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.

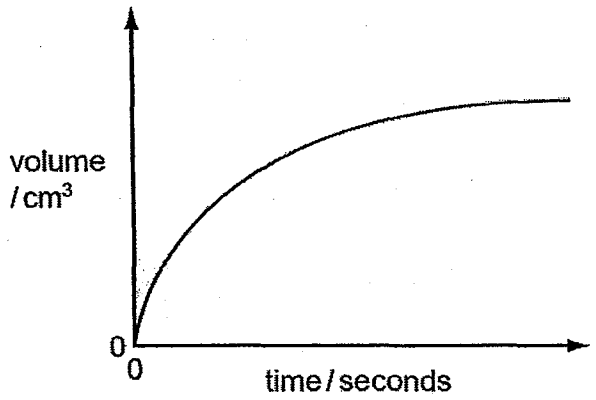
Setter: Mr Goh Weibin
Vetters: Mr Hoon Yengwei

[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

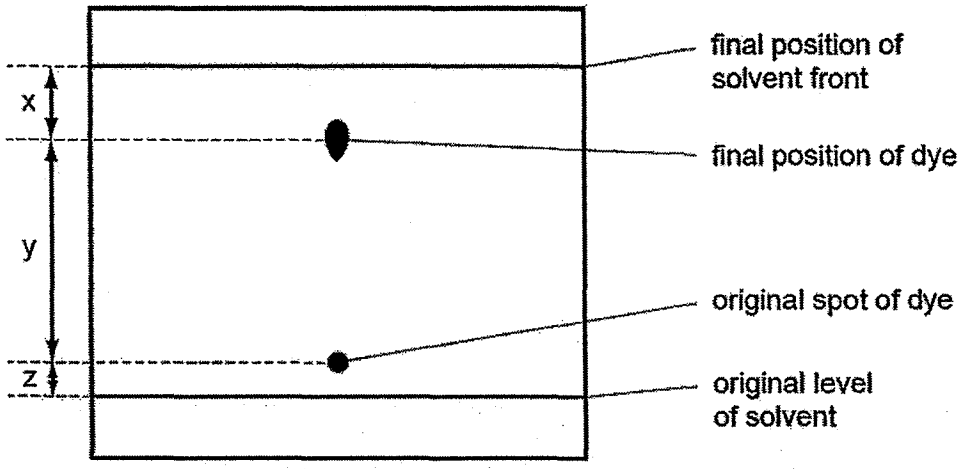
B burette and pipette

C gas syringe and stop watch

D pipette and stop watch

3 The diagram shows the chromatogram obtained by analysis of a single dye.

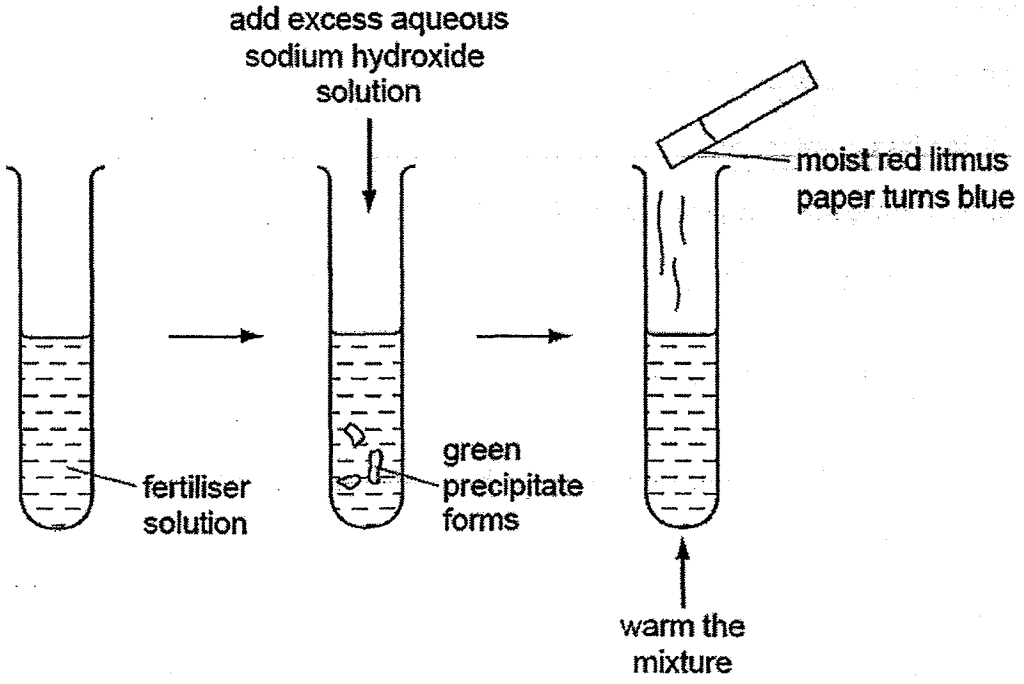
Three measurements are shown.



How is the R_f value of the dye obtained?

A $\frac{x}{x+y}$ **B** $\frac{y}{x+y}$ **C** $\frac{y}{x+y+z}$ **D** $\frac{y+z}{x+y+z}$

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.

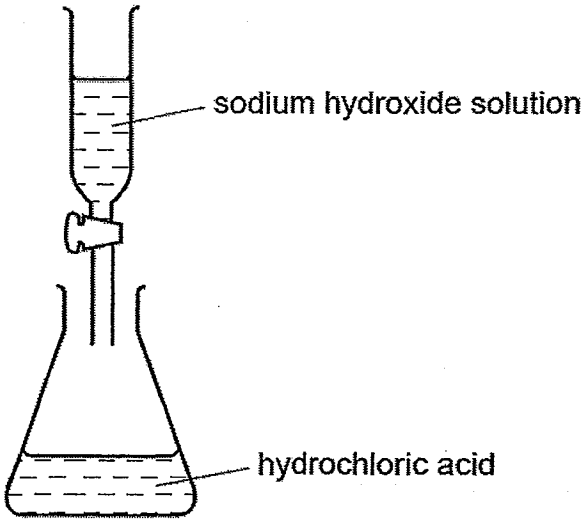
11 The relative molecular mass, Mr, of copper(II) sulfate, $CuSO_4$, is 160.

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 $\frac{18 \times 100}{160}$ **B** $\frac{5 \times 18 \times 100}{160 + 18}$ **C** $\frac{18 \times 100}{160 + 18}$ **D** $\frac{5 \times 18 \times 100}{160 + (5 \times 18)}$

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

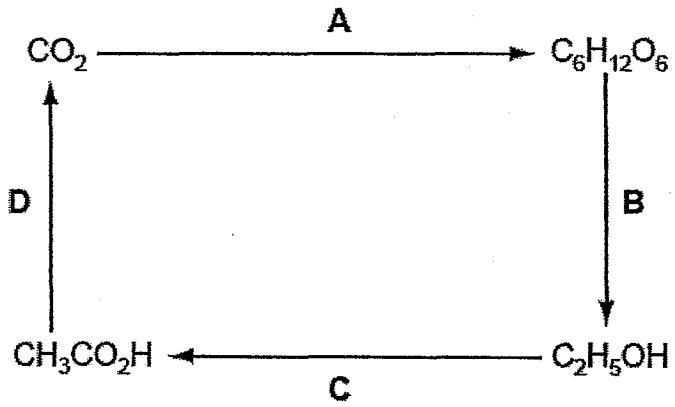
4 sulfur dioxide

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?

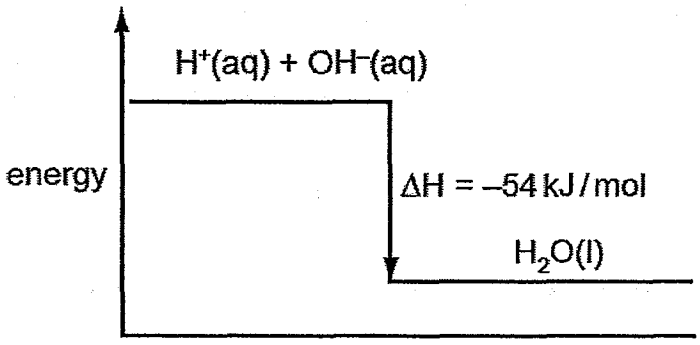
A As an oxidising agent only

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?

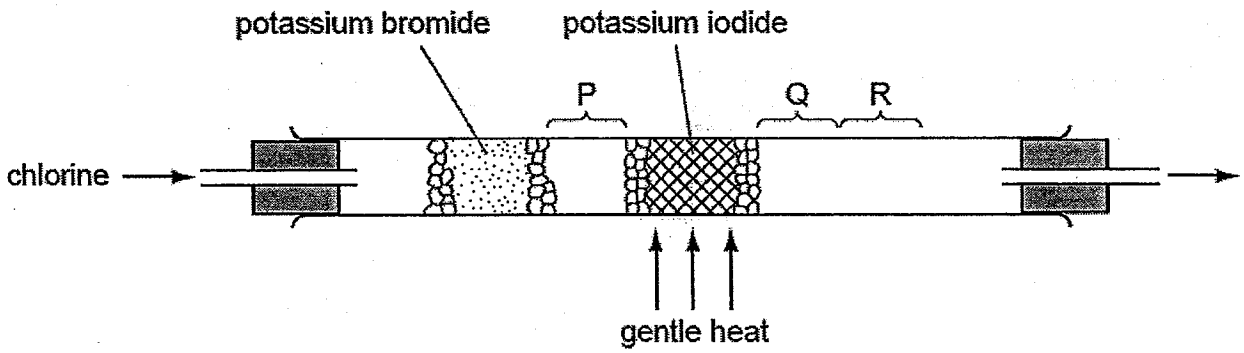
A lead and dilute sulfuric acid

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?

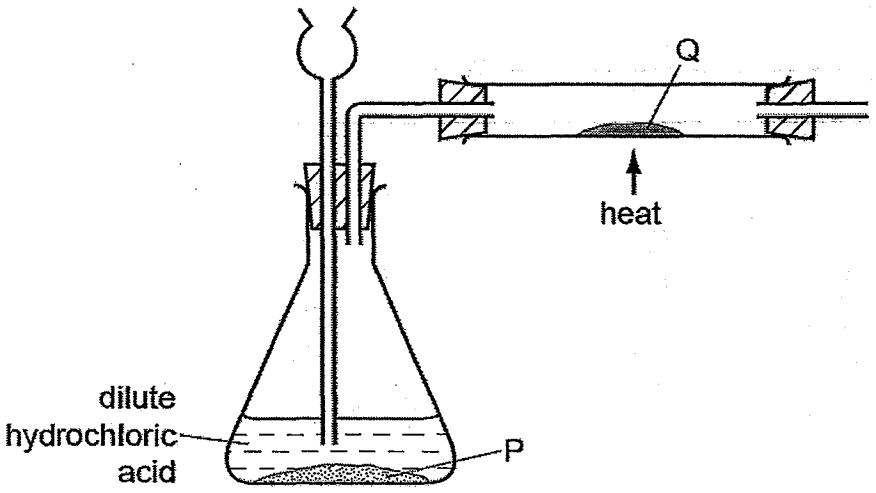
	at P	at Q	at R
A	green gas	red brown vapour	violet vapour
B	green gas	violet vapour	black solid
C	red brown vapour	violet vapour	black solid
D	violet vapour	red brown vapour	red brown vapour

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?

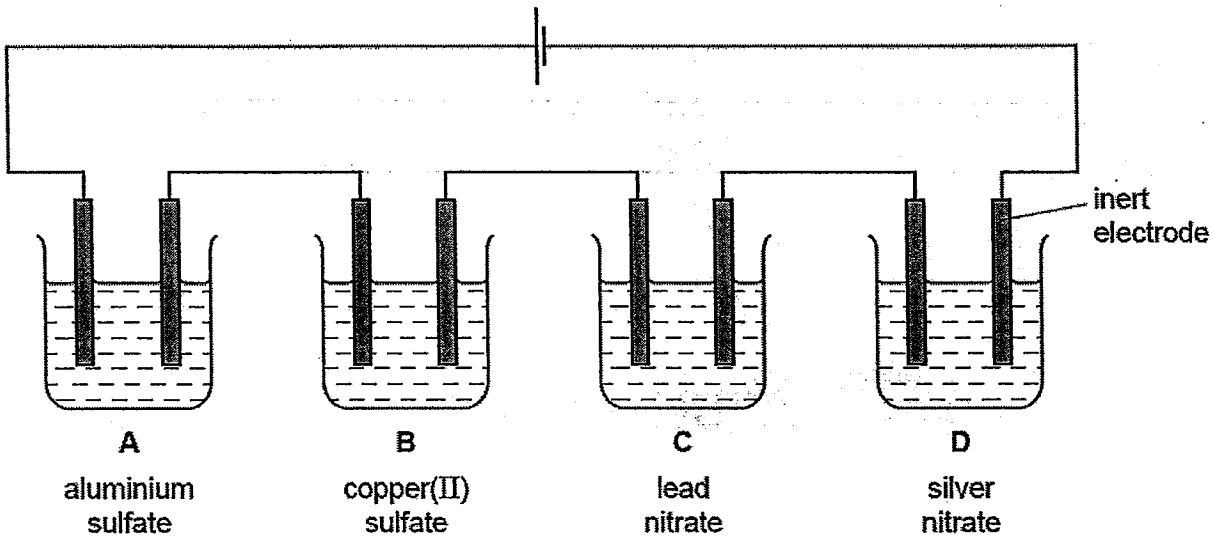
A copper and magnesium carbonate

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?

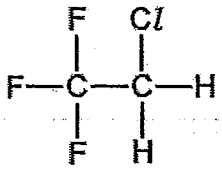
A 1

B 2

C 3

D 4

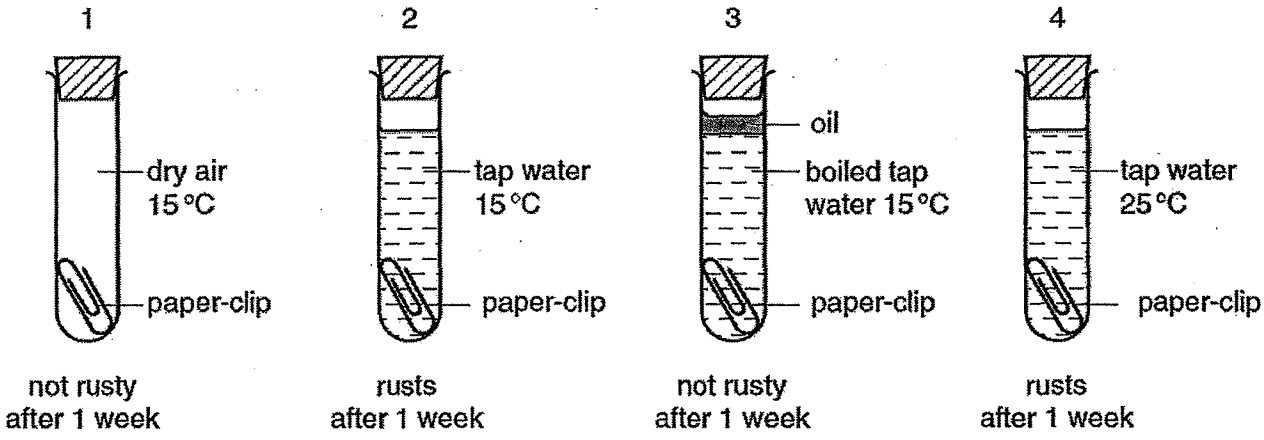
29 CFC compounds were commonly used as aerosol propellants. The structure of one CFC compound is shown.



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

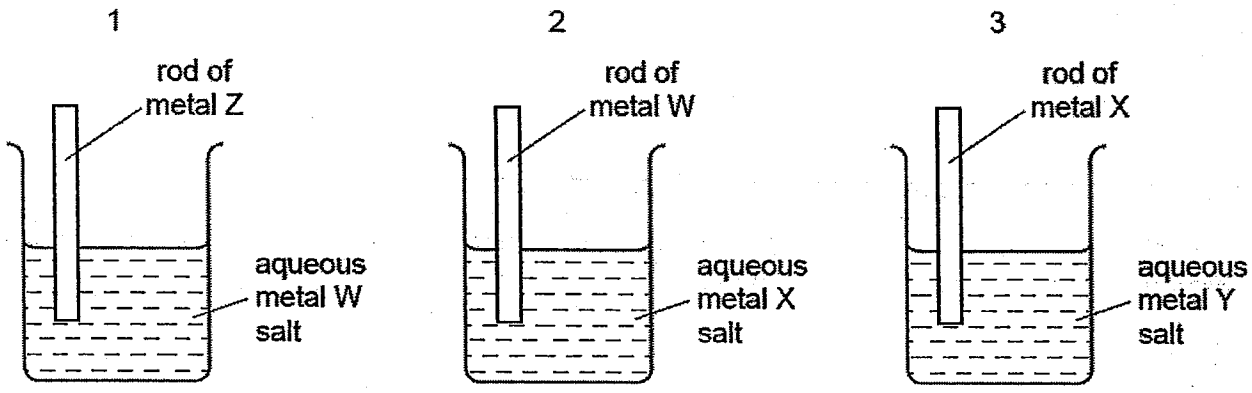
C 2 and 3

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?

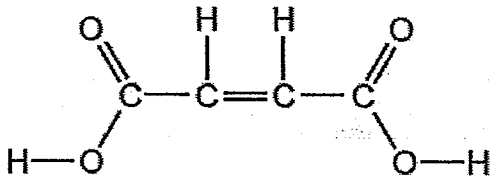
A HCO_2CH_3 and CH_3CO_2H

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

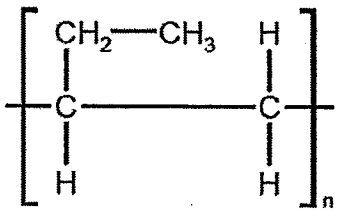
B ethanol

C iodine

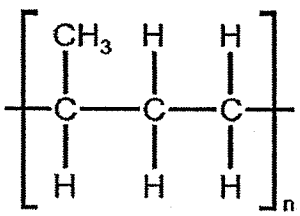
D zinc

40 Which partial structure is correct for the product of polymerisation of butene, $CH_2CHCH_2CH_3$?

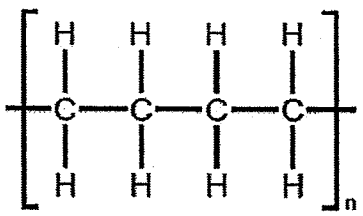
A



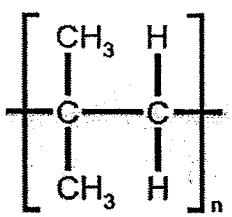
B



C



D



DATA SHEET
The Periodic Table of the Elements

Group I	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 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 †															

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.).

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.

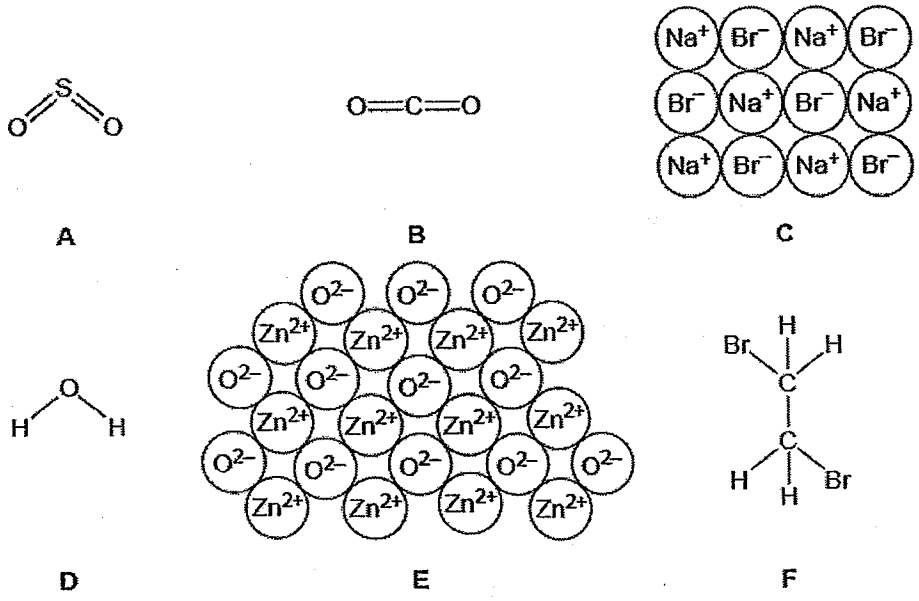
Setter: Mr Hoon Yeng Wei
Vetter: Mdm Tan Pui San

[Turn over

Section A (50 Marks)

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

A1 The diagram shows the structures of various compounds.



(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.

.....

.....

.....

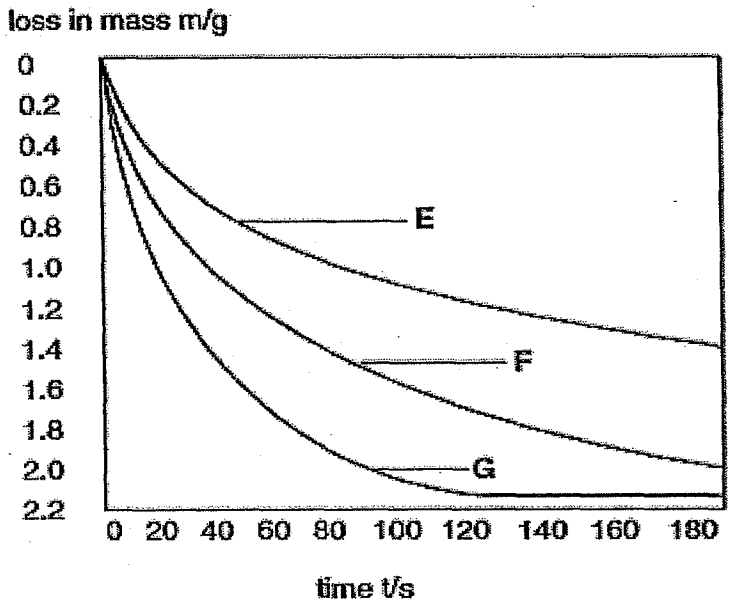
.....[2]

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.

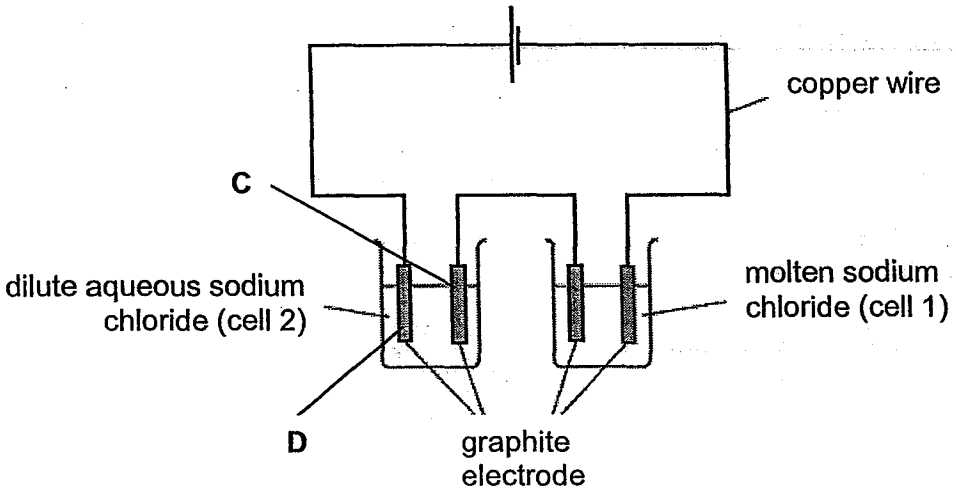
..... [1]

(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]

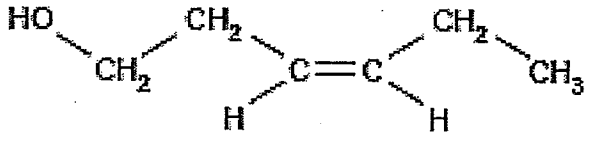
(ii) State the catalyst required for esterification to take place.

..... [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.

.....

.....

.....

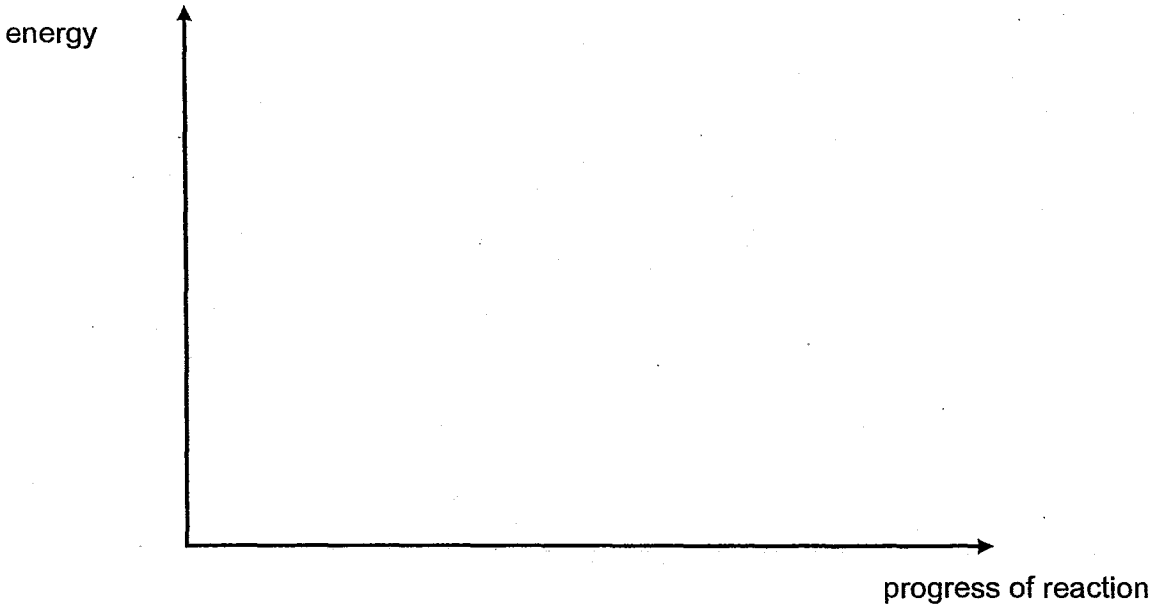
.....

.....[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 °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	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 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 †															

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

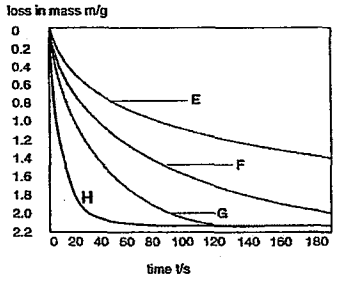
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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 <u>incomplete combustion</u> 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]	

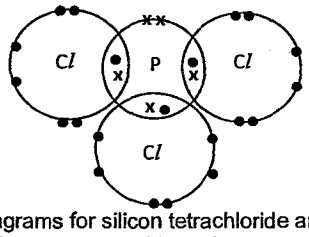
A 4	ai	During the reaction, **carbon dioxide is produced** for all three reactions and **escapes from the flask** thus all flasks and their contents lose mass.	1m for the 2 points [1]	
	ii	The rates of reaction decreases with time	1m	
	b	The reaction is fastest in flask G.	1m	
	ci	120s – 130 s	1m	
	cii	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.]	

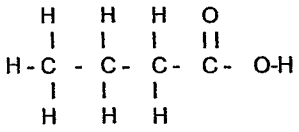
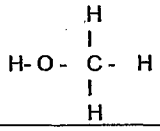
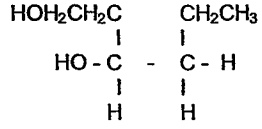
A 5	**ai**	Ammonia gas	1m	
	aii	NH_4^+	1m	
	aiii	Iron(II) hydroxide or $Fe(OH)_2$	1m	
	b	Barium sulfate or $BaSO_4$	1m	
	c	Salt 1: $(NH_4)_2SO_4$ Salt 2: $FeSO_4$	1m each [2]	
A 6	**ai**	$N_2 + 3H_2 \rightleftharpoons 2NH_3$	1m, must be reversible.	
	aii	• Pressure of 100 atms or over • Temperature of 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	

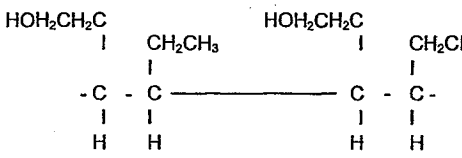
	bi	$4\ NH_3(g) + 3\ O_2(g) \longrightarrow 2\ N_2(g) + 6\ H_2O(g)$	1m for state symbols 1m for balanced equation [2]	
	bii	The oxidation state of **nitrogen** has **increased** from **-3 in ammonia to 0 in nitrogen gas.** Thus, ammonia has been oxidised. The oxidation state of **oxygen** has **decreased 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 $P_4S_3 + 8O_2 \rightarrow 2P_2O_5 + 3SO_2$	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	$2H^+ + 2e^- \rightarrow H_2$	1 m	
	c	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	1 m	
	d	$Na^+ + e^- \rightarrow Na$ No of moles of Na = 10 / 23 = 0.43478 mol $2H^+ + 2e^- \rightarrow H_2$	1 m for correct calculation of	

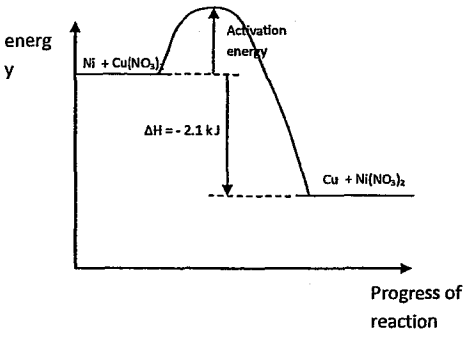
		$H^+ + e^- \rightarrow \frac{1}{2} H_2$ Comparing mole ratio, 1 / 0.5 No of moles of H_2 = 0.43478 / 2 = 0.21739 mol Volume of H_2 = 0.21739 x 24 = 5.21736 dm^3 = 5.22 dm^3 (3 s.f.)	mole 1 m 1 m [3]	
	e	The oxygen liberated will react with the **carbon electrode to form CO_2.**	1 m	
B 9	a	Metallic chlorides have <u>high melting and boiling points,</u>. Non- metallic chlorides have <u>low melting and boiling points</u>.	1m for both correct answer.	
	b	Metallic chlorides <u>do not react with water to form acids.</u> Non-metallic chlorides <u>form an acid</u> 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	$PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$	1 m for correct balancing and equation	
	e	Phosphorus trichloride is a covalent compound with a **simple molecular structure.** There is <u>weak intermolecular force of attraction / weak van der Waals force of attraction</u> 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 <u>sulfur</u>. Add aqueous <u>$Ba(NO_3)_2$ with HNO_3</u>. If **white precipitate is observed, then acid is H_2SO_4.** If <u>precipitate is not observed, it is H_2SO_3</u>.	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 concentrated sulfuric acid.	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 HC*l* 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 C*l* = 1.42 / 35.5 = 0.04 mol Mass of M in MC*l* = 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 → 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]	