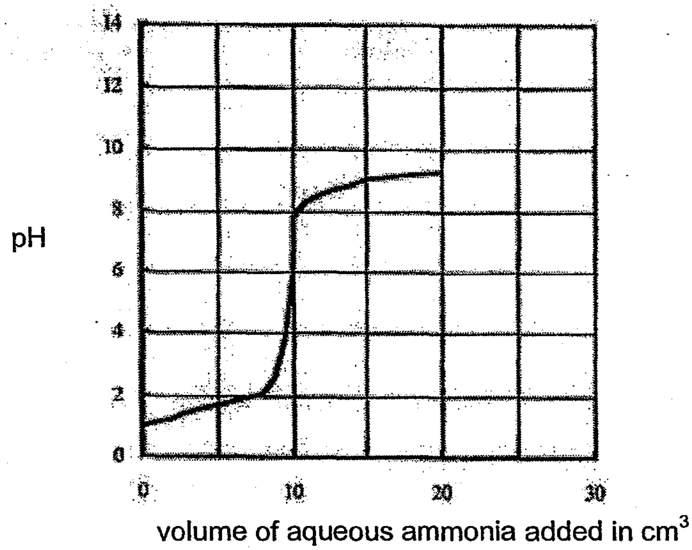
C zinc hydroxide

D zinc nitrate

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

Indicator	pH range for the colour change	Colour	
		Lower pH	Higher pH
Indigo carmine	11.6 to 14.0	Blue	Yellow
Methyl red	4.2 to 6.3	Red	Yellow
Methyl violet	0.3 to 3.0	Yellow	Violet
Phenolphthalein	8.2 to 10.0	Colourless	Pink

If aqueous ammonia is added to hydrochloric acid, the following graph is obtained, which shows the change of pH with the volume of aqueous ammonia added.



Which of the indicators below would be the best choice to use in the titration?

A indigo carmine

B methyl red

C methyl violet

D phenolphthalein

13 Which of the following equations suggests that a metal oxide, RO, behaves as an amphoteric oxide?

A $RO(s) + 2H^+(aq) \rightarrow R^{2+}(aq) + H_2O(l)$

B $RO(s) + 2OH^-(aq) \rightarrow RO_2^{2-}(aq) + H_2O(l)$

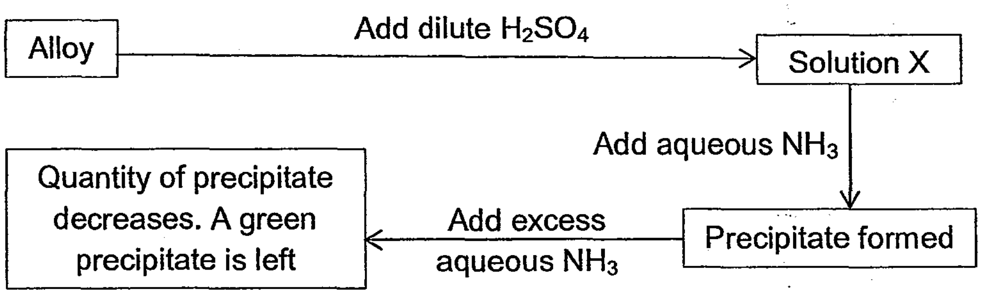
C $RO(s) + H_2O(l) \rightarrow R^{2+}(aq) + 2OH^-(aq)$

D $RO(s) + NH_4^+(aq) \rightarrow R^{2+}(aq) + H_2O(l) + NH_3(g)$

14 Which of the following salts is **not** obtained by crystallization?

A barium nitrate
B iron(II) sulfate
C lead(II) chloride
D calcium chloride

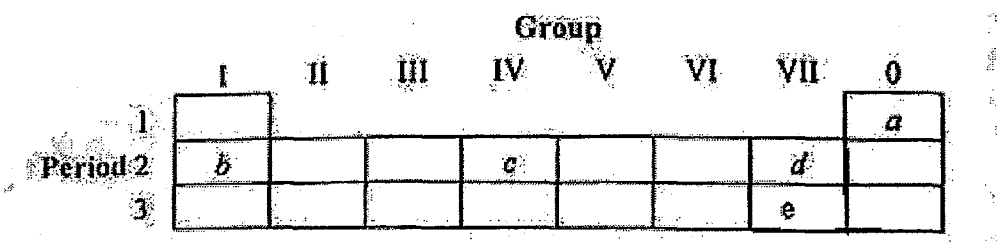
15 A sample of an alloy containing two metals was subjected to the following tests.



What are the two metals present in the alloy?

A aluminium and iron
B calcium and iron
C lead and iron
D zinc and iron

16 A part of the Periodic Table is shown below.



Which of the following statements is correct?

A ***a*** has an octet structure of valence electrons.
B ***c*** forms an ionic compound with ***d***.
C ***e*** is a strong oxidizing agent.
D The metallic character of the elements increases from ***b*** to ***d***.

17 The electronic structures of six elements, **P** – **U** are listed below.

P: 2,7	**Q**: 2,2	**R**: 2,4
S: 2,8,1	**T**: 2,8	**U**: 2,8,7

Which of the following is a list of non-metals, with the most reactive first and least reactive last?

A **P, R, S, U**

B **P, U, R, T**

C **S, P, Q, T**

D **U, P, S, R**

18 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	Grey solid	Yellow solid	Grey solid	Yellowish-green gas
Reaction with cold water	Extremely violent reaction	No reaction	Vigorous 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**

19 If 40 g of calcium contains x number of atoms, how many atoms are there in 71 g of chlorine gas, Cl_2?

A $0.5x$

B x

C $1.5x$

D $2x$

20 When an impure sample of calcium carbonate, weighing 12.0 g was added to excess of dilute hydrochloric acid, the volume of carbon dioxide given off, measured at r.t.p. was found to be 2640 cm^3.
What is the percentage purity of the sample?

A 45.8 %

B 51.3 %

C 78.0 %

D 91.7 %

21 60 cm^3 of oxygen was mixed with 10 cm^3 of gaseous hydrocarbon in a closed vessel. After explosion and cooling, the gases occupied 50 cm^3 and after passing the gas through aqueous sodium hydroxide, 30 cm^3 of oxygen remained.
Deduce the molecular formula of the hydrocarbon.

A CH_4

B C_2H_4

C C_2H_6

D C_3H_6

22 In which of the following set-ups will the concentration of copper(II) ions in the electrolyte remain unchanged when electrolysis takes place?

Setup	Electrolyte	Positive Electrode	Negative Electrode
1	$CuSO_4$ (aq)	Copper	Copper
2	$CuSO_4$ (aq)	Copper	Platinum
3	$CuSO_4$ (aq)	Platinum	Copper

A 1 only

B 1 and 2 only

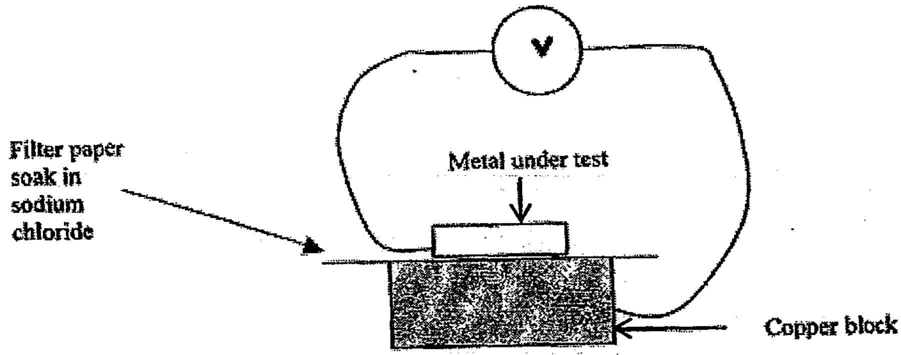
C 2 and 3 only

D 1, 2 and 3

23 A pupil tries to electroplate an iron ring with nickel. Which of the following combinations is correct?

	Electrolyte	Anode	Cathode
A	iron(II) sulfate solution	iron ring	nickel rod
B	iron(II) sulfate solution	nickel rod	iron ring
C	nickel(II) sulfate solution	iron ring	nickel rod
D	nickel(II) sulfate solution	nickel rod	iron ring

24 The apparatus shown below was used to compare the reactivity of metals, **P**, **Q**, **R** and **S**.



In each case, the voltmeter reading was recorded in the table shown below.

Metal under test	Direction of electron flow in external circuit	Voltage recorded / V
P	**P** to Cu	+0.87
Q	Cu to **Q**	-1.20
R	**R** to Cu	+1.58
S	**S** to Cu	+0.36

What is the correct order of the metals in **decreasing** reactivity (most reactive to least reactive)?

A **P, Q, R, S**

B **Q, S, P, R**

C **R, P, S, Q**

D **R, S, Q, P**

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

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

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

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

Which of the above statements are correct?

A 1, 2 and 3 **C** 1, 3 and 4

B 1, 2 and 4 **D** 2, 3 and 4

26 Flour mills producing rice flour constantly face a greater danger of explosions with naked flame than rice grains. What is the most likely reason for this?

A Flour mills contain methane which combine with the rice flour to form an explosive mixture

B Rice flour has a larger surface area than rice grains.

C Rice flour is more flammable than rice grains.

D Rice in powdered form acts as a catalyst for combustion.

27 When sodium thiosulfate reacts with dilute hydrochloric acid, a fine suspension of sulfur is formed. An experiment was carried out and the time taken for the suspension to appear was recorded at various temperatures in the table below.

Temperature / °C	Time taken / s
30	97
35	52
40	42
50	24

Which one of the following conclusions can be drawn from the results?

A The higher the temperature, the faster is the rate of formation of sulfur.

B The higher the temperature, the slower is the rate of formation of sulfur.

C The longer the time taken, the lower is the temperature rise of the reaction.

D The shorter the time taken, the higher is the temperature rise of the reaction.

28 Which of the following colour changes is **not** correct when sulfur dioxide is bubbled in the given test reagents?

	test reagents	colour changes
A	I_2 (aq) + KI (aq)	brown → violet
B	$Fe_2(SO_4)_3$ (aq)	yellow → green
C	$K_2Cr_2O_7$ (aq) + H_2SO_4 (aq)	orange → green
D	$KMnO_4$ (aq) + H_2SO_4 (aq)	purple → colourless

29 A weed-killer can be prepared by heating a bleach solution.

$$\underset{\text{bleach}}{3NaClO} \rightarrow 2NaCl + \underset{\text{weed-killer}}{NaClO_3}$$

What are the oxidation states of chlorine in these three compounds?

A	-1	-1	+5
B	+1	-1	+5
C	+1	-1	+7
D	+2	+1	+7

30 Which method(s) can be used to reduce carbon dioxide emissions into the atmosphere?

I.	Use electric cars
II.	Fit catalytic converters to cars
III.	Use natural gas for generating electricity

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

31 It was found that cars which were parked near a coal-fired power station often corroded more quickly.
Which gas, when present in above average levels in the air is a possible explanation for this?

A carbon dioxide
B oxides of nitrogen
C sulfur dioxide
D water vapour

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

- carbon monoxide
- carbon dioxide
- nitrogen monoxide
- nitrogen dioxide
- sulfur 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

33 In the Haber process, how is ammonia separated from the unreacted nitrogen and hydrogen gases?

A by cooling and compressing

B by diffusion

C by filtration

D by fractional distillation

34 Hydrogen will form water when passed over heated oxides of **P** and **Q**, but not when passed over the oxide of **R**. Furthermore, **Q** reduces the oxide of **P**.

From the given information, it can be deduced that the order of reactivity of the metals (from the most reactive to the least) is ______________.

A **P, Q, R**

B **Q, P, R**

C **R, P, Q**

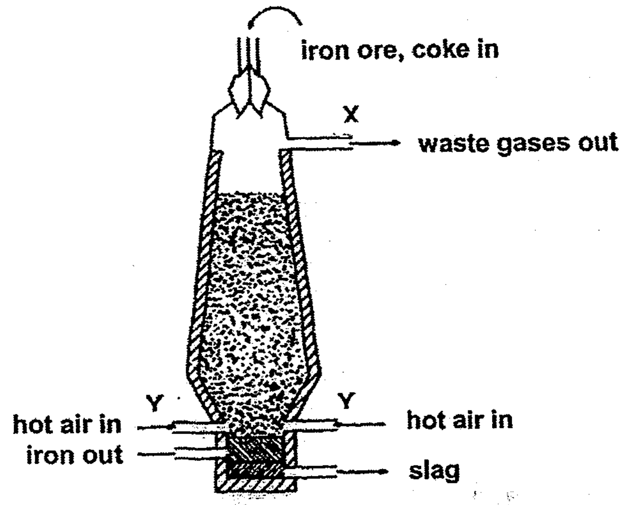
D **R, Q, P**

35 Metal **M** will displace copper from aqueous copper(II) sulfate solution, but will not displace iron from aqueous iron(II) sulfate solution. **M** is extracted from its oxide by heating the oxide with carbon.

Which of the following gives the **descending** order of reactivity of **M**, copper and iron, relative to sodium?

	most reactive	→		**least reactive**
A	sodium	metal **M**	iron	copper
B	sodium	iron	metal **M**	copper
C	copper	iron	metal **M**	sodium
D	copper	metal **M**	iron	sodium

36 The following diagram of a Blast Furnace has been **incorrectly** labelled.

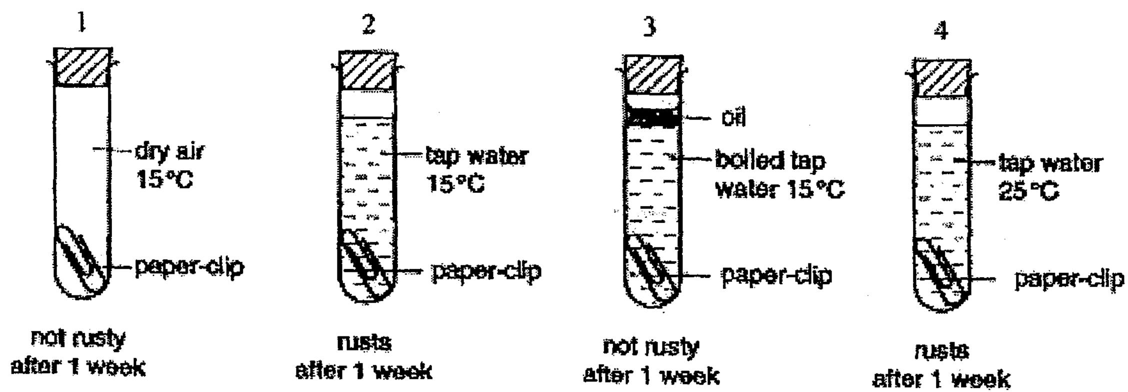


Which of the following modifications in the labelling should be made?

I Hot air should enter at **X** and waste gases should leave at **Y**.
II Iron ore, coke and limestone should be added at the top of the furnace.
III The slag should be above the iron.

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

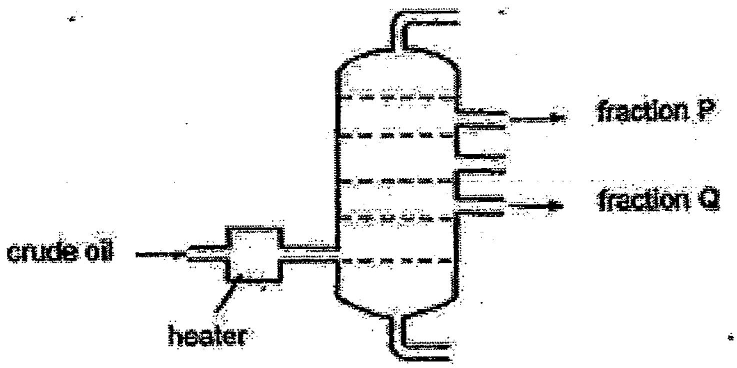
37 Four experiments on rusting are shown.



Which two experiments can be used to show that air is needed for iron to rust?

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

38 The diagram shows the fractional distillation of crude oil.



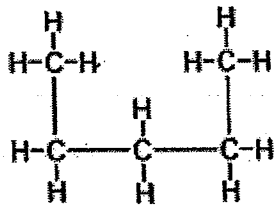
Which statements about the fractions **P** and **Q** are correct?

	P is more flammable than Q	**P has a higher boiling point than Q**	**P is more viscous than Q**
A	Yes	No	No
B	Yes	Yes	No
C	No	Yes	Yes
D	No	No	Yes

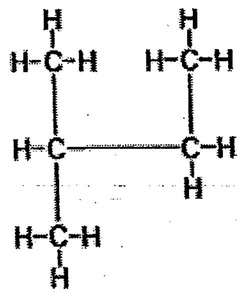
39 Which set contains the correct process for converting substance **X** to the products?

	substance X	**process**	**products**
A	alkanes	cracking	alkenes and hydrogen
B	carboxylic acid	combustion	carbon dioxide and hydrogen
C	ethanol	hydration	ethene and water
D	glucose	fermentation	ethanol and oxygen

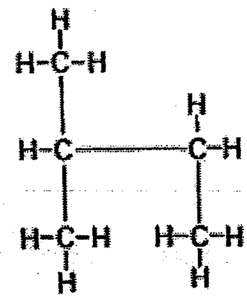
40 Five structural formulae are shown below.



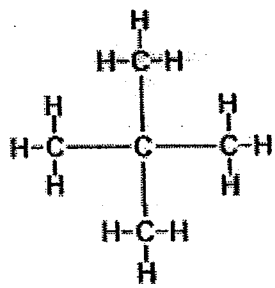
1



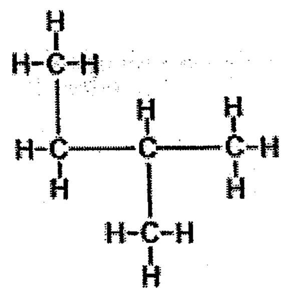
2



3



4



5

How many of the structures represent isomers of one another?

A 2

B 3

C 4

D 5

2014 Anderson Sec Chemistry Preliminary Exam

Paper 1

Answers

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

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 Sulphur 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 Rh Rhodium 45	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	Ac Actinium 89 †	Rf Rutherfordium 104	Db Dubnium 105	Sg Seaborgium 106	Bh Bohrium 107	Hs Hassium 108	Mt Meitnerium 109									

140 Ce Cerium 58	141 Pr Praseodymium 92	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 Lanthanum series
† 90–103 Actinium 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.).

ANDERSON SECONDARY SCHOOL
SCIENCE DEPARTMENT
PRELIMINARY EXAMINATION 2014

CANDIDATE NAME	

CLASS	4	/		INDEX NUMBER	

CHEMISTRY

Paper 2 Theory

5073/02
29th August 2014
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **All** questions.

Section B
Answer **THREE** questions, the last question is in the form of EITHER/ OR.
Write your answers on the writing papers provided.

At the end of the examination, fasten the separate Answer papers securely to the question paper.

The number of marks is given in the brackets [ ] at the end of each question or part question.
You may use a calculator.
A copy of the Periodic Table is printed on page 16.

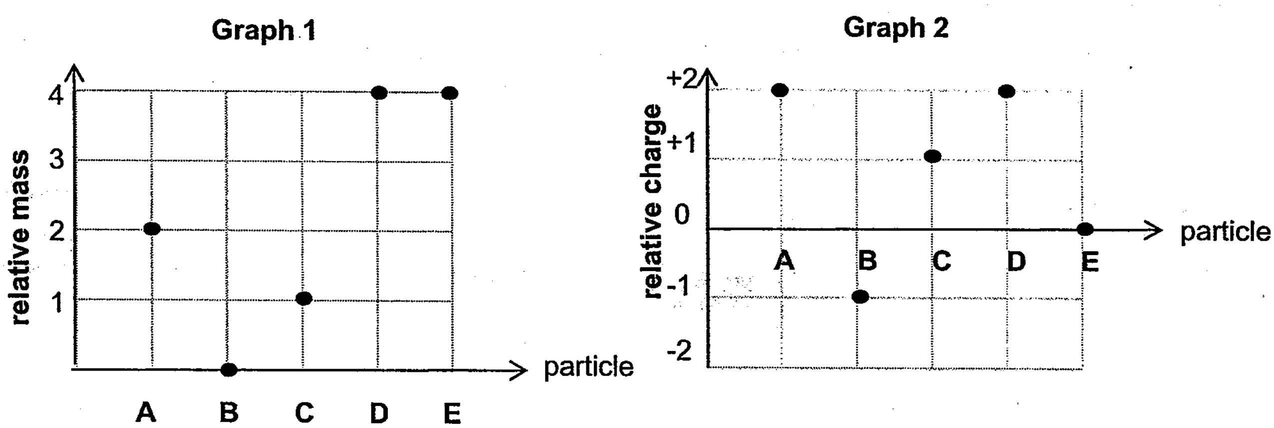
For Examiner's Use	
Section A	
Section B	
Total	

This document consists of ***16*** printed pages including this cover page.

Section A

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

A1 Use Graphs 1 and 2 to answer the following questions about particles **A** - **E**.



(a) Which particle is an electron? [1]

....

(b) Which particle could be made up of two protons but no neutrons in the nucleus? [1]

....

(c) Which particle could represent the nucleus of a helium atom? [1]

....

(d) Which combination of particles would produce a particle that has the same proton number as lithium? [1]

....

(e) Which two particles could represent the nuclei of isotopes? Explain how you deduce your answer, stating the number of particles present. [3]

....

....

....

....

[Total: 7 marks]

A2 The table below shows the effect of heat on some metal oxides.

Metal oxide	**Colour of oxide before heating**	**Effect of heating**
Mercury(II) oxide	red	oxygen evolved, silvery liquid remains
Lead(IV) oxide	brown	oxygen evolved, solid turns yellow
Zinc oxide	white	solid turns yellow on heating and becomes white on cooling
Iron(II) oxide	black	solid turns brown

(a) Which of these oxides are chemically unchanged when heated? [1]

....

(b) Write a balanced chemical equation to show the reaction that occurred when mercury(II) oxide was heated . [1]

....

(c) State the type(s) of reaction undergone by lead(IV) oxide and iron(II) oxide respectively on heating. [2]

....

....

(d) Zinc is found in the block of "transition elements" in the Periodic Table. However, it does not display characteristics that are typical of transition elements.

Using information from the table above, explain how ***two*** characteristics displayed by zinc differ from the typical characteristics of transition elements. [2]

....

....

....

....

[Total: 6 marks]

A3 There are two proposed methods to prepare CH_2BrCH_2Br.

Method 1: Ethene undergoes addition reaction with bromine.

$$CH_2{=}CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$$

Method 2: Ethane undergoes substitution reaction with bromine.

(a) Give the chemical name of CH_2BrCH_2Br. [1]

....

(b) Write a balanced chemical equation for **Method 2**, similar to that given for **Method 1** above. [1]

....

(c) A student commented, "**Method 1** would produce a higher percentage yield of CH_2BrCH_2Br than **Method 2**".

Explain why the student's comment is correct. [2]

....

....

....

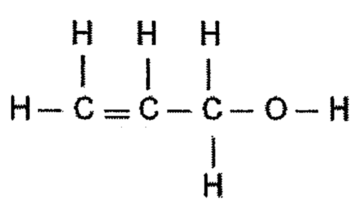
(d) State another advantage of using **Method 1**. [1]

....

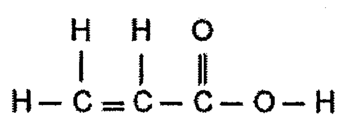
....

[Total: 5 marks]

A4 Two bottles containing the following chemicals were mixed up in the laboratory.



Compound A



Compound B

(a) To distinguish the chemicals, a laboratory worker added sodium carbonate separately to small portions of the aqueous solution of Compound **A** and Compound **B**.

(i) Explain the results that would be obtained in the test. [2]

....

....

....

....

(ii) Explain why aqueous solutions of the compounds were used in the test. [1]

....

....

(iii) One of the compounds produced a sodium salt in the test. Show the structural formula of this salt in the space below. [1]

(b) Compounds **A** and **B**, under the right conditions, polymerise to form a polymer with the monomer sequence, - A – B – A – B – A – B - , without any loss of material.

Give the full structural formula of the polymer formed. [1]

[Total: 5 marks]

A5 (a) Lithium is a group I element. Statements, 1 to 3, regarding the properties of lithium compounds, are given below.

1 Lithium chloride is soluble in water.
2 Lithium chloride is covalent in character.
3 Lithium oxide dissolves in water to form a solution with a pH of more than 7.

(i) Which one of the statements does not describe the typical properties of compounds of group I elements? Explain your answer. [2]

....

....

....

....

(ii) Describe a chemical test to show that a solution contains chloride ions. [2]

....

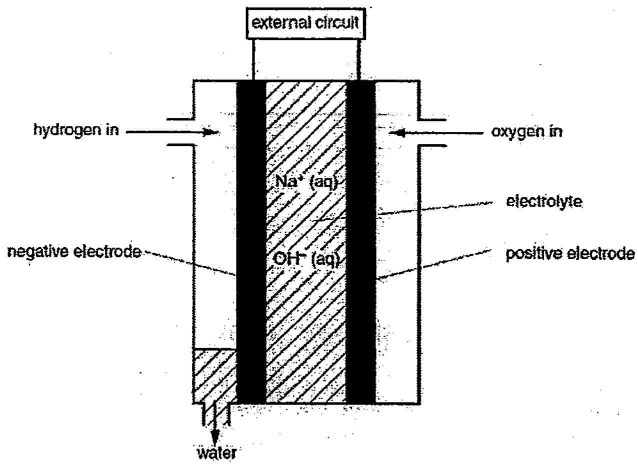
....

(b) Sodium is also a group I element. Put ticks (√) in the boxes below to show whether the given statements about sodium is/are true or false. [3]

	True	**False**
Sodium is made by reducing sodium oxide with carbon.		
Sodium has an oxidation state of +1 in the compound Na_2O_2.		
Sodium only conducts electricity when molten.		

[Total: 7 marks]

A6 The NASA space shuttle uses fuel cells to generate electricity. The diagram below shows a hydrogen-oxygen fuel cell.



At the positive electrode:

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

At the negative electrode:

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

(a) Is the positive electrode the cathode or anode? Explain your answer. [2]

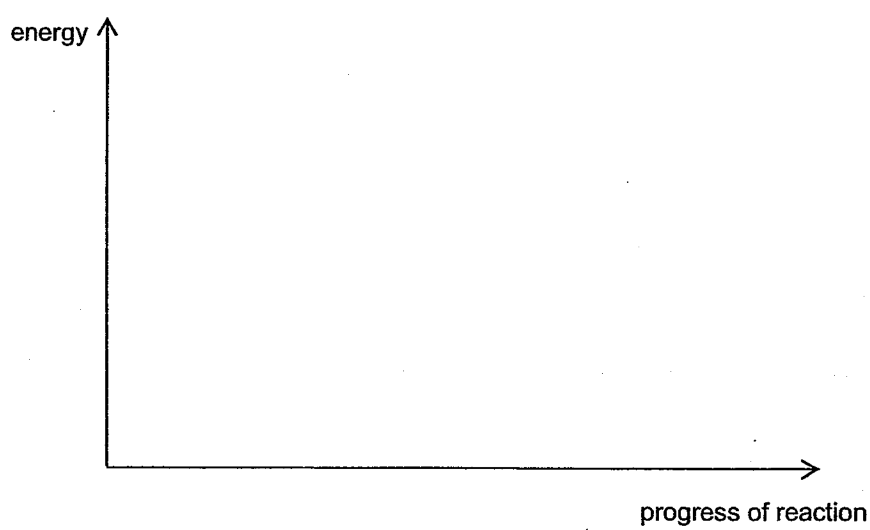
....

....

(b) Write a chemical equation for the overall reaction in the fuel cell. [1]

....

(c) Draw an energy profile diagram for the overall chemical reaction that occurred in the fuel cell. [2]



(d) (i) State an advantage and a disadvantage of using fuel cell over burning of coal to generate electricity. [2]

Advantage: ....

....

Disadvantage: ....

....

[Total: 7 marks]

A7 (a) For many years domestic rubbish has been disposed of in landfill sites. These sites produce a mixture of gases called landfill gas, which contains methane and carbon dioxide. Landfill gas is formed in many stages.

In one of the stages, methanoic acid and ethanoic acid are produced.

In the final stage, bacteria convert the organic acids into carbon dioxide and methane.

(i) Construct a balanced chemical equation for the bacterial action on ethanoic acid, forming methane and carbon dioxide. [1]

....

(ii) Calculate, using the bond energies given in the table below, the enthalpy change (ΔH) of the decomposition of ethanoic acid. [2]

Bond energy	**Bond energy (kJ/mol)**	**Bond energy**	**Bond energy (kJ/mol)**
C – H	413	C – O	358
O = O	495	C = O	799
O – O	146	O – H	463
C – C	348		

(iii) Explain **one** environmental problem that can arise from the emission of methane to the atmosphere. [2]

....

....

....

....

(b) Dengue fever is a cause of concern for the health authorities of tropical countries due to the high levels of rainfall. Health officers can commonly be seen spraying a layer of kerosene onto the surface of stagnant pools of water to kill mosquito larvae. With time, the layer of kerosene will slowly evaporate from the surface of water. Hence, re-spraying of kerosene is required.

(i) Explain, with reference to **two** physical properties of kerosene, how spraying a layer of kerosene on stagnant water can kill mosquito larvae. [2]

....

....

....

....

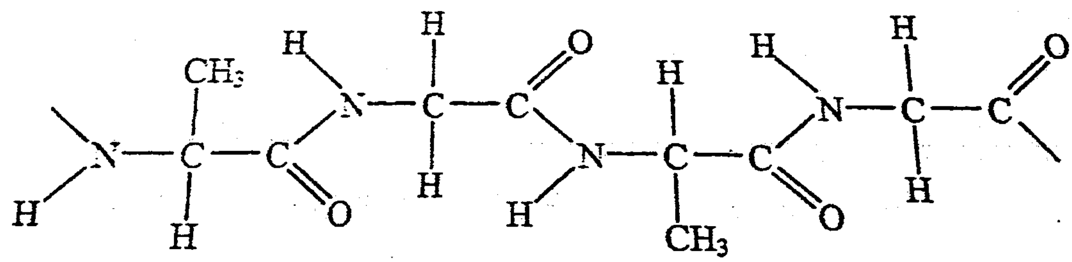
(ii) Suggest why kerosene is more suitable than petrol for spraying onto the water in the prevention of dengue. [1]

....

....

[Total: 8 marks]

A8 Hair is made up of long molecules of protein. The diagram below shows part of a protein molecule.



(a) Name the type of linkages that join the repeating units in the protein molecule. [1]

....

(b) Draw the structures of the monomers used to form this part of the protein molecule. [2]

(c) Name a synthetic polymer that has the same linkage as protein. [1]

....

(d) Why is this synthetic polymer a condensation polymer? [1]

....

....

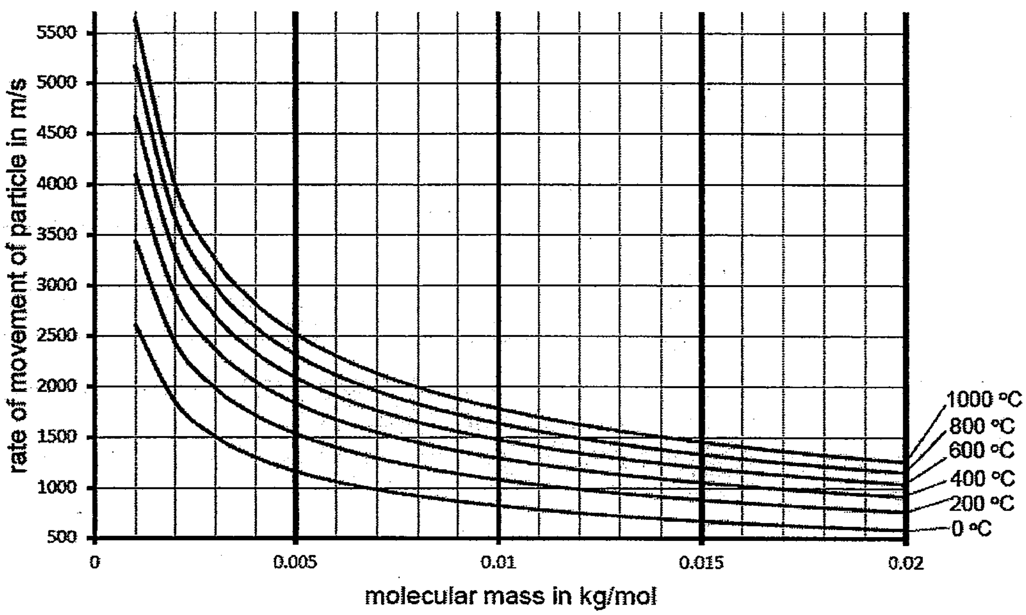
[Total: 5 marks]

Section B

Answer all **three** questions in this section.
The total mark for this section is 30.

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

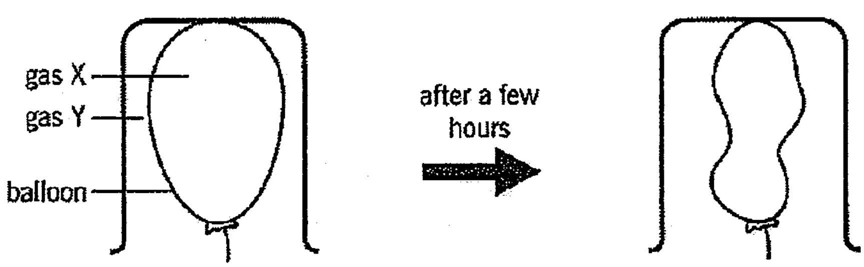
B9 (a) The graphs below show the relationship between the molecular mass of gases and the rate at which the gas particles move through air at different temperatures.



(i) Using information from the graph, describe the trends for the rate of movement of gas particles. [2]

(ii) What is the rate of movement of particle in a gas with molecular mass of 12 g/mol at 800°C? [1]

(b) A balloon filled with gas **X** is placed inside a beaker. The beaker is filled with gas **Y** as shown. After a few hours, the balloon shrinks in size.



Explain why the balloon shrinks in size. [2]

(c) The table below shows the solubility of four gases in water for a range of temperatures.

temperature/ °C	solubility in μmol/dm³			
	hydrogen	oxygen	methane	carbon dioxide
15	15.1	27.6	31.1	821
20	14.6	25.0	28.1	707
25	14.1	22.9	25.2	615
30	13.8	21.2	23.5	541
35	13.5	19.8	21.8	480

where $\mu = 1 \times 10^{-6}$

Nuclear reactions produce a lot of heat and some nuclear reactors make use of water as a coolant.

Using the information from the table, explain how warm water that is pumped out from nuclear reactors will affect the marine life in a river. [2]

(d) Silicon and carbon are Group IV elements. Both silicon and carbon form oxides that have similar chemical formula.

Unlike carbon dioxide, silicon(IV) oxide is not soluble in water.

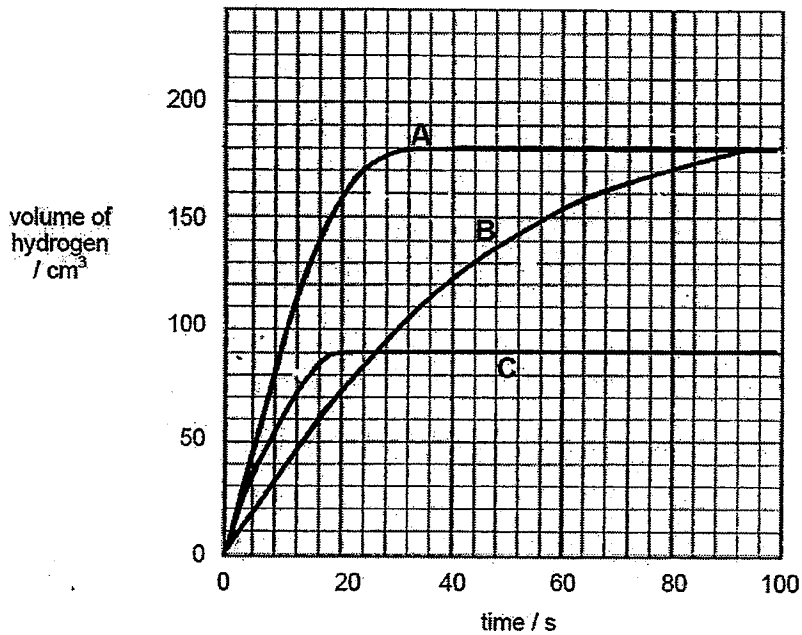
(i) Using the structure of silicon(IV) oxide, explain why it is not soluble in water. [2]

(ii) State a chemical property of silicon(IV) oxide that is similar to that of carbon dioxide. [1]

[Total: 10 marks]

B10 A student carried out two separate reactions between 0.488 g of zinc and two acids, hydrochloric acid and sulfuric acid. The volume and concentration of the acids used were both 20.0 cm^3 and 2.00 mol/dm^3 respectively. The curves **A** and **B** shown in the graph below show the results of the reactions.

He carried out a third reaction **C** with 20.0 cm^3 of a 2.00 mol/dm^3 acid, but forgot to weigh the mass of zinc as well as take note of which acid, hydrochloric acid or sulfuric acid, was used.



(a) With relevant calculations, explain why the same volume of gas was produced for both curve **A** and curve **B**. [3]

(b) Between curve **A** and **B**, identify the curve for the reaction that used sulfuric acid. Explain your choice. [2]

(c) In experiment **C**, identify the acid used and calculate the mass of zinc the student had used. [2]

(d) The student repeated experiment **C** using the same mass of zinc and the same volume and concentration of the acid, but this time, he added in a small amount of copper(II) sulfate crystals to the reaction mixture.

He noted that the effervescence was more vigorous and a brown deposit was formed. The volume of hydrogen collected was slightly less than in experiment **C**.

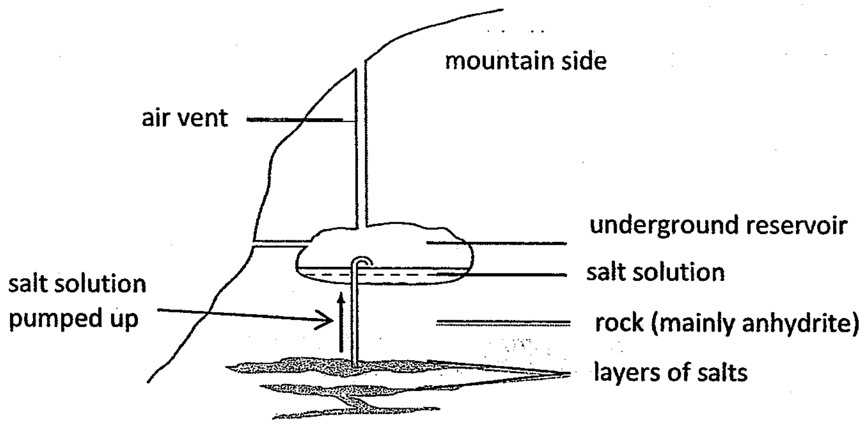
(i) Explain why less hydrogen was collected. [2]

(ii) The student concluded that copper(II) sulfate acted as a catalyst. Comment with a reason whether the student's conclusion is right or wrong. [1]

[Total: 10 marks]

B11 Either

The diagram below shows a salt mine in a mountain. It was found that the layers of salt consist of magnesium chloride and sodium chloride. These salts are dissolved in water from underground springs and then pumped up to a reservoir where it is stored as a solution.



(a) Suggest how the salts are recovered from the salt solution obtained. [1]

(b) Draw a dot and cross diagram to show the bonding in magnesium chloride. Show only the valence electrons. [2]

(c) Magnesium can be extracted from the molten magnesium chloride obtained from the mountain by electrolysis using graphite electrodes. Magnesium formed is tapped off.

(i) Why is the aqueous form of magnesium chloride **not** used for the electrolysis? [1]

(ii) Explain why there is no need to remove the sodium chloride impurity from magnesium chloride before the electrolysis. [1]

(iii) Suggest an advantage of not removing the sodium chloride impurity for the electrolysis of magnesium chloride. [1]

(iv) Write the half equations for the reactions that will occur at the electrodes. [2]

(d) The rock that surrounds the layers of salts is made up mainly of anhydrite. Pure anhydrite has the chemical formula, $CaSO_4$.

(i) Pure anhydrite can be made by reacting calcium hydroxide with sulfuric acid. Write a balanced chemical equation for this reaction. [1]

(ii) The spring water running through the rocks changes anhydrite into gysum ($CaSO_4.2H_2O$). This reaction is exothermic.

Use this information to explain why the temperature of the mine never falls below 17°C even in cold winters. [1]

[Total: 10 marks]

B11 OR

(a) Fertilisers are added to the soil to improve crop yields.

A farmer has the choice of three nitrogenous fertilisers: ammonium nitrate, NH_4NO_3, diammonium hydrogenphosphate, $(NH_4)_2HPO_4$, or urea, $CO(NH_2)_2$.

Show by calculations, which fertilisers provides the most nitrogen nutrient to the crops. [2]

(b) Ammonia, an important chemical in the fertilizer industry, is manufactured by the Haber process. State the optimum conditions for the manufacture of ammonia by the Haber process. [1]

(c) Diammonium hydrogenphosphate, $(NH_4)_2HPO_4$, can be prepared in the laboratory by the reaction between aqueous ammonia and phosphoric acid.

(i) Name the method used to prepare this salt from aqueous ammonia and phosphoric acid and explain why this method is used. [2]

(ii) Give the formulae of **two** other possible salts formed in the reaction between aqueous ammonia and phosphoric acid. [1]

(d) The farmer mixed up two bags of unlabelled fertilisers, one of which contains ammonium nitrate. He decided to test the fertilisers for nitrate ions.
Describe the chemical test for nitrate ions. [2]

(e) (i) Certain bacteria in the soil convert nitrogen gas into ammonium salts. The ionic equation for the conversion is as follows.

$$N_2 + 8H^+ + 6e^- \rightarrow 2NH_4^+$$

Explain in terms of oxidation states whether the conversion involves oxidation or reduction. [1]

(ii) In a similar reaction, a different type of bacterium converts nitrate ions in the presence of hydrogen ions into nitrogen gas and water.

Write a balanced ionic equation for this reaction. (State symbols are not required) [1]

[Total: 10 marks]

END OF PAPER

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 Sulphur 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 Rh Rhodium 45	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	Ac Actinium 89 †	Rf Rutherfordium 104	Db Dubnium 105	Sg Seaborgium 106	Bh Bohrium 107	Hs Hassium 108	Mt Meitnerium 109									

140 Ce Cerium 58	141 Pr Praseodymium 92	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 Lanthanum series
† 90–103 Actinium 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.).

Anderson Secondary School Chemistry Preliminary Exam 2014

Paper 2 (Marking Scheme)

Section A (50 marks)

A1(a)B [1]

(b) A [1]

(c) D [1]

(d) A and C / D and C [1]

(e) A and D [1]
Both have <u>same number of protons which is two</u> as they have the <u>same</u> relative charge (of 2+). [1]
Both have (<u>different number of neutrons</u>. A has no neutrons while D has 2 neutrons), as shown by their <u>different</u> relative masses. [1]

A2(a)zinc oxide [1]

(b) $2HgO \rightarrow 2Hg + O_2$ [1]

(c) Lead(IV) has undergone <u>thermal</u> decomposition [1]
iron(II) oxide has undergone oxidation [1]

(d) Zinc forms <u>white</u> oxide unlike of iron / mercury / transition elements form <u>coloured oxides/compounds</u>. [1]
Zinc exhibits a <u>fixed oxidation state of +2</u> / fixed charge of 2+ or +2 <u>in the oxide</u>, instead of <u>variable oxidation states</u> displayed by transition elements / mercury /iron <u>in the oxides/compounds</u>. [1]

A3(a)1,2-dibromoethane [1]

(b) $CH_3CH_3 + 2Br_2 \rightarrow CH_2BrCH_2Br + 2HBr$ [1]

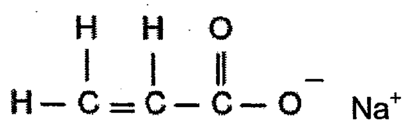
(c) **Method 1** produces <u>only one product</u> . [1]
Method 2 produces a mixture of <u>substituted / organic</u> products. [1]

(d) **Method 1** as it occurs at room conditions / temperature and pressure or does not require uv while **Method 2** requires presence of ultraviolet radiation / uv. So, **Method 1** is less costly / more energy saving / safer to carry out. [1]

A4(a)(i) Effervescence would be observed only in compound **B**.
Compound **A** is an *alcohol/contains hydroxyl group while **B** is a carboxylic acid/contains (carboxyl group, giving rise to acidic properties). Hence, only **B** can react with sodium carbonate to liberate carbon dioxide [2]

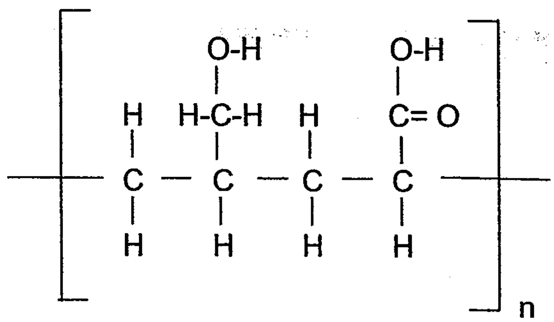
(ii) Water is needed for the dissociation / ionization of **B** or carboxylic acid to produce hydrogen ions / H^+, responsible for acidic properties. [1]

(iii)



[1]

(b)



[1]

(OR – the functional groups can be at adjacent carbon atoms or at the 1st and 4th carbon atoms in the chain)

A5(a)(i) Statement 2
Group I elements have one valence electron which is lost (readily) to form stable ions / to achieve stable noble gas electronic configuration. Hence, lithium chloride should be ionic in character /contain ions. [2]

(ii) Add acidified silver nitrate /(nitric acid and aqueous silver nitrate) to the solution. [1]
Chloride is present if a white precipitate is formed. (Reject ppt) [1]

(b) [3X1]

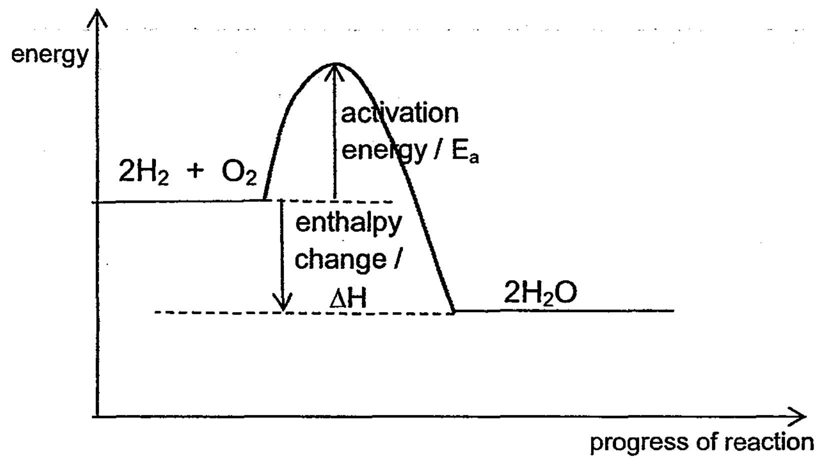
	True	False
Sodium is made by reducing sodium oxide with carbon.		√
Sodium has an oxidation state of +1 in the compound Na_2O_2.	√	
Sodium only conducts electricity when molten.		√

A6(a)Cathode as reduction occurred. [1]

The reaction involves a gain of electrons / oxygen gaining electrons / oxidation state or number of oxygen decreases from 0 (in O_2) to -2 (in OH^-). [1]

(b) $2H_2 + O_2 \rightarrow 2H_2O$ [1]

(c)



[2]

(d) Advantage: Water, the sole product of fuel cell, is harmless to the environment while pollutants (such as soot/carbon monoxide may be produced when coal is incompletely burnt) / (sulphur dioxide emitted as coal contains sulphur as impurities). [1]

Disadvantage: Hydrogen being a gas requires special storage arrangement as it has to be stored under high pressure unlike coal, a solid at room temperature.

[1]

A7(a)(i) $CH_3COOH \rightarrow CO_2 + CH_4$ [1]

(ii) Bonds broken: 3 C-H, 1 C-C, 1 C=O, 1 C-O and 1 O-H
Bonds formed: 2 C=O and 4 C-H

Energy absorbed to break bonds = [(3X413) + 348 + 799 + 358 + 463] kJ
= 3207 KJ

OR $\Delta H_{\text{bond-breaking}}$ = + 3207 kJ

Energy liberated to form bonds = [(2X799) + (4X413)] kJ
= 3250 kJ

OR $\Delta H_{\text{bond-froming}}$ = - 3250 kJ

ΔH = + 3207 - 3250 kJ
= - 43 kJ

[2]

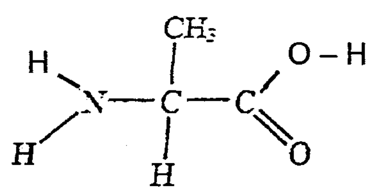
(iii) Methane is a greenhouse gas which traps heat/infrared radiation and will cause global warming / enhanced average global temperature. [1]
This will cause melting of polar ice-caps, leading to rising sea levels and *flooding of low-lying lands. (or other effects)
OR extreme weather such as droughts or typhoons, leading to destruction of crops or habitats/properties. [1]

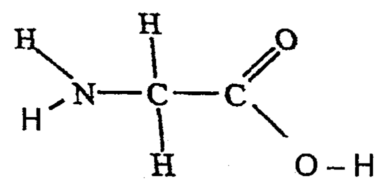
(b) (i) Kerosene is immiscible with water and being less dense than water, oxygen is insoluble in kerosene / it forms a impermeable/non-porous layer **over/on** the water surface, thus preventing the entry of air/oxygen required for the respiration/survival of the larvae. [2]

(ii) Kerosene has a higher boiling point / less volatile than petrol and evaporate more slowly, thus remaining longer on the water surface / less frequent re-spraying is needed. [1]

A8(a)Amide linkage [1]

(b)





[2X1]

(c) Nylon [1]

(d) When the monomers join, simple/small molecules, such as water, are removed. [1]

Section B (30 marks)

B9(a)(i) As the molecular mass of the gas increases, the rate of movement of the particle decreases at a fixed temperature. [1]
As the temperature of the gas increases, the rate of movement of the particles increases for a fixed molecular mass. [1]

(ii) 1500 m/s [1]

(b) Gas **X** is less dense / has lower molecular mass than gas **Y**.
Gas **X** diffuses **faster** out of the balloon than **Y** diffuses into the balloon.
This results in the gas pressure within the balloon to *decrease / lower than atmospheric pressure outside, causing the shrinkage to occur. [2]

(c) From the table, the higher the temperature, the lower the solubility of gases [1]
[OR the lower the solubility of oxygen and carbon dioxide]
Warm water from the nuclear plant pumped into the river would contain less oxygen for the respiration of marine organisms and less carbon dioxide for photosynthesis in plants, thus, destroying marine life.
[1]

(d) (i) Silicon(IV) oxide is a macromolecule, consisting of atoms joined by strong covalent bonds in a three dimensional network. [1]
A large amount of energy is required to break the strong covalent bonds. There is no/little attraction between water molecules and the atoms of silicon(IV) oxide / water molecules cannot surround the atoms . [1]

(ii) Silicon(IV) oxide is an acidic oxide / reacts with alkali to form salt and water only. [1]

B10(a) Solution 1

No. of moles of Zn = 0.488 / 65 = 0.00751

No. of moles of acid = 2.00 X (20/1000) = 0.04

Mole ratio of Zn to HCl = 1 : 1

Mole ratio of Zn to H_2SO_4 = 1 : 2

Hence, Zn is the limiting reactant.

For both reactions, 1 mol of Zn produces 1 mol of H_2, thus same volume of gas were produced in the experiments.

Solution 2

No. of moles of Zn = 0.488 / 65 = 0.00751

No. of moles of acid = 2.00 X (20/1000) = 0.04

From the graph, volume of H_2 produced is 180 cm^3

No. of moles of H_2 produced is (180 / 24000) = 0.0075

No. of mole of H_2 produced = No. of mole of Zn reacted,

Zn is the limiting reactant, producing the same volume of gas in both experiments.

[3]

(b) Curve **A** used sulfuric acid.
Sulfuric acid contains twice the / higher H^+ concentration than hydrochloric acid. Thus, sulfuric acid reacted faster with the zinc, as shown by the steeper gradient of curve **A**. [2]

(c) Acid used in **C** is sulfuric acid.

Volume of hydrogen gas (from graph) = 90 cm^3

No. of moles of hydrogen gas = 90/24000 = 3.75×10^{-3}
Mass of zinc = $3.75 \times 10^{-3} \times 65$ g = 0.244 g (to 3 s.f.)

OR Since 0.488 g zinc produced 180 cm^3 of hydrogen gas (from graph), (0.488 ÷ 2) = 0.244 g of zinc was used.

[2]

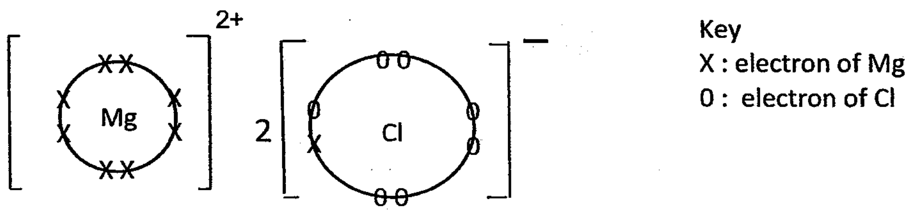
(d) (i) Zinc is more reactive than copper. Some of the zinc is used up to displace copper from the copper(II) sulfate / reacts with copper(II) sulfate to form copper and zinc sulfate.
Hence, less zinc is available to react with the acid to produce hydrogen. [2]

(ii) Wrong
Catalyst is recovered chemically unchanged at the end of the reaction. Copper(II) sulfate had reacted to form copper. (Allow ECF frong wrong reaction stated in part (i) [1]

B11 Either

(a) Heat / Evaporation to dryness [1]

(b)



[2]

(c) (i) Aqueous salt contains hydrogen ions / H^+ which will be discharged/reduced preferably to Mg^{2+}, forming hydrogen gas instead of magnesium. [1]

(ii) Mg^{2+} is preferentially discharged/reduced over Na^+ during electrolysis. [1]

(iii) Sodium chloride impurity lowers the melting point of magnesium chloride so less energy will be needed to obtain / maintain the molten salt. [1]

(iv) Cathode: $Mg^{2+} (l) + 2e^- \rightarrow Mg (l)$ [1]

Anode: $2Cl^- (l) \rightarrow Cl_2 (g) + 2e^-$ [1]
(Award max of 1 m if electrodes are not specified)

(d) (i) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$ [1]

(ii) The heat liberated by the reaction to the surroundings leads to temperature rise and this prevents the temperature from falling further.

[1]

B11 OR

(a)

	NH_4NO_3	$(NH_4)_2HPO_4$	$CO(NH_2)_2$
% N by mass	(28/80) X100 % = 35.0 %	(28/132) X 100 % = 21,2 %	(28/60) X 100 % = 46.7 %

(Working must be shown. Deduct max of ½ m for no 3 s.f.)
Urea / $CO(NH_2)_2$ provides the most nitrogen. [2]

(b) Conditions: 450°C, 250 atm and iron as catalyst [1]

(c) (i) Titration because the salt and the starting materials are soluble (in water). Using indicator, the exact volumes of acid and alkali needed for complete neutralization can be determined. Hence a pure salt can be obtained. [2]

(ii) $NH_4H_2PO_4$ and $(NH_4)_3PO_4$ [1]

(d) Add aqueous sodium hydroxide and aluminium to the fertilizer. [1]

On warming, ammonia gas which turns damp red litmus paper blue will be liberated if nitrate ion is present. [1]

(e) (i) Reduction occurs because oxidation state of nitrogen decreases from 0 (in N_2) to -3 (in NH_4^+). (Award ½ m if oxidation states are stated without the substances) [1]

(ii) $2NO_3^- + 12H^+ + 10e^- \rightarrow N_2 + 6H_2O$ [1]

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination 3
Secondary 4

A

CHEMISTRY

5073/2

Paper 2

17 September 2014

1 hour 45 minutes

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any rough working. You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE ON THE MARGINS.
A copy of the Periodic Table is printed on page 13.

Section A
Answer all questions in the spaces provided.

For examiner's use only: **Section A** **/ 50**

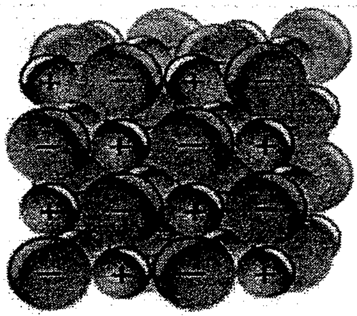
At the end of the examination, fasten all your work for each section securely together.
Hand in each section separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **13** printed pages, **including** this cover page.
Page 12 has been intentionally left blank.

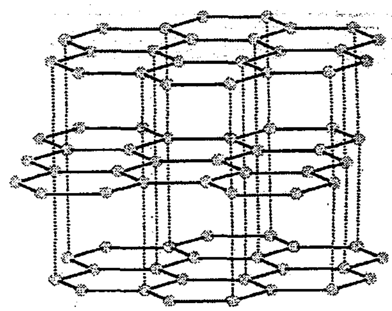
[Turn over]

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

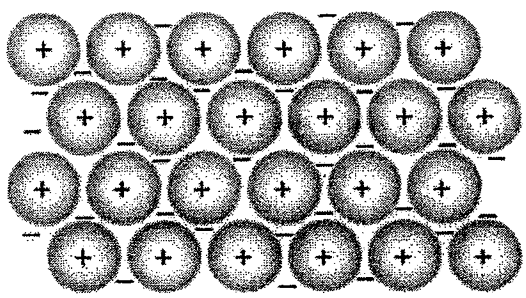
A1 Four structures of solids are shown below.



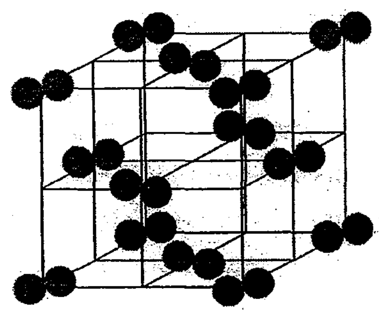
Structure A



Structure B



Structure C



Structure D

Use the letters **A**, **B**, **C** and **D** to answer parts **(a)** to **(e)**. Each letter can be used once, more than once, or not at all.

(a) Which of the above structures best represents lithium bromide? **[1]**

____

(b) Which of the above structures best represents iodine? **[1]**

____

(c) State all the structures above which represent substances that conduct electricity because of the presence of mobile electrons. **[1]**

____

Question 1 continues...

(d) Which of the structures represents the material that is best used as the anode during the electroplating of copper? **[1]**

____

(e) Some of the structures represent substances that have high melting points. State the letters of **two** of these structures and explain why they have high melting points, in terms of the bonding present in them. **[4]**

Structure: __________

Explanation: ______________________________________

____

____

____

Structure: __________

Explanation: ______________________________________

____

____

____

[Total marks: 8]

A2

A "barium meal" is used in radiology to improve X-ray images of the gastrointestinal tract (the gut). It also helps to observe digestion and to detect ulcers and tumours in the stomach.

The "barium meal" is administered to the patient as follows:

(i) The patient takes some citric acid and sodium hydrogen carbonate (**$NaHCO_3$**) tablets. This produces a salt (sodium citrate), water and an acidic gas which helps to expand the stomach and gut walls.

(ii) The patient drinks a suspension of barium sulfate, which will not be absorbed by the body.

(iii) Barium sulfate prevents X-rays from passing through and thus images can be clearly seen.

(a) State the word or phrase in the information given above which tells you that barium sulfate is insoluble in water. **[1]**

____

(b) Describe a chemical test to confirm the identity of the gas produced in step **(i)**. **[2]**

____

____

(c) Describe briefly how a pure, dry sample of barium sulfate can be prepared in the laboratory. Include the names of the reagents in your answer. **[3]**

____

____

____

____

____

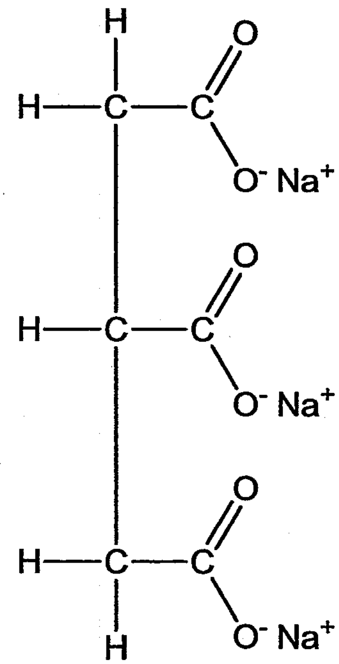
Question 2 continues...

(d) Suggest why barium chloride should not be taken by the patient in place of barium sulfate. **[1]**

____

____

(e) Sodium citrate is formed in step **(i)**. It has the following structure:



By referring to the structure of sodium citrate, draw the structure of citric acid. **[1]**

[Total marks: 8]

A3 The following information was found on a 100PLUS can:

NUTRITIONAL INFO

Serving per package: 1 Serving size: 325ml

	Per serving	Per 100ml
Energy	370 kj	113 kj
	88 kcal	27 kcal
Total fat	0 g	0 g
Protein	0 g	0 g
Carbohydrate	22.1 g	6.8 g
- Sucrose	15.6 g	4.8 g
- Glucose	6.5 g	2.0 g
Sodium	156 mg	48 mg
Potassium	46 mg	14 mg
Calcium	2 mg	0.6 mg
Chloride	127 mg	39 mg
Phosphate	55 mg	17 mg

These substances exist as **aqueous ions** in the mixture (1 g = 1000 mg)

Ingredients: Carbonated water, sucrose, glucose, citric acid, sodium citrate, sodium chloride, potassium phosphate, citrus flavouring, preservative (sodium benzoate E211) and calcium phosphate.

(a) The "citrus flavouring" found in the ingredients of 100PLUS is artificially made in the laboratory. Suggest a homologous series of organic compounds that this artificially-flavoured compound could belong to: ______________ **[1]**

(b) Calcium ions and phosphate (V) ions, $\mathbf{PO_4^{3-}}$, are found in 100PLUS. State the chemical formula of calcium phosphate. **[1]**

____

(c) Suggest the name or formula of a positive ion which is also found in 100PLUS, but not listed in the table above: ______________ **[1]**

(d) Calculate the concentration of potassium ions in **mol/dm^3** per can (serving) of 100PLUS. **[2]**

Question 3 continues...

(e) By referring to the masses of sodium and chloride ions in the table, show by calculation that there are compounds of sodium other than sodium chloride. **[2]**

(f) A student wanted to remove **all** the chloride ions in a can (serving) of 100PLUS by adding 1 mol/dm^3 of aqueous lead(II) nitrate to form a precipitate of lead(II) chloride.

(i) What is the **minimum** volume of aqueous lead(II) nitrate he should add? **[2]**

(ii) The student then proceeded to add excess aqueous lead(II) nitrate and found that the mass of the precipitate formed was larger than expected. Suggest why. **[1]**

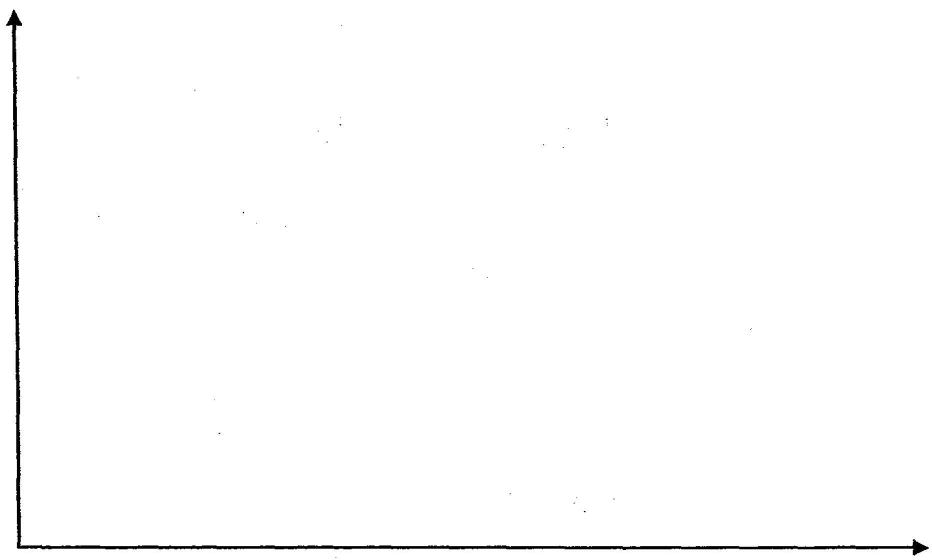
___

Question 3 continues...

(g) The energy which a can (serving) of 100PLUS provides comes from the breaking down of the carbohydrates (sucrose and glucose) in our bodies. This can be represented by the unbalanced equation:

$$C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O \qquad \Delta H < 0$$

Draw an energy profile diagram of the above reaction. Label clearly the axes, reactants, products, activation energy and enthalpy change. **[3]**



(h) Explain why the reaction in part **(g)** is an exothermic reaction, in terms of bond-breaking and bond-forming. **[2]**

[Total marks: 15]

A4 Petrol and naphtha are two fractions obtained from the fractional distillation of petroleum. They contain the following hydrocarbons:

Fraction	Hydrocarbons
Petrol	Alkanes containing 5 to 8 carbon atoms
Naphtha	Alkanes containing 9 to 12 carbon atoms

(a) Describe how petroleum is separated by fractional distillation. **[3]**

____

____

____

(b) Octane is one of the alkanes found in petrol. Octane contains 8 carbon atoms and can be cracked to form propane and another hydrocarbon **X**.

(i) Write a balanced chemical equation for this reaction, stating the actual molecular formula of **X**. **[1]**

____

(ii) Describe how propane and **X** can be distinguished from each other by using aqueous bromine. **[2]**

____

____

____

(c) A different hydrocarbon, **Y**, is known to belong to <u>either the petrol or naphtha fractions</u>.
A student wishes to find out which fraction **Y** belongs to by comparing the physical properties of **Y** and octane.
State a relevant physical property, <u>other than relative molecular mass</u>, and describe how this property can be used to determine which fraction **Y** belongs to. **[2]**

____

____

____

(d) Methane is also found in petroleum fractions.
Methane is able to undergo a reaction with chlorine and fluorine to form $\mathbf{CCl_2F_2}$.

(i) State the **type** of reaction methane undergoes to form $\mathbf{CCl_2F_2}$, and state the condition required. **[2]**

____

____

(ii) Draw a dot-and-cross diagram to represent the bonding in $\mathbf{CCl_2F_2}$. Show only the outermost electrons. **[2]**

(iii) Describe how $\mathbf{CCl_2F_2}$ affects the environment and state one harmful effect it causes. **[2]**

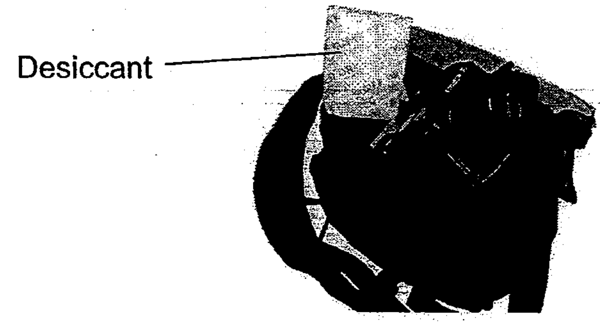
____

____

____

[Total marks: 14]

A5 Desiccants are dehydrating agents which absorb water vapour from the surroundings. Desiccants have important applications, e.g. in the storing of electronic equipment such as cameras:



The desiccant absorbs moisture, preventing fungal growth on the camera lens. Common desiccants include silica gel, phosphorus pentoxide and calcium oxide.

(a) Silica gel is a form of silicon dioxide and can absorb up to 25% of its own mass of water before it becomes saturated. Suggest how saturated silica gel can be recycled. **[1]**

____

____

(b) Phosphorus pentoxide (**P_4O_{10}**) can be manufactured by burning red phosphorus (**P_4**) in oxygen. Construct a balanced chemical equation for this reaction. **[1]**

____

(c) Phosphorus pentoxide is a very powerful desiccant and absorbs water readily. However, it becomes corrosive after absorbing moisture.
Explain why phosphorus pentoxide becomes corrosive after absorbing moisture. **[2]**

____

____

____

(d) Phosphorus pentoxide reacts with calcium oxide. State the name of this type of reaction. **[1]**

____

[Total marks: 5]

- End of Section A –

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	– 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 (top) / X (centre) / b (bottom)
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.).

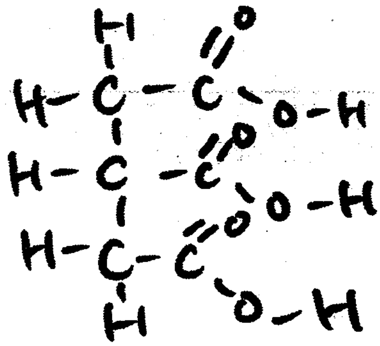
2014 Prelim 3 Answers

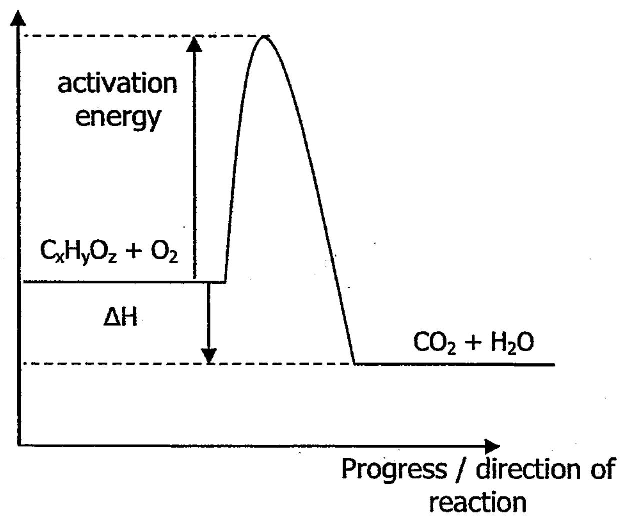
Paper 1

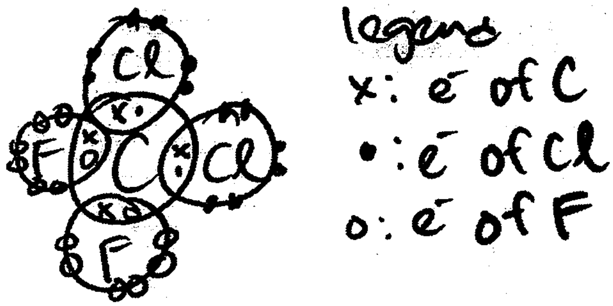
1 A	2 C	3 C	4 B	5 A	6 D	7 C	8 D	9 B	10 C
11 C	12 C	13 C	14 B	15 A	16 B	17 D	18 B	19 C	20 B
21 D	22 D	23 A	24 C	25 D	26 B	27 C	28 B	29 D	30 A
31 B	32 A	33 C	34 D	35 B	36 B	37 D	38 D	39 C	40 C

Paper 2 Section A

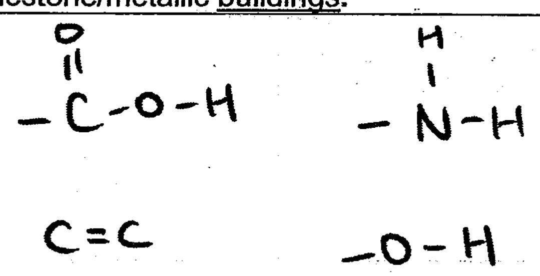
	Marking scheme
A1a)	A
b)	D
c)	B, C
d)	C
e)	ANY TWO: • Structure A • Strong electrostatic forces of attraction between ions **AND** • requiring a lot of heat/energy to overcome • Structure B • Strong covalent bonds between atoms **AND** • requiring a lot of heat/energy to overcome • Structure C • Strong electrostatic forces between positive ions and sea of mobile, delocalised electrons **AND** • requiring a lot of heat/energy to overcome
A2a)	Suspension
b)	Bubble the gas into limewater. Gas forms a white precipitate with limewater
c)	• Add aqueous barium nitrate to aqueous sodium sulphate • Filter the mixture and collect residue • Wash residue with distilled water **AND** • Press dry between sheets of filter paper **OR** • React barium carbonate with dilute nitric acid. Add dilute sulfuric acid • Filter and collect residue • Wash with distilled water and press dry

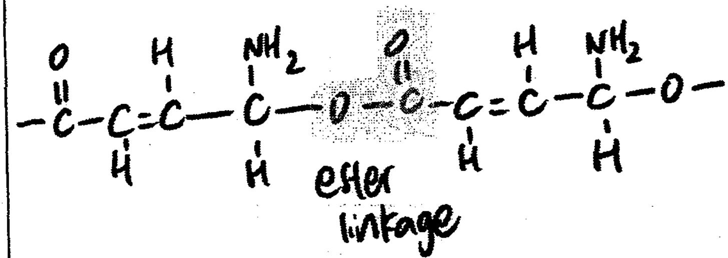
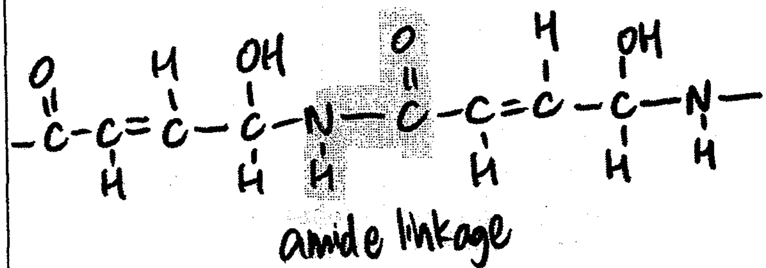
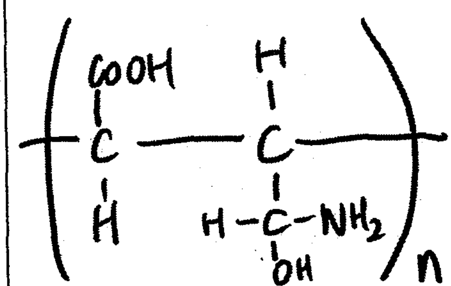
d)	Barium chloride is <u>soluble</u> and can be <u>absorbed</u> by the body
e)	
A3a)	Esters
b)	$Ca_3(PO_4)_2$
c)	H^+ / hydrogen
d)	No. of mol of potassium ions = (46/1000) / 39 = 0.00118 mol Concentration = 0.00118 / (325/1000) = 0.00363 mol/dm^3 (3sf)
e)	No. of mol of sodium ions = (156/1000) / 23 = 0.00678 mol **AND** No. of mol of chloride ions = (127/1000) / 35.5 = 0.00358 mol For every mol of NaCl, no. of mol of Na^+ = no. of mol of Cl^-. Since there are <u>more mol of Na^+ ions than Cl^-</u>, there are other compounds of sodium.
fi)	No. of mol of chloride ions = (127/1000) / 35.5 = 0.00358 mol No. of mol of lead (II) ions needed to form a precipitate with all chloride ions = 0.00358/2 = 0.00179 mol No. of mol of lead (II) nitrate = no. of mol of lead (II) ions = 0.00179 mol

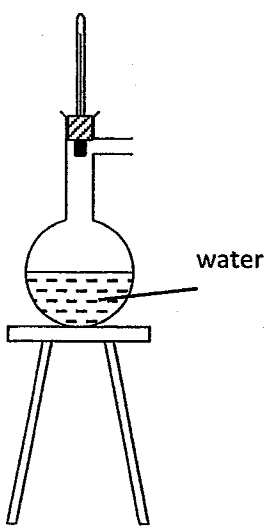
	Volume of lead (II) nitrate = (0.00179/1) x 1000 = 1.79 cm^3
fii)	Lead (II) phosphate is also insoluble and is formed as a precipitate
g)	 Correct shape, i.e. energy of products less than reactants • Labels • Activation energy • Enthalpy change • Reactants and products
h)	• Energy released when bonds in CO_2 and H_2O are formed • Is greater than • Energy absorbed to break bonds in $C_xH_yO_x$ and O_2
A4a)	• Whole mixture is heated into a vapour • Vapour is passed into a fractionating column where the column is cooler at the top and hotter at the bottom • Each fraction condenses according to its different boiling points • The smaller hydrocarbons are collected at the top, the larger ones at the bottom
bi)	$C_8H_{18} \rightarrow C_3H_8 + C_5H_{10}$
ii)	Bubble propane and X into separate test tubes of aqueous bromine X turns brown aqueous bromine colourless while aqueous bromine remains brown when propane is bubbled

c)	ANY ONE: Melting/boiling poin If Y has a higher melting/boiling point, it belongs to naphtha. If it has a lower melting/boiling point, it belongs to petrol Flammability If Y is more flammable, it belongs to petrol. If it is less flammable, it belongs to naphtha Viscosity If Y is more viscous, it belongs to naphtha. If it is less viscous, it belongs to petrol
di)	Substitution. Ultraviolet light
ii)	
iii)	It will decompose under ultraviolet light to form chlorine atoms, which breaks down ozone to oxygen, increasing the amount of ultraviolet radiation Skin cancer / eye cataract
A5a)	Heat saturated silica gel to evaporate the water
b)	$P_4 + 5O_2 \rightarrow P_4O_{10}$
c)	Phosphorus pentoxide is an oxide of phosphorus, a non-metal Oxides of non-metals tend to be acidic, dissolving in water to form acids
d)	Neutralisation / acid-base

Paper 2 Section B

	Marking scheme
B6ai)	• The rate of the reaction doubles when the concentration of Br_2 doubles. • From experiment 1 and 2, the rate of reaction increases from 0.007 mol/dm^3 s to 0.014 mol/dm^3 s when the concentration increases from 0.001 mol/dm^3 to 0.002 mol/dm^3
aii)	First order reaction
bi)	• The rate of the reaction increases by 4 times when the concentration of $C_6H_5NH_2$ doubles. • From experiment 3 and 4, the rate of reaction increases from 0.021 mol/dm^3 s to 0.084 mol/dm^3 s when the concentration increases from 0.001 mol/dm^3 to 0.002 mol/dm^3
bii)	Second order reaction
c)	0.028 mol/dm^3 s
d)	• Increased concentration increases the number of particles per unit volume • Increase in frequency of effective/successful collisions • Increases the speed of reaction
e)	I do not agree as sulfuric acid only acts as an oxidising agent in step 2. **In step 1:** • Sulfuric acid is not an oxidising agent. • There is no change in the oxidation state of any element. **In step 2:** • Sulfuric acid is an oxidising agent. • It causes the oxidation state of bromine to increase from -1 in HBr to 0 in Br_2
f)	Sulfur dioxide is produced. It will dissolve in rainwater to form acid rain, corroding limestone/metallic buildings.
B7a)	
bi)	A process where two or more monomers react to form a large molecule and a small molecule such as water is eliminated.

bii)	 
c)	
EITHER **B8a)**	The student is correct if the metal is a group I metal as all group I chlorides are soluble. Mobile ions are present OR The student is incorrect if the metal is silver metal as Ag*Cl* is insoluble. No mobile ions are present
b)	X: negative terminal Y: positive terminal
ci)	Electrode P : $2H^+(aq) + 2e^- \rightarrow H_2(g)$ Effervescence of a colourless gas will be seen.
cii)	Hydrogen ions are discharged/reduced at the cathode and hydroxide ions are discharged/oxidised at the anode. The rate at which hydrogen ions are discharged at the cathode is the same as the rate at which hydroxide ions are discharged at the anode. **OR** the concentration of hydrogen and hydroxide ions remains equal at the end of electrolysis.
d)	**$2H^+(aq) + 2e^- \rightarrow H_2(g)$** No. of mol of H_2 gas produced = 300 / 24000

	= 0.0125 mol No. of mol of H_2: No. of mole of e^- 1 : 2 0.0125 mol : 0.025 mol **$Li^+(l)$ + e^- → Li(s)** No. of mol of Li: No. of mole of e^- 1 : 1 0. 025 mol : 0.025 mol Relative atomic mass of metal M = 0.175 / 0.025 = 7 Metal M is Lithium.
OR B8	
a)	Mercury, nickel, zinc, magnesium
bi)	• (Grey) Magnesium dissolves • Green solution turns colourless • Silvery solid forms
bii)	$Mg (s) + Ni^{2+} (aq) \rightarrow Mg^{2+} (aq) + Ni (s)$
ci)	
cii)	$ZnO + H_2O \rightarrow ZnO + H_2$
ciii)	Green solid turns silver. ($NiO + H_2 \rightarrow Ni + H_2O$) <u>Green nickel(II) oxide</u> has been <u>reduced by hydrogen</u> to form <u>silver nickel metal</u>.

civ)	$ZnO + H_2O \rightarrow ZnO + H_2$ No. of mol of Zn used = 10 / 65 = 0.15385 mol No. of mol of Zn: No. of mole of H_2 produced 1 : 1 0.15385 mol : 0.15385 mol $NiO + H_2 \rightarrow Ni + H_2O$ Mass of Ni produced = 18 – 10 = 8g No. of mol of Ni produced = 8 / 59 = 0.13559 mol No. of mol of Ni: No. of mole of H_2 used 1 : 1 0. 13559 mol : 0. 13559 mol No. of mole of excess H_2 = 0.15385 – 0.13559 = 0.01826 mol Volume of = 0.01826 x 24 = 0.438 dm^3 (438 cm^3)

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination 3
Secondary 4

B

CHEMISTRY

5073/2

Paper 2

17 September 2014

1 hour 45 minutes

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any rough working. You may use a calculator.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE ON THE MARGINS

Section B
Answer all questions in the foolscap paper provided.

For examiner's use only: **Section B** **/ 30**

At the end of the examination, fasten all your work for each section securely together.
Hand in each section separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **7** printed pages, **including** this cover page.
Page 8 has been intentionally left blank.

[Turn over]

Section B (30 marks)

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

B6 This is a question about the two methods that can be used to manufacture HBr.

Method 1: Reaction of amine with bromine

Reaction: $C_6H_5NH_2 + 3Br_2 \rightarrow C_6H_2NH_2Br_3 + 3HBr$

The initial rate of this reaction was determined using different concentrations of the reactants as shown in the following experiments.

Experiment No.	Concentration of $C_6H_5NH_2$ (mol/dm^3)	Concentration of Br_2 (mol/dm^3)	Initial rate of reaction (mol/dm^3 s)
1	0.001	0.001	0.007
2	0.001	0.002	0.014
3	0.001	0.003	0.021
4	0.002	0.003	0.084
5	0.003	0.003	0.189

Table 1

From the data in *Table 1*, changes in the concentration of each reactant affect the rate of reaction differently. Knowing how the rate is affected by the concentration of each reactant will allow us to predict the rate of reaction.

Depending on how the rate is affected by concentrations of each reactant, we can classify reactions into the following two types.

Type of reaction	Characteristic	Example
1. First order reaction with respect to reactant **A**	The *rate* of reaction is *proportional* to the *concentration of* **A**	If you double the concentration of **A**, the rate doubles as well. If you increase the concentration of **A** by a factor of 4, the rate goes up 4 times as well.
2. Second order reaction with respect to reactant **A**	The *rate* of reaction is *proportional* to the *square of the concentration of* **A**	If you doubled the concentration of **A**, the rate would go up 4 times (2^2). If you tripled the concentration of **A**, the rate would increase 9 times (3^2).

Table 2

Method 2: Reaction of solid bromide with concentrated sulfuric acid

Step 1: $Br^- + H_2SO_4 \rightarrow HBr + HSO_4^-$
Step 2: $2HBr + H_2SO_4 \rightarrow Br_2 + 2H_2O + SO_2$

HBr can be obtained from *Step 1*. However, *Step 2* may occur if H_2SO_4 is used in excess.

Method 1

(a) (i) Using information from *Table 1*, describe how the rate of reaction changes as the concentration of $\mathbf{Br_2}$ changes. [2]

(ii) Determine the order of reaction with respect to $\mathbf{Br_2}$. [1]

(b) (i) Using information from *Table 1*, describe how the rate of reaction changes as the concentration of $\mathbf{C_6H_5NH_2}$ changes. [2]

(ii) Determine the order of reaction with respect to $\mathbf{C_6H_5NH_2}$. [1]

(c) Determine the rate of reaction when concentration of $\mathbf{C_6H_5NH_2}$ is 0.002 mol/dm^3 and concentration of $\mathbf{Br_2}$ is 0.001 mol/dm^3. [1]

(d) Use ideas about collisions between particles to explain the effect of concentration on the speed of reaction. [2]

Method 2

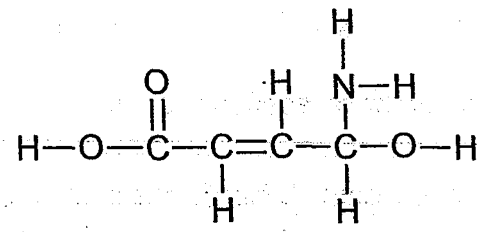
(e) A student claimed that concentrated sulfuric acid functions as an oxidising agent in both steps.

Do you agree with the student? Explain in terms of oxidation states for both steps 1 and 2. [2]

(f) It is not environmentally friendly to produce **HBr** via method 2. Suggest a reason why. [1]

[Total marks: 12]

B7 The structure of an organic compound **Z** is shown below.



(a) Draw all the functional groups in compound **Z**. **[2]**

(b) Under suitable conditions, molecules of compound **Z** undergo condensation polymerisation to form more than one possible polymer.

(i) Define condensation polymerisation. **[2]**

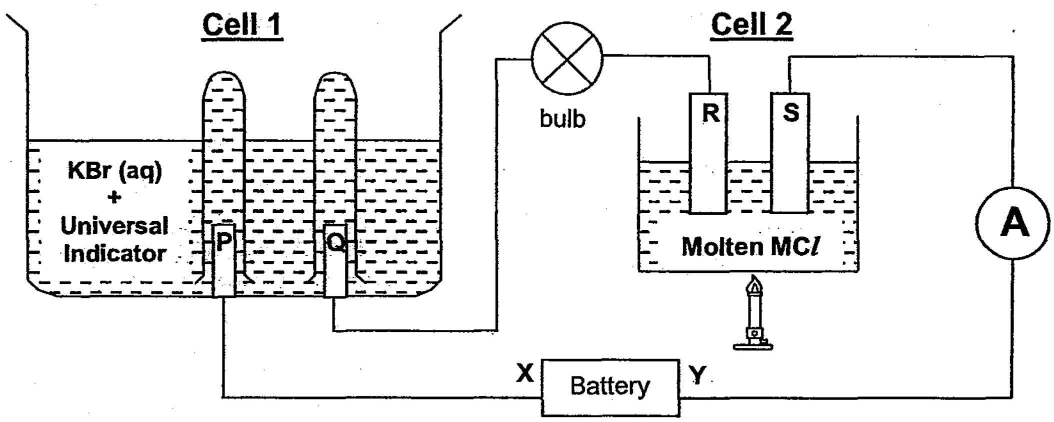
(ii) Draw the structures of **any two** possible **condensation polymers**, showing two repeating units for each polymer.
Circle and label all linkages clearly. **[3]**

(c) Molecules of compound **Z** are also able to undergo addition polymerisation under suitable conditions. Draw the structure of the **addition polymer** formed. **[1]**

[Total marks: 8]

EITHER

B8 The following set-up can be used for the electrolysis of molten metal chloride (**M*Cl***) and a solution of potassium bromide. The four electrodes **P**, **Q**, **R** and **S** in the circuit are graphite rods. **X** and **Y** are the terminals of the battery.



(a) When the heat source was removed from **Cell 2**, no current is observed to flow. A student made the following comment.

Student: 'A current will be observed if we add water into **Cell 2**.'

Is the student correct? Explain your answer. **[2]**

(b) When the switch is on, metal **M** begins to deposit on electrode **R**. Deduce the polarity of the battery at terminals **X** and **Y**. **[1]**

(c) **(i)** With the aid of an ionic equation, describe what would be observed at electrode **P** after the current has flowed for a while. **[2]**

(ii) The colour of the universal indicator remains green throughout the experiment. Explain why this is so. **[2]**

(d) It was known that the electrolyte in **Cell 2** contains a group I metal. After carrying out electrolysis for 30 minutes at a constant current, 300cm^3 of gas is collected at electrode **P** and the gain in mass at electrode **R** is 0.175g. What is the identity of the group I metal? **[3]**

[Total marks: 10]

OR

B8 The reactivity of metals can be compared by their reactions with water, steam and displacement reactions. Some data of the experiments are recorded in the table below.

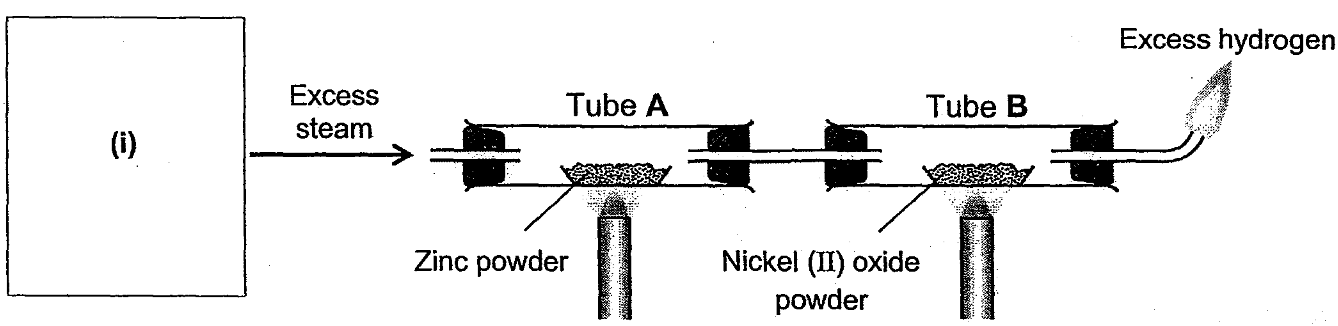
Metals	Displacement reactions	Reaction with water and steam	Observations during reaction with steam
Mercury	Mercury does not displace any of the metals	Has no reaction with steam	Silvery metal remains unchanged
Magnesium	$Mg + Zn(NO_3)_2 \rightarrow Mg(NO_3)_2 + Zn$	Reacts slowly with cold water but burns in steam	Grey solid turns white
Nickel	$Ni + Hg(NO_3)_2 \rightarrow Ni(NO_3)_2 + Hg$	Has no reaction with water, reacts slowly with steam	Silvery solid turns green
Zinc	$Zn + Ni(NO_3)_2 \rightarrow Zn(NO_3)_2 + Ni$	Has no reaction with water, reacts slowly with steam	Grey solid turns yellow when hot

(a) From the table above, arrange the metals in ascending order of their chemical reactivity. **[1]**

(b) **(i)** Solutions containing nickel(II) ions are usually green. What would you expect to see if magnesium is added to nickel(II) nitrate solution? **[1]**

(ii) Write an ionic equation, with state symbols, for the reaction. **[1]**

(c) The apparatus below was set up. Steam was passed into the first tube. The zinc and the nickel(II) oxide were then heated.



(i) Complete the above diagram by drawing a suitable set-up in the box labelled **(i)** to show how you would provide a steady supply of steam for the experiment. **[1]**

(ii) Write an equation for the reaction that occurs in tube **A**. **[1]**

(iii) Nickel lies in between iron and lead in the reactivity series. What would you observe in tube **B**? Explain your answer. **[2]**

(iv) The following data were obtained from the above experiment.

Mass of zinc powder used in tube **A**	10 g
Mass of empty crucible in tube **B**	10 g
Mass of empty crucible + contents after heating in tube **B**	18 g

Determine the volume of excess hydrogen which did not react in tube **B**. **[3]**

[Total marks: 10]

- End of Section B -

Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2014

CHEMISTRY 5073/01

Paper 1 Multiple Choice

1 SEPT 2014
1 hour

READ THESE INSTRUCTIONS FIRST

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

Write in soft pencil.

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

Write your name, index number and class on the answer sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the answer sheet.

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 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	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

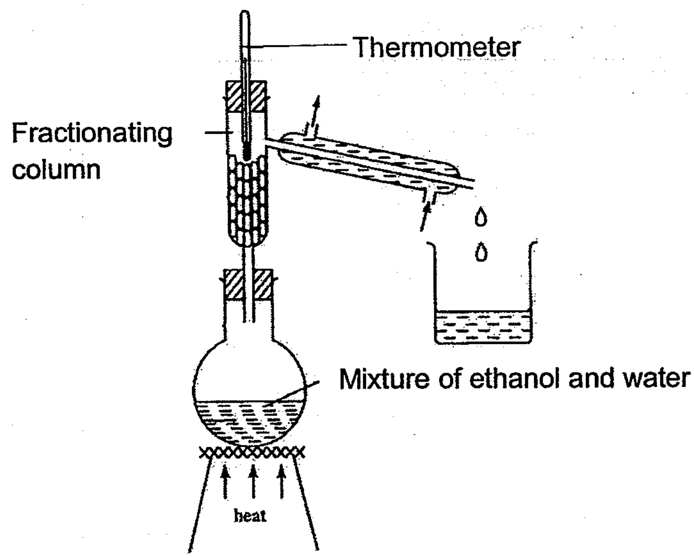
†90-103 Actinoid series

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

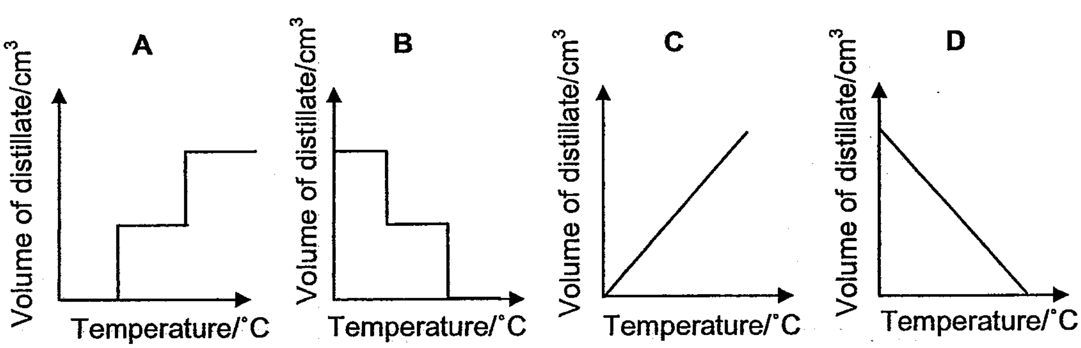
Key

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

1. A student sets up the following apparatus to separate ethanol (boiling point 78 °C) and water (boiling point 100 °C).



Which graph correctly shows the relationship between total volume of distillate plotted against temperature?



2. Which statement is correct about two gases with the same relative molecular mass?

A They have the same melting and boiling points

B They have the same mass.

C They have the same rate of diffusion at room temperature and pressure.

D They have the same solubility in water at room temperature and pressure.

3. Element **X** has n protons and forms ions with a charge of 2-.
Element **Y** has (n+3) protons.

Which of the following correctly shows the structure and formula of a compound formed between elements **X** and **Y**?

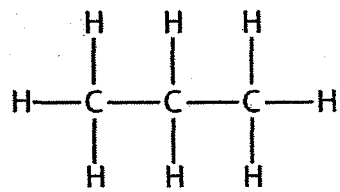
A an ionic compound $\mathbf{YX_2}$

B a covalent compound $\mathbf{YX_2}$

C an ionic compound $\mathbf{Y_2X}$

D a covalent compound $\mathbf{Y_2X}$

4. Propane has the structure as shown below.



How many electrons in a molecule of propane is/are not involved in bonding?

A	0	**C**	2
B	4	**D**	6

5. Which statement is correct about the melting point of caesium chloride, CsC*l*?

A It has a low melting point as its molecules are held together by weak van der waals' forces.

B It has a high melting point as the ions are held together by strong electrostatic attractions.

C It has a low melting point as the atoms are held together by weak covalent bonds.

D It has a high melting point as the atoms are held togeter by strong covalent bonds.

6. When a 2.31 g sample of oxide of nitrogen was analysed, it was found to contain 0.68 g of nitrogen.

What is the empirical formula of the oxide of nitrogen?

A	NO	**C**	NO_2
B	N_2O	**D**	N_2O_4

7. $35.0\ cm^3$ of $0.500\ mol/dm^3$ dilute hydrochloric acid was added to 0.70 g of a sample of sodium carbonate contaminated with sodium chloride. The excess acid required $15.0\ cm^3$ of $0.400\ mol/dm^3$ sodium hydroxide solution for neutralisation.

Find the percentage purity of the sodium carbonate in the sample.

A 43.5 % **C** 87.1 %

B 45.4 % **D** 90.9 %

8. What volume of air is required to ensure the complete combustion of $150\ cm^3$ of carbon monoxide at room temperature and pressure?

A $75\ cm^3$ **C** $250\ cm^3$

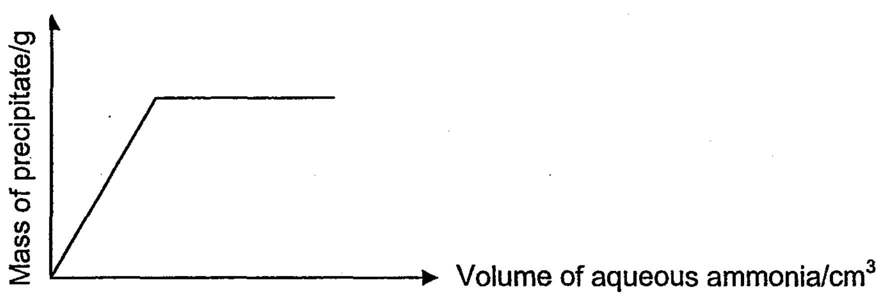
B $375\ cm^3$ **D** $500\ cm^3$

9. Which solution will produce gases when reacted with both sulfuric acid and warm aqueous sodium hydroxide?

A $(NH_4)_2CO_3$ **C** NH_4NO_3

B $NaCl$ **D** $Fe(NO_3)_2$

10. An aqueous solution of a salt was placed in a test tube and aqueous ammonia was gradually added from a burette. The mass of the precipitate was obtained when various volumes of aqueous ammonia were added and a graph was obtained as shown.

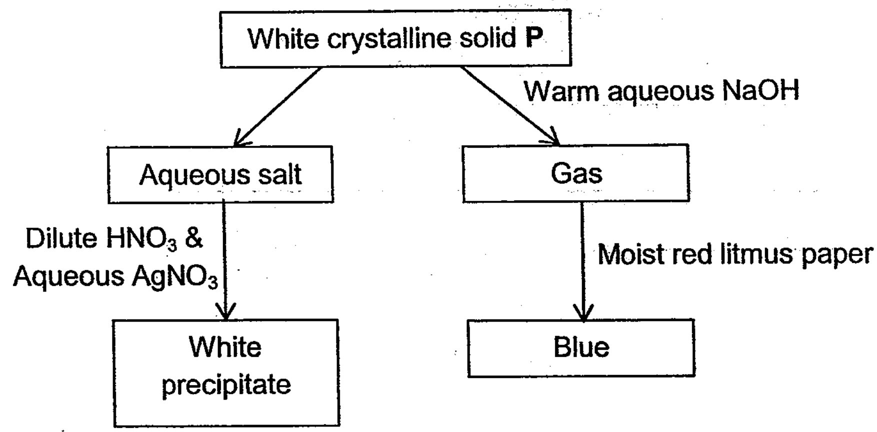


Which salt would show this behaviour?

A copper(II) nitrate **C** iron(II) sulfate

B zinc chloride **D** sodium nitrate

11. The diagram below shows the reaction of a white crystalline solid **P**.



Which is the identity of the white crystalline solid P?

A aluminium sulfate

B ammonium chloride

C ammonium nitrate

D magnesium chloride

12. Which of the following **cannot** be a reducing agent?

A HNO_3

B NH_3

C H_2

D KI

13. In which experiment does the oxidation state of iodine remain unchanged?

A Chlorine gas is bubbled into aqueous magnesium iodide.

B Acidified potassium manganate(VII) is added into aqueous potassium iodide.

C Bromine water is added to aqueous sodium iodide.

D Aqueous silver nitrate is added into aqueous sodium iodide.

14. 1.0 mol/dm^3 of 25.0 cm^3 aqueous hydrochloric acid requires 25.0 cm^3 of 1.0 mol/dm^3 of aqueous sodium hydroxide for complete neutralisation.

Which acid of the same concentration will require a different volume for complete neutralisation given that the same volume and concentration of sodium hydroxide is used?

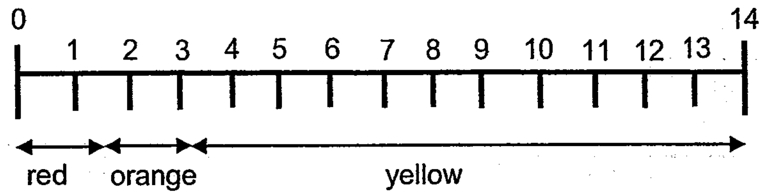
A Ethanoic acid

B Nitric acid

C Propanoic acid

D Sulfuric acid

15. The colours of an indicator **X** in solutions of different pH are shown below:



Which pair of solutions can be differentiated by using Indicator **X**?

A aqueous solutions of ammonia and ethanoic acid at the same concentration

B aqueous solutions of sodium chloride and ethanoic acid at the same concentration

C aqueous solutions of sodium hydroxide and carbonic acid at the same concentration

D aqueous solutions of hydrogen chloride and carbonic acid at the same concentration

16. How can lead(II) sulfate best be prepared from lead(II) oxide?

A by adding dilute sulfuric acid

B by adding dilute hydrochloric acid followed aqueous sodium sulfate

C by adding dilute nitric acid followed by aqueous sodium sulfate

D by heating lead(II) oxide followed by adding sulfuric acid

17. In which reaction is sulfuric acid **not** acting as an acid?

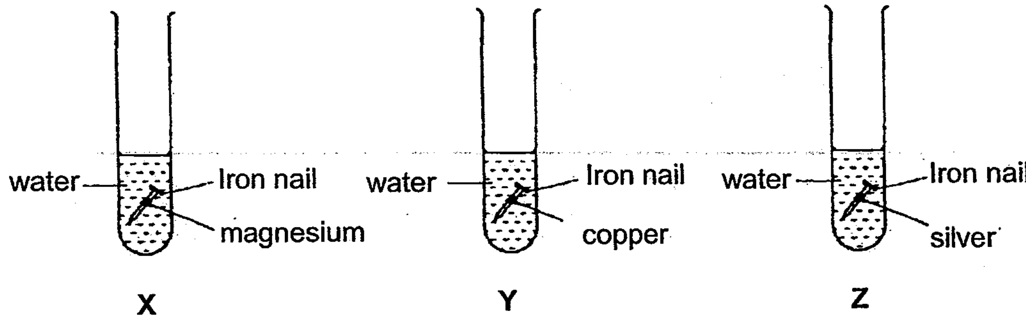
A formation of sodium sulfate by adding sodium carbonate

B formation of magnesium sulfate by adding magnesium

C formation of barium sulfate by adding aqueous barium hydroxide

D formation of barium sulfate by adding aqueous barium nitrate

18. Three experiments are set up to investigate the sacrificial protection of iron.



In which test tube(s) will the iron nail rust?

A X only

B X and Y only

C X and Z only

D Y and Z only

19. Small pieces of different metals were added to metal ions in water. Use the information below to answer **Question 19** and **20**.

Solution	**Metal added**				
	X	**Iron**	**Copper**	**Zinc**	**Y**
Copper(II) chloride	Copper displaced	Copper displaced	———	Copper displaced	Copper displaced
Nitrate of metal X	———	Metal **X** displaced	No reaction	Metal **X** displaced	Metal **X** displaced
Iron(II) chloride	No reaction	———	No reaction	Iron displaced	Iron displaced
Chloride of metal Y	No reaction	No reaction	No reaction	No reaction	———
Zinc chloride	No reaction	No reaction	No reaction	———	Zinc displaced

Which of the following correctly shows the different metals arranged in the order of increasing reactivity?

A copper, **X**, iron, zinc, **Y**

B copper, iron, **X**, zinc, **Y**

C **X**, copper, iron, zinc, **Y**

D **X**, iron, copper, **Y**, zinc

20. Which method should be used to extract metal **Y** from its ore?

A by heating the ore with ammonia

B by heating the ore

C by electrolysis of its molten ore

D by heating the ore with carbon

21. A sample of air along the Pan Island Expressway (PIE) is collected and its composition is examined.

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

A Carbon monoxide

B Nitrogen monoxide

C Nitrogen dioxide

D Sulfur dioxide

22. Which property generally decreases when going across a period of the Periodic Table from Group I to Group VII?

A the reducing power of an element

B the number of electrons in the valence shell

C the acidity of the oxides of the elements

D the tendency of the elements to form negative ions

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

$$\mathbf{Z}^- (aq) + \mathbf{Y}_2 (aq) \rightarrow \text{no reaction}$$
$$\mathbf{X}^- (aq) + \mathbf{Z}_2 (aq) \rightarrow \text{no reaction}$$
$$2\mathbf{Y}^- (aq) + \mathbf{X}_2 (aq) \rightarrow 2\mathbf{X}^- (aq) + \mathbf{Y}_2 (aq)$$

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

24. Which statement is true about the Haber Process?

A Nitrogen is obtained from the cracking of petroleum.

B Increasing the pressure to above 200 atmospheres will speed up the reaction but cause the yield to be low.

C Increasing the temperature to above 450 °C will speed up the reaction but cause the yield to be low.

D Unreacted gases produced are released into the atmosphere.

25. The enthalpy change when one mole of hydrogen ions is neutralised is known as the enthapy of neutralisation.

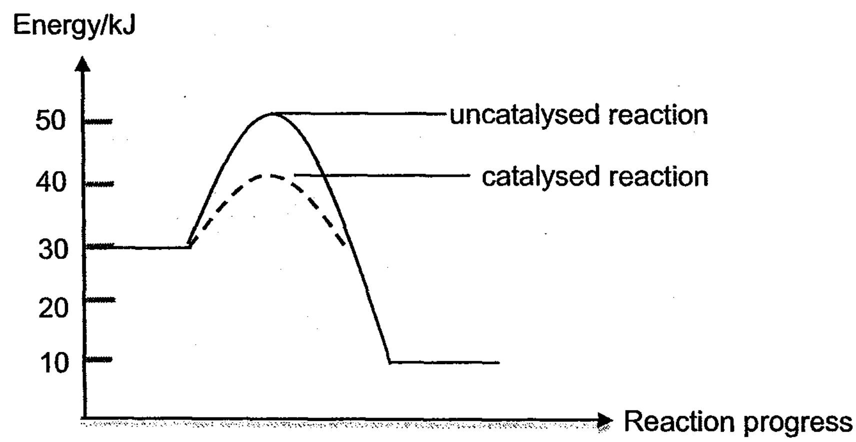
$$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l) \qquad \Delta H = -57 \text{ kJ/mol}$$

How much energy is released when one mole of sulfuric acid is completely neutralised?

A 28.5 kJ **C** 114 kJ

B 57 kJ **D** 228 kJ

26. The energy diagram for a particular reaction under catalysed and uncatalysed conditions is shown below.



What is the activation energy of the **backward catalysed** reaction?

A + 10 kJ **C** + 30 kJ

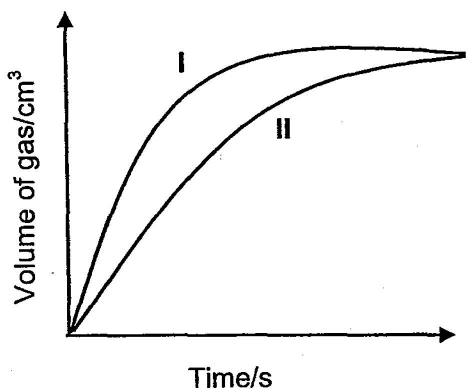
B + 20 kJ **D** + 40 kJ

27. In two separate experiments, magnesium carbonate was reacted with an excess of dilute acid. The following shows the different conditions used in each experiment, with all other conditions being identical in both experiments.

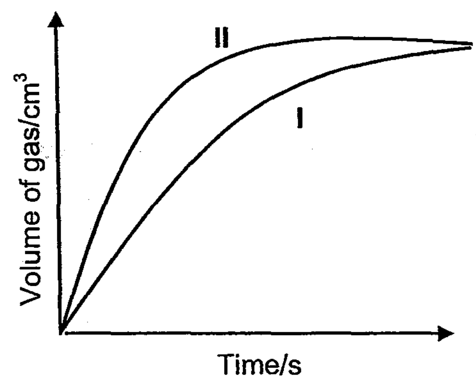
Experiment **I** : 0.05 dm^3 of 1.0 mol/dm^3 of hydrochloric acid
Experiment **II** : 0.05 dm^3 of 1.0 mol/dm^3 of sulfuric acid

Which graph correctly represents the results of the two experiments?

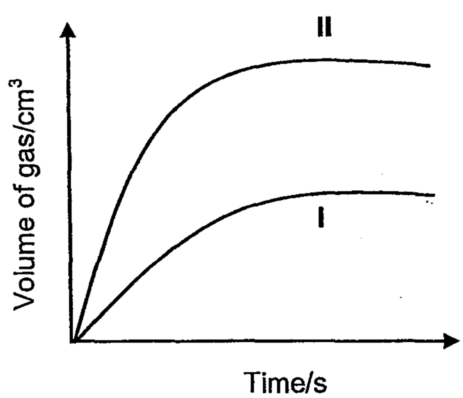
A



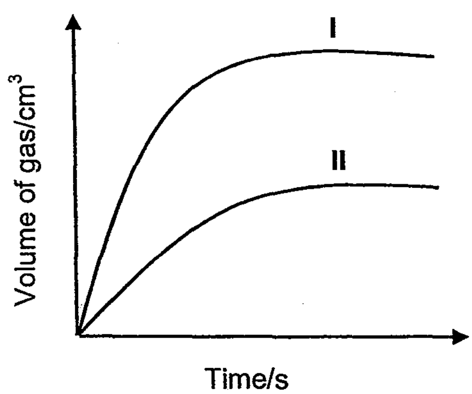
C



B



D



28. Which statement best explains why the speed of a chemical reaction slows down as the reaction nears completion?

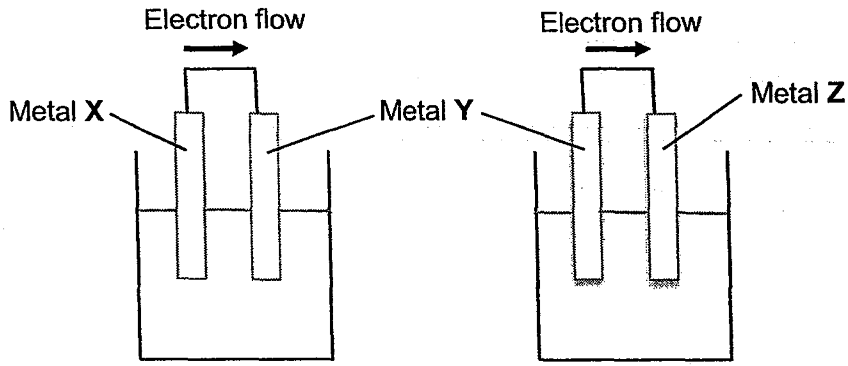
A The concentration of the reactant particles decreases.

B Particles lose their kinetic energy as the reaction proceeds.

C Most of the energy produced during the reaction has been used up.

D The temperature of the reaction falls as heat is lost to the surroundings.

29. Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the circuit.



Which set of metals would give the electron flows in the direction shown?

	Metal **X**	Metal **Y**	Metal **Z**
A	Ag	Cu	Zn
B	Cu	Zn	Ag
C	Zn	Ag	Cu
D	Zn	Cu	Ag

30. A compound was being electrolysed using graphite electrodes and the half ionic equations below show the reactions at the electrodes.

Cathode: $2X^{+}(aq) + 2e^{-} \rightarrow X_2(g)$
Anode: $2Y^{-}(aq) \rightarrow Y_2(g) + 2e^{-}$

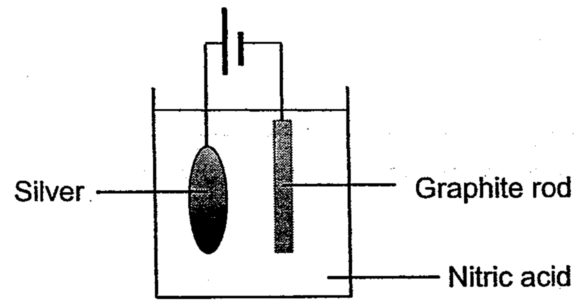
What can be the possible identity of the compound?

A aqueous potassium chloride
B aqueous sulfuric acid
C concentrated magnesium chloride
D molten calcium chloride

31. Which statement is true about the hydrogen-oxygen fuel cell?

A Hydrogen gas is oxidised at the negative electrode to form water.
B Hydrogen gas is reduced at the negative electrode to form water.
C Oxygen gas is oxidised at the negative electrode to form hydroxide ions.
D Oxygen gas is reduced at the negative electrode to form hydroxide ions.

32. An electrolytic cell is set up as shown.



Which of the following will be observed?

A The solution turns blue.

B The graphite rod will be coated with silver.

C Effervescence will be seen at the silver rod.

D Effervescence will be seen at the graphite rod.

33. Useful fractions are obtained by the fractional distillation of petroleum.

Which fraction is correctly matched with its uses?

	Fraction	**Use**
A	Petrol	Aircraft fuel
B	Bitumen	Car fuel
C	Kerosene	For making roads
D	Liquid Petroleum Gas	For cooking purposes

34. The molecular formula of oleic acid is $C_{18}H_{32}O_2$.

How many C=C bonds are present in one mole of oleic acid?

A 1 **C** 3

B 2 **D** 4

35. The equation for the reaction of a hydrocarbon C_xH_y is shown below.

$$C_xH_y + Br_2 \rightarrow C_xH_{y-1}Br + HBr$$

Which statement is true?

A This reaction is called addition of bromine.

B The brown aqueous bromine will decolourise rapidly.

C This reaction requires UV light.

D C_4H_8 can be a possible identity for the hydrocarbon.

36. Which statement about the homologous series of alcohols is **NOT** true?

A They can be represented by a general formula.

B They have the same empirical formula.

C Their melting points generally increase down the homologous series.

D They can be prepared by the hydration of their corresponding alkenes.

37. An alcohol **X** can react with acid **Y** to form an ester with the formula $C_6H_{12}O_2$.

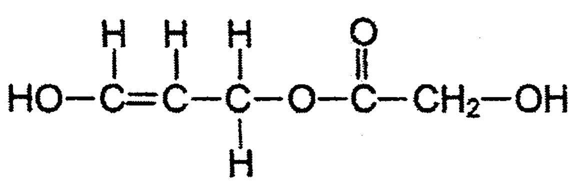
Alcohol **X** can be oxidised to acid **Y** by heating with aqueous acidified potassium manganate(VII).

What is the structural formula of the ester?

A $C_2H_5COOC_3H_7$ **C** $C_3H_7COOC_3H_7$

B $HCOOC_2H_5$ **D** $CH_3COOC_4H_9$

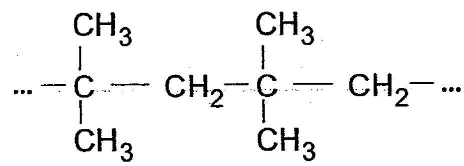
38. An organic compound has the following structure.



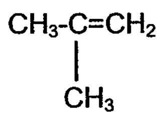
Which of the following correctly shows the reactions of the compound?

	With aqueous Na_2CO_3	With aqueous Br_2	With acidfied potassium manganate(VII)
A	Effervescence observed	Turns colourless	Turns colourless
B	Effervescence observed	No visible reaction	Remains purple
C	No visible reaction	Turns colourless	Turns colourless
D	No visible reaction	No visible reaction	Remains purple

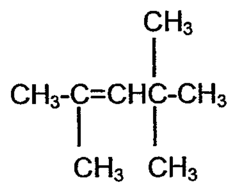
39. Drugs can be administered in patches made from 'pressure-sensitive adhesives' that stick to the skin but are easy to remove. One such pressure-sensitive adhesive has the following structure.

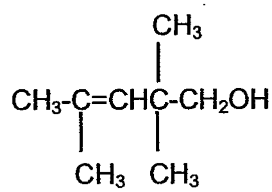


Which monomer could be used to make this polymer?

A 

B $CH_3CH{=}CHCH_3$

C 

D 

40. Which physical property does not change during the polymerisation of ethene to form polyethene?

A boiling point

B density

C mass

D relative molecular mass

END OF PAPER ☺

2014 Chemistry Preliminary Examination

Paper 1 Answers & Worked Solutions

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

Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2014

CHEMISTRY

Paper 2

5073/02
19 August 2014
1 hr 45 mins

READ THESE INSTRUCTIONS FIRST
Write your name, index number and class in the spaces provided at the top of this page and on any separate answer paper used.
Write in blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.
You may use a calculator.
All final answers for calculations are to be rounded off to **3 significant figures**.
Do not use staples, paper clips, highlighters, and glue or correction fluid.

A copy of the Periodic Table is printed on page 16.
Section A (50 Marks)
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B (30 Marks)
Answer all **THREE** questions from this section.
The last question is in the form of EITHER/OR and only ONE of the alternatives should be attempted.

Begin each question on a **fresh piece of paper**.
Fasten your answers to Section B together.

The number of marks is given in brackets [ ] at the end of each question or part question.

Submit Section A & B separately.

For Examiner's Use	
Section A	
B8	
B9	
B10 EITHER/OR	
Total	80

This paper consists of 16 printed pages, including the cover page.

Section A (50 Marks)

Answer all questions in this section in the spaces provided.

A1 The equations **A, B, C, D** and **E** show some reactions involving compounds of **M**.

A $MCO_3\,(s) \rightarrow MO\,(s) + CO_2\,(g)$

B $2MO\,(s) + C\,(s) \rightarrow 2M\,(s) + CO_2\,(g)$

C $MO\,(s) + H_2SO_4\,(aq) \rightarrow MSO_4\,(aq) + H_2O\,(l)$

D $MSO_4\,(aq) + 2NaOH\,(aq) \rightarrow M(OH)_2\,(s) + Na_2SO_4\,(aq)$

E $M(OH)_2\,(s) + 2HCl\,(aq) \rightarrow MCl_2\,(aq) + 2H_2O\,(l)$

Use the letters **A, B, C, D** and **E** to answer the following questions.

(a) Which equation shows a change in the oxidation state of **M**?

____ [1]

(b) Two of the reactions are exothermic reactions. Give the letters for the equations of these reactions.

____ [1]

(c) When reaction **D** is carried out, a blue precipitate which is insoluble in excess aqueous sodium hydroxide is observed.

State the expected observation when aqueous ammonia is added dropwise in excess into a portion of aqueous MSO_4.

____

____ [2]

[Total: 4]

A2 The melting points of the oxides of the third period elements are given below.

Compound	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_2	Cl_2O
Melting Point/ °C	1275*	2800	2045	1700	24	-73	-20

sublimation occurs

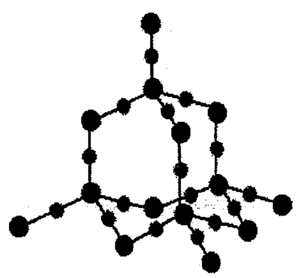
(a) Dichlorine monoxide, Cl_2O, has a low melting point of -20 °C.

Draw a 'dot-and cross' diagram to show the bonding in dichlorine monoxide.

You only need to show the outer shell electrons.

[2]

(b) Silicon dioxide has a structure as shown below.



Explain, in terms of bonding and structure, why the melting point of silicon dioxide is higher than that of dichlorine monoxide.

____

____

____

____ [3]

(c) A scientist discovered a new element, **Y**, which can also be placed in Period 3. Oxide of **Y** has a melting point of -95 °C.

Using your understanding of bonding and structure, indicate with a (✓) whether the statements are true or false.

	True	**False**
Oxide of **Y** can conduct electricity when molten.		
Oxide of **Y** is a crystalline solid at room temperature.		
Oxide of **Y** can be dissolved in an organic solvent.		
Oxide of **Y** can be used as a refractory material that lines the inner surface of blast furnace.		

[2]

[Total:7]

A3 The table below shows results from a laboratory investigation on the rate of decomposition of 50 cm^3 of aqueous hydrogen peroxide into water and oxygen using 0.5 g of powdered manganese(IV) oxide as catalyst.

Experiment	**Concentration of aqueous hydrogen peroxide (mol/dm^3)**	**Initial temperature (°C)**	**Time to collect 20 cm^3 of oxygen (s)**
A	0.1	25	200
B	0.2	25	100
C	0.3	25	65
D	0.4	25	50

(a) **(i)** State the trend in the results shown above.

____

____ [1]

(ii) Use ideas about collisions between particles to explain the trend stated in **(a)(i)**.

____

____

____ [2]

(b) Predict the time taken to collect 20 cm^3 of oxygen when 0.6 mol/dm^3 of hydrogen peroxide is used. Use the results in the table to explain your answer.

____

____

____ [2]

(c) A student wants to investigate what the result will be if **no** catalyst is added into 0.1 mol/dm^3 of aqueous hydrogen peroxide.

(i) State whether the expected result will show a shorter or longer time compared to when a catalyst is used.

____ [1]

(ii) Use collision theory to explain the expected result when no catalyst is added into the aqueous hydrogen peroxide.

____

____

____ [2]

(d) Another student wants to investigate if surface area of catalyst will affect the result.

Describe clearly the experimental procedures and expected results for the investigation. Explain the expected results.

____

____

____

____

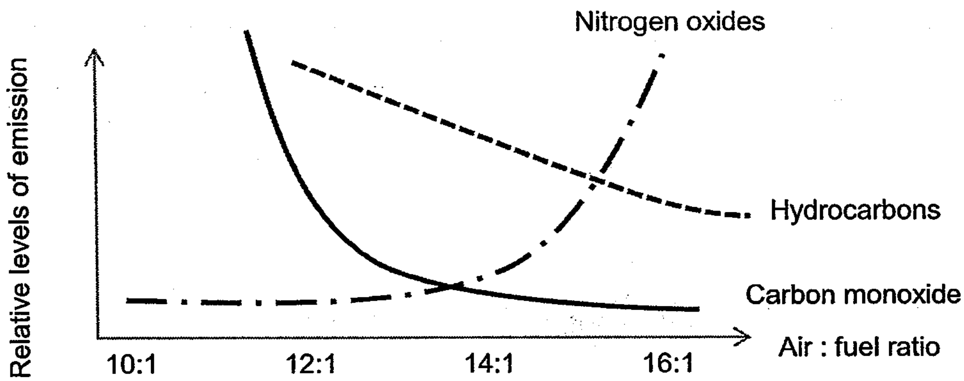
____

____ [3]

[Total: 10 marks]

A4 Most vehicles are operated using either petrol engine or hydrogen fuel cell.

For vehicles which are run by petrol engine, air : fuel ratio in the engine plays an important role to determine the relative levels of emission of different air pollutants as shown in the diagram given below.



(a) Use the information from the diagram to show that lesser pollutants are released when petrol is burnt in excess oxygen.

[1]

(b) Suggest why the level of nitrogen oxides increases when the air : fuel ratio is greater than 14:1.

[2]

(c) The diagrams below show the substances that enter and leave vehicles that use petrol engines and fuel cells.

In petrol engine	Petrol and air → Combustion chamber → Catalytic converter → **X**, N_2, CO_2
In fuel cell	H_2 and O_2 → Fuel Cell → **X**

(i) Identify the unknown substance, **X**.

[1]

(ii) Write a balanced chemical equation to show one reaction that occurs in the catalytic converter to produce two of the waste gases shown in the flowchart.

____ [1]

(iii) The release of carbon dioxide by the petrol engine vehicles to the air causes global warming. Explain how fuel cell can also contribute to global warming.

____

____ [1]

(d) Brazil uses ethanol as fuel to run their vehicles. The ethanol is obtained from fermentation of sugarcane juice.

Explain how ethanol fuel helps to maintain the level of carbon dioxide in air.

____

____

____ [2]

[Total: 8 marks]

A5 Ammonia is made in the Haber Process by the reaction involving nitrogen and hydrogen as shown in the equation below.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92\ \text{kJ/mol}$$

The table below shows some bond energies.

Bond	**Bond Energy (kJ/mol)**
$3H_2 \rightarrow 6H$	+1308
$2N + 6H \rightarrow 2NH_3$	-2346

(a) Use the information given above to answer the following questions.

During the Haber Process, two types of bond breaking occur.
One type of bond breaking can be illustrated by the following equation,

$$N_2 \rightarrow 2N$$

Write the equation that represents another bond breaking and bond formation process that occur.

Bond breaking: ____

Bond formation: ____ [2]

(b) Hence, using the information provided and your answer to **(a)**, calculate the bond energy of $N_2 \rightarrow 2N$.

[2]

(c) In the Haber Process, a mixture of ammonia gas, nitrogen and hydrogen enters a condenser. Only ammonia gas condenses to form liquid ammonia. The other gases do not.

State whether the boiling point of ammonia is higher or lower than that of nitrogen and hydrogen.

____ [1]

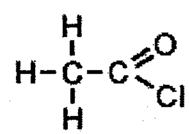
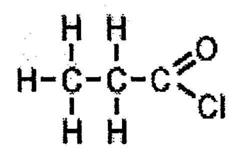
(d) Explain by using oxidation state, why the making of ammonia by Haber Process is a redox reaction.

____

____ [2]

[Total: 7 marks]

A6 Some members of the homologous series of acyl chlorides are given below.

Name of acyl chloride	**Full structural formula of acyl chloride**
Ethanoyl chloride	
Propanoyl chloride	
Butanoyl chloride	

(a) Complete the table above by drawing the full structural formula of butanoyl chloride. [1]

(b) State the general formula for acyl chlorides.

____ [1]

(c) Ethanoyl chloride can also react with methanol to form an ester and another product.

(i) Write a balanced chemical equation for the reaction by drawing full structural formulas for the reactants and products formed.

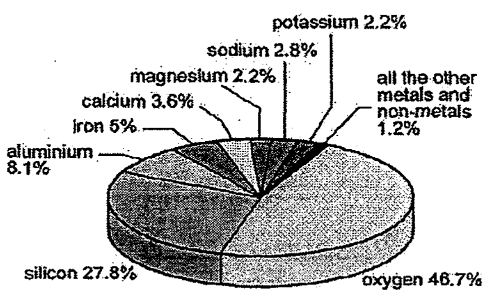
[2]

(ii) Name the ester formed.

____ [1]

[Total: 5 marks]

A7 The pie chart below shows the percentage abundance of elements in the Earth's crust.



(a) There are many oxides present in the Earth's crust. Explain how the pie chart above shows that the statement is true.

____ [1]

(b) Suggest a reason why there is a very low percentage of non-metals in the Earth's crust.

____ [1]

(c) Iron exists in the crust as oxides. A sample of 116 g of iron oxide is found to contain 84 g of iron.

Determine the empirical formula of this oxide.

[3]

(d) There is a high demand for both aluminium and iron in the industry and the percentage of abundance of aluminium is higher than that of iron.

Iron is obtained from the reduction of iron oxide by carbon.

(i) State clearly the method used to extract aluminium from its oxide.

______________________________ [1]

(ii) Price of aluminium per kilogram is greater than that of iron for the same mass. Explain why this is so.

____

______________________________ [1]

(e) A piece of block is made up of an alloy of aluminium and iron. The block is then coated with a thin layer of aluminium around it to prevent rusting.

Explain how prevention of rusting is possible by coating a layer of aluminium around iron block.

____

______________________________ [1]

[Total: 8 marks]

Section B

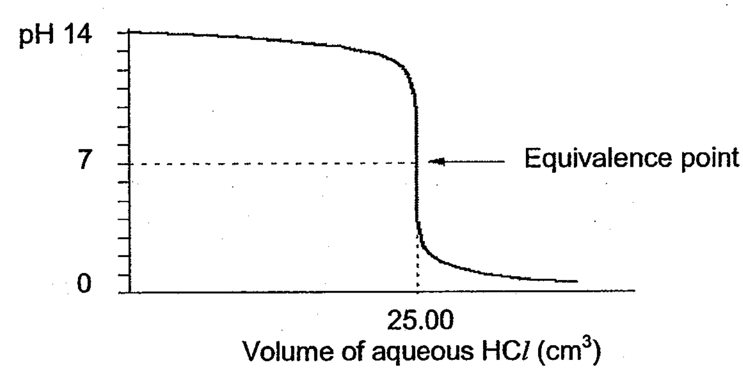
Answer all **three** questions in this section.
The last question is in the form of an either/or and only **one** of the alternatives should be attempted.
Write your answers on the writing paper provided.

B8 A pH datalogger measures pH changes during some titration experiments.

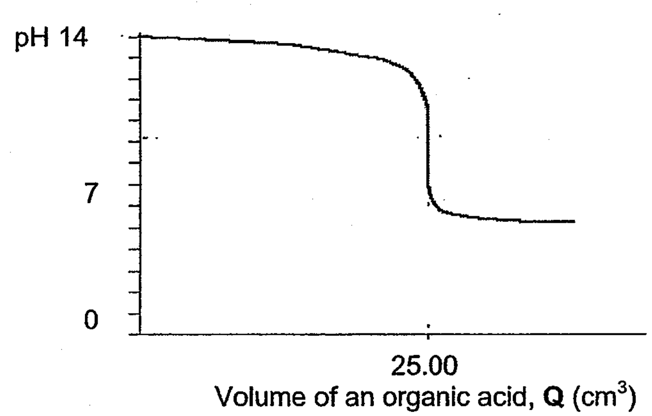
In **Experiment 1**, dilute hydrochloric acid was added from a burette to 20.0 cm^3 of 0.2 mol/dm^3 aqueous sodium hydroxide. The equivalence point of the reaction is at pH=7.

Equivalence point of a titration is reached when the reactants have just reacted or neutralised each other according to the stoichiometric ratio given by the balanced equation of the reaction.

Graph 1: Experiment 1



Graph 2: Experiment 2



Experiment 2 is carried out by titrating a weak organic acid, **Q**, of concentration 0.2 mol/dm^3 with a solution of sodium hydroxide of the same concentration as that used in **Experiment 1**.

(a) Use the information given to calculate the concentration of hydrochloric acid used in **Experiment 1**. [2]

(b) State the equivalence point for **Experiment 2**. [1]

(c) It is given that the weak organic acid, **Q**, is ethanol and that it dissolves in water according to the chemical equation given below.

$$CH_3CH_2OH\ (aq) \rightleftharpoons CH_3CH_2O^-\ (aq) + H^+\ (aq)$$

Explain why ethanol is considered to be a weak organic acid.

Use the information provided in graph 2 to support this. [2]

(d) Write a balanced chemical equation for the reaction between ethanol and magnesium. [2]

(e) A list of indicators with the pH range at which it changes colour is given.

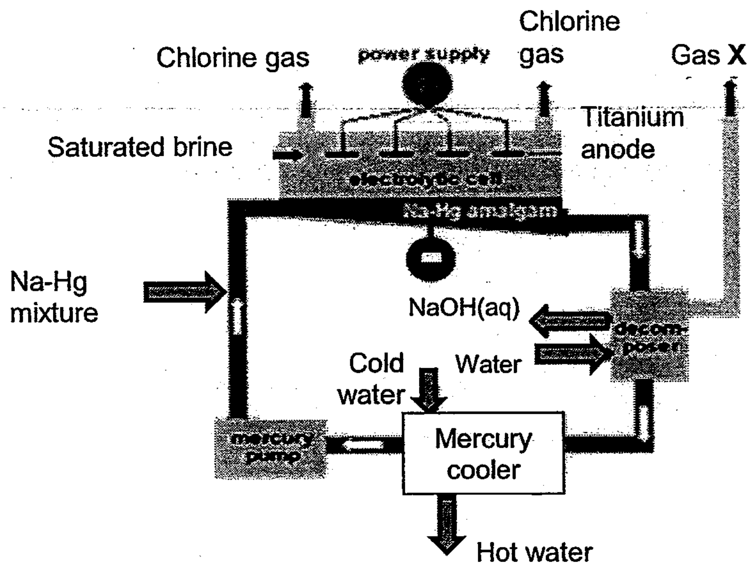
Indicator	Colour Change	pH range at which colour change occurs
Bromthymol blue	Yellow - blue	6.0 - 7.6
Litmus	Red - blue	5.0 - 8.0
Methyl orange	Red - orange	3.1 - 4.4
Phenolpthalein	Colourless - red	8.2 - 9.8
Thymol blue	Red - yellow	1.2 - 2.8

(i) Identify two suitable indicators that should be used to distinguish the equivalence point obtained for **Experiment 1 and 2.** Reference to the type of experiments should be given in your answers. [2]

(ii) Explain your reasoning for the indicators that you have chosen. [1]

[Total: 10 marks]

B9 Castner-Kellner cell can be used to perform electrolysis of brine. Brine is saturated sodium chloride solution.



In the Castner-Kellner cell, the cathode is the mercury that flows along the bottom of the cell.

Chlorine gas is produced at the anode whereas solid sodium is produced at the cathode.

Sodium dissolves in the liquid mercury to form Na-Hg amalgam. The amalgam flows into the decomposer. In the decomposer, the amalgam reacts with water to form sodium hydroxide and gas **X**. Mercury is released here.

(a) Write a half ionic equation with state symbols to show the formation of chlorine gas. [1]

(b) Describe a simple test to show that the gas produced is chlorine. [2]

(c) Calculate the mass of solid sodium formed when 7200 dm^3 of chlorine gas forms at the anode. [2]

(d) Identify gas **X** and write a balanced chemical equation to show the reaction that occurs in the decomposer. [2]

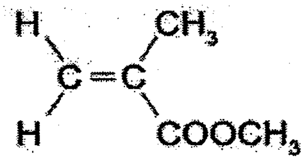
(e) Explain why there is a need to pump the mercury back through the cell. [1]

[Total: 8 marks]

B10
Either

(a) Plastic packaging provides excellent protection for many products. Traditional plastics are manufactured from oil, coal and natural gas and are cheap to manufacture.

An example of plastic that is commonly used is Perspex. Perspex is a polymer that is made up of the joining of large number of methyl-2-methylpropenoate.
The molecular structure of the methyl-2-methylpropenoate is shown below.



Methyl-2-methylpropenoate

(i) State one advantage and one disadvantage of using plastics such as Perspex. [2]

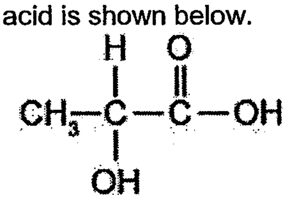
(ii) Draw the structure of Perspex, showing two repeat units. [1]

(iii) A manufacturer controls the average relative molecular mass of Perspex in the range of 24 000 to 30 000.

What is the range of the average number of repeat units in the Perspex? Show your working. [3]

(b) In recent years, there have been efforts made to produce plastics from natural plant polymers. To manufacture these plastics, starch that is harvested from corn or wheat will then be transformed into lactic acid by micro-organisms. Lactic acid will join together to form a polymer known as polyactide.

The molecular structure of lactic acid is shown below.



Lactic acid

(i) List TWO advantages of using plastics manufactured from natural plant polymers. [2]

(ii) Draw the structure of polyactide, showing two repeat units. [1]

(iii) Name one natural polymer that has the same linkage as polyactide. [1]

(c) State two differences between the formation of Perspex and polyactide. [2]

[Total: 12 marks]

B10 Or Group I and Group VII elements show trends in their melting points and boiling points.

	Element	Melting point/°C	Boiling point/°C
Group I	Lithium	180	1330
	Sodium	97.8	890
	Potassium	64	774
Group VII	Chlorine	-101	-35
	Bromine	-7	59
	Iodine	114	184

(a) **(i)** State the trends observed in the melting points and boiling points of Group I elements. [1]

(ii) In terms of bonding and structure, explain the trend stated in **(a) (i)** [2]

Explain why all group 1 elements are solid at room temperature. [1]

(b) When group I metals tarnish in air, different types of oxide are formed.

Element	Oxides formed	Formula
Lithium	Lithium oxide	Li_2O
Sodium	Sodium oxide	Na_2O
	Sodium peroxide	Na_2O_2
Potassium	Potassium superoxide	KO_2
Rubidium	Rubidium superoxide	RbO_2

State the formulae of the

(i) peroxide ion and

(ii) superoxide ion [2]

(c) A scientist discovered a new Group VII element, **Z**, which is a solid at room temperature with a melting point of 135 °C.

(i) Where would you place element **Z** in the Periodic Table? Using the information from the table, explain your answer. [3]

(ii) Describe a simple test that you can carry out by using aqueous $\mathbf{Z_2}$, to determine the relative reactivity of element **Z** compared to iodine. [3]

[Total: 12 marks]

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	– 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 X b

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

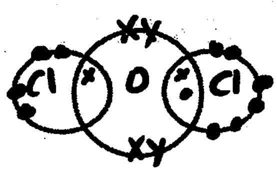
CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
CHEMISTRY PRELIMINARY EXAMINATION 2014
MARK SCHEME

A1 **(a)** B ;

(b) C and E ;
One correct [0]

(c) **Blue precipitate** forms. ;
The blue precipitate **dissolves** to form **dark blue solution** when excess aqueous ammonia is added. ;

A2 **(a)**



Correct no. of electrons shared;

Correct no. of valence electrons in the shells;

(b) Silicon dioxide has a **giant covalent structure** with **strong covalent bonds** between the atoms. ;

Dichlorine monoxide has a **simple molecular structure** with **weak intermolecular force of attraction.** ;

A lot of energy is required to break the strong covalent bonds in silicon dioxide, hence silicon dioxide has a higher melting point than dichlorine monoxide. ;
OR OR
Less energy is required to overcome the weak intermolecular force of attraction in dichlorine monoxide. ;

(c)

True	False
	✓
	✓
✓	
	✓

All correct;;

2-3 correct;

1-correct [0]

A3 **(a)** (i) As the **concentration of aqueous hydrogen peroxide increases,** the **time taken** to collect 20 cm^3 of oxygen **decreases.** ;

(ii) As concentration of hydrogen peroxide increases, **increase in number of particles per unit volume.** ; ;
Thus **increase frequency of effective collisions between the reacting particles** will increase speed of reaction.

(b) 32.5s. ;

When **concentration of aqueous hydrogen peroxide is doubled, time taken to collect 20 cm^3 of oxygen is halved.** Thus, when 0.6 mol/dm^3 of hydrogen is used, time taken is half of that when 0.3 mol/dm^3 of solution is used. ;

(c) Time taken will be longer. ;

- When no catalyst is used, the **activation energy is high.**
- **Less number of particles with energy greater or equals than activation energy to react.**
- Thus, **Increase frequency of effective** collisions.

3 points mentioned;;
1-2 points mentioned;

(d)

1) Measure **0.5 g of lumps of manganese(IV) oxide** and add **into 50 cm^3 of 0.1 mol/dm^3 of aqueous hydrogen peroxide solution**
2) **Record the time taken to collect 20 cm^3** of oxygen.
3) The **time taken will be longer than 200s** or when powdered catalyst is used.
4) Lumps of manganese(IV) oxide has **smaller surface area and thus lower frequency of effective collisions** between the reacting particles. Speed of reaction is slower.

4 points mentioned;;

3-2 points;

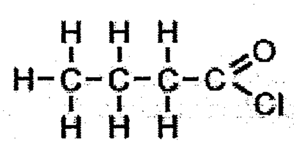
1point Mentioned [0]

A4 (a) Amount of oxygen is in excess as the **air: fuel ratio increases**. This results in the **relative level emission of carbon monoxide and hydrocarbons to decrease.** ;

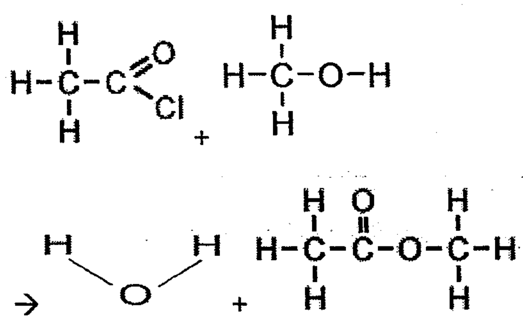
(b) **High in air: fuel** results in **complete combustion** which will then result in large amount of energy released. ;

More energy is given out to break the strong triple covalent bonds in N_2 ;
OR
More energy results in **more nitrogen reacts with the oxygen to form oxides of nitrogen** ;

(ci) **X** is water

	(cii)	$2NO + 2CO \rightarrow N_2 + 2CO_2$ Or other relevant chemical reactions that produce nitrogen, carbon dioxide and water.	;
	(ciii)	The **process** to obtain hydrogen such as 1) **Hydrolysis of water** or 2) **Water is a greenhouse gas that contributes to global warming.** 3) From **catalytic cracking of petroleum at high temperature** **Releases carbon dioxide when fossil fuel is burnt to provide energy.**	One complete answer with mention of source and name of pollutant;
	(d)	Ethanol **burns to release carbon dioxide**, the **carbon dioxide released will be removed from air by photosynthesis carried out by sugarcane plants (which are planted for sugar-highlight in class).** There is **no net gain or loss of carbon dioxide** in air.	3 points mentioned;; 1-2 points mentioned;
A5	**(a)**	Bond breaking: $3H_2 \rightarrow 6H$	;
		Bond formation: $2N + 6H \rightarrow 2NH_3$	;
	(b)	Let x be the bond energy for $N_2 \rightarrow 2N$	
		$x + 1308 - 2346 = -92$	;
		$x = 946$ **kJ/mol**	; Penalise for no unit
	(c)	Boiling point of ammonia is **higher.**	
	(d)	Nitrogen is reduced to ammonia as the **oxidation state of nitrogen decreases from 0 in N_2 to -3 in NH_3**	;
		Hydrogen is oxidised to ammonia as the **oxidation state of hydrogen increases from 0 in N_2 to +1 in NH_3** Oxidation and reduction occur simultaneously.	;
A6	**(a)**		Correct drawing of ester linkage;
	(b)	$C_nH_{2n+1}COCl$	;

(c)

(i) 

Correct structure methanol and water; Correct structure for ester;

(ii) Methyl ethanoate ;

A7 (a) There is a high percentage of **metals in the crust which can oxidise in air** and exist as oxide of metals. ;

(b) Non-metals and their oxides mainly exist as **liquid or gas.** ;

(c)

	Fe	O	
Mass(g)	84	116-84 =32	
No. of moles	84/56 =1.5	32/16 =2	;
Ratio	3	4	;

Empirical formula = Fe_3O_4 ;

(d)
(i) Electrolysis of molten aluminium oxide. ;
(ii) Extraction of aluminium is done by electrolysis which requires a **larger amount of electrical energy** and heat energy to decompose the oxide to form aluminium. ;

(e) The layer of aluminium will oxidise to form **aluminium oxide** which is **impervious to air and water.** ;

Thus, prevent the rusting of iron in the block.
OR

Aluminium is **more reactive than iron** and thus, it oxidises readily to form **aluminium oxide that is impervious to air and water.**
OR
Aluminium is **more reactive than iron** and thus, **aluminium will be preferentially oxidised.** Iron will not be oxidised and hence, will not undergo rusting.

B8 (a) No. of moles of NaOH= 0. 2x (20/1000) = 0.004 mol ;

No. of moles of HCl = 0.004 mol

Concentration of HCl = 0.004/(25/1000) = 0.160 mol/dm^3 ;

(b) pH=9. ;

(c) Ethanol **dissociates partially in water** to form **hydrogen ions.**

(Evidence) In graph 2, when **excess ethanol** is added, the **pH of the resulting solution is 6.**

(d) $Mg + 2CH_3CH_2OH \rightarrow (CH_3CH_2O)_2Mg + H_2$

Correct formulae for all;
Equation is balanced;

(e) ;

(i) Experiment 1: bromthymol blue and Experiment 2: phenolpthalein ;;

(ii) The indicators chosen have their **colour changes occur close to the end-point** of the chemical reactions. Thus, provide a more accurate result. ;

B9 **(a)** $2Cl^- (aq) \rightarrow Cl_2 (g) + 2e^-$;

(b) Test the gas with **moist blue litmus.** ;
If it turns **red and then bleaches,** the gas is chlorine. ;

(c) $2Cl^- (aq) \rightarrow Cl_2 (g) + 2e^-$

$Na^+ (aq) + e^- \rightarrow Na (s)$

Ratio of no. of moles chlorine: electrons: sodium= 1:2:2

No. of moles of chlorine gas = 7200/24=300 mol ;
No. of moles of electrons = 300 x 2 = 600 mol
Mass of Na= 600 x 23 = 13 800 g ;

(d) Gas **X** is hydrogen. ;

$2Na + 2H_2O \rightarrow 2NaOH + H_2$;

(e) To conserve the finite resource of mercury. ;

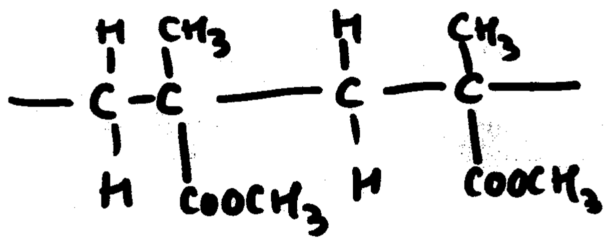
B10
Either

(a) **(i)** Advantage: It is durable. ; Reject cheap

Disadvantage: ;

1) It will cause shortage of land available to hold items that are non-biodegradable.
2) It produces toxic gases when burnt

(ii) Perspex



Two repeat units are correctly shown;

(iii) Mr of Perspex = 5x12 + 8 + 2 x16 = 100 ;

Minimum no. of repeat units = 24 000/100 = 240 ;

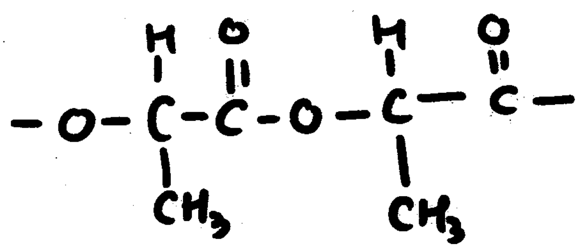
Maximum no. of repeat units = 30 000/100 = 300

Average range is 240 to 300. ;

(b)

(i) 1) Plastics made from plants are non-biodegradable. ;
2) Plants are renewable source. ;

(ii) polyactide



Two repeat units are correctly drawn with ester linkage shown;

(iii) Fats ;

(c)

1) Only Perspex is formed during its formation. Polyactide is formed together with another product.

2) No mass loss during the formation of Perspex whereas there is mass loss during formation of polyactide.

		3) There are loss of small molecules in the formation of polyactide but no loss of small molecules in the formation of Perspex.	
		4) Perspex is formed by addition polymerisation whereas polyactide is formed by condensation polymerisation.	Any 2 correct answers;;
	(e)	Mr of Perspex = 5x12 + 8 + 2 x16 = 100	;
		Minimum no. of repeat units = 24 000/100 = 240	;
		Maximum no. of repeat units = 30 000/100 = 300	
		Average range is 240 to 300.	;
B10 Or	**(a)**	(i) Down Group I, the melting point and boiling decreases.	;
	(a)	(ii) 1. Group I elements are metals with **metallic structure.** 2. As the Group 1 atomic radius increases down the group, the **electrostatic force of attraction between the metals ions and sea of delocalised electrons gets weaker./ metallic bonds get weaker** 3. **Less energy** is required to break the metallic bonds.	3 correct points mentioned;; 1-2 correct points mentioned;
		(iii)Their melting points are above room temperature.	;
	(b)	(i) O_2^{2-}	;
		(ii) O_2^-	;
	(c)	(i) Below iodine.	;
		Element **Z** has melting point greater than iodine. Since the melting point of Group VII increases down the group, element **Z** should be placed below iodine.	; ;
		(ii) Equal volume of aqueous **Z_2** is added to a certain volume of aqueous **potassium iodide.**	;
		If the **colourless potassium iodide turns reddish brown**, it indicates that **Z_2** is **more reactive** than iodine. If the colourless potassium iodide remains unchanged for certain period of time, element Z is less reactive than iodine.	Colour change is described clearly; Correct deduction;

Geylang Methodist School (Secondary)
Preliminary Examination 2014

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **Sec 4 Express**

Additional materials : OAS **1 hour**

Setter : Ms Tong Ai Li **1 September 2014**

READ THESE INSTRUCTIONS FIRST

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

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

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

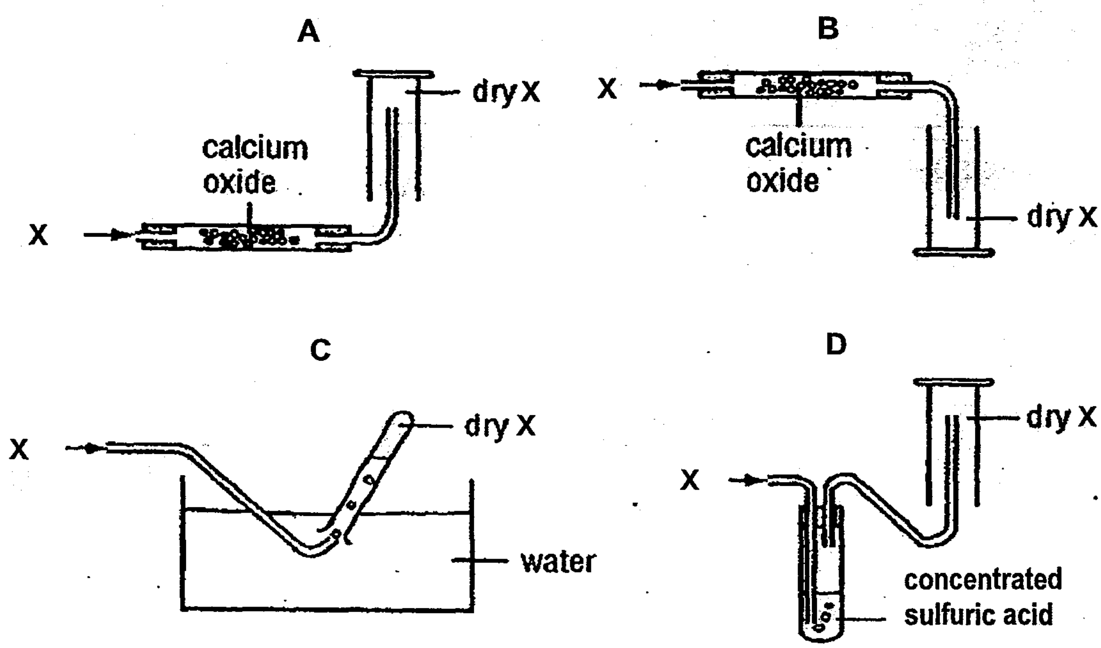
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark.
A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 19.

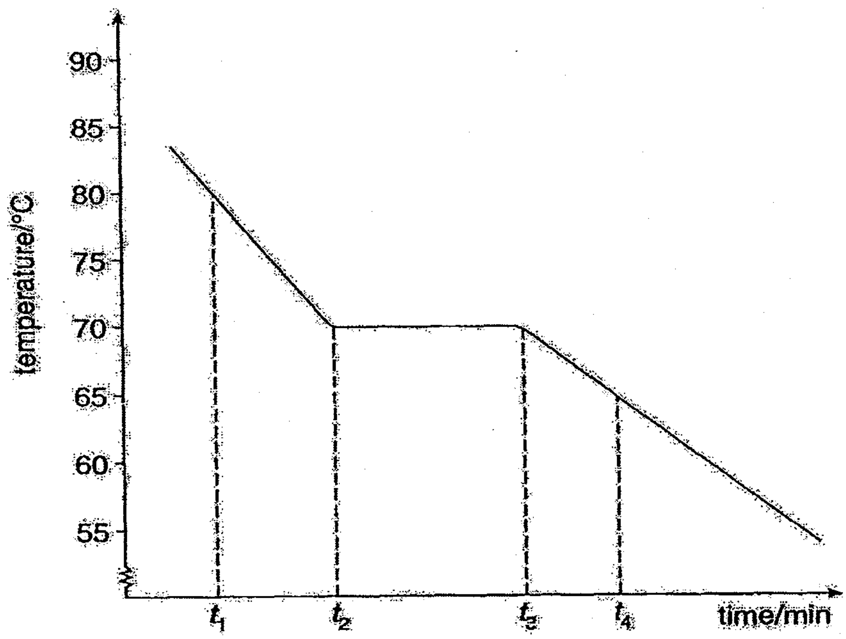
This document consists of **18** printed pages and **1** blank page.

1 Gas X is less dense than air, very soluble in water and is alkaline in nature.

Which method is used to obtain a dry sample of the gas?



2 Stearic acid is a solid at room temperature. The cooling curve of stearic acid is shown below.



From the graph, we can infer that

A at the time interval t_1 to t_2, heat is absorbed from the surroundings.

B at time t_2, all the stearic acid exists as a solid.

C at the time interval t_2 to t_3, crystals of stearic acid are formed.

D at the time interval t_2 to t_3, all the stearic acid exists as a solid.

3 50 cm^3 of methane diffused through a porous pot in 100 seconds. 50 cm^3 of gas Y took 400 seconds to diffuse under the same conditions of temperature and pressure.

What could gas Y be?

A ammonia

B carbon dioxide

C butane

D sulfur dioxide

4 A student was given an unknown white solid X. He did a melting point determination and obtained a value of 121 °C. A Chemistry book listed a substance called benzoic acid as having a melting point of 121°C. To check whether or not X was benzoic acid, he mixed X with benzoic acid using 1 part of X to 4 parts of benzoic acid. He found that the melting point of this mixture was 116°C.

What can he deduce about substance X from this?

A X is benzoic acid.

B X is not benzoic acid.

C X is impure benzoic acid.

D X really melts at 116 °C and not 121 °C.

5 Derek and Adrian were investigating the substances that produce the colour in a type of sweet. The solution obtained from the sweet was separated by chromatography. The chromatograms obtained by Derek and Adrian are shown in Figures M and N.

Why are the two chromatograms different?

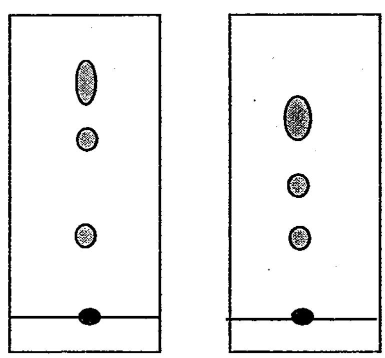


Figure M Figure N

A Derek and Adrian used different solvents.

B One of the boys did not use enough solvent.

C The solvent moved up the paper at different speeds.

D The solvent in Figure N did not reach the top of the paper.

6 The ion X^- contains 19 particles in the nucleus and 10 electrons outside the nucleus.

What does the nucleus of the ion X^- contain?

	protons	neutrons
A	8	11
B	11	8
C	9	10
D	10	9

7 Element P and Q form a compound with formula PQ_3. This compound exists as a liquid at room temperature.

What are the correct electron arrangements of atoms P and Q?

	P	Q
A	1	2.3
B	2.1	2.8.3
C	2.8.3	2.7
D	2.8.5	2.8.7

8 The equation shows the reaction between element X and dilute hydrochloric acid.

$$X(s) \quad + \quad 2\,HCl(aq) \quad \rightarrow \quad XCl_2(aq) \quad + \quad H_2(g)$$

What types of bonding are present in element X and in compound XCl_2?

	in element X	in compound XCl_2
A	covalent	covalent
B	covalent	ionic
C	metallic	covalent
D	metallic	ionic

9 Chlorine gas is a severe irritant to the eyes and respiratory system. The maximum safe toleration level of chlorine gas in air is 0.005 mg/dm^3. (1 mg = $\frac{1}{1000}$ g)

How many molecules of chlorine gas are present in 1 dm^3 of air at this toleration level?

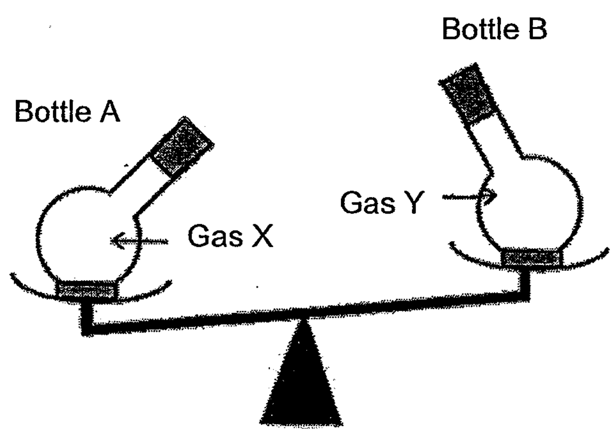
A $\frac{0.005}{6\times10^{23}} \times 71$

B $\frac{0.005}{71} \times 6 \times 10^{23}$

C $\frac{0.005}{1000} \times \frac{1}{71} \times 6 \times 10^{23}$

D $\frac{0.005}{1000} \times 71 \times 6 \times 10^{23}$

10 At room temperature and pressure, two identical flasks which have been filled up with gas X and Y were put on a balance. The result is shown below.



Which of the following statements is correct?

A The number of gas particles in bottle A is greater than the number of gas particles in bottle B.

B The number of moles of gas particles in bottle A is greater than the number of moles of gas particles in bottle B.

C The molar mass of gas particles in bottle A is greater than the molar mass of gas particles in bottle B.

D The molar volume of gas particles in bottle A is greater than the molar volume of gas particles in bottle B.

11 30.0 cm^3 of aqueous KOH is required to completely react with 15.0 cm^3 of 0.20 mol/dm^3 of aqueous H_2SO_4?

What is the concentration of the aqueous KOH used?

A 0.10 mol/dm^3

B 0.20 mol/dm^3

C 0.40 mol/dm^3

D 0.50 mol/dm^3

12 Element X exists as a gaseous molecule X_2 at room temperature and pressure. One volume of element X combines with two volumes of hydrogen gas to form 2 volumes of gaseous hydride of X.

What is the chemical formula of the hydride of X formed?

A HX

B HX_2

C H_2X

D H_2X_2

13 The table shows the properties of four compounds.

Which compound could be ethanoic acid?

compound	degree of ionization in water	addition of an aqueous solution of the compound to magnesium
A	high	hydrogen produced
B	high	no reaction
C	low	hydrogen produced
D	low	no reaction

14 Which of the following cannot be prepared by reacting metal with dilute acid?

A Aluminium nitrate

B Copper(II) nitrate

C Magnesium nitrate

D Zinc sulfate

15 Methylamine, CH_3NH_2, is a weak base. Its properties are similar to those of ammonia.

Which of the following reagents will displace methylamine from its salt, methylammonium sulfate?

A magnesium

B dilute hydrochloric acid

C aqueous sodium carbonate

D aqueous potassium hydroxide

16 In which equation is the underlined substance reduced?

A $\underline{CuSO_4}(aq) + Mg(s) \rightarrow Cu(s) + MgSO_4(aq)$

B $2\underline{FeCl_2}(s) + Cl_2(g) \rightarrow 2FeCl_3(s)$

C $2\underline{SO_2}(g) + O_2(g) \rightarrow 2SO_3(g)$

D $\underline{NaOH}(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

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

Which statement is not correct?

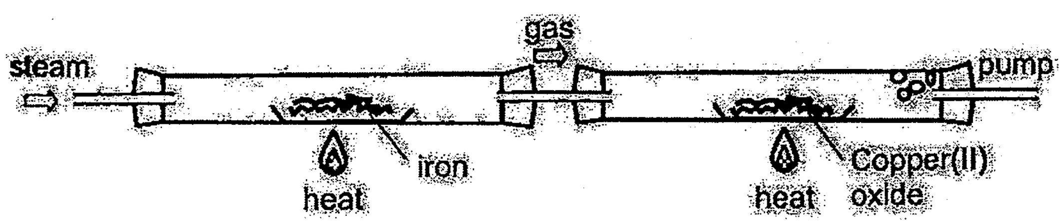
A The copper is oxidised.

B The total mass of the crystals of silver increases gradually.

C The total number of positive ions in the solution is unchanged.

D The solution turns blue.

18 Which of the following is not a product of the reaction sequence below?



A copper

B iron(III) oxide

C oxygen

D water vapour

19 The following observations were made when nickel and iron were placed separately into solutions of metals P, Q and R.

	salt solution of P	salt solution of Q	salt solution of R
nickel	displaced	not displaced	not displaced
iron	displaced	displaced	not displaced

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

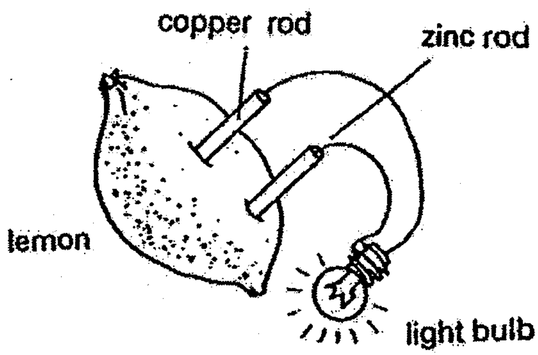
A P, Ni, Fe, Q, R

B R, Fe, Ni, Q, P

C R, Fe, Q, Ni, P

D R, Q, Fe, Ni, P

20 The diagram below shows a simple cell made with lemon.



Which of the following statements concerning this lemon cell is not correct?

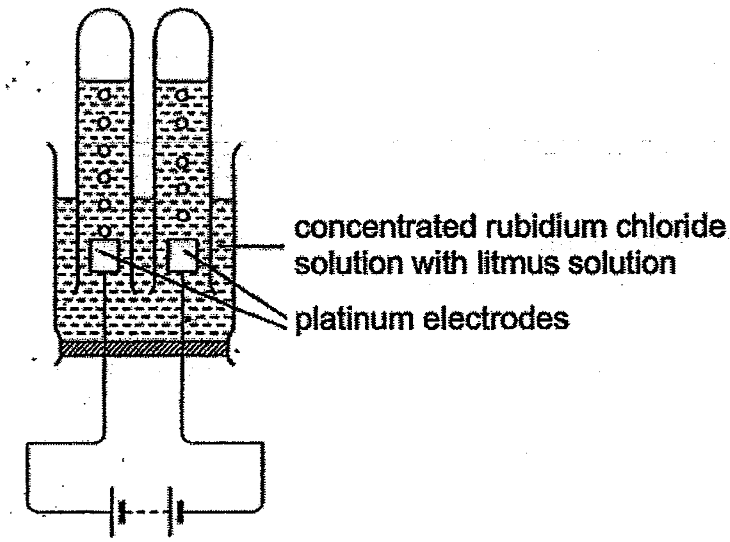
A Electrons flow from zinc rod to copper rod.

B The light bulb will not light up if the copper rod is replaced by a magnesium rod.

C The electrolyte in a lemon cell is the organic acid and mineral salts in the lemon.

D The light bulb will also light up if the lemon is replaced by an orange.

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



Which of the following statements is true?

A The anode decreases in mass.

B The pH of the electrolyte decreases.

C A greenish-yellow gas is formed at the cathode.

D The solution turns purple around the cathode.

22 In electroplating a chromium bracelet with silver, which of the following combinations is correct?

	anode	cathode	electrolyte
A	bracelet	silver	silver nitrate
B	silver	bracelet	silver nitrate
C	bracelet	silver	chromium nitrate
D	silver	bracelet	chromium nitrate

23 The table below gives some information about element Y.

Density / g/cm^3	6.2
Melting point / °C	1280
Formulae of oxides	YO (white) Y_2O_3 (brown)
Chemical properties	Reacts readily with O_2 or Cl_2

Which of the following statements about element Y is likely to be correct?

A Y is an alkali metal.

B Y is a metal in Group III.

C Y is a transition metal.

D Oxides of Y are amphoteric.

24 The metal rubidium is below potassium in Group I of the Periodic Table.

Which statement is most likely to be correct?

A Rubidium has a higher melting point than potassium.

B Rubidium has a higher tendency to be oxidised than potassium.

C Rubidium is less dense than potassium.

D Rubidium reacts less vigorously in water than potassium.

25 Which process is endothermic?

A The combustion of ethanol in air

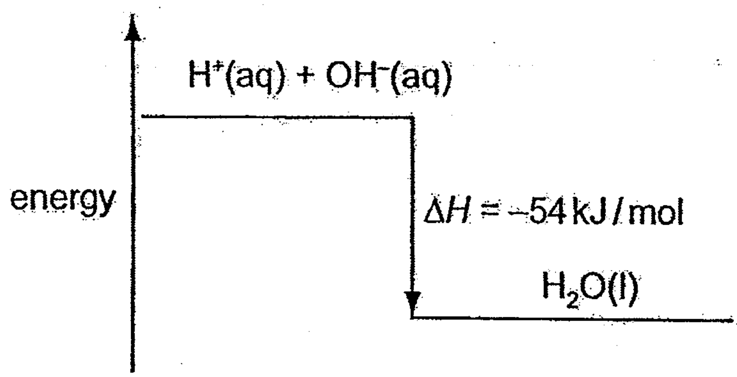
B The addition of water to anhydrous copper(II) sulfate

C The oxidation of carbon to carbon dioxide

D The decomposition of calcium carbonate in blast furnace

26 The energy level diagram for the reaction between sodium hydroxide and hydrochloric acid is shown below.

What can be deduced from the diagram?



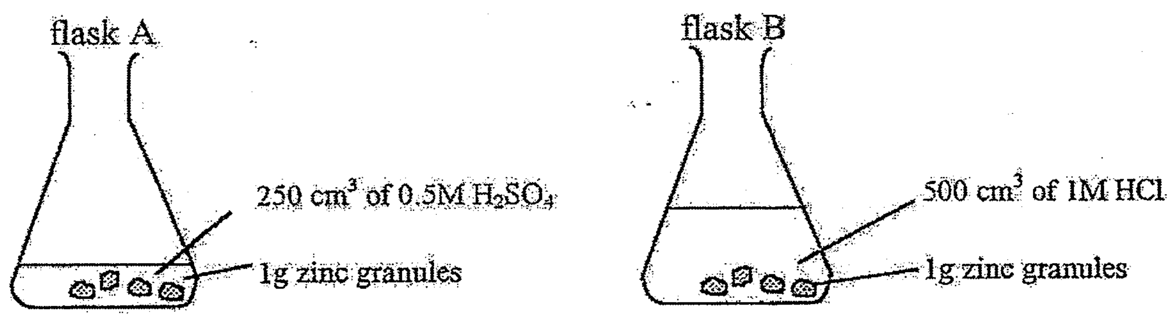
A The reaction is rapid.

B Heat is needed to start the reaction.

C The OH^- ions have more energy than the H^+ ions.

D The products contain less energy than the reactants.

27 Which of the following statements about the experiment below is correct?



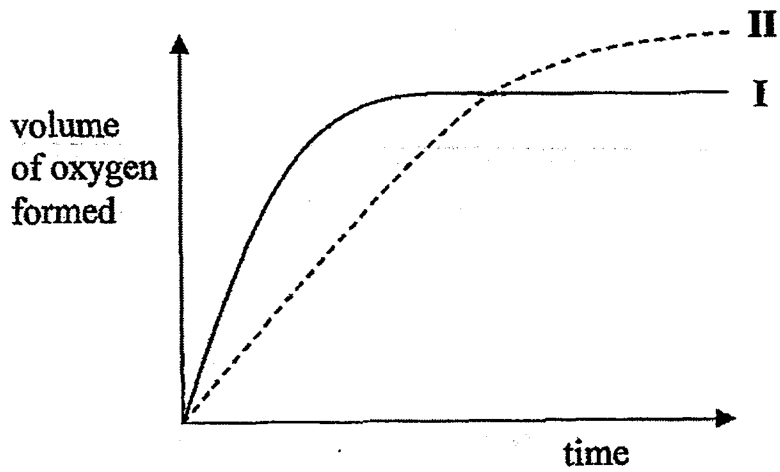
A Flask A produces a larger volume of gas

B Flask B produces a larger volume of gas

C Flask B produces gas at a faster rate

D Both flask A and flask B produce gas at the same rate

28 Curve **I** is obtained by the decomposition of 100 cm^3 of 1 mol/dm^3 aqueous hydrogen peroxide, catalysed by manganese(IV) oxide.



What change to the conditions will produce curve **II**?

A Lowering the temperature.

B Using 150 cm^3 of 1 mol/dm^3 aqueous hydrogen peroxide.

C Using 150 cm^3 of 0.5 mol/dm^3 aqueous hydrogen peroxide.

D Using 150 cm^3 of 0.75 mol/dm^3 aqueous hydrogen peroxide.

29 Nitrogen and hydrogen reacts to form ammonia in the Haber process.

Which statement is correct?

A A high yield of ammonia is favoured by high temperature.

B Increasing the pressure speeds up the reaction.

C Nickel catalyst is used to increase the production of ammonia.

D The reaction between nitrogen and hydrogen is irreversible.

30 A metal R lies between magnesium and iron in the reactivity series.

Which reaction is R most likely to undergo?

A It displaces sodium from an aqueous solution of sodium salt.

B Its oxide decomposes to give the metal on heating.

C It liberates hydrogen from dilute hydrochloric acid.

D It reduces magnesium oxide to magnesium on heating.

31 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.

Which compound would cause the most depletion of the ozone layer?

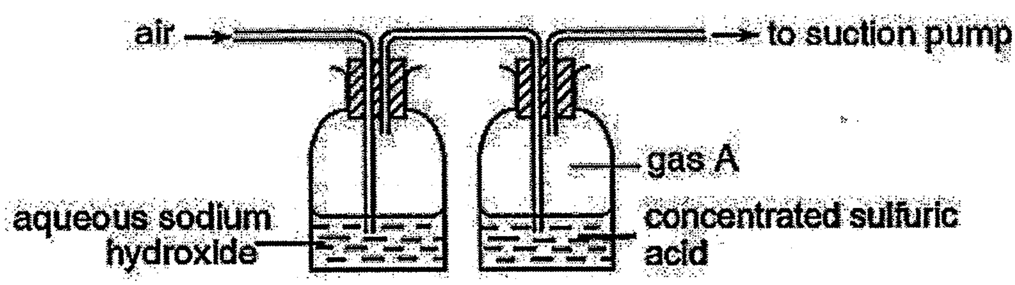
A CCl_3F

B CF_4

C $CHClF_2$

D CH_2F_2

32 A sample of air is passed through the apparatus shown below.



What would be the composition of gas A after passing air through aqueous sodium hydroxide and then concentrated sulfuric acid?

A Noble gases only

B Oxygen, carbon dioxide, nitrogen

C Oxygen, nitrogen, water vapour

D Noble gases, oxygen, nitrogen

33 Which one of the following statements correctly describes the fraction collected at the bottom of the fractionating column during fractional distillation of petroleum?

A It has the lowest boiling point.

B It has the highest viscosity.

C It has the lowest density.

D It contains small molecules.

34 The reaction between a hydrocarbon C_yH_6 and chlorine can be represented as follows.

$$C_yH_6\,(g) \quad + \quad 2Cl_2\,(g) \quad \rightarrow \quad C_yH_4Cl_2\,(g) \quad + \quad 2HCl\,(g)$$

Which of the following statement is correct?

A It is an addition reaction.

B Ultraviolet light is required for the reaction to take place.

C The molecular formula of the hydrocarbon is C_3H_6.

D High temperature and a catalyst are required in the reaction.

35 The equation shows the cracking of one mole of pentane, C_5H_{12}, into two organic compounds at high temperature, in the presence of a solid catalyst.

$$C_5H_{12} \rightarrow C_3H_8 + X$$

Compound X is further reacted with 1 mole of chlorine to form Y.

Which of the following is likely to be the structure of compound Y?

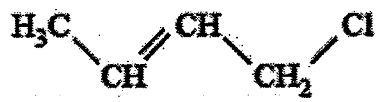
A CH_2CH_2

B CH_2ClCH_2Cl

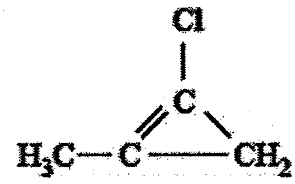
C $CHCl_2CHCl_2$

D CH_3CHCl_2

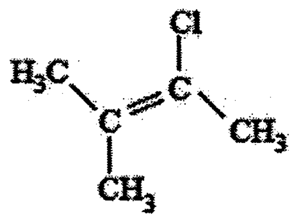
36 Which of the following formulae represents a pair of isomers?



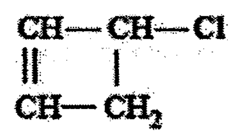
(I)



(II)



(III)



(IV)

A (I) and (II) **C** (I) and (III)

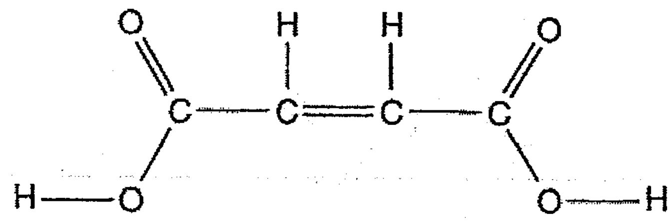
B (I) and (IV) **D** (II) and (IV)

37 Methanoic acid reacts with propanol to form a sweet smelling substance Z.

Which of the following gives a correct description of Z?

	name	chemical formula
A	methyl propanoate	$C_2H_5COOCH_3$
B	methyl propanoate	$CH_3COOC_2H_5$
C	propyl methanoate	$C_2H_5COOCH_3$
D	propyl methanoate	$HCOOC_3H_7$

38 The structure of an organic compound is shown below:



Which one of the following statements is not correct?

A Its aqueous solution reacts with sodium carbonate.

B It decolourises an aqueous solution of bromine.

C It is oxidised by acidified potassium manganate(VII) to form an alcohol.

D It is an unsaturated compound.

39 Which of the following can best be used to distinguish between propene and propane?

A Limewater

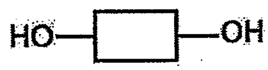
B Litmus solution

C Aqueous bromine

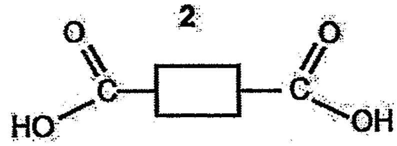
D Acidified potassium manganate(VII)

40 The structure of five monomers are shown.

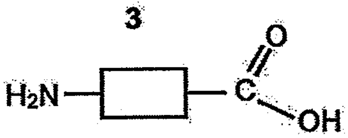
1



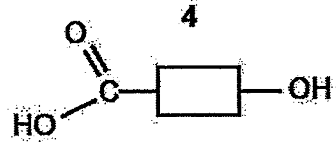
2



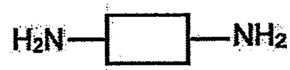
3



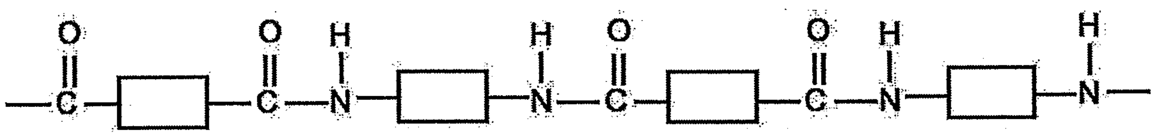
4



5



Which pair of monomers will form a polyamide with the following structure?



A	1 and 2	**C**	2 and 5
B	2 and 3	**D**	4 and 5

End of Paper 1

GEYLANG METHODIST SCHOOL (SECONDARY)
Prelim 2014
4E Pure Chemistry 5073/01 Answers

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

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.).

17

Geylang Methodist School (Secondary)
Preliminary Examination 2014

Candidate Name			
Class		Index Number	

CHEMISTRY **5073/02**

Paper 2 **Sec 4 Express**

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

Setters : Ms Ng Peck Suan
Mr Lim Zong Han **28 August 2014**

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions in the spaces provided on the Question Paper.

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

For Examiner's Use	
Section A	
B8	
B9	
B10	
Total	80

Section A

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

A1 Choose from the following substances to answer the questions below.

Hydrogen	Oxygen	Helium	Caesium
Sulfur	Nylon	Sodium chloride	

Each substance can be used once, more than once, or not at all.

Name a substance which

(a) is an element and is soft with a low density;

....[1]

(b) is a polymer containing amide linkage;

....[1]

(c) conduct electricity in the solid state;

....[1]

(d) combust to produce a pollutant;

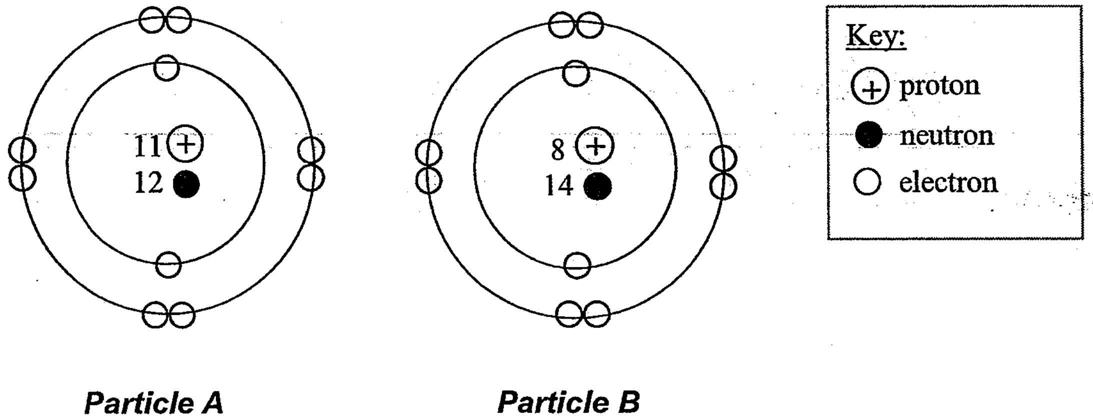
....[1]

(e) is produced at the anode during electrolysis of dilute copper(II) sulfate.

....[1]

[5 marks]

A2 The structures of two particles, **A** and **B**, are shown.



(a) Give the formula of each particle.

.... [1]

(b) Give the formula of the compound formed between **A** and **B**.

.... [1]

(c) Calculate the mass of one mole of the compound formed between **A** and **B**.

....

.... [2]

[4 marks]

A3 The table below shows the colours of manganese in different oxidation states.

(a) Fill in the missing oxidation state of manganese in the following ions.

ion / substance	colour	oxidation state of manganese
MnO_4^-	Purple	
Mn^{2+}	Light pink	
MnO_4^{2-}	Green	+6
MnO_2	Black	

[1]

(b) When solid manganese(II) nitrate, $Mn(NO_3)_2$, is heated, the products are solid manganese(IV) oxide, MnO_2, and a brown gas, NO_2, only.

(i) Write a balanced chemical equation, including state symbols for the above reaction.

.... [2]

(ii) Describe any colour change observed when manganese(II) nitrate is heated.

.... [1]

(iii) Using the change in oxidation state, explain whether manganese(II) nitrate is oxidized or reduced.

....

....

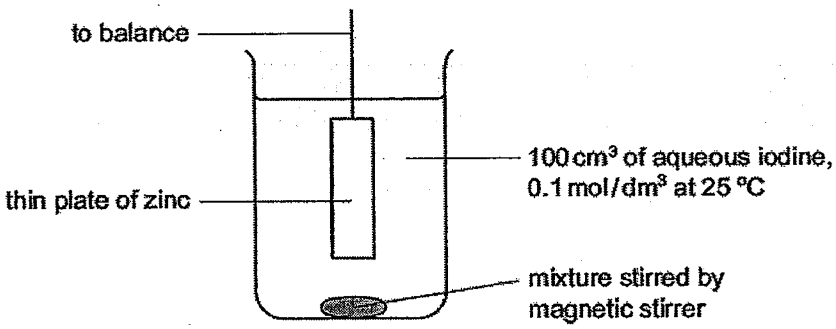
....

....

.... [2]

[6 marks]

A4 Zinc reacts with aqueous iodine to form zinc iodide.
The following apparatus was used to measure the rate of the reaction between zinc and aqueous iodine at 25°C.



The mass of the zinc plate was measured every minute until the reaction was complete.

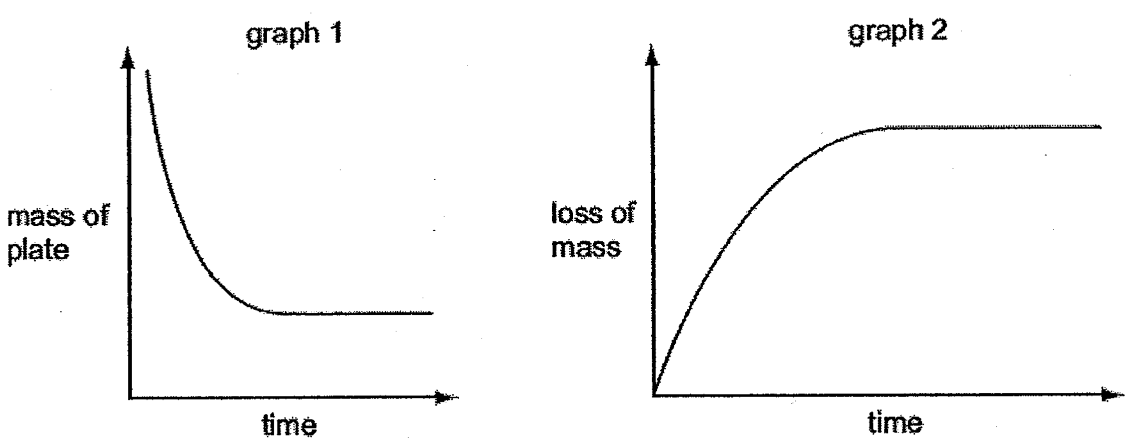
(a) Describe what test can be done to confirm the presence of zinc ions in the solution.

....

....

.... [2]

(b) From the results of this experiment, two graphs were plotted.



(i) Which reagent, iodine or zinc, was in excess? Give a reason for your choice with reference to the graphs above.

....

.... [1]

(ii) Explain why the mass of the zinc plate decreased.

....

.... [1]

(c) Explain, in terms of reacting particles, the effect on the rate of reaction if the experiment was repeated at 15°C with all other conditions kept constant.

....

....

....

.... [2]

(d) The experiment was repeated with 100 cm^3 of 0.05 mol/dm^3 iodine, keeping all other conditions the same. Sketch the curve that would be obtained on graph 1 and label it '**X**'. [1]

(e) In another experiment, the aqueous iodine was replaced with 100 cm^3 of 0.1 mol/dm^3 aqueous chlorine. Sketch the curve that would be obtained on graph 2 and label it '**Y**'. [1]

(f) Describe and explain what would be observed if chlorine was bubbled into the zinc iodide solution formed.

....

....

....

.... [2]

[10 marks]

A5 Iron(III) chloride can be prepared by passing chlorine gas over heated iron filings which are in excess.

(a) State how the solid iron(III) chloride formed can be obtained from the mixture.

....

.... [1]

(b) Iron(II) chloride can be prepared from iron and hydrochloric acid.

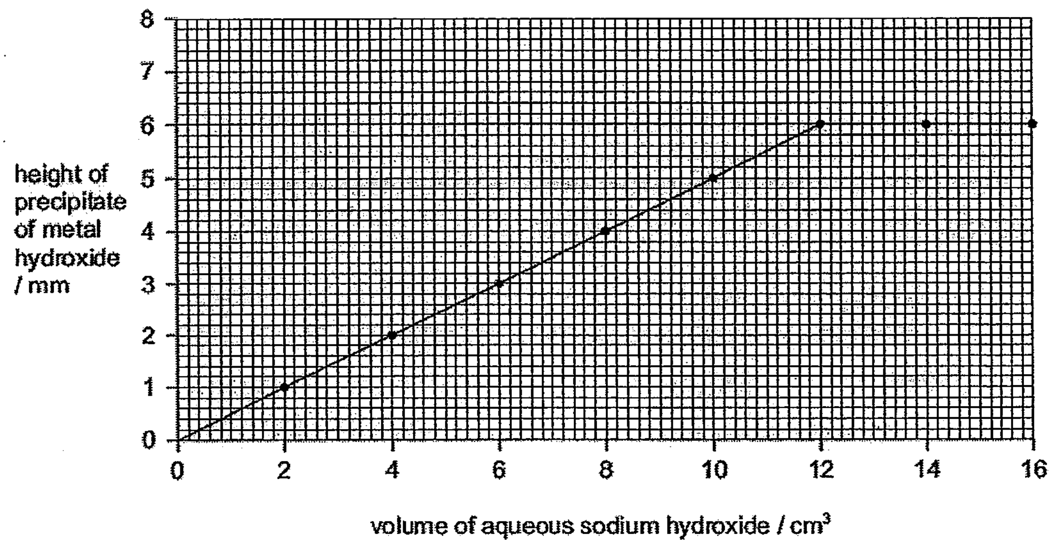
Describe how a pure solution of aqueous iron(II) chloride can be prepared.

....

....

.... [2]

(c) 2.0 cm^3 portions of aqueous sodium hydroxide was added to 4.0 cm^3 of aqueous iron (III) chloride. Both solutions had a concentration of 1.0 mol/dm^3. After each addition of sodium hydroxide, the mixture was stirred, allowed to settle and the height of the precipitate formed was measured. The results are shown on the following graph.



(i) Write the ionic equation with state symbols for the formation of the precipitate.

.... [2]

(ii) Calculate the number of moles of iron(III) chloride used.
Hence calculate the maximum mass of precipitate formed in the above reaction.

[3]

(d) If the iron(II) chloride had been used instead of iron(III) chloride, using the graph above, predict the minimum volume of sodium hydroxide that would be required to produce the maximum height of precipitate

.... [1]

(e) Describe and explain how the graph would be different if aluminium chloride had been used instead of iron (III) chloride.

....

....

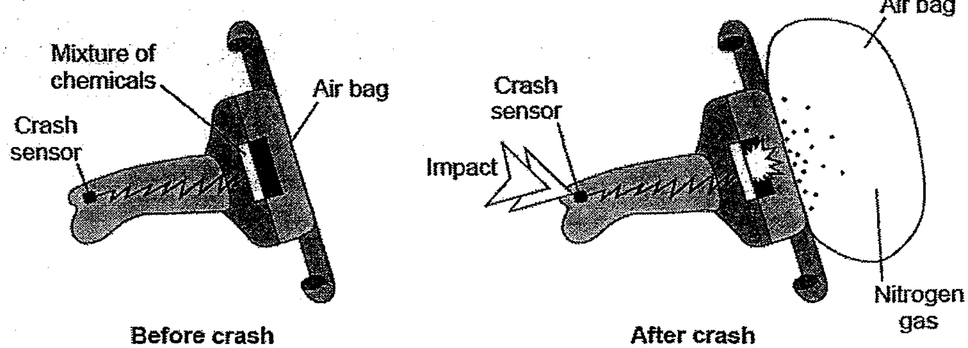
....

....

.... [2]

[11 marks]

A6 Air bags are used to protect passengers in a car during an accident. When the crash sensor detects an impact it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.



(a) The mixture of chemicals contains sodium azide (NaN3), which decomposes on heating to form sodium and nitrogen.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

An air bag contained 130 g of sodium azide. When the sodium azide decomposed, 60 dm^3 of nitrogen was obtained at room temperature and pressure.

(i) Calculate the percentage yield of nitrogen from the decomposition of sodium azide.

[3]

(ii) By showing valence electrons only, draw a dot and cross diagram to show the bonding in nitrogen gas.

[2]

(b) The sodium produced when the sodium azide decomposes is dangerous.
The mixture of chemicals in the air bag contains potassium nitrate and silicon dioxide which help to make the sodium safe. Sodium reacts with potassium nitrate to produce sodium oxide, potassium oxide and nitrogen.

(i) Write the equation for the reaction between sodium and potassium nitrate.

.... [1]

(ii) The silicon dioxide reacts with the sodium oxide and potassium oxide to form silicates.

Suggest why sodium oxide and potassium oxide are dangerous in contact with the skin.

....

....

.... [1]

[7 marks]

A7 In the Haber Process, ammonia gas is produced. One of the uses of ammonia is to make fertilizers. Ammonium sulfate, ammonium phosphate and urea are three fertilizers. They are used to provide soil with essential elements for plants growth. Some information on the fertilizers are given below.

fertilizer	relative molecular mass	cost / kg
ammonium sulfate $(NH_4)_2SO_4$	132	1.30
ammonium phosphate $(NH_4)_3PO_4$	149	1.00
urea $CO(NH_2)_2$	60	1.10

(a) If you are a farmer and you would like to buy fertilizer to enhance the protein formation in plants, which one of the above fertilizers would you buy? Explain your choice of answer and show your working.

....

....

....

....

.... [2]

(b) In regions where acid rain is frequent, it is not a practice for farmers to neutralize the acidic soil with slaked lime, calcium hydroxide at the same time as adding the fertilizer. Explain.

....

....

.... [1]

(c) Calculate the mass of ammonia required to produce 13.2 tonnes of ammonium sulphate. (1 tonne = 1000 kg)

[2]

(d) State the source of reactants used in the Haber process.

....

....

....

.... [2]

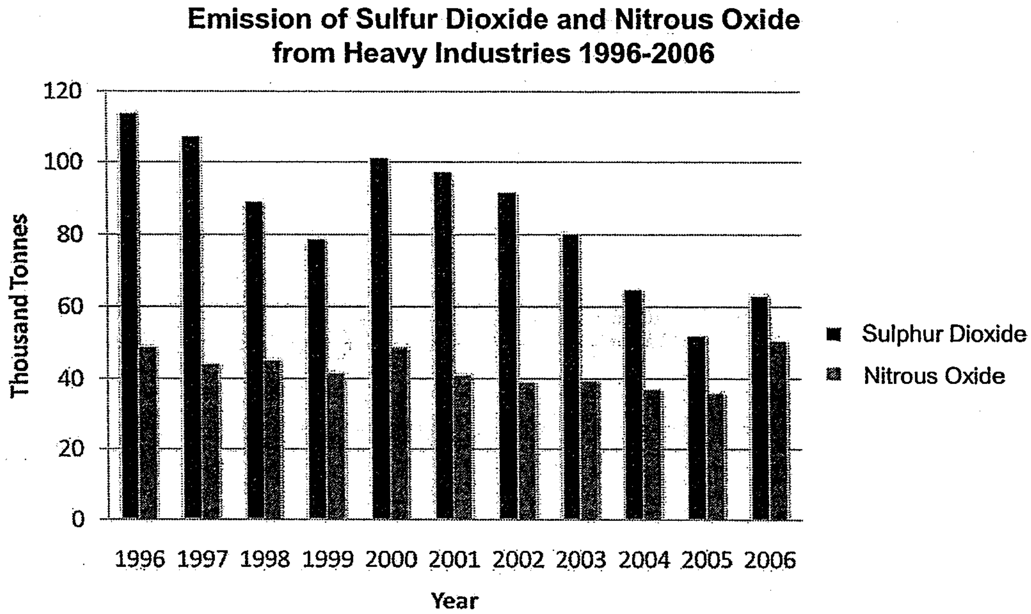
[7 marks]

End of Section A

Section B

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

B8 The bar chart illustrates the amount of air pollutants, namely sulfur dioxide and nitrous oxide gases from heavy industries in the past ten years in Scotland.



Source: UK National Air Quality Archive

(a) **(i)** State one effect of sulfur dioxide gas on humans. [1]

(ii) Suggest a reason why the emission of nitrous oxide is always less than sulfur dioxide. [1]

(b) There is a downward trend in the amount of sulfur dioxide gas emitted from the year 2000 to 2005.

(i) Suggest a method that may be used by the government to minimise the amount of sulfur dioxide gas released by the industrial factories. [1]

(ii) Explain how the method suggested in **b(i)** helps to remove the sulfur dioxide gas.
You should include chemical equations in your answer. [2]

(c) Sulfur dioxide and nitrous oxide gases both contribute to the formation of acid rain when they are dissolved in rainwater.

(i) Describe a **simple** test to be conducted to show which one of the acid formed is stronger as compared to the other. [1]

(ii) Explain why both gases will form acids of different strengths. [3]

(d) Explain why rain water is slightly acidic even if there is completely no emission of sulfur dioxide and nitrous oxide gases from heavy industries. [1]

[Total: 10]

B9 Ethylene glycol is oxidized by a purple solution to form colourless products. The time taken for the purple colour to decolourise can be used to measure the rate of this reaction.

Peter was asked to perform the experiment and the table below shows the results obtained.

concentration of ethylene glycol (% by volume)	4	10	15	24	30
time taken for purple colour to decolourise (s)	375	150	95	62	50

(a) Using a graph paper provided, putting time taken on the y-axis, draw a smooth curve using the data above. [3]

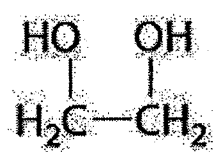
(b) Use your graph to estimate the time taken for the purple colour to decolourise when the concentration of ethylene glycol is 20%. [1]

(c) If the concentration of ethylene glycol increases from 20% to 40%, what will happen to the rate of reaction? [1]

(d) By using the collision theory, give a reason to support your answer in **(c)**. [2]

(e) **(i)** Suggest the identity of the purple solution.
Explain your answer. [2]

(ii) Ethylene glycol is also known as ethane-1,2-diol and it has the following structural formula.



Write the structural formula of the compound formed when ethylene glycol is being oxidized by the purple solution.

[1]
[Total: 10]

EITHER

B10 Magnesium is the eighth most common element in the Earth's crust. The metal is widely used in alloys which are light and strong. The Mg^{2+} cation is the second most abundant cation in seawater, which makes seawater and sea-salt an attractive commercial source of magnesium.

To extract the magnesium, calcium hydroxide is added to seawater to form magnesium hydroxide precipitate.

Magnesium hydroxide (brucite) is filtered out and reacted with hydrochloric acid to obtain concentrated magnesium chloride.

(a) Write the chemical equation for the reaction between brucite and hydrochloric acid. [1]

From the concentrated magnesium chloride, electrolysis produces magnesium and chlorine gas.

(b) Write the ionic half equation that has occurred at
(i) the cathode
(ii) the anode [2]

(c) Why is the outcome of the electrolysis unexpected? [2]

The United States has traditionally been the major world supplier of magnesium metal. However, as of 2005, China has taken over as the dominant supplier, pegged at 60% world market share. Unlike the electrolytic process described above, China relies on a different method of obtaining the metal from its ores, the silicothermic Pidgeon process.

The basic chemical equation for this process is

$$Si(s) + 2MgO(s) \rightarrow SiO_2(s) + 2Mg(g)$$

The magnesium is obtained by distilling the magnesium vapour.

(d) Compare the physical states of the two products of the Pidgeon process and explain why SiO_2 exists as a solid at such high temperatures. [2]

(e) (i) Under very high temperatures, carbon can reduce magnesium oxide.

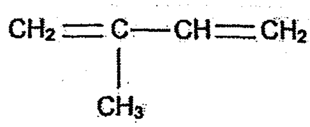
Write the chemical equation, with state symbols, of the reduction reaction between carbon and magnesium oxide. [2]

(ii) With reference to equations above, explain why the use of carbon, instead of silicon should not be used in this process to extract magnesium. [1]

[Total: 10]

OR

B10 Natural rubber is used extensively as synthetic rubber. It is originated from latex, which is a soft, natural polymer of cis-1,4-polyisoprene, more commonly known as isoprene. It is often used in the automotive industry for tyres, belts, and dampeners. Its structural formula is shown below.



(a) (i) Which homologous series would you classify isoprene? Give a reason for your answer. [2]

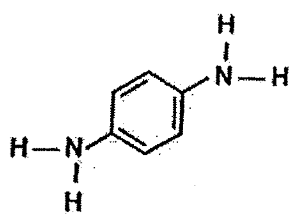
(ii) Describe one chemical test to justify your answer in **(a)(i)**.

State any observations made. [2]

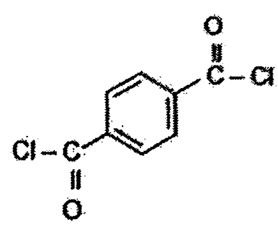
(b) What type of polymerisation would isoprene monomers undergo to form synthetic rubber? [1]

(c) Draw a repeat unit of the synthetic rubber formed. [1]

(d) Another polymer that has a wide range of applications is Kevlar, a polyamide. For example, Kevlar fibers are used to make bulletproof vests. It is synthesised from the monomers,1,4-phenylene-diamine and terephthaloyl chloride in a polymerisation reaction yielding hydrogen chloride as a by-product.



1,4-phenylene-diamine



terephthaloyl chloride

(i) What type of polymerisation would 1,4-phenylene-diamine and terephthaloyl chloride monomers undergo to form Kevlar?

Explain your answer. [2]

(ii) Draw a repeat unit of Kevlar. [1]

(iii) State one physical property of Kevlar that makes it a suitable material to make sports (badminton, squash, tennis... etc) rackets. [1]

[Total: 10]

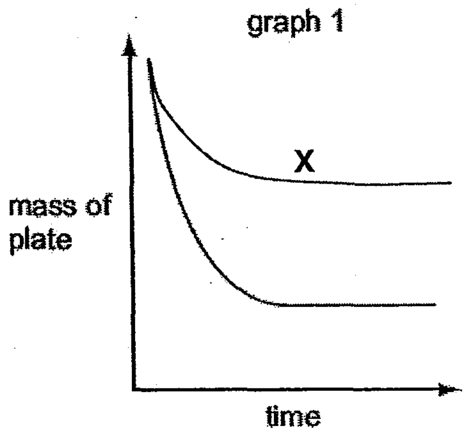
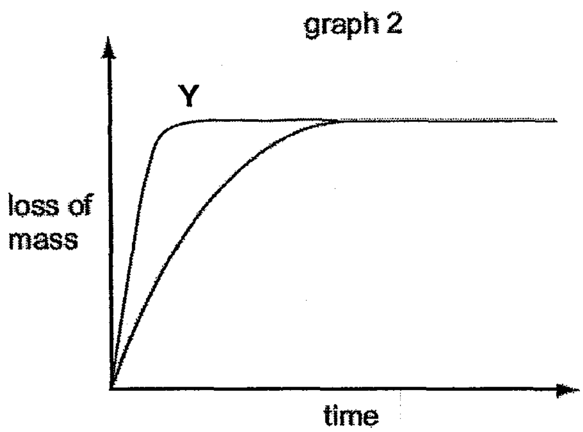
End of Paper

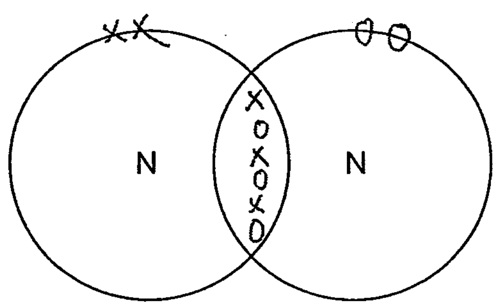
Geylang Methodist School (Secondary)
Preliminary Exam 2014
Sec 4EXP P Chemistry Papers 2 5073 / 02
Marking Scheme

	Paper 2 Section A	marks
A1 (a)	Caesium	[1]
(b)	Nylon	[1]
(c)	Caesium	[1]
(d)	Sulfur or nylon	[1]
(e)	Oxygen	[1]
A2 (a)	A^+, B^{2-}	Both correct [1m] Only 1 correct [0]
(b)	A_2B	[1]
(c)	Mass = 1 x (23x2)+22 = 68.0 g	[1] [1]
A3 (a)	(see table below)	All 3 oxidation states correct [1m] Any one incorrect [0]

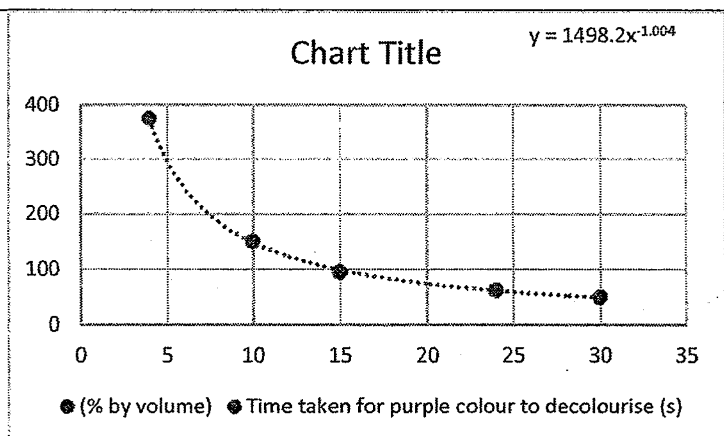
ion / substance	colour	oxidation state of manganese
MnO_4^-	Purple	**+7**
Mn^{2+}	Light pink	**+2**
MnO_4^{2-}	Green	+6
MnO_2	Black	**+4**

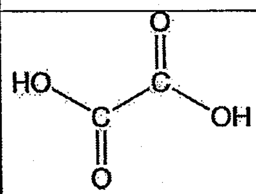
(b) (i)	$Mn(NO_3)_2$ (s) $\rightarrow$ MnO_2 (s) + $2NO_2$ (g)	[1] for equation, [1] for state symbols
(ii)	Pink $Mn(NO_3)_2$ turns black with brown gas evolved	[1]
(iii)	The oxidation state of manganese increased from +2 in $Mn(NO_3)_2$ to +4 in MnO_2. Hence $Mn(NO_3)_2$ is oxidised.	[1] [1]
A4 (a)	Add aqueous ammonia slowly to the solution until is in excess; If a white precipitate forms and the precipitate is soluble in excess aqueous ammonia, zinc ions are present.	[1] [1]
(b) (i)	Zinc is in excess. This is because the **mass of zinc** dropped to a constant value which **was not zero** indicating that zinc was not used up in the reaction.	Both main points in [1m] Either point not in [0]
(ii)	The **zinc has reacted** with the iodine molecules **to form zinc ions** in solution. OR The **zinc has ionized or been oxidized.**	[1]

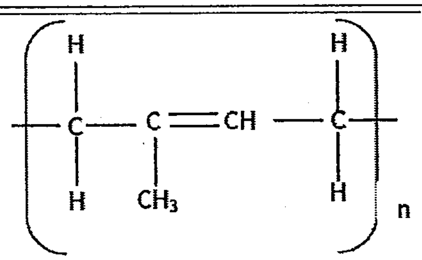
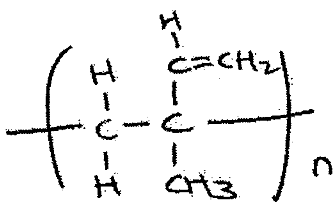
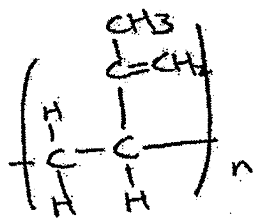
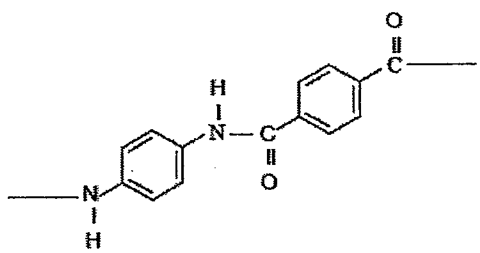
(c)	When the temperature is lowered from 25°C to 15°C, the **kinetic energy** of the reactant particles **decreases** and the particles **move slower**. This results in a **decrease in the number of collisions** between reactant particles and the **probability of effective collisions occurring decreases** and thus the rate of reaction decreases	[1] [1]
(d)		[1]
(e)		[1]
(f)	When chlorine is bubbled into colourless aqueous zinc iodide, a **brown solution of iodine** is formed; This is **because chlorine is more reactive than iodine** and **can displace iodide ions** from the aqueous zinc iodide to form brown iodine solution.	[1] [1]
A5 (a)	The iron(III) chloride can be separated from the excess iron using a magnet. Also accept : Add excess water and filter, crystallise filtrate	[1]
(b)	**Add excess iron** to a fixed volume of hydrochloric acid; **Filter** the mixture to obtain a pure solution of iron (II) chloride.	[1] [1]

(c) (i)	$Fe^{3+}(aq) + 3OH^{-}(aq) \rightarrow Fe(OH)_3(s)$	Ionic eqn [1] State symbols [1]
(ii)	No. of moles of iron (III) chloride reacted = 1 x 0.004 = 0.004 No. of moles of precipitate formed = 0.004 Mass of precipitate formed = 0.004 x (56 + 3x17)= 0.428 g	[1] [1] [1]
(d)	8 cm^3 Working not required. Should students asked for explanation: $Fe^{3+}(aq) + 3OH^{-}(aq) \rightarrow Fe(OH)_3(s)$ $Fe^{2+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s)$ From the graph, 3 mol of OH^- requires 12cm^3 of NaOH to produce max ht of ppt Thus, 2 mol of OH- will require 2/3 x 12 = 8 cm^3 of NaOH to produce max ht of ppt	[1]
(e)	Difference: The graph will increase from zero to a maximum value then decreases back to zero as the volume of sodium hydroxide increases. Reason for difference: The precipitate of aluminium hydroxide formed dissolves in excess sodium hydroxide thus the mass of precipitate decreases as it dissolves.	[1] [1]
A6 (a)(i)	No. of moles of sodium azide used = $\frac{130}{65} = 2$ No. of moles of nitrogen produced = 3 Theoretical yield of nitrogen = 3 x 24 = 72 dm^3 Percentage yield of nitrogen = $\frac{60}{72}$x100 = 83.3%	[1] [1] [1]
(ii)		[1] - for correct number of electrons [1] - for correct number of shared electrons
(b)(i)	$10Na + 2KNO_3 \rightarrow 5Na_2O + K_2O + N_2$	[1]
(ii)	Sodium oxide and potassium oxide form strong and **corrosive alkalis** when in contact with moisture on the skin.	[1]

A7 (a)	% of N in $(NH_4)_2SO_4 = \frac{2 \times 14}{2(14+4)+32+64} \times 100\%$ $= 21.2\%$ % of N in $(NH_4)_3PO_4 = \frac{3 \times 14}{3(14+4)+31+64} \times 100\%$ $= 28.1\%$ % of N in $CO(NH_2)_2 = \frac{2 \times 14}{12+16+2(14+2)} \times 100\%$ $= 46.1\%$ Urea would be chosen as it contains the greatest percentage of nitrogen.	Working = [1] Correct choice = [1]
(b)	The <u>ammonium ion</u> present in the fertilizer will <u>react</u> with the <u>slaked lime</u> (or calcium hydroxide) to produce <u>ammonia gas</u> which is lost to the surroundings. This process removes the nitrogen element from the soil which is much needed by plants for growth.	[1]
(c)	$2NH_3\,(aq) + H_2SO_4\,(aq) \longrightarrow (NH_4)_2SO_4(aq)$ No. of moles of $(NH_4)_2SO_4$ $= \frac{13.2 \times 10^6}{2(14+4)+32+64}$ $= 0.1 \times 10^6$ mol No. of moles of $NH_3 = 2 \times 0.1 \times 10^6$ $= 0.2 \times 10^6$ mol Mass of $NH_3 = 0.2 \times 10^6 \times (14+3)$ $= 3.4 \times 10^6$ $= 3.4$ tonnes	[1] [1]
(d)	Hydrogen is obtained from the cracking of large hydrocarbons while the nitrogen is obtained from the fractional distillation of liquid air.	[1] [1]

	Paper 2 Section B	
B8		
(a) (i)	• Irritates the eyes • Cause breathing difficulties by irritating the lungs. • Inflammation of lungs (bronchitis) (any 1 of the above)	[1] Do not accept formation of acid rain
(ii)	The fossil fuels burnt in the heavy industries contain a high percentage of **sulfur as an impurity**, thus it will be oxidised to form sulfur dioxide gas, thus the emission of nitorus oxide is comparatively lesser than sulfur dioxide.	[1]
(b) (i)	Installing a **Flue Gas Desulfurisation** plant (FGD).	[1]
(ii)	• As sulfur dioxide passes through the plant, it reacts with an aqueous suspension of calcium carbonate / calcium oxide to form calcium sulphite. $CaCO_3\,(s) + SO_2\,(g) \rightarrow CaSO_3\,(s) + CO_2\,(g)$ • The calcium sulphite is futher oxidised to calcium sulphate by atmospheric oxygen. $2\,CaSO_3\,(s) + O_2\,(g) \rightarrow 2\,CaSO_4\,(s)$	[2] for both points and correct equations [1] for at either both points / one point and one correct equation
(c) (iii)	Use a pH meter or universal indicator to determine which acid is stronger. [0] for addition of metal to acid / other chemical reaction	[1]
(iv)	Sulfur dioxide dissolves in water to form sulfurous acid which oxidises to **sulfuric acid**. Nitrogen dioxide dissolves in water to form **nitric acid**. Sulfuric acid contains **twice the amount of hydrogen ions** as compared to nitric acid, thus sulfuric acid is stronger than nitric acid.	[1] [1] [1]
	Carbon dioxide found in the atmosphere (0.03%) dissolves in rainwater to form carbonic acid, which is a weak acid.	[1]
B9		
(a)		[1] for smooth curve [1] for correct points [1] for appropriate axes

(b)	73.5 s	[1] Accept range between 70 s to 75 s
(c)	Increases Do not accept if time taken for the reaction is shorter	[1]
(d)	Increase in concentration of ethylene glycol means **more particles per unit volume** Increasing the frequency of **successful/effective collision** Leading to shorter time taken for decolourisation	[1] [1]
(e) (i)	Purple solution is **acidified aqueous potassium manganate(VII)**	[1]
	It is an oxidising agent which **oxidises** ethylene glycol / when it reacts with ethylene glycol, it changes from **purple to colourless** rapidly.	[1]
(ii)		[1]
B10	**Either**	
(a)	$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$	[1]
(b) (i) **(ii)**	Mg_2+ + 2e $\rightarrow$ Mg $2Cl^- \rightarrow Cl_2 + 2e$	[1] [1]
(c)	At the cathode, hydrogen ions should be preferentially discharged to form hydrogen gas. Hydrogen ions are less stable than magnesium ions.	[1] [1]
(d)	Macromolecular structure. Strong covalent bonds between the silicon and oxygen atoms which extend throughout the entire structure. Large amount of energy required to overcome these strong bonds.	[1] [1]
(e) (i) **(ii)**	$C(s) + 2MgO(s) \rightarrow CO_2(g) + 2Mg(g)$ Carbon dioxide gas produced will contaminate the magnesium vapour.	[1] correct equation [1] correct state symbols [1]

B11	**Or**	
(a) (i)	Alkene Contains at least one set of C=C double bond 2	[1] [1]
(ii)	**Add bromine water to isoprene** bromine water turned from **reddish brown to colourless** rapidly	[1] [1]
(b)	Addition	[1]
(c)	  	[1]
(d) (i)	Condensation polymer. Due to the production of small molecules / hydrochloric acid. (OR) A byproduct is also formed.	[1] [1]
(ii)		[1]
(iii)	Strong / High strength Low density / light weight Do not accept Hard	[1] accept any right answer

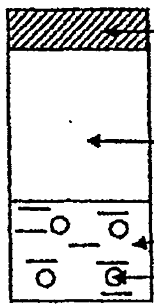
End of Paper

MGS Prelim 2014 P1

1 A new substance was discovered and a series of experiments were conducted on it. Which observation suggests that the substance cannot be an element?

A It dissolved in water to form a colourless solution.
B It had a fixed melting point.
C Electrolysis of the molten substance formed two products.
D When heated in air, it could form two oxides.

2 The gas jar contains compound W which is present in the solid, liquid and gaseous states.



Which one of the following statements is correct?

A Gaseous W molecules move at fixed position.
B Energy is released when W changes from gas to liquid.
C A gaseous W molecule has a lower mass than liquid W molecule.
D Energy is released when W changes from solid to liquid.

3 You are given a mixture of methylbenzene and dilute aqueous solution of copper(II) sulfate. Methylbenzene boils at 111°C and is insoluble in water. To obtain samples of methylbenzene and copper(II) sulfate crystals, which two methods would you employ?

	Method 1	Method 2
A	using of a separating funnel	evaporation
B	fractional distillation	crystallization
C	simple distillation	evaporation
D	using of a separating funnel	crystallization

4 In paper chromatography, which of the following is true of the substances in the mixture?

A They have the same R_f value.
B They are soluble in the solvent used.
C They are coloured.
D They are placed such that the spot is just below the liquid.

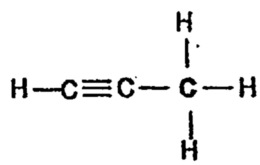
5 Deuterium is an isotope of hydrogen and has the symbol D. Which formula is incorrect for a deuterium compound?

A $ZnOD$
B CD_3CO_2D
C $C_2D_4Br_2$
D D_2O_2

6 Which one of the following ions has the most shells that contain electrons?

A Be^{2+}
B S^{2-}
C O^{2-}
D Mg^{2+}

7 An organic molecule has the structural formula:



What is the total number of shared pairs of electrons?

A 12
B 10
C 8
D 6

8 The table gives information about three solid substances, L, M and N.

Test on substances	Results		
	L	M	N
Electrical conductivity	Non-conductor in both solid and liquid state	Good conductor in both solid and liquid states	Non-conductor in solid state but good conductor in liquid state
Hit with a hammer	No change	Flattened	Shattered

What could these three substances be?

	L	M	N
A	bromine	zinc	calcium oxide
B	silicon dioxide	sodium	copper(II) sulfate
C	iodine	copper	methane
D	sodium	sulfur	sodium chloride

9 Which statement explains why aluminium oxide has a high melting point?

A There is a strong force of attraction between the ions and the delocalized electrons.

B The structure of aluminium oxide is similar to that of silicon(IV) oxide.

C Aluminium atoms and oxygen atoms are joined together by very strong triple covalent bonds.

D There is a very strong force of attraction between the aluminium ions and the oxide ions.

10 The equation shows the reaction between oxide of the metallic element X and dilute sulfuric acid.

$$XO\,(aq) + H_2SO_4\,(aq) \rightarrow XSO_4\,(aq) + H_2O\,(l)$$

Which particles are responsible for the electrical conductivity in X, XO and XSO_4?

	X	XO	XSO_4
A	cations	electrons	electrons
B	cations and anions	anions	cations
C	electrons	electrons	cations and anions
D	electrons	cations and anions	cations and anions

11 In moving across Period 3 from Group I to Group VII, the elements

1 have oxides whose characteristics change from acidic to basic.

2 have mass numbers differing by one unit.

3 show a gradual transition in properties from metallic to non-metallic properties.

A 3 only

B 2 only

C 1 and 2

D 1, 2 and 3

12 Phosphorus and nitrogen are both in Group V of the Periodic Table. Which ions would be produced when phosphine, PH_3, dissolves in water?

A PH_4^+, OH^-

B PH_3^+, OH^-

C PH_4^+, H^+

D PH_3^+, H^+

13 Element Y forms the compound Na_2YO_4. Which property of the compound shows that element Y is a transition element?

A Aqueous Na_2YO_4 gives a precipitate with aqueous lead(II) nitrate.

B Aqueous Na_2YO_4 can be produced by reacting an oxide of Y with aqueous sodium hydroxide.

C Acidified aqueous Na_2YO_4 oxidises aqueous iron(II) sulfate.

D Aqueous Na_2YO_4 has a yellow colour.

14 Sulfur trioxide decomposes according to the following equation:

$$2SO_3 \rightarrow 2SO_2 + O_2$$

What is the total volume of gas produced from the decomposition of 100 cm^3 of sulfur trioxide (all volumes of gases being measured at r.t.p.)?

A 200 cm^3

B 100 cm^3

C 150 cm^3

D 50 cm^3

15 The active component of tobacco, nicotine, found in cigarette smoking is thought to increase the chances of a person developing lung cancer. The relative molecular mass of nicotine is 162 and quantitative elemental analysis gave the following percentages by mass:

Carbon	74.0%
Hydrogen	8.7%
Nitrogen	17.3%

Which of the following is the correct molecular formula for nicotine?

A $C_{10}H_{14}N_2$

B $C_{10}H_{16}N_2$

C C_5H_7N

D $C_9H_{10}N_2$

16 Which of the following has the same number of atoms as 6 dm^3 of chlorine gas at room temperature and pressure?

A 0.125 g of hydrogen

B 8.5 g of ammonia

C 20 g of argon

D 24 g of magnesium

17 The overall equations to manufacture three fertilizers (ammonium sulfate, calcium hydrogen phosphate and ammonium phosphate) are shown below.

Reaction 1: $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$

Reaction 2: $2H_2SO_4 + Ca_3(PO_4)_2 \rightarrow Ca(H_2PO_4)_2 + 2CaSO_4$

Reaction 3: $3H_2SO_4 + Ca_3(PO_4)_2 + 6NH_3 \rightarrow 2(NH_4)_3PO_4 + 3CaSO_4$

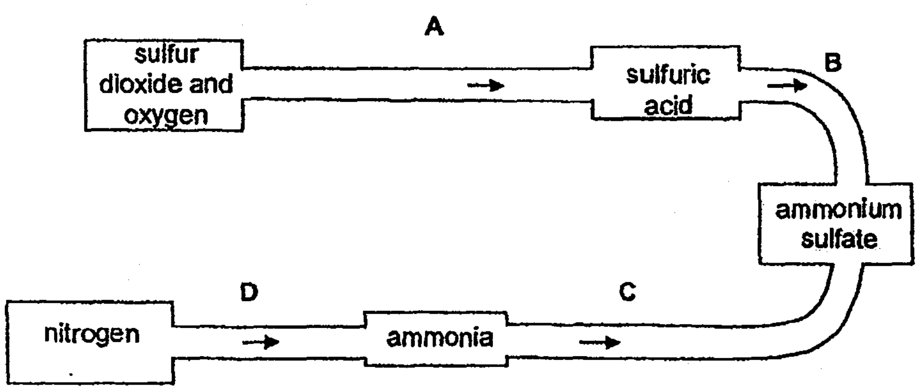
The relative molecular mass, M_r, of sulfuric acid and of each fertilizer is shown in the table.

Name of Compounds	H_2SO_4	$(NH_4)_2SO_4$	$Ca(H_2PO_4)_2$	$(NH_4)_3PO_4$
M_r	98	132	234	149

In each reaction, 98 tonnes of sulfuric acid was used. Which reactions gave the greatest and least mass of fertilizer?

	Greatest Mass	Least Mass
A	2	1
B	1	3
C	2	3
D	3	1

18 The diagram shows some of the stages in the manufacture of an important fertiliser, ammonium sulfate.



From which of the connecting pipes, A – D, would a major leak produce the greatest increase in the pH of rainwater?

19 The table below gives information about three indicators.

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

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

	Thymol Blue	Congo Red	Phenolphthalein
A	blue	colourless	red
B	yellow	red	colourless
C	yellow	blue	colourless
D	red	blue	red

20 Which of the following elements form oxides whose aqueous solutions have a pH greater than 7?

1 Copper
2 Iron
3 Zinc
4 Calcium

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

21 In the reaction

$$2FeCl_3 (aq) + H_2S (g) \rightarrow 2HCl (aq) + S (s) + 2FeCl_2 (aq)$$

Which of the following are true?

1 Hydrogen sulfide is reduced to hydrochloric acid.
2 Iron(III) ions gain electrons.
3 The colour of the solution changes from yellow brown to a pale green.
4 Oxidation state of sulfur decreases.

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

22 Which of the following is an example of a redox reaction?

A $ZnCl_2 + 2NaOH \rightarrow Zn(OH)_2 + 2NaCl$
B $CaO + SiO_2 \rightarrow CaSiO_3$
C $Mg + 2HCl \rightarrow MgCl_2 + H_2$
D $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

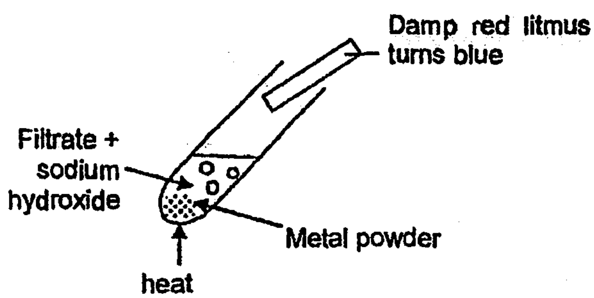
23 The following sequence shows the steps in the conversion of calcium phosphate, $Ca_3(PO_4)_2$, to phosphorous acid, H_3PO_3

$Ca_3(PO_4)_2 \rightarrow P_4 \rightarrow P_4O_6 \rightarrow H_3PO_3$

The oxidation numbers of phosphorous in this sequence are respectively

A +5, 0, +3, +3
B +5, 0, +5, +5
C +1, +4, +3, +1
D +2, +4, +4, +1

24 A crime suspect was thought to have been in a field on which a farmer had recently sprayed some fertiliser consisting of a potassium salt.
The forensic scientist obtained the mud from the suspect's shoe and dissolved it in water. The mixture was filtered and the filtrate was heated with aqueous sodium hydroxide and a metal in powdered form. The result of the reaction is shown in diagram below:



What is the fertiliser?

A KCl
B KNO_3
C K_2HPO_4
D K_2SO_4

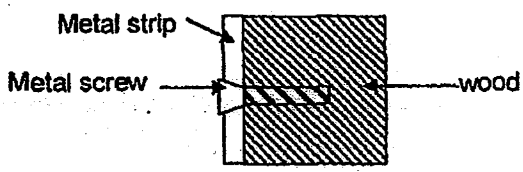
25 The following observations were made when nickel and iron were put separately into salt solutions of three metals P, Q and R.

Metals	Salt solution of P	Salt solution of Q	Salt solution of R
Nickel, Ni	Yes, displaced	Not displaced	Not displaced
Iron, Fe	Yes, displaced	Yes, displaced	Not displaced

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

A R, Q, Fe, Ni, P
B R, Fe, Q, Ni, P
C R, Fe, Ni, Q, P
D P, Ni, Fe, Q, R

26 Metal strips are secured on the outside of the wooden box by means of screws. After a few weeks of being exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



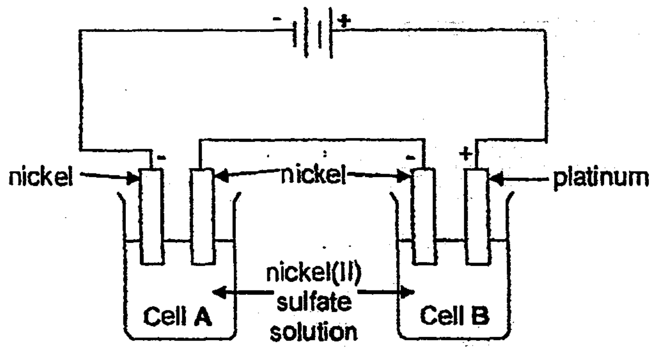
Which of the following statements best explains the observation?

A The metal screw loses electrons less readily than the metal strip.
B The metal screw stops oxygen in the air from getting to the metal strip
C The metal strip has a protective oxide layer but not the metal screw.
D The metal screw is a pure metal and the metal strip is an alloy.

27 A metal W is placed between calcium and aluminium in the reactivity series. Which method can be used to extract W?

A Reduction of the oxide of W using aluminium
B Reduction of the oxide of W using carbon.
C Electrolysis of an aqueous solution of a chloride of W.
D Electrolysis of a molten compound of W.

28 Two electrolytic cells, A and B, were set up as shown below. The electrolyte in both cells is green nickel(II) sulfate solution of the same concentration. Cell A has two nickel electrodes, while Cell B has a nickel cathode and a platinum anode.



A steady current was passed through both cells for some time, and the results were summarised in the table below.

Cell	Cathode	Anode
A	3.0 g of nickel is deposited	Nickel dissolves
B	Nickel is deposited	Oxygen evolved

Which statement about the reactions is true?

1 The platinum anode in Cell B decreases in mass by 3.0 g.
2 The green colour of the nickel(II) sulfate solution in Cell B fades slowly and eventually disappears.
3 The nickel anode in Cell A gains mass by 3.0 g.
4 The intensity of the green colour of the nickel(II) sulfate solution in Cell A remains the same.

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

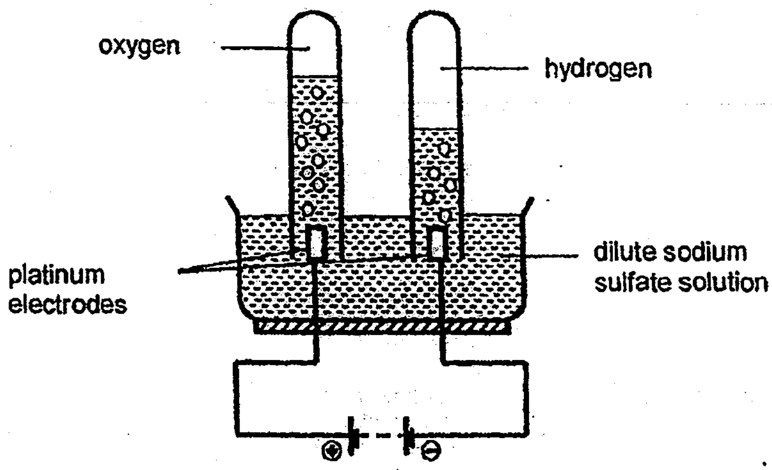
29 Element X is extracted by electrolysis of a molten compound of elements X and Y. The electrode reactions are as follows:

Cathode: $X^+ + e^- \rightarrow X$ Anode: $2Y^{2-} \rightarrow Y_2 + 4e^-$

Which of the following could be the compound?

A Magnesium sulfate
B Potassium oxide
C Sodium chloride
D Aluminium chloride

30 The diagram represents an experiment in which electric current is passed through dilute sodium sulfate solution.

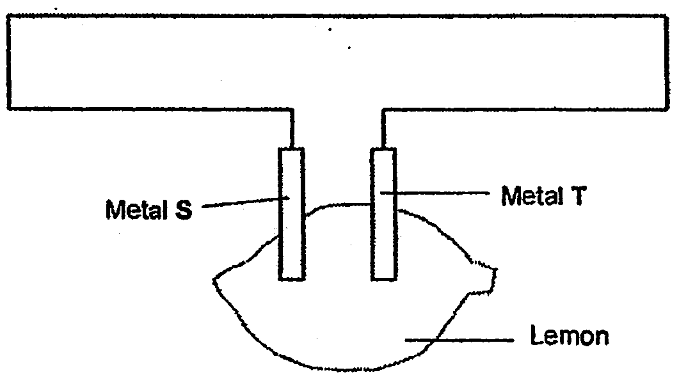


Which of the following correctly explains the result of the experiment.

1 Oxygen is formed due to the discharge of sulfate ions.
2 The ratio of hydrogen to oxygen atoms in a water molecule is 2:1.
3 Hydroxide ion is discharge in preference to sulfate ion.
4 Sodium is discharged in preference to hydrogen.

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

31 In the set-up shown below, metal **S** is more reactive than metal **T**.



Which one of the following statements concerning this set-up is correct?

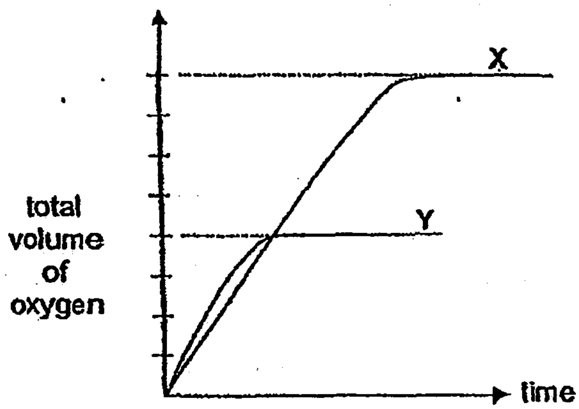
A Electrons flow from metal **T** to metal **S** in the external circuit.
B Oxygen will be liberated at metal **T**.
C Oxidation occurs at Metal **S**.
D Electrical energy is changed into chemical energy

32 When excess calcium carbonate reacts with dilute hydrochloric acid, the reaction slows down and finally stops.

Which statement best explains why this happens?

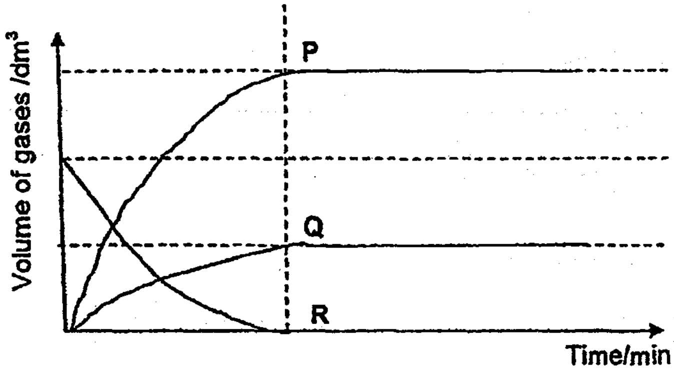
A The calcium carbonate is completely used up.
B The calcium carbonate is covered by bubbles of carbon dioxide.
C An insoluble layer of calcium chloride is formed.
D The hydrochloric acid is completely used up.

33 Graphs **X** and **Y** shown below represent the results of two experiments demonstrating the catalytic decomposition of hydrogen peroxide. Assuming that all other conditions are kept constant, which one of the following is a correct explanation of the results?



	Experiment X	Experiment Y
A	20 cm^3 of 1.0 mol/dm^3 hydrogen peroxide was used.	10 cm^3 of 2.0 mol/dm^3 hydrogen peroxide was used.
B	20 cm^3 of 1.0 mol/dm^3 hydrogen peroxide was used.	5 cm^3 of 2.0 mol/dm^3 hydrogen peroxide was used.
C	1.0 g of manganese(IV) oxide was used.	0.5 g of manganese(IV) oxide was used.
D	The reaction was carried out at 60°C.	The reaction was carried out at 30°C.

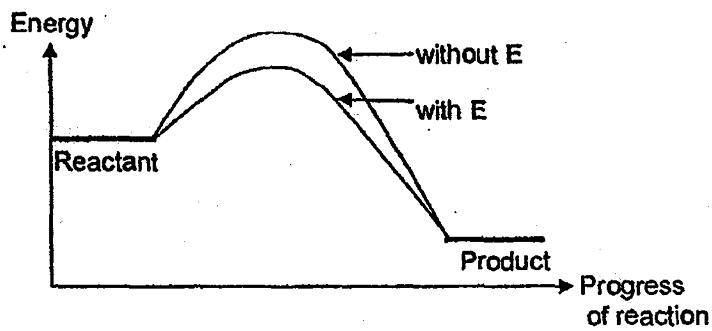
34 The following graph shows the changes in the volume of three gases **P**, **Q** and **R** with time during a chemical reaction. The volumes are all measured at the same temperature and pressure.



Which equation represents the reaction?

A $R \rightarrow 2P + Q$
B $2P \rightarrow Q + R$
C $2R \rightarrow 3P + Q$
D $3P + Q \rightarrow 2R$

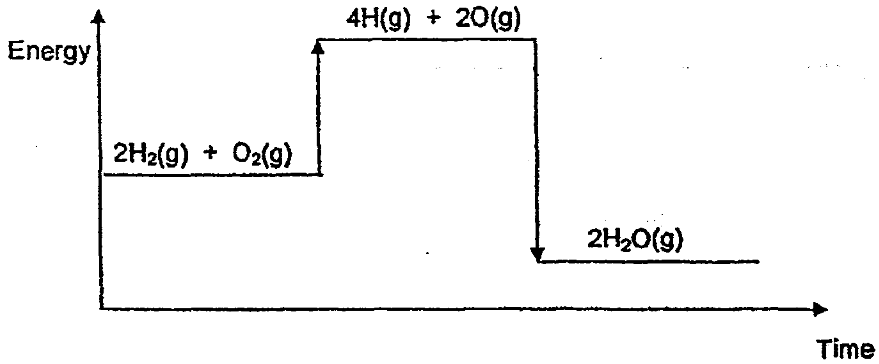
35 The energy profile diagram shows how adding a substance **E** to a reaction mixture changes the reaction pathway.



Which change is likely to be observed when **E** is added to the reaction mixture?

A The speed of the reaction increases.
B The speed of the reaction decreases.
C The reaction becomes less exothermic.
D The reaction becomes more exothermic.

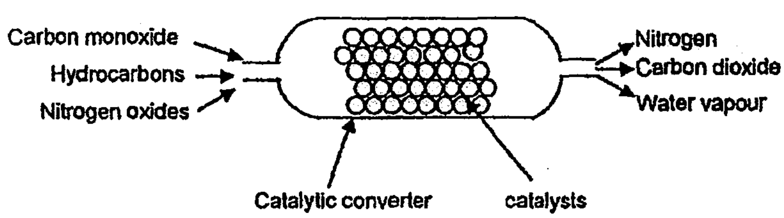
36 The energy level diagram for burning hydrogen gas in oxygen to form steam is shown in the diagram.



Which of these statements about the reaction is correct?

A The volume of the reactants is equal to the volume of the products.
B The reaction is endothermic as heat energy is taken in.
C Less energy is given out during the making of the O-H bond than is absorbed during the breaking of H-H and O=O bonds.
D The enthalpy change of the reaction (ΔH) has a negative value.

37 The diagram below shows a section of a catalytic converter in the exhaust system of a car.



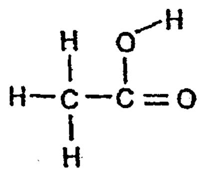
Carbon monoxide, hydrocarbons and nitrogen oxides in the exhaust gases are converted to nitrogen, carbon dioxide and water vapour in the catalytic converter through a number of processes.

Which processes take place at the converter?

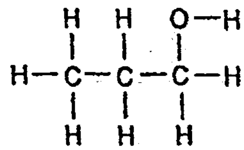
1 Carbon monoxide reacts with hydrocarbons.
2 Redox reactions occur.
3 Carbon monoxide reacts with nitrogen oxides.
4 Hydrocarbons react with nitrogen oxides.

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

38 The structural formulae of compounds (i) and (ii) are shown below :



(i)

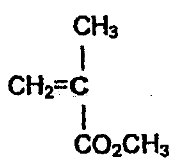


(ii)

What is the **best** method to distinguish between (i) and (ii)?

A Using potassium hydroxide
B Using bromine water
C Using dilute sulfuric acid
D Using sodium carbonate

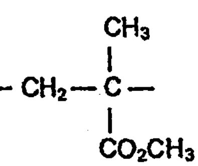
39 In an artificial hip joint, bone cement is used to attach the poly(ethene) cup for the joint to the pelvic girdle. Bone cement is formed by the polymerisation of methyl 2-methylpropenoate and the process is highly exothermic.



methyl 2-methylpropenoate

Which of the following are correct statements about this polymerisation?

1 The repeat unit of the polymer is

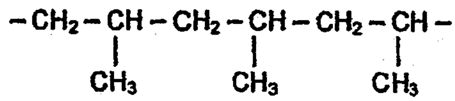


2 Less energy is released in making the C – C bonds than absorbed in breaking a C = C bond.

3 The formation of the cement occurs by addition polymerisation.

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

40 The structure of the polymer is shown below.



Which is the molecular formula of the monomer?

A C_4H_8

B C_3H_6

C C_5H_{10}

D C_2H_4

END OF PAPER

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 †															

*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 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.).

2014 MGS Chemistry (5073) Prelim P1 answer key

1	C		21	C	
2	B		22	C	
3	D		23	A	
4	B		24	B	
5	A		25	B	
6	B		26	C	
7	C		27	D	
8	B		28	B	
9	D		29	B	
10	D		30	B	

11	A		31	C	
12	A		32	D	
13	D		33	B	
14	C		34	C	
15	C		35	A	
16	C		36	D	
17	B		37	B	
18	C		38	D	
19	B		39	C	
20	A		40	B	

Section A (50 marks)

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

1 Choose from the following elements to answer the questions below.

Aluminium, Argon, Iron, Nickel, Nitrogen, Phosphorus, Sodium

Each element can be used once, more than once or not at all.

Name the element that

(a) is used as a catalyst in the hydrogenation of alkenes,

[1]

(b) is manufactured by electrolysis,

[1]

(c) reacts with oxygen to give an acidic oxide,

[1]

(d) reacts with chlorine to form a solid that dissolves in water to give a coloured solution.

[1]

2 Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas was bubbled into a beaker of aqueous potassium iodide.

(a) Describe the arrangement and movement of the chlorine molecules.

[2]

(b) Describe and explain what you see when the chlorine was bubbled into the beaker of aqueous potassium iodide.

[2]

(c) This reaction is an exothermic reaction. Explain in terms of bond making and bond breaking why this is so.

[2]

3 (a) Zinc sulfide is a commonly-found compound which is insoluble in water. State and explain the difference in electrical conductivity between zinc sulfide and sulfur dioxide in terms of bonding and structure.

____

____

____

____

____ [3]

(b) Zinc sulfide is roasted in oxygen and the products are zinc oxide and sulfur dioxide. Describe how you would test for sulfur dioxide.

____

____

____ [2]

(c) Another purpose of zinc oxide is to remove sulfur dioxide from waste gases in factories before they are released into the environment. Only one product is formed.

(i) Suggest why sulfur dioxide is a pollutant.

____

____

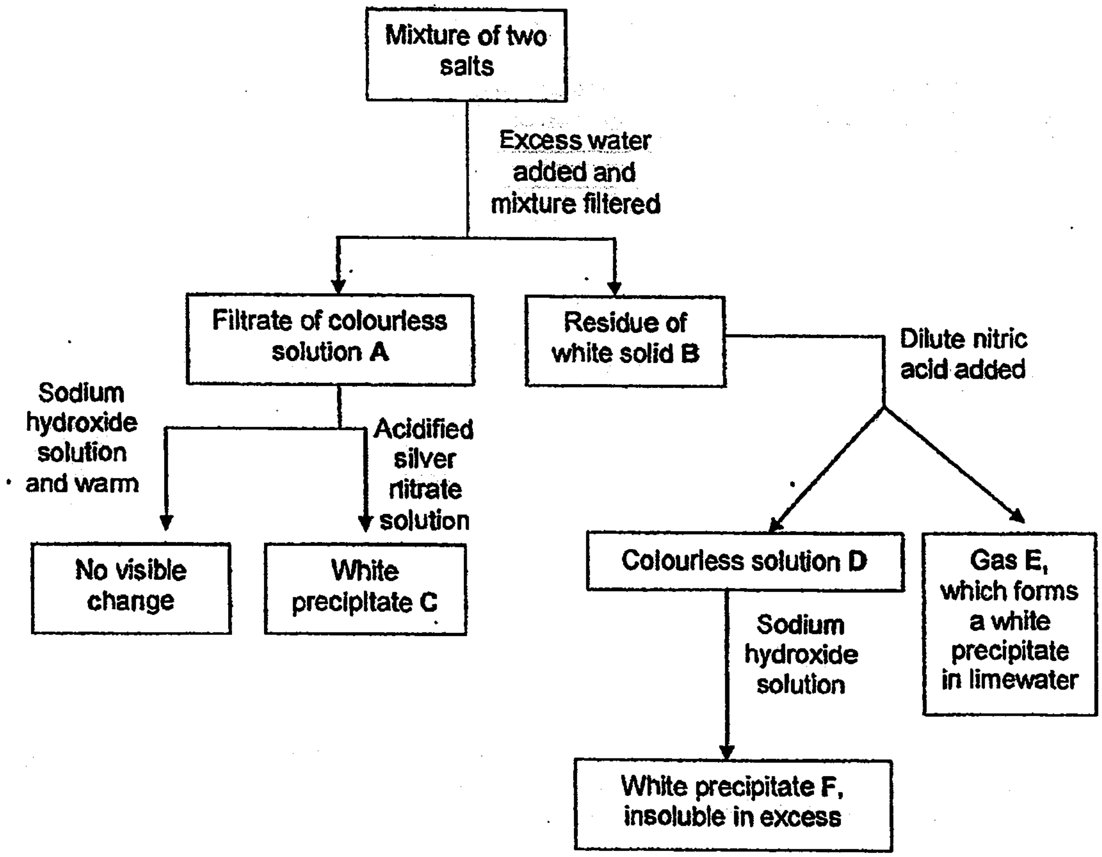
____ [1]

(ii) Write the balanced chemical equation, including state symbols, for the reaction to remove sulfur dioxide and name the product.

____

____ [3]

4 Two white salts, one soluble and another insoluble in water, were mixed and a series of tests were carried out according to the reaction scheme given.



(a) Identify substances A, B, D and F.

A: ______________________________

B: ______________________________

D: ______________________________

F: ______________________________ [4]

(b) Write the ionic equation for the formation of precipitate C.

______________________________ [1]

(c) Gas E can react with sodium hydroxide solution to produce a salt and water. Write the balanced chemical equation for this reaction.

______________________________ [1]

5 25 cm^3 of 1.5 mol/dm^3 of dilute hydrochloric acid was reacted with 20 cm^3 of 2.0 mol/dm^3 of aqueous potassium carbonate at room temperature and pressure to obtain potassium chloride.

$$2HCl + K_2CO_3 \rightarrow 2KCl + H_2O + CO_2$$

(a) Discuss the suitability of reacting potassium with dilute hydrochloric acid to obtain potassium chloride. State the expected observation.

....

....

.... [2]

(b) Draw a 'dot and cross' diagram of the electronic structure of potassium chloride. Show only the valence shells.

[2]

(c) Suggest and explain how the speed of reaction and volume of carbon dioxide would be affected should the hydrochloric acid be replaced with 25.0 cm^3 of 1.5 mol/dm^3 ethanoic acid.

....

....

....

....

....

....

.... [2]

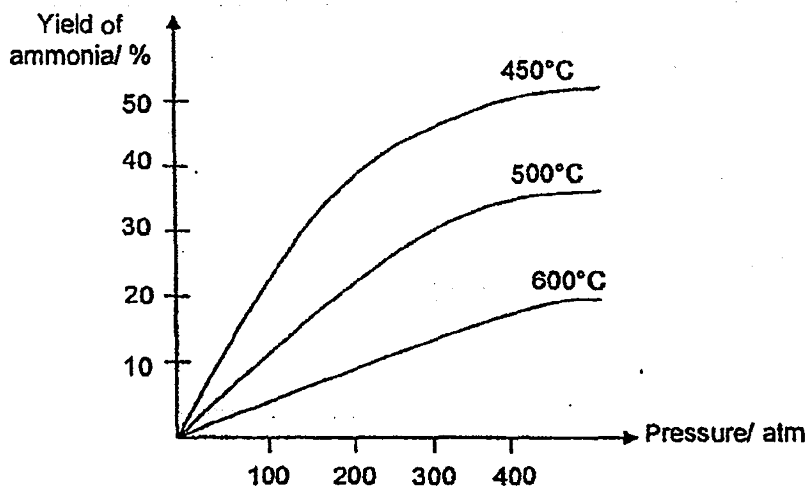
(d) Write the chemical equation for another suitable method of obtaining potassium chloride salt besides the reaction shown above.

.... [1]

6 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen.

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

The graph below shows the percentage yield of ammonia formed under different conditions of temperature and pressure.



(a) Use the graph to deduce the effect of increasing temperature and pressure on the yield of ammonia.

[2]

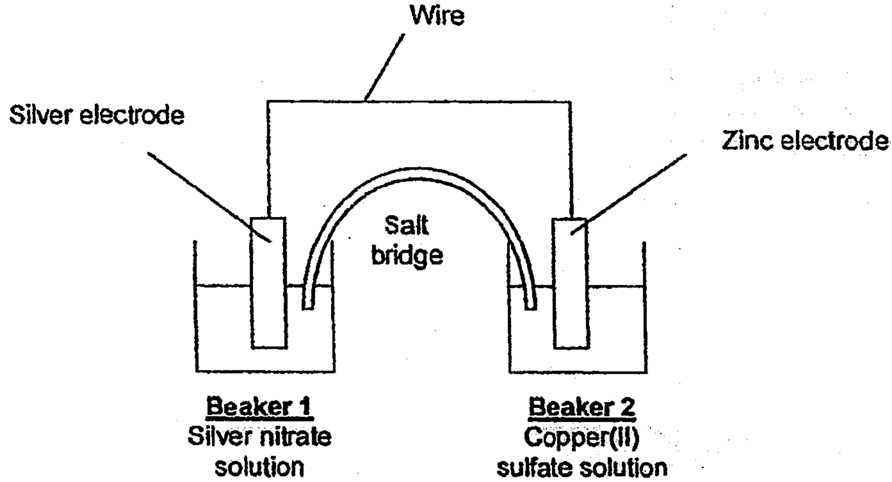
(b) Calculate the volume of ammonia produced from 350 dm^3 of hydrogen if the percentage yield of ammonia is 10 %.

[2]

(c) Identify the reducing agent. Explain your answer in terms of oxidation state.

[2]

7 A simple cell was set up as shown below. The salt bridge allows for the flow of ions so as to maintain electrical conduction.

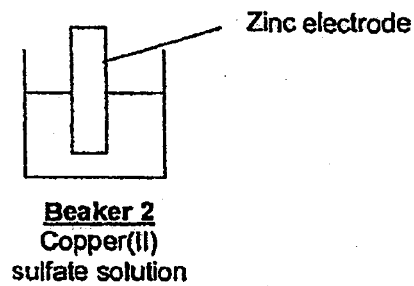


(a) Write the half-equations for the reactions that take place at both electrodes.

____

____ [2]

(b) State and explain one similarity and one difference in the observations made of the reactions in **Beaker 2** before and after the wires and salt bridge are removed.



(i) Similarity

____

____

____ [1]

(ii) Difference

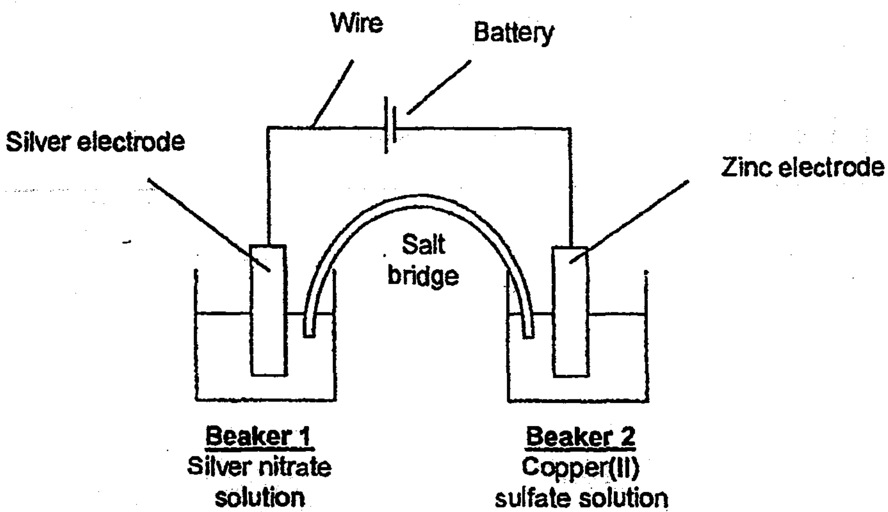
____

____

____

____ [2]

(c) A battery was added to the setup as shown in the diagram below.



Write the half-equations that occur in this setup.

Silver electrode: ______________________________

Zinc electrode: ______________________________ [2]

8 Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

(a) State the essential conditions needed for the rusting of iron.

______________________________ [1]

(b) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

____

______________________________ [2]

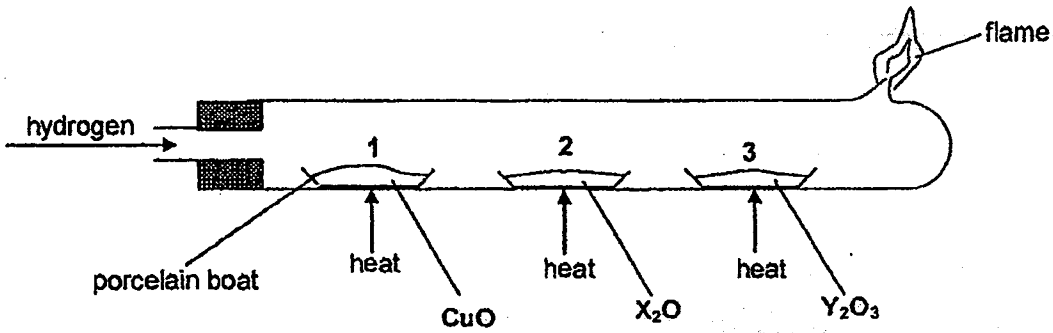
(c) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

[2]

Section B (30 marks)

Answer all three questions from this section on the writing papers provided.
The last question is in the form of EITHER/OR and
only one alternative should be attempted.

9 In an experiment, hydrogen gas was passed over equal masses of three heated metal oxides in identical porcelain boats as shown in the diagram.



The porcelain boats were weighed 5 minutes into the experiment. After weighing, the experiment was allowed to continue for another 20 minutes where no further changes were observed. At the end of the experiment, the heat source was turned off. However, the hydrogen is kept flowing until the tube is cold.

The table shows some data from this experiment.

	at the start of experiment	5 minutes into the experiment	at the end of experiment
mass of empty porcelain boat / g	16.35	-	16.35
mass of porcelain boat 1 and its contents / g	22.35	21.15	21.15
mass of porcelain boat 2 and its contents / g	22.35	22.35	22.35
mass of porcelain boat 3 and its contents / g	22.35	21.20	20.55

(a) Explain why a flame is necessary at the end of the glass tube. [1]

(b) Describe the observation seen in porcelain boat 1.
Write a chemical equation for the reaction that had occurred. [2]

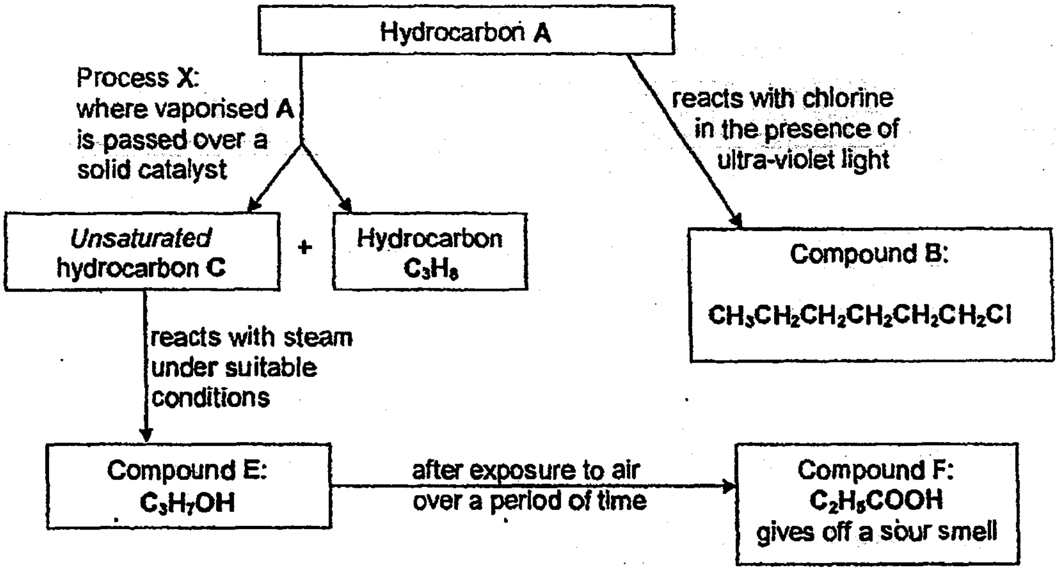
(c) Arrange the three metals, Cu, X and Y, in the order of their reactivity from the most reactive metal to the least reactive metal. With reference to the data given, explain how you reach this conclusion. [3]

(d) Suggest a possible metal for X. [1]

(e) (i) Use the data given to calculate the mass of O in Y_2O_3 in boat 3. [1]

(ii) Hence, or otherwise, calculate the relative atomic mass of Y.
From your result, identify Y. [2]

10 The reaction scheme below involves several organic substances.



Answer the following based on the reaction scheme.

(a) Explain what is meant by "*unsaturated*" hydrocarbon. [1]

(b) Draw the structural formula of hydrocarbon **C**. [1]

(c) (i) Name process **X** and give a substance that can be used as the solid catalyst. [2]

(ii) Write a balanced chemical equation for process **X** to show how unsaturated hydrocarbon **C** can be formed from hydrocarbon **A**. [1]

(d) Compound **E** can also be converted quickly into compound **F** in the chemistry laboratory.

(i) Describe how this can be done and state any observation from the reaction. [2]

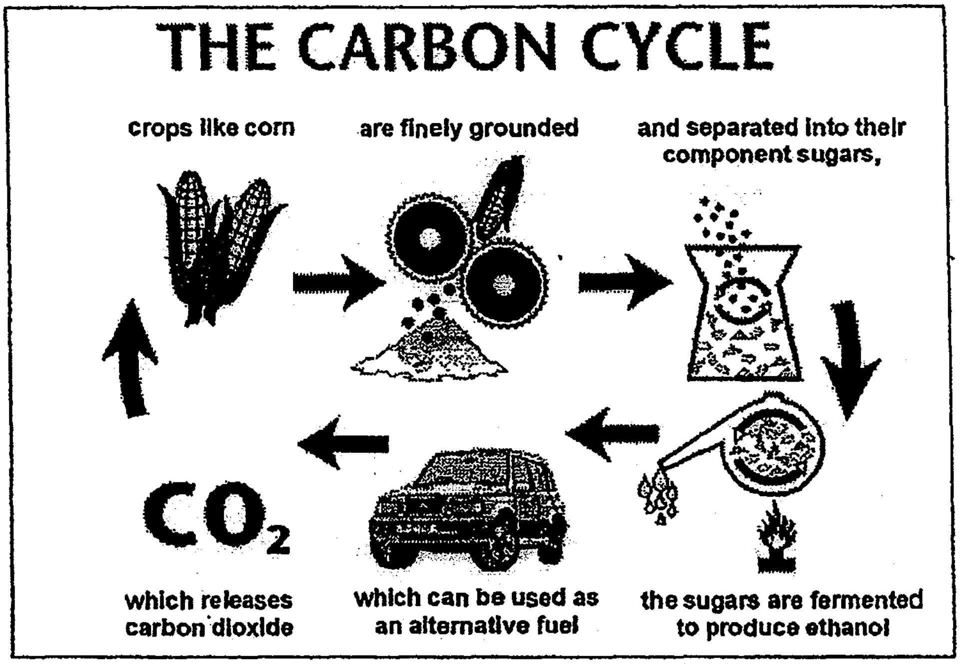
(ii) Describe a test to show that compound **E** has indeed been turned into compound **F**. [2]

(e) Compound **E** has two isomers with molecular formula C_3H_7OH. Draw the structural formulae of both isomers. [1]

Either

11 To rely less heavily on crude oil for fuels, scientists have been exploring different types of alternative fuels. One of such alternative fuels is **bioethanol**. A number of countries, including the United States and Brazil, have been producing ethanol from plants, such as corn or sugar cane, to be used as an alternative to petrol. Scientists claim that it is more environmentally friendly to use bioethanol than petrol because bioethanol is *'Carbon Neutral'*. Furthermore, ethanol *burns cleanly* with a non-luminous flame.

The diagram below, extracted from a poster, shows the carbon cycle for bioethanol.



(a) Other than environmental concerns, suggest two reasons why crude oil should not be used as fuels. [2]

(b) With the help of an equation, describe how ethanol is produced from sugar solution by fermentation. [2]

(c) Based on the carbon cycle, explain why bioethanol is *'Carbon Neutral'* and therefore more environmentally friendly. [2]

(d) Suggest what is meant by 'burns cleanly' as given in the passage above. [1]

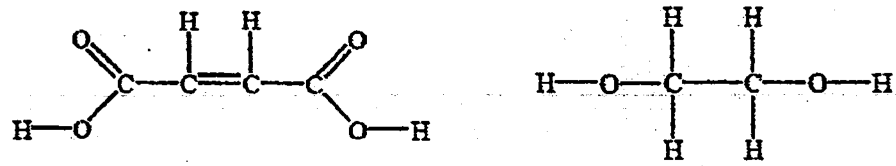
(e) Biodiesel is another alternative fuel for motorcars that is similar to bioethanol. It is produced from used vegetable oil that can be collected from the food industries. The used vegetable oil is treated and undergo a chemical process which turns it into biodiesel.

(i) Refer to the diagram above and draw a similar carbon cycle for biodiesel. [2]

(ii) Biodiesel is also carbon neutral. Suggest another advantage of using biodiesel. [1]

Or

11 (a) The structural formulae of butanedioic acid and ethane-1,2-diol are shown below.

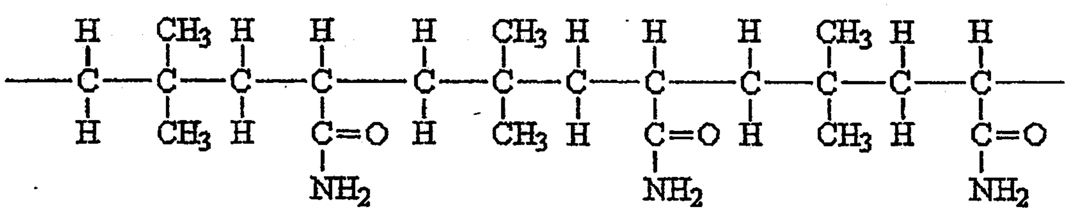


(i) State the observations when aqueous bromine is added to butanedioic acid and ethane-1,2-diol. Draw the structural formula of the product(s) formed. [3]

(ii) Butanedioic acid and ethane-1,2-diol can polymerize under suitable conditions to form a polymer. Draw the polymer showing 2 repeat units. [2]

(iii) Is the polymer formed by butanedioic acid and ethane-1,2-diol an *additional* polymer or a *condensation* polymer? Explain. [1]

(b) Another polymer **P** has the following structrure:



(i) Derive the structural formula of the two monomers that are used to form polymer **P**. [2]

(ii) Explain why polymer **P** is a solid at room temperature while its monomers are liquids. [2]

--- End of Paper ---

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 †															

*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
X
b

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

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

Section A (50 marks)

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

1 Choose from the following elements to answer the questions below.

Aluminium, Argon, Iron, Nickel, Nitrogen, Phosphorus, Sodium

Each element can be used once, more than once or not at all.

Name the element that

(a) is used as a catalyst in the hydrogenation of alkenes,

[1]

(b) is manufactured by electrolysis,

[1]

(c) reacts with oxygen to give an acidic oxide,

[1]

(d) reacts with chlorine to form a solid that dissolves in water to give a coloured solution.

[1]

2 Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas was bubbled into a beaker of aqueous potassium iodide.

(a) Describe the arrangement and movement of the chlorine molecules.

[2]

(b) Describe and explain what you see when the chlorine was bubbled into the beaker of aqueous potassium iodide.

[2]

(c) This reaction is an exothermic reaction. Explain in terms of bond making and bond breaking why this is so.

[2]

3 **(a)** Zinc sulfide is a commonly-found compound which is insoluble in water. State and explain the difference in electrical conductivity between zinc sulfide and sulfur dioxide in terms of bonding and structure.

[3]

(b) Zinc sulfide is roasted in oxygen and the products are zinc oxide and sulfur dioxide. Describe how you would test for sulfur dioxide.

[2]

(c) Another purpose of zinc oxide is to remove sulfur dioxide from waste gases in factories before they are released into the environment. Only one product is formed.

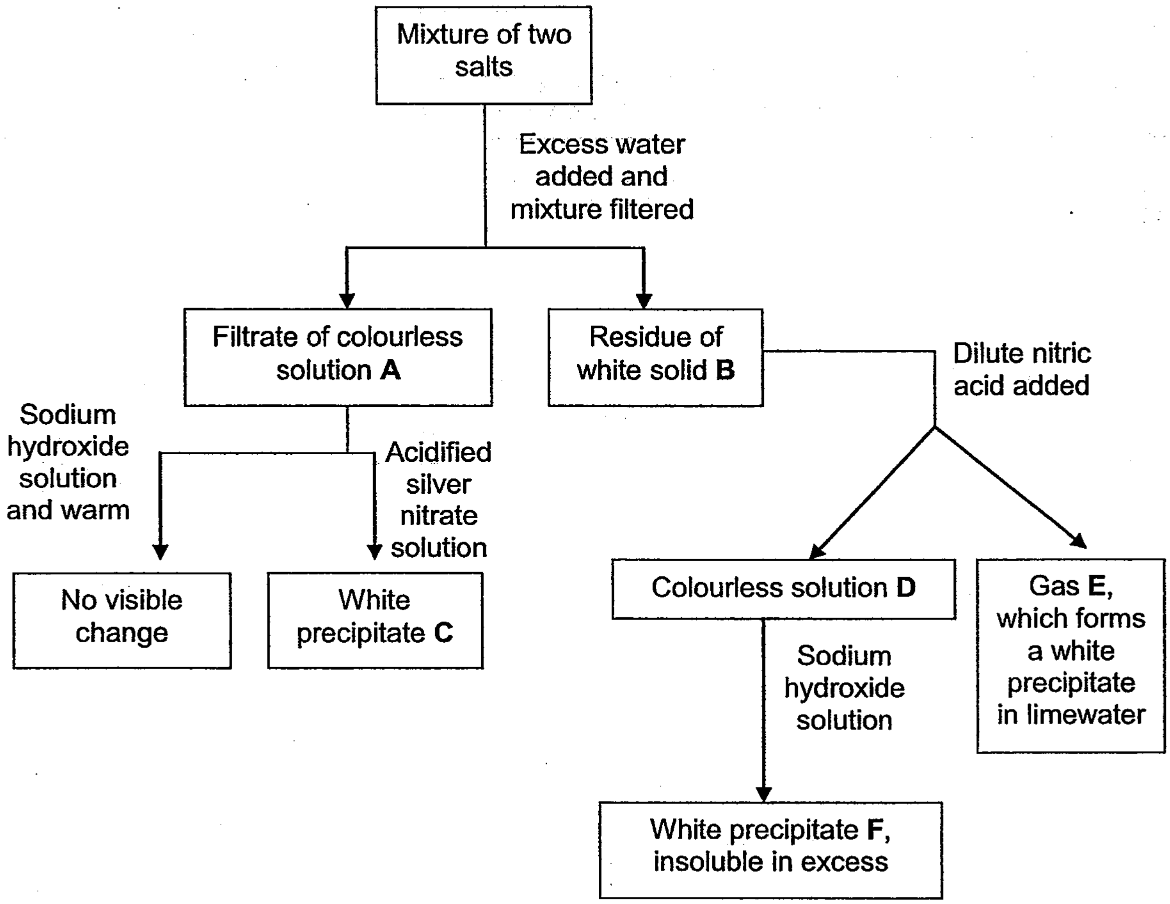
(i) Suggest why sulfur dioxide is a pollutant.

[1]

(ii) Write the balanced chemical equation, including state symbols, for the reaction to remove sulfur dioxide and name the product.

[3]

4 Two white salts, one soluble and another insoluble in water, were mixed and a series of tests were carried out according to the reaction scheme given.



(a) Identify substances **A**, **B**, **D** and **F**.

A: ____________________

B: ____________________

D: ____________________

F: ____________________ [4]

(b) Write the ionic equation for the formation of precipitate **C**.

____________________ [1]

(c) Gas **E** can react with sodium hydroxide solution to produce a salt and water. Write the balanced chemical equation for this reaction.

____________________ [1]

5 25 cm^3 of 1.5 mol/dm^3 of dilute hydrochloric acid was reacted with 20 cm^3 of 2.0 mol/dm^3 of aqueous potassium carbonate at room temperature and pressure to obtain potassium chloride.

$$2HCl + K_2CO_3 \rightarrow 2KCl + H_2O + CO_2$$

(a) Discuss the suitability of reacting potassium with dilute hydrochloric acid to obtain potassium chloride. State the expected observation.

[2]

(b) Draw a 'dot and cross' diagram of the electronic structure of potassium chloride. Show only the valence shells.

[2]

(c) Suggest and explain how the speed of reaction and volume of carbon dioxide would be affected should the hydrochloric acid be replaced with 25.0 cm^3 of 1.5 mol/dm^3 ethanoic acid.

[2]

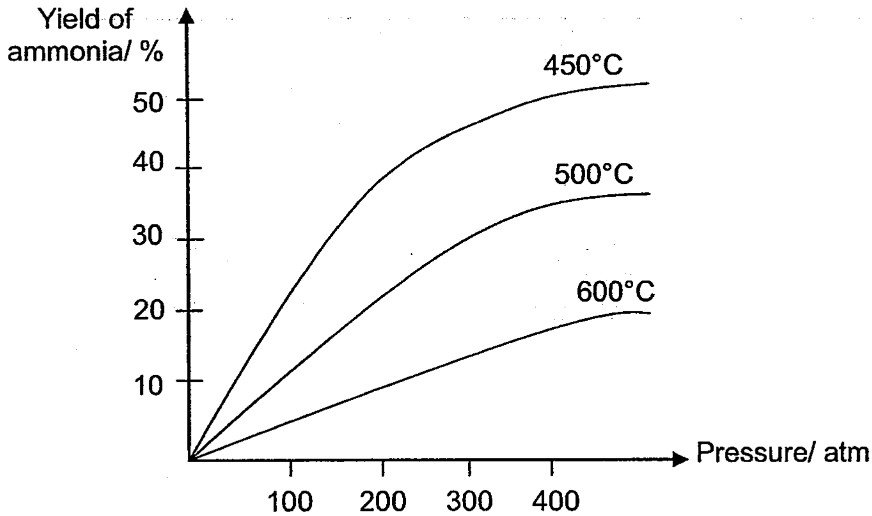
(d) Write the chemical equation for another suitable method of obtaining potassium chloride salt besides the reaction shown above.

[1]

6 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

The graph below shows the percentage yield of ammonia formed under different conditions of temperature and pressure.



(a) Use the graph to deduce the effect of increasing temperature and pressure on the yield of ammonia.

[2]

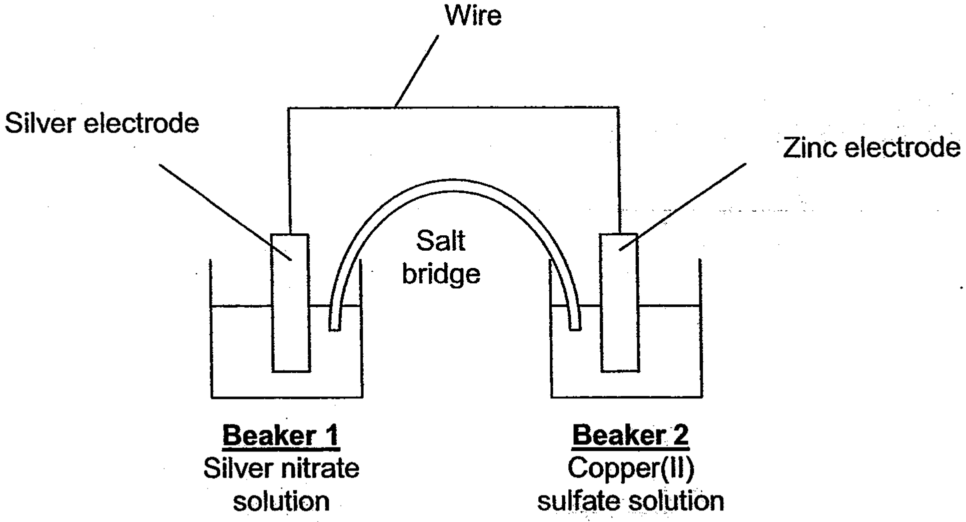
(b) Calculate the volume of ammonia produced from 350 dm^3 of hydrogen if the percentage yield of ammonia is 10 %.

[2]

(c) Identify the reducing agent. Explain your answer in terms of oxidation state.

[2]

7 A simple cell was set up as shown below. The salt bridge allows for the flow of ions so as to maintain electrical conduction.

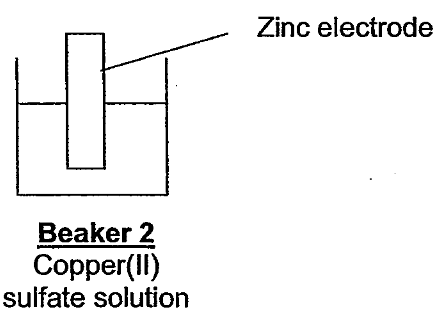


(a) Write the half-equations for the reactions that take place at both electrodes.

____

____ [2]

(b) State and explain one similarity and one difference in the observations made of the reactions in **Beaker 2** before and after the wires and salt bridge are removed.



(i) Similarity

____

____

____ [1]

(ii) Difference

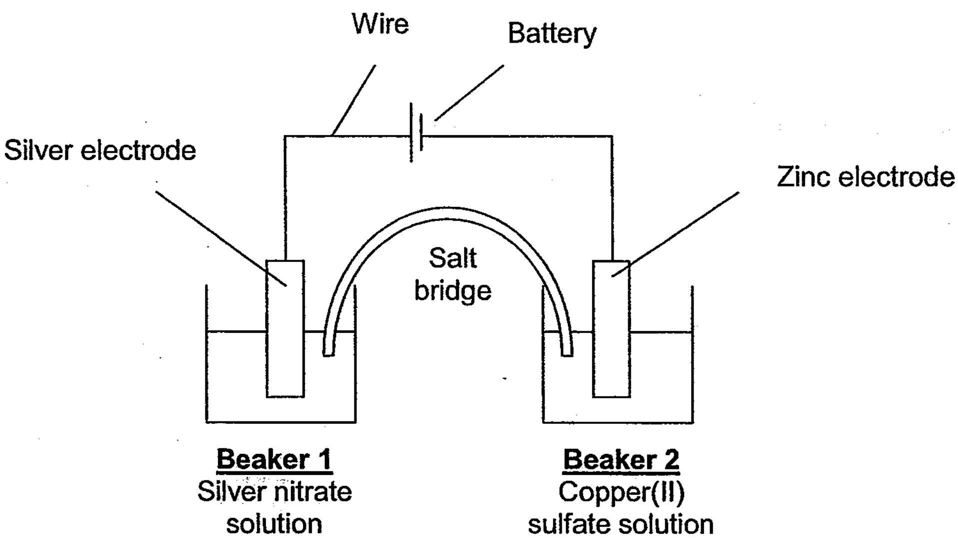
____

____

____

____ [2]

(c) A battery was added to the setup as shown in the diagram below.



Write the half-equations that occur in this setup.

Silver electrode: ______________________________

Zinc electrode: ______________________________ [2]

8 Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

(a) State the essential conditions needed for the rusting of iron.

______________________________ [1]

(b) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

____

______________________________ [2]

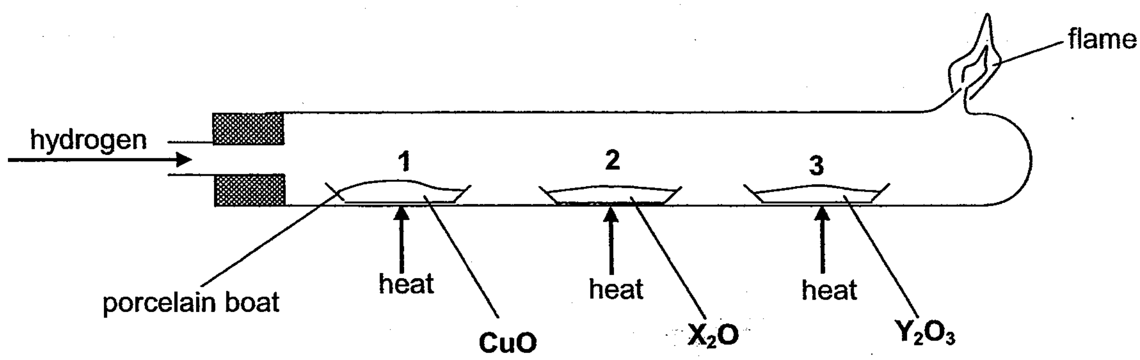
(c) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

[2]

Section B (30 marks)

Answer all three questions from this section on the writing papers provided.
The last question is in the form of EITHER/OR and
only one alternative should be attempted.

9 In an experiment, hydrogen gas was passed over equal masses of three heated metal oxides in identical porcelain boats as shown in the diagram.



The porcelain boats were weighed 5 minutes into the experiment. After weighing, the experiment was allowed to continue for another 20 minutes where no further changes were observed. At the end of the experiment, the heat source was turned off. However, the hydrogen is kept flowing until the tube is cold.

The table shows some data from this experiment.

	at the start of experiment	5 minutes into the experiment	at the end of experiment
mass of empty porcelain boat / g	16.35	-	16.35
mass of porcelain boat **1** and its contents / g	22.35	21.15	21.15
mass of porcelain boat **2** and its contents / g	22.35	22.35	22.35
mass of porcelain boat **3** and its contents / g	22.35	21.20	20.55

(a) Explain why a flame is necessary at the end of the glass tube. [1]

(b) Describe the observation seen in porcelain boat **1**.
Write a chemical equation for the reaction that had occurred. [2]

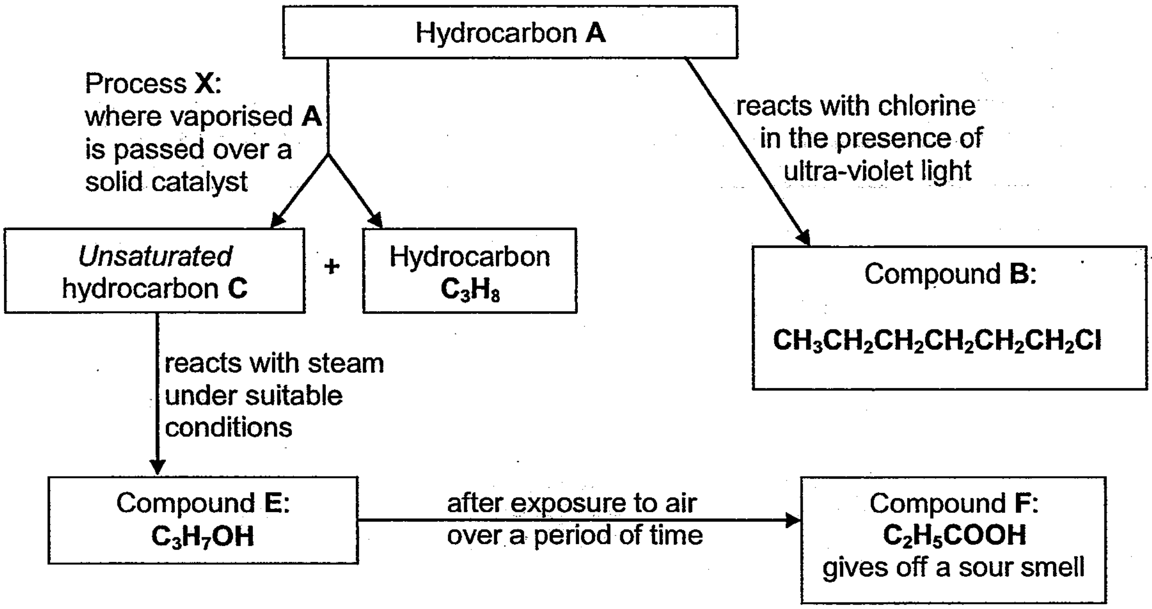
(c) Arrange the three metals, **Cu**, **X** and **Y**, in the order of their reactivity from the most reactive metal to the least reactive metal. With reference to the data given, explain how you reach this conclusion. [3]

(d) Suggest a possible metal for **X**. [1]

(e) **(i)** Use the data given to calculate the mass of **O** in Y_2O_3 in boat **3**. [1]

(ii) Hence, or otherwise, calculate the relative atomic mass of **Y**.
From your result, identify **Y**. [2]

10 The reaction scheme below involves several organic substances.



Answer the following based on the reaction scheme.

(a) Explain what is meant by *"unsaturated"* hydrocarbon. [1]

(b) Draw the structural formula of hydrocarbon **C**. [1]

(c) **(i)** Name process **X** and give a substance that can be used as the solid catalyst. [2]

(ii) Write a balanced chemical equation for process **X** to show how unsaturated hydrocarbon **C** can be formed from hydrocarbon **A**. [1]

(d) Compound **E** can also be converted quickly into compound **F** in the chemistry laboratory.

(i) Describe how this can be done and state any observation from the reaction. [2]

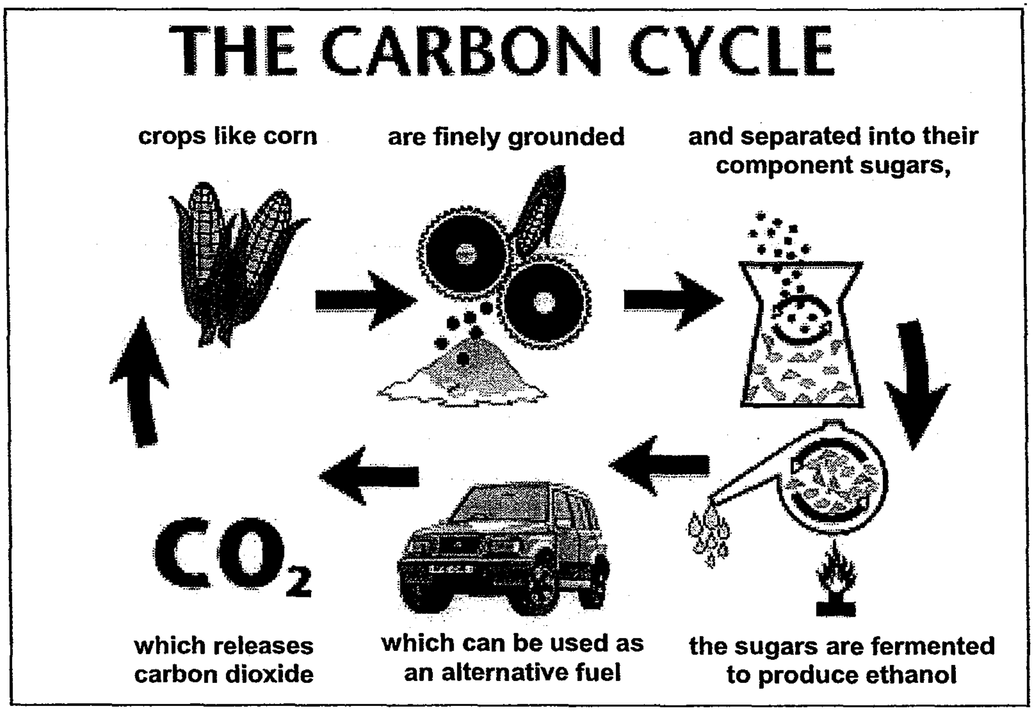
(ii) Describe a test to show that compound **E** has indeed been turned into compound **F**. [2]

(e) Compound **E** has two isomers with molecular formula C_3H_7OH. Draw the structural formulae of both isomers. [1]

Either

11 To rely less heavily on crude oil for fuels, scientists have been exploring different types of alternative fuels. One of such alternative fuels is **bioethanol**. A number of countries, including the United States and Brazil, have been producing ethanol from plants, such as corn or sugar cane, to be used as an alternative to petrol. Scientists claim that it is more environmentally friendly to use bioethanol than petrol because bioethanol is *'Carbon Neutral'*. Furthermore, ethanol *burns cleanly* with a non-luminous flame.

The diagram below, extracted from a poster, shows the carbon cycle for bioethanol.



(a) Other than environmental concerns, suggest two reasons why crude oil should not be used as fuels. [2]

(b) With the help of an equation, describe how ethanol is produced from sugar solution by fermentation. [2]

(c) Based on the carbon cycle, explain why bioethanol is *'Carbon Neutral'* and therefore more environmentally friendly. [2]

(d) Suggest what is meant by 'burns cleanly' as given in the passage above. [1]

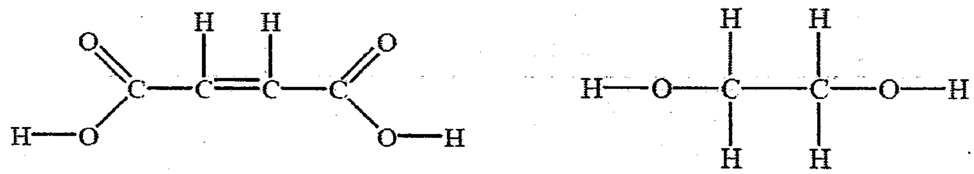
(e) Biodiesel is another alternative fuel for motorcars that is similar to bioethanol. It is produced from used vegetable oil that can be collected from the food industries. The used vegetable oil is treated and undergo a chemical process which turns it into biodiesel.

(i) Refer to the diagram above and draw a similar carbon cycle for biodiesel. [2]

(ii) Biodiesel is also carbon neutral. Suggest another advantage of using biodiesel. [1]

Or

11 **(a)** The structural formulae of butanedioic acid and ethane-1,2-diol are shown below.

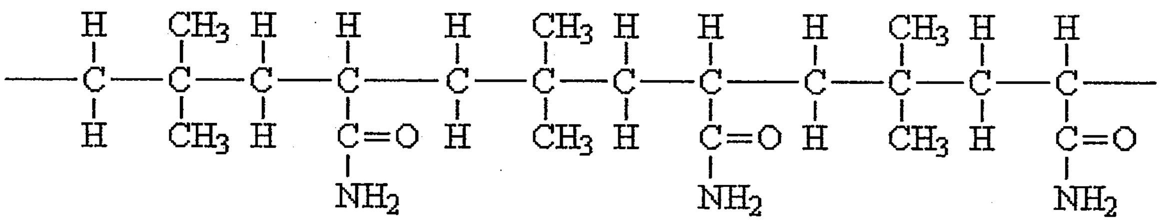


(i) State the observations when aqueous bromine is added to butanedioic acid and ethane-1,2-diol. Draw the structural formula of the product(s) formed. [3]

(ii) Butanedioic acid and ethane-1,2-diol can polymerize under suitable conditions to form a polymer. Draw the polymer showing 2 repeat units. [2]

(iii) Is the polymer formed by butanedioic acid and ethane-1,2-diol an *additional* polymer or a *condensation* polymer? Explain. [1]

(b) Another polymer **P** has the following structrure:



(i) Derive the structural formula of the two monomers that are used to form polymer **P**. [2]

(ii) Explain why polymer **P** is a solid at room temperature while its monomers are liquids. [2]

--- End of Paper ---

Periodic Table

DATA SHEET
The Periodic Table of the Elements

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 Kryptor 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 Technetiu m 43	101 Ru Ruthenium 44	103 Rh Rhodiur 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimon y 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 Tantalur 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 Bismutr 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Franciur 87	226 Ra Radium 88	227 Ac Actiniu 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 X b

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

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

5073 Chemistry Prelim Exam 2014 Paper 2 Section A Answers

1 Choose from the following elements to answer the questions below.

Aluminium, Argon, Iron, Nickel, Nitrogen, Phosphorus, Sodium

Each element can be used once, more than once or not at all.

Name the element that

(a) is used as a catalyst in the hydrogenation of alkenes,

nickel [1]

(b) is manufactured by electrolysis,

Aluminium/ sodium [1]

(c) reacts with oxygen to give an acidic oxide,

Phosphorus/ nitrogen [1]

(d) reacts with chlorine to form a solid that dissolves in water to give a coloured solution.

Iron/ nickel [1]

2 Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas was bubbled into a beaker of aqueous potassium iodide.

(a) Describe the arrangement and movement of the chlorine molecules.

Arrangement is disorderly and far apart, [1]

moving randomly at high speeds in all directions. [1]

(b) Describe and explain what you see when the chlorine was bubbled into the beaker of aqueous potassium iodide.

Colourless potassium iodide solution turned reddish-brown. [1]

Chlorine is more reactive than iodine and displaces the iodide ions from the potassium iodide solution. [1]

(c) This reaction is an exothermic reaction. Explain in terms of bond making and bond breaking why this is so.

The amount of energy taken in to break the bonds in chlorine and potassium iodide is less than the amount of energy given out to form the bonds in potassium chloride and iodine. [1] [1]

State specific reactants and products

(minus 1m if specific reactants and products aren't stated

No marks if student writes 'more than' rather than 'less than')

3 (a) Zinc is commonly found in the form of zinc sulfide, a solid which is insoluble in water. Zinc sulfide is roasted in oxygen and the products are zinc oxide and sulfur dioxide. State and explain the difference in electrical conductivity between zinc sulfide and sulfur dioxide in terms of bonding and structure.

Zinc sulfide has a giant ionic lattice structure and sulfur dioxide has a simple molecular structure. [1]

Zinc sulfide conducts electricity when molten due to the mobile ions/ ions no longer held in fixed positions. [1]

Sulfur dioxide does not conduct electricity in any physical state due to the absence of mobile charged particles. [1]

(b) Describe how you would test for sulfur dioxide.

Place a piece of filter paper soaked with acidified potassium dichromate (VI)/ manganate(VII) solution at the mouth of the test tube. [1]

If the orange acidified potassium dichromate (VI) solution turns green, the gas is sulfur dioxide./ If the purple acidified potassium manganite (VII) solution turns colourless, the gas is sulfur dioxide. [1]

(c) Another purpose of zinc oxide is to remove sulfur dioxide from waste gases in factories before they are released into the environment. Only one product is formed.

(i) Suggest why sulfur dioxide is a pollutant.

(Any of the following reasons) [1]

- **Irritates the eyes and lungs and causes breathing difficulties.**
- **Reacts with water in the atmosphere to form acid rain which corrodes building and harms aquatic life and plants.**

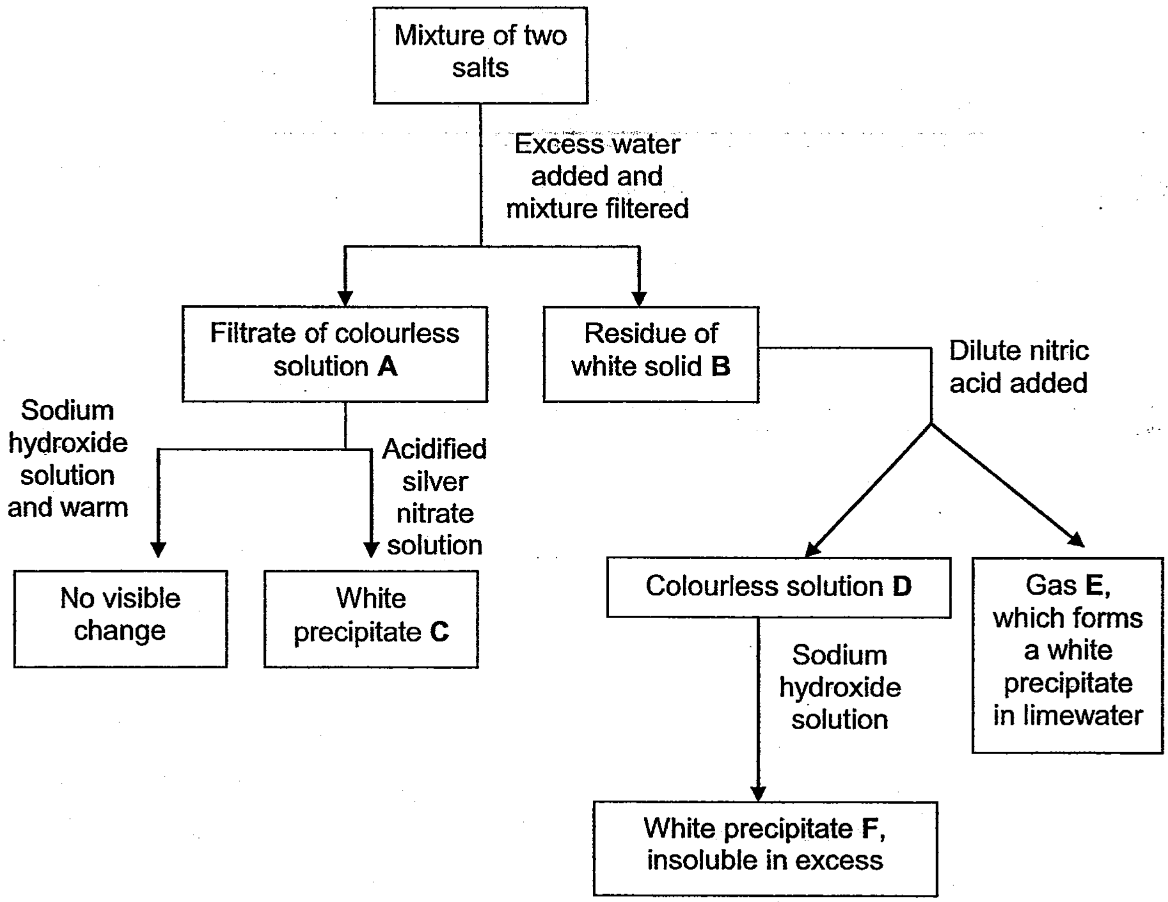
(ii) Write the balanced chemical equation, including state symbols, for the reaction to remove sulfur dioxide and name the product.

$ZnO\ (s) + SO_2\ (g) \rightarrow ZnSO_3\ (s)$ [2]

(allow 1m for state symbols even if formula of zinc sulfite is incorrect)

The salt is zinc sulfite. [1]

4 Two white salts, one soluble and another insoluble in water, were mixed and a series of tests carried out on the mixture as shown below.



(a) Identify substances **A**, **B**, **D** and **F**.

A – sodium chloride/ potassium chloride/ NaCl/ KCl **[1]**

B – calcium carbonate/ $CaCO_3$ **[1]**

D – calcium nitrate/ $Ca(NO_3)_2$ **[1]**

F – calcium hydroxide/ $Ca(OH)_2$ **[1]**

(b) Write the ionic equation for the formation of precipitate **C**.

$Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl (s)$ **[1]**

No marks awarded if state symbols are not given.

(c) Gas **E** can react with sodium hydroxide solution to produce a salt and water. Write the balanced chemical equation for this reaction.

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$ **[1]**

5 25 cm^3 of 1.5 mol/dm^3 of dilute hydrochloric acid was reacted with 20 cm^3 of 2.0 mol/dm^3 of aqueous potassium carbonate at room temperature and pressure to obtain potassium chloride.

$$2HCl + K_2CO_3 \rightarrow 2KCl + H_2O + CO_2$$

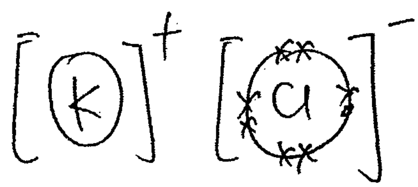
(a) Discuss the suitability of reacting potassium with dilute hydrochloric acid to obtain potassium chloride. State the expected observation.

It is unsuitable as potassium is a very reactive metal and the reaction/ experiment is not safe [1].

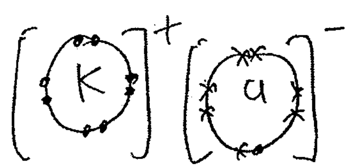
The reaction will be explosive/ a lot of heat and light evolved. [1]

[2]

(b) Draw a 'dot and cross' diagram of the electronic structure of potassium chloride. Show only the valence electrons.



OR



(c) Suggest and explain how the speed of reaction and volume of carbon dioxide would be affected should the hydrochloric acid be replaced with 25 cm^3 of 1.5 mol/dm^3 ethanoic acid.

The speed of reaction will decrease and the volume of carbon dioxide will be the same. [1]

as ethanoic acid is a weak acid and has fewer hydrogen ions per unit volume at any one time. [1]

The volume of carbon dioxide will remain constant as the number of moles of hydrogen ions for both acids is the same/ both are monobasic. [1]

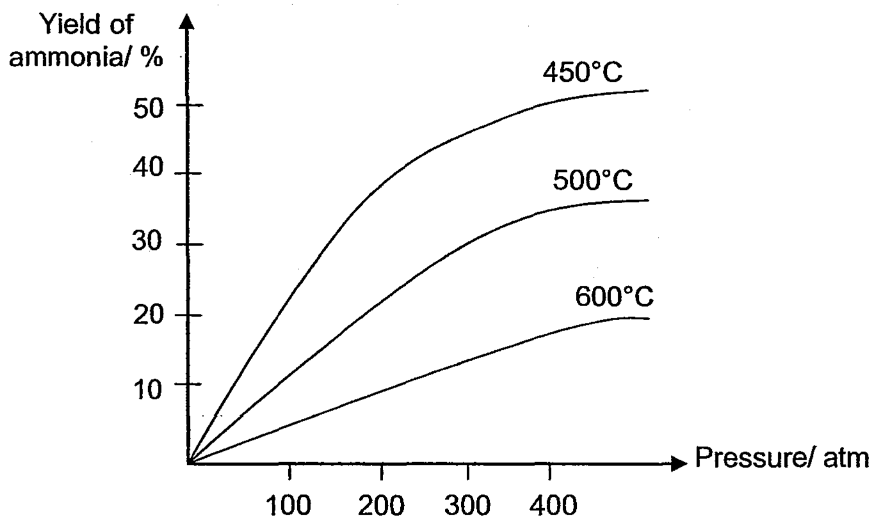
(d) Write the chemical equation for another suitable method of obtaining potassium chloride salt besides the reaction shown above.

$KOH + HCl \rightarrow KCl + H_2O$ [1]

6 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

The graph below shows the percentage yield of ammonia formed under different conditions of temperature and pressure.



(a) Use the graph to deduce the effect of increasing temperature and pressure on the yield of ammonia.

Increasing the temperature will decrease the yield of ammonia and [1]
increasing the pressure will increase the yield of ammonia. [1]

(b) Calculate the volume of ammonia produce from 350 dm^3 of hydrogen if the percentage yield of ammonia is 10 %.

Volume of ammonia produced = 350/3 x 2 x 10% [1]

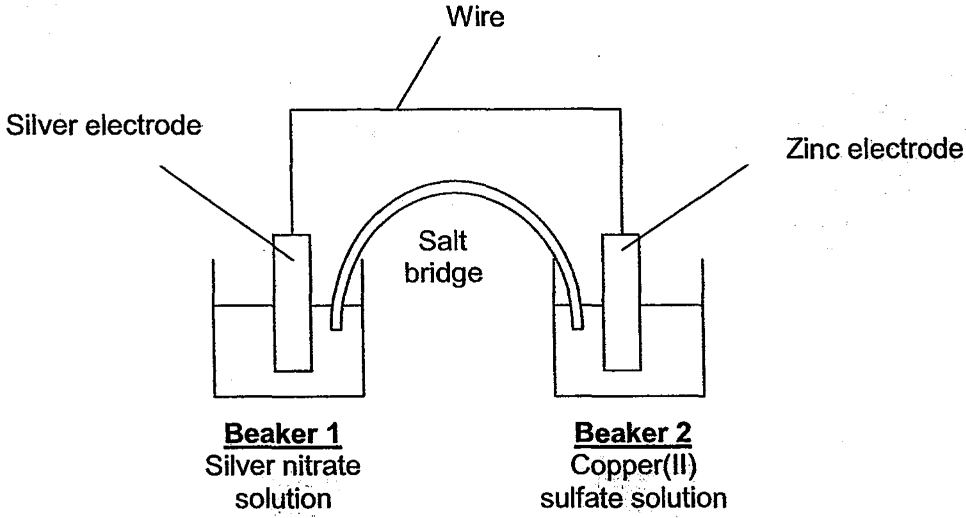
= 23.3 dm^3 [1]

(c) Identify the reducing agent. Explain your answer in terms of oxidation state.

The reducing agent is hydrogen. [1]

It has caused the oxidation state of nitrogen to decrease from 0 in N_2 to -3 in NH_3. [1]

7 A simple cell was set up as shown below.

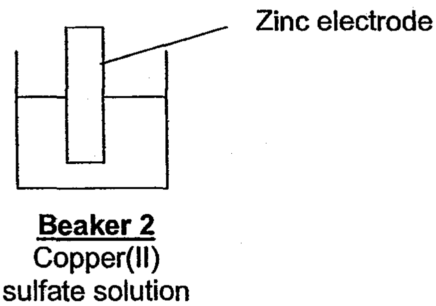


(a) Write the half-equations for the reactions that take place at both electrodes.

Silver electrode: Ag^{+} (aq) + e → Ag (s) **[1]**

Zinc electrode: Zn(s) → Zn^{2+} (aq) + 2e **[1]**

(b) State and explain one similarity and one difference that will be observed in **Beaker 2** when the wires and salt bridge are removed.



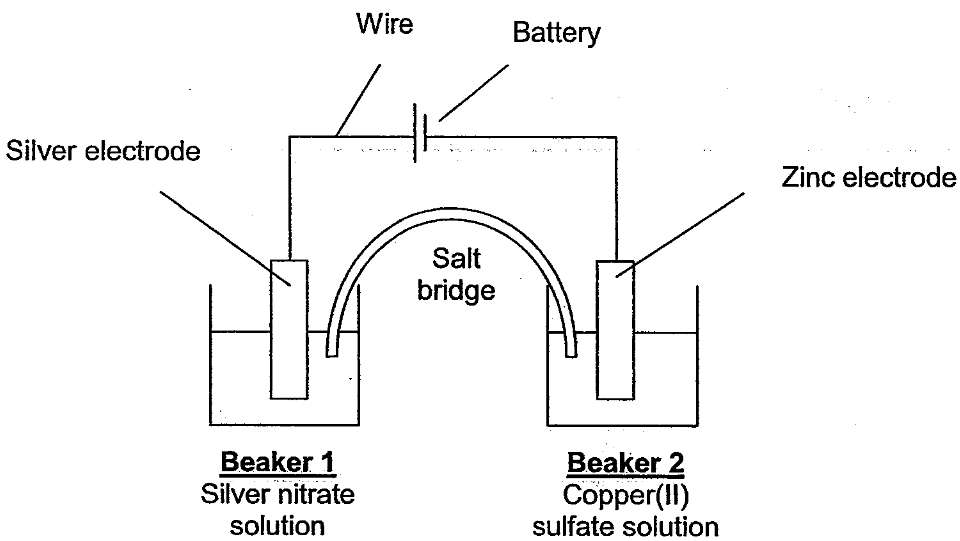
(i) Similarity: Zinc electrode dissolves/ shrinks. **[1]**

(ii) Differences (choose either one):

When wire was present, no change to blue colour of solution. [1]
When wire was removed, blue colour of solution fades/ becomes lighter as copper(II) ions are being displaced from the solution by the more reactive zinc. [1]
Ans 1

Reddish-brown solid deposited when wires were removed, not seen when wires were there as copper(II) ions are being displaced from the solution by the more reactive zinc. [1] [1]
Ans 2

(c) A battery was added to the setup as shown in the diagram below.



Write the half-equations that occur in this setup.

Silver electrode: **Ag (s) → Ag^+ (aq) + e** [1]

Zinc electrode: **Cu^{2+} (aq) + 2e → Cu (s)** [1]

Note: If state symbols are not written for all the half-equations, only penalise once throughout the paper.

8 Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

(a) State the essential conditions needed for the rusting of iron.

Air/ oxygen and water [1]

(b) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

Magnesium is more reactive than iron. [1]

It will undergo sacrificial protection/ corrode in its place/ lose electrons to iron. [1]

(c) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

Simplest mole ratio of Fe, K, C, N

$$= \frac{0.195}{56} : \frac{0.547}{39} : \frac{0.252}{12} : \frac{0.294}{14}$$

= 0.003482: 0.01403: 0.021: 0.021

$$= \frac{0.003482}{0.003482} : \frac{0.01403}{0.003482} : \frac{0.021}{0.003482} : \frac{0.021}{0.003482}$$

= 1: 4: 6: 6

Empirical formula is $FeK_4C_6N_6$.

[1] for working, [1] for giving empirical formula.

[2]

Paya Lebar Methodist Girls' School (Secondary)
Preliminary 2 Examination 2014
Secondary 4 Express

CANDIDATE NAME			
CENTRE NUMBER		INDEX NUMBER	

CHEMISTRY **5073/01**

Paper 1 Multiple Choice

30 July 2014 (Wednesday)

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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

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.

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	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series

†90-103 Actinoid series

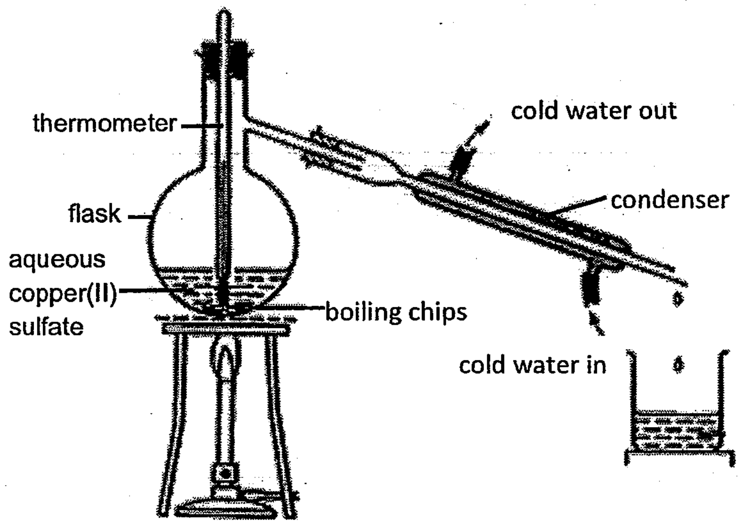
140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium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

1 An aqueous solution of copper(II) sulfate is distilled.



At which temperature does the aqueous solution of copper(II) sulfate begin to boil if the thermometer is dipped into the solution, and what is left in the distillation flask?

	temperature at which solution begins to boil if thermometer is dipped into solution	final contents of distillation flask
A	96 °C	blue residue
B	99 °C	white residue
C	100 °C	no residue
D	105 °C	white residue

2 Hexane and water are immiscible liquids.

Which method could be used to separate a mixture of hexane and water and how is the purity of hexane determined after the separation?

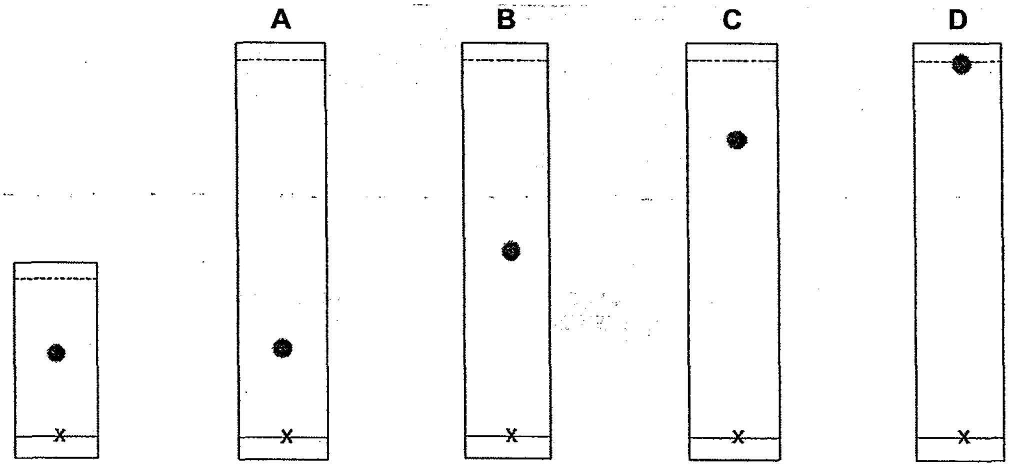
	method of separation	purity check
A	filtration	determine the boiling point
B	distillation	obtain a chromatography
C	use a separating funnel	determine the boiling point
D	use a separating funnel	obtain a chromatography

[Turn Over

3 The diagram shows a chromatogram for a drug that is banned for use by athletes.

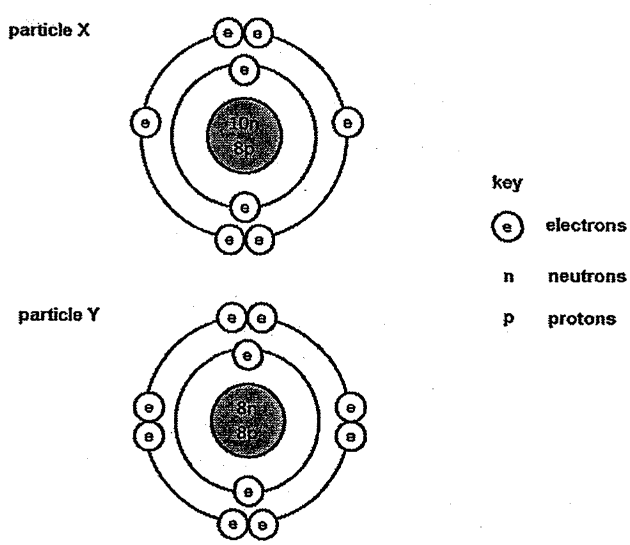
A second chromatogram is conducted on the same drug using the same solvent on a longer sheet of paper.

Which chromatogram shows the correct results?



Chromatogram of banned drug

4 The diagrams below show the electronic structures of two particles of the **same** element.

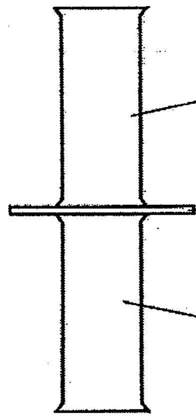


Which of the following shows the correct identities of particle X and particle Y?

	particle X	particle Y
A	isotope of oxygen	ion of oxygen
B	ion of oxygen	isotope of oxygen
C	ion of neon	ion of oxygen
D	isotope of neon	atom of neon

5 Nitrogen dioxide is a dark brown gas and its relative molecular mass is 46.

A gas jar containing nitrogen dioxide is sealed with a glass plate and is then inverted on top of a gas jar containing air.



The glass plate is removed.

Which of the following correctly describes the colours inside the gas jar after a long period of time and the reason for the observation?

	upper gas jar	lower gas jar	reason for the observation
A	brown	brown	Nitrogen dioxide and air diffuse evenly through both gas jars.
B	colourless	dark brown	Nitrogen dioxide sinks into the lower gas jar while air rises into the upper gas jar.
C	dark brown	light brown	Some nitrogen dioxide diffuses slowly into the lower gas jar as gas particles move slowly.
D	light brown	dark brown	Nitrogen dioxide and air diffuse through both gas jars, but nitrogen dioxide is heavier so more molecules sink into the lower jar.

6 The melting point of sodium chloride is much lower than the melting point of magnesium oxide.

Which statement explains this?

A Sodium is more reactive than magnesium.

B The melting point of sodium is lower than that of magnesium.

C A chloride ion has more protons than an oxide ion.

D The attraction between Na^{+} and Cl^{-} is weaker than that between Mg^{2+} and O^{2-}.

7 Element Q has an electronic structure 2,4.

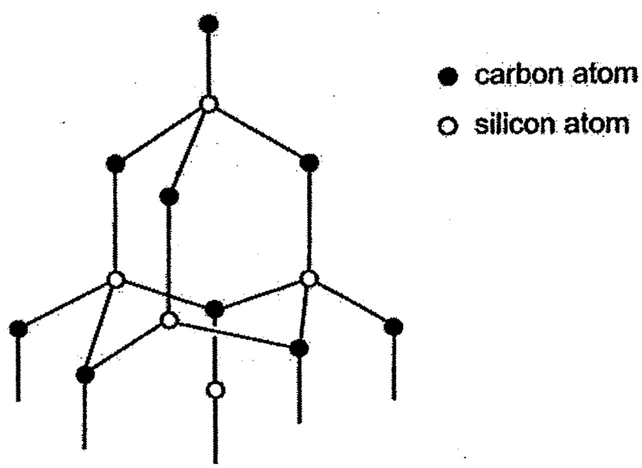
Element R has an electronic structure 2,8,6.

Element Q reacts with element R to form a new compound.

Which of the following correctly shows how element Q reacts with element R and the mass of 1 mole of the new compound formed?

	Reaction between Q and R	mass of 1 mole of new compound / g
A	two electrons are shared between an atom of Q and an atom of R	76
B	four electrons are shared between an atom of Q and an atom of R	38
C	four electrons are shared between an atom of Q and an atom of R	76
D	two electrons are transferred from an atom of Q to an atom of R	76

8 The diagram shows the structure of silicon carbide, $(SiC)_n$.



Which set of properties does silicon carbide have?

	physical property	products of combustion of $(SiC)_n$
A	acts as a lubricant	a solid residue only
B	insoluble in water	a colourless gas only
C	conducts electricity	a solid residue and a colourless gas
D	high melting point	a solid residue and a colourless gas

9 The properties of W, X, Y and Z are shown in the table.

property	W	X	Y	Z
melting point (°C)	1728	−183	114	approx. 3500
boiling point (°C)	2230	−162	184	approx. 4800
electrical conductivity	no	no	no	yes

What are the correct identities of W, X, Y and Z?

	methane	silicon dioxide	iodine	graphite
A	W	X	Y	Z
B	X	W	Y	Z
C	Y	Z	W	X
D	Z	W	X	Y

10 Metals have positive ions in a 'sea of delocalised electrons'.

Which metal atom provides the most number of moles of electrons for the 'sea'?

A aluminium

B copper

C magnesium

D sodium

11 In the extraction of sodium by electrolysis of molten sodium oxide, 57.5 g of sodium is collected at the cathode.

What is the volume of oxygen gas formed at the anode?

A 15 dm^3 **B** 30 dm^3 **C** 60 dm^3 **D** 90 dm^3

12 Which substance would give a neutral solution when added to 25 cm^3 of 0.2 mol/dm^3 phosphoric acid, H_3PO_4?

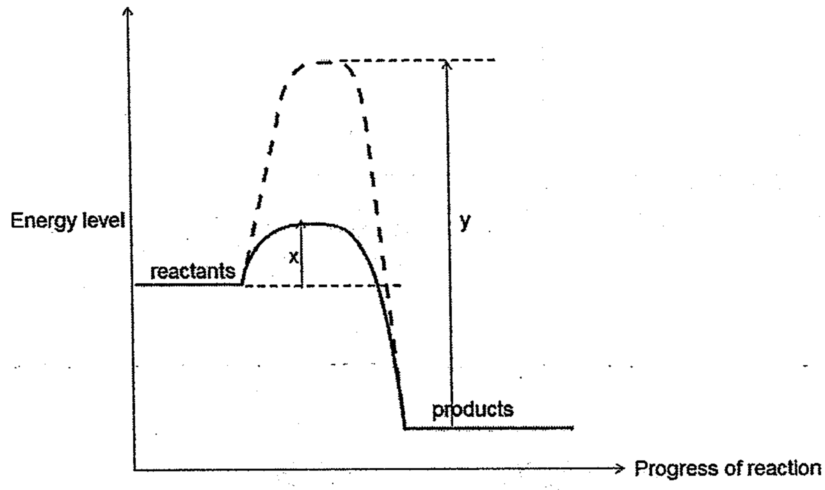
A 10 cm^3 of 1.0 mol/dm^3 sodium hydroxide

B 30 cm^3 of 1.0 mol/dm^3 sodium hydroxide

C 30 cm^3 of 0.5 mol/dm^3 sodium hydroxide

D 20 cm^3 of 0.5 mol/dm^3 sodium hydroxide

13 The energy profile diagram for a chemical reaction is shown.



Which statement/s is/are correct?

1 The number of bonds formed is greater than the number of bonds broken.

2 The value of x shows the activation energy in the presence of a catalyst.

3 The value of y shows the overall enthalpy change.

4 The total energy change in bond formation is greater than that in bond breaking.

A 1 and 2 only

B 1 and 3 only

C 2 and 4 only

D 1, 2 and 3 only

14 The scheme shows four stages, I to IV, by which crude oil is purified and eventually converted to carbon dioxide and water.

crude oil $\xrightarrow{\text{I}}$ crude oil vapour $\xrightarrow{\text{II}}$ diesel oil $\xrightarrow{\text{III}}$ ethene $\xrightarrow{\text{IV}}$ carbon dioxide + water

Which stages are exothermic?

A I and II only

B II and IV only

C I, II and IV only

D All of the stages

15 The list shows reactions in which copper(II) sulfate is either a reactant or a product.

1	addition of iron metal to aqueous copper(II) sulfate
2	addition of aqueous copper(II) sulfate to aqueous ammonium carbonate
3	electrolysis of aqueous copper(II) sulfate using copper electrodes
4	formation of copper(II) sulfate from copper(II) oxide

In which reactions are there **no** changes in the oxidation state of copper?

A 1 and 3 only

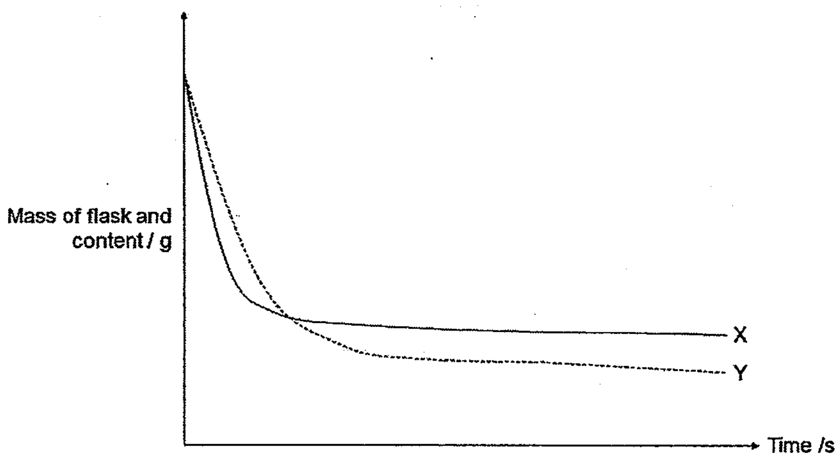
B 2 and 4 only

C 2 and 3 only

D 3 and 4 only

16 Excess zinc reacts with 20 cm^3 of 0.1 mol/dm^3 nitric acid to give off hydrogen gas.

The mass of the flask and its content against time was plotted as shown by curve X in the graph below.



Which set of conditions will result in a change in the graph shown by curve Y?

	metal	acid
A	iron	15 cm^3 of 0.1 mol/dm^3 nitric acid
B	iron	25 cm^3 of 0.1 mol/dm^3 nitric acid
C	magnesium	20 cm^3 of 0.1 mol/dm^3 nitric acid
D	magnesium	25 cm^3 of 0.1 mol/dm^3 nitric acid

17 Which product is formed at the anode when concentrated aqueous lead(II) bromide is electrolysed?

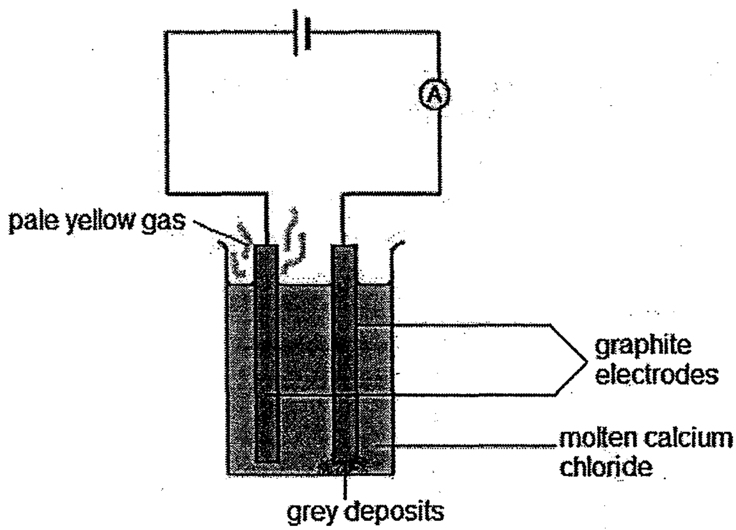
A lead atoms

B hydrogen molecules

C oxygen molecules

D bromine molecules

18 The diagram shows the electrolysis of molten calcium chloride.



The following students make conclusions about what happened during electrolysis.

Matthew: Calcium is oxidised.
Jewel: The pale yellow gas and grey deposits are new elements formed.
Jonah: The overall equation is $Ca^{2+} + 2Cl^{-} \rightarrow CaCl_2$

Who is/are correct?

A Jewel only

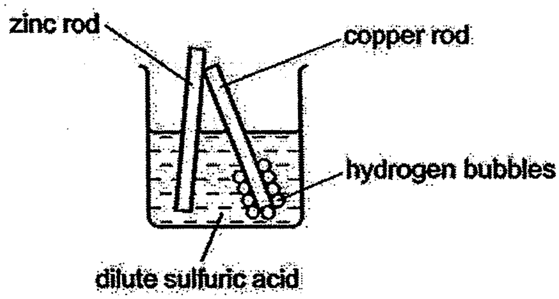
B Jonah only

C Matthew and Jewel

D Jewel and Jonah

19 In an experiment, rods of copper and zinc are dipped into dilute sulfuric acid, with their top ends touching.

Hydrogen bubbles collect around the copper rod.



Which statement about the experiment is correct?

A Copper reacts with the acid.

B Protective layer prevents zinc from reacting with acid.

C Electrons flow from zinc to copper.

D The zinc becomes coated with copper.

20 Fertilisers can be manufactured on a large scale using the Haber process.

The reaction can be represented by the equation below.

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

Which of the following statement is correct?

A Using iron as a catalyst increases the yield of ammonia.

B An increase in temperature will increase the rate and yield of the forward reaction.

C 115 kJ of energy is given off when 30 dm^3 of nitrogen gas is used.

D The ammonia produced is separated from the unreacted hydrogen and nitrogen by fractional distillation.

21 Which of the following reagents could be used to distinguish between potassium sulfate and sodium chloride?

A hydrochloric acid

B aqueous ammonia

C aqueous lead(II) nitrate

D aqueous barium nitrate

22 One mole of compound R gives two moles of ions in an aqueous solution. R reacts with ammonium carbonate to give an alkaline gas.

What is compound R?

A calcium hydroxide

B ethanoic acid

C sodium hydroxide

D sulfuric acid

23 Which statement/s is/are true about hydrogen chloride?

1 It reacts with magnesium to give off hydrogen gas when dissolved in dry methylbenzene.

2 It dissociates partially into ions when bubbled into distilled water.

3 It turns moist blue litmus paper red.

A 1 only

B 3 only

C 2 and 3 only

D 1, 2 and 3

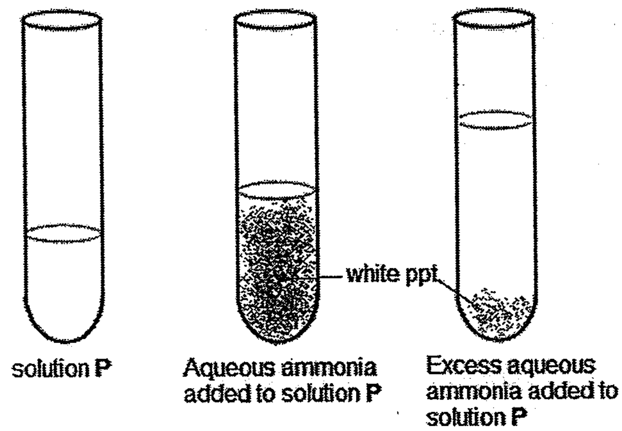
24 Potassium ethanoate, CH_3COOK, can be prepared by mixing ethanoic acid and potassium hydroxide.

$$CH_3COOH + KOH \rightarrow CH_3COOK + H_2O$$

Which of the following shows the correct mixture to form the salt, CH_3COOK?

	ethanoic acid	potassium hydroxide
A	15 cm^3 of 1 mol/dm^3 CH_3COOH	15 cm^3 of 0.5 mol/dm^3 KOH
B	25 cm^3 of 1 mol/dm^3 CH_3COOH	30 cm^3 of 0.5 mol/dm^3 KOH
C	10 cm^3 of 2 mol/dm^3 CH_3COOH	25 cm^3 of 1 mol/dm^3 KOH
D	20 cm^3 of 2 mol/dm^3 CH_3COOH	40 cm^3 of 1 mol/dm^3 KOH

25 Solution P contains a cation of a metal M and aqueous ammonia was added to it. The results are seen below.



Which of the following is correct about metal M?

	when reacted with oxygen	when dropped into aqueous lead(II) nitrate
A	forms a basic oxide	no visible reaction
B	forms an amphoteric oxide	no visible reaction
C	forms a basic oxide	grey deposits formed
D	forms an amphoteric oxide	grey deposits formed

26 Which statement describes the changes in the element from left to right across a period of the Periodic Table?

A The ability to conduct electricity decreases.

B The ability to gain electrons decreases.

C The elements form acidic to basic oxides.

D The number of neutrons in an atom decreases.

27 Which statement about groups in the Periodic Table is correct?

A All groups contain both metals and non-metals.

B Atoms of elements in the same group have the same total number of electrons.

C In Group I, reactivity decreases with increasing proton number.

D In Group VII, the melting point of the elements increases with proton number.

28 X, Y and Z are in the same period of the Periodic Table.

X is used to fill light bulbs. Y floats and reacts violently with water. Z gives a brown solution when reacted with potassium iodide.

What is the order of these three elements across the Periodic Table?

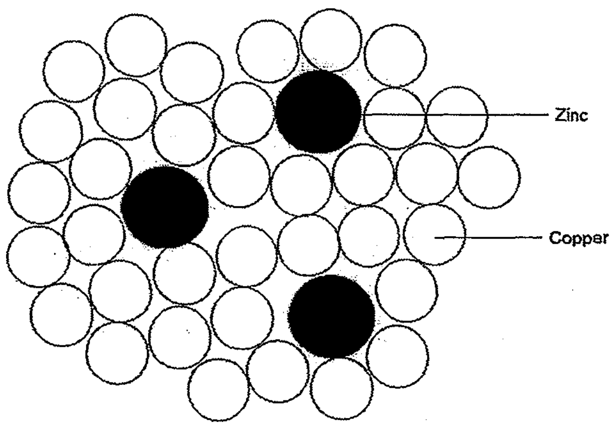
A XYZ

B YZX

C YXZ

D ZYX

29 The diagram shows the structure of brass.



Why is brass harder than pure copper?

A The zinc atoms form strong electrostatic bonds with copper atoms.

B There are fewer zinc atoms than copper atoms.

C The zinc atoms prevent the layers of copper atoms from slipping over each other easily.

D Zinc atoms contribute more electrons to the 'sea of delocalised electrons'.

30 How does the mass of a sample of copper(I) oxide change when it is heated in hydrogen and in oxygen?

	mass after heating in hydrogen	mass after heating in oxygen
A	unchanged	increases
B	unchanged	unchanged
C	decreases	increases
D	decreases	unchanged

31 Which metal carbonate decomposes on heating to give a yellow solid when hot and a white solid when cold?

A aluminium carbonate

B iron(III) carbonate

C lead(II) carbonate

D zinc carbonate

32 The table below shows the observations when three different metals, P, Q and R are reacted with hydrochloric acid and water.

Experiment	P	Q	R
Metal + hydrochloric acid	Effervescence	No effervescence	Effervescence
Metal + water	No effervescence	No effervescence	Effervescence

Which of the following statement about the three metals is correct?

A Metal P can be extracted by electrolysis of an aqueous solution of its salt.

B Metal R can be extracted by electrolysis of its molten ore.

C Metal P can be obtained easily by heating its ore with metal Q.

D Metal Q can displace both metal P and R from aqueous solution of their salts.

33 Which of the following statements about the extraction of iron are correct?

1 Carbon monoxide acts as the reducing agent.

2 Limestone is added to remove basic impurities.

3 Iron floats on top of slag when they are collected at the bottom of the Blast Furnace.

A 1 only

B 2 only

C 1 and 2 only

D 2 and 3 only

34 Sulfur dioxide is an air pollutant that causes acid rain.

Which of the following about sulfur dioxide is correct?

	source of sulfur dioxide	use of sulfur dioxide
A	combustion of fossil fuels	in car batteries
B	photochemical activities	as food preservative
C	volcanic eruptions	in the manufacture of fertilisers
D	volcanic eruptions	as food preservative

35 The table shows the composition of four different types of petroleum (crude oil).

	Types of petroleum			
fraction	Arabian Light / %	Iranian Light / %	South Sea / %	North Sea / %
Gasoline	18	23	21	23
Naphtha	11.5	18	13	24
Diesel oil	18	35	20	15
Bitumen	52.5	24	46	38

Which type of petroleum produces the most pollution due to combustion of fossil fuels in vehicles?

A Arabian Light

B Iranian Light

C South Sea

D North Sea

36 How many different alcohols have the molecular formula C_4H_9OH?

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

37 1 mole of ethane reacts with 2 moles of chlorine in the presence of UV light.

What is the formula of the organic product in this reaction?

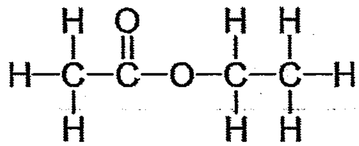
A C_2H_5Cl

B $C_2H_4Cl_2$

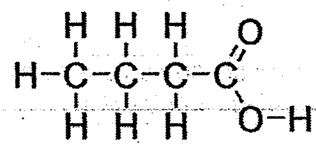
C $C_2H_2Cl_4$

D $C_2H_2Cl_2$

38 Which of the following reagents cannot be used to distinguish between compound P and compound Q?



compound P



compound Q

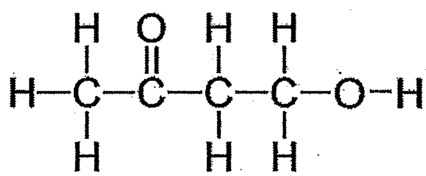
A aqueous bromine

B aluminium metal

C sodium carbonate

D methyl orange

39 An organic compound has the structure as shown below.



Which of the following about the compound is correct?

A It decolourises aqueous bromine.

B It decolourises acidified potassium manganate(VII).

C It oxidises potassium iodide and causes the solution to turn brown.

D It undergoes condensation polymerisation on its own.

40 Which of the following monomers cannot form polymers with itself?

A $CH_3CHOHCOOH$

B $CH_2{=}CHCOOCH_3$

C CH_3CHNH_2COOH

D $HOOCCH_2COOH$

Answer for Pure Chemistry Prelim 2 2014

QN	ANS	EXPLANATION
1	D	Temperature of the solution will be higher than 100 °C as it is near to the heat source. When water is removed by distillation, the copper(II) sulfate will eventually become the anhydrous form, which is a white solid.
2	C	Immiscible liquids are separated by separating funnel. As hexane is colourless, the spot on the chromatogram may not be obvious. Determining the boiling point will be a better method to determine its purity.
3	B	The R_f value of the same substance remains the same regardless of the length of the paper if the same solvent is used to carry out the chromatography.
4	A	The element is oxygen as the proton number is 8. X is the isotope as it has different number of neutrons as compared to an oxygen atom. Y is an ion as it has gained 2 electrons.
5	A	Nitrogen dioxide is heavier than nitrogen in air, it moves faster to fill the bottom jar. However after some time, the concentration of gases in both jars will even out.
6	D	Since the attraction is weaker, the amount of energy needed to overcome the attraction will be lesser. This will result in a lower melting point for sodium chloride.
7	C	Q and R will form covalent compound as both are non-metals. Q needs to form 4 bonds while R needs to form 2 bonds to achieve the stable electronic configuration. Hence they will form the compound, QR_2, with Q forming a double bond with each R (4 electrons). Mass of 1 mole of QR_2 = 12+32+32 = 76
8	D	Silicon carbide will undergo thermal oxidation to form SiO_2 (solid) and CO_2 (gas). It is also insoluble in water, has high melting point and does not conduct electricity.
9	B	W and Z have high melting and boiling points hence they have giant molecular structures. But since only Z conducts electricity, Z is graphite and W is silicon dioxide. X and Y have low melting and boiling points hence they have simple molecular structures. But as iodine is a bigger molecule with larger surface area for contact, it will have a higher melting and boiling point. Hence X is methane and Y is iodine.
10	A	Aluminium forms a charge of +3, so it loses 3 electrons to the 'sea', which is more than the 2 electrons for copper and magnesium and 1 electron for sodium.
11	A	No of moles of sodium = 57.5 / 23 = 2.5 $Na^+(aq) + e \rightarrow Na(s)$ $2O^{2-}(aq) \rightarrow O_2(g) + 4e$ no of moles of electrons = 2.5 no of moles of oxygen gas = 2.5/4 = 0.625 Volume of oxygen gas = 0.625 x 24 = 15dm^3
12	C	no of moles of H_3PO_4 = 25/1000 x 0.2 = 0.005 no of moles of NaOH needed = 0.015 (30/1000 x 0.5)
13	C	It is an exothermic reaction, hence the total amount of energy given off during bond formation is greater than the total amount of energy absorbed during bond breaking. Catalyst provides an alternative pathway with lower activation energy, hence X shows the lowered activation energy.
14	B	I – evaporation, endothermic. II – condensation, exothermic. III – cracking, endothermic. IV – combustion, exothermic
15	B	In 1, copper is reduced from Cu^{2+} to Cu. In 3, copper is oxidised at the anode and reduced at the cathode. In 2 and 4, copper's oxidation state remains as +2.
16	B	The reaction is slower, hence a less reactive metal is used. The amount of product formed is greater as seen from the greater loss in mass, hence more limiting reagent is used.
17	D	Bromide ions are attracted to the anode and discharged as bromine molecules.
18	A	Calcium ions are reduced to calcium metal. Chlorine gas and calcium metal formed are elements. Overall equation gives Ca and Cl_2 as products.
19	C	Zinc is more reactive, hence it loses electrons which flows to copper.
20	C	no of moles of N_2 = 30 / 24 = 1.25 Amount of energy given off = 1.25 x 92 = 115 kJ

21	D	Barium sulfate is a white precipitate while barium chloride is soluble and gives a colourless solution.
22	C	R is an alkali as it gives ammonia when reacted with ammonium carbonate. 1 sodium hydroxide dissociates to give 2 ions, Na^+ and OH^-.
23	B	Hydrogen chloride must dissolve in water in order to react like an acid and it dissociates completely in water. Hence statement 1 and 2 are wrong. Being an acidic gas, it turns moist blue litmus paper red.
24	D	Potassium ethanoate is a soluble salt with soluble starting materials, hence it is prepared by titration. Exact amount of both starting materials are needed.
25	D	M is zinc, hence it forms an amphoteric oxide. It will also displace lead from lead(II) nitrate, so a grey deposits formed.
26	A	From left to right, the elements change from metal to non-metal. Hence the ability to conduct electricity decreases.
27	D	As the proton number increases, the molecules become bigger. The surface area for contact increases hence the forces of attraction between the molecules increases. This results in higher melting points down the group.
28	B	X is a noble gas, Y is a Group I metal, Z is a halogen.
29	C	Zinc atoms disrupt the orderly arrangement in copper, preventing them from slipping over each other.
30	C	Copper(I) oxide is reduced to hydrogen to form copper metal, hence there is a decrease in mass. Copper(I) oxide is oxidised when heated in oxide to form copper(II) oxide, resulting to an increase in mass.
31	D	Zinc oxide is yellow when hot and white when cold.
32	B	R is the most reactive metal that can only be extracted by electrolysis of its molten ore.
33	A	Carbon monoxide reduces iron ore to iron. Limestone is used to remove acidic oxide. And iron is denser, hence it sinks.
34	D	Source of sulfur dioxide is volcanic eruptions and burning of sulfur-containing fossil fuels. Sulfur dioxide is used as food preservatives.
35	B	Iranian Light contains the higher percentage of gasoline and diesel, which are used as fuel for cars and heavy vehicles respectively.
36	C	4 isomers formed by shifting the position of the –OH functional group and by branching.
37	B	With 2 moles of chlorine, 2 hydrogen atoms are replaced by 2 chlorine atoms with hydrogen chloride formed as side product.
38	A	There is no c-c double bond in both compounds, hence there will be no decolouration of bromine for both.
39	B	It undergoes oxidation to form carboxylic acid, decolourising acidified potassium manganite(VII).
40	D	It does not have c-c double bond or 2 different functional groups that can react to form amide or ester linkage.

Paya Lebar Methodist Girls' School (Secondary)
Preliminary 2 Examination 2014
Secondary 4 Express

CANDIDATE NAME									
CENTRE NUMBER					INDEX NUMBER				

CHEMISTRY **5073/02**

Paper 2

30 July 2014 (Wednesday)

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer all **three** questions, the last question is in the form either/or.
Write your answers on the lined paper provided and, if necessary, continue on separate answer paper.

At the end of the examination, fasten all your work securely.
The number of marks is given in the 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	/50
B8	
B9	
B10	
Total	/80

This document consists of 20 printed pages.

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	– 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
X
b

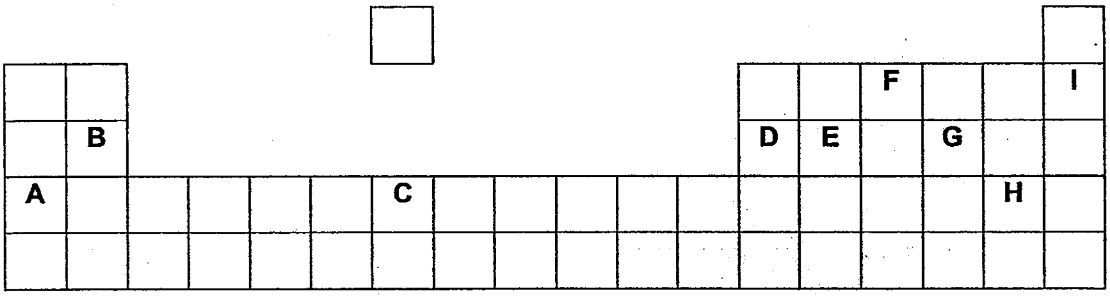
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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

Section A

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

A1 The diagram shows the outline of part of the Periodic Table.



Use the symbols from the table to answer the following questions.

(a) Which elements exist as diatomic molecules?

....[1]

(b) Which elements form basic oxides?

....[1]

(c) Which element has a stable electronic configuration?

....[1]

(d) Which element has a giant molecular structure?

....[1]

(e) Which element combines with chlorine to form a liquid compound with formula $\mathbf{XC}l_2$?

....[1]

(f) Which element has low melting and boiling point, but is also a good electrical conductor?

....[1]

(g) Which element and its compounds are commonly used as catalysts for reactions?

....[1]

[Total: 7]

A2 Methanoic acid can be produced by the oxidation of methanol with oxygen in the presence of bacteria.

For Examiner's Use

(a) Write the balanced chemical equation for the reaction, showing the **full** structural formulae of the reactants and products.

[1]

(b) Use the bond energies given below to calculate the energy change for this reaction.

Bond	Bond energy in kJ
C – H	413
C = O	745
O = O	495
O – H	467
C – O	358

[2]

(c) Based on your answer in part **(b)**, sketch the energy profile diagram for the reaction.

[2]

(d) Draw a 'dot-and-cross' diagram to show the bonding in methanoic acid.

Show the outer shell electrons only.

[2]

(e) Methanoic acid reacts with sodium hydroxide to form a salt, sodium methanoate and water.

Draw a 'dot-and-cross' diagram to show the bonding in the salt formed.

Show the outer shell electrons only.

[2]

[Total: 9]

For Examiner's Use

A3 An unknown metal M does not react with steam and reacts very slowly with dilute hydrochloric acid.

A strip of iron was dropped into a solution of $M(NO_3)_2$.

(a) Predict the observation and explain your answer.

....

....[2]

(b) The experiment was repeated using iron filings instead.

Explain, using ideas about particles colliding, if the rate of reaction increased or decreased.

....

....

....[2]

(c) The resulting mixture was filtered and acidified potassium manganate(VII) was added to it.

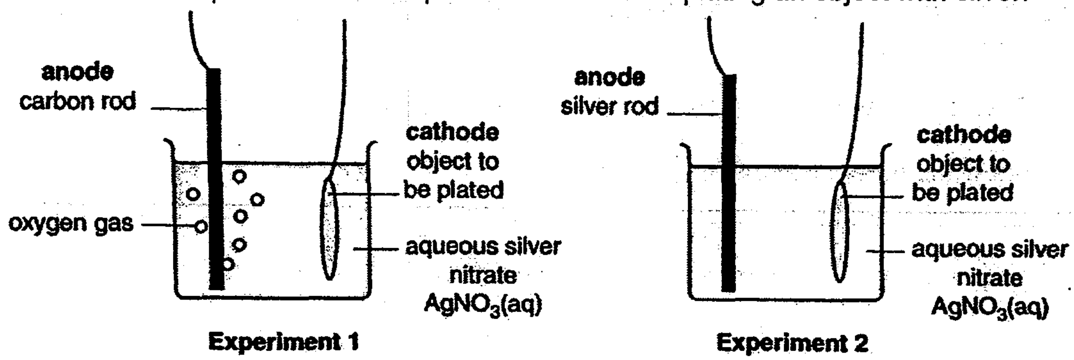
Predict the observation and explain your answer.

....

....[2]

[Total: 6]

A4 A student sets up two different experiments for electroplating an object with silver.



(a) Write equations, with state symbols, to show the reactions that happen at the anode in each experiment.

Experiment 1: ....

Experiment 2: ....[2]

(b) Predict what will happen to the concentration of silver ions in both experiments. Explain your answer.

....

....

....

....

....[3]

(c) The student made the following modifications to Experiment 2.

(1) A gold object is placed at the cathode.

(2) The battery is replaced with a voltmeter.

Do you think the gold object will be plated with silver? Explain your answer.

....

....

....

....[2]

[Total: 7]

For Examiner's Use

A5 Rainwater is weakly acidic as it contains dissolved hydrogen ions.

For Examiner's Use

Hard water, which contains calcium or magnesium ions, is formed when the acidic rainwater flows over rocks that contain calcium carbonate or magnesium carbonate

(a) Write a balanced ionic equation to show how magnesium ions are released in hard water.

....[1]

(b) In heavily industrialised areas, it is found that sulfate ions are present in water.

(i) Suggest a reason for this observation.

....

....[1]

(ii) Describe a simple test to show the presence of sulfate ions.

....

....[1]

(iii) A student predicts that the water from heavily industrialised areas is strongly acidic as compared to normal rainwater.

Describe how the student can use indicator to test her prediction.

....

....

....

....[2]

(iv) The equation shows how sodium carbonate removes hardness from the water.

$$MgSO_4(aq) + Na_2CO_3(aq) \rightarrow MgCO_3(s) + Na_2SO_4(aq)$$

With reference to the above equation, suggest how the hardness from water can be removed.

....

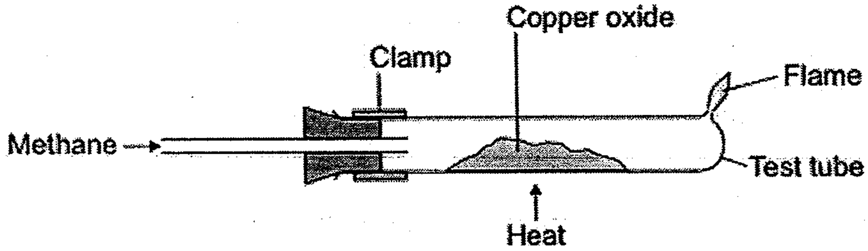
....

....[2]

[Total: 7]

A6 The apparatus below is used for the reaction of copper(II) oxide with methane.

For Examiner's Use



$$4\,CuO(s) + CH_4(g) \rightarrow 4\,Cu(s) + 2H_2O(g) + CO_2(g)$$

(a) Explain why a flame is set to burn at the end of the tube.

....

....[1]

(b) The experiment was repeated three times.

The mass of copper(II) oxide used and the mass of copper produced were measured each time.

The results are shown in the table.

Experiment	1	2	3
Mass of copper(II) oxide used / g	4.0	4.0	4.0
Mass of copper produced / g	3.3	3.5	3.1

(i) Calculate the average mass of copper produced and hence, calculate the volume of methane gas needed for the reaction.

[3]

(ii) The student explained that the mass of copper produced was higher in the second experiment because he turned off the supply of methane before the copper produced was cooled down.

For Examiner's Use

Do you agree with him? Explain your answer.

....

....[1]

(c) If aluminium oxide was used in the reaction above, there will be no change in mass.

Explain why this statement is true.

....

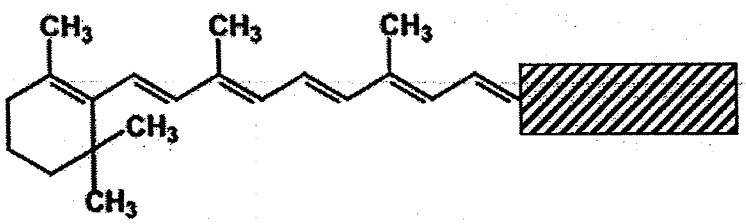
....

....[2]

[Total: 7]

A7 Beta-carotene, a pigment found in yellow and orange fruits and vegetables, protects the body from free radicals and help to boost the body's immune system.

The diagram below shows the structure of beta-carotene.



(a) Beta-carotene is polyunsaturated.

Explain the term *'**polyunsaturated**'* and describe a test to confirm the presence of unsaturation in beta-carotene.

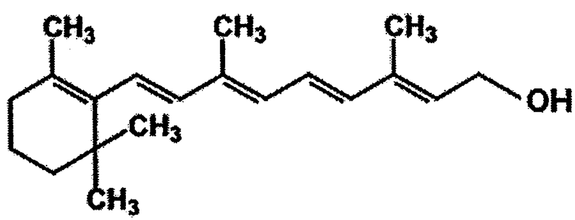
....

....

....[2]

(b) Beta-carotene is broken down in the human body to give Vitamin A and a product **X**.

The diagram below shows Vitamin A.



(i) Describe how the body breaks down beta-carotene and draw the structure of the product **X** formed in the process.

....

....[1]

[1]

(ii) Beta-carotene can also undergo hydration reaction in the laboratory.

State the conditions needed for this reaction.

....[1]

(c) A student predicts that Vitamin A will have a higher melting point than beta-carotene.

Do you agree with her? Explain your answer.

....

....

....

....[2]

[Total: 7]

For Examiner's Use

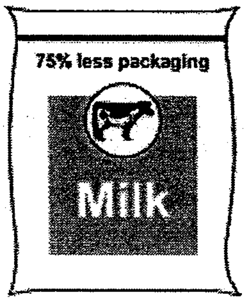
Section B

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 Read the information about milk bottles.

Supermarkets launch eco-friendly plastic milk bags. Could this be the end of milk bottle?



Milk bottles are made from glass or from plastic.

Glass milk bottles contain 0.5 litres of milk. When the milk is used up, the empty bottles are returned to be re-used. Glass milk bottles are re-used 24 times on average. The glass to make new milk bottles is produced when a mixture of sand, limestone, soda and recycled glass is heated to about 1600 °C in a furnace. There are almost unlimted amounts of the raw material needed to produce this glass. About 35% of used glass is recycled.

The most common plastic milk bottles contain 2 litres of milk. When the milk is used up, the empty bottles are discarded as waste. The plastic used to make these milk bottles is poly(ethene). Poly(ethene) is produced from crude oil by first using fractional distillation, then cracking the naphtha fraction and finally polymerising the ethene. About 5% of used poly(ethene) is recycled.

The new plastic milk bags contains 2 litres of milk. The milk bags are also made from poly(ethene). A milk bag uses 75% less poly(ethene) than is used to make the poly(ethene) milk bottles. When the milk is used up, the empty bags are discards as waste.

(a) Sand, SiO_2, is the main component of glass.

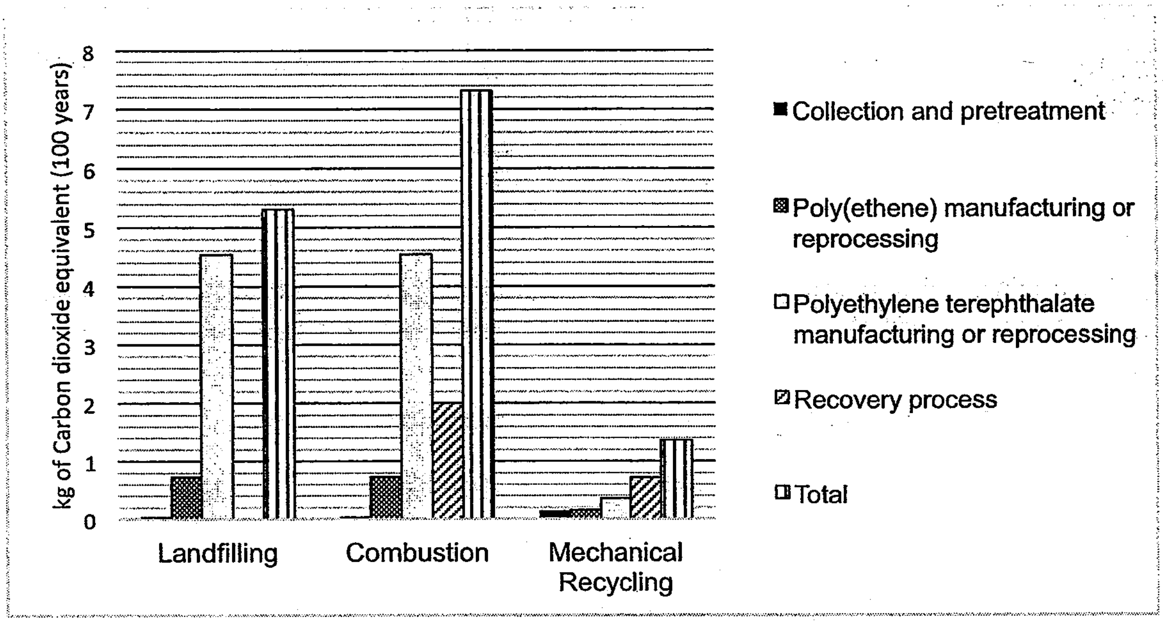
Explain why the mixture has to be heated to about 1600 °C in the recycling process. [2]

(b) Describe the process of obtaining naphtha by fractional distillation of crude oil. [3]

(c) Explain **two** advantages that make plastic milk bags eco-friendly as compared to using glass or plastic milk bottles. [2]

Another type of plastic, polyethylene terephthalate, is also used extensively in the manufacturing of plastic bottles.

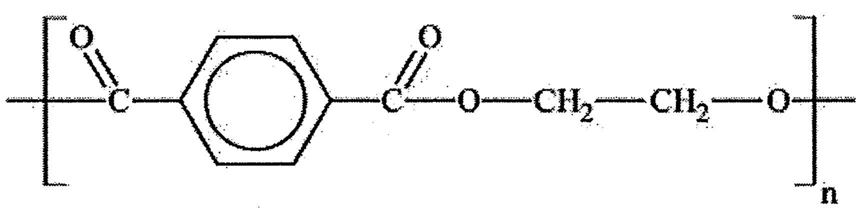
Landfilling and combustion represent the amount of carbon dioxide emitted from the production and transportation of new plastics, while mechanical recycling represents the amount emitted from the recycling of plastics.



(d) Which process emits the most amount of carbon dioxide? [1]

(e) Using data from the graph, explain why the recycling of plastics is important. [1]

(f) Polyethylene terephthalate has the structure as shown below.

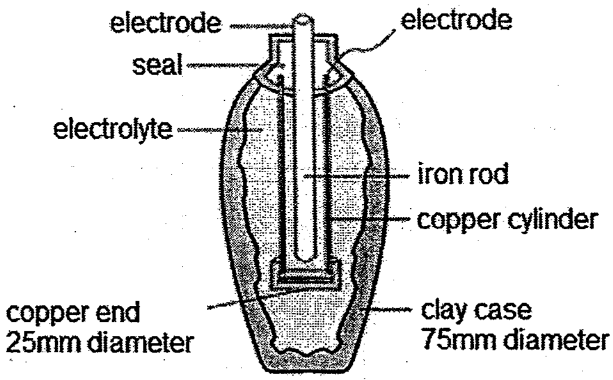


Draw the structures of its monomers and hence state one difference between the reactions that formed this plastic and poly(ethene) respectively. [3]

[Total: 12]

[Turn Over

B9 The Baghdad battery was discovered near Iraq in 1936.



It consisted of a ceramic jar that housed a copper tube which contained an iron rod. When a simple acid like lime juice, wine or vinegar was added, an electric current would be produced.

(a) With the help of half equations, explain how the battery works. [2]

(b) Suggest why silver nitrate would not be a good electrolyte for this battery. [1]

(c) A student suggested a way to improve the battery is to replace the iron with zinc.

Do you agree with her? Explain your answer. [2]

(d) In the present society, the Baghdad battery is no longer in use.

Instead, fuel cells involving hydrogen and ethanol are commonly used to generate electric current.

(i) Both fuels have different effects on the environment when used as fuels.

Outline **one** environmental difference between the two fuels. [1]

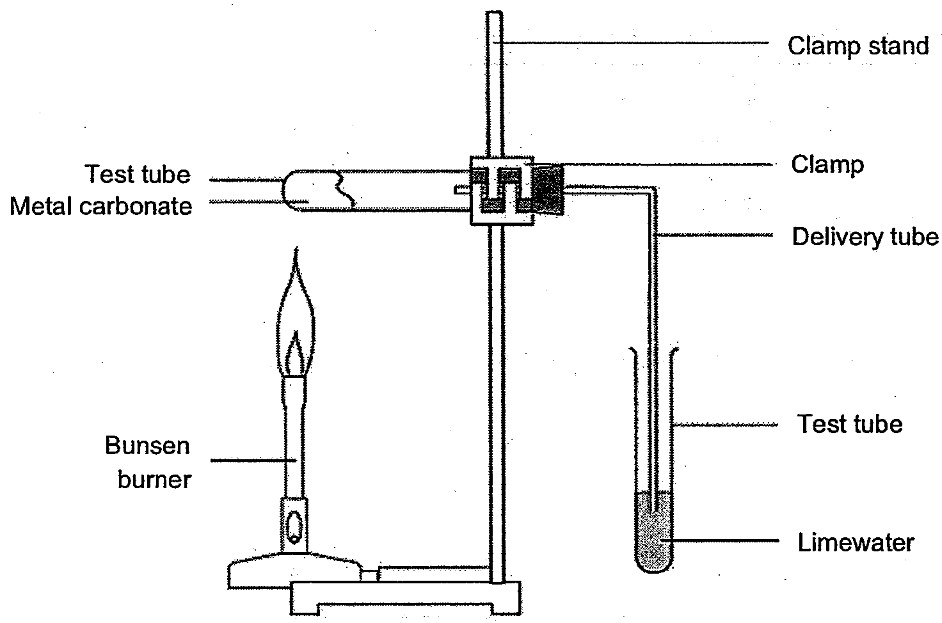
(ii) Ethanol can be obtained from sugar from sugar canes.

Outline the steps to obtain pure ethanol from sugar. [2]

[Total: 8]

EITHER

B10 Using the set up below, a student decided to investigate the thermal stability of the carbonates of the four metals.



(a) What would he observe as reaction proceeds? [1]

(b) Describe how he can use his results to place the metal carbonates in order of thermal stability. [1]

(c) He conducted the experiment using zinc carbonate, sodium carbonate and silver carbonate.

(i) Predict the thermal stability of the three carbonates by ranking them in decreasing order of stability. Explain your answer. [3]

(ii) The student used 1.2 g of zinc carbonate during the experiment.

After heating, he measured the mass of the remaining solid and found that the mass was 0.65 g.

$$ZnCO_3 \rightarrow ZnO + CO_2$$

Calculate the percentage purity of the original sample of zinc carbonate. [3]

(d) When silver carbonate undergoes complete decomposition, silver metal is formed.

However, zinc metal cannot be obtained in the same way.

Describe a method to obtain pure zinc metal from its ore. [2]

[Total: 10]

OR

B10 Some nitrogen compounds are commonly used as fertilisers.

One of such compounds is urea.

The table shows the data from the analysis of a sample of urea.

Element present	**% by mass**
nitrogen	46.5
hydrogen	6.5
carbon	20.0
oxygen	27.0

(a) Use the data to work out the empirical formula of the urea. [3]

(b) Write a balanced chemical equation to show how urea can be formed from ammonia and carbon dioxide. [1]
(Take the empirical formula as the molecular formula of urea.)

(c) Farmers that grow crops often use large quantity of fertilisers.

Farmers also often add calcium hydroxide to soil to neutralise soil acidity.

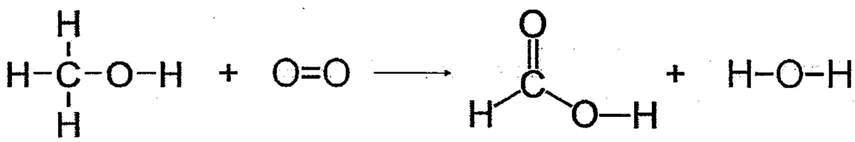
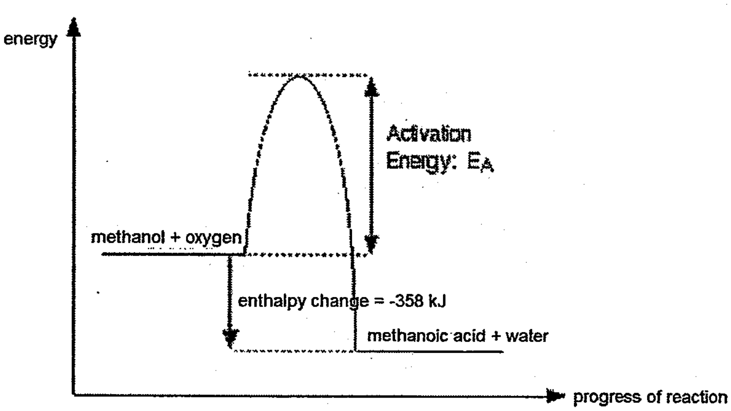
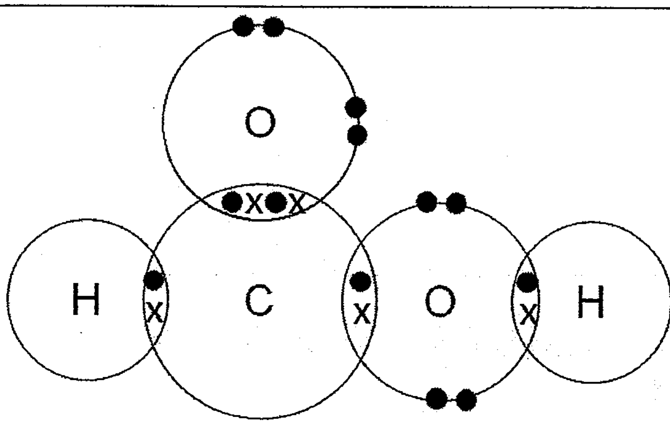
Why is it important not to add fertilisers to soils that have been recently treated with calcium hydroxide? [2]

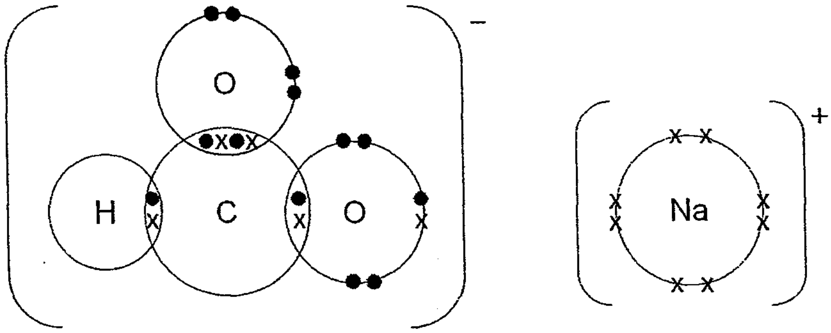
(d) Another common fertiliser, ammonium nitrate, can be synthesized easily in the laboratory.

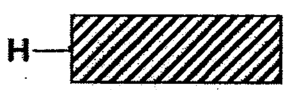
Describe the method to obtain ammonium nitrate. [4]

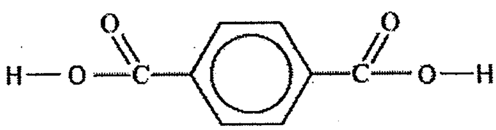
[Total: 10]

Answer for Pure Chemistry Prelim 2 2014

Qn	Answer	Mark
1(a)	**F, H**	1
1(b)	**A, B, C**	1
1(c)	**I**	1
1(d)	**E**	1
1(e)	**G**	1
1(f)	**A**	1
1(g)	**C**	1
2(a)		1
2(b)	$\Delta H = 2(413) + 495 + (-745) + 2(-467)$ $= -358$ kJ	1; 1
2(c)		1; (shape) 1 (enthalpy and activation energy)
2(d)		1; (arrangement) 1 (configuration)

2(e)		1 for each ion
3(a)	A grey deposit is formed and the solution turns green. Metal becomes smaller or dissolves. Iron reacts with steam, hence it is more reactive than M and it will displace M from its nitrate solution.	1; 1
3(b)	The rate of reaction increased because as iron filings are smaller in size than iron strip. This results is a larger surface area exposed for reaction, leading to an increase in the frequency of effective collisions and a faster rate of reaction.	1; 1
3(c)	The solution turned from green to brown/yellow, (while potassium manganate(VII) is decolourised) Fe^{2+} is oxidized to Fe^{3+} by oxidizing agent, potassium manganate(VII).	1; 1
4(a)	In experiment 1 – $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$ In experiment 2 – $Ag(s) \rightarrow Ag^+(aq) + e$	1; 1
4(b)	In experiment 1, the concentration of silver ions will decrease. In experiment 2, the concentration of silver ions will remain the same. This is because in experiment 1, silver ions are discharged at the cathode. This is because in experiment 2, for every one mole of silver ion that is discharged at the cathode, one mole of silver metal is oxidised to form a silver ion at the anode. Hence silver ions are constantly replaced.	1; 1; 1
4(c)	Yes it will be plated with silver. Silver is more reactive than gold. Hence it will lose electrons to form silver ions, supplying electrons to the circuit in the process. Silver ions will be attracted to the gold object and be discharged to form silver metal. The silver metal formed will coat the object.	1; 1
5(a)	$2H^+(aq) + MgCO_3(s) \rightarrow Mg^{2+}(aq) + H_2O(l) + CO_2(g)$	1
5(b)(i)	In heavily industralised areas, there is high frequency of burning of fossil fuels. When burning fossil fuels that contain sulfur, sulfur dioxide is formed, which then dissolves in rain to form sulfurous acid. Sulfurous acid is oxidized to form sulfuric acid, which dissociates to give the sulfate ions.	1
5(b)(ii)	Add dilute nitric acid and barium nitrate. If white precipitate appears, sulfate ions are present.	1
5(b)(iii)	Add Universal Indicator to a sample of water from heavily industrialised areas and a sample of normal rainwater separately. The Universal Indicator will turn red or orange in the sample of water from heavily industralised areas if it is strongly acidic, while it will turn yellow in the sample of normal	1; 1

	rainwater if it is weakly acidic.	
5(b)(iv)	Add sodium carbonate to the water until no more precipitate is formed. Filter to remove the precipitate which is magnesium carbonate.	1; 1
6(a)	The flame is used to burn off excess methane. OR To draw a constant supply of methane over CuO.	1
6(b)(i)	Average mass of copper produced = (3.3 + 3.5 + 3.1) / 3 = 3.3 g Number of moles of copper formed = 3.3 / 64 = 0.0515625 mol Volume of methane gas needed = 0.0515625 / 4 x 24 = 0.309 dm^3 or 309cm^3	1; 1 1
6(b)(ii)	Yes I agree because without the constant supply of methane, oxygen enters the tube and copper oxide may be formed again, resulting in a higher mass than other experiments. OR Yes I agree because some copper(II) oxide may not have been reduced by methane. The mass of copper(II) oxide is higher than copper.	1
6(c)	Aluminium is more reactive than copper, hence aluminium oxide formed will be very stable. It cannot be reduced by heating with methane.	1; 1
7(a)	'Polyunsaturated' refers to the presence of many C-C double bonds. Add aqueous bromine to the beta-carotene, and it will decolourise to show the presence of unsaturation.	1; 1
7(b)(i)	The body breaks down beta-carotene by the reacting with water and breaking of the c-c double bond. 	1; 1
7(b)(ii)	60 atm, 300°C, phosphoric acid as catalyst (60-70 atm)	1
7(c)	No I do not agree. Both molecules have simple molecular structure with weak intermolecular forces of attraction between molecules. Vitamin A is a smaller molecule, hence the surface area for contact decreases, resulting in less extensive intermolecular forces of attraction formed between molecules. Less heat is then required to overcome these forces of attraction, resulting in lower melting points.	1; 1
8(a)	Silicon dioxide has a giant molecular structure with an extensive network of strong covalent bonds. Hence a lot of energy is needed to break these bonds before silicon dioxide can undergo chemical reaction to form glass. Heating to 1600 °C provides this amount of energy.	1; 1
8(b)	Crude oil is first vapourised and passed into a fractionating column. The hot vapour will rise up the column. The vapours with lower boiling points will be able to reach the top of the column while the vapours with higher boiling points will be collected near the bottom of the column. The vapours are then channeled out from the various levels in the fractionating	1; 1; 1

	column and condensed to be collected as liquids. Naphtha is collected as one of the middle fractions.	
8(c)	Making plastic milk bags does not require as much raw materials as the production of glass and plastic milk bottles. Making plastic milk bags also requires lesser energy as compared to the amount of energy needed to maintain the high temperature in the production of glass bottles, and the amount of energy needed to obtain more ethene from cracking and fractional distillation.	1; 1
8(d)	Combustion	1
8(e)	The mass of carbon dioxide produced during the production and transportation of new plastics 88.9% more than that needed for recycling. ($\frac{12.6-1.4}{12.6}$ x 100%) Hence it is important to recycle plastics in order to reduce the amount of carbon dioxide, a greenhouse gas, given out.	1
8(f)	 H—O—CH_2—CH_2—O—H This plastic is a condensation polymer while poly(ethene) is an addition polymer. Hence in the reaction to form this plastic, a side product, water, was formed. In the reaction for form poly(ethene), no side product was formed.	1; 1; 1
9(a)	$Fe(s) \rightarrow Fe^{2+}(aq) + 2e$ $2H^{+}(aq) + 2e \rightarrow H_2(g)$ Iron is more reactive than copper, hence it will lose electrons to become the negative terminal. Copper will then become the positive terminal where hydrogen ions are discharged to form hydrogen gas. This results in a flow of electrons which constitute the electric current.	1; 1
9(b)	Silver is less reactive than both iron and copper, hence it will be displaced from its nitrate solution.	1
9(c)	Yes I agree. Zinc is more reactive than iron, hence the potential difference between the electrodes will be larger. A battery with a large potential difference will be more effective.	1; 1
9(d)(i)	Hydrogen burns in oxygen to give water which is not a pollutant. Ethanol burns in excess oxygen to give water and carbon dioxide. Carbon dioxide is a greenhouse green which causes global warming.	1
9(d)(ii)	Sugar undergoes fermentation in the presence of yeast at 37 °C. The solution is then filtered and the filtrate is separated using fractional distillation to obtain the pure ethanol.	1; 1
Either 10(a)	He would observe that a white precipitate is formed in limewater. There may also be a change in the colour of the residue in the test tube.	1
10(b)	He needs to measure and record the mass of metal carbonates before and after the reaction in order to calculate the decrease in mass. The smaller the decrease in mass, the	1

<table>
<tr><td></td><td>more stable the metal carbonate. (Vice versa)</td><td></td></tr>
<tr><td>10(c)(i)</td><td>sodium carbonate, zinc carbonate, silver carbonate
The more reactive the metal, the more stable metal carbonate formed.
Sodium, being the most reactive metal, forms the most stable metal carbonate, while silver, the least reactive metal, forms the least stable metal carbonate.</td><td>1;
1;
1</td></tr>
<tr><td>10(c)(ii)</td><td>No of moles of ZnO formed = 0.65 / (65+16)
= 0.00802469
Mass of pure $ZnCO_3$ present = 0.00802469 x (65+12+16 x 3)
= 1.00309 g
Percentage purity of $ZnCO_3$ = 1.00309/1.2 x 100
= 83.6%</td><td>1;
1;
1</td></tr>
<tr><td>10(d)</td><td>Zinc metal must be obtained from the electrolysis of its molten ore. The electrolyte is molten zinc oxide, electrodes are graphite.
$Zn^{2+}(l) + 2e \rightarrow Zn(l)$
Zinc ions are attracted to the cathode where it gains electrons to form zinc metal, which then sinks to the bottom of the container and be tapped out.
OR
Zinc metal can be obtained from its ore by reduction with carbon.
$2ZnO + 2C \rightarrow 2Zn + CO_2$ / $C + O_2 \rightarrow CO_2$, $CO_2 + C \rightarrow 2CO$, $ZnO + CO \rightarrow Zn + CO_2$
Zinc oxide will be reduced as carbon gains the oxygen to form carbon dioxide.</td><td>1;
1</td></tr>
<tr><td>OR
10(a)</td><td>
<table>
<tr><td></td><td>N</td><td>H</td><td>C</td><td>O</td></tr>
<tr><td>% by mass</td><td>46.5</td><td>6.5</td><td>20.0</td><td>27.0</td></tr>
<tr><td>divided by Ar</td><td>3.321429</td><td>6.5</td><td>1.666667</td><td>1.6875</td></tr>
<tr><td>divided by smallest no</td><td>1.99</td><td>3.90</td><td>1.00</td><td>1.01</td></tr>
<tr><td>ratio</td><td>2</td><td>4</td><td>1</td><td>1</td></tr>
</table>
Empirical formula = N_2H_4CO</td><td>1;
1;
1</td></tr>
<tr><td>10(b)</td><td>$2NH_3 + CO_2 \rightarrow N_2H_4CO + H_2O$</td><td>1</td></tr>
<tr><td>10(c)</td><td>Fertilisers are made up of ammonium salts that react with calcium hydroxide to give off ammonia gas which escapes into the environment.
This removes the element nitrogen, which is necessary for plant growth.</td><td>1;
1</td></tr>
<tr><td>10(d)</td><td>Fill the burette with dilute nitric acid. Pipette 25.0 cm^3 of aqueous ammonia and transfer it into a conical flask. Add 2-3 drops of a suitable indicator to aqueous ammonia. Add dilute nitric acid from the burette dropwise till a colour change is observed. Record the volume of dilute nitric acid needed.
Repeat the experiment without using the indicator. Heat the resulting solution to saturation. Cool to allow crystals to form. Filter to obtain the crystals. Wash with small amount of distilled water and pat dry with pieces of filter paper.</td><td>1;
1;
1;
1</td></tr>
</table>

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination 2014
Secondary Four

CHEMISTRY
PAPER 1 Multiple Choice

5073/01

Tuesday **12 AUGUST 2014** **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 2.

This booklet consists of 17 printed pages.

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 †															

*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

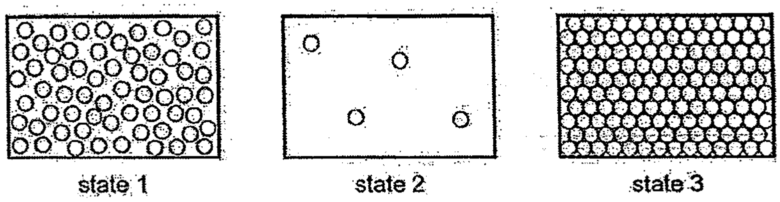
Key:

a
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.).

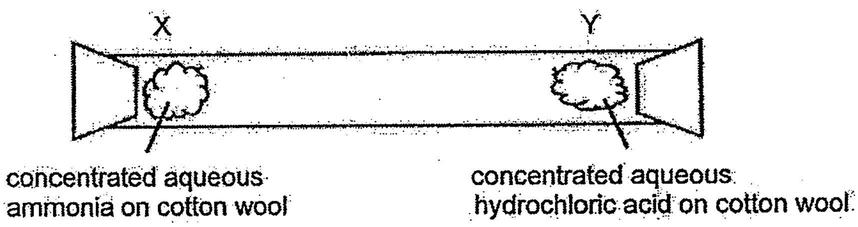
1 The diagrams show the arrangement of particles in three different physical states of substance X.



Which statement about the physical states of substance X is correct?

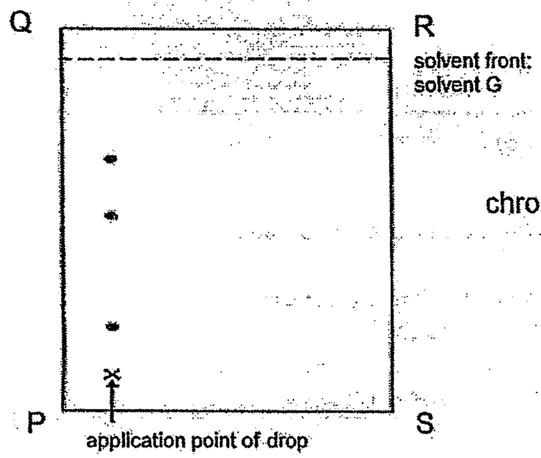
A Particles in state 1 vibrate about fixed positions.
B State 1 changes to state 2 by diffusion.
C State 2 changes directly to state 3 by condensation.
D The substance in state 3 has a fixed volume.

2 The apparatus below was set up. Two cotton wool plugs were soaked in concentrated aqueous ammonia and concentrated aqueous hydrochloric acid respectively.
These plugs were placed at opposite ends of a long glass tube as shown below. After some time, a white solid formed within the tube. The experiment was repeated at a higher temperature. Which of the following is **true** of the **repeat experiment?**



A The white solid now forms even closer to X compared to the first experiment.
B The white solid now forms even closer to Y compared to the first experiment.
C The white solid forms at a much faster rate compared to the first experiment.
D The white solid forms along the entire glass tube.

3 A drop of a substance that contains a mixture of four amino acids was applied to a plate. The plate was placed in solvent G and the following chromatogram was obtained.



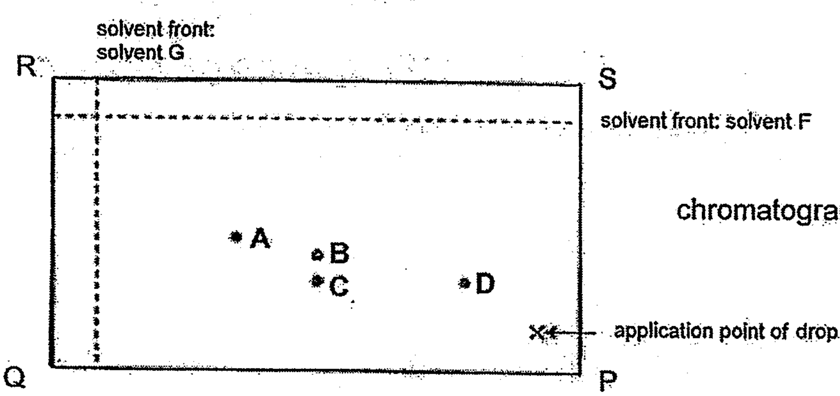
chromatogram I

The R_f values for each of the amino acids in solvent G are provided in the table below.

amino acid	R_f (solvent G)
alanine	0.51
arginine	0.16
threonine	0.51
tyrosine	0.68

The plate was dried, rotated through 90° in an anticlockwise direction and then placed in solvent F. The R_f values for each of the amino acids in solvent F are provided in the table below. Chromatogram II was obtained.

amino acid	R_f (solvent F)
alanine	0.21
arginine	0.21
threonine	0.34
tyrosine	0.43



chromatogram II

Which spot on chromatogram II represents alanine?

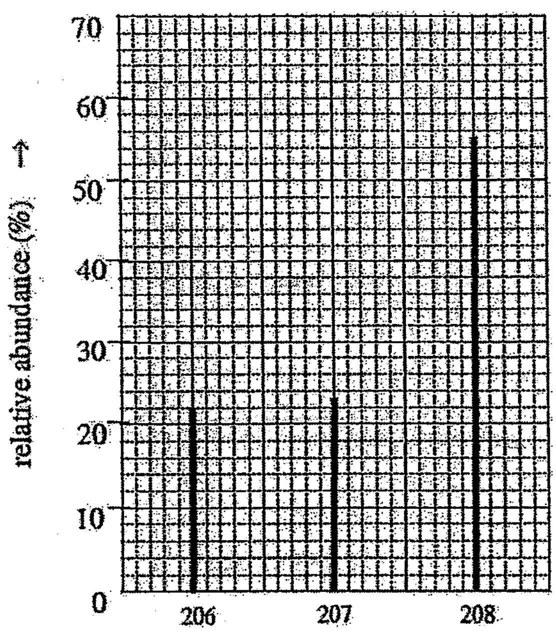
4 Which of the following correctly describes the sequence of procedures to collect separate samples of sand, salt and water from a mixture of sand and salt solution?

A filtration, evaporation
B filtration, distillation
C crystallization, filtration
D sublimation, filtration, distillation

5 In which set does each of the three particles have the same total number of electrons?

A	Li^+	Na^+	K^+
B	K^+	Ca^{2+}	Br^-
C	F^-	Ne	Na^+
D	Cl^-	Br^-	I^-

6 Element X has three isotopes, ^{206}X, ^{207}X and ^{208}X. The graph below shows the relative abundances of the isotopes.



What is the relative atomic mass of X?

A 206.8
B 207.0
C 207.3
D 207.5

7 Three substances, R, S and T, have physical properties as shown.

substance	melting point/°C	boiling point/°C	electrical conductivity	
			of solid	of liquid
R	801	1413	poor	good
S	2852	3600	poor	good
T	3550	4827	good	-

What could the identities of R, S and T be?

	R	S	T
A	sodium fluoride	potassium chloride	copper
B	sodium bromide	barium oxide	silicon dioxide
C	sodium chloride	magnesium oxide	graphite
D	bromine	calcium oxide	diamond

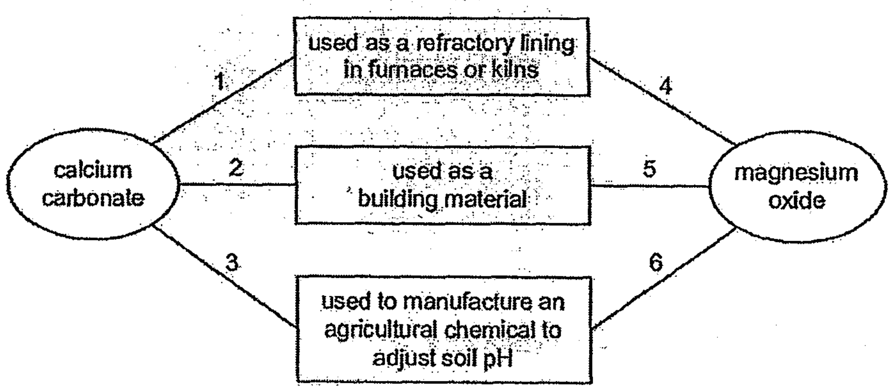
8 Silicon carbide has a structure similar to diamond. Boron nitride has a structure similar to graphite. Bronze is an alloy.

Which statements about silicon carbide, boron nitride and bronze are correct?

1 All are bonded covalently.
2 All except silicon carbide conduct electricity when solid.
3 All have high melting points.
4 All are insoluble in water.

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

9 The diagram shows some applications of compounds of Group II elements.



Which numbered links are correct?

	calcium carbonate	magnesium oxide
A	1,2 and 3	4,5
B	1,2 and 3	5,6
C	2 and 3 only	4 only
D	2 and 3 only	6 only

10 Which two statements are true for all elements between proton numbers 21 and 30?

The elements

1 conduct electricity.
2 do not react with water.
3 form ions with charges +2 and +3 only.
4 form coloured sulfates.

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

11 A part of the Periodic Table is shown below.

	Group I	II	III	IV	V	VI	VII	0
First Period								*x*
Second Period	*v*	*y*		*w*				
Third Period						*u*		

Which of the following statements is correct?

A *x* exists as discrete diatomic molecules.
B *v* gains electrons more readily than *u*.
C *w* forms an ionic compound with *y*.
D *v* is a solid at room temperature and pressure.

12 Which of the following formulae for compounds of germanium, Ge, is unlikely to be correct?

A GeF_3
B GeS_2
C GeO_2
D GeH_4

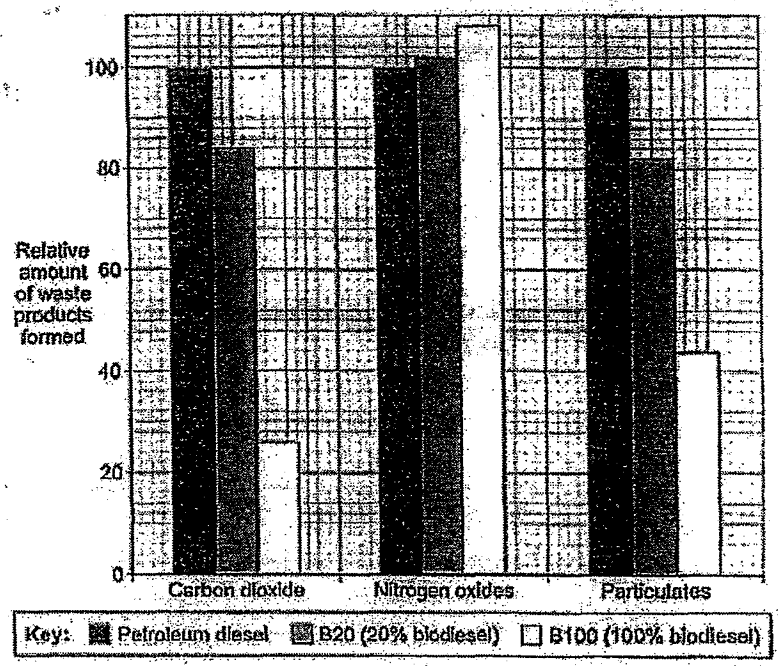
13 Alloy X is strong and has a low density.
Alloy Y is heavy and is resistant to corrosion.

Which could be uses of X and Y?

	Bridge supports	Aircraft	Overhead cables
A	X	X	Y
B	X	Y	Y
C	Y	X	X
D	Y	Y	X

For questions 14 and 15 refer to the information below.

Biodiesel can be mixed with petroleum diesel to make a fuel for cars. The bar chart compares the relative amounts of waste products made when three different types of diesel fuel burn in a car engine.



14 From the graph, it can be seen that biodiesel releases carbon dioxide but some scientists claim that biodiesel is a carbon neutral fuel.

What is the basis for this argument?

A Biodiesel produces less carbon dioxide when it burns.
B Plants take up carbon dioxide as they grow.
C Biodiesel is not a carbon compound.
D Plants release carbon dioxide in respiration.

15 One possible disadvantage of using fuel with a high percentage of biodiesel is that

A It is non-biodegradable.
B It could increase the amount of acid rain.
C It is non-renewable.
D It could increase global warming.

16 The following facts are known about four metals, P, Q, R and S.

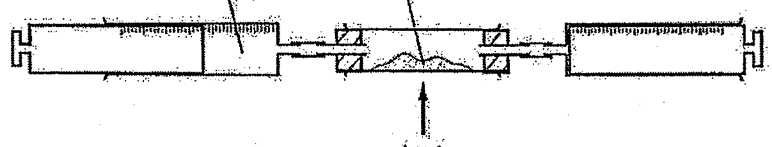
(i) R displaces P and S from solutions of their ions.
(ii) Q reacts with water, R does not.
(iii) If plates of P and S are dipped into an electrolyte and joined by wires through a meter, electrons flow from P to S through the meter.

The order of reactivity, the most reactive being placed first, is

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

17 A sample of clean, dry air is passed over hot copper until all the oxygen in the air reacts with copper.

The volume of gas at the end of the reaction is 120cm^3.
What is the starting volume of dry air?



A 132 cm^3 B 152 cm^3 C 180 cm^3 D 571 cm^3

18 A commercial production of iodine involves the reduction of a solution of iodate(V) ions, IO_3^-, with hydrogen sulfite ions HSO_3^-.

The equation for the reaction may be written as

$$xIO_3^- + yHSO_3^- \rightarrow zSO_4^{2-} + I_2 + 3H^+ + H_2O$$

What are the numbers x, y and z?

A 2,5,5
B 2,5,2
C 5,2,2
D 5,5,2

19 A student was asked to prepare a sample of magnesium sulfate by choosing a solid substance to add to dilute sulfuric acid. The experiment failed. Which of the following solid substances was chosen?

A Magnesium
B Magnesium oxide
C Magnesium carbonate
D Magnesium nitrate

20 Two indicators, bromophenol blue and congo red, show the following colors in acidic and alkaline solutions.

indicator	acid	alkali
bromophenol blue	yellow	blue
congo red	violet	red

A few drops of each indicator are added to separate samples of a solution of pH 2. What are the colors of the indicators in this solution?

	in a solution of pH 2	
	bromophenol blue	congo red
A	blue	red
B	blue	violet
C	yellow	red
D	yellow	violet

21 A black powder is suspected to be carbon or a mixture of carbon and copper(II) oxide. Which of the following methods can be used to identify the black powder?

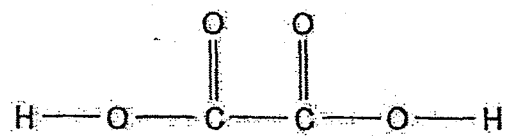
1 adding dilute sulfuric acid to the powder
2 adding sodium hydroxide to the powder
3 heating the powder strongly

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

22 A sample of insecticide DDT, $C_{14}H_9Cl_5$, was found to contain 0.120g of carbon. What mass of chlorine was present in the sample?

A 0.127g
B 0.254g
C 0.994g
D 1.01g

23 The structure of oxalic acid is shown below.



A 25.0 cm^3 of oxalic acid reacts completely with 15.0 cm^3 of 2.50 mol/dm^3 of sodium hydroxide.
The concentration of oxalic acid solution is

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

24 Three electrolysis cells are set up. Each cell has inert electrodes.

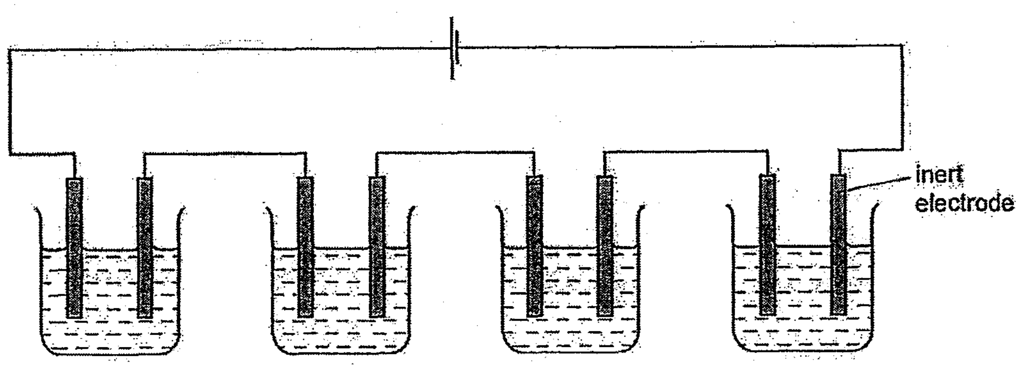
The electrolytes are listed below.

cell 1 : aqueous sodium chloride
cell 2 : concentrated hydrochloric acid
cell 3 : molten lead(II) bromide

In which cell is a gas formed at both electrodes?

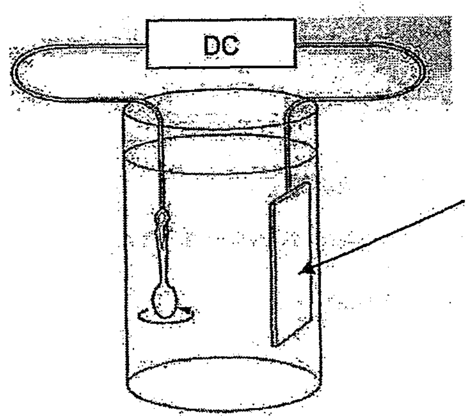
A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

25 When electrolyzed using inert electrodes, which dilute solution would produce the greatest increase in mass of the cathode?
[A_r: Al, 27; Cu, 64; Pb, 207; Ag,108]



A	B	C	D
aluminium sulfate	copper(II) sulfate	lead(II) nitrate	silver nitrate

26 The apparatus shown below is used to plate a spoon with chromium.



Which statement is **not** correct?

A Chromium would stick to the spoon because it is preferentially discharged.
B The electrolyte would be a chromium salt dissolved in water.
C The ionic equation at the chromium electrode is $4OH^- \rightarrow 2H_2O + O_2 + 4e$.
D The spoon would be connected to the negative terminal of the power supply.

27 In which of the following reactions does the metal atom show the greatest change in oxidation number?

A MnO_4^- to Mn^{2+}
B MnO_2 to $Mn(OH)_3$
C PbO_2 to $PbSO_4$
D VO_2^+ to VO^{2+}

28 The table shows the heat of combustion for four compounds.

Compound	M_r	Heat of combustion(kJ mol^{-1})
CO	28	233
CH_4	16	890
C_2H_2	26	1300
C_2H_6	30	1560

Which of these compounds produces the most energy when 1.00 g of the compound is completely burned?

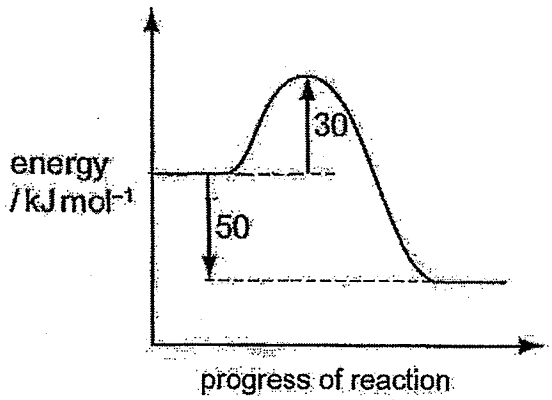
A CO
B CH_4
C C_2H_2
D C_2H_6

29 Which of the following reactions is endothermic?

A $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
B $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$
C $2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$
D $C_9H_{20}(l) \rightarrow C_2H_6(g) + C_3H_6(g) + C_4H_8(g)$

30 The reaction pathway for a reversible reaction is shown below.

Which statement is correct?

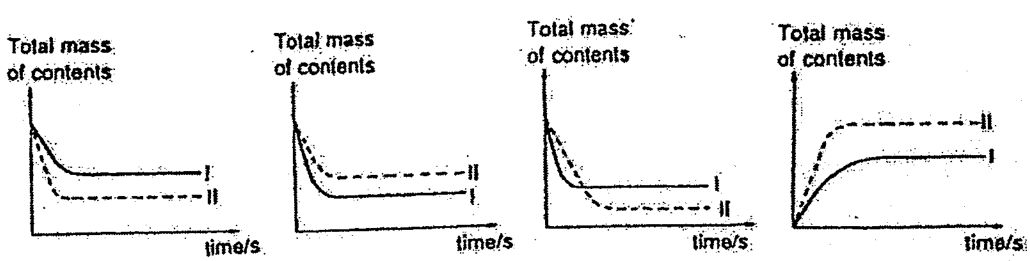


A The activation energy of the reverse reaction is +80kJ mol^{-1}
B The activation energy of the forward reaction is -30kJ mol^{-1}
C The enthalpy change for the forward reaction is +50kJ mol^{-1}
D The enthalpy change for the reverse reaction is +30kJ mol^{-1}

31 Two experiments I and II were carried out to find the rate of production of carbon dioxide from excess powdered limestone and dilute hydrochloric acid. The total mass of contents in each of the conical flasks was measured as the reaction progresses.

Experiment	Solution used
I	100 cm^3 of 0.2 mol/dm^3 of hydrochloric acid
II	50 cm^3 of 1.0 mol/dm^3 of hydrochloric acid

All other conditions were identical in both experiments. Which one of the following shows the correct experimental results?



A B C D

32 A sample of an alloy of two metals was added to excess dilute sulfuric acid. A pink solid, G, and a colourless solution, H were obtained. Addition of aqueous ammonia to this colourless solution gave a white precipitate, I, which was soluble in excess aqueous ammonia.

The identities of G, H and I are

	G	H	I
A	iron	calcium sulfate	calcium hydroxide
B	iron	aluminum sulfate	aluminium hydroxide
C	copper	lead(II) sulfate	lead(II) hydroxide
D	copper	zinc sulfate	zinc hydroxide

33 An aqueous sample of T shows these observations with the following reagents.

Reagent	Observation
Aqueous ammonia	Reddish brown precipitate
Lead(II) nitrate	White precipitate
Barium nitrate	White precipitate

What is compound T?

A iron(III) sulfate
B iron(II) sulfate
C iron(III) chloride
D potassium iodide

34 An organic compound has the following percentage composition by mass : 54.5% C, 9.1% H and 36.4% O. Which of the following could this compound be?

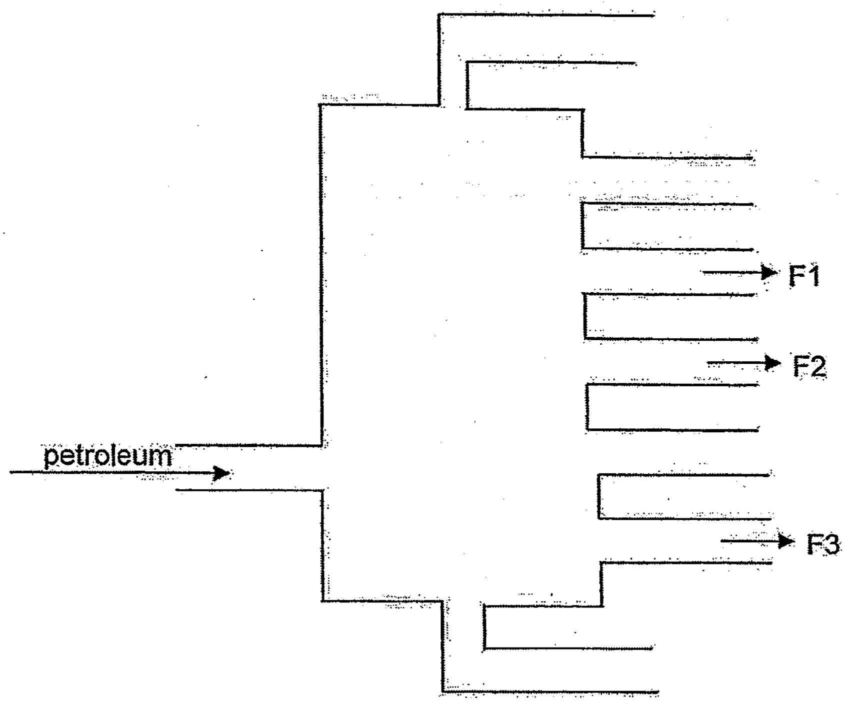
A methanoic acid
B propanoic acid
C butanoic acid
D pentanoic acid

35 2.30g of ethanol were mixed with an excess of aqueous acidified potassium permanganate. The reaction mixture was then boiled under reflux for one hour. The desired organic product was then collected by distillation. The yield of the product was 60.0%.

What mass of product was collected?

A 1.32g B 1.38g C 1.80g D 3.20g

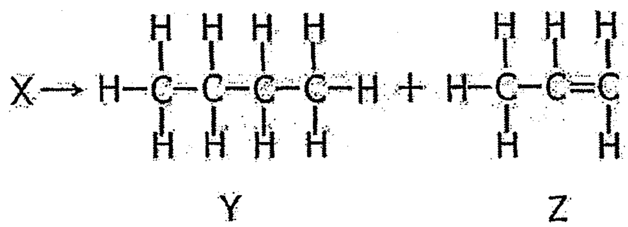
36 The diagram below represents the fractionating column of an oil refinery.



What are the uses of fractions F1, F2 and F3?

	F1	F2	F3
A	Fuel for car engines	For making feedstock	Making roads
B	Fuel for car engines	Fuel for aircraft engines	Fuel for diesel engines
C	For making feedstock	Fuel for aircraft engines	For making waxes
D	Fuel for aircraft engines	For making feedstock	For making waxes

37 A chemist carried out a cracking reaction on a hydrocarbon, X, and obtained two products, Y and Z.



The chemist then wrote the following statements in his notebook.

1 A molecule of X has 7 carbon atoms.
2 Y is unsaturated.
3 Z will decolourise bromine water
4 One molecule of Z will react with excess oxygen to produce 2 molecules of water and 3 molecules of carbon dioxide

Which statements are correct?

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

38 The table shows the boiling points of four fractions, P, Q, R and S, obtained when crude oil is distilled.

Fraction	P	Q	R	S
Boiling point range/°C	35 – 75	80 – 145	150 – 250	Greater than 250

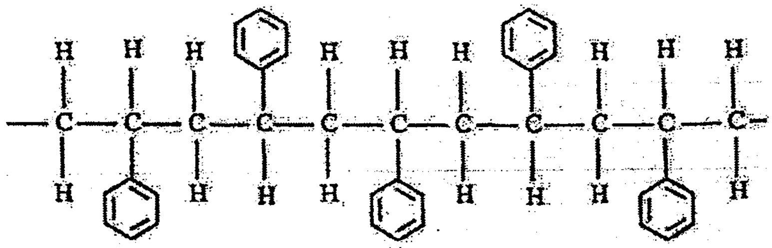
How is fraction P different from fraction S?

A Fraction P is more viscous than fraction S.
B Fraction P is in less demand than fraction S.
C Fraction P is more flammable than fraction S.
D Fraction P contains molecules of larger molecular masses than fraction S.

39 The number of structural isomers of C_4H_9Cl is

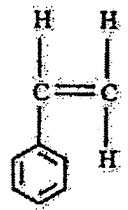
A 2
B 3
C 4
D 5

40 A section of a polymer chain is given below.

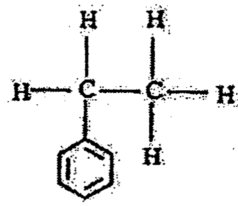


The monomer for this polymer would be

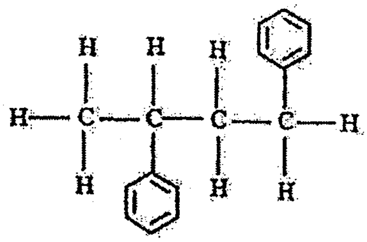
A



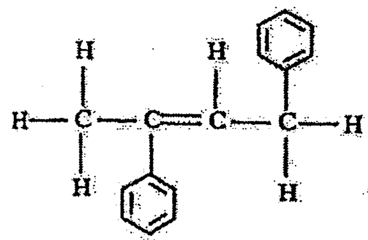
C



B



D



Answers for MCQ Prelim 2014

1-5	D	C	C	B	C
6-10	C	C	D	C	B
11-15	D	A	C	B	B
16-20	A	B	A	D	D
21-25	C	A	B	A	D
26-30	C	A	B	D	A
31-35	A	D	A	C	C
36-40	C	A	C	C	A

NAME & REGISTER NO.	CLASS	CENTRE NO:	INDEX NO:

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination 2014

CHEMISTRY **5073 / 02**
PAPER 2

Friday **1 August 2014** **1 hour 45 minutes**

Additional Materials: Writing Paper.

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 on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer all questions in the spaces provided.

Section B
Answer all three questions, the last question is in the form either / or.
Write your answers on the separate answer paper 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 2.

For Examiner's Use	
Section A	
B8	
B9	
B10	
Total	

This question paper consists of 17 printed pages

The Periodic Table of the Elements

Key
relative atomic mass
atomic symbol
name
atomic number

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 sulphur 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	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
†90-103 Actinoid series	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

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

Section A (50 marks)

Answer all questions in this section in the spaces provided.

A1 The following are names of different types of reactions.

addition	combustion	displacement	oxidation
subsitution	polymerization	reduction	neutralization

Choose one of these reactions to represent each of the following equations. Each answer can be used once, more than once or not at all.

(a) $CH_3CH_2CH_3 + Br_2 \rightarrow CH_3CH_2CHBr_2 + 2HBr$ ……………………………………………

(b) $Fe^{3+} + e \rightarrow Fe^{2+}$ ……………………………………………

(c) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ ……………………………………………

(d) $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ ……………………………………………

(e) $nCH_2 = CH_2 \rightarrow -(CH_2 - CH_2)-_n$ ……………………………………………

[Total:5 marks]

A2(a) This question is based on Group VII elements.

The following report appeared in a newspaper.

> <u>Vehicle Crashed on Driveway</u>
>
> "Drums of purple liquid bromine broke open after a vehicle crash on the motorway. Traffic was diverted as the accident resulted in irritation to the drivers' eyes. Firemen sprayed water over the scene of the accident, dissolving the bromine and washing it away."

(i) Identify an error in the report. Explain your answer. [1]

____

(ii) Explain how the liquid bromine comes into contact with the driver's eyes. [2]

____

____

____

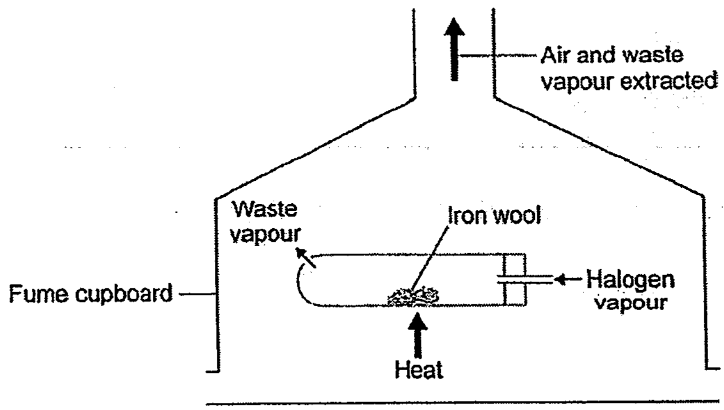
(iii) Comment on the method used by the firemen to get rid of bromine. Include in your answer the negative impact on the environment. [2]

____

____

____

(b) A teacher demonstrated an experiment involving passing bromine vapour through heated iron wool in a fume cupboard. A red-brown solid was produced.



(i) Write an equation for the reaction above. [1]

____

(ii) State and explain the type of reaction that occurs when bromine reacts with heated iron wool. [3]

____

____

____

____

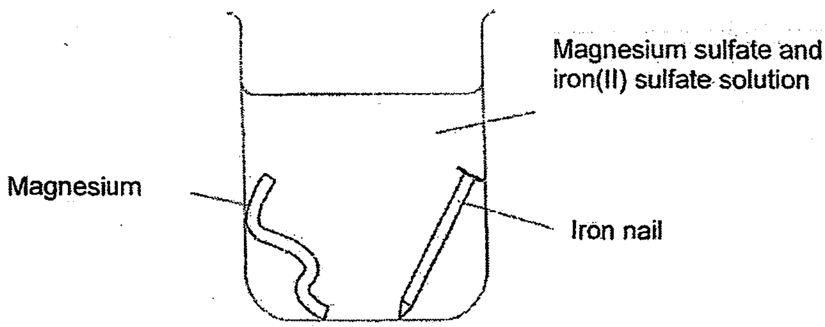
(c) The disinfecting action of chlorine in swimming pools is due to the presence of chloric(I) acid, HClO, formed by the reaction of chlorine with water.
In many swimming pools, chemicals other than chlorine are used to form chloric(I) acid. These chemicals include potassium chlorate(I), calcium chlorate(I) and chlorine dioxide.

Complete the following table. [1]

Name of Compound	**Formula**
Chloric(I) acid	HClO
Potassium chlorate(I)	KClO
Calcium chlorate(I)	
Chlorine dioxide	

[Total:10 marks]

A3 A student set up a laboratory experiment with a beaker containing a strip of magnesium, an iron nail, and a solution of iron(II) sulfate and magnesium sulfate. This was left for several days.



(a) Describe, using relevant ionic equations, what would happen to the

(i) magnesium strip [2]

____

____

____

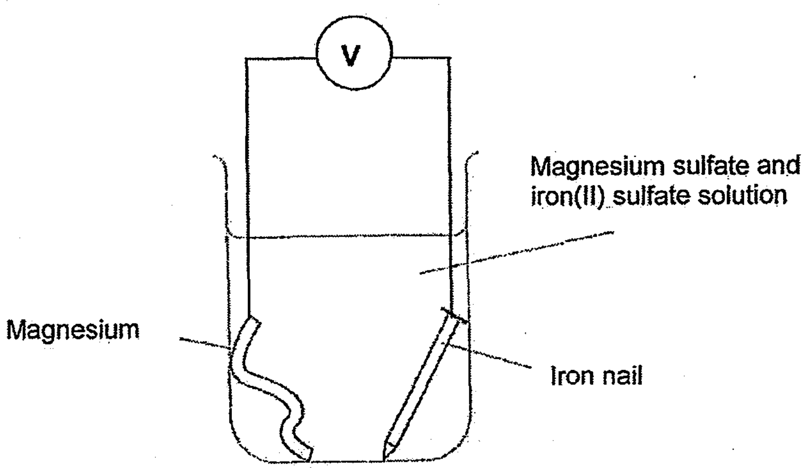
____

(ii) iron nail [2]

____

____

(b) An electric current was generated by connecting the magnesium strip to the iron nail by using wires as shown.

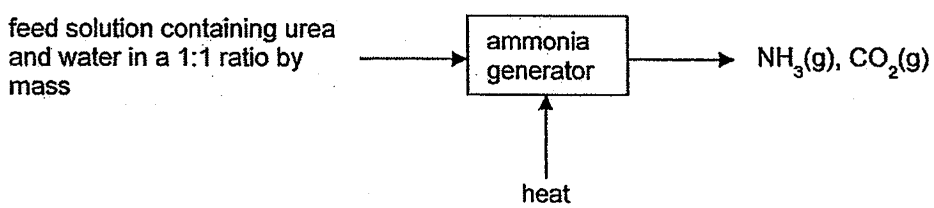


(i) Explain why bubbles were seen at the iron nail. [3]

(ii) Describe how the voltage of this cell can be increased? [1]

[Total:8 marks]

A4 There are two ways of producing ammonia in an industrial plant. One way is to use the Haber Process, and another way is using small scale ammonia generators. A simplified diagram of a plant that uses small scale ammonia generators is shown below.



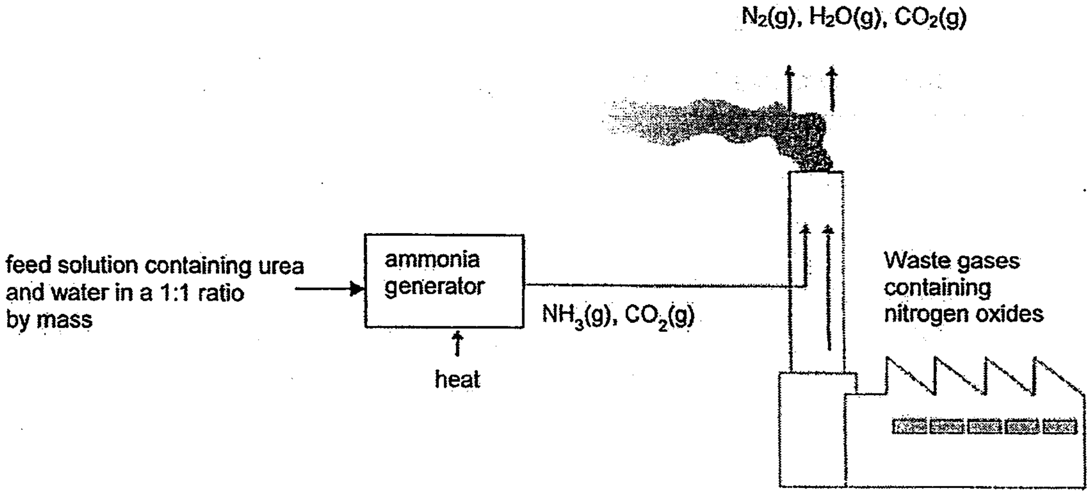
(a) The chemical reaction occurring in the ammonia generator is

$(NH_2)_2CO(s) + H_2O(l) \rightleftharpoons 2\,NH_3(g) + CO_2(g)$

In a particular generator a 1:1 **mass** ratio (equal mass) of urea and water is used.

State the excess reactant? Explain your answer. [2]

(b) The ammonia generated in small scale ammonia generators is used to treat waste gases containing nitrogen oxides. This treatment converts the oxides of nitrogen to nitrogen and water.



(i) Write a chemical equation for the reaction of nitrogen monoxide with ammonia. [1]

____

(ii) State the effect on the composition of the gases released into the atmosphere when an insufficient amount of ammonia was added to nitrogen monoxide. Explain how this affects the environment. [2]

____

____

____

(iii) Give one advantage, other than cost, of producing ammonia on-site (at the same location) by this method rather than having ammonia delivered from a plant at another location. [1]

____

____

(c) Ammonia is manufactured on a large scale by the reaction between nitrogen gas and hydrogen gas in the Haber Process.

State the essential conditions required for the production of ammonia. [2]

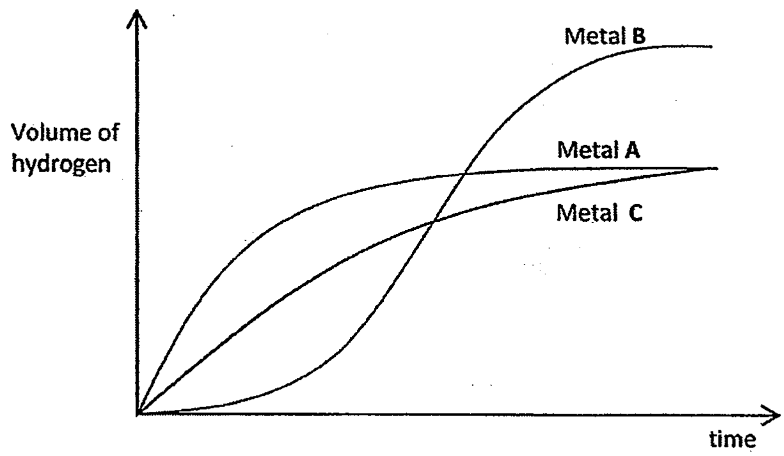
____

[Total: 8 marks]

A5 Excess hydrochloric acid was added to powdered zinc. The hydrogen evolved was collected and its volume measured every 20 seconds.

The experiment was repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.

The graph below shows the volume of hydrogen produced from each metal against time.



(a) Identify metal **B** and explain the shape of the graph for metal **B**. [3]

____

____

____

____

(b) Identify metals **A** and **C**. [1]

____

(c) Using the concept of moles, explain why metals **A** and **C** form the same volume of hydrogen but metal **B** forms a larger volume. [2]

____

____

____

____

[Total: 6 marks]

A6 A student was tasked to identify an unknown carbonate of a Group II metal. She set up an experiment to measure the volume of carbon dioxide given off when a weighed sample of this carbonate was reacted with nitric acid.

Her results are shown in the table.

mass of Group II carbonate	0.888 g
volume of gas collected	144 cm^3

The equation for the reaction is

$XCO_3\ (s) + 2HNO_3\ (aq) \rightarrow X(NO_3)_2\ (aq) + H_2O\ (l) + CO_2\ (g)$
where X is the symbol for the Group II metal.

(a) Based on her results, she did some calculations and concluded that the unknown carbonate was strontium carbonate. Explain, showing your working clearly, how she arrived at this conclusion. [3]

(b) She decided to do a cation test to confirm the identity of the metal carbonate. She made a solution by reacting the metal carbonate with hydrochloric acid. She then added aqueous sodium hydroxide until in excess. She observed that a white precipitate insoluble in excess aqueous sodium hydroxide was obtained and concluded that it was indeed strontium carbonate.
Give a reason why this conclusion may be incorrect. [1]

____

____

(c) The student was told by Professor Choo that the metal was not strontium but calcium. The student calculated that if metal X were calcium, 0.888g of calcium carbonate would produce 213cm^3 of carbon dioxide. Assuming that she had measured the mass of the metal carbonate and the volume of the gas correctly, suggest a reason why the volume of gas collected was only 144cm^3. [1]

____

____

[Total: 5 marks]

A7 Zinc is a reactive metal that will react with oxygen at high temperatures. Its two main ores are zinc sulfide and zinc carbonate. The relative abundance of each ore is about the same throughout the world.
There are 3 stages in the production of zinc from its ores.

Stage 1: The ores, zinc sulfide and zinc carbonate, were first heated separately to produce zinc oxide.
Zinc sulfide when heated in air produces sulfur dioxide as the other product.

(a) Write the equations for the two reactions that took place when the ores are heated in Stage 1. [2]

____

____

Stage 2: The zinc oxide is then mixed with carbon (coke) and heated in a furnace.
In the furnace, carbon monoxide is produced.

Stage 3: Zinc is extracted by the following reaction:
$ZnO + CO \rightarrow Zn + CO_2$

(b) Describe the 2 reactions occurring in the furnace that led to the production of carbon monoxide in Stage 2. [2]

____

____

____

(c) The atmosphere inside the furnace is kept rich in carbon monoxide. Explain why. [1]

____

____

(d) Zinc ores also contain lead compounds. Lead is produced with zinc in the furnace. The temperature inside the furnace is about 1500°C.

	Boiling point/°C	**Density in g/cm^3**	**Reactivity**
Lead	1749	11.3	Low
Zinc	907	7.1	High

Suggest how the two metals are separated in the furnace. [1]

____

____

(e) Lead and iron are also manufactured by the reduction of the oxides with carbon monoxide.
Which of the three metal oxides, lead(II) oxide, iron(III) oxide and zinc oxide, is the most easily reduced? Explain your answer. [2]

____

____

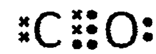
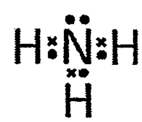
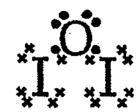
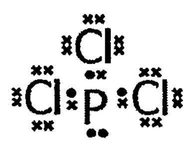
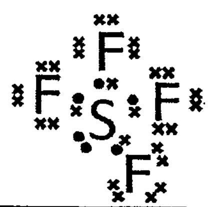
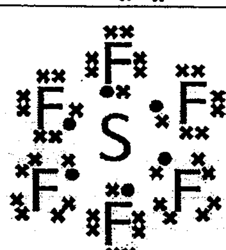
____

[Total: 8 marks]

Section B (30 marks)

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

B8 A molecule that is made up of more than two atoms usually has a central atom that all other atoms are bonded to. The table below shows information about some of these molecules with central atoms (except carbon monoxide) formed by elements in Periods 2 and 3 of the Periodic Table. Study the information carefully and answer the questions that follow.

Central atom	Period that Central atom belongs to	Formula of molecule	Dot-and-cross diagram of molecule
C	2	CO	
		CO_2	
N	2	NH_3	
O	2	I_2O	
P	3	PCl_3	
		PCl_5	
S	3	SF_4	
		SF_6	

* Only valence electrons are shown

(a) Draw a dot-and-cross diagram of the carbon dioxide molecule, similar to the diagrams in the table. [1]

(b) Comment on the unusual bonding seen in the dot-and-cross diagram in carbon monoxide and phosphorus pentachloride (PCl_5). [2]

(c) Based on the information given in the table, draw the dot-and-cross diagram of BrF_5. [1]

(d) Interhalogen compounds are formed between atoms of different Group VII elements and these are very strong oxidizing agents.

(i) Explain the term *oxidizing agent.* [1]

(ii) Chlorine and fluorine react exothermically to form ClF_3. When gaseous ClF_3 is added to water, a vigorous reaction occurs, giving three gases. One of the gases produced turns moist blue litmus red and then bleaches it. Another relights a glowing splint, and the third is hydrogen fluoride gas.
Construct a balanced chemical equation, with state symbols, for the reaction. [2]

(iii) Another interhalogen compound is BrF_3 which is a straw-coloured liquid with a pungent odour. The liquid is able to conduct electricity.

$$BrF_3 \rightarrow BrF_2^{+} + \_\_\_\_$$

Copy and complete the equation above. Explain why BrF_3 is a good conductor of electricity while bromine and fluorine are non-conductors of electricity. [3]

B9 Hydrogen peroxide is often used to bleach or lighten hair colour.
Hydrogen peroxide slowly decomposes to produce water and oxygen.

$$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$$

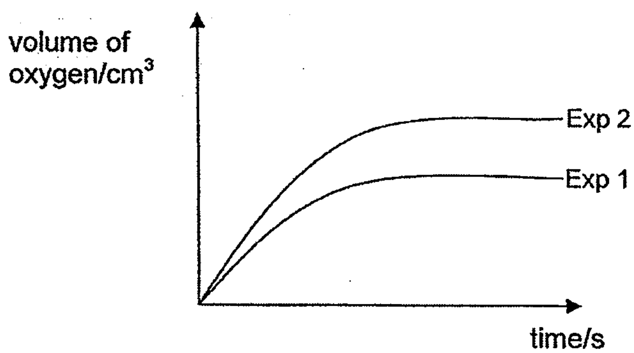
(a) The decomposition of hydrogen peroxide involves a change from a liquid reactant to a gaseous product. Describe the differences in movement and arrangement of particles between a liquid and a gas. [2]

(b) Explain, in terms of the collision theory, why the rate of decomposition of hydrogen peroxide increases with (i) an increase in temperature and (ii) the addition of a catalyst. [3]

(c) Two experiments were performed to investigate the effect of a change in concentration on the rate of decomposition of hydrogen peroxide at room temperature. 1g of a catalyst in the form of small pellets was added.

Experiment 1: mixture of 4 cm^3 of hydrogen peroxide and 46 cm^3 of water
Experiment 2: mixture of 6 cm^3 of hydrogen peroxide and 44 cm^3 of water

The results of the two experiments were plotted and shown below.



Two further experiments were carried out.

In experiment 3, a mixture of 2 cm^3 of hydrogen peroxide and 48 cm^3 of water was used. 1g of the same catalyst was added.

In experiment 4, a mixture of 6 cm^3 of hydrogen peroxide and 44 cm^3 of water was used. 1g of the same catalyst was added in powdered form.

Copy the graphs above and sketch on the same axes, two curves to show the progress of the reaction in both experiments 3 and 4.

[2]

(d) The equation for the decomposition of hydrogen peroxide can be represented by using structural formulae as shown:

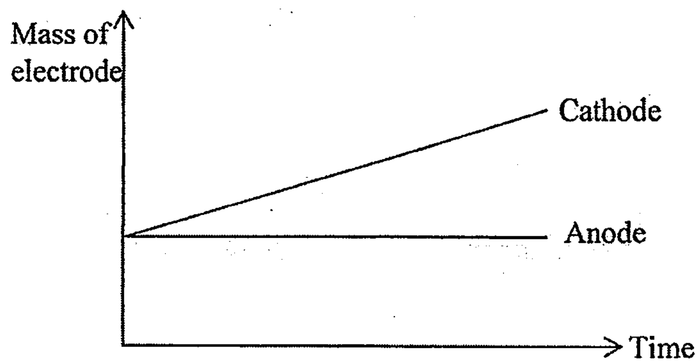
$$2\text{H-O-O-H} \rightarrow 2\text{H-O-H} + \text{O=O}$$

Using the bond energies in the table below, calculate the energy change for this reaction. [3]

Bond	Bond energy in kJ per mole
H – O	464
O – O	146
O = O	498

B10 Either

A student was given two different types of electrodes (carbon and copper electrodes), a fixed volume of 1.0 mol/dm^3 of copper(II) sulfate solution, some electrical wires and batteries.
He carried out the electrolysis of the copper(II) sulfate solution using the different electrodes. First, he carried out the experiment with the carbon electrodes. At regular intervals, the cathode and anode were removed, dried and weighed. The results were plotted on the graph below.



(a) (i) Give the formulae of the ions present in the electrolyte. [2]

(ii) Explain why the cathode shows an increase in mass initially. [1]

(iii) Describe what is observed at the anode with an appropriate equation. [2]

He carried out the same experiment with copper electrodes. Similarly, at regular intervals, the cathode and the anode were removed, dried and weighed.

(b) (i) Predict and draw on a separate graph how the mass of the anode and cathode will change as electrolysis takes place. [2]

(ii) Explain how the graph for the anode is derived with a relevant equation. [2]

(iii) The student noticed that the colour of the electrolyte remained the same as electrolysis took place. Explain why. [1]

B10 Or

(a) Ethanol is manufactured in two ways – fermentation of sugars and addition of steam to ethene.

(i) State the conditions needed for each reaction. [2]

Countries A to D are ethanol-producing countries. Study the table below and use the information to answer the questions given.

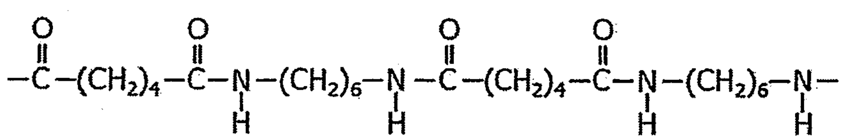
Country	Land Area/ km^2	Population	Climate	Other information
A	8 500 000	Sparingly populated	Mostly tropical	It is a poor country with no oil reserves.
B	710	Densely populated	Mostly tropical	It is a relatively rich country with no oil reserves.
C	9 800 000	Densely populated	Seasonal	It is a relatively rich country that has its own oil reserves.
D	330 000	Moderately populated	Mostly tropical	It is a relatively rich country that has its own oil reserves.

(ii) State the country which is likely to produce ethanol by fermentation of sugars. Explain your answer. [1]

(iii) State the country which is likely to produce ethanol by addition of steam to ethene. Explain your answer. [1]

(iv) Give one advantage of manufacturing ethanol using fermentation of sugars rather than addition of steam to ethene. [1]

(b) The diagram below shows a section of the polymer chain of nylon.



Nylon is a polyamide and is formed by condensation polymerization.

(i) Explain the term '*condensation polymerisation*'. [1]

(ii) With reference to the diagram above, deduce the structural formulae of the two monomers of nylon. [2]

(iii) Given that the relative molecular mass of the polymer is 5650. Calculate the number of repeating units in this polymer. [2]

~End of Paper~

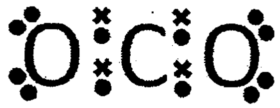
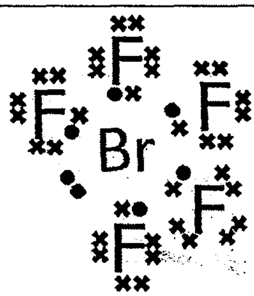
Answers to 2014 Preliminary Paper 2 Section A

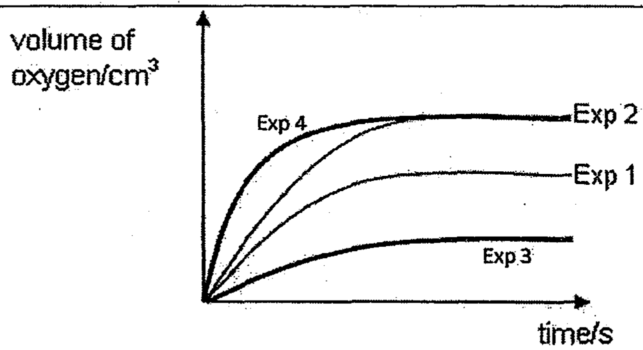
A1	(a) Substitution (b) Reduction (c) Combustion (d) Displacement (e) Polymerization Total[5]
A2(a)	(i) Bromine is reddish brown liquid. (ii) Liquid bromine (low boiling point) **evaporates (easily)** to form bromine gas. The gaseous bromine moving freely and randomly **diffuses.** (ii) The method used to dispose of bromine is wrong. Bromine will dissolve in water to produce (hydrobromic) acid. The acid when washed away will cause soil to be acidic, affecting plant growth or cause lakes/rives to be acid leading to death of fishes etc.
(b)	(i) $2Fe + 3Br_2 \rightarrow 2FeBr_3$ (ii)Redox. The oxidation number of bromine decreases from 0 to -1. Hence bromine is reduced. The oxidation number of iron increases from 0 to +3. Hence iron is oxidized. Or Each Iron atom loses 3 electrons to form iron(III) ion. Hence, iron is oxidised. Each bromine atom gain 1 electron to form bromide ion. Hence, bromine is reduced.
(c)	$Ca(ClO)_2$, ClO_2 Total: [10]
A3(a)	(i) Magnesium strip will decrease in size/Grey solid deposited on magnesium strip. Magnesium being more reactive than iron will displace iron(II) ions from the iron(II) sulfate solution to form grey iron metal and magnesium sulphate solution. $Mg + Fe^{2+} \rightarrow Mg^{2+} + Fe$ The iron nail will rust/corrode and a reddish-brown coating formed on iron nail. $Fe - 3e \rightarrow Fe^{3+}$
(b)	(i) Magnesium, being more reactive than iron, will lose electrons to iron. Iron nail becomes negatively charged (and hydrogen ions, magnesium ions and iron(II) ions are attracted to the iron nail) Hydrogen ions are preferentially discharged (less stable than the other ions) to form hydrogen gas. (ii) Voltage is increased by replacing the iron nail with copper/lead/silver Total[8]

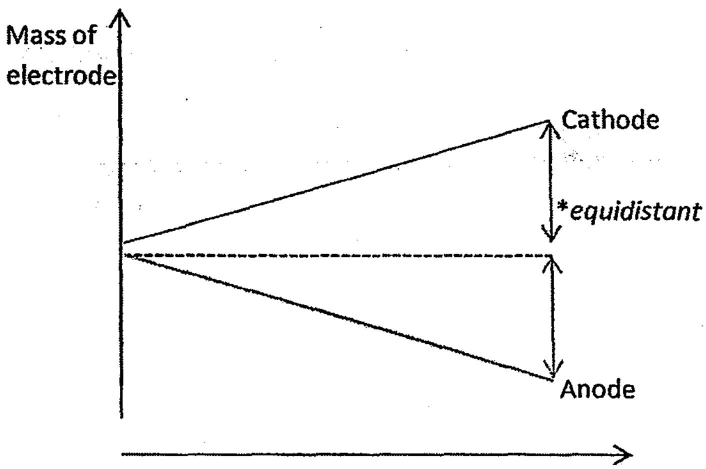
A4(a)	Mr $(NH_2)_2CO$ = 60 , Mr(H_2O) =18 (not necessary) The relative molecular mass of urea is **higher** than that of water. Hence, no. of moles of water is higher than that of urea. Since the mole ratio of urea to water is 1:1, water is in excess.
(b)	(i) $6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$ (ii) There will be unreacted nitrogen monoxide released into the atmosphere together with less nitrogen and water produced. Nitrogen monoxide will react with air to form nitrogen dioxide. Nitrogen dioxide will react with moisture and air to form nitric acid that dissolves in water to form acid rain. (iii) Producing ammonia on site is easier as minimum storage and transportation of ammonia is required. Not producing ammonia on site means ammonia being a gas has to be stored in thick pressurized containers which are heavy and difficult to transport.
(c)	Temperature of 400- 450°C, pressure of 200-250 atmospheres and finely divided iron as catalyst. Total[8]
A5(a)	Metal **B** is aluminum. Reaction is slower at the start/less steep because of the oxide layer reacting with acid. Reaction is faster/ steeper when the oxide layer is removed exposing the aluminium which then reacts with the acid.
(b)	Metal **A** is magnesium. Metal **C** is zinc.
(c)	$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$ $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ $Mg + 2HCl \rightarrow MgCl_2 + H_2$ For both magnesium and zinc, 1 mole of metal produces 1 mole of H_2, therefore same volume of gas produced. For aluminium, 1 mole of metal produces 1.5 moles of H_2, therefore higher volume of gas produced. Total[6]
A6(a)	(i) No. of moles of $CO_2 = \frac{144}{24000}$ $= 0.006$ No. of moles of XCO_3 = 0.006 [1] $0.006 = \frac{0.888}{x+12+16x3}$ [1] X = 148-12-48 X = 88 [1] X is Strontium. The carbonate is strontium carbonate.

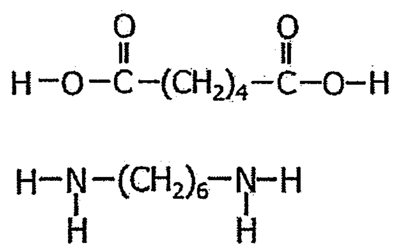
(b)	Calcium ions would also form a white precipitate insoluble in excess aqueous sodium hydroxide. Or Calcium compounds/calcium chloride/calcium ions would also give the same results with excess aq sodium hydroxide.
(c)	Impure calcium carbonate was used. So volume of carbon dioxide is less than 213 cm^3. (carbon dioxide is slightly soluble in water/ gas was lost between adding acid and replacing bung/ temperature was lower than room temperature - reject because difference in volume of gas is too great.) Total[5]
A7(a)	$2ZnS + 3O_2 \rightarrow 2ZnO + SO_2$ $ZnCO_3 \rightarrow ZnO + CO_2$
(b)	Carbon (Coke) reacts with oxygen in the air to form carbon dioxide. Carbon dioxide reacts with more coke to form carbon monoxide.
(c)	The atmosphere rich in carbon monoxide prevents the hot molten zinc from reacting with oxygen in the air to form zinc oxide again.
(d)	At 1500°C, zinc would be a gas that can be tapped off while lead will still be in liquid (or solid) state at the bottom of the furnace.
(e)	Lead(II) oxide is the most easily reduced Lead is the least reactive of the three metals and therefore would form the least stable compound. Total[8]

Answers to 2014 Preliminary Paper 2 Section B

B8(a)		
(b)	The carbon atom and the oxygen atom in carbon monoxide do not share equal number of electrons to attain the stable electronic configuration. Oxygen atom shared 4 electrons while carbon atom shared only 2 electrons. OR For carbon monoxide, one pair of electrons for sharing comes from the oxygen atom instead of one electron from each of carbon and oxygen. The P atom has a total of 10 valence electrons on the outermost shell instead of the usual configuration of 8 valence electrons.	
(c)		
(d)(i)	Oxidizing agent - Oxidises another substance and is itself reduced - Gives oxygen or takes hydrogen from another substance - Increases the oxidation number of another substance while it itself shows a decrease in oxidation number - Takes electrons from another substance (one of the above)	
(d)(ii)	$4ClF_3$ (g) + $6H_2O$ (l) → $2Cl_2$ (g) + $3O_2$ (g) + 12HF (g)	
(d)(iii)	$BrF_3 \rightarrow BrF_2^+ + F^-$ BrF_3 is made up of ions. In the liquid state, the <u>ions are mobile</u> and hence can conduct electricity. However, bromine and fluorine exists as molecules (absence of mobile charged particles) and hence cannot conduct electricity.	

B9(a)	Movement : The particles in the liquid states roll and slide over each other/ translate while the particles in the gaseous state moves **freely** and randomly. Arrangement: The particles in the liquid state are closely packed but not in an orderly arrangement while the particles in the gaseous state are very far apart.	
(b)	As the temperature increases, the particles gain kinetic energy and thus the particles **move faster**. Hence the frequency of collision increases which leads to an increase in the frequency of effective collision. Hence the rate of reaction increases. Catalyst provides an alternative pathway with lower activation energy for the reaction hence more particles are able to attain the activation energy and thus there will be more effective collisions per unit time, thus the rate of reaction is faster.	
(c)		
(d)	4(O-H) + 2(O-O) - 4(O-H) – (O=O) Energy change =4(464) + 2(146) – 4(464) – 498 = -206 kJ Or Energy absorbed to break bonds =4(464) + 2(146)= 2148 kJ Energy released to form bonds =4(464) +498 = 2354kJ Energy change = 2148 -2354 = -206kJ	

either B10(a)	(i) Cu^{2+} , SO_4^{2-}, H^+, OH^- 1 mark for each set (ii) The <u>Copper(II) ion, being less stable, will be preferentially discharged instead of hydrogen ion</u> at the cathode resulting in the formation of copper that will coat round the cathode and resulted in the increase in mass. (iii) Effervescence of a colourless gas is observed at the anode. $4OH^- \rightarrow 2H_2O + O_2 + 4e$	
(b)(i)		
(ii)	$Cu \rightarrow Cu^{2+} + 2e$ The copper electrode is an active electrode and will ionized to produce copper(II) ion which goes into solution.	
(iii)	The rate at which copper(II) ions are discharged at the cathode is the same rate at which copper is ionized at the anode to form copper(II) ions. Hence, the electrolyte remains the same.	

or 10 (a)	(i) Fermentation: Temp: 35-38 ^{0}C, absence of oxygen, yeast Hydration condition : Temp: 300^{0}C , catalyst : phosphoric acid, pressure 70 atmospheres.	
	(ii)(a) Country A because it is a country with tropical climate, large land area for the plantation of sugar and also it has no oil reserves that can fermented to produce ethanol. (b) Country C because it is a country with it's own oil reserve that can be hydrated to produce ethanol. Furthermore, it is densely populated and has limited land area for crop plantation.	
	(iii) Ethanol made from ethene is said to be non-renewable because the raw material ethene is a finite resource from the fossil fuel. Ethanol made from sugars is renewable because the plant is a renewable source of raw material.	
(b)	(i) Condensation polymerization is a process whereby a polymer is formed by the joining of many monomers with the elimination of small molecules/water.	
	(ii) 	
	(iii) Mr of one repeated unit = 226 5650 ÷ 226 = 25 (Ans)	

Name: ______________________________ Class: ______ Reg. No. : ___

ST JOSEPH'S INSTITUTION

SECONDARY 4 PRELIMINARY EXAMINATION

CHEMISTRY **5073 / 01**

Paper 1 Multiple Choice 27 August 2014

1 hour

(08:00 – 09:00 h)

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your answers in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the cover page of this Question Booklet and on the separate Answer Sheet.

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

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.

At the end of the examination, hand in the Question Booklet and Answer Sheet.

This document consists of **20** printed pages.

DATA SHEET
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	226 Ra Radium 88	227 Ac Actinium 89 †															

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

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	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 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.).

1 The melting point of lithium chloride is 605 ^{0}C and the boiling point of water is 100 ^{0}C. What is the most likely boiling point of a sample of water that contains a small quantity of lithium chloride?

A 600 ^{0}C **B** 456 ^{0}C **C** 104 ^{0}C **D** 90 ^{0}C

2 Which of the following observations suggests that matter exists as very small, moving particles?

A Solids will melt when heated.

B Some gases are less dense than air, but others are more dense.

C The smell of scent soon fills a room when the bottle is opened.

D Gold can be beaten into sheets.

3 Which one of the following substances

(i) is an element;

(ii) also forms crystals composed of small molecules?

A copper **B** graphite

C ice **D** Iodine

4 A flask contains the liquids trichloromethane and water. They are separated using a separating funnel. Which conclusion can be made from these observations?

A Trichloromethane and water have different masses.

B Trichloromethane and water have different boiling points.

C Trichloromethane has a different density compared to water.

D Trichloromethane and water do not mix.

5 A mixture of solids is treated with excess dilute sulfuric acid. A colourless gas is evolved and some, but not all, of the mixture dissolves. What could the mixture contain?

A Ammonium hydroxide and potassium oxide
B Copper(II) carbonate and lead(II) oxide
C Iron(II) carbonate and zinc oxide
D Magnesium carbonate and iron(II) chloride

6 Which of the following solutions can be used to distinguish between aqueous sodium hydroxide and aqueous ammonia?

A Copper(II) sulfate solution
B Iron(II) chloride solution
C Potassium chloride solution
D Zinc nitrate solution

7 In which one of the following sets do all three particles have the same total number of electrons?

A	Cl^-	Br^-	I^-
B	F^-	Ne	Na^+
C	H^-	H	H^+
D	Li^+	Na^+	K^+

8 An element **X** forms compounds having the formulae Na_2**X**, **X**O_2 and **X**O_3. What is **X** likely to be?

A carbon
B chlorine
C nitrogen
D sulfur

9 Which one of the following atoms, **A**, **B**, **C** or **D**, would readily form an ion with a charge of +2?

	Mass number	*Atomic (proton) number*
A	12	6
B	16	8
C	24	12
D	31	15

10 What particles are present in solid lead(II) bromide and in molten lead(II) bromide?

	Solid lead(II) bromide	*Molten lead(II) bromide*
A	ions	ions and electrons
B	ions	ions
C	molecules	ions
D	molecules	molecules

11 The formation of charged particles to produce an ionic compound is due to

A the charging of the atoms by friction as they collide with each other.

B the sharing of electrons between metallic and non-metallic atoms.

C the passage of an electric current through the compound.

D the transfer of electrons from metallic to non-metallic atoms.

12 What is formed when an element X of proton (atomic) number 19 reacts with an element Y of proton (atomic) number 17?

A A covalent compound of formula **XY**.

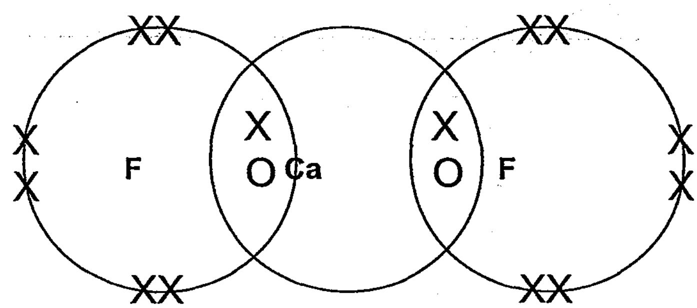
B A covalent compound of formula XY_2.

C An ionic compound of formula **XY**.

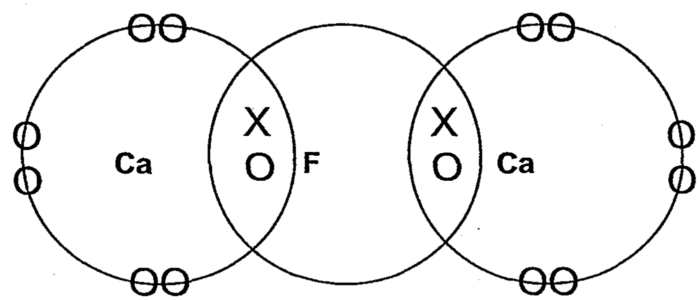
D An ionic compound of formula XY_2.

13 Which of the following diagrams shows the electron arrangement in calcium fluoride? (NB Only the outermost electrons of each atom or ion are shown)

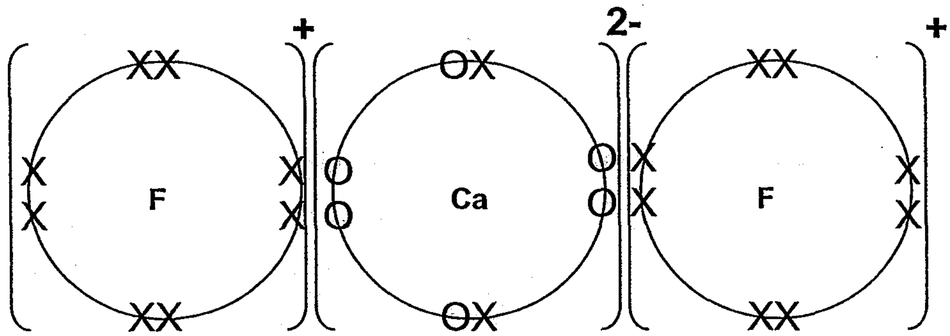
A



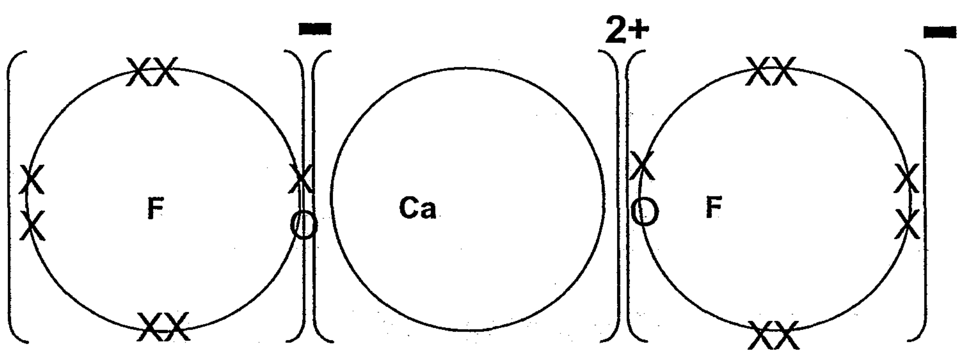
B



C



D



14 A 10g sample of metal oxide of chemical formula MO_2 was found to contain 4g of oxygen. What is the identity of the metal?

A Iron

B Lead

C Titanium

D Zinc

15 Which of the following compounds contains the highest percentage by mass of carbon?

A Carbon dioxide

B Sodium carbonate

C Ammonium carbonate

D Carbon monoxide

16 Steel pans sometimes blacken because of the sulfur coming from the proteins in the eggs reacting with iron to form iron(II) sulfide.

$$Fe\ (s) + S\ (s) \rightarrow FeS\ (s)$$

What mass of iron(II) sulfide is formed from using the pans to fry a hundred eggs each containing 0.032g of sulfur?

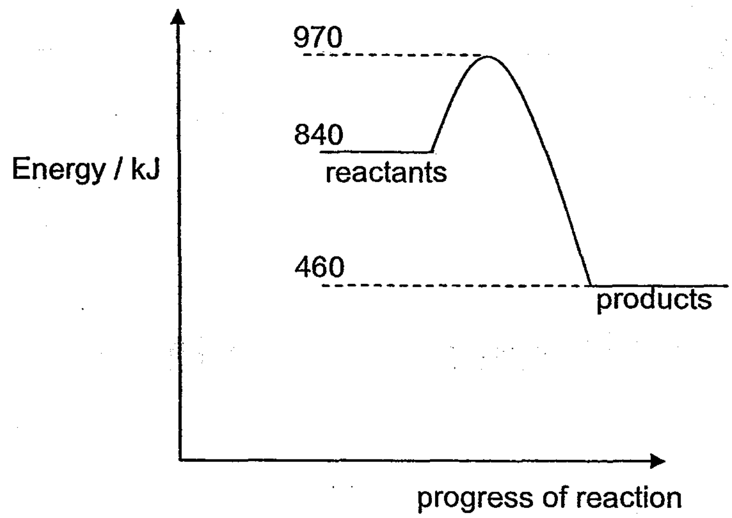
A 0.88g

B 8.8g

C 88g

D 5.6g

17 The diagram below shows the energy profile diagram for a chemical reaction.



Which of the following statements is true?

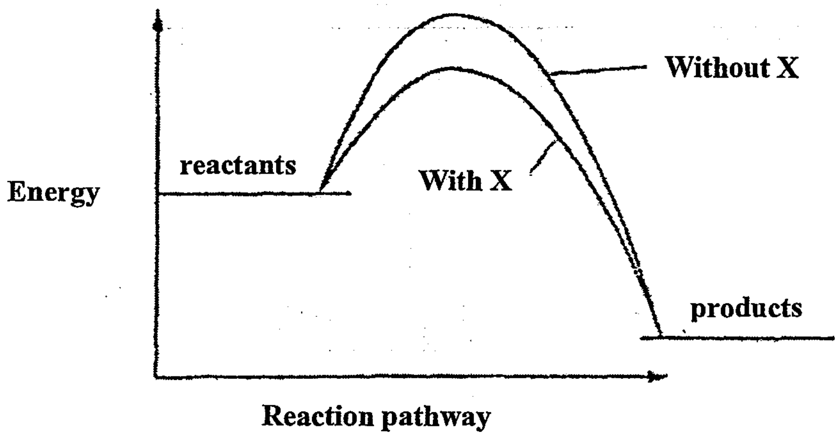
A The reaction is endothermic with activation energy of 970 kJ.

B The reaction is endothermic with 460 kJ of heat taken in.

C The reaction is exothermic with activation energy of 510 kJ.

D The reaction is exothermic and 380 kJ of heat energy is given out.

18 The energy profile diagram shows how adding substance **X** to a reaction mixture changes the reaction pathway.



Which of the following changes is likely to be observed when **X** is added to the reaction mixture?

A The reaction becomes less endothermic.

B The reaction becomes more exothermic.

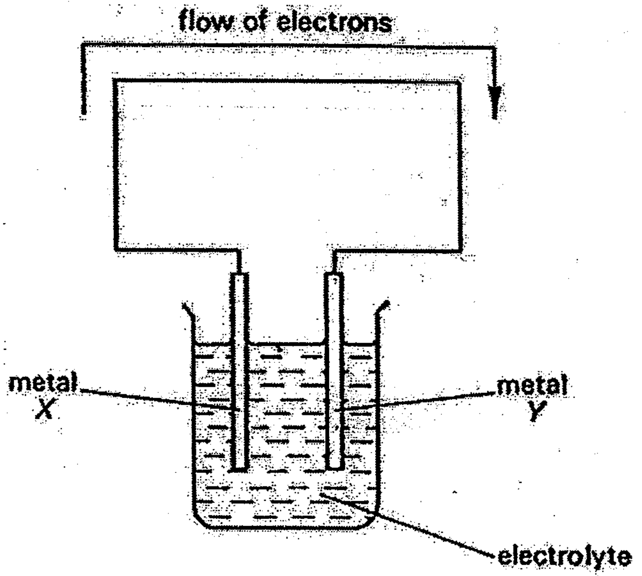
C The activation energy decreases.

D The energy level of the reactants decreases.

19 What are the products of the electrolysis of concentrated aqueous sodium chloride using inert electrodes?

	Anode (+)	***Cathode (-)***
A	chlorine	hydrogen
B	chlorine	sodium
C	oxygen	chlorine
D	oxygen	hydrogen

20 The apparatus shown in the diagram below is set up.

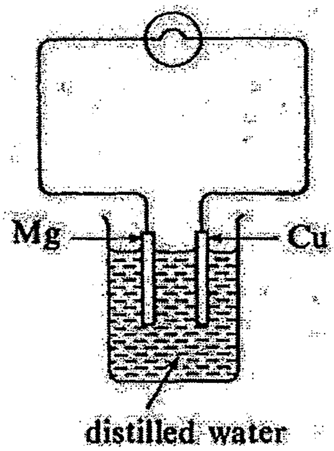


For which one of the following pairs of metals would electrons flow as shown in the diagram?

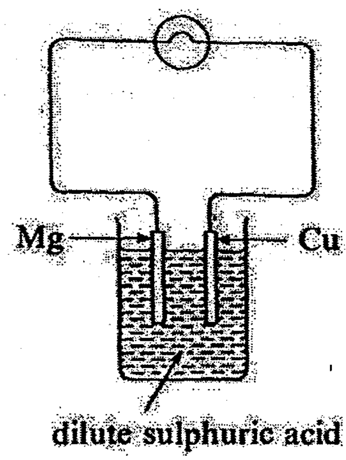
	Metal X	*Metal Y*
A	copper	zinc
B	iron	aluminium
C	lead	magnesium
D	zinc	lead

21 In which of the following cells would the bulb be expected to shine the brightest?

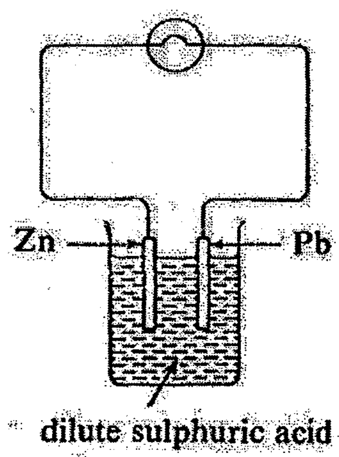
A



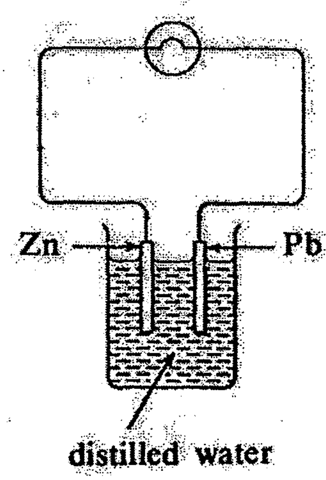
B



C



D



22 If the oxidation number of element X is +5, which of these formulae is correct?

A K_2XO_4

B $Ca(XO_3)_2$

C KXO_5

D PX_5

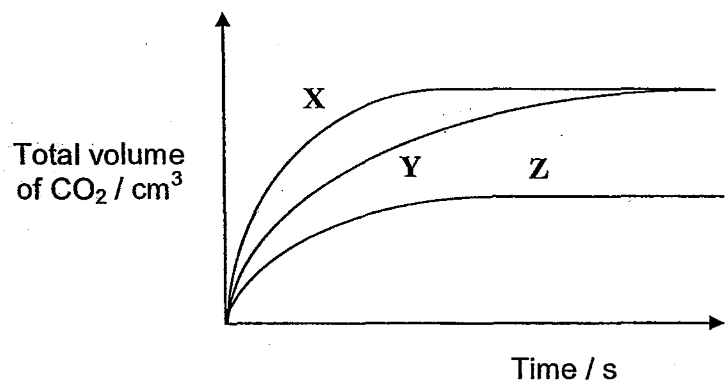
23 Two experiments were carried out under the same conditions of temperature and pressure, reacting marble with dilute hydrochloric acid.

In Experiment 1, an excess of powdered marble was added to 20 cm^3 of dilute hydrochloric acid.

In Experiment 2, an excess of marble chips was added to 20 cm^3 of dilute hydrochloric acid of the same concentration.

The total volumes of carbon dioxide given off were measured at intervals and plotted against time.

Which of the following pairs of curves would be obtained in the two experiments?



	Experiment 1	***Experiment 2***
	Powdered marble	*Marble chips*
A	X	Y
B	X	Z
C	Y	X
D	Y	Z

24 Which of the following equations does not represent a redox reaction?

A $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

B $Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$

C $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

D $Cl_2(g) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(aq)$

25 The reaction between hydrogen sulfide and chlorine is as follows

$$H_2S(g) + Cl_2(g) \rightarrow 2HCl(g) + S(s)$$

In this reaction,

A chlorine is the reducing agent.

B chlorine is oxidised to hydrogen chloride.

C hydrogen sulfide is oxidised to sulfur.

D the oxidation number of hydrogen has increased.

26 Which of the following statements is correct about the chemical reactions of dilute ethanoic acid, dilute hydrochloric acid and dilute sulfuric acid?

A They all dissociate fully to produce hydrogen ions in water.

B They all react with copper(II) oxide to release hydrogen gas.

C They all react with silver nitrate to form insoluble salts.

D They all react with aqueous potassium hydroxide to form soluble salts.

27 Which of the following salts is the most suitable to be prepared by titration method?

A Ammonium nitrate

B Barium sulfate

C Copper(II) nitrate

D Magnesium chloride

28 Nitrogen and hydrogen react according to the equation:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

A high yield of ammonia is favoured by conditions of high pressure and low temperature. However, in practice, a high temperature is employed because at low temperatures,

A lower frequency of effective collisions occur.

B ammonia liquefies.

C the catalyst is inactive.

D the reacting gases do not have to be very pure.

29 The table shows the proton (atomic) number of four elements.

Element	**W**	**X**	**Y**	**Z**
Proton (atomic) number	9	11	17	19

Which statement is correct?

A **W** is a metal

B **X** is more reactive than **Z**

C **W** is more reactive than **Y**

D **Y** and **Z** are in the same period

30 An element in the third period of the Periodic Table (sodium to argon) is a non-conductor of electricity and forms an acidic oxide that is very soluble in water. What is the element?

A Aluminium

B Magnesium

C Silicon

D Sulfur

31 Iron filings are wrapped in a damp cloth and left to rust in the apparatus as shown in Fig. 31.1. Which letter in Fig. 31.2 indicates the water level when rusting has finished?

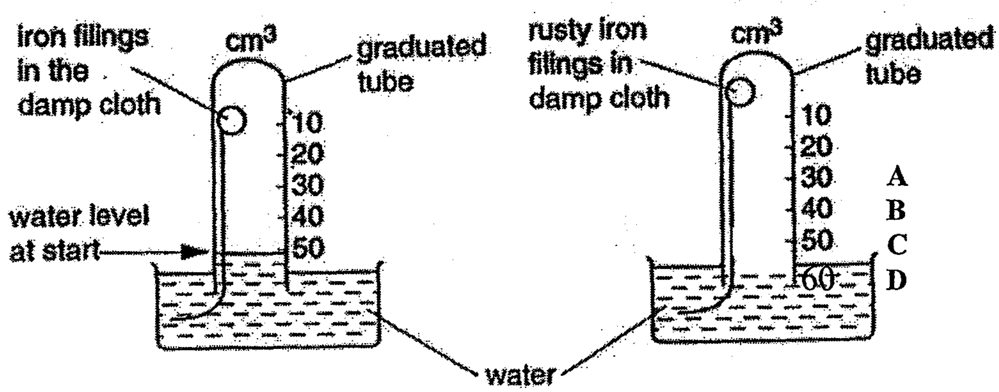


Fig. 31.1

Fig. 31.2

32 Which statement about the production of iron from iron(III) oxide in a blast furnace is NOT correct?

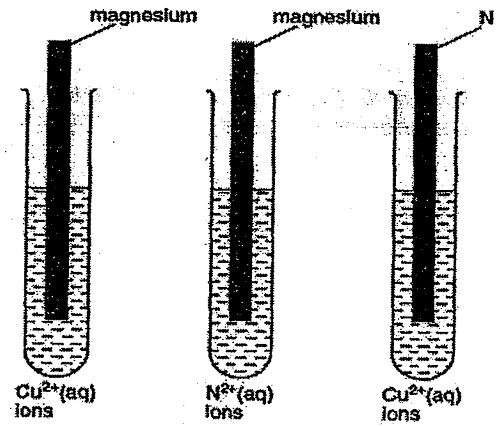
A The iron(III) oxide is reduced by carbon monoxide.

B Carbon dioxide reacts with coke to form carbon monoxide.

C Calcium silicate is formed by the reaction of limestone with sand.

D Molten iron formed is more dense than molten slag.

33 Three test tubes were arranged as in the diagrams below. The tests were conducted to determine the reactivity of three metals (Mg, Cu and an unknown metal N). Each test tube contained a piece of one metal, half-immersed in an aqueous solution containing the ions of one of the other two metals. A deposit was formed in all three test tubes.



Metal **N** could be

A Aluminium

B Calcium

C Silver

D Zinc

34 In which pair do both pollutants cause damage to buildings?

A Carbon monoxide and chlorofluorocarbons

B Carbon monoxide and sulfur dioxide

C Ozone and nitrogen dioxide

D Nitrogen dioxide and sulfur dioxide

35 Water can be formed by a number of reactions involving organic substances. Which reaction does not produce water?

A Fermentation of glucose.

B Incomplete combustion of ethane.

C Oxidation of propanol.

D Reaction of methanol with methanoic acid.

36 A carboxylic acid has two carbon-carbon double covalent bonds. What could its molecular formula be?

A $C_{16}H_{33}CO_2H$

B $C_{16}H_{29}CO_2H$

C $C_{17}H_{39}CO_2H$

D $C_{17}H_{35}CO_2H$

37 Compound **X** has the molecular formula C_2H_6O.

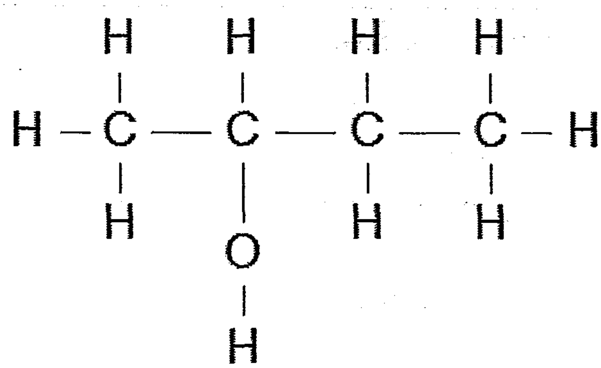
It was found that

- **X** can be made via fermentation process.
- **X** can be oxidised to **Y**.
- **X** can react with **Y** to form **Z** and water.

Which of the following show the correct identity of **X**, **Y** and **Z**?

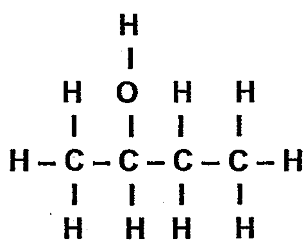
	X	**Y**	**Z**
A	propane	propanol	propyl propanoate
B	methane	ethanoic acid	ethyl methanoate
C	ethanol	ethanoic acid	ethyl ethanoate
D	ethanoic acid	ethanol	ethyl ethanoate

38 The structure of butan-2-ol is shown below.

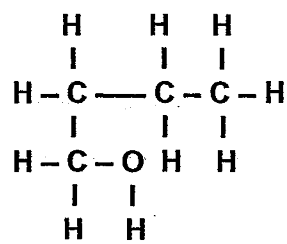


Which structure is an isomer of the structure shown above?

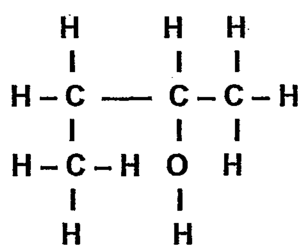
A



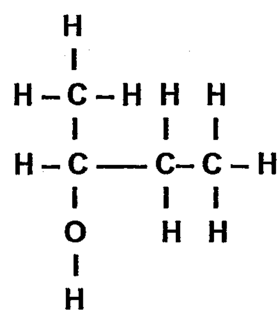
C



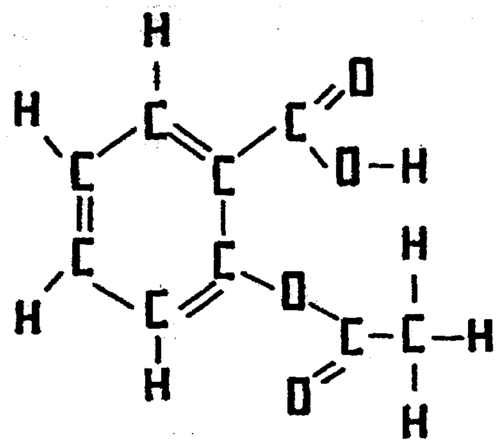
B



D



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



Which statement about aspirin is incorrect?

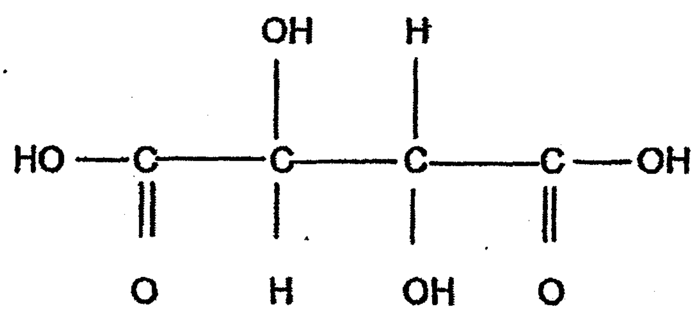
A It can undergo substitution reaction with chlorine.

B Its aqueous solution reacts with sodium hydroxide.

C It turns acidified potassium manganate(VII) from purple to colourless.

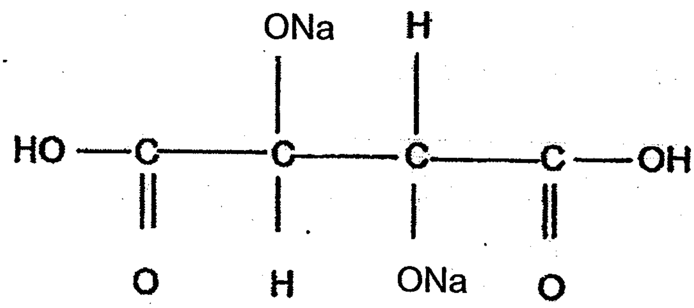
D It is formed from an organic acid and an alcohol.

40 Tartaric acid is a white crystalline organic acid. It occurs naturally in many plants, particularly grapes, bananas and tamarinds, and is one of the main acids found in wine.

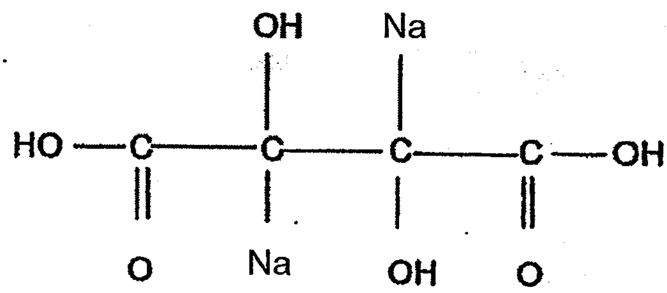


What is the formula of the salt formed when tartaric acid reacts with sodium carbonate?

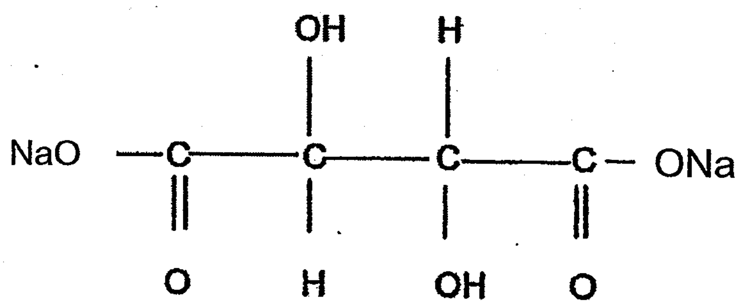
A


ONa
H
HO
C
C
C
C
OH
O
H
ONa
O

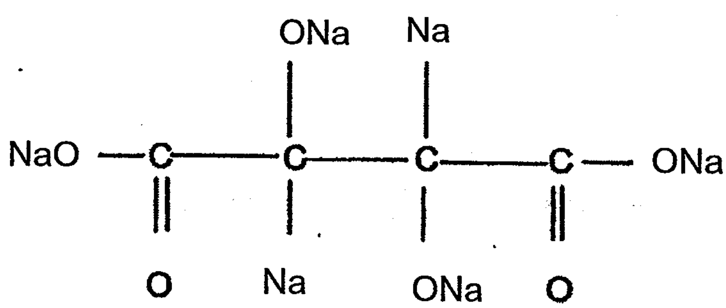
B


OH
Na
HO
C
C
C
C
OH
O
Na
OH
O

C


OH
H
NaO
C
C
C
C
ONa
O
H
OH
O

D


ONa
Na
NaO
C
C
C
C
ONa
O
Na
ONa
O

SJI Preliminary Examinations 2014

Chemistry 5073/1

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

Name: ______________________________ Class: ________ Reg. No. : _____

ST JOSEPH'S INSTITUTION

SECONDARY 4 PRELIMINARY EXAMINATION

CHEMISTRY **5073 / 02**

Paper 2 Theory 18 August 2014

Candidates answer on the Question paper. 1 hour 45 minutes (11:00 – 12:45 h)

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

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

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

At the end of the examination, fasten all your work securely together for each section.
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.

Hand in Section A and B separately.

For Examiner's use	
Section A	
B10	
B11	
B12	
Total	

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

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 †															

*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 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.).

Section A

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

A1 Iodine is the least reactive element in Group VII of the Periodic Table. Its compounds are used in medicine and photography and in dyes.

(a) Solid iodine sublimes upon heating. State the change in the **arrangement** and **movement** of the particles in this process.

....

....

....

.... [2]

(b) **(i)** Silver iodide compound decomposes upon heating to produce silver and iodine gas.
Write a balanced chemical equation for the reaction.

.... [1]

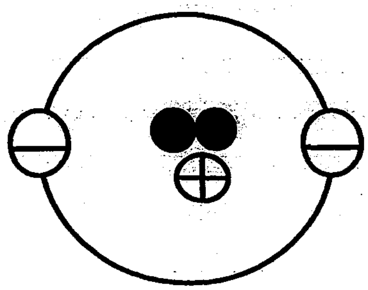
(ii) 28g of silver iodide was decomposed and 1dm^3 of iodine gas was collected. Calculate the percentage yield of the reaction.

[3]

[Total : 6]

A2 Tritium is an isotope of hydrogen.

An ion of tritium has the following structure.



(a) Complete the following table to show the names and the charges of the particles in this tritium ion.

Symbol	**Name**	**Charge**
●	neutron	
⊕		+1
⊖		-1

[2]

(b) Using the symbol **T** to represent tritium, give the formula of

(i) the ion shown above ....

(ii) the compound formed between tritium and sodium. .... [2]

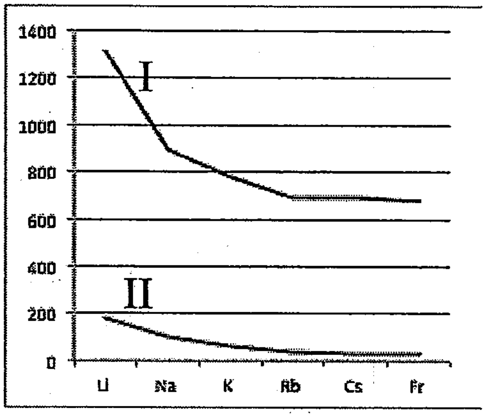
(c) Would you expect the oxide of tritium to be a solid, a liquid or a gas at room temperature and pressure? Explain your reasoning.

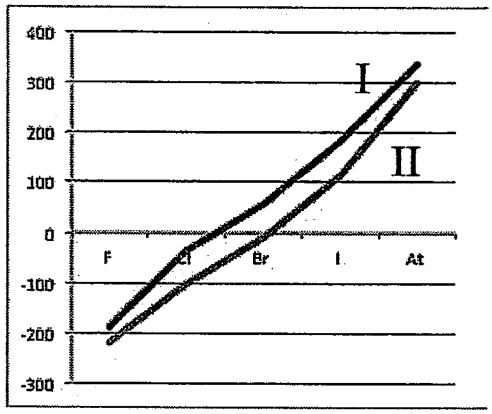
....

.... [1]

[Total : 5]

A3 The graphs below show the melting and boiling points for elements in Group I and Group VII.





I - boiling point

II - melting point

(a) State the trends of melting point for Group I and Group VII elements down their respective groups.

....

.... [2]

(b) Explain, using bonding and structures, the trend of melting points for Group I and Group VII elements.

....

....

....

....

....

....

....

.... [4]

[Total : 6]

A4 The following information was found on a milk carton.

	Per 100ml
Proteins	3.3g
Fats	3.7g
Carbohydrates	4.7g
Calcium	120mg

(a) Based on the information provided, would you expect the milk to boil at a fixed temperature? Explain your answer.

....

....

....

....

.... [2]

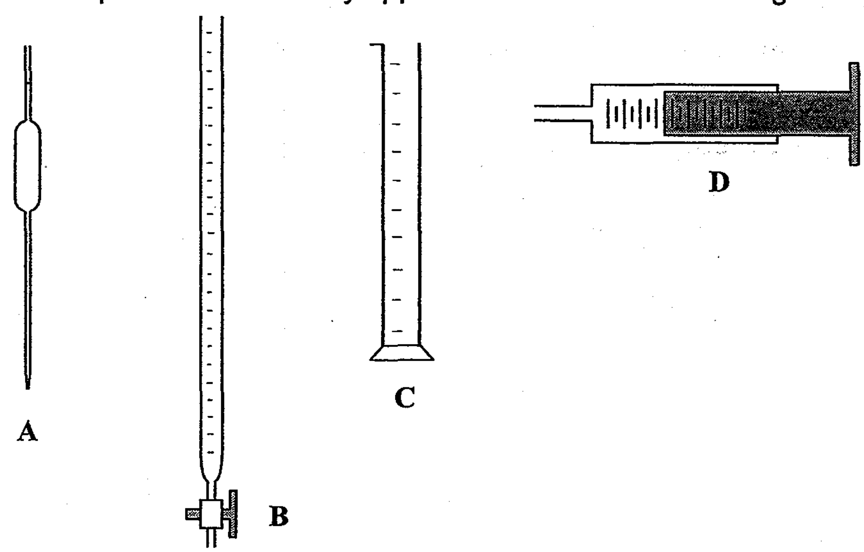
(b) **(i)** Identify an element found on the milk label.

.... [1]

(ii) State the electron arrangement of the ion of the element identified in (i).

.... [1]

(c) Several pieces of laboratory apparatus are shown in the diagram.



Give the **letter** and **name** of the piece of apparatus best used for the following:

(i) Delivering 25 cm^3 of milk into a carton.

.... [1]

(ii) Delivering exactly 20.8 cm^3 of milk into a carton.

.... [1]

[Total : 6]

A5 Chloroflurocarbons (CFCs) have been used in large quantities as solvents and aerosol propellants. CFCs are chemically inert and do not react with air or water.

When CFC molecules diffuse high up into the atmosphere they destroy the ozone layer in the stratosphere, which is about 30 kilometres from the Earth surface.

To prevent the damage of ozone, the use of CFCs is being greatly reduced and they are being replaced with other organic compounds that cause little or no harm to the ozone layer.

(a) One of the most widely used CFCs was CCl_2F_2 which can be made from methane in a series of reactions.

(i) Name the type of reaction that is used to make CCl_2F_2 from methane.

.... [1]

(ii) Explain how the destruction of ozone layer by CFCs in the stratosphere affects mankind.

....

....

.... [2]

(b) A list of some CFCs in current use and their possible replacements is given in the following table.

Formula	**Code Number**	**Potential for destroying the ozone layer (on a scale 0.0 – 1.0)**
Compounds in current use:		
CCl_2F_2	11	1.0
CCl_2FCCl_2F	113	0.8
***Possible replacement compounds*:**		
CH_2ClF	22	0.05
CF_3CH_2F	134a	0.0
CF_3CCl_2H	123	0.02
CH_3CCl_2F	141b	0.12
CH_3CHF_2	152a	0.0

(i) Both compounds 134a and 152a do not harm the ozone layer. Suggest a reason for this.

....

.... [1]

(ii) What do the formulae of compounds 22, 123 and 141b have in common that differs from the formulae of the compounds in 'current use'?

....

.... [1]

[Total : 5]

A6 A student conducted two experiments to find out the relative reactivity of copper and three other solid metals, X, Y and Z.

In experiment I, he heated each of the oxides of the metals in a test-tube.
In experiment II, he tested the action of metals X, Y and Z on aqueous copper(II) sulfate.

He then tabulated the results of both experiments as follows.

Experiment I	**Copper(II) oxide**	**Oxide of X**	**Oxide of Y**	**Oxide of Z**
Action of heat	No reaction	No reaction	No reaction	Metal Z is formed

Experiment II	**X**	**Y**	**Z**
Action on aqueous copper(II) sulfate	Copper is deposited	A gas is evolved	No reaction

(a) Based on the experimental results, arrange the four metals, Cu, X, Y and Z in **descending** order of reactivity.

.... [1]

(b) **(i)** Suggest from the reactivity series, the possible identity of metals X and Z.

.... [2]

(ii) Based on the identity of X in (i), describe two observations that would be obtained in the reaction between X and aqueous copper(II) sulfate.

....

....

.... [2]

(c) Sketch a graph of temperature of the reaction mixture versus time from the time metal X is added to the aqueous copper(II) sulfate solution until there is no further change.

[1]

[Total : 6]

A7 In acidic media, manganese(II) ions react with sodium bismuthate, $NaBiO_3$, as shown below:

$$14H^{+} + 2Mn^{2+} + 5NaBiO_3 \rightarrow 7H_2O + 2MnO_4^{-} + 5Bi^{3+} + 5Na^{+}$$

(a) Determine the oxidation number of bismuth in sodium bismuthate.

[1]

(b) Does sodium bismuthate undergo oxidation or reduction in this reaction? Explain your answer with reference to oxidation numbers.

....

....

.... [1]

(c) Underline the substance that acts as a reducing agent. Explain your choice in terms of oxidation numbers.

....

....

....

.... [2]

[Total : 4]

A8 In parts of Africa, salts are traditionally obtained from papyrus plant ash. Plant ash is a mixture of large insoluble particles and salts which are soluble in water.

The composition and solubility of some salts found in the ash from the papyrus plant are shown in the table below

Salt	**M_r**	**Mass of salt per 100g of ash / g**	**Solubility of salt in g / dm^3**
Magnesium sulfate	120	5	220
Potassium carbonate	138	10	1120
Potassium chloride	64.5	18	359
Potassium sulfate	174	4	122
Sodium carbonate	106	12	70
Sodium chloride	58.5	40	359

(a) **(i)** Which salt in the table has the lowest solubility in mol/dm^3?

.... [1]

(ii) Which negatively-charged ion is present in the highest mass in 100g of ash?

.... [1]

(b) Describe briefly how a student may determine through experimental procedure, the mass of sulfate ions present in 100g of the ash mixture that has been dissolved in water.

....

....

....

....

.... [4]

(c) Another student suggested that the identity of the magnesium ion could be confirmed by adding aqueous sodium hydroxide in excess to a sample of the aqueous ash mixture.
He observed a white precipitate forming which dissolved in excess aqueous sodium hydroxide to form a colourless solution.
Do you agree with his observation? Explain.

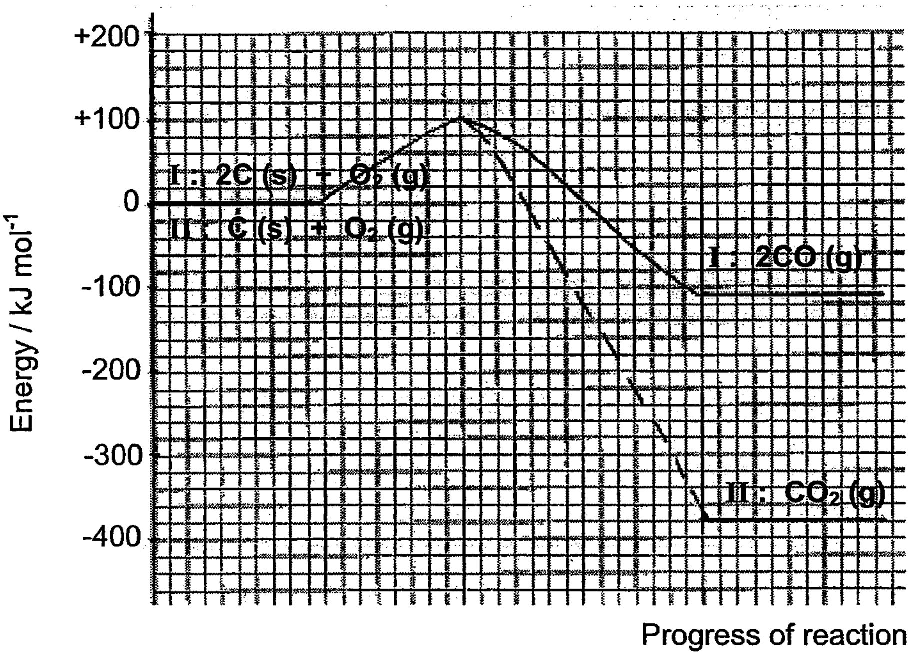
....

....

.... [2]

[Total : 8]

A9 The following graphs show the energy changes which occur during the incomplete and complete combustion of one mole of carbon.



I : $2C\ (s) + O_2\ (g) \rightarrow 2CO\ (g)$

II : $C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$

(a) Explain, using bond breaking and bond formation, whether the reactions are exothermic or endothermic.

....

....

....

.... [2]

(b) Use the graphs to estimate the enthalpy change, ΔH, for each reaction.

For complete combustion, ΔH = ... kJ / mol

For incomplete combustion, ΔH = ... kJ / mol

[2]

[Total : 4]

Section B

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

B10 The speed of reaction between three compounds – hydrogen peroxide, hydrochloric acid and potassium iodide – was studied in a series of experiments.

$$H_2O_2(aq) + 2KI(aq) + 2HCl(aq) \rightarrow 2H_2O(l) + I_2(aq) + 2KCl(aq)$$

The speed of reaction was measured as a function of the concentration of each reactant. The table below shows the results obtained.

Experiment	Concentration of H_2O_2 (mol/dm^3)	Concentration of HCl (mol/dm^3)	Concentration of KI (mol/dm^3)	Speed of reaction (mol/dm^3/s)
1	0.1	0.1	0.1	0.0001
2	0.2	0.1	0.1	0.0002
3	0.1	0.2	0.1	0.0001
4	0.2	0.1	0.2	0.0004

(a) **(i)** Using the information given, state how the concentration of hydrogen peroxide affects the speed of reaction. [2]

(ii) Besides hydrogen peroxide, identify another reactant whose concentration affects the speed of reaction and suggest how the speed is affected. Explain your answer using the data provided above. [2]

(b) Sketch the graph of the concentration of hydrogen peroxide against the speed of reaction. [2]

(c) Other than the concentration factor, state and explain using collision theory one factor that increases the speed of reaction. [2]

(d) Explain, in terms of oxidation number, why this reaction is a redox reaction. [2]

[Total : 10]

B11 A student carried out an electrolysis of dilute sulfuric acid and collected the gases formed.

(a) Draw a labelled diagram to show the apparatus used and the products formed. [2]

(b) **(i)** Write half equations for the reactions at the anode and cathode. Use the half equations to construct an overall equation for the reaction and give tests for any gases evolved.

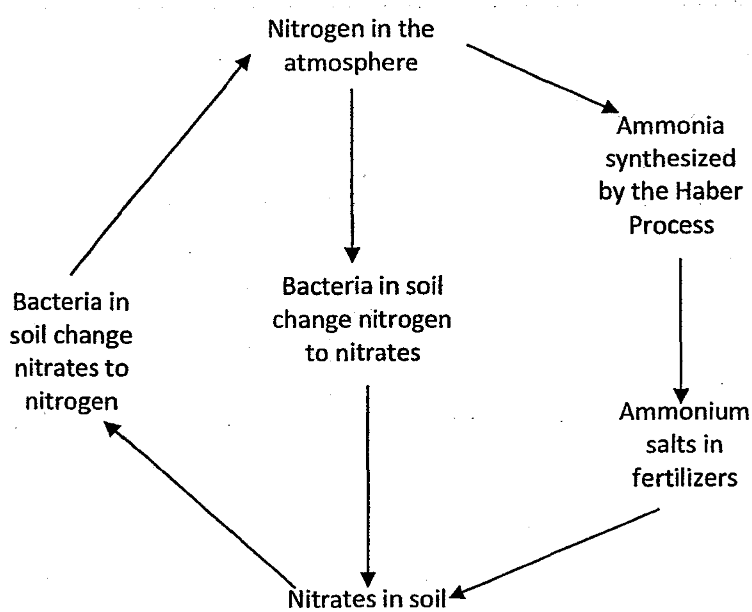
(ii) Use your equations to explain how the composition of the solution changes after the electrolysis has been running for some time. [5]

(c) Electrolysis is used to coat a layer of silver onto a spoon.
Starting with a metallic spoon, suggest suitable materials that can be used as the electrolyte, the anode and cathode needed to silver-plate the spoon. [3]

[Total : 10]

EITHER

B12 A simplified diagram of the nitrogen cycle is shown below.



(a) Nitrogen from the atmosphere reacts with hydrogen gas to form ammonia in the Haber Process. The equation for this reaction is as follows:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The reversible reaction requires the use of a catalyst, which operates most efficiently within a temperature range of 280 ˚C to 450˚C. The hydrogen gas required is obtained from cracking of oil.

(i) Explain the meaning of the term 'reversible'. [1]

(ii) Hydrogen gas can also be produced by electrolysis of water. Suggest an advantage of this method compared to cracking of oil. [1]

(iii) Draw a dot-and-cross diagram (showing valence electrons only) to show the structure of nitrogen gas. With reference to the structure, suggest why nitrogen gas is unreactive. [2]

(iv) Name the catalyst used in the Haber Process and explain how it speeds up the rate of production of ammonia. [2]

(v) As nitrogen gas reacts with hydrogen gas to form ammonia, there is a decrease in pressure. Explain why this happens. [2]

(b) **(i)** Although certain bacteria in the soil convert nitrogen gas into nitrates, other bacteria convert nitrogen into ammonium salts. The ionic equation for this second reaction is:

$$N_2 + 8H^+ + 6e^- \rightarrow 2NH_4^+$$

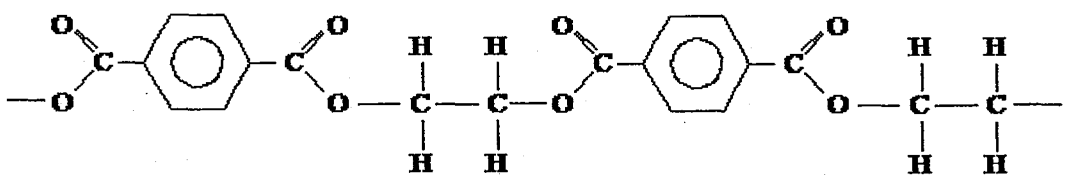
Explain why this is a reduction reaction. [1]

(ii) In the presence of hydrogen ions, a different type of bacterium converts nitrate ions into nitrogen gas and water. Write the ionic equation for this reaction. [1]

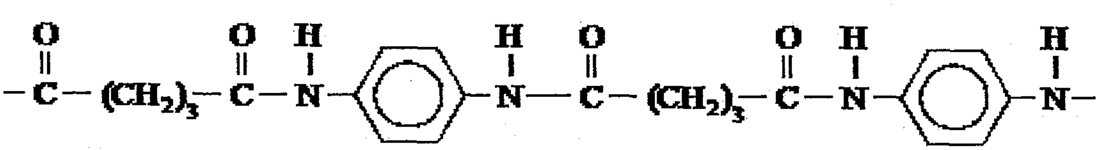
[Total : 10]

OR

B12 **(a)** The diagrams below show the structures of two synthetic polymers.



Polymer A



Polymer B

(i) Construct a table to show the following information about these two polymers

- The formula and name of the type of linkages present in each type of polymer.
- The structures of the monomers that react to form each polymer. [3]

(ii) From the monomers that form polymers **A** and **B**, draw the structure of another polymer that may possibly formed. [1]

(iii) A student bought a sports bag which is made using polymer **B**. The bag had a warning label which stated:

"Non-biodegradable. Harmful when disposed"

Explain what the label means. [2]

(b) This question concerns the chemistry of ethene and compounds derived from it.

Consider the following statements and then answer the questions below.

- Ethene may be polymerised to form poly(ethene).
- Treatment of ethene with aqueous bromine gives a compound **C**.
- Compound **C** may be converted in the laboratory into a compound **D**, which has a percentage composition by mass of: C 38.71%; H 9.68%; O 51.61%. The relative molecular mass, M_r, of **D** is 62.

(i) Explain the meaning of the term 'polymerisation'. [1]

(ii) Write the chemical equation to represent the treatment of ethene with aqueous bromine. [1]

(iii) Use the analytical data provided above to calculate and deduce the molecular formula of compound **D**. [2]

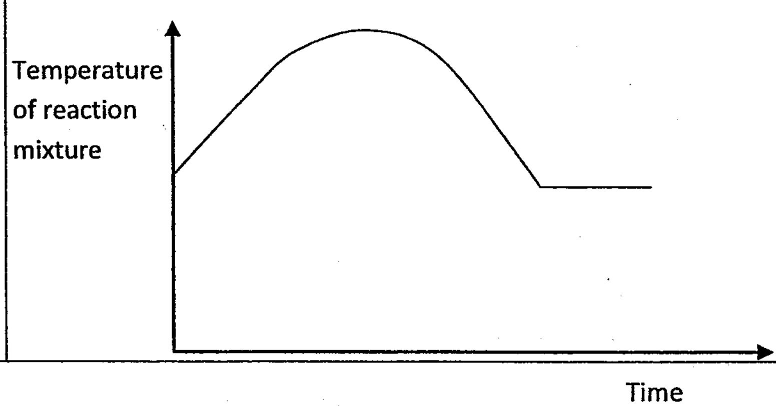
[Total : 10]

SJI Preliminary Examinations 2014

Chemistry 5073/2

A1	**(a)**	Close together to far apart Orderly arranged to disorderly arranged Vibrate about fixed position to moving randomly at high speeds
	(b)(i)	$2AgI \rightarrow 2Ag + I_2$
	(b)(ii)	mol AgI = 28/235=0.1191mol mol I_2 = 0.1191/2 = 0.05955mol volume of I_2 = 0.05955x24dm^3 = 1.43dm^3 % yield = 1/1.43 x 100 = 69.9%

A2	**(a)**	Symbol	Name	Charge
		●	neutron	0
		⊕	proton	+1
		⊖	electron	-1
	(b)(i)	T^-		
	(b)(ii)	NaT		
	(c)	Liquid. This is because it combines with oxygen to form T_2O which is similar to H_2O, which is a liquid		

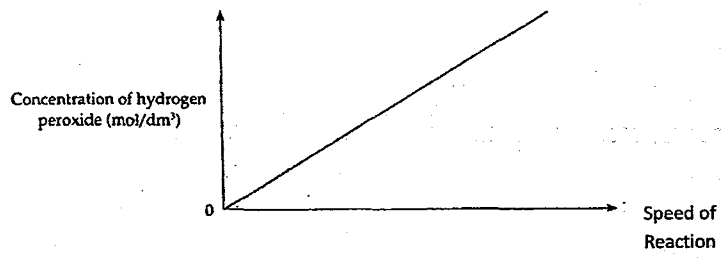
A3	**(a)**	the melting point decreases down Group I and increases down Group VII
	(b)	The atomic size increases down Group I, leading to greater size of their respective positive ions. Down group I, lesser energy required to overcome the electrostatic forces of attraction between the positive ions. (to overcome the attractive forces holding the positive ions in fixed arrangement) Down Group VII, the atomic size increases, leading to an increase in the molecular sizes of the elements. There will be stronger intermolecular forces of attraction, resulting in more energy required to overcome these forces.
A4	**(a)**	Milk will not boil at a fixed temperature as it is a mixture
	(b)(i)	Calcium
	(b)(ii)	2.8.8
	(c)(i)	C – measuring cylinder
	(c)(ii)	B – Burette
A5	**(a)(i)**	Substitution reaction
	(a)(ii)	**More ultraviolet radiation enters** the Earth's atmosphere, Causing **higher instances of skin cancer and eye cataract.**
	(b)(i)	**Both compounds do not contain the element chlorine** and cannot generate chlorine radicals, which cause ozone depletion.
	(b)(ii)	The formulae of the compounds **contain an additional element hydrogen while those in current use contains only C, Cl and F.**
A6	**(a)**	Y, X, Cu, Z
	(b)(i)	X could be (Magnesium), (Aluminium), Zinc, Iron, Lead Z could be Silver, Gold, Platinum
	(b)(ii)	Reddish brown solid is deposited. Blue solution turns colourless (or green with iron)
	(c)	

A7	**(a)**	Let x be the oxidation state of bismuth in sodium bismuthate. $(+1) + x + 3(-2) = 0$ $x = +5$
	(b)	Sodium bismuthate undergoes reduction. The oxidation state of bismuth **decreases** from **+5 in sodium bismuthate to +3 in bismuth(III) ions.**
	(c)	Underline : <u>Mn^{2+}</u> Manganese(II) ions reduces sodium bismuthate as the oxidation state of bismuth decreases from +5 in sodium bismuthate to +3 in bismuth(III) ions. Manganese(II) ions are oxidised as the oxidation state of manganese increases from +2 in manganese(II) ions to +7 in the manganate(VII) ions.

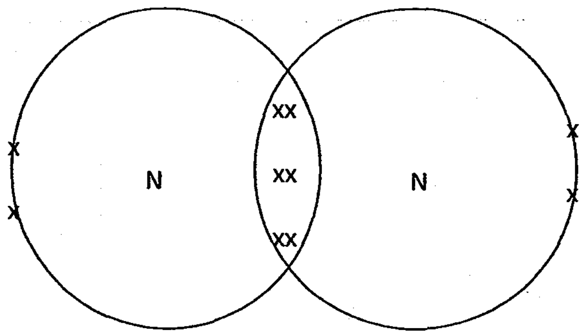
A8	**(a)(i)**	Sodium carbonate <u>(70/106 mol/dm^3)</u>
	(a)(ii)	Chloride ion
	(b)	Add excess nitric acid to remove all carbonate ions. Add aqueous barium salt to precipitate out the sulfate. Filter the mixture to collect the residue. Wash with distilled water, dry residue and weigh. Use stoichiometry to find mass of sulphate ions $BaSO_4 \rightarrow Ba^{2+} + SO_4^{2-}$
	(c)	No. Magnesium hydroxide has no amphoteric properties / does not behave as an acid and does not react with more alkali to form a soluble salt.

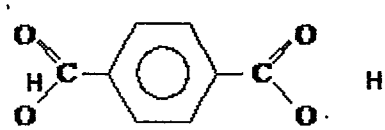
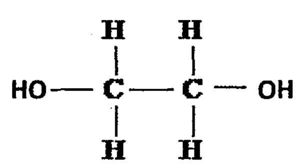
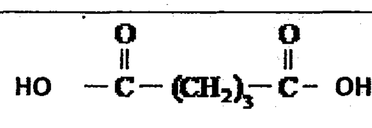
A9	**(a)**	Energy <u>absorbed to break bonds in reactants</u> (in carbon and O=O bonds); is <u>less than</u> energy <u>released in the formation of bonds in products</u> (in CO and C=O bonds). The reactions are exothermic.
	(b)	-380 kJ/mol (complete combustion) -110 kJ / mol <u>(incomplete combustion)</u>

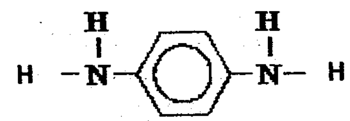
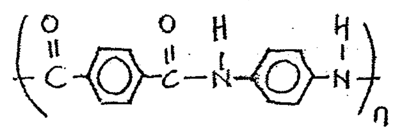
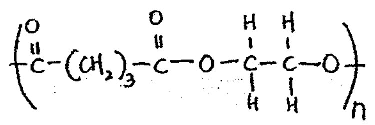
B10	**(a)(i)**	Using <u>Expt 1 and 2,</u> when the concentration of hydrogen peroxide <u>doubles</u> from <u>0.1 to 0.2 mol/dm^3</u> and with the concentrations of HCl and KI constant at 0.1mol/dm^3, the <u>speed of reaction doubles from 0.0001 to 0.0002 mol/dm^3/s,</u>
	(a)(ii)	Using <u>Expt 2 and 4</u>, when the concentration of hydrogen peroxide and hydrochloric acid is <u>constant at 0.2 and 0.1 mol/dm^3</u> respectively,

		doubling the concentration of KI from 0.1 to 0.2 mol/dm^3 doubles the speed of reaction from 0.0002 to 0.0004 mol/dm^3/s.
	(b)	
	(c)	increase temperature, particles gain energy and move faster more particles with energy equivalent to or greater than the activation energy increase frequency of effective collisions between particles.
	(d)	hydrogen peroxide is reduced as the oxidation number of oxygen decreases from -1 in H_2O_2 to -2 in H_2O KI is oxidised as the oxidation number of I decreases from -1 in KI to 0 in I_2 Since oxidation and reduction occur simultaneously, the reaction is a redox reaction.

B11	(a)	Correct labelling of anode and cathode Correct ratio of gases in tubes and must be collected.
	(b) (i)	Anode : $4OH^- \rightarrow 2\ H_2O + O_2 + 4e$ Cathode : $2\ H^+ + 2e \rightarrow H_2$ Overall : $4\ H^+ + 4\ OH^- \rightarrow 2\ H_2 + O_2 + 2\ H_2O$ $2H_2O \rightarrow 2H_2 + O_2$ Test for gases: Oxygen – rekindles a glowing splint Hydrogen – gives a ‘pop’ sound when tested with a lighted splint
	(ii)	After some time, the sulfuric acid becomes more concentrated as water has been removed during electrolysis
	(c)	Electrolyte : any solution containing silver ions (e.g. silver nitrate solution) Anode : pure silver metal Cathode : spoon

B12	**Either (a)(i)**	The term 'reversible' refers to a reaction that has both a forward and reverse reaction occurring simultaneously. The reactants form the products in the forward reaction, while the products are converted to the reactants in the reverse reaction.
	(a)(ii)	Water is more abundant compared to oil, which is a limited resource.
	(a)(iii)	 Nitrogen gas is unreactive as **a lot of energy is required to break the strong triple covalent bonds** between nitrogen atoms.
	(a)(iv)	Catalyst is finely divided iron The iron provides **an alternative pathway for the reaction**, which has a **lower activation energy**.
	(a)(v)	**One** mole of nitrogen gas reacts with **three** moles of hydrogen gas to form **two** moles of ammonia gas. There are **fewer molecules per unit volume** formed compared to the reactants, causing fewer collisions on the walls of the vessel.
	(b)(i)	**Nitrogen gains electrons** to form ammonium ions. Or Oxidation number of N decreases from 0 in N_2 to -3 in NH_4^+
	(b)(ii)	$2NO_3^- \ + \ 12H^+ \ + \ 10e^- \ \rightarrow \ N_2 \ + \ 6H_2O$

B12	**OR (a)(i)**	Polymer A	O ll -O- C - Ester linkage	 
		Polymer B	O H ll l	

			-C – N - Amide linkage		
	(ii)	 OR 			
	(iii)	Cannot be decomposed **by bacteria** in the soil. Land pollution – takes up land space to dispose which deprive the land for other uses/land pollution Air pollution – releases toxic fumes like CO when burned away			
	b(i)	the joining together of monomers / small molecules to form long chains / large molecules			
	(ii)	$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$			
	(iii)	C 38.71/12 = 3.23 ; H 9.68/1 = 9.68 ; O 51.61/16 = 3.23 ratio C:H:O = 1:3:1 /empirical formula = CH_3O empirical mass = 31 so molecular formula = 2 × CH_3O = $C_2H_6O_2$			

SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATION

Name: ______________________________ (   )   Class: 4E

CHEMISTRY

5073/01

Tuesday 26 August 2014

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

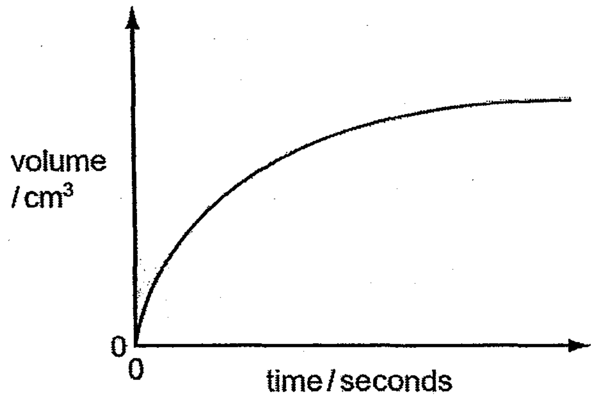
Setter: Mr Goh Weibin
Vetters: Mr Hoon Yengwei

[Turn over

1 Which process provides the best evidence for the particle theory of matter?

A boiling **B** cracking **C** diffusion **D** filtration

2 A student measures the rate of reaction between calcium carbonate and dilute hydrochloric acid. A graph showing the volume of gas produced against time is shown.



Which apparatus was used to measure the variables shown on the graph?

A balance and gas syringe

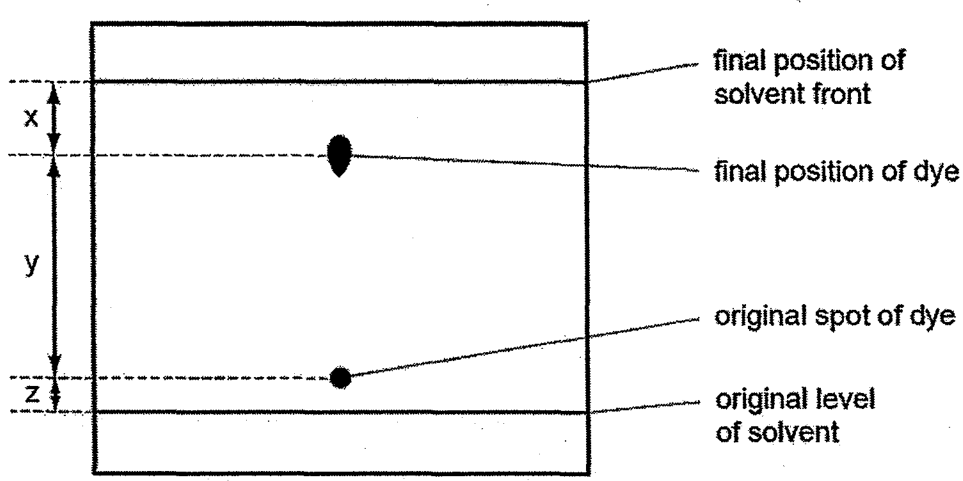
B burette and pipette

C gas syringe and stop watch

D pipette and stop watch

3 The diagram shows the chromatogram obtained by analysis of a single dye.

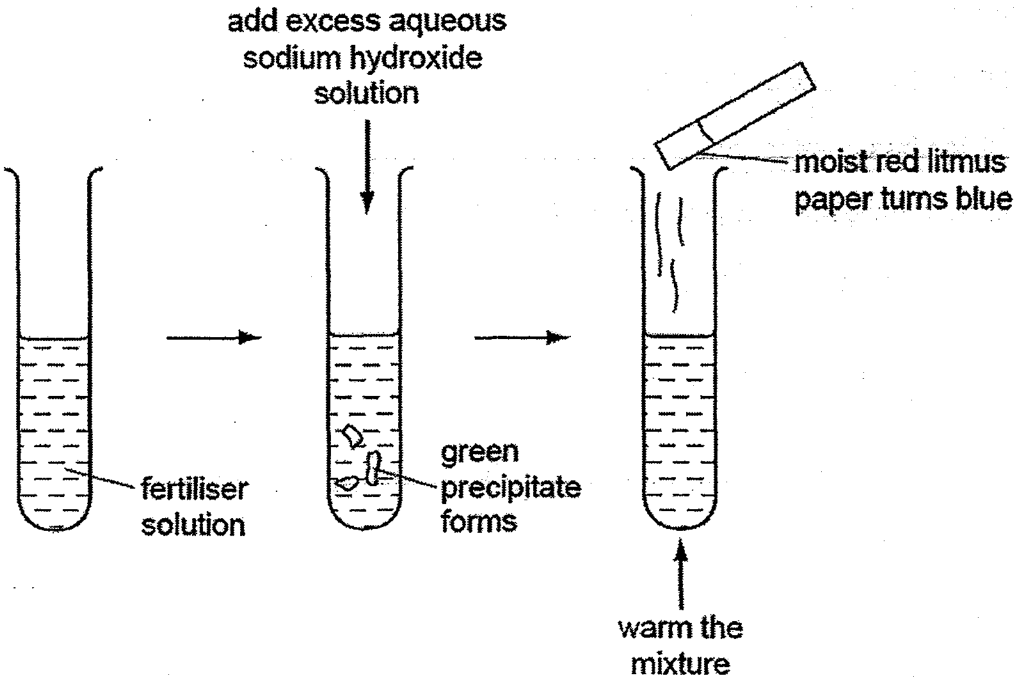
Three measurements are shown.



How is the R_f value of the dye obtained?

A $\dfrac{x}{x+y}$ **B** $\dfrac{y}{x+y}$ **C** $\dfrac{y}{x+y+z}$ **D** $\dfrac{y+z}{x+y+z}$

4 A solution of fertiliser was tested as shown.



Which ions must be present in the fertiliser?

A Cr^{3+} and NO_3^-

B Cr^{3+} and Fe^{2+}

C NH_4^+ and Fe^{2+}

D NH_4^+ and NO_3^-

5 Substance X has a simple molecular structure and substance Y has a giant molecular structure.

Which row is correct?

	X could be	Y could be
A	an element only	an element only
B	an element only	an element or a compound
C	an element or a compound	an element only
D	an element or a compound	an element or a compound

6 Hydrogen can form both H^+ and H^- ions.

Which one of the statements below is correct?

A An H^+ ion has more protons than an H^- ion.

B An H^+ ion has no electrons.

C An H^- ion has one more electron than an H^+ ion.

D An H^- ion is formed when a hydrogen atom loses an electron.

7 Both magnesium oxide, MgO, and aluminium oxide, Al_2O_3, are solids at room temperature, 25 °C.

MgO has a melting point of 2852 °C and a boiling point of 3600 °C.

Al_2O_3 has a melting point of 2072 °C and a boiling point of 2880 °C.

Over which temperature range will both pure compounds conduct electricity?

A 25 to 2852 °C

B 2072 to 2852 °C

C 2852 to 2880 °C

D 2880 to 3600 °C

8 Which statement shows that diamond and graphite are different forms of the element carbon?

A Both have giant molecular structures.

B Complete combustion of equal masses of each produces equal masses of carbon dioxide as the only product.

C Graphite conducts electricity, whereas diamond does not.

D Under suitable conditions, graphite can be converted into diamond.

9 Which quantity is the same for one mole of ethanol and one mole of ethane?

A mass

B number of atoms

C number of molecules

D volume at room temperature and pressure

10 Two different hydrocarbons each contain the same percentage by mass of hydrogen.

It follows that they have the same

A empirical formula.

B number of isomers.

C relative molecular mass.

D structural formula.

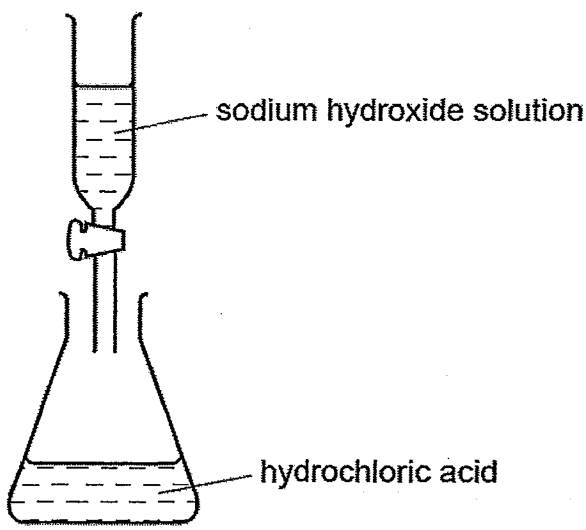
11 The relative molecular mass, Mr, of copper(II) sulfate, $CuSO_4$, is 160.

The relative molecular mass, Mr, of water, is 18.

What is the percentage by mass of water in copper(II) sulfate crystals, $CuSO_4.5H_2O$?

A $\dfrac{18 \times 100}{160}$ **B** $\dfrac{5 \times 18 \times 100}{160 + 18}$ **C** $\dfrac{18 \times 100}{160 + 18}$ **D** $\dfrac{5 \times 18 \times 100}{160 + (5 \times 18)}$

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



What would be the pH change in this reaction?

A decrease to 1

B decrease to 7

C increase to 7

D increase to 12

13 Which statement does **not** describe a property of a weak acid in solution?

A It forms a salt with sodium hydroxide.

B It has a pH of between 8 and 9.

C It is only partly dissociated into ions.

D It reacts violently with sodium metal.

14 Four oxides are added separately to aqueous sodium hydroxide.

1 carbon monoxide

2 iron(II) oxide

3 lead(II) oxide

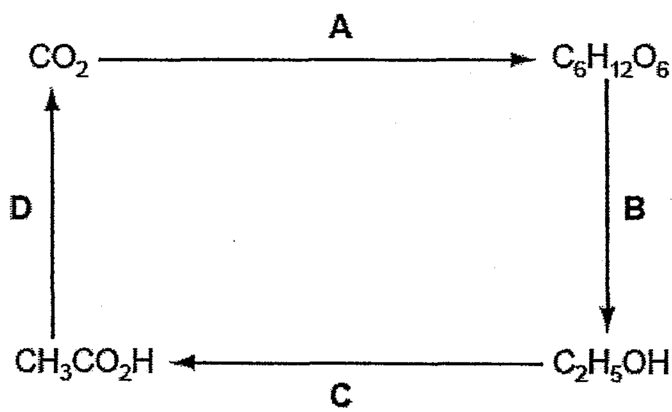
4 sulfur dioxide

Which oxides react with aqueous sodium hydroxide?

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

15 The diagram shows the steps by which carbon dioxide can be converted into organic products and finally returned to the atmosphere.

Which step is endothermic?



16 Which property is common to calcium, potassium and sodium?

A Their atoms all have more neutrons than protons.

B Their ions all have eight electrons in their outer shell.

C They all sink when added to water.

D They are all deposited at the positive electrode when their molten chloride is electrolysed.

17 Substance X liberates iodine from aqueous potassium iodide and decolourises acidified potassium manganate(VII).

How is the behaviour of X described?

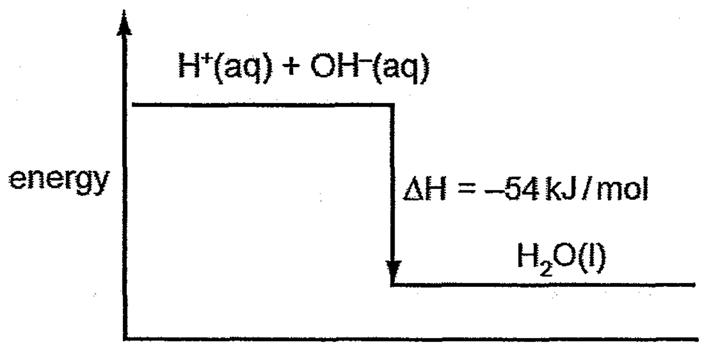
A As an oxidising agent only

B As an oxidising agent and a reducing agent

C As neither an oxidising agent nor a reducing agent

D As a reducing agent only

18 The energy diagram for the reaction between sodium hydroxide and sulfuric acid is shown.



Which quantity of heat is liberated when 100 cm^3 of 1 mol/dm^3 sulfuric acid reacts with 100 cm^3 of 1 mol/dm^3 sodium hydroxide?

A 0.54 kJ B 2.70 kJ C 5.40 kJ D 10.8 kJ

19 The oxide of an element X increases the rate of decomposition of hydrogen peroxide. At the end of the reaction the oxide of X is unchanged.

Which details are those of X?

	proton number	mass number
A	18	40
B	20	40
C	25	55
D	82	207

20 Which pair of compounds could be used in the preparation of lead(II) sulfate?

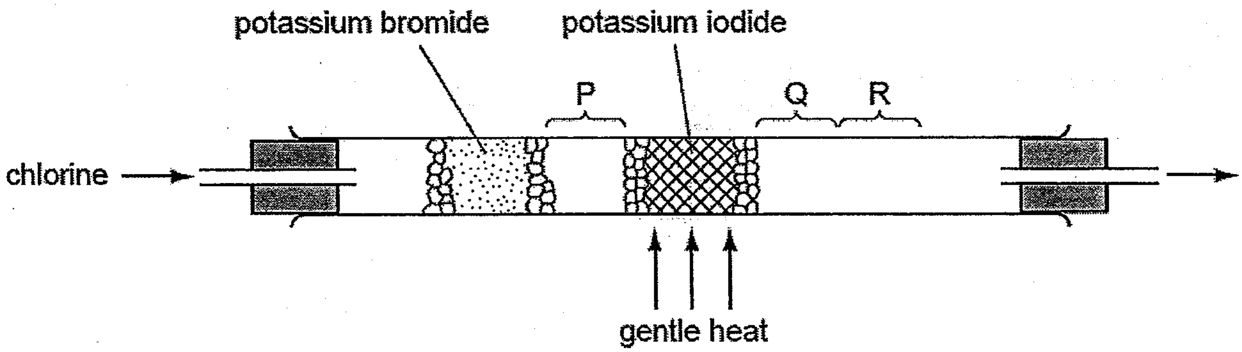
A lead and dilute sulfuric acid

B lead(II) carbonate and dilute sulfuric acid

C lead(II) nitrate and dilute sulfuric acid

D lead(II) hydroxide and dilute sulfuric acid

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



After a short while, coloured substances are seen at P, Q and R.

What are these coloured substances?

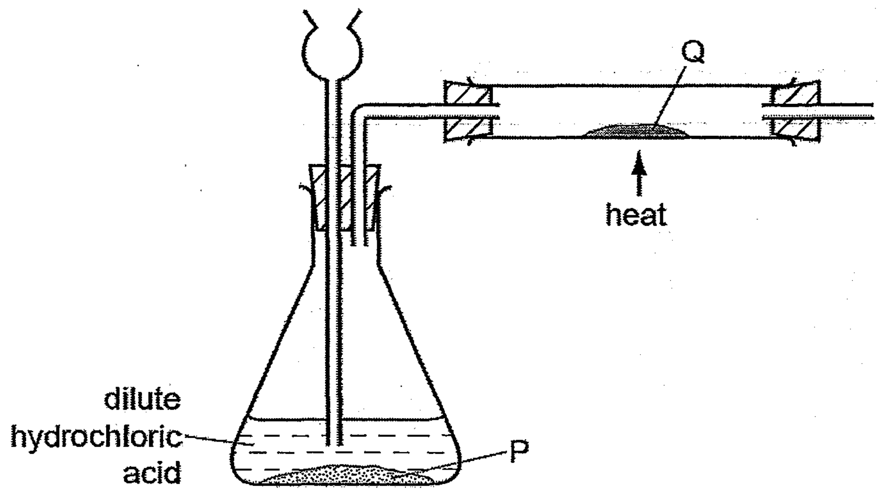
	at P	at Q	at R
A	green gas	red brown vapour	violet vapour
B	green gas	violet vapour	black solid
C	red brown vapour	violet vapour	black solid
D	violet vapour	red brown vapour	red brown vapour

22 An ionic compound has the formula X_3Y_2.

To which groups of the Periodic Table do X and Y belong?

	group for X	group for Y
A	II	III
B	III	II
C	II	V
D	V	II

23 The diagram shows the apparatus used in an experiment to reduce substance Q with the gas generated in the flask.



What are substances P and Q?

	P	Q
A	lead	copper(II) oxide
B	magnesium	zinc oxide
C	potassium	copper(II) oxide
D	zinc	lead(II) oxide

24 In which line in the table is all the information correct?

	reaction at electrode	electrode	product
A	$2X^- \rightarrow X_2 + 2e^-$	cathode	metal
B	$X^+ + e^- \rightarrow X$	anode	metal
C	$2X^- \rightarrow X_2 + 2e^-$	anode	non-metal
D	$X^+ + e^- \rightarrow X$	cathode	non-metal

25 Which mixture would react with sulfuric acid to form two **different** gases?

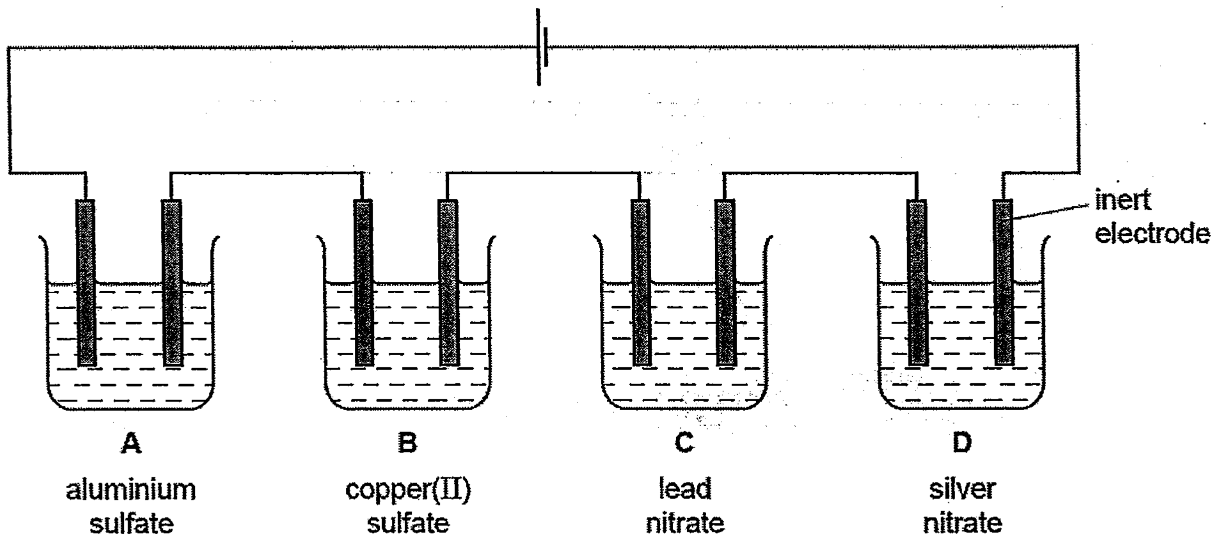
A copper and magnesium carbonate

B copper(II) carbonate and magnesium

C copper(II) carbonate and magnesium oxide

D copper(II) oxide and magnesium

26 When electrolysed using inert electrodes, which dilute solution would produce the greatest increase in mass of the cathode?
[Ar: Al, 27; Cu, 64; Pb, 207; Ag, 108]



27 In which parts of a motor car do the reactions, shown in the equations, take place?

	$N_2 + O_2 \rightarrow 2NO$	$2CO + 2NO \rightarrow 2CO_2 + N_2$
A	engine	engine
B	engine	exhaust
C	exhaust	engine
D	exhaust	exhaust

28 Equations for reactions of iron and iron compounds are shown.

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

$$2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$$

$$FeSO_4 + Mg \rightarrow Fe + MgSO_4$$

$$FeSO_4 + 2NaOH \rightarrow Fe(OH)_2 + Na_2SO_4$$

How many of these are redox reactions?

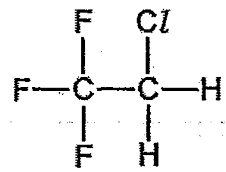
A 1

B 2

C 3

D 4

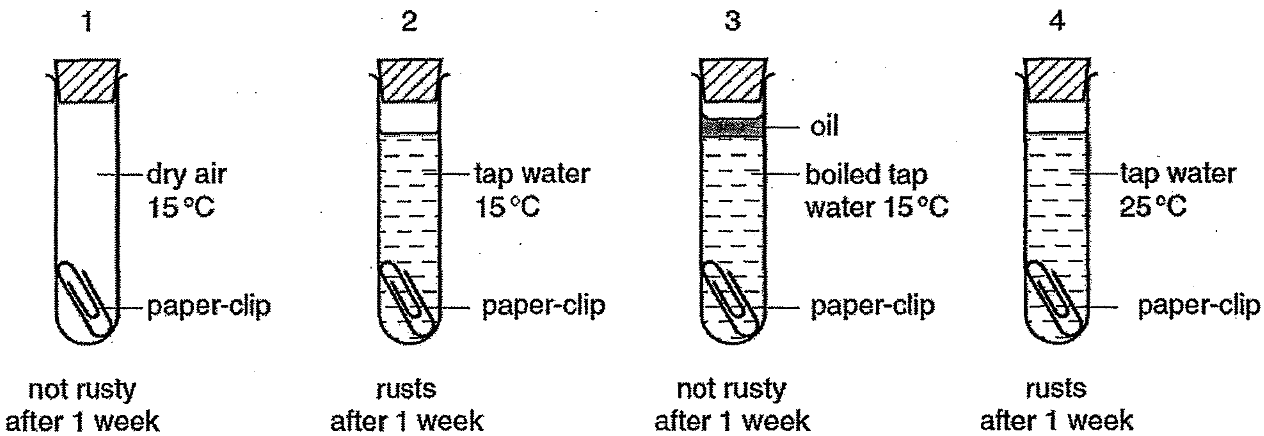
29 CFC compounds were commonly used as aerosol propellants. The structure of one CFC compound is shown.



Which element in this compound causes a depletion of ozone in the atmosphere?

A carbon **B** chlorine **C** fluorine **D** hydrogen

30 Four experiments on rusting are shown.



Which two experiments can be used to show that air is needed for iron to rust?

A 1 and 3

B 1 and 4

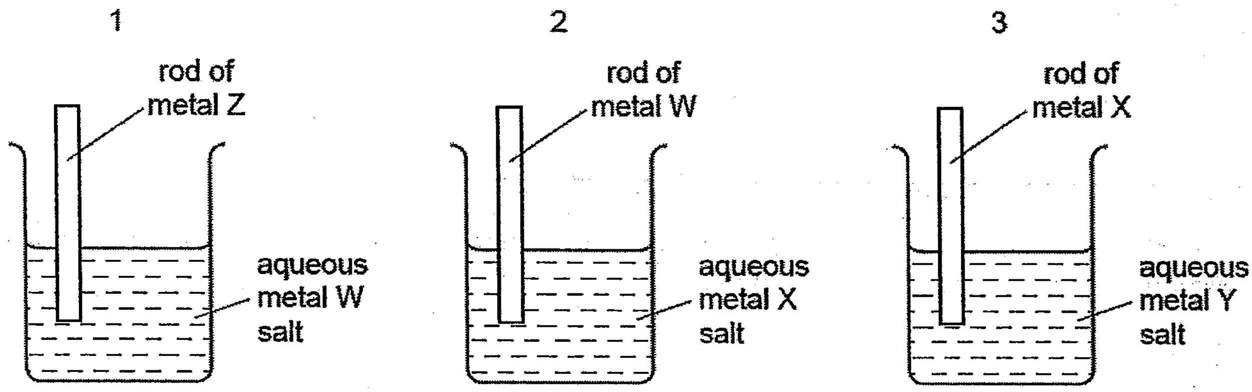
C 2 and 3

D 2 and 4

31 Which substance, in the given physical state, is found at the bottom of the blast furnace?

	substance	physical state
A	calcium silicate	solid
B	calcium silicate	liquid
C	iron	solid
D	iron	liquid

32 Three different beakers are set up as shown.



In beaker 1 metal W is displaced from solution.
In beaker 2 metal X is displaced from solution.
In beaker 3 metal Y is displaced from solution.

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

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

33 Which bond is present in both nylon and Terylene?

A C – O **B** C = O **C** N – C **D** N – H

34 Compounds X and Y belong to the same homologous series. Compound X is more viscous than compound Y.

What could be the formulae of compound X and Y?

	compound X	compound Y
A	C_8H_{16}	C_9H_{20}
B	C_8H_{18}	C_9H_{20}
C	C_9H_{18}	C_8H_{18}
D	C_9H_{20}	C_8H_{18}

35 The two statements are about the fractional distillation of crude oil. The statements may or may not be correct. They may or may not be linked.

Statement 1 Fractional distillation is used to separate crude oil into useful fractions.

Statement 2 The fractions with lower boiling points are found at the top of the fractionating column.

What is correct about these two statements?

A Both statements are correct and statement 2 explains 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 1 is incorrect but statement 2 is correct.

36 Under certain conditions, 1 mole of ethane reacts with 2 moles of chlorine in a substitution reaction.

What is the formula of the organic product in this reaction?

A C_2H_5Cl **B** $C_2H_4Cl_2$ **C** $C_2H_2Cl_4$ **D** CH_2Cl_2

37 A student investigated the reaction of different vegetable oils with hydrogen. 100 cm^3 of hydrogen was passed through 1 g samples of vegetable oils containing a suitable catalyst.

The volume of hydrogen remaining after each reaction was recorded.

vegetable oil	volume of hydrogen remaining / cm^3
P	100
Q	87
R	63
S	0

Which vegetable oils are unsaturated?

A P only

B Q and R only

C Q, R and S only

D S only

38 Which pair of compounds are both esters and are isomers of each other?

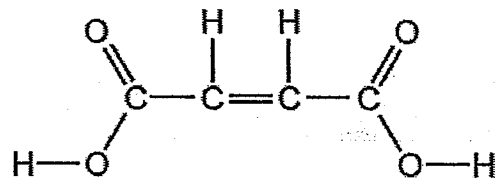
A HCO_2CH_3 and CH_3CO_2H

B $CH_3CO_2CH_3$ and $C_2H_5CO_2H$

C $CH_3CO_2C_2H_5$ and $C_2H_5CO_2CH_3$

D $C_3H_7CO_2CH_3$ and $CH_3CO_2C_2H_5$

39 The structural formula of butenedioic acid is shown.



With which substance will butenedioic acid react to form only one product?

A calcium carbonate

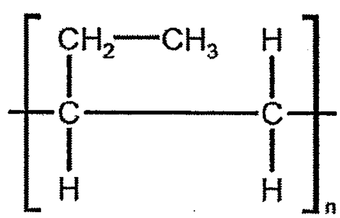
B ethanol

C iodine

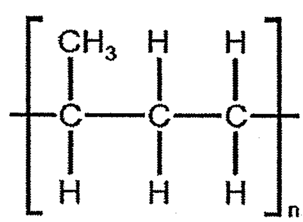
D zinc

40 Which partial structure is correct for the product of polymerisation of butene, $CH_2CHCH_2CH_3$?

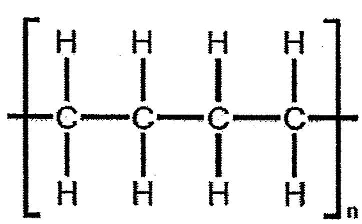
A



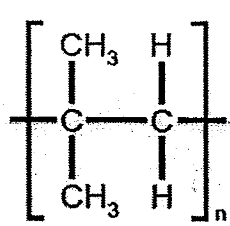
B



C



D



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** Sulphur 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 †															

*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 **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.).

Swiss Cottage Secondary
2014 4E Preliminary Examinations
Mark Scheme

Section A

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

Answers arranged horizontally (1,2,3,4,5,6,7,8,9,10), (11,12,13,14,15,16,17,18,19,20), and so on..

SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR EXPRESS
PRELIMINARY EXAMINATIONS

Name: ______________________________( ) Class: Sec 4E _______

CHEMISTRY
Paper 2

5073/02
Friday 22 Aug 2014
1 hour 45 min

Additional materials: Nil

READ THESE INSTRUCTIONS FIRST

Write in blue or black ink. You may use a calculator.

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

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

The number of marks is given in brackets [ ] at the end of each question or part of the question.
Omission of essential working will result in loss of marks.
A copy of the Periodic Table is printed on page **17**.

This question paper consists of **17** printed pages.

Setter: Mr Hoon Yeng Wei
Vetter: Mdm Tan Pui San

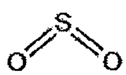
[Turn over

*We Nurture Students to **Think, Care** and **Lead** with **P.R.I.D.E.***

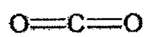
Section A (50 Marks)

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

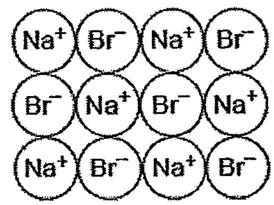
A1 The diagram shows the structures of various compounds.



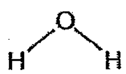
A



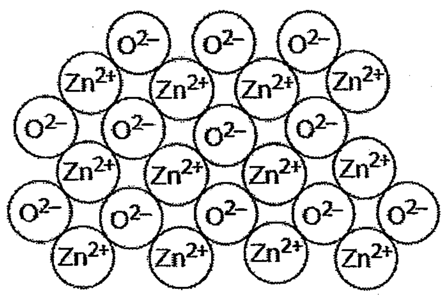
B



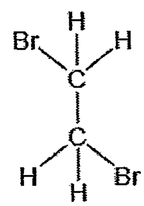
C



D



E



F

(a) Use the letters **A** to **F** to answer the following questions.
Each compound may be used once, more than once or not at all.

(i) Which **one** of these compounds is most likely to contribute to acid rain?

.... [1]

(ii) Which **one** of these compounds is an amphoteric oxide?

.... [1]

(iii) Which **two** of these compounds have giant structures?

.... and .... [1]

(iv) Which **one** of these compounds when molten, releases a reddish brown gas at the anode on electrolysis?

.... [1]

(b) Carbon monoxide is a poisonous atmospheric pollutant.
State how this gas gets into the air.

....[1]

A2 Some properties of three solids, **I**, **J** and **K** are given in table below. Use this information to complete the last column of the table.

solid	percentage composition by mass	solid conducts electricity	strong heat in oxygen	element or mixture or compund
I	constant	no	decomposes	
J	varies	no	burns	
K	constant	yes	oxidises to form one substance	

[3]

A3 Diamond has a melting point of about 3700 °C and graphite has a melting point of about 3300 °C.

(a) Explain why both diamond and graphite have very high melting points.

....

....

....

....

....[3]

(b) Compare the electrical conductivity of diamond and graphite. Explain your answer.

....

....

....

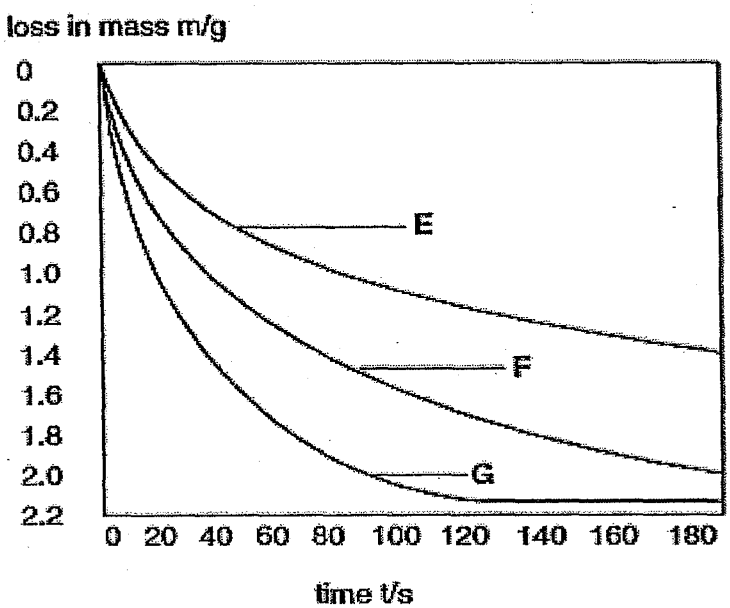
....[2]

A4 Three samples of calcium carbonate are placed in flasks for an investigation.

In flask **E** is 5 g of calcium carbonate – large lumps.
In flask **F** is 5 g of calcium carbonate – medium-sized lumps.
In flask **G** is 5 g of calcium carbonate – small lumps.

The same volume, an excess, of dilute hydrochloric acid is added to each flask.
The flasks are placed on three electronic balances.
A datalogger is used to plot the loss of mass of the flasks and their contents against time.

The results are shown below.



(a) (i) Why do the three flasks and their contents lose mass?

....

....[1]

(ii) How do the rates of reaction change with time?

.... [1]

(b) In which flask is the reaction fastest at time t = 20 s?

....[1]

(c) **(i)** How long does it take for the reaction in flask **G** to stop?

.... [1]

(ii) Why does this reaction stop?

.... [1]

(d) Sketch on graph, the curve you would expect if 5 g of powdered calcium carbonate is used instead of 5 g of lumps of calcium carbonate. Label this curve **H**.

[2]

A5 Mohr's salt is a pale green crystalline solid which is soluble in water. Mohr's salt is a 'double salt' which contains the following:

- two cations, one of which is Fe^{2+},
- one anion which is SO_4^{2-},
- and water of crystallisation.

(a) The identity of the second cation was determined by the following test.
Solid Mohr's salt was heated with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution.

(i) Name the gas produced.

.... [1]

(ii) What is the formula of the second cation identified by this test?

.... [1]

(iii) In this test, a grey - green solid residue was also formed.
Suggest the identity for this solid.

.... [1]

(b) The identity of the anion present in Mohr's salt was confirmed by adding dilute hydrochloric acid followed by aqueous barium chloride to an aqueous solution of Mohr's salt. A white precipitate was formed.

Suggest the identity of the white precipitate.

....[1]

(c) When a double salt such as Mohr's salt is made, the two individual salts are mixed together in a 1:1 molar ratio, dissolved in water and the solution crystallised.

(i) Give the formula of **each** of the two salts that would be mixed to make the double salt, Mohr's salt.

salt 1 ....

salt 2 ....

[2]

A6 Ammonia was named after the shrine of Jupiter Ammon which was near the Egyptian-Libyan border. In ancient times ammonia was obtained by distilling camel dung.

(a) Now ammonia is synthesised from its elements in the Haber Process.

(i) Write an equation for this process.

.... [1]

(ii) State the **three** usual operating conditions of the Haber Process.

.... [2]

(iii) State **two** modern commercial uses of ammonia.

....

.... [1]

(b) Ammonia does not burn in air but will burn in pure oxygen to produce nitrogen and steam.

(i) Write a balanced chemical equation, with state symbols, for this process.

.... [2]

(ii) Use oxidation states to explain why **(b)(i)** is a redox reaction.

....

....

....

.... [3]

A7 Compounds of phosphorus have many uses in everyday life, e.g. fertilisers, matches and in water softeners.

(a) State the full electronic configuration of phosphorus.

.... [1]

(b) The salt sodium phosphate, Na_3PO_4, is a water-softening agent.

Write the chemical equation for the complete neutralisation of phosphoric acid with aqueous sodium hydroxide.

.... [1]

(c) Sodium phosphate was prepared from 50.0 cm^3 of 0.500 mol/dm^3 H_3PO_4 and an excess of aqueous sodium hydroxide.

Use your equation in **(b)** to calculate the concentration of NaOH used, in mol/dm^3 given that 15 cm^3 of NaOH is used.

[3]

(d) Phosphorus sulfide, P_4S_3, is used in small amounts in the tip of a match. On striking a match, this compound burns to form phosphorus oxide, P_4O_{10} and an acidic oxide.

(i) Construct a balanced chemical equation for this reaction.

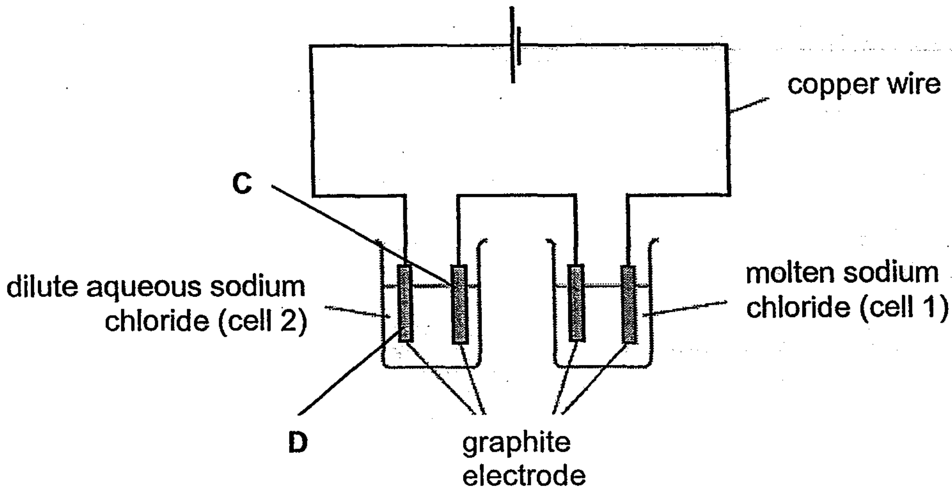
.... [1]

(ii) Both oxides formed in **(i)** dissolve in water to give acidic solutions. Construct an equation for the reaction of each oxide with water.

....

.... [2]

A8 The setup below was used to investigate the electrolysis of molten and dilute aqueous sodium chloride using graphite electrodes.



(a) Describe what you would observe at electrode **C**.

....[1]

(b) Write half-ionic equation for the reaction at electrode **C**.

....[1]

(c) Write half-ionic equation for the reaction at electrode **D**.

....[1]

(d) If 10 g of sodium was produced at cell 1, calculate the volume of gas measured at room temperature liberated at electrode **C** in cell 2.

[3]

(e) Explain why there is a decrease in size of electrode **D** if electrolysis were carried out for a long time.

....[1]

Name:______________________________( ) Class:____

Section B

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

B9 The table shows the information about the chlorides of five elements.

name	formula	melting point / °C	boiling point / °C	behaviour with water
magnesium chloride	$MgCl_2$	714	1418	dissolves without any apparent reaction
phosphorus trichloride	PCl_3	-92	76	reacts giving an acidic liquid
silicon tetrachloride	$SiCl_4$	790	1407	reacts giving an acidic liquid
strontium chloride	$SrCl_2$	875	1250	dissolves without any apparent reaction
disulfur chloride	S_2Cl_2	-80	138	reacts giving an acidic liquid

(a) Give one difference in the physical property between metallic and non-metallic chlorides.

....

....[1]

(b) Give one difference in the chemical property between metallic and non-metallic chlorides.

....

....[1]

(c) Which of the chlorides are formed by covalent bonding? Draw a 'dot and cross' diagram to illustrate the bonding. You only need to draw the valence electrons. [2]

(d) The reaction between silicon tetrachloride and water can be represented by the following equation:

$$SiCl_4(s) + 4H_2O(l) \rightarrow H_4SiO_4\ aq) + 4HCl(aq)$$

Write a balanced chemical equation for the reaction you would expect between phosphorus trichloride and water.

....[1]

(e) Phosphorus trichloride fumes at room temperature and pressure. Account for this observation.

....

....

....

....[2]

(f) When disulfur dichloride reacts with water. It gives a yellow precipitate and a solution that contains hydrochloric acid and another acid. Suggest the identity of this precipitate and a test to determine whether the other acid is sulfurous acid or sulfuric acid.

....

....

....

....[3]

B10 Esters are compounds which give fruits their flavours. They also provide the scent in flowers.

(a) The ester $CH_3(CH_2)_2CO_2CH_3$ contributes to the aroma of apples.

(i) Draw the two starting materials needed to produce this ester.

[2]

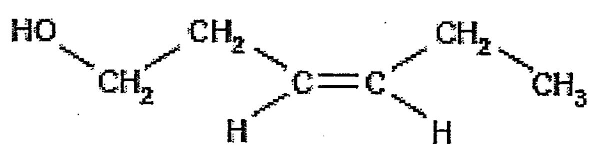
(ii) State the catalyst required for esterification to take place.

.... [1]

(iii) Apart from their uses as perfumes and food flavourings, state one major commercial use of esters.

.... [1]

(b) Leaf alcohol is formed when insects such as caterpillars eat green leaves. The structure of leaf alcohol is as follows:



(i) Leaf alcohol was reacted to form a product which increased the *Mr* value by 18 units. Suggest a structure for this product and deduce the type of reaction that took place.

structure of product:

type of reaction.. [2]

(ii) Describe a simple chemical test to distinguish between leaf alcohol and your product in **(b)(i)**.

test...

observation...

....

....[2]

(iii) Draw two repeat units of the polymer formed by addition polymerisation of leaf alcohol.

[2]

Either

B11 A metallic element, **M**, has the following properties.

- less dense than water
- soft
- melts below 100°C
- occurs naturally in its chloride , formula **M**Cl
- the oxide of **M** reacts with water to form a soluble hydroxide

(a) Suggest to which Group of the Periodic Table metal **M** belongs to.

....[1]

(b) Suggest how metal **M** can be extracted from its compounds. Explain your reasoning.

....

....[2]

(c) Outline a method to prepare crystals of **M**Cl, starting with the hydroxide, **M**OH.

....

....

....

....

....

....

.... [4]

(d) 6.72 g of **M**C*l* contains 1.42 g of chlorine.

Calculate the number of moles of chlorine ions in the sample, and hence deduce a value for the relative atomic mass of **M**.

[3]

Or

B11 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulfide, NiS.

- stage 1 – nickel(II) sulfide is heated in air to form nickel(II) oxide and sulfur dioxide.
- stage 2 – nickel(II) oxide is heated with carbon to give impure nickel.
- stage 3 – impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, $Ni(CO)_4$.
- stage 4 – nickel tetracarbonyl is decomposed to give pure nickel.

(a) Construct the balanced equation for the reaction in stage 1.

.... [1]

(b) Calculate the mass of sulfur dioxide that is formed when 182 kg of nickel(II) sulfide is heated in air.

[3]

(c) In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions. The results are shown in the table.

	aqueous zinc nitrate, $Zn(NO_3)_2$	aqueous nickel(II) nitrate, $Ni(NO_3)_2$	aqueous copper(II) nitrate, $Cu(NO_3)_2$
zinc	no reaction	green solution turn colourless and zinc coated with a silver solid	blue solution turn colourless and zinc coated with a pink solid
nickel		no reaction	
copper	no reaction	no reaction	no reaction

(i) Predict the observations when nickel is added to separate solutions of zinc nitrate and copper(II) nitrate.

Write a chemical equation for **one** of the reactions that takes place.

....

....

....

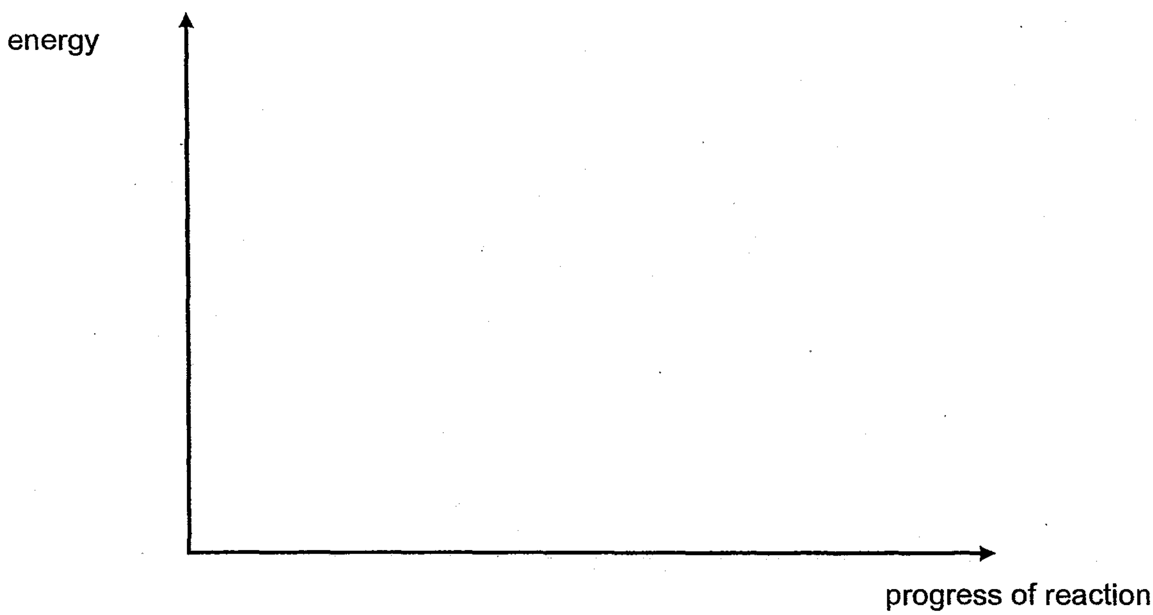
....

....[3]

(ii) 100 cm^3 of copper(II) nitrate solution is poured into a polystyrene cup. The temperature of the solution is measured. Nickel powder is gradually added to the solution with stirring until in excess. The maximum temperature of the solution is measured. The temperature increased by 5.0 $^\circ C$. The net change in heat energy, ΔH, for this experiment is 2.1 kJ.

Draw the labelled energy profile diagram for the reaction between nickel and copper(II) nitrate solution. Label **'activation energy** and **'ΔH'**.

[3]



~ End of paper ~

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** Sulphur 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 †															

*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

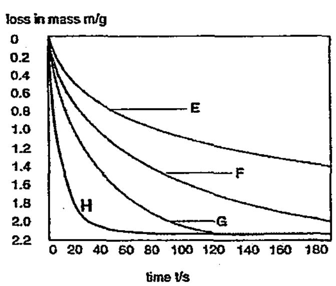
a **X** b	a = relative atomic mass X = atomic symbol b = proton (atomic) number

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

Swiss Cottage Secondary
2014 4E Preliminary Examinations
Mark Scheme

Section B				
Qn		**Mark Scheme**	**Mk**	**Markers Comments**
A 1	**ai**	A	1m [1]	
	ii	E	1m [1]	
	iii	C and E	1m for both, no marks for any incorrect answer[1]	
	iv	C	1m [1]	

	b	Gas is released into the atmosphere by incomplete combustion of **fossil fuels/hydrocarbons/carbon source** in car exhausts/engines; gas fires/boilers	1m [1]	
A 2		I; compound J; mixture K; element	1m each [3]	
A 3	a	Both diamond and graphite **have giant molecular structures.** The carbon atoms in both structures are bonded together by **strong covalent bonds. A lot of heat energy** is required to break these strong covalent bonds. Thus it has very high melting point.	1m each for key words. [3]	
	b	Diamond does not conduct electricity as it **does not have mobile electrons.** On the other hand, graphite has 1 **delocalised / mobile valence electron** per carbon atom that is not involved in bonding thus is able to act as charge carriers.	1m each for key words. [2]	

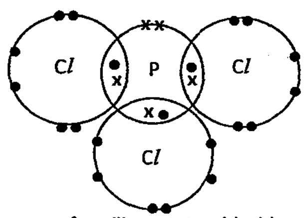
A 4	ai	During the reaction, **carbon dioxide is produced** for all three reactions and **escapes from the flask** thus all flasks and their contents lose mass.	1m for the 2 points [1]	
	ii	The rates of reaction decreases with time	1m	
	b	The reaction is fastest in flask <u>G</u>.	1m	
	ci	120s – 130 s	1m	
	cii	The reaction stopped as **calcium carbonate has been completely reacted.**	1m	
	d		1m for correct curve (ending together with G) 1m for faster initial rate. [2] [1m to be deducted for not labelling.]	

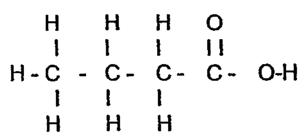
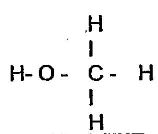
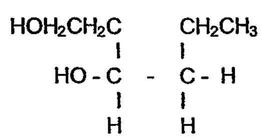
A 5	ai	Ammonia gas	1m	
	aii	NH_4^+	1m	
	aiii	Iron(II) hydroxide or $Fe(OH)_2$	1m	
	b	Barium sulfate or $BaSO_4$	1m	
	c	Salt 1: $(NH_4)_2SO_4$ Salt 2: $FeSO_4$	1m each [2]	
A 6	ai	$N_2 + 3H_2 \rightleftharpoons 2NH_3$	1m, must be reversible.	
	aii	• Pressure of 100 atms or over • Temperature of 400 - 500°C • iron catalyst	2m for 3 correct answers, 1 m for 2, 0 mark for 1. [2]	
	aiii	Commercial uses are producing **fertilizers / cleaning agents / explosives.**	1m for both any of correct answers	

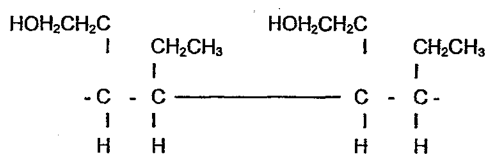
	bi	$4\ NH_3(g) + 3\ O_2(g) \longrightarrow 2\ N_2(g) + 6\ H_2O(g)$	1m for state symbols 1m for balanced equation [2]	
	bii	The oxidation state of **nitrogen** has **increased** from **-3 in ammonia to 0 in nitrogen gas.** Thus, ammonia has been oxidised. The oxidation state of **oxygen** has **decreased from 0 in oxygen to -2 in water.** Thus, oxygen has been reduced. There is **oxidation and reduction** thus the reaction is a **redox reaction.**	1 m 1 m 1m [3]	
A 7	a	2.8.5	1m	
	b	$3\ NaOH + H_3PO_4 \rightarrow Na_3PO_4 + 3\ H_2O$	1m for correct balanced eq	
	c	No of moles of phosphoric acid = (50 x 0.5) / 1000 = 0.025 mol	1 m	

		Compare mole ratio, NaOH / H_3PO_4 = 3 / 1 No of moles of sodium hydroxide = 3 x 0.025 = 0.075 mol Concentration of NaOH used = 0.075 / 0.015 = 5 moles / dm^3	1 m 1 m	
	di	$P_4S_3 + 8O_2 \rightarrow P_4O_{10} + 3SO_2$ or $P_4S_3 + 8O_2 \rightarrow 2\,P_2O_5 + 3SO_2$	1m	
	dii	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ $SO_2 + H_2O \rightarrow H_2SO_3$	1m 1m	
A 8	a	**Effervescence / bubbling** will be observed.	1 m	
	b	$2\,H^+ + 2e^- \rightarrow H_2$	1 m	
	c	$4\,OH^- \rightarrow 2\,H_2O + O_2 + 4e^-$	1 m	
	d	$Na^+ + e^- \rightarrow Na$ No of moles of Na = 10 / 23 = 0.43478 mol $2\,H^+ + 2e^- \rightarrow H_2$	1 m for correct calculation of	

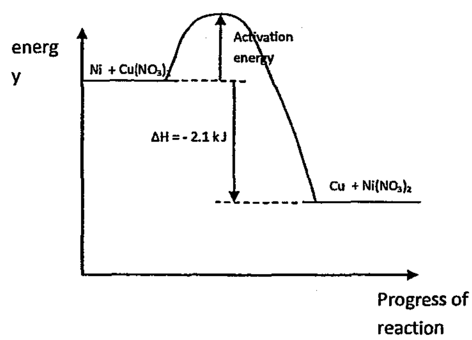
		$H^+ + e^- \rightarrow \frac{1}{2} H_2$	mole	
		Comparing mole ratio, 1 / 0.5 No of moles of H_2 = 0.43478 / 2 = 0.21739 mol	1 m	
		Volume of H_2 = 0.21739 x 24 = 5.21736 dm^3 = 5.22 dm^3 (3 s.f.)	1 m [3]	
	e	The oxygen liberated will react with the **carbon electrode to form CO_2.**	1 m	
B 9	a	Metallic chlorides have high melting and boiling points,. Non- metallic chlorides have low melting and boiling points.	1m for both correct answer.	
	b	Metallic chlorides do not react with water to form acids. Non-metallic chlorides form an acid when reacted with water.	1m for both correct answer.	

	c	 Accept diagrams for silicon tetrachloride and disulfur chloride, if students are able to draw them correctly.	1m for correct bonding 1m for all correct valence electrons [2] No deduction of marks for wrong size.	
	d	PCl_3 + 3 H_2O → H_3PO_3 + 3 HCl	1 m for correct balancing and equation	
	e	Phosphorus trichloride is a covalent compound with a **simple molecular structure**. There is weak intermolecular force of attraction / weak van der Waals force of attraction between molecules. Thus **little heat energy** is required to overcome these weak forces of attraction.	2 m for 3 key points 1m for 2 key points 0m for 1 or 0 key points.	
	f	The yellow precipitate is sulfur. Add aqueous $Ba(NO_3)_2$ with HNO_3. If **white precipitate is observed, then acid is H_2SO_4.** If precipitate is not observed, it is H_2SO_3.	1 m 1m for identification of H_2SO_4 1m for identification of	

			H_2SO_3 [3]	
B 1 0	ai	Reagent 1:  Reagent 2 	1m for each correct answer [2]	
	aii	The catalyst is <u>concentrated sulfuric acid</u>.	1m	
	aiii	**Solvents in perfumes.**	1m	
	bi	 Reaction : addition reaction / hydration	1m	

			1m [2]	
	bii	Test: Addition of bromine solution / aqueous bromine Observation: The <u>reddish brown bromine solution</u> will <u>decolourise</u> with leaf alcohol while the product in **b(i)** will <u>remain reddish brown</u>.	1 m 1m [2]	
	biii		1m for each correct repeat unit [2]	
Either				
B 1 1	**a**	Metal M belongs to Group I.	1m	
	b	Metal M can be extracted by <u>electrolysis of its molten compound</u> due the **high reactivity of metal M.**	1m 1m	

	c	Titration method is to be used. Fill up a burette with solution of hydrochloric acid. Pipette 25.0 cm^3 of MOH into a 250 cm^3 conical flask. Add one or two drops of a suitable indicator. Titrate the solutions till **end-point**. Record the volume of HCl required for complete neutralisation. Repeat the titration without the indicator. Heat the solution until it is saturated. Allowed the saturated solution to cool for crystallisation to take place. Filter the crystals and dry between few sheets of filter paper.	1 m, for both suitable indicator, end-point. 1m 1m 1m [4]	
	d	No of moles of Cl = 1.42 / 35.5 = 0.04 mol Mass of M in MCl = 6.72 – 1.42 = 5.3 g Ar of M = 5.3 / 0.04 = 132.5	1m 1m 1m [3]	
Or				
B 1 1	a	Stage 1: $2\ NiS + 3\ O_2 \rightarrow 2\ NiO + 2\ SO_2$	1m	
	b	No of moles of NiS = 182 000 / 91 = 2 000 mol Comparing mole ratio, SO_2 / NiS , 2 / 2 Mass of SO_2 = 2 000 x 64 = 128 000 g	1m 1m 1m answer in g or kg is accepted.	

		= 128 kg	[3]	
	c	When nickel is added to copper(II) nitrate solution, the **blue solution turn colourless with reddish brown copper** coated on the nickel metal. $Ni + Cu(NO_3)_2 \rightarrow Ni(NO_3)_2 + Cu$ When nickel is added to zinc(II) nitrate solution, the **colourless solution remain colourless / no visible change.**	1m 1m 1m [3]	
	d		1m correct exothermic diagram 1m correct drawing of E_a and ΔH 1m labeling of reactants and products [3]	