TEST CODE **002693**

FORM TP 2363

MAY/JUNE 2003

CARIBBEAN EXAMINATIONS COUNCIL

SECONDARY EDUCATION CERTIFICATE EXAMINATION

CHEMISTRY

Paper 03 – General Proficiency

1 hour

02 JUNE 2003 (a.m.)

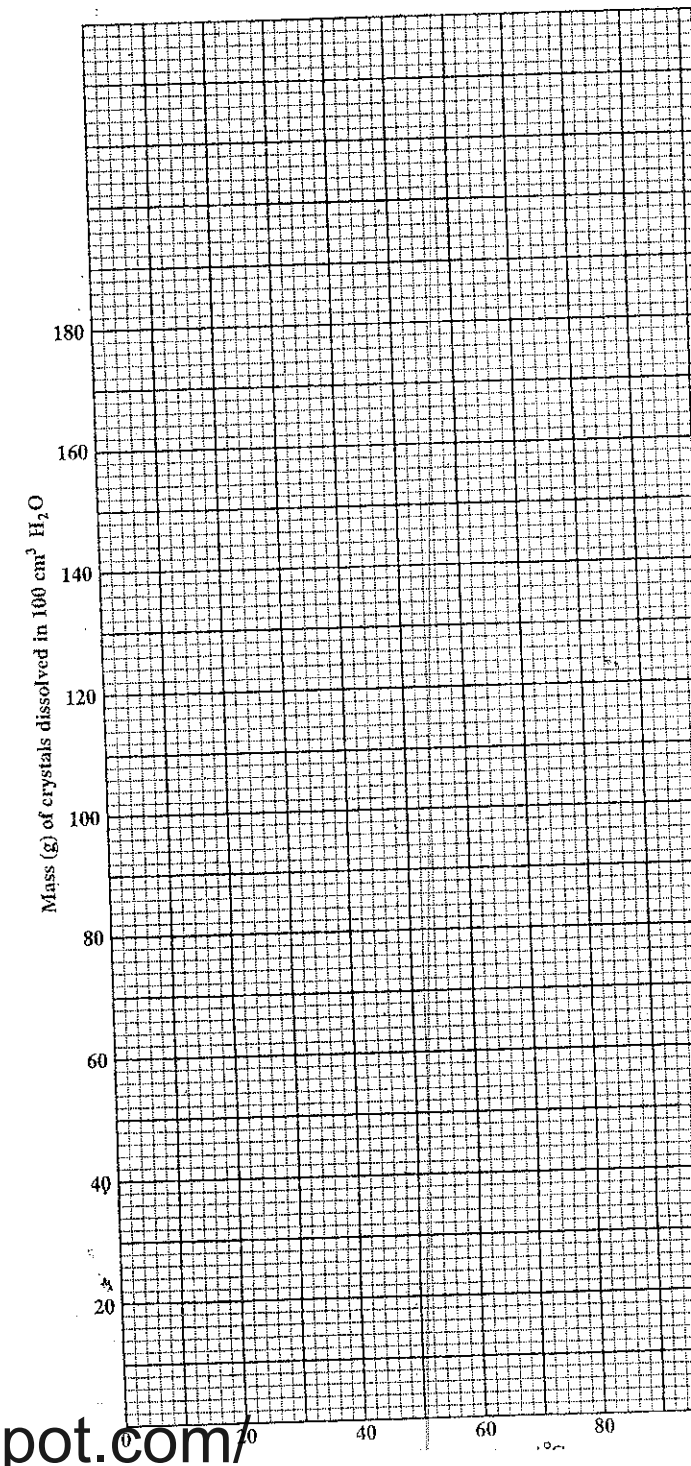
In addition to the 1 hour, candidates are allowed a reading time of 10 minutes. Writing may begin during the 10-minute period.

READ THE FOLLOWING DIRECTIONS CAREFULLY

1. Candidates MUST answer THREE questions on this paper. Choose ONE from Section A, ONE from Section B and ONE from Section C.
2. All working MUST be shown for calculations.
3. The use of non-programmable calculators is allowed.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

Answer Sheet for Question 1.



SECTION A

Answer ONE question from this section.

1. Solid, gaseous and liquid substances combine in various ways to form mixtures. The properties of mixtures depend on those of the substances that make them up. These properties also serve as a means by which mixtures may be classified and a basis on which they may be separated.

(a) Suspensions, solutions and colloids are examples of mixtures. Distinguish among solutions, suspensions and colloids. **(4 marks)**

(b) A student carried out an experiment to compare the solubilities of three salts, hydrated copper (II) sulphate, potassium nitrate and sodium chloride at different temperatures. Table 1 shows the data collected during the experiment.

TABLE 1: COMPARISON OF SOLUBILITIES OF THREE SALTS

Temperature/ °C	Mass (g) of crystals dissolved in 100 cm^3 of water		
	Hydrated Copper (II) sulphate	Potassium Nitrate	Sodium Chloride
10	17	21	35.8
20	21	30	36.0
40	29	44	36.6
60	40	110	37.3
80	55	170	38.4

(i) Using the data in Table 1, describe the effect of temperature on the solubilities of hydrated copper (II) sulphate, potassium nitrate and sodium chloride. **(3 marks)**

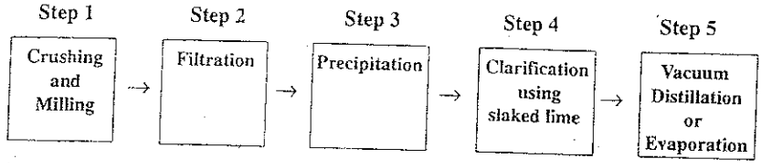
(ii) On the graph sheet provided, plot the data for potassium nitrate. **(3 marks)**

(iii) From your graph:

a) Predict how much potassium nitrate will dissolve at 90 °C

b) Determine how much potassium nitrate will be precipitated if the solution is cooled from 60 °C to 10 °C. **(2 marks)**

(c) The flow chart shows the steps in the extraction of sucrose from sugar cane.



(i) Briefly outline what happens in Step 1. **(2 marks)**

(ii) Discuss the processes which takes place in Steps 2, 4 and 5 above. **(6 marks)**

Total 20 marks

2. Electrolysis is a chemical process. It is used to extract highly reactive substances such as sodium and chlorine from their compounds.

(a) (i) Define the term 'electrolysis'. **(2 marks)**

(ii) Using molten sodium chloride as an example of an electrolyte:

a) Describe what happens during the process of electrolysis.

b) Show why electrolysis is a chemical process.
Support your answer with relevant ionic equations. **(5 marks)**

(b) Using the electrolysis of brine and aqueous sodium hydroxide at inert electrodes, as examples, discuss the effects of each of the following on the products of electrolysis.

(i) Position of ions in the electrochemical series

(ii) Concentration of the electrolyte **(6 marks)**

(c) Corrosion of metals is a universal problem. Aluminium is made corrosion resistant by first anodizing and then dyeing.

(i) By using appropriate diagrams and equations, explain what happens during the anodizing of aluminium. **(5 marks)**

(ii) Discuss how anodizing of aluminium facilitates the process of dyeing. **(1 mark)**

(iii) The anodized aluminium may be affected by some chemicals. Suggest ONE substance that would react with the anodized aluminium. **(1 mark)**

Total 20 marks

SECTION B

Answer ONE question from this section.

3. Man is constantly seeking to develop new, improved and cheaper materials to serve his daily needs. One such class of materials is that of polymers. Polymers, in the form of fibres, films and moulded objects, pervade every aspect of our daily lives.

(a) Polymers can be classified as either natural or synthetic.

Briefly discuss the structure of ONE named synthetic and ONE named naturally occurring polymer. You should include in your answer:

(i) The structure of the monomer units of EACH polymer **(2 marks)**

(ii) Appropriate structures to show how these monomer units are linked to form the polymer **(4 marks)**

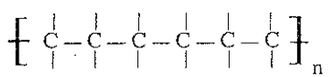
(iii) A comment on the type of linkage (bonding) formed between the monomer units **(2 marks)**

(iv) ONE difference in property between the monomer and its polymer **(2 marks)**

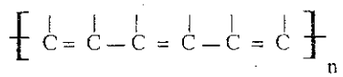
(v) The type of reaction occurring during the polymerization process **(2 marks)**

(b) Plastics are widely used in industry as electrical insulators. Recently, however, a new class of polymers called electrically conducting polymers have emerged. They are light weight and are being used as substitutes for metals as conductors.

Consider the partial structures of the two polymers, **A** and **B** below.



A



B

State which ONE of these two polymers, **A** or **B**, would most likely be electrically conducting. Explain your answer. **(4 marks)**

(c) A student suggests that the problem of plastic disposal can be solved by making u plastics synthesized from a mixture of natural and synthetic polymers. Such plastics w be biodegradable (capable of being broken down by microorganisms).

(i) Do you agree with this suggestion?

Support your answer with reasons.

(ii) Give ONE limitation to the suggestion. **(4 marks)**

Total 20 marks

4. Sulphur dioxide is an important starting material in the industrial preparation of sulphuric acid. Normally it is produced by burning sulphur in air. However, it can be produced from the naturally occurring $Fe S_2$. When burnt in oxygen, $Fe S_2$ produces sulphur dioxide as well as iron III oxide (Fe_2O_3), which can be used in the Blast Furnace to produce iron.

(a) Describe the industrial preparation of sulphuric acid starting from $Fe S_2$.

Include relevant equations in your answer. **(11 marks)**

(b) (i) Sulphur dioxide and sulphur trioxide are pollutants, which are emitted from plants that use coal as fuels. Predict what is likely to happen when sulphur trioxide is inhaled into the lungs. **(4 marks)**

(ii) There are many techniques available for removing sulphur dioxide from effluent gases emitted from factories. One possible way is to react the sulphur dioxide with hydrogen sulphide as shown in the equation below:

$$2H_2S(g) + SO_2(g) \rightarrow 3\,S(s) + 2\,H_2O\,(l)$$

State ONE likely advantage and ONE disadvantage of using this method for the removal of sulphur dioxide from effluent gases. **(2 marks)**

(iii) Calcium oxide (CaO) is a basic oxide and is used to remove sulphur dioxide, an acidic gas, from exhaust gases from factories, by precipitating the SO_2 in the form of calcium sulphate.

Explain how this is possible.

Illustrate your answer by means of an equation. **(3 marks)**

Total 20 marks

SECTION C

Answer ONE question from this section.

5. Cement is widely used in the construction industry as a binder in the making of concrete. Concrete is used in the construction of buildings and roads because it is inexpensive, strong, durable and tolerant of a wide range of temperatures.

Cement is made by strongly heating limestone ($Ca\ CO_3$)with alumina (Al_2O_3) in a kiln. One component of Portland Cement is tricalcium aluminate, $(3CaO) \cdot Al_2O_3$.

(a) Write chemical equations, to show how it is possible to obtain tricalcium aluminate, starting with limestone and alumina. **(4 marks)**

(b) During the process of making concrete, water is added. The hardening process occurs as the concrete sets and carbon dioxide is absorbed from the atmosphere.

(i) With the aid of an equation, explain the role of water in the hardening of concrete. **(4 marks)**

(ii) Wet concrete mixture is tested with moist blue and red litmus paper.

a) Describe the resulting observations of the test.

b) Explain your answer in (ii) a) above. **(4 marks)**

(iii) A construction worker spills some muriatic acid (hydrochloric acid) on a concrete floor. A vigorous effervescence is observed as the concrete partially dissolves.

a) Suggest the name of the compound in the concrete which causes this reaction.

b) Account for the formation of the compound named in (iii) a) above. Use ONE relevant equation to explain your answer. **(4 marks)**

(c) Paints can be classified as either emulsion or oil based.

(i) What are the THREE basic ingredients of a paint. **(3 marks)**

(ii) State ONE way in which the composition of an emulsion paint differs from the composition of an oil paint. **(1 mark)**

Total 20 marks

6. The humus content of soils, the availability of mineral nutrients and soil acidity all play an important role in plant growth.

(a) Discuss the importance of humus in soil. **(5 marks)**

(b) (i) Describe the process of determining the pH of a soil sample. **(2 marks)**

(ii) A soil sample from Farmer Welgro's estate is found to have a pH of 5.0. Describe a method that Farmer Welgro can use to reduce the acidity of his soil.

Include in your answer:

a) The normal pH range of soils

b) The name AND chemical formula of the substance recommended for use

c) A chemical explanation as to how this recommended substance can bring about a reduction in soil acidity

d) Relevant chemical equations **(8 marks)**

(c) (i) Name an element which is essential for plant growth.

(ii) Design an experiment to investigate the effects of the deficiency of this element on plant growth. **(5 marks)**

Total 20 marks

END OF TEST

Answer ALL questions.

Do NOT spend more than 30 minutes on Question 1.

1. (a) When aqueous sulphuric acid is added to aqueous silver nitrate, a white precipitate of silver sulphate is obtained.

Figure 1 below shows the results obtained from six sets of experiments. In each experiment, a different volume of sulphuric acid is added from a burette to 50 cm^3 of a 0.50 M silver nitrate solution in a beaker. Each of the six precipitates obtained is filtered, washed, dried and weighed. The volumes of sulphuric acid added and the corresponding masses in grams of precipitate obtained are shown in Figure 1.

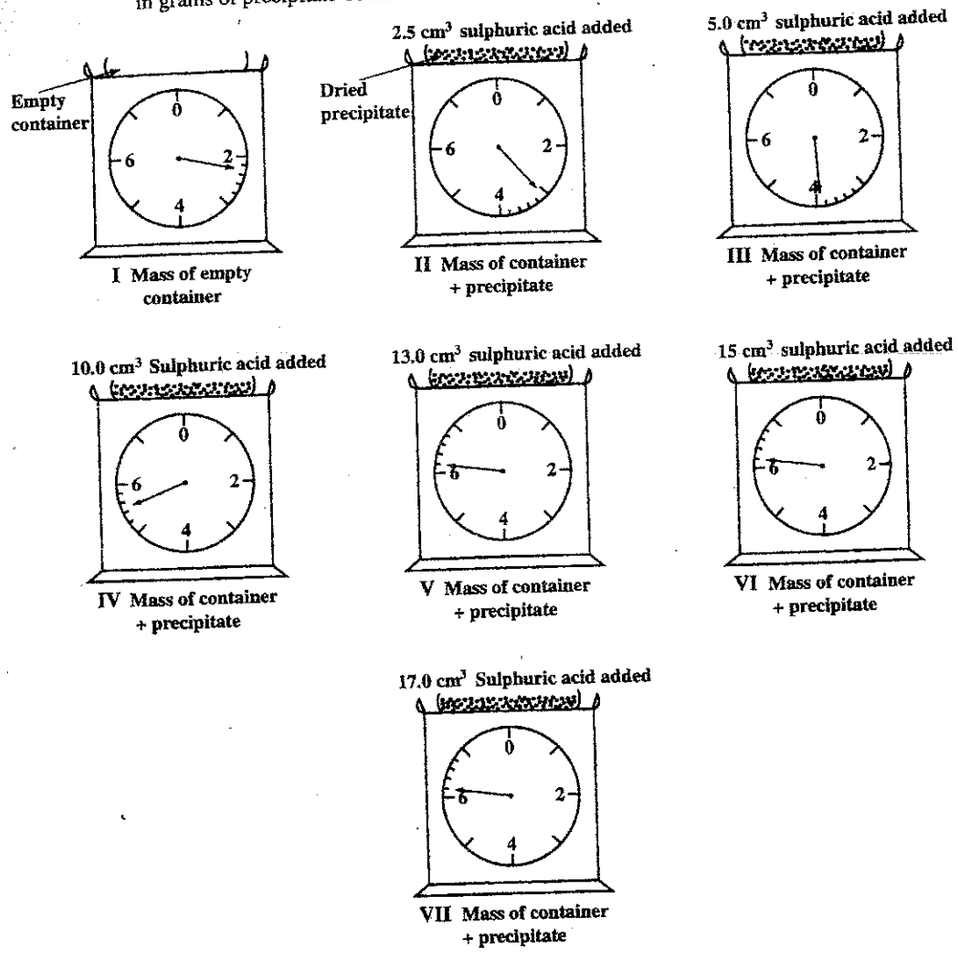


Figure 1. Mass of silver sulphate precipitate obtained when different volumes of sulphuric acid are added.

(i) From the results shown in Figure 1, construct a suitable table in the space provided below. In this table record the volumes of aqueous sulphuric acid added and the corresponding mass of dry silver sulphate precipitate obtained.

(4 marks)

(ii) Using the graph page provided on page 4, plot a graph of mass of precipitate obtained against volume of sulphuric acid added. **(3 marks)**

(iii) Use the data from your graph to determine the MINIMUM volume of sulphuric acid required to precipitate out the silver ions present in the silver nitrate solution.

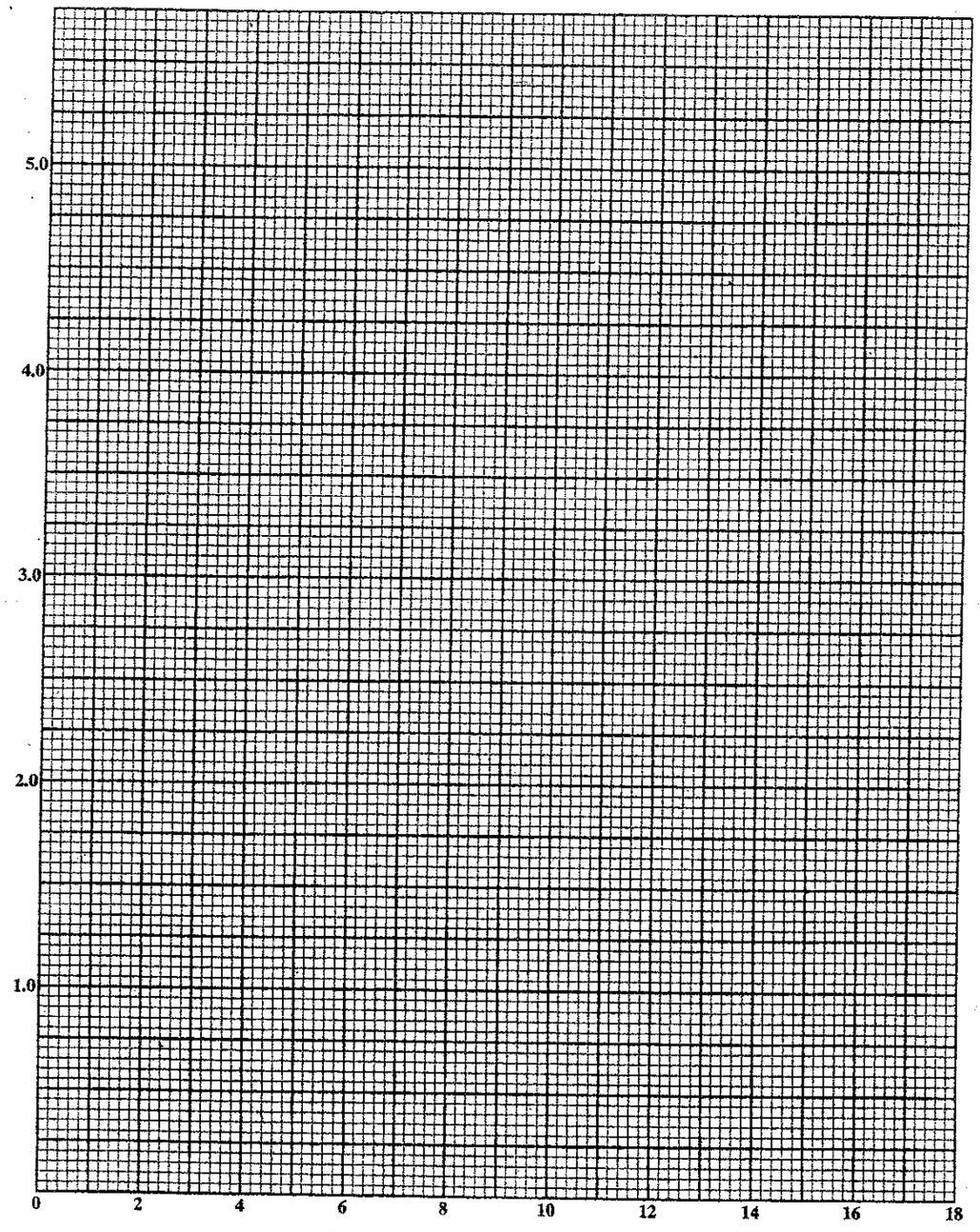
Volume of sulphuric acid = _____ cm^3

(1 mark)

(iv) Write a balanced equation for the reaction between sulphuric acid and silver nitrate. Include state symbols.

_____

(2 marks)



GO ON TO THE NEXT PAGE

(v) Calculate the following:

a) The number of moles of silver ions in 50 cm³ of the 0.50 M si nitrate solution used.

_____

_____

_____

(2 marks)

b) The number of moles of sulphuric acid in the volume of this acid you obtained in (a) (iii) on page 3. You should make use of the equation you have written in (iv) on page 3 in your calculation.

_____

_____

(1 mark)

c) The number of moles of sulphuric acid in 1 dm³ of this solution.

_____

_____

(1 mark)

GO ON TO THE NEXT PAGE

(b) A student carries out a number of tests on a sample of compound Y. The observations are recorded in Table 1 below. You are required to fill in the inferences that can be made based on the observations recorded.

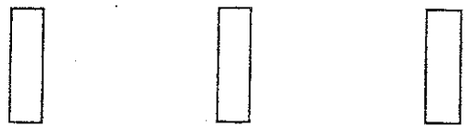
TABLE 1: RESULTS OF VARIOUS TESTS

Test	Observation	Inference
(i) To a sample of solid Y was added aqueous sodium hydroxide and the mixture heated. Moist red and blue litmus paper were held at the top of the test tube.	A colourless gas with a pungent odour was given off. Turned the moist red litmus paper blue.	
(ii) To an aqueous solution of Y was added aqueous sodium hydroxide until in excess.	A white precipitate was formed. The precipitate dissolved in excess aqueous sodium hydroxide.	
(iii) To an aqueous solution of Y was added aqueous ammonia solution until in excess.	A white precipitate was formed. The precipitate dissolved in excess aqueous ammonia solution.	
(iv) To an aqueous solution of Y was added an aqueous solution of barium nitrate. This was followed by the addition of aqueous nitric acid.	A white precipitate was formed. The precipitate was insoluble in aqueous nitric acid.	

(8 marks)

(c) Metals can be arranged in a series depending upon their relative reactivities. This series is referred to as the reactivity series.

You are provided with strips of metals A, B and C.



Plan and design an experiment to determine the relative order of reactivity of these THREE metals.

Your answer should include the following:

(i) Hypothesis to be tested

(1 mark)

(ii) Materials/Apparatus

(2 marks)

(iii) Method

(2 marks)

(iv) Variables

(1 mark)

(v) Data to be collected

(1 mark)

(vi) Predicted results

(1 mark)

Total 30 marks

2. Natural gas and petroleum are the main sources of hydrocarbons. Hydrocarbons a source of energy as well as a source of raw materials for the synthesis of a large nu industrial compounds.

(a) (i) Give the name of the MAIN component of natural gas.

(1 mark)

(ii) Write a balanced equation to show the complete combustion of the MAIN component of natural gas.

(2 marks)

(b) Figure 2 below shows the different stages involved in the fractional distillation of petroleum (crude oil).

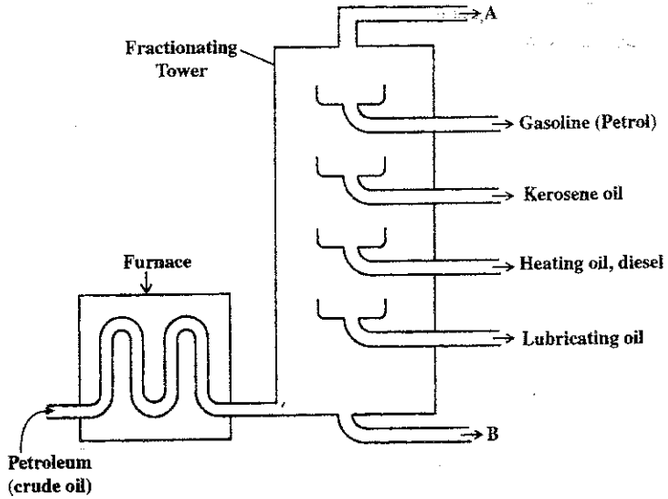


Figure 2. The fractional distillation of petroleum (crude oil)

(i) Identify Fractions A and B in Figure 2.

A: _____

B: _____

(2 marks)

(ii) Briefly discuss the chemical principle upon which the separation process shown in Figure 2 is based.

_____

_____

_____

_____

_____

(3 marks)

(c) In the petrochemical industry, dodecane ($C_{12}H_{26}$) is broken down to form heptane (C_7H_{16}) and one other hydrocarbon.

(i) Identify the OTHER hydrocarbon that is formed when dodecane is broken down.

_____

(1 mark)

(ii) a) Name the process by which dodecane is broken down to form heptane.

_____

(1 mark)

b) Explain the importance of the process named in (c) (ii) a) above in the petrochemical industry.

_____

_____

_____

_____

(2 marks)

(iii) Give a suitable chemical test that can be used to distinguish between heptane and the other hydrocarbon identified in (c) (i) above. In your answer:

a) Name the reagent.

b) Describe any changes which may occur.

c) Write a balanced equation for the reaction occurring.

Reagent:

_____

Observed changes:

_____

_____

Equation:

_____

(3 marks)

Total 15 marks

3. A student designed an experiment to determine the amount of heat produced from burning the fuel, propanol (C_3H_7OH). A diagram of the apparatus used is shown in Figure 3 below.

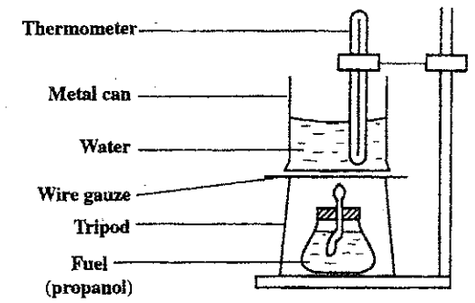


Figure 3. Burning of Propanol

Table 2 below gives the data collected during the experiment.

TABLE 2: DATA FROM THE BURNING OF PROPANOL

Mass of fuel /g	2.42
Mass of water /kg	0.30
Final temperature of water /°C	58.7
Initial temperature of water /°C	23.5

(a) (i) Using the relationship:

$\Delta H = mc\,\Delta T$

where ΔH = change in enthalpy of water

m = mass of water, in kg

ΔT = change in temperature of the water

c = specific heat capacity of water = 4 200 $JK^{-1}\,Kg^{-1}$

Calculate the quantity of heat transferred to the water after burning.

_____

_____

(1 mark)

(ii) Calculate the amount of heat produced by burning 1 mole of propanol.

Relative Atomic Masses: C = 12; O = 16; H = 1

(2 marks)

(iii) State ONE assumption upon which calculations in (c) (i) and (c) (ii) are based.

(1 mark)

(b) Draw a fully labelled energy profile diagram for the burning of propanol in air, identifying the reactants and products on the diagram.

(3 marks)

(c) Examine the student's arrangement of the apparatus for the experiment in Figure 3, page 11. Suggest ONE possible improvement that could be made so as to get more reliable results.

(1 mark)

(d) State THREE characteristics of an efficient fuel.

(3 marks)

(e) There are different forms of energy. During a chemical reaction, energy can be converted from one form to another. Identify the energy conversions that occur when propanol is burnt to heat the water.

(4 marks)

Total 15 marks

4. Table 3 below shows some of the properties of two elements **A** and **B**.

TABLE 3: PROPERTIES OF ELEMENTS, A AND B

Element	Number of		Mass Number	Electron Configuration	Expected Oxidation Number in Compounds
	Protons	Neutrons			
A	11		23		
B		13		2.8.1	+ 1

(a) Fill in the missing data in Table 3. **(5 marks)**

(b) Element **A** reacts with water to produce a solution of its hydroxide and hydrogen gas.

(i) Write a balanced equation for the reaction between **A** and water.

_____

(2 marks)

(ii) Both **A** and **B** give identical products when reacted with water. Account for this observation.

_____

_____

_____

(3 marks)

(c) Element **B** is radioactive. Radioactive elements are widely used in medicine, agriculture and in industry.

(i) What is meant by the term 'radioactive element'?

_____

_____

(1 mark)

(ii) Name TWO OTHER radioactive elements and give ONE use of EACH of these elements.

Element: _____

Use: _____

Element: _____

Use: _____

(4 marks)

Total 15 marks

5. Two gases **X** and **Y** dissolve in water to produce colourless solutions, **I** and **II**, respectively. Table 4 gives a summary of some of the reactions of the aqueous solutions, **I** and **II**.

TABLE 4: RESULTS OF REACTIONS OF SOLUTIONS, I AND II

Aqueous Solution	pH	Addition of barium nitrate followed by dilute nitric acid	Excess aqueous sodium hydroxide added and the resulting mixture heated
Solution I (formed by gas X)	2	White precipitate formed with aqueous barium nitrate. Precipitate does not dissolve on addition of acid.	No visible change.
Solution II (formed by gas Y)	11	No visible change.	Pungent gas, which turns moist red litmus blue, is evolved on heating.

(a) Define the term 'acid anhydride'.

_____

_____

(1 mark)

Based on the information given in Table 4,

(b) Identify gases **X** and **Y**.

Gas **X** is _____

Gas **Y** is _____

(2 marks)

(c) (i) Which of the gases, **X** or **Y**, is an acid anhydride?

_____

(ii) Explain your answer to (c) (i) above.

_____

_____

(2 marks)

(d) Write equations for the formation of solutions **I** and **II**, when gases **X** and **Y** are dissolved in water.

Formation of Solution **I**:

_____

Formation of Solution **II**:

_____

(2 marks)

(e) Explain the difference in the observed pH of solutions **I** and **II**.

_____

_____

_____

_____

(4 marks)

(f) Write an equation for the reaction between solutions **I** and **II**.

_____

(2 marks)

(g) How would the pH of a solution of carbon dioxide in water compare with the pH of solution **I**? Give a reason for your answer.

_____

_____

_____

_____

_____

_____

(2 marks)

Total 15 marks

END OF TEST

SECTION A

Answer ONE question from this section.

1. There are many ways of classifying salts. For example, salts may be classified as acid salts, normal salts or basic salts. Salts can be prepared by various methods such as the action of acid on metals and by titration.

(a) (i) Explain what is meant by a 'normal salt' and an 'acid salt'. **(2 marks)**

(ii) Describe a suitable test that could be used to distinguish between a normal salt and an acid salt. **(2 marks)**

(b) In preparing samples of barium sulphate and zinc sulphate, discuss the possibilities of using

(i) action of acid on the metal
(ii) titration using acid and alkali.

(9 marks)

(c) Giving full experimental details, outline a suitable method for preparing a sample of dry barium sulphate. Include in your answer

(i) the reactions to be used
(ii) a description of the method
(iii) all relevant equations.

(7 marks)

Total 20 marks

2. Oxygen gas can be prepared by the decomposition of hydrogen peroxide according to the following equation:

$$2H_2O_2(l) \longrightarrow H_2O(l) + 2O_2(g)$$

Figure 1 shows the results of two experiments for preparing oxygen from hydrogen peroxide. In Experiment I manganese dioxide (MnO_2) is added to the hydrogen peroxide at room temperature. In Experiment II, the hydrogen peroxide is heated to 100°C and the volume of oxygen produced with time recorded.

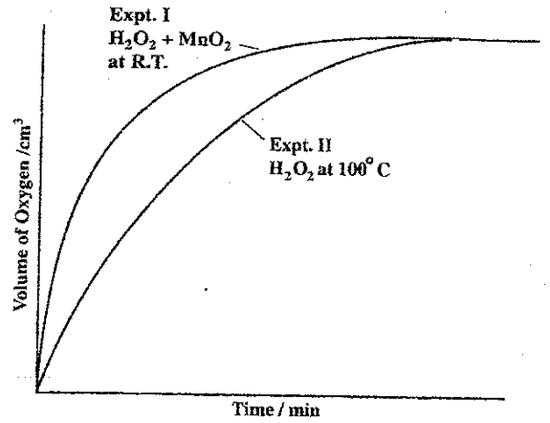


Figure 1. Preparation of oxygen from hydrogen peroxide

(a) Draw a fully labelled diagram of the apparatus that could have been used to carry out Experiment I. **(4 marks)**

(b) (i) Make a sketch of the graph in Figure 1 in your answer booklet. **On your sketch,** draw the results for the decomposition of hydrogen peroxide at room temperature in the absence of manganese dioxide. **(2 marks)**

(ii) Considering the information in Figure 1 and your answer to (b) (i), discuss the effect of the following on the rate of production of oxygen:

a) Temperature

b) Manganese dioxide

In your discussion, include energy profile diagrams WHERE NECESSARY. **(10 marks)**

(iii) How will the mass of manganese dioxide at the end of the reaction compare to that at the beginning of Experiment I? Give ONE reason for your response. **(2 marks)**

(c) Describe how it can be confirmed that the gas produced in Experiment I is oxygen. **(2 marks)**

Total 20 marks

SECTION B

Answer ONE question from this section.

3. Ethanol is an important industrial compound. It finds widespread use as a solvent, in alcoholic beverages and as a fuel (gasohol). All ethanol used in alcoholic beverages and in gasoline is obtained by the fermentation process. A small amount of ethanol is also obtained from ethene. Ethanol produced from ethene cannot be used by law in the manufacture of alcoholic beverages.

(a) (i) Briefly discuss how ethanol can be obtained from

a) a fermentation process

b) ethene.

You should include in your answer the necessary reagents, the reaction conditions and any relevant chemical equations. **(9 marks)**

(ii) Draw a fully labelled diagram of the apparatus which can be used to obtain a sample of ethanol from the product mixture at the end of the fermentation process described in (a) (i) above. **(4 marks)**

(iii) How can it be determined that the sample collected in (a) (ii) above is ethanol? **(2 marks)**

(b) Ethanol is readily oxidized in the body to produce carbon dioxide and water. This reaction gives off 30 kJ per gram of ethanol consumed.

Calculate the amount of energy that will be produced when 100 cm^3 of an alcoholic drink is consumed. (Assume that the alcoholic drink contains 15% by weight of ethanol and that 1 cm^3 of the drink weighs 1 gram). **(2 marks)**

(c) The breath analyzer is used to detect the level of ethanol in the blood stream of suspected drunken drivers.

State the chemical principles upon which the breath analyzer test is based. **(3 marks)**

Total 20 marks

4. The extraction of a metal from its ore is dependent on its position in the electrochemical [illegible] Metals can be extracted by either electrochemical or chemical reductions.

(a) The following are suggested as possible routes for the extraction of magnesium and zinc from their respective oxides.

For magnesium

Route 1: $Mg\,O(s) \longrightarrow Mg(s)$ – chemical reduction

Route 2: $Mg\,O(s) \longrightarrow MgCl_2(aq) \longrightarrow MgCl_2(s) \longrightarrow Mg(s) + Cl_2(g)$ – electrochemical reduction

For zinc

Route 3: $ZnO(s) \longrightarrow Zn(s)$ – chemical reduction

Route 4: $ZnO(s) \longrightarrow ZnCl_2(aq) \longrightarrow ZnCl_2(s) \longrightarrow Zn(s) + Cl_2(g)$ – electrochemical reduction

Identify the more feasible route for the extraction of EACH of the pure metals from their oxides?

In EACH case give a reason for your answer. **(4 marks)**

(b) The conventional process for extracting aluminium metal from its ore is the electrolysis of bauxite.

Recently a more economical approach for the extraction of aluminium has been developed. It is called the Alcoa chlorine approach. This is shown below.

$$2\,Al_2O_3(s) + 6\,Cl_2(g) + 3\,C(s) \longrightarrow 4\,AlCl_3(s) + 3\,CO_2(g)$$

$$4\,AlCl_3(l) \xrightarrow{\text{electrolysis}} 4\,Al(l) + 6\,Cl_2(g)$$

The Alcoa Chlorine Process

Compared to bauxite (Al_2O_3), which has a melting point of 2054°C, $AlCl_3$ has a melting point of 192.6°C.

(i) Why is the conventional process uneconomical for refining bauxite in the Caribbean? **(2 marks)**

(ii) Why is the Alcoa chlorine approach a more economical process for refining bauxite? **(3 marks)**

(c) Aluminium, unlike iron, is used in the making of aircrafts.

(i) Give ONE reason why aluminium, and NOT iron, is used in the making of aircrafts. **(1 mark)**

(ii) Explain why iron rusts and aluminium does not rust. Support your answer with suitable balanced equations. **(10 marks)**

Total 20 marks

SECTION C

Answer ONE question from this section.

5. Fibres form the building blocks of raw materials from which fabrics are made. Fibres can occur naturally or can be produced synthetically.

(a) Fibres consist of monomers which are linked together to form macromolecules having suitable length, strength and flexibility.

(i) For EACH of the following sources, name ONE example of fibres used in the manufacture of fabrics:

a) Plant

b) Animal

c) Synthetic **(3 marks)**

(ii) For EACH of the fibre types named in (a) (i) above:

a) Give the type of monomer unit present in the fibres.

b) Illustrate, by means of suitable structures, how THREE of these monomer units can be linked together to form part of the macromolecules present in the fibres. **(9 marks)**

(b) All naturally occurring fibres have a great affinity for water either in the liquid or vapour form. This property makes these fibres suitable for making fabrics.

Suggest why it is recommended that in hot weather, you wear clothing made from naturally occurring fibres rather than from synthetic fibres. **(4 marks)**

(c) Mrs Welby buys fabric made from natural fibres as well as from synthetic fibres.

(i) Which type of fabric will be susceptible to destruction by micro-organisms?

(ii) Give TWO reasons for your answer.

In answering this question, you should consider the type of bonding in the fibres and the information given in (b) above. **(4 marks)**

Total 20 marks

6. Although nitrogen makes up 78% of the atmosphere, nitrogen molecules cannot be used directly by higher plants or by animals. Nitrogen first has to be converted into nitrates before it can be utilized by plants. This is shown as part of the nitrogen cycle in Figure 2.

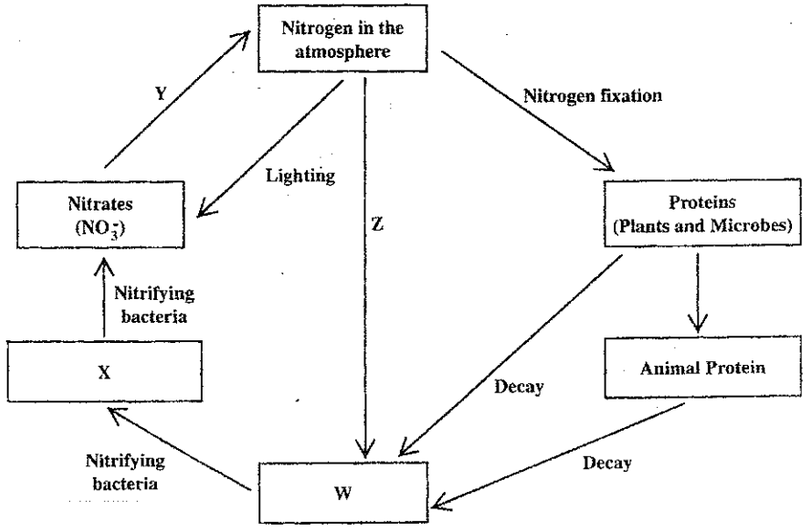


Figure 2. The nitrogen cycle

(a) (i) Identify W, X, Y and Z. **(4 marks)**

(ii) Explain the effects of step Y on the availability of nitrates to plants. **(3 marks)**

(b) Organic farming is a practice of growing crops without the use of synthetic fertilizers or any pesticides.

State THREE advantages and THREE disadvantages of organic farming. **(6 marks)**

(c) Discuss the possible long term implications of the widespread use of

(i) biological control

(ii) chemical control.

Your answer should include a definition of biological control and chemical control. **(7 marks)**

Total 20 marks

END OF TEST

You should NOT spend more than 30 minutes on this question.

1.

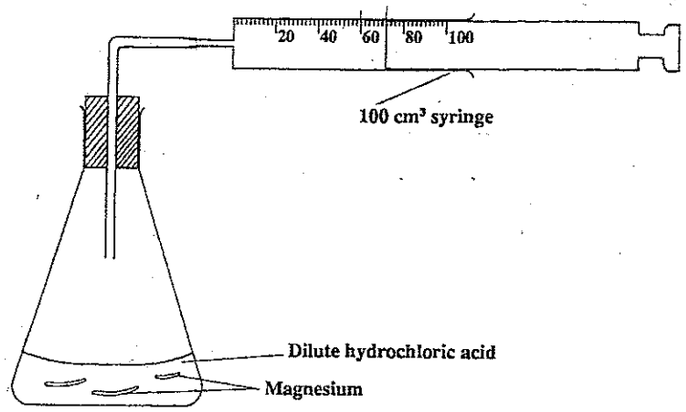


Figure 1

(a) (i) Write an ionic equation for the reaction taking place in the flask.

.....

(2 marks)

(ii) What is the volume of hydrogen collected in the syringe?

.....

(1 mark)

(iii) How many moles of hydrogen were collected at rtp?
(1 mol of any gas at rtp has a volume of 24 dm^3.)

.....

.....

.....

(2 marks)

(iv) How many moles of magnesium were used up?

.....

(1 mark)

(v) Explain why the volume of gas in the syringe determined in (ii) on page 2 is the volume of hydrogen produced, although air was already in the flask when the hydrogen was being produced.

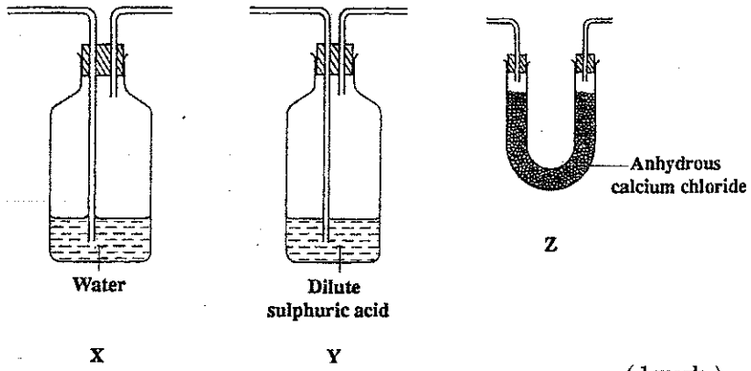
.....

.....

.....

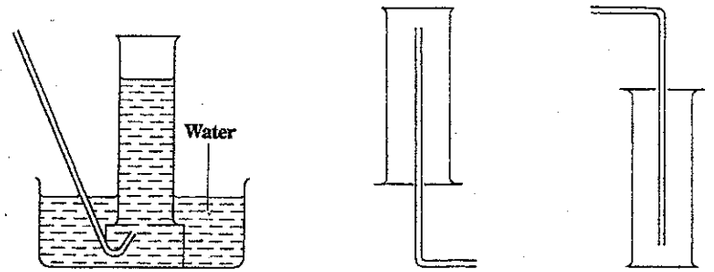
(1 mark)

(vi) You are required to collect a gas jar of dry hydrogen. Select from the diagrams below by circling **X**, **Y** or **Z**, the apparatus you would use for drying the gas.



(1 mark)

Select from the diagrams below by circling **P**, **Q** or **R**, the apparatus you would use to collect the gas after it was dried.



(1 mark)

(vii) In collecting the gas (see Figure 1 on page 2), it was important to stopper the flask as soon as the magnesium ribbon was added to the hydrochloric acid. However, in collecting the dry hydrogen in (vi) on page 3, some gas should be allowed to escape before collecting the dry hydrogen. Suggest a reason for this.

.....

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.....

(3 marks)

(b) Figure 2 below shows seven test tubes with the results obtained in precipitation reactions using 1.0 mol dm^{-3} lead (II) nitrate solution (M) and 1.0 mol dm^{-3} potassium iodide solution (N).
A key is given to help you interpret the results.

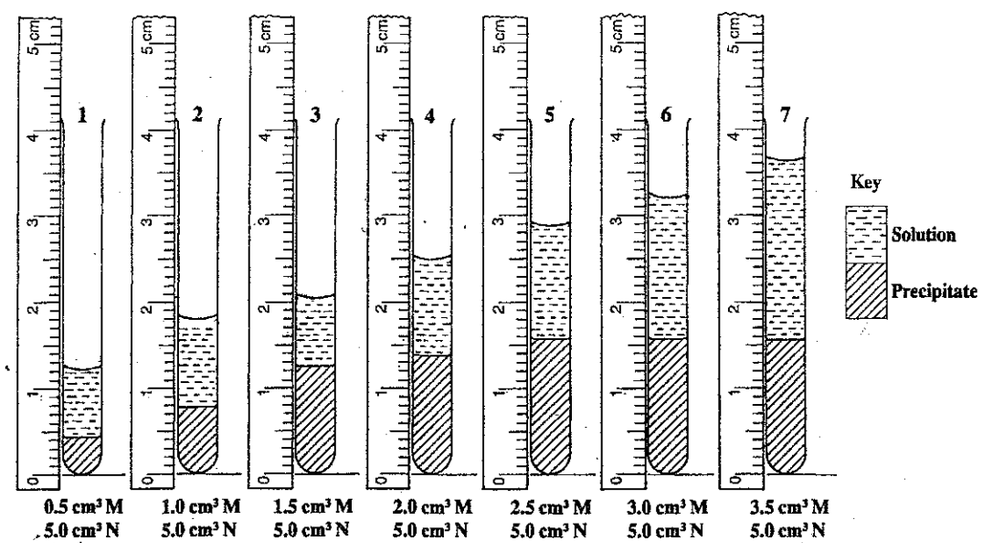


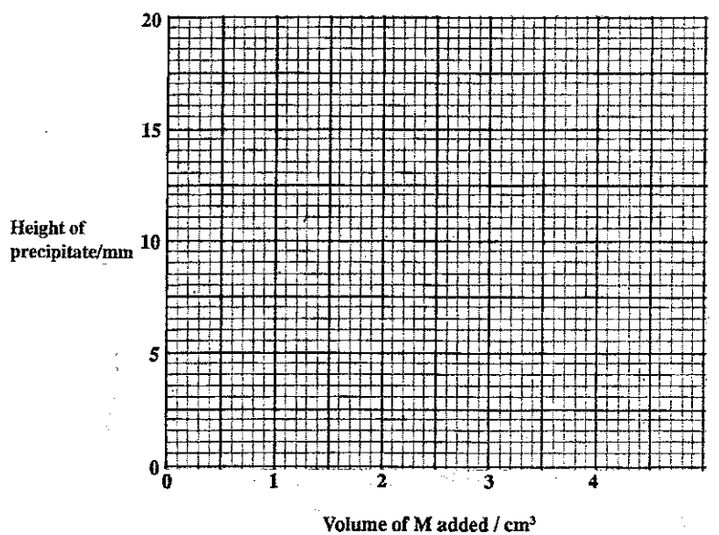
Figure 2

(i) Read off the height of the precipitate present in EACH test tube to the nearest millimetre and record it on the table below. (1 cm = 10 mm)

Volume of M added/cm^3	Height of precipitate/mm

(4 marks)

(ii) Plot the results on the grid below. Draw the line of best fit.



(6 marks)

(iii) In which test tube are the ions of neither solution M nor N in excess?

.....

(1 mark)

(iv) Name the ions present in the SOLUTION in Test tube 6 on page 4.

.....

(3 marks)

(v) Use the information in Figure 2 on page 4 to complete the statements below.

a) 5.0 cm^3 of solution N completely reacts with ..... cm^3 of Solution M.
(1 mark)

b) 1 mole of lead ions completely reacts with ..... moles of iodide ions.
(1 mark)

(vi) Use the answer in (v) b) to write the equation for the reaction taking place between lead ions and iodide ions.

.....

.....

(2 marks)

Total 30 marks

2. (a) Complete Table 1 below. You are NOT required to identify the species. Use the symbols X, Y and Z in writing the formulae of the chlorides.

Species	Atomic Number of Element	Mass Number of Element	Arrangement of Electrons in Species	Number of Neutrons in Nucleus	Formula of the Chloride	Type of Bonding in Chloride
X	6			6		
Y^+		23	2, 8			
Z		32		16		

Table 1

(12 marks)

(b) Illustrate, using an example, what you understand by the term 'isotope'.

.....

.....

.....

.....

(3 marks)

Total 15 marks

3. Polymer A can be represented by the formula $\cdots X-O-X-O-X\cdots$ and can be converted to simple sugars. Polymer A gives a blue black colour with iodine.

(a) State the name of Polymer A and the group of compounds to which it belongs.

.....

(2 marks)

(b) Give the name and molecular formula of a simple sugar that can be formed from Polymer A.

.....

(2 marks)

(c) State ONE difference in physical properties between Polymer A and a simple sugar.

.....

.....

.....

(1 mark)

(d) Explain how a simple sugar can be used to supply energy in the human body. Include a chemical equation to represent the reaction in your answer.

.....

.....

.....

.....

(4 marks)

(e) To a mixture of Polymer A in water, excess dilute hydrochloric acid was added and the mixture boiled. A few drops of iodine were then added. What would you observe?

.....

.....

(1 mark)

(f) Simple sugars are reducing agents. What would you expect to observe if a solution of iron (III) chloride were warmed with a simple sugar and some aqueous sodium hydroxide added? Write TWO ionic equations to support your answer.

.....

.....

.....

(5 marks)

Total 15 marks

4. An unknown mass of marble chips was added to an excess of 2 mol dm^{-3} hydroch... volume of gas evolved at specific times was measured using a gas syringe and the re... as shown on the graph in **Figure 3** below. Marble chips should be assumed to be pur... carbonate.

[Relative atomic masses: Ca = 40; C = 12; O = 16
1 mol of any gas at rtp has a volume of 24 dm^3.]

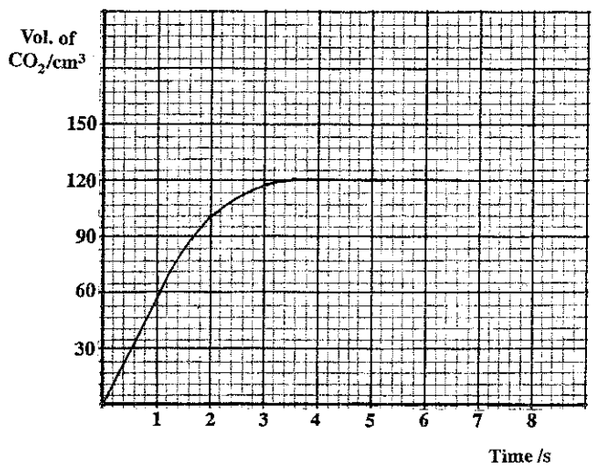


Figure 3

(a) Write a balanced equation for the reaction between hydrochloric acid and marble chips.

.....

.....

(2 marks)

(b) Use data from the graph to determine:

(i) The total volume of carbon dioxide evolved

.....

.....

(2 marks)

(ii) The mass of carbon dioxide evolved

.....

.....

(1 mark)

(iii) The mass of marble chips used

.....

.....

(2 marks)

(c) How would you show that the gas produced is carbon dioxide?

.....

.....

(2 marks)

(d) Explain why nitric acid and NOT sulphuric acid could be used to replace the hydrochloric acid used in the investigation.

.....

.....

.....

.....

(2 marks)

(e) Explain why the graph has the shape shown.

.....

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(2 marks)

(f) Suppose that this experiment were to be repeated using calcium carbonate powder in place of marble chips, would you expect it to be completed in a shorter or longer time? Explain your answer.

.....

.....

.....

.....

(2 marks)

Total 15 marks

GO ON TO THE NEXT PAGE

5. **Figure 4** is a diagram of an apparatus that could be used to prepare a dry sample of ammonia.

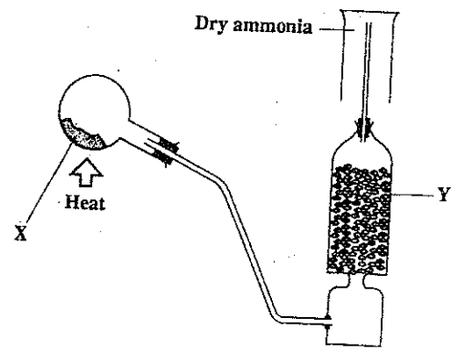

Figure 4

(a) **X** is a mixture of two compounds. Name them.

.....

(2 marks)

(b) Write an equation to show how the compounds in **X** react to form ammonia.

.....

.....

(2 marks)

(c) (i) Give the name of a compound that could be **Y**.

.....

(1 mark)

(ii) Why is it possible to collect ammonia using the method shown?

.....

.....

(1 mark)

(d) State the conditions necessary for the production of nitric acid from ammonia.

.....

.....

.....

(2 marks)

(e) What would you expect to observe if a sample of ammonia gas collected were bubbled into aqueous copper (II) sulphate until no further change took place.

.....

.....

.....

.....

(2 marks)

(f) Describe THREE ways in which the manufacture of ammonia in industry differs from the preparation shown in **Figure 4** on page 11.

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.....

(5 marks)

Total 15 marks

END OF TEST

SECTION ONE

Answer ONE question from this section.

1. (a) You were asked to prepare a pure dry sample of hydrated copper (II) sulphate crystals, starting with copper (II) oxide and 100 cm^3 sulphuric acid of concentration 1.0 mol dm^{-3}.

(i) Describe how, using the usual laboratory apparatus, you would prepare this sample. Write an equation for the reaction occurring. Calculate the mass of copper sulphate crystals ($CuSO_4.5H_2O$) you would expect to obtain from the preparation.
(Relative atomic mass: Cu = 64; S = 32; O = 16; H = 1)

(ii) The supply of copper (II) oxide ran out. The teacher suggested that copper oxide could be prepared by heating either copper nitrate (a deliquescent* compound) or copper (II) carbonate (a fine powder).

Which of the these two compounds is more suitable for the preparation of copper oxide? Give ONE reason for your choice.

Write balanced equations for the action of heat on a) copper (II) nitrate and b) copper (II) carbonate.

(*Deliquescent means the compound absorbs moisture from the atmosphere and dissolves in it.)
(18 marks)

(b) Some distilled water was added to separate samples of (i) copper (II) nitrate and (ii) copper (II) carbonate and the mixtures stirred and filtered. A few drops of sodium hydroxide solution were added to each filtrate.

What would you expect to observe with EACH filtrate? **(2 marks)**

Total 20 marks

2. (a) Describe the steps that you would take to prepare 2 dm^3 of 0.1 mol dm^{-3} hydrochloric acid, starting with 8.0 mol dm^{-3} hydrochloric acid and using standard laboratory apparatus. **(8 marks)**

(b) Certain insoluble salts are formed when tests to identify anions are carried out in the laboratory.

Name TWO reagents that are used for this purpose. For EACH reagent, give the name of ONE ion that it identifies. Write an ionic equation to represent EACH of these reactions. (Include state symbols.) **(6 marks)**

(c) The Head of the Science Department was given the following advice on how to dispose of 2 dm^3 of concentrated sulphuric acid that was badly contaminated and no longer suitable for use in the laboratory:

"Pour it down the concrete drain leading from the laboratory, when there is a heavy shower of rain."

Give your view on this advice with THREE supporting reasons.

Suggest another way of disposing of concentrated sulphuric acid. **(6 marks)**

Total 20 marks

SECTION TWO

Answer ONE question from this section.

3. Plans are being made to send a manned spacecraft early in this century to the planet Mars. To avoid the need to take fuel for the return journey, it is proposed that an unmanned spacecraft be sent ahead of time with the capability of generating the required fuel. Hydrogen sent from Earth is to be combined with carbon dioxide on Mars to form methane (fuel) and water. The water would then be electrolysed.

(a) Write a balanced equation for the production of methane from hydrogen and carbon dioxide. **(2 marks)**

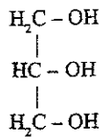
(b) (i) Describe the electrolysis of water, including the conditions that would be required for this to take place. Write the relevant electrode equations. (Include a diagram of the apparatus used to carry out this process.)

(ii) Suggest TWO ways that the astronauts could make use of the products of the electrolysis to ensure their safe return to Earth. **(14 marks)**

(c) The use of nuclear fuel for space flights has been ruled out in the past. Suggest TWO advantages and TWO disadvantages of using nuclear fuel for the Mars journey. **(4 marks)**

Total 20 marks

4. Fats are esters derived from long chain organic acids and the trihydroxy alcohol, glycerol. Glycerol has the following structure:



Glycerol

(a) (i) Write a balanced equation to represent the reaction which is expected to take place when glycerol reacts completely with EACH of the following:

a) Sodium

b) A long chain organic acid of formula, R'COOH

(ii) Describe what you would expect to observe when glycerol is heated with acidified potassium dichromate solution. Give a reason for your answer.

(iii) How would you expect the solubility of glycerol in water to differ from that of the product obtained when glycerol reacts completely with the acid, R'COOH ? Give TWO reasons for your answer.

(iv) Assuming that the organic acid, R'COOH, is a straight chain saturated acid, calculate the number of hydrogen atoms that would be present in the R' group that contains 18 carbon atoms. **(15 marks)**

(b) (i) Describe how you would prepare a sample of soap from a sample of fat.

(ii) State TWO ways in which this soap differs from a soapless detergent. **(5 marks)**

Total 20 marks

SECTION THREE

Answer ONE question from this section.

5. Paints, fibres, glass and alloys are some of the common materials found in and around the home.

(a) Paints are generally composed of a solid and a liquid.

(i) Give the name and chemical formula of a solid used in paint.

(ii) Give the name of ONE chemical used as a liquid in an oil-based paint and ONE used in an emulsion. **(4 marks)**

(b) (i) Give the name of ONE vegetable fibre and ONE animal fibre used in making fabrics.

(ii) Draw TWO diagrams, one to represent part of the chemical structure of a vegetable fibre and the other to represent part of the chemical structure of an animal fibre. **(6 marks)**

(c) (i) Chemically, glass is a mixture of silicates and silicon dioxide. The silicate ion has the formula SiO_3^{2-}. Select ONE type of glass and give the chemical formulae of two silicates used in its manufacture.

(ii) State ONE important property of this type of glass and relate this property to its major use. **(4 marks)**

(d) Brass is an alloy containing copper and zinc.

(i) What is meant by the term 'alloy'?

(ii) Describe how you would test for the presence of zinc in brass. Include ONE chemical equation to represent one of the TWO steps that would be necessary in the test. **(6 marks)**

Total 20 marks

6. There are many substances that are essential for healthy plant growth. This question addresses some of them.

(a) Give the names and chemical symbols of FOUR important elements essential for plant growth. For any TWO of the elements named, identify ONE source of each and ONE effect of its deficiency.

(6 marks)

(b) Figure 1 below represents part of the Nitrogen Cycle in nature. Some of the names of reactions and compounds formed have been replaced by the letters A, B, C, D and E.

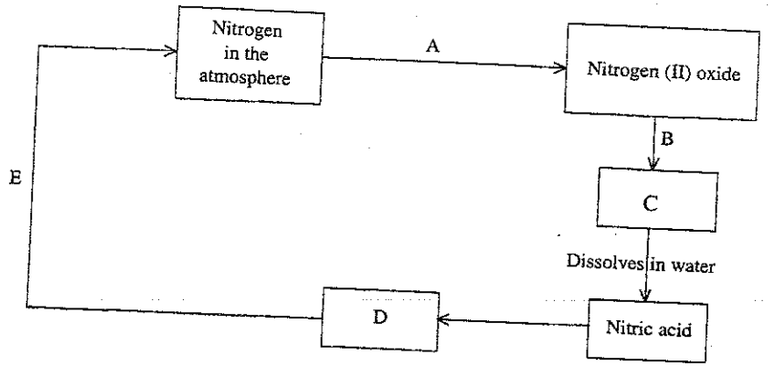


Figure 1

(i) Write the names of the types of chemical reactions taking place at A, B and E.

(ii) Write the name and chemieal formula of Compound C.

(iii) Name the type of compound that should be placed in Box D.

(6 marks)

(c) Lime is added to soils to increase the pH and reduce the problems caused by acid soils, but it can also cause nitrogen to be lost from the soil.

(i) State ONE problem associated with acid soils.

(ii) Explain how the addition of lime can increase the pH of an acid soil.

(iii) Suggest ONE way in which lime can cause nitrogen to be lost from the soil. (Include a balanced ionic equation.)

(5 marks)

(d) Hydroponics is an alternative method of growing crops, but there are problems linked with its use.

Identify TWO such problems and suggest ONE way in which an attempt could be made to solve ONE of these problems.

(3 marks)

Total 20 marks