Register No.	Class

Name _____

BENDEMEER SECONDARY SCHOOL
2016 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 1
5073/01

DATE : **25 Aug 2016**
DURATION : **1 hour**

READ THESE INSTRUCTIONS FIRST

Write in 2B pencil.
Do not use paper clips, glue or correction fluid.
Write your name, class and register number on the question paper and OTAS 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 **2B pencil** on the OTAS sheet.

Read the instructions on the OTAS 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.
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is provided on page **15**.

40

This document consists of **15** printed pages.

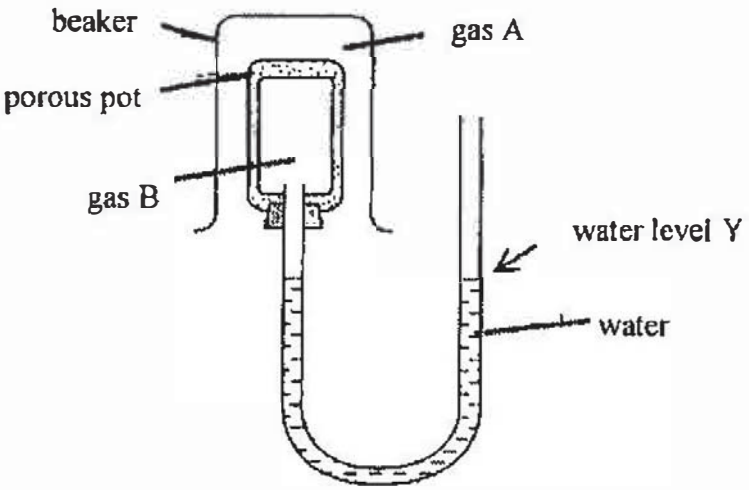
1 Study the following statements in a student's notebook.

I In a solid, the particles are stationary and held in fixed positions due to strong forces of attraction.
II When a solid is heated, the particles expand and become larger.
III At the melting point, the particles are able to slide and roll over one another.
IV When the boiling point is reached, evaporation and boiling start to take place and the gas is formed.

Which statement(s) is/are true?

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

2 A student uses the following apparatus to carry out a series of experiments to compare the rate of diffusion between different gases K, L, M and N.



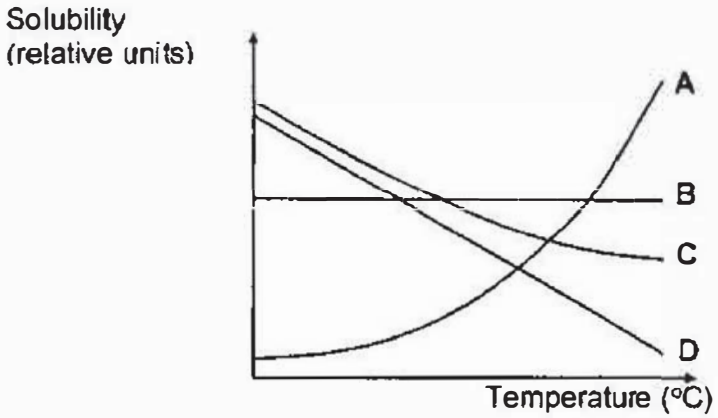
The table below summarises the observations made.

experiment	gas A	gas B	observation after 5 mins
1	K	L	water level Y rises
2	M	N	water level Y falls
3	L	N	water level Y rises

What is the correct order of gas in increasing relative molecular mass?

A K, L, M, N
B K, L, N, M
C M, L, N, K
D M, N, L, K

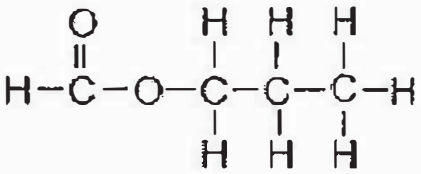
3 The solubility curves for four solids, **A**, **B**, **C** and **D**, in water are shown below.
Which solid is most suitable to be collected by crystallisation from its aqueous salt?



4 An ion X^{2-} has p nucleons and q electrons.
What does the nucleus of an atom X contain?

	number of protons	number of neutrons
A	q – 2	p – q
B	q – 2	p – (q – 2)
C	q + 2	p – (q – 2)
D	q + 2	q – (p + 2)

5 The diagram shows the molecule propyl methanoate.



What is the total number of electrons that are not involved in chemical bonding in the molecule?

A 8 **B** 12 **C** 20 **D** 28

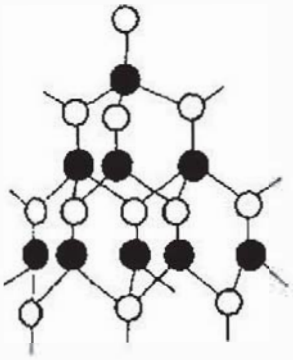
6 Two statements about chlorine are made below.

Statement 1: Chlorine has weak covalent bonds in its simple molecular structure.
Statement 2: Chlorine is soluble in water.

What statement(s) is/are correct?

A Both statements are correct and statement 1 explains statement 2.
B Both statements are correct but statement 1 does not explain statement 2.
C Both statements are incorrect.
D Statement 2 is correct but statement 1 is incorrect.

7 The diagram shows part of the structure of the compound silicon carbide.



key

○ = a carbon atom

● = a silicon atom

Which set of information about silicon carbide is correct?

	empirical formula	when strongly heated in oxygen
A	SiC	burns, giving a solid residue only
B	SiC	burns, giving a solid residue and a colourless gas
C	Si_2C	burns, giving a solid residue only
D	SiC_2	burns, giving a solid residue and a colourless gas

8 All of the following substances can conduct electricity in the solid state except

A aluminium.
B graphite.
C mercury.
D sodium chloride.

9 4 g of hydrogen is mixed with 16 g of oxygen and the mixture is ignited. What is the mass of reactants left and product formed at the end of the reaction?

	mass of hydrogen / g	mass of oxygen / g	mass of water / g
A	0	0	20
B	0	8	12
C	2	0	18
D	2	8	20

10 Which of the following has the same number of atoms as 6 dm^3 of fluorine gas at r.t.p?

A 0.5 g of hydrogen gas
B 8.5 g of ammonia
C 10 g of argon
D 23 g of sodium

11 When 200 g of compound X containing carbon, hydrogen, aluminium and oxygen is heated in excess oxygen, 42.2 g of aluminium oxide is obtained as residue.
What is the percentage by mass of aluminium in the sample?

A 11.2% **B** 13.5% **C** 21.1% **D** 27.0%

12 The percentage composition by mass of a compound containing carbon, fluorine and chlorine is as follows:

Carbon : 18.05% Fluorine : 28.50% Chlorine : 53.45%

Which of the following could be the molecular formula of this compound?

A CF_3Cl **B** CF_2Cl_2 **C** $C_2F_2Cl_2$ **D** C_2F_2Cl

13 Both hydrochloric acid and ethanoic acid have the same concentration of 1.00 mol/dm^3. Which method(s) is/are suitable to test for their strengths?

I using a pH meter
II measuring their electrical conductivity
III titration using sodium hydroxide solution

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

14 In a titration experiment, five students each added hydrochloric acid from a burette to 25.0 cm^3 of aqueous sodium hydroxide in a conical flask.

The volume of hydrochloric acid used by each student is shown in the table below.

student	1	2	3	4	5
volume / cm^3	25.2	25.3	25.3	26.1	25.2

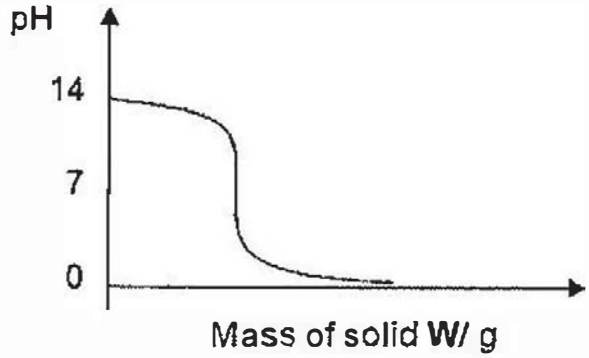
What could be a reason for the result obtained by student 4?

A The burette had been washed with hydrochloric acid.
B The flask had been washed with aqueous sodium hydroxide.
C The student had used too much indicator.
D The pipette had been washed with aqueous sodium hydroxide.

15 Which two processes are involved in the preparation of zinc sulfate crystals from dilute sulfuric acid and zinc oxide?

A neutralisation and filtration
B neutralisation and oxidation
C precipitation and filtration
D precipitation and oxidation

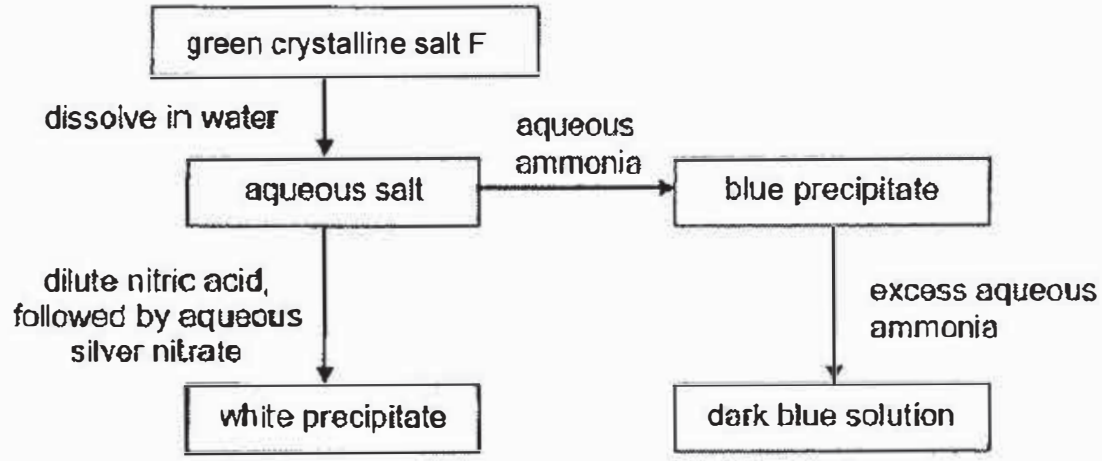
16 Solid **W** is gradually added to solution **X**. The changes in pH are shown on the graph.



What are **W** and **X**?

	solid **W**	solution **X**
A	insoluble metal oxide	nitric acid
B	soluble metal oxide	hydrochloric acid
C	soluble non-metal oxide	aqueous ammonia
D	soluble non-metal oxide	sodium hydroxide

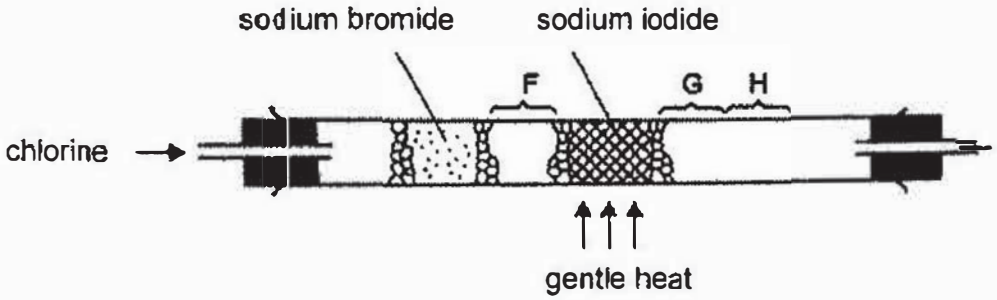
17 The scheme shows some reactions of salt F.



What is the identity of **F**?

A copper(II) chloride
B copper(II) iodide
C iron(II) chloride
D iron(II) iodide

18 Using the apparatus shown, chlorine is passed through the tube. After some time, coloured substances are seen at **F**, **G** and **H**.



What are these coloured substances?

	F	G	H
A	green gas	violet vapour	black solid
B	green gas	red brown vapour	violet vapour
C	red brown vapour	violet vapour	black solid
D	violet vapour	red brown vapour	red brown vapour

19 The element, selenium (Se), is found in the same group of the Periodic Table as sulfur.
What is the chemical formula of lithium selenide?

A LiSe B Li_2Se C $LiSeO_4$ D $Li(SeO_4)_2$

20 The tablebelow shows four metals and some of their reactions.

metal	action of heat on carbonate	effect of hydrogen on heated oxide	action of dilute sulfuric acid on metal
G	decompose	reduced	no reaction
H	no reaction	no reaction	hydrogen evolved
I	decompose	no reaction	hydrogen evolved
J	decompose	reduced	hydrogen evolved

What is the correct order of reactivity for these four metals?

	most reactive → least reactive			
A	H	J	I	G
B	H	I	J	G
C	I	J	G	H
D	I	H	G	J

21 Different types of steel differ in how much carbon they contain.
Which are the properties of a high carbon steel?

A soft and brittle
B soft and easily shaped
C strong and brittle
D strong and easily shaped

22 Ethanol reacts with acidified potassium manganate(VII) to form ethanoic acid. The half-equation for manganate can be written as:

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

Which line of information can be deduced?

	reducing agent	change in oxidation state of Mn	colour change
A	ethanol	+7 to +2	purple to colourless
B	ethanol	+8 to +2	no change
C	hydrogen ions	+7 to +2	purple to colourless
D	hydrogen ions	-1 to +2	no change

23 When a mineral is heated strongly to constant mass, a colourless gas is evolved and forms a white precipitate with limewater. The remaining solid is cooled and added to hydrochloric acid. Vigorous effervescence is observed.

What is the mineral?

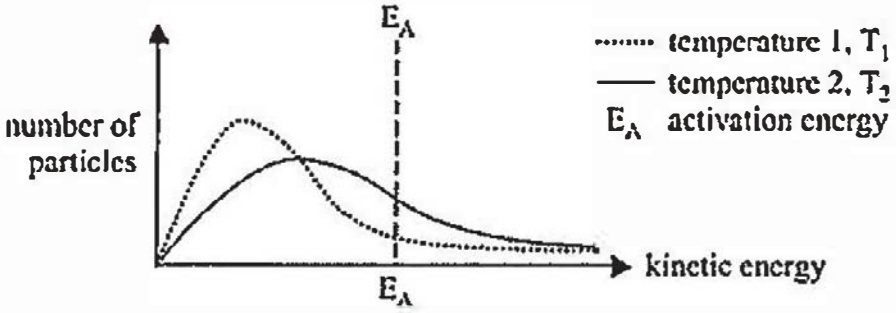
A $CaCO_3$
B $MgCO_3.CaCO_3$
C $Mg(OH)_2.3H_2O$
D $Na_2CO_3.CaCO_3.5H_2O$

24 Which processes are endothermic?

1 $Br_2 \rightarrow 2Br$
2 burning fossil fuel
3 obtaining lime from limestone
4 reacting hydrogen with oxygen

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

25 The diagram represents the distribution of kinetic energy of reactant particles at two different temperatures. Assuming that the areas under the two curves are equal, which statement is correct?

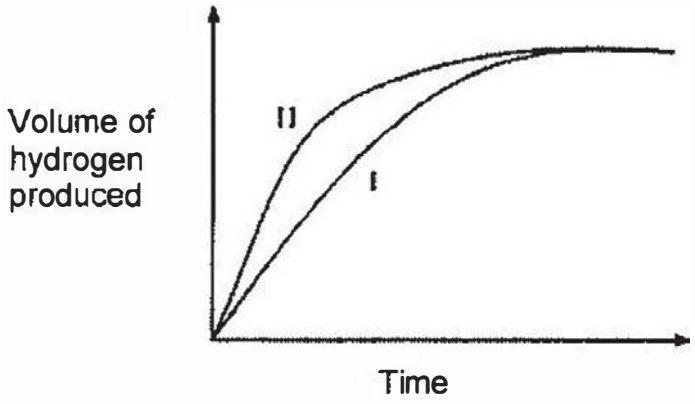


A At T_1, the activation energy is lower than at T_2.
B At T_1, the enthalpy change of the reaction is higher than at T_2.
C At T_2, a greater number of particles have sufficient energy to react.
D At T_2, the reaction takes a longer time to complete.

26 Which quantities of the acid will produce the fastest initial rate of reaction when 4.00 g of magnesium ribbon is added to it at r.t.p.?

A 15.0 cm^3 of 2.00 mol/dm^3 nitric acid
B 20.0 cm^3 of 1.00 mol/dm^3 hydrochloric acid
C 20.0 cm^3 of 1.00 mol/dm^3 sulfuric acid
D 30.0 cm^3 of 2.00 mol/dm^3 ethanoic acid

27 Excess zinc was added to 100 cm^3 of hydrochloric acid, concentration 1 mol/dm^3. Graph I shows the results obtained from this reaction.



Graph II could be obtained by adding excess

A magnesium reacting with 100 cm^3 of 1 mol/dm^3 hydrochloric acid.
B zinc reacting with 100 cm^3 of 1 mol/dm^3 sulfuric acid.
C zinc reacting with 100 cm^3 of 2 mol/dm^3 ethanoic acid.
D zinc reacting with 100 cm^3 of 2 mol/dm^3 hydrochloric acid.

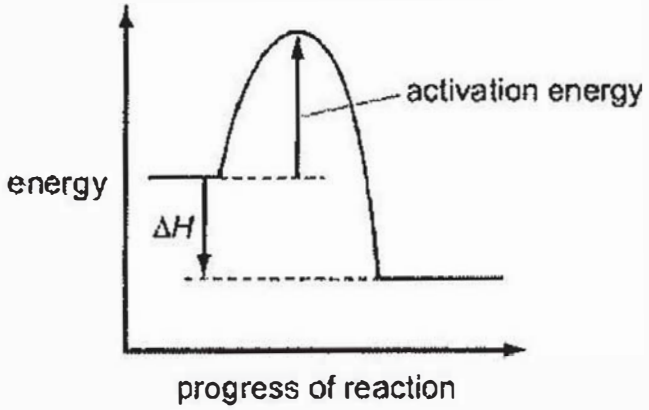
28 In the Haber process, a high yield of ammonia is favoured by conditions of high pressure and low temperature. However, in practice a high temperature is employed because at low temperature,

A ammonia decomposes back to its original reactant.
B the activation energy is too low.
C the catalyst is inactive.
D the reaction is too slow.

29 Which pollutant gas is produced by the decomposition of vegetation?

A CH_4 B CO C NO D SO_2

30 The energy profile for the forward direction of a reversible reaction is shown.



What is the sign of activation energy and the type of enthalpy change for the reverse reaction?

	sign of activation energy	enthalpy change
A	negative	endothermic
B	negative	exothermic
C	positive	endothermic
D	positive	exothermic

31 Which reaction does not involve either oxidation or reduction?

A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
B $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$
C $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$
D $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

32 Dilute sulfuric acid is electrolysed using graphite electrodes.
Which statement is not true?

A Hydrogen ions gain electrons and are reduced.
B The concentration of the acid increases.
C The ratio of mass of hydrogen to oxygen gas produced is 1:8.
D The same products are obtained when concentrated aqueous hydrochloric acid is electrolysed.

33 Which of the following gas(es) can be removed by a catalytic converter?

I carbon monoxide
II sulfur dioxide
III nitrogen dioxide

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

34 In an electrolysis experiment, the same amount of charge deposited 32 g of copper and 13 g of chromium.

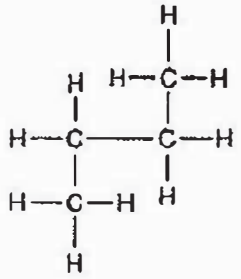
What was the charge on the chromium ion?

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

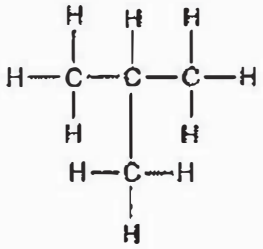
35 Which statement about fractional distillation of petroleum is correct?

A At each level in the fractionating column, only one compound is collected.
B The higher up the fractionating column, the greater the temperature.
C The molecules collected at the bottom of the fractionating column are the most flammable.
D The molecules reaching the top of the fractionating column have the smallest relative molecular mass.

36 Four hydrocarbons structures are shown.



1



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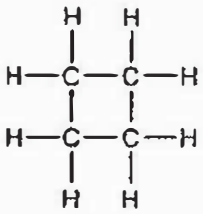

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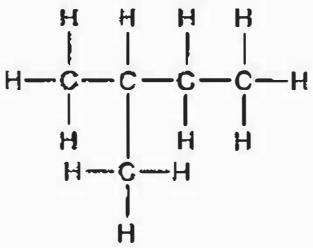


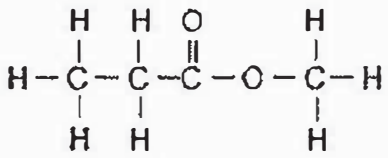
4

Which hydrocarbons are isomers of each other?

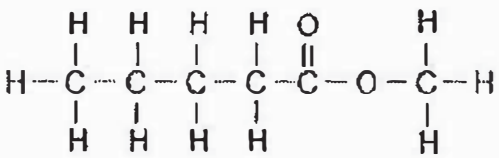
A 1 and 2
B 3 and 4
C 1, 2 and 3
D 1, 2 and 4

37 An ester was produced by the condensation reaction of methanol and butanoic acid. Which structure represents the ester compound?

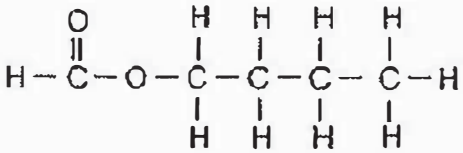
A



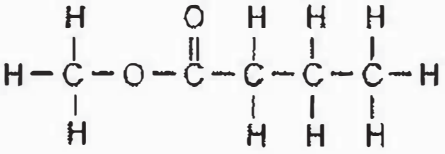
B



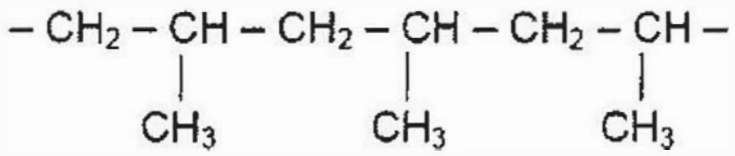
C



D



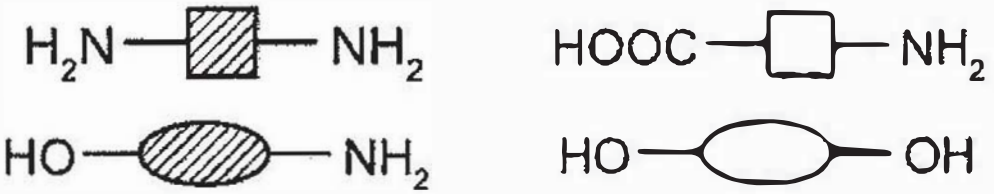
38 A polymer has the following structure:



What is the monomer?

A butene **B** butane **C** ethene **D** propene

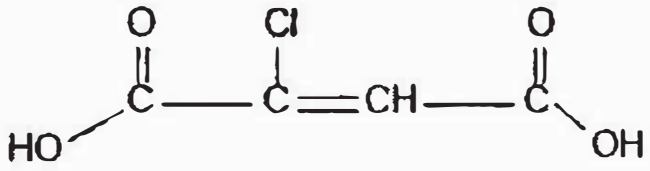
39 The diagrams show four monomers.



How many of these monomers could react with the molecule below to form a polymer?

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

40 The diagram below shows the structural formula of chloromaleic acid.



Which statement is true about chloromaleic acid?

A It can undergo a substitution reaction with halogens.
B It decolourises bromine solution in the absence of sunlight.
C It will react with magnesium to produce a gas that relights a glowing splint.
D It will turn litmus paper blue.

Register No.	Class

Name _____

BENDEMEER SECONDARY SCHOOL
2016 PRELIMINARY EXAMINATION 2
SECONDARY 4 EXPRESS
CHEMISTRY PAPER 2
5073/02

DATE : **23 Aug 2016**
DURATION : **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on the work you hand in.
Write in dark blue or black pen.
You may use a 2B pencil for any diagrams or graphs.
Do not use paper clips, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** three questions in the spaces provided. The last question is in the form of either/or and only one of the alternatives should be attempted.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.

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 to found on page **19**.

80

This document consists of **19** printed pages.

[Turn over

Section A

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

A1 For each of the following statements, select an element from Period 2 of the Periodic Table that best fits the description given.

(a) Its only oxidation state is 0.

..... [1]

(b) It is the strongest oxidising agent.

..... [1]

(c) It forms a pollutant during lightning activity.

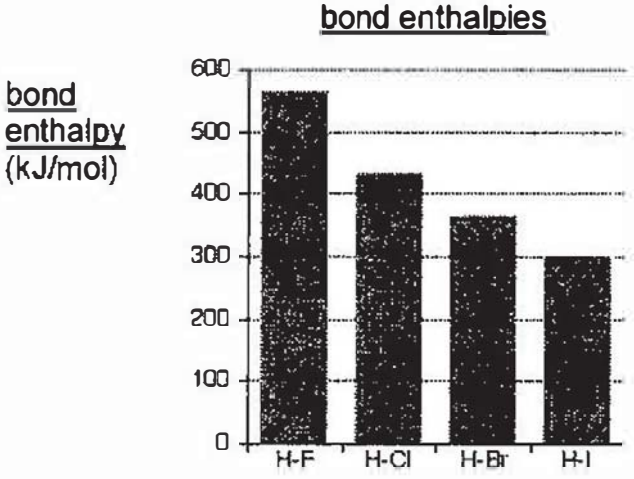
..... [1]

(d) It forms a compound used to reduce iron(III) oxide in haematite.

..... [1]

[Total: 4 marks]

A2 The bond enthalpy is the energy required to break or form a chemical bond. The bond enthalpy of some hydrogen halides are shown in the chart below.



(a) Describe the trend shown by the chart.

..... [1]

(b) **(i)** Which hydrogen halide will form the strongest acid?

..... [1]

(ii) Explain your answer to (b)(i).

.....

..... [2]

(c) (i) Hydrogen bromide can be produced by reacting hydrogen gas and bromine gas according to the following reaction:

$$H_2(g) + Br_2(g) \rightarrow 2HBr(g)$$

Some data on bond energies are shown in the table below.

bond	H-H	H-Br	Br-Br
bond energy (kJ/mol)	432	363	193

Calculate the enthalpy change of this reaction.

[1]

(ii) State whether the reaction is exothermic or endothermic, and explain your choice using ideas about bond breaking and bond forming.

.....

.....

.....

..... [2]

(iii) Draw an energy profile diagram for the production of hydrogen bromide. Your diagram should include the ethalpy change and activation energy of the energy of the reaction.

[2]
[Total: 9 marks]

A3 A student performed three experiments using three metals, iron, manganese and chromium. In the first experiment, he added the metals separately into dilute sulfuric acid. In the second experiment, he heated the metals in air. In the last experiment, he put strips of the metals in metal salt solutions.

Table 3.1 shows the results of the first two experiments.

Table 3.1

metal	reaction with sulfuric acid	reaction with air
iron	metal dissolves slowly with effervescence, a pale green solution is formed	burns in air to form dark brown iron(III) oxide
manganese	metal dissolves quickly with effervescence, a pale pink solution, manganese(II) sulfate, is formed	burns in air with an intense white light forming a red solid, manganese(II,III) oxide, Mn_3O_4
chromium	metal dissolves readily with effervescence, a violet solution, chromium(III) sulfate, is formed	burns in air to form green chromium(III) oxide, Cr_2O_3

(a) From the information above, state two properties of iron, manganese and chromium to show that they are transition metals.

.....

..... [2]

(b) Fig. 3.1 shows strips of manganese and chromium in iron(II) sulfate and manganese(II) sulfate solutions.

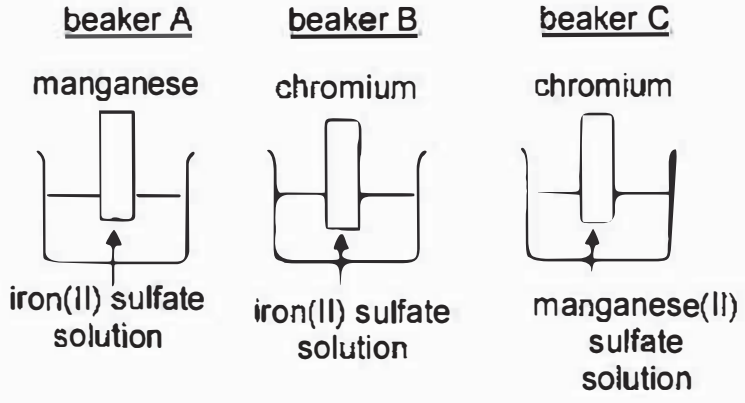


Fig 3.1

State the observations you would expect in Table 3.2.

Table 3.2

beaker A	beaker B	beaker C

[3]

(c) Chromium ore is processed and purified into chromium(III) oxide. This is reacted very exothermically with aluminium to form chromium metal.

$$Cr_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Cr(s)$$

Chromium metal is used to electroplate other metals like steel because of its anti–corrosion properties.

(i) Explain, in terms of oxidation states, why the extraction of chromium from chromium oxide is a redox reaction.

.....

.....

..... [2]

(ii) Explain why using chromium to electroplate steel is more effective than tin-plating?

.....

.....

..... [2]

[Total: 9 marks]

A4 People with kidney problems are advised against eating caramnola fruit, commonly known as starfruit, as it contains a significant amount of oxalic acid.
The concentration of oxalic acid is generally between 0.500 mol/dm^3 to 1.00 mol/dm^3.
The acid concentration in starfruit can be determined by performing an acid-base titration with sodium hydroxide solution.
(Assume that oxalic acid found in starfruit is dibasic and can be represented by H_2A.)

(a) A student suggested that 25.0 cm^3 of the oxalic acid from starfruit should be pipetted into a conical flask and titrated against 0.100 mol/dm^3 of sodium hydroxide solution.

(i) Based on the information provided, calculate the maximum volume of sodium hydroxide solution required for complete neutralisation of the oxalic acid.

[2]

(ii) Suggest why the student's procedure may not be appropriate using common laboratory apparatus.

..... [1]

(b) Oxalic acid contains 26.7% carbon and 2.20% hydrogen by mass. The rest is oxygen.

(i) Determine the empirical formula of oxalic acid.

[2]

(ii) The relative molecular mass of oxalic acid is 90.0.
Determine its molecular formula.

[1]

(iii) A patient was advised by the doctor to consume not more than 0.05 g of oxalic acid per day. If a typical serving of starfruit contains 1.10×10^{-4} moles of oxalic acid, calculate the maximum number of starfruits the patient can eat a day.

[2]

[Total: 8 marks]

A5 An experiment was conducted to investigate the rate of reaction between calcium carbonate and dilute hydrochloric acid, by measuring the volume of gas evolved at regular time intervals.

(a) 15.0 g of calcium carbonate was reacted with 150 cm^3 of 2 mol/dm^3 of hydrochloric acid.

(i) Write the chemical equation for the reaction. Hence calculate the volume of carbon dioxide produced.

[3]

(ii) Hence, sketch a graph of volume of carbon dioxide gas produced against time. Label this graph as *Graph I*. Indicate the volume of carbon dioxide gas produced clearly on the graph.

[2]

(iii) In another experiment, the same mass of calcium carbonate was reacted with 150 cm^3 of 1 mol/dm^3 hydrochloric acid.
On the same axes as the graph in **(a)(ii)**, sketch the graph that you would expect to obtain and label this graph as *Graph II*.
Indicate the volume of carbon dioxide gas produced clearly on the graph.
[1]

(iv) Explain the differences in the shapes of Graph I and II.

.....

.....

..... [2]

(b) Other than concentration of acid, give one other factor that would alter the rate of reaction and explain your reasoning in terms of collision theory.

.....

.....

.....

.....

..... [2]

[Total: 10]

A6 Alkynes are hydrocarbons containing carbon-carbon triple bond (C≡C). Table 6.1 and Table 6.2 show some properties of the first four members of the alkyne and alkene homologous series respectively.

Table 6.1

alkyne	molecular formula	boiling point / °C
ethyne	C_2H_2	- 84
propyne	C_3H_4	- 23
butyne	C_4H_6	8
pentyne	C_5H_8	40

Table 6.2

alkene	molecular formula	boiling point / °C
ethene	C_2H_4	- 104
propene	C_3H_6	- 48
butane	C_4H_8	- 6
pentene	C_5H_{10}	30

(a) (i) Deduce the general formula of the alkyne homologous series.

..... [1]

(ii) Draw the full structural formula of the alkyne with 7 carbon atoms.

[1]

(b) (i) Describe the trend of the boiling points as the molecules become larger.

..... [1]

(ii) Do alkenes or alkynes burn with a smokier flame? Explain your answer.

.....

..... [1]

(iii) A very old organic Chemistry textbook has the following line.

> *.....in general, the higher the relative molecular mass of the molecule, the higher the melting and boiling points of the compound due to the higher intermolecular forces of attraction.*

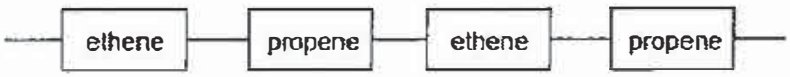
Use the data in the table to justify whether the statement is valid.

.....

.....

..... [2]

(c) By polymerizing a mixture of ethene and propene monomers, a synthetic rubber, ethylene-propylene, can be made. One possible structure of the polymer is shown below:



(i) Propyne can react with a gas to form propene.
Write the chemical formula of the gas used to form propene.

..... [1]

(ii) Give the full structural formula for the repeating unit in this polymer structure.

[2]

(iii) When the mixture of ethene and propene polymerises, it is unlikely to form the regular, repeating pattern. Explain why.

.....

..... [1]

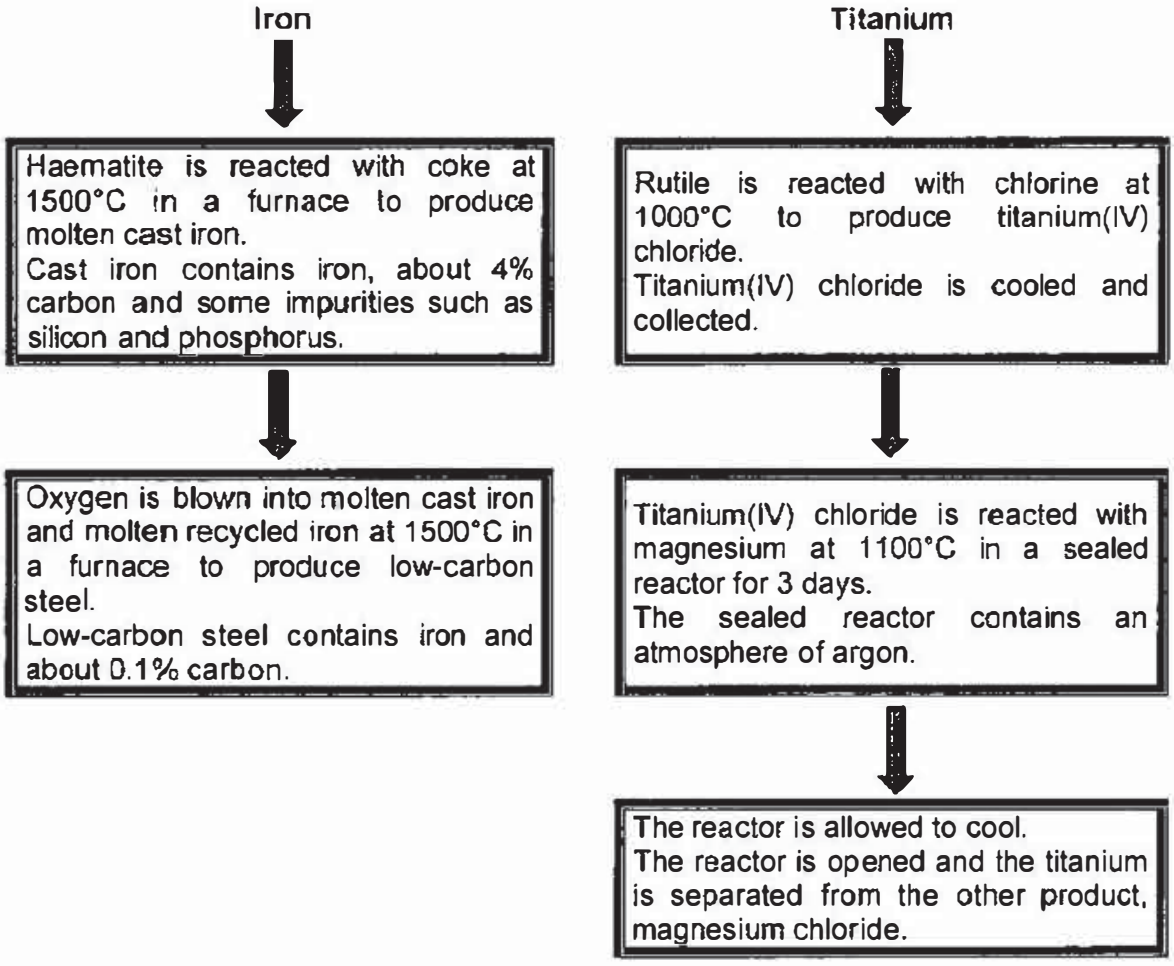
[Total: 10]

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.

B7 Iron is produced in the blast furnace using the ore haematite containing iron(III) oxide (melting point 1566°C) as one of the raw materials.

Titanium is produced from the ore rutile containing titanium dioxide (melting point 1843°C) which cannot be reduced by coke and hence requires a different method of extraction.



Iron blast furnaces produce about 20 000 tonnes of the metal per hour.
Titanium reactors produce about 1 tonne of the metal per day.

(a) Explain why the production of titanium requires "an atmosphere of argon"?

.....

..... [2]

(b) The melting point of iron(III) oxide is higher than the temperature in the blast furnace. Explain why iron(III) oxide could remain in molten state in the blast furnace.

.....

..... [1]

(c) Other than blowing oxygen into molten cast iron, lime (calcium oxide) is also added in the same furnace during the production of low-carbon steel.
Explain the purpose of lime in the furnace.

..... [1]

(d) There is less titanium than iron in the Earth's crust. Other than titanium's scarcity, explain why titanium costs much more than iron.

.....

.....

.....

..... [2]

(e) Explain why water is used to wash titanium at the last stage.

..... [1]

(f) Suggest the position of titanium in the Reactivity Series of Metals.
Explain your answer.

.....

.....

.....

..... [3]

(g) Draw a "dot-and-cross" diagram to illustrate the bonding in magnesium chloride.

[2]

[Total: 12 marks]

B8 Fig 8.1 below shows an experimental set-up of a simple cell and an electrolytic cell. Both electrodes X and Y are made of graphite. The switch is then closed and reactions take place in both cells.

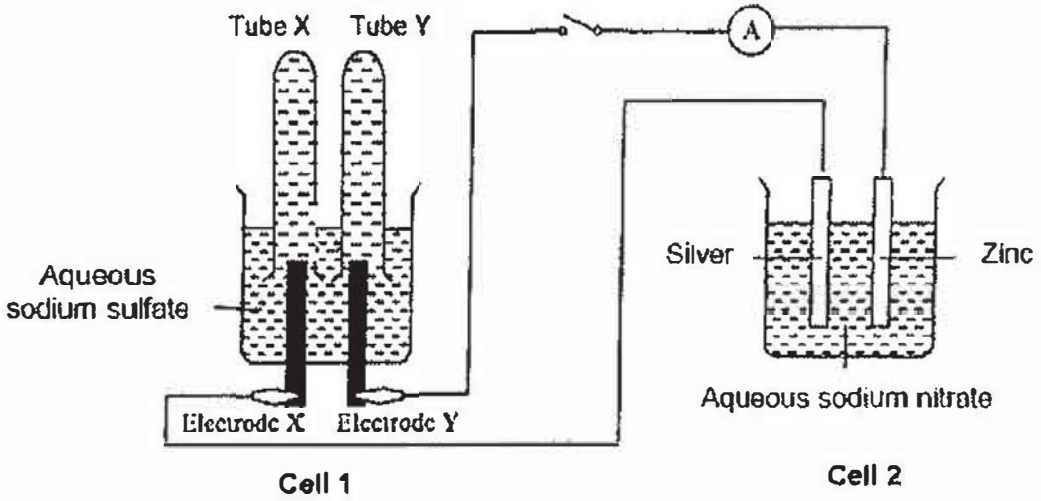


Fig. 8.1

(a) Write the ionic equations for the reactions which take place at the electrodes of Cell 1.

electrode X : ..... [1]

electrode Y : ..... [1]

(b) Shade the tubes in Fig. 8.2 to show the new levels of sodium sulfate solution after the switch is closed for a while. Your diagram should represent the relative volumes of gases collected in tube X and tube Y. Label clearly the gases collected in each tube.

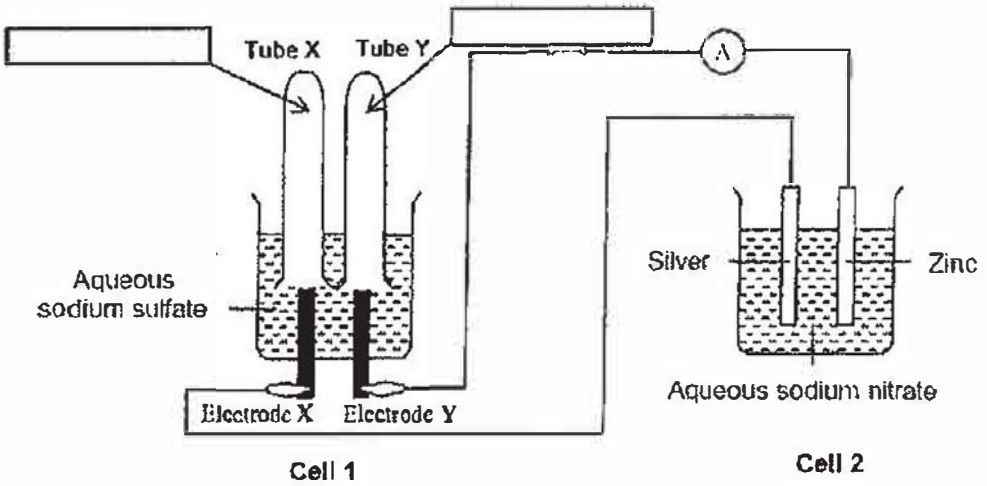


Fig. 8.2

[2]

(c) State and explain an observation that can be made in Cell 2 during the experiment.

Observation: ..... [1]

Explanation: ..... [1]

(d) Electrode X is then replaced by a copper rod. State an observation and explain your answer.

Observation: ..... [1]

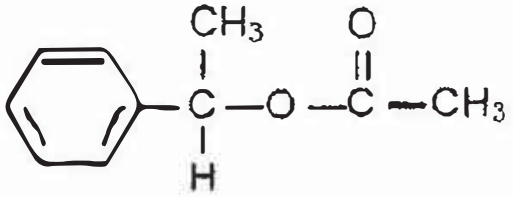
Explanation: ..... [1]

[Total: 8]

B9 Either

Perfumes usually contain three groups of compounds called the top note, the middle note and the end note.

(a) Top notes consist of small, light molecules that evaporate quickly. An example of a top note compound is styrallyl acetate as shown below:



(i) With reference to the structure of the compound, explain why it is likely to have a pleasant smell.

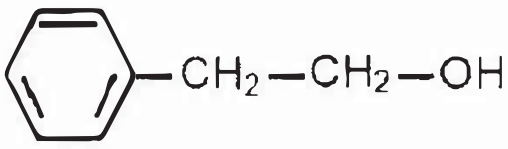
.....

..... [1]

(ii) Draw the structural formula of the alcohol and carboxylic acid used to make styrallyl acetate.

[2]

(b) The middle note compounds form vapours less rapidly than the top note compounds. A typical compound of the middle note is 2-phenylethanol. The structure of 2-phenylethanol is shown below:



(i) Describe a chemical test which would distinguish between the top note and the middle note compounds.

.....

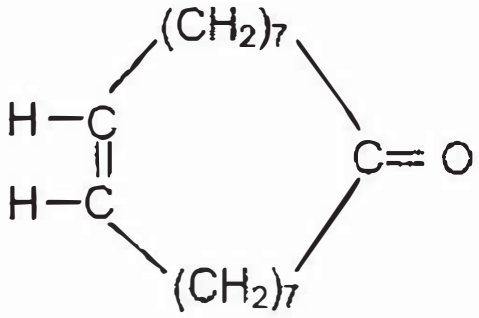
.....

..... [2]

(ii) Name and draw the full structural formula of the molecule formed in the positive test in **(b)(i)**.

[2]

(c) The end note compound of a perfume has a long lasting odour which stays with the user. An example of an end note compound is shown below.



(i) Explain why the end note compound is described as unsaturated.

.....

..... [1]

(ii) The end note compound undergoes hydrogenation reaction.
State the conditions that are essential for the hydrogenation reaction.

..... [1]

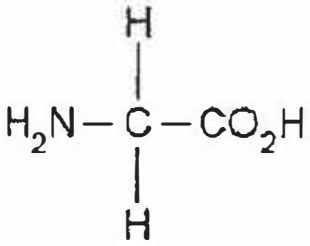
(iii) Iodine reacts with unsaturated compounds. The iodine value is a measure of how unsaturated a compound is. It is based on the mass, in grams, of iodine that reacts with 100 g of the compound.
If the relative molecular mass of the end note compound is 250, calculate the iodine value for the end note compound.

[1]

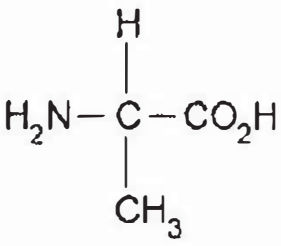
[Total: 10 marks]

B9 OR

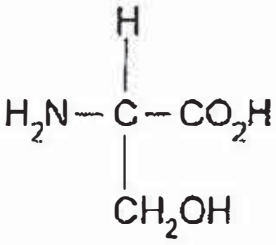
The silk of a spider's web is composed of polyamide chains which are mainly made from the amino acids, glycine, alanine and serine, with smaller amounts of four other amino acids.



glycine



alanine



serine

(a) Assuming the polyamide is made from repetitive sequences of –glycine–alanine–serine–, draw the structural formula of the repeat unit.

[2]

(b) The M_r of each polyamide chain is about 600 000.
Assuming the polyamide chain is made from equal amounts of the above three amino acids, calculate the average number of amino acids monomers in each polyamide chain.

[3]

(c) A student separates the other four amino acids by paper chromatography using two different solvents. The solvent front of solvent 1 takes five minutes to reach the end of the chromatogram while the solvent front of solvent 2 takes ten minutes.
Table 9.1 shows the R_f values she obtained for these amino acids.

Table 9.1

amino acid	R_f in solvent 1	R_f in solvent 2
A	0.2	0.5
B	0.0	0.4
C	0.8	0.9
D	0.3	0.4

(i) Which amino acid travels fastest in both solvents?

..... [1]

(ii) Suggest how the student can make the colourless amino acids become visible to the naked eye.

..... [1]

(iii) The student writes the following statements about the chromatography.

Conclusion: Solvent 2 gives a better separation than solvent 1.

Source of error: Duration of chromatography for solvent 2 is longer than for solvent 1.

Do you agree with the student? Explain your reasoning.

.....

.....

.....

.....

..... [3]

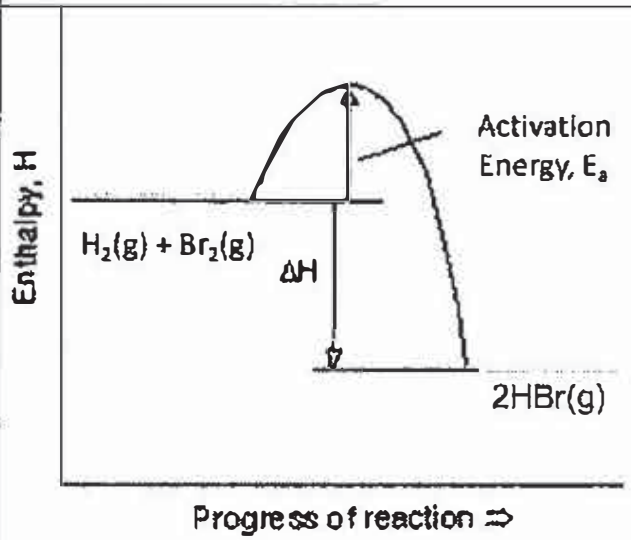
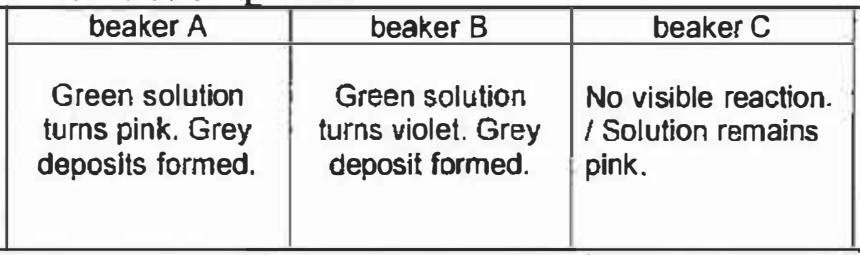
End of Paper

Answer Scheme

Section A

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

Section B

Qn	Answers	Marks
A1(a)	Neon	1m
(b)	Fluorine	1m
(c)	Nitrogen	1m
(d)	Carbon	1m
A2(a)	**Down the group**, the bond dissociation energy of the hydrogen halides **decreases.**	1m
(b)(i)	Hydrogen iodide.	1m
(ii)	HI has the **lowest bond enthalpy energy** *(ACCEPT: weakest bond)*, thus it is **easiest for it to ionize to form H^+ ions.**	1m 1m
(c)(i)	Enthalpy change: +432 + 193 – 2(363) = -101kJ	1m
(ii)	**Exothermic** reaction. The energy **absorbed to break the H-H bonds and Br-Br bonds is lesser** than the **energy released to form the H-Br bonds.**	1m 1m
(iii)		2m
A3(a)	They have variable oxidation states. They form coloured compounds.	1m 1m
(b)		3m 1m per box
(c)(i)	Cr has **decreased in oxidation state from +3 in Cr_2O_3 to 0 in Cr**, while Al has increased in **oxidation state from 0 in Al to +3 in Al_2O_3.** Since both reduction and oxidation have taken place, it is a redox reaction.	2m
(ii)	**Chromium is more reactive than iron** in steel and will **provide sacrificial protection for the iron** even when the **protective layer is**	2m

	beaker A	beaker B	beaker C
	Green solution turns pink. Grey deposits formed.	Green solution turns violet. Grey deposit formed.	No visible reaction. / Solution remains pink.

<table>
<tr><td></td><td>scratched and exposed. However, Iron is more reactive then tin and will corrode more when layer of tin is scratched and exposed.</td><td></td></tr>
<tr><td>A4(a)(i)</td><td>$H_2A + 2NaOH \rightarrow Na_2A + 2H_2O$
$C_A = 1.00\ mol/dm^3$, $C_{NaOH} = 0.100\ mol/dm^3$, $V_A = 25.0\ cm^3$

$V_{NaOH} = 2 \times 1 \times 25 / 0.1$
$= 500\ cm^3$</td><td>1m

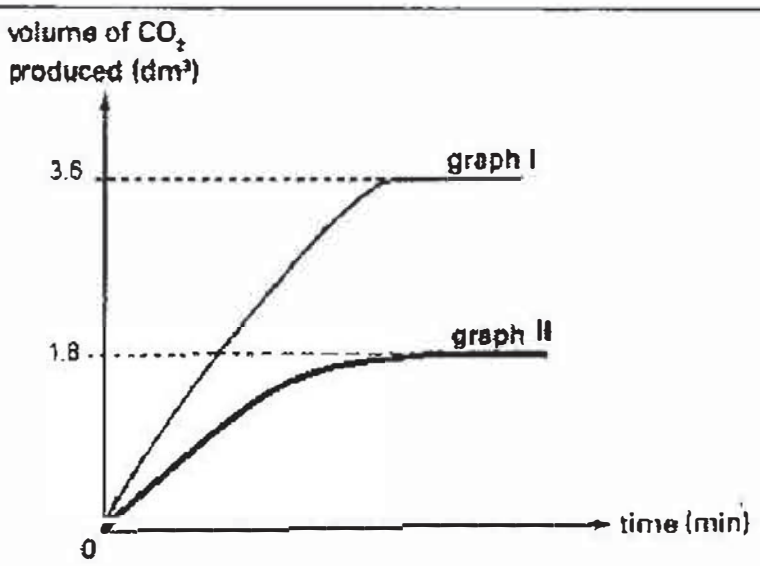
1m</td></tr>
<tr><td>(ii)</td><td>The volume of NaOH cannot be placed in the burette as the burette is usually able to hold a maximum volume of $50.0cm^3$ only.</td><td>1m</td></tr>
<tr><td>(b)(i)</td><td><table>
<tr><th>element</th><th>carbon</th><th>hydrogen</th><th>oxygen</th></tr>
<tr><td>%</td><td>26.7</td><td>2.20</td><td>71.1</td></tr>
<tr><td>Ar</td><td>12</td><td>1</td><td>16</td></tr>
<tr><td>no. of moles</td><td>2.225</td><td>2.2</td><td>4.444</td></tr>
<tr><td>ratio</td><td>1.01</td><td>1</td><td>2.02</td></tr>
<tr><td>to nearest whole no.</td><td>1</td><td>1</td><td>2</td></tr>
</table>
empirical formula = CHO_2</td><td>2m</td></tr>
<tr><td>(ii)</td><td>Molecular mass = 90
n = 90/ Mr (CHO_2)
= 90/ (12 + 1 +32)
=2
Molecular formula of oxalic acid = $H_2C_2O_4$ / $C_2H_2O_4$ / HOOCCOOH</td><td>1m</td></tr>
<tr><td>(iii)</td><td>1 mole of oxalic acid = 90 g
1.10×10^{-4} moles of oxalic acid = $1.10 \times 10^{-4} \times 90$
=0.0099 g
No of starfruit = 0.05/0.0099
= 5.05
=5
The patient can consume a maximum of 5 starfruits a day.</td><td>1m

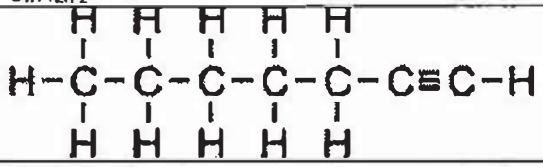
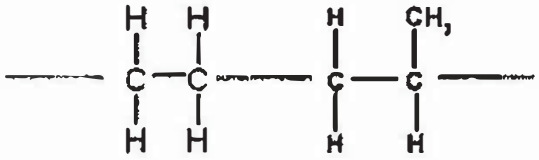
1m</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>A5(a)
(i)</td><td>$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$</td><td>1m</td></tr>
<tr><td></td><td>moles of $CaCO_3$ = mass / molar mass = 15.0 / (40+12+48) = 0.15 mol
moles HCl = molarity x vol = 0.15 x 2 = 0.30 mol [To demonstrate limiting reagent]

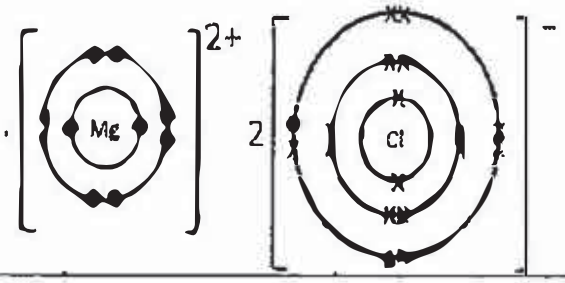
$CaCO_3 : CO_2 = 1 : 1$ (allow ECF)

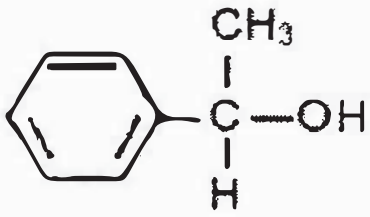
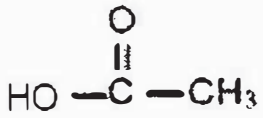
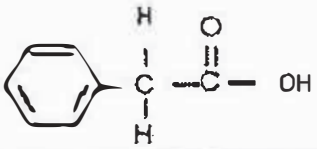
Vol. of CO_2 = 0.15 x $24dm^3$ = 3.60 dm^3</td><td>1m

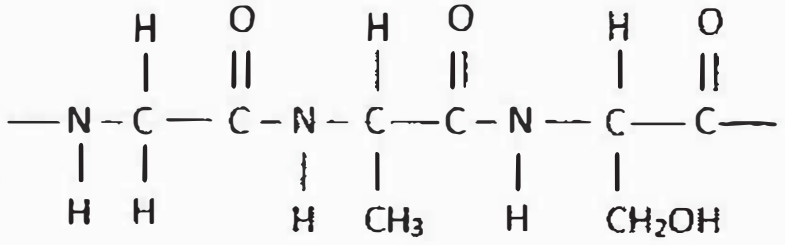
1m</td></tr>
</table>

(ii) and (iii)	 Note: Graph II's **gradient must be less steep** and it **levels off at a later time**, as compared to Graph I.	1m for axis, label with units and values 1m for shape of graph I and II 1m for values of 1.8 and 3.6 dm^3
(iv)	Graph II has a **less steep gradient than graph I** as the hydrochloric acid used is of a **lower concentration**. Or Graph I has a **steeper gradient than graph II** as the hydrochloric acid used is of a **higher concentration**. However, the **volume of carbon dioxide obtained is halved in Experiment II** as the **number of moles of hydrochloric acid used is halved**. Or However, the **volume of carbon dioxide obtained is doubled in Experiment I** as the **number of moles of hydrochloric acid used is twice the amount of Experiment II**.	1m 1m
(b)	Temperature of acid / particle size of calcium carbonate. Increasing the temperature of acid will **increase the kinetic energy of reacting particles**. This will in turn **increase the frequency of effective collisions** and hence **increasing the rate of reaction**. Or Decreasing the particle size of calcium carbonate will **increase the surface area exposed for reacting particles to collide into**. This will in turn **increase the frequency of effective collisions** and hence **increasing the rate of reaction**.	 1m 1m 1m 1m

A6(a)(i)	C_nH_{2n-2}	1m
(ii)		1m
(b)(i)	As the molecules become larger, the boiling points increases.	1m
(ii)	Alkynes burn with a smokier flame because they have a higher percentage of carbon compared to alkenes.	1m
(iii)	Although ethyne (Mr = 26) has a relative molecular mass smaller than ethene (Mr = 28), the boiling point of ethyne is -84 °C whereas the boiling point of ethene is lower at -104 °C. The textbook is invalid as alkynes have higher boiling points even though it has smaller relative molecular mass.	1m 1m
(c)(i)	H_2	1m
(ii)		2m
(iii)	Some of the ethene or propene may self-polymerise to form poly(ethene) or poly(propene).	1m
Section B		
B7(a)	argon is used to create an <u>unreactive /</u> <u>inert</u> atmosphere as any <u>oxygen would react with / air would oxidise</u> <u>magnesium / titanium.</u>	1m 1m
(b)	The presence of **impurities such as silicon dioxide / sand lower the melting point of iron(III) oxide** and hence iron(III) oxide could melt at lower temperatures. *Accept: impurities such as silicon and phosphorus* OR The **energy released** from the **combustion of carbon/coke** results in **more heat / higher temperature in the blast furnace** for the iron(III) oxide to melt.	1m
(c)	To **react with acidic impurities such as silicon dioxide** and remove them as molten slag.	1m
(d)	Any two. 1. There are **more stages to manufacture** titanium thus less efficient / more energy are needed 2. **In one day, blast furnace** could produce (24 x 20000 =) **480000 tonnes of metal** while the **reactors** could only produce **1 tonne of metal** and hence the **rate of production is slower**. [student must extract the data on the quantities of metal produced to support the production rate is slower] 3. Blast furnace **uses coke/carbon** which is **abundant and cheaper than magnesium / Magnesium** used in reactor is **more**	2m

	expensive than coke/carbon because it is extracted by **electrolysis**.	
(e)	To remove **soluble magnesium chloride** from titanium.	1m
(f)	**Titanium is below magnesium AND above zinc** in the reactivity series. **Magnesium** could **displace titanium from titanium(IV) chloride** and hence magnesium is more reactive than titanium. **Titanium dioxide cannot be reduced by coke** but iron(III) oxide can be reduced by coke. Therefore, titanium is more reactive as it forms more stable compound than iron.	1m 1m 1m
(g)		2m
B8(a)	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$	1m
	$2H^+(aq) + 2e \rightarrow H_2(g)$	1m
(b)	Tube X: oxygen Tube Y: hydrogen Drawing must depict ratio of O:H as 1:2	1m 1m
(c)	Observation : Size of zinc decreases OR bubbles seen at silver electrode Explanation : zinc, the more reactive metal, ionizes to form zinc ions OR Hydrogen ions accept electrons to form hydrogen gas	1m 1m
(d)	Observation: electrolyte will turn blue OR size of copper decreases. Explanation : Copper electrode (the anode) ionizes to form copper(II) ions which is blue, hence electrolyte turns blue OR copper electrode becomes smaller as copper ionizes	1m 1m

Either		
B9(a)(i)	The compound consists of a functional group named ester.	1m
(ii)	Alcohol  Carboxylic acid 	2m
(b)(i)	**Add acidified potassium manganate(VII) solution** to each sample of top note compound and middle note compound. If the acidified potassium manganate(VII) solution **turned from purple to colourless, the sample is middle note.** If the acidified potassium manganate(VII) solution remained purple, the sample is top note. OR **Add acidified potassium dichromate(VI) solution** to each sample, if the solution turned **from orange to green**, the sample is middle note or if the solution remained green, the sample is top note.	1m 1m
(ii)	2-phenylethanoic acid 	1m 1m
(c)(i)	The end note consists of carbon-carbon double bond.	1m
(ii)	Temperature of 200°C and the catalyst used is nickel	1m

(iii)	1 mol of end note reacts with 1 mol of iodine. No of mole of end note = 100/250 = 0.4 mol No of mole of iodine = 0.4 mol Mass of iodine =0.4 X 2 X127 =101.6 = 102 (3sf) Iodine value is **101.6/102.**	1m
OR		
B9(a)	 1m for correct linkage. 1m for everything else.	2m
(b)	Mr of repeat unit = 215 Average no. of monomers = 600 000/215 X 3 = **8372.09 = 8372 or 8370 (3 s.f.)** Note: If Mr of glycine = 75; Mr of alanine = 89; Mr of serine = 105, and average no. of monomers = 600 000/269 X 3 = **6691.4 = 6691 or 6690 (3sf)**, then only 2m.	**1m** 2m
(c)(i)	C	1m
(ii)	Use a locating agent.	1m
(iii)	No, because solvent 2 does not give a better separation than solvent 1 as **B and D have identical Rf values** hence cannot be distinguished. Duration of chromatography is also **not a source of error**, because Rf **is a ratio** (of distance travelled by dye to distance travelled by solvent) / Rf is only dependent of solubility of component in a specific solvent./Rf values are not time dependent.	1m 1m 1m