2.3 CHEMISTRY (233)

2.3.1 Chemistry Paper 1 (233/1)

1 (a) What name is given to the process by which alcohol is formed from a carbohydrate?

(1 mark)

(b) Explain why the solubility of ethane in water is lower than that of ethanol.

(2 marks)

2 Complete the nuclear equation below:

(a) $^{131}_{53}I \longrightarrow \, ^{131}_{54}Xe \, + \, \underline{\hspace{2cm}}$

(1 mark)

(b) The half-life of $^{131}_{53}I$ is 8 days.

Determine the mass of $^{131}_{53}I$ remaining if 50 grammes decayed for 40 days.

(1 mark)

(c) Give **one** harmful effect of radioisotopes.

(1 mark)

3 A mixture contains ammonium chloride, copper (II) oxide and sodium chloride. Describe how each of the substances can be obtained from the mixture.

(3 marks)

4 The set-up below shows how nitrogen gas is prepared in the laboratory.
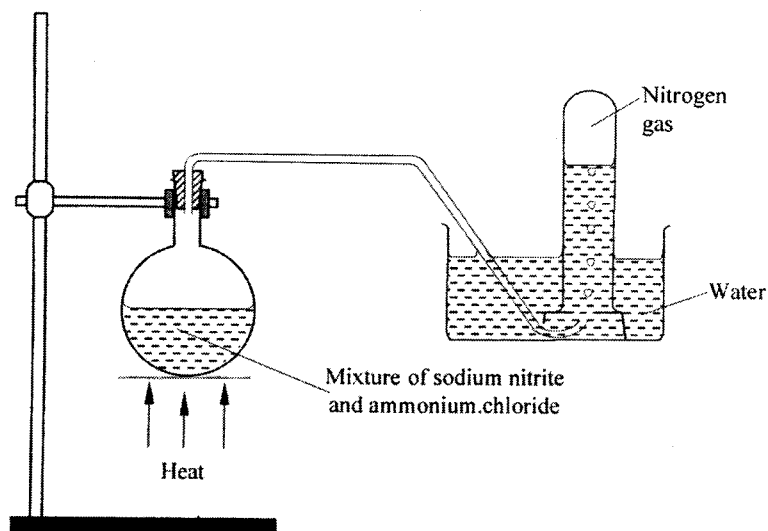
(a) Describe how nitrogen gas is formed in the flask.

(2 marks)

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(b) Nitrogen is inert. State **one** use of the gas based on this property. (1 mark)

5 The diagram below represents part of the periodic table. Use it to answer the questions that follow:

(a) Write the electronic arrangement for the stable ion formed by W. (1 mark)

(b) Write an equation for the reaction between V and Q. (1 mark)

(c) How do the ionisation energies of the elements M and T compare? Explain. (1 mark)

6 A certain mass of gas occupies $0.15dm^3$ at 293K and 98,648.5Pa. Calculate its volume at 101325Pa and 273K. (2 marks)

7 When lead(II) nitrate is heated, one of the products is a brown gas.

(a) Write the equation of the reaction that occurs. (1 mark)

(b) If $0.290dm^3$ of the brown gas was produced, calculate the mass of the lead(II) nitrate that was heated. (R.F.M of lead (II) nitrate = 331; Molar gas volume = $24dm^3$). (2 marks)

8 (a) What is meant by a strong acid? (1 mark)

(b)   In an experiment, 40cm³ of 0.5M hydrochloric acid was reacted with excess sodium carbonate and the volume of carbon (IV) oxide produced recorded with time.
In another experiment, the same volume and concentration of ethanoic acid was also reacted with excess sodium carbonate and the volume of carbon(IV) oxide produced recorded with time.

On the grid below, sketch and label the curves if the volumes of carbon (IV) oxide were plotted against time.   (2 marks)
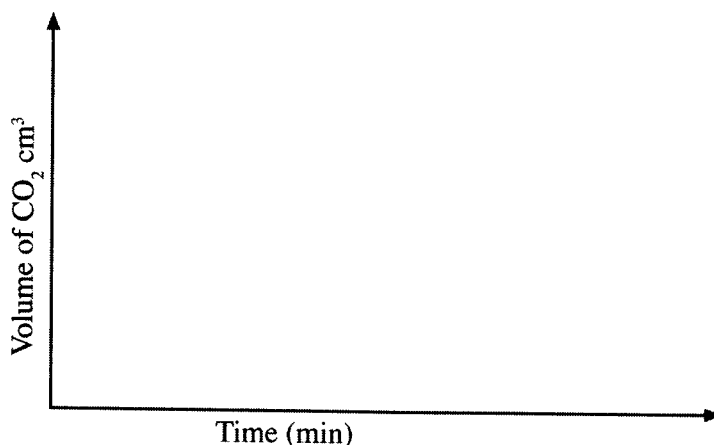
9   State **two** reasons why hydrogen is **not** commonly used as a fuel.   (2 marks)
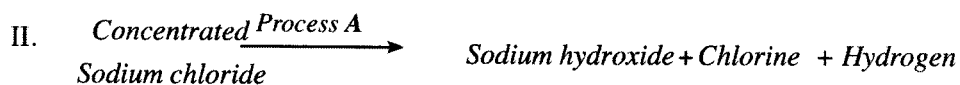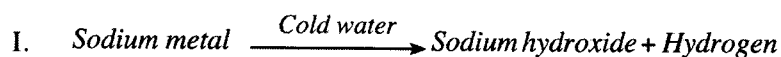
10   During a class experiment, chlorine gas was bubbled into a solution of potassium iodide.

(a)   State the observations made.   (1 mark)

(b)   Using an ionic equation, explain why the reaction is redox.   (2 marks)

11   Exhaust fumes of some cars contain carbon (II) oxide and other gases.

(a)   Explain how carbon (II) oxide is formed in the internal combustion engines.
                                                                              (1 mark)

(b)   Name **two** gases other than carbon (II) oxide that are contained in exhaust fumes and are pollutants.   (2 marks)

12   Sodium hydroxide can be prepared by the following methods; I and II.

I.   *Sodium metal* $\xrightarrow{\text{Cold water}}$ *Sodium hydroxide + Hydrogen*

II.   *Concentrated* $\xrightarrow{\text{Process A}}$ *Sodium hydroxide + Chlorine + Hydrogen*
      Sodium chloride

(a)   Name **one** precaution that needs to be taken in method I.   (1 mark)

(b)   Give the name of process A.   (1 mark)

(c)   Give **one** use of sodium hydroxide.   (1 mark)

13   Distinguish between the terms deliquescent and efflorescent as used in chemistry.

                                                                                (2 marks)

14   Two organic compounds P and Q decolourise acidified potassium manganate (VII) solution;
        but only P reacts with sodium metal to give a colourless gas.
   Which homologous series does compound P belong?   Give a reason.   (2 marks)

15   Soap dissolves in water according to the equation below;

        $NaSt_{(aq)} \longrightarrow Na_{(aq)}^+ \quad + \quad St^-$ where St^- is the stearate ion.
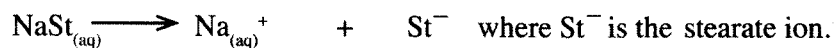
        (a)   Write the formula of the scum formed when soap is used in hard water.   (1 mark)

        (b)   Write the ionic equation for the reaction that occurs when sodium carbonate is used
                to remove hardness in water.   (1 mark)

16   Ethanoic acid and ethanol react as shown in the equation below:

        $$CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightleftharpoons CH_3COOC_2H_{5\,(l)} + H_2O_{(l)}$$
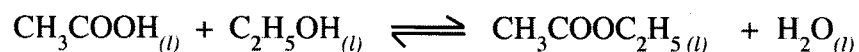
        Other than warming, how would the state of equilibrium be established within a short time?
                                                                                (1 mark)

17 The set up below was used to prepare a gas and study some of its properties. Study it and answer the questions that follow:
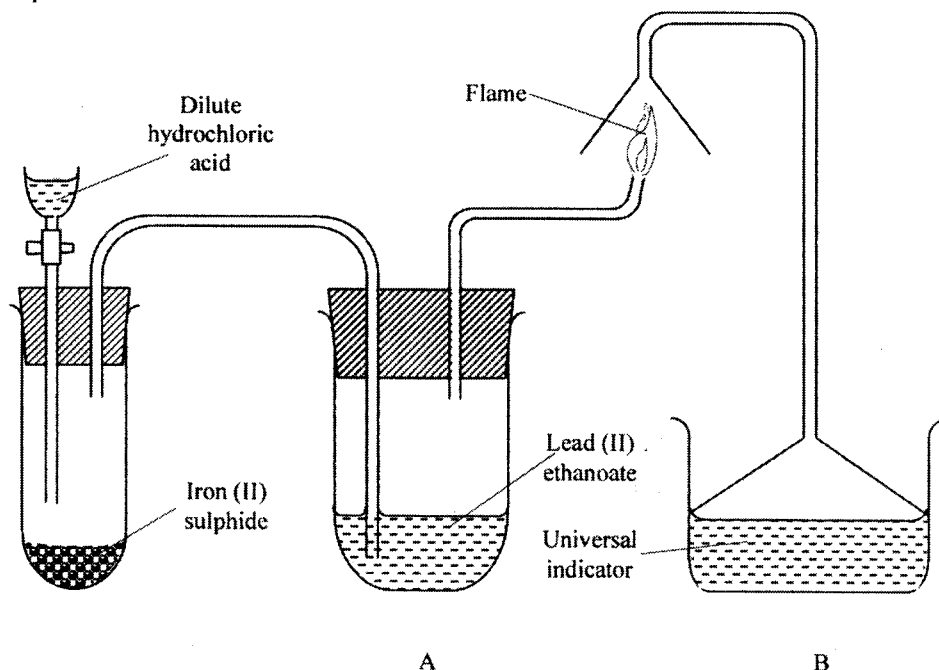
(a) State and explain the observations made in the:

(i) tube labelled A; (1 mark)

....

(ii) beaker labelled B. (1 mark)

....

(b) State **one** precaution that should be taken when carrying out this experiment.

(1 mark)

....

18 Under certain conditions, chlorine gas reacts with sodium hydroxide to form sodium hypochlorite.

(a) Name the conditions under which sodium hydroxide reacts with chlorine to form sodium hypochlorite. (1 mark)

(b) State **two** uses of sodium hypochlorite. (2 marks)

19 50kg of ammonium sulphate $(NH_4)_2SO_4$ and 30kg of urea $CO(NH_2)_2$ fertilizers were applied in two equal sizes of plots A and B to enrich their nitrogen content. Show by working, which plot was more enriched with nitrogen. (N = 14; S = 32; O = 16; C = 12; H = 1)

(3 marks)

20 Describe how the P^H of anti-acid (Actal) powder can be determined in the laboratory.

(2 marks)

21 Graphite is one of the allotropes of carbon.

(a) Name **one** other element which exhibits allotropy. (1 mark)

22 The table below gives some properties of three elements in group (VII) of the periodic table. Study it and answer the questions that follow:

| Element	Atomic No.	Melting Point (°C)	Boiling Point (°C)
Chlorine	17	-101	-34.7
Bromine	35	-7	58.8
Iodine	53	114	184

(a) Which element is in liquid form at room temperature? Give a reason. (1 mark)

(b) Explain why the boiling point of iodine is much higher than that of chlorine.

(2 marks)

23 The thermalchemical reaction between carbon and sulphur is as shown by the equation below:

$$C_{(s)} + 2S_{(s)} \longrightarrow CS_{2(l)} \qquad \Delta H = {}^{+}117.0 \text{ kJmol}^{-1}.$$
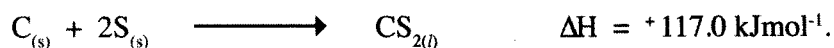
On the grid below, sketch and label the energy level diagram for the reaction. (2 marks)

Reaction co-ordinate

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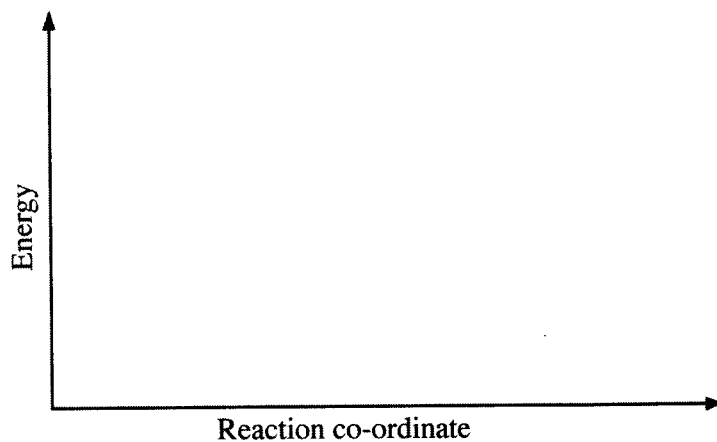
24 The table below gives the number of electrons, protons and neutrons in substances X, Y and Z. Study it and answer the questions that follow.
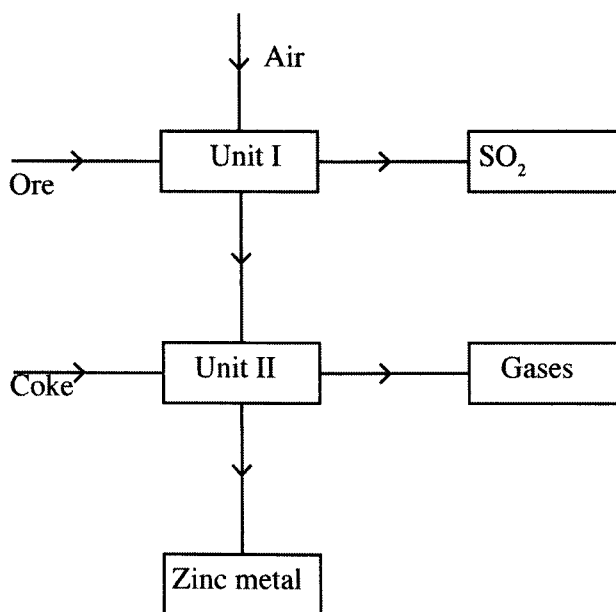
Substance	Electrons	Protons	Neutrons
X	10	10	10
Y	10	8	10
Z	8	8	8

    (a)   Which letter represents an ion?   (1 mark)

    (b)   Which of the substances are isotopes? Give a reason.   (2 marks)

25   (a)   State the Gay Lussac's Law.   (1 mark)

    (b) $10cm^3$ of a gaseous hydrocarbon, C_2H_x required $30cm^3$ of oxygen for complete combustion. If steam and $20cm^3$ of carbon (IV) oxide were produced, what is the value of X?   (2 marks)

26 The data given below was recorded when metal M was completely burnt in air. M is not the actual symbol of the metal. (R.A.M; M = 56, O =16)
Mass of empty crucible and lid = 10.240g
Mass of crucible, lid and metal M = 10.352g
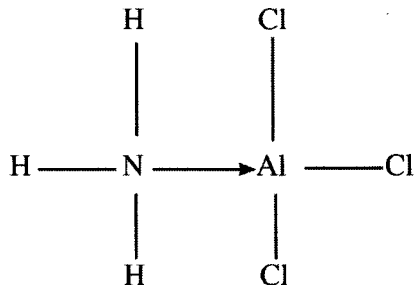Mass of crucible, lid and metal oxide = 10.400g

    (a)   Determine the mass of: (½ mark)

        (i)   metal M;

        (ii)   oxygen.   (½ mark)

    (b)   Determine the empirical formula of the metal oxide.   (2 marks)

27   The flow chart below shows some processes involved in the industrial extraction of zinc metal.

```
                              ↓ Air
                        ┌──────────┐        ┌──────────┐
        Ore  ──────→    │  Unit I  │ ──→    │   SO₂    │
                        └──────────┘        └──────────┘
                              │
                              ↓
                        ┌──────────┐        ┌──────────┐
        Coke ──────→    │ Unit II  │ ──→    │  Gases   │
                        └──────────┘        └──────────┘
                              │
                              ↓
                        ┌──────────┐
                        │Zinc metal│
                        └──────────┘
```

(a)   Name **one** ore from which zinc is extracted.   (1 mark)

(b)   Write the equation of the reaction taking place in unit II.   (1 mark)

(c)   Name **two** uses of zinc metal.   (1 mark)

**28**   The diagram below shows the bonding between aluminium chloride and ammonia.

```
              H            Cl
              |            |
              |            |
    H ———— N ———→ Al ———— Cl
              |            |
              |            |
              H            Cl
```

(a)   Name the types of bonds that exist in the molecule.   (1 mark)

(b)   How many electrons are used for bonding in the molecule?   (1 mark)

29   Explain why the following substances conduct an electric current.

(a)   Magnesium metal.   (1 mark)

(b)   Molten magnesium chloride.   (1 mark)

30   A sample of river water is suspected to contain zinc and sulphate ions.
Describe how the presence of zinc ions and sulphate ions can be established.   (3 marks)

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1   The flow chart below shows some of the processes involved in large scale production of sulphuric (VI) acid. Use it to answer the questions that follow.
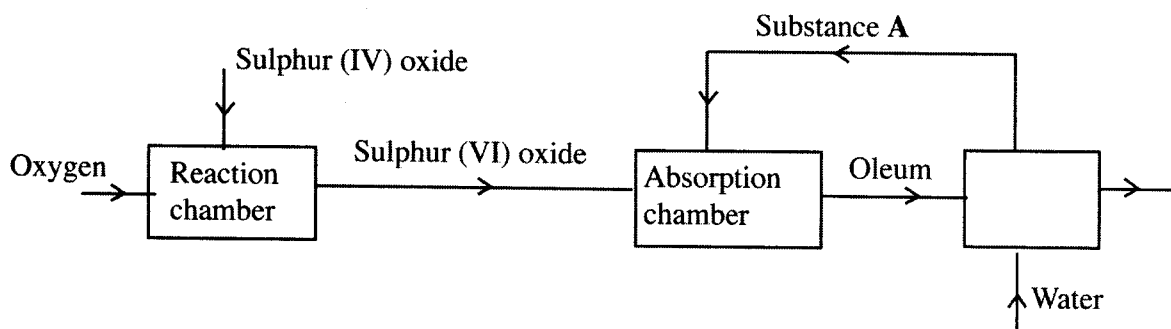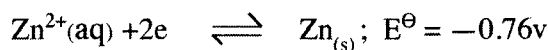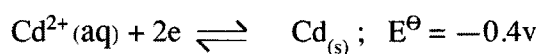

(a)   Describe how oxygen is obtained from air on a large scale.   (3 marks)

(b)   (i)   Name substance **A**.   (1 mark)

....

(ii)   Write an equation for the process that takes place in the absorption chamber.   (1 mark)

(c)   Vanadium (V) oxide is a commonly used catalyst in the contact process.

(i)   Name another catalyst which can be used for this process.   (1 mark)

(ii)   Give **two** reasons why vanadium (V) oxide is the commonly used catalyst.   (2 marks)

(d)   State and explain the observations made when concentrated sulphuric (VI) acid is added to crystals of copper (II) sulphate in a beaker.   (2 marks)

(e)   The reaction of concentrated sulphuric (VI) acid with sodium chloride produces hydrogen chloride gas. State the property of concentrated sulphuric (VI) acid illustrated in this reaction.   (1 mark)

(f)   Name **four** uses of sulphuric (VI) acid.   (2 marks)

2   The set-up below was used by a student to investigate the products formed when aqueous copper (II) chloride was electrolysed using carbon electrodes.
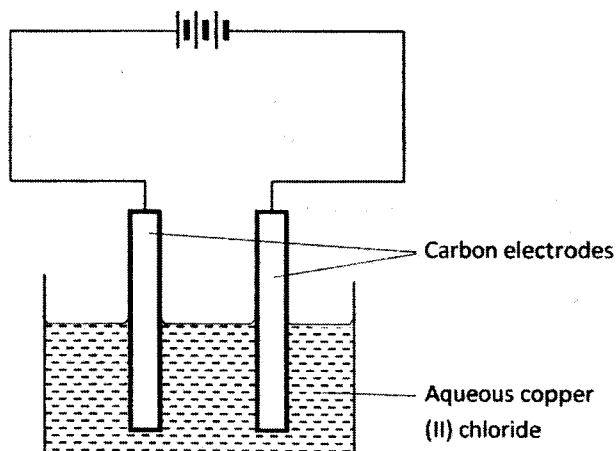
(a)   (i)   Write the equation for the reaction that takes place at the cathode.   (1 mark)

(ii)   Name and describe a chemical test for the product initially formed at the anode when a highly concentrated solution of copper (II) chloride is electrolysed.
(3 marks)

(iii)   How would the mass of the anode change if the carbon anode was replaced with copper metal? Explain.   (2 marks)

(b)   0.6 g of metal B were deposited when a current of 0.45A was passed through an electrolyte for 72 minutes. Determine the charge on the ion of metal B.
(Relative atomic mass of B = 59, 1 Faraday = 96 500 coulombs)   (3 marks)

(c)   The electrode potentials for cadmium and zinc are given below:

$$Cd^{2+}(aq) + 2e \rightleftharpoons Cd_{(s)} ; \quad E^{\ominus} = -0.4v$$

$$Zn^{2+}(aq) + 2e \rightleftharpoons Zn_{(s)} ; \quad E^{\ominus} = -0.76v$$

Explain why it is **not** advisable to store a solution of cadmium nitrate in a container made of zinc.   (2 marks)

3   (a)   Ethanol can be manufactured from ethene and steam as shown in the equation below:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g)$$

Temperature and pressure will affect the position of equilibrium of the above reaction. Name the other factor that will affect the position of equilibrium of the above reaction.   (1 mark)

(b)   The data in the table below was recorded when one mole of ethene was reacted with excess steam. The amount of ethanol in the equilibrium mixture was recorded under different conditions of temperature and pressure. Use the data to answer the questions that follow.

Temperature ($^{\circ}$C)	Pressure (Atm)	Amount of ethanol at equilibrium (Moles)
300	50	0.40
300	60	0.46
300	70	0.55
250	50	0.42
350	50	0.38

(i)   State whether the reaction between ethene and steam is exothermic or endothermic. Explain your answer.   (3 marks)

(ii)   State and explain **one** advantage and **one** disadvantage of using extremely high pressure in this reaction.

        I.   Advantage   (2 marks)

        II.   Disadvantage   (2 marks)

(c)   In an experiment to determine the rate of reaction between calcium carbonate and dilute hydrochloric acid, 2g of calcium carbonate were reacted with excess 2 M hydrochloric acid. The volume of carbon (IV) oxide evolved was recorded at regular intervals of one minute for six minutes. The results are shown in the table below.

Time (minutes)	1	2	3	4	5	6
Volume of carbon (IV) oxide (cm^3)	170	296	405	465	480	480

(i)   Plot a graph of time in minutes on the horizontal axis against volume of carbon (IV) oxide on the vertical axis.   (3 marks)
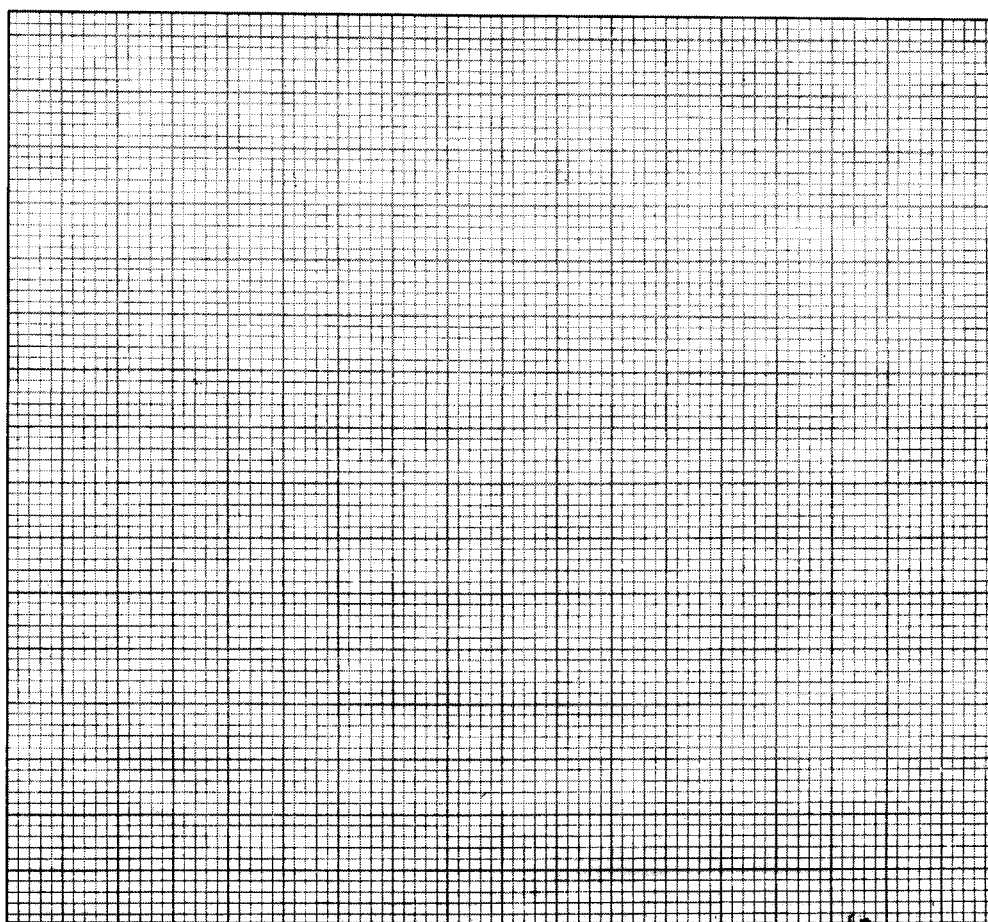
(ii)   Determine the rate of reaction at 4 minutes.   (2 marks)

4   (a)   When excess calcium metal was added to 50 cm^3 of 2 M aqueous copper (II) nitrate in a beaker, a brown solid and bubbles of gas were observed.

(i)   Write **two** equations for the reactions which occurred in the beaker.   (2 marks)

(ii)   Explain why it is **not** advisable to use sodium metal for this reaction.
                                        (2 marks)

(b) Calculate the mass of calcium metal which reacted with copper (II) nitrate solution. (Relative atomic mass of Ca = 40) (2 marks)

(c) The resulting mixture in (a) above was filtered and aqueous sodium hydroxide added to the filtrate dropwise until in excess. What observations were made?

(1 mark)

(d) (i) Starting with calcium oxide, describe how a solid sample of calcium carbonate can be prepared. (3 marks)

(ii) Name **one** use of calcium carbonate. (1 mark)

5 (a) Other than their location in the atom, name **two** other differences between an electron and a proton. (2 marks)

(b) The table below gives the number of electrons, protons and neutrons in particles **A, B, C, D, E, F** and **G**.

Particle	Protons	Electrons	Neutrons
A	6	6	6
B	10	10	12
C	12	10	12
D	6	6	8
E	13	10	14
F	17	17	18
G	8	10	8

(i) Which particle is likely to be a halogen? (1 mark)

(ii) What is the mass number of **E**? (1 mark)

(iii) Write the formula of the compound formed when **E** combines with **G**.

(1 mark)

(iv) Name the type of bond formed in (iii) above.

(1 mark)

(v) How does the radii of **C** and **E** compare? Give a reason. (2 marks)

(vi) Draw a dot (.) and cross (x) diagram for the compound formed between **A** and **F**. (1 mark)

(vii) Why would particle **B** not react with particle **D**? (1 mark)

6 (a) Study the flow chart below and answer the questions that follow.
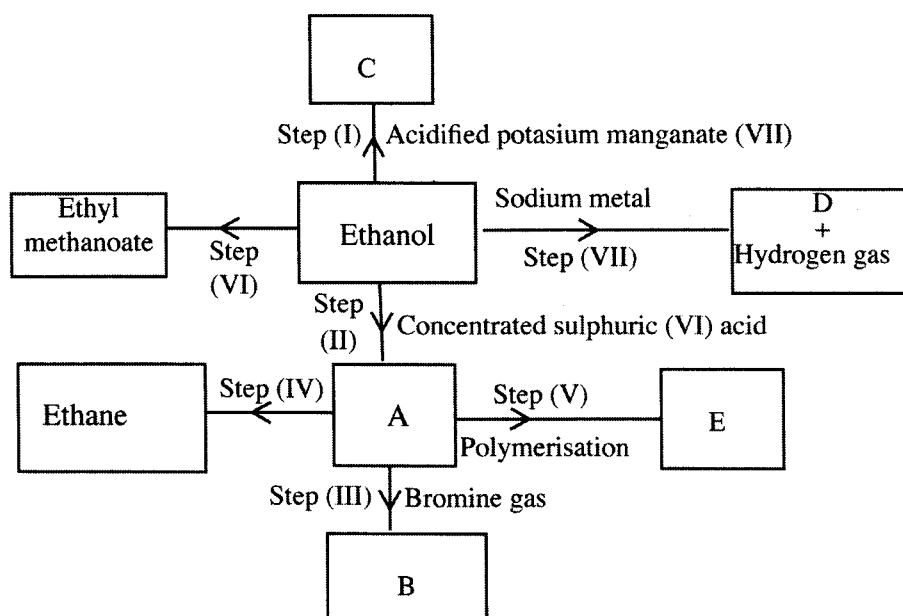
(i) I What observation will be made in Step I? (1 mark)

    II Describe a chemical test that can be carried out to show the identity of compound **C**. (2 marks)

(ii) Give the names of the following: (2 marks)

    I **E** ....

    II Substance **D** ....

(iii) Give the formula of substance **B**. (1 mark)

....

(iv) Name the type of reaction that occurs in: (1 mark)

    I Step (II) ....

    II Step (IV) ....

(v) Give the reagent and conditions necessary for Step (VI). (2 marks)

    Reagent: ....

    Conditions ....

(b) (i) Name the following structure.

$$H - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - OH$$
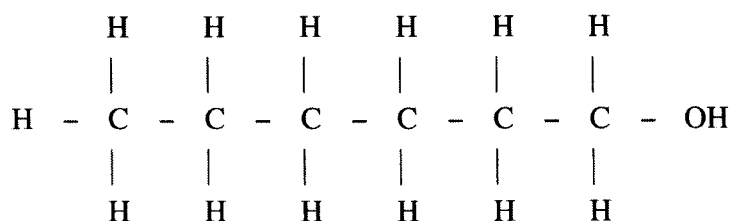
(1 mark)

....

(ii) Draw the structure of an isomer of pentene. (1 mark)

7 (a) What is meant by molar heat of combustion? (1 mark)

(b) State the Hess's Law. (1 mark)

(c) Use the following standard enthalpies of combustion of graphite, hydrogen and enthalpy of formation of propane.

ΔH_C^θ (Graphite) $= -393 kJ\ mol^{-1}$

$\Delta H_C^\theta (H_2(g)) = -286 kJ\ mol^{-1}$

$\Delta H_f^\theta (C_3H_8(g)) = -104 kJ\ mol^{-1}$

(i) Write the equation for the formation of propane. (1 mark)

(ii) Draw an energy cycle diagram that links the heat of formation of propane with its heat of combustion and the heats of combustion of graphite and hydrogen.
(3 marks)

(iii) Calculate the standard heat of combustion of propane. (2 marks)

(d) Other than the enthalpy of combustion, state **one** factor which should be considered when choosing a fuel. (1 mark)

(e) The molar enthalpies of neutralization for dilute hydrochloric acid and dilute nitric (V) acid are −57.2kJ/mol while that of ethanoic acid is −55.2kJ/mol. Explain this observation.
(2 marks)

3.3.3 Chemistry Paper 3 (233/3)

1   You are provided with:

- 1.60g of solid **A**, a dibasic acid.
- Solution **B** containing 4.75g per litre of salt **B**.
- Aqueous sodium hydroxide, solution **C**.
- Phenolphthalein indicator.

You are required to prepare a solution of solid **A** and use it to determine the:-

- Concentration of sodium hydroxide, solution **C**
- React salt **B** with excess sodium hydroxide and then determine the relative molecular mass of salt **B**.

Procedure I

(a)   Using a burette, place $25.0cm^3$ of solution **B** in each of two 250ml conical flasks. Using a pipette and **pipette filler**, add $25.0cm^3$ of solution **C** to each of the two conical flasks. (The sodium hydroxide added is in excess). Label the conical flasks 1 and 2.

(b)   Heat the contents of the first conical flask to boiling and then let the mixture boil for 5 minutes. Allow the mixture to cool.

(c)   Repeat procedure (b) with the second conical flask.

While the mixtures are cooling, proceed with procedure II.

Procedure II

(a)   Place **all** of solid **A** in a 250 ml volumetric flask. Add about $150cm^3$ of distilled water, shake well to dissolve the solid and then add water to make up to the mark. Label this as solution **A**.

(b)   Place solution **A** in a clean burette. Using a pipette and **pipette filler**, place $25.0cm^3$ of solution **C** in a 250ml conical flask. Add 2 drops of phenolphthalein indicator and titrate with solution **A**. Record your results in Table 1. Repeat the titration two more times and complete the table.

Table 1

	I	II	III
Final burette reading			
Initial burette reading			
Volume of solution A used (cm^3)			

(4 marks)

Calculate the:-

(i)   average volume of solution A used: ($\frac{1}{2}$ mark)

(ii)   concentration in moles per litre of the dibasic acid in solution A;   (2 marks)
        (Relative molecular mass of A is 126).

(iii)   moles of the dibasic acid used;   (1 mark)

(iv)   moles of sodium hydroxide in 25.0cm^3 of solution C.   (1 mark)

(v)   concentration of sodium hydroxide in moles per litre.   (2 marks)

Procedure III

Add 2 drops of phenolpthalein indicator to the contents of the first conical flask prepared in procedure I and titrate with solution A. Record your results in Table 2. Repeat the procedure with the contents of the second conical flask and complete the table.

Table 2

	1st conical flask	2nd conical flask
Final burette reading		
Initial burette reading		
Volume of solution A used (cm^3)		

(3 marks)

Calculate the:-

(i)   average volume of solution A used;   (½ mark)

(ii)   moles of the dibasic acid used;   (1 mark)

(iii)   moles of sodium hydroxide that reacted with the dibasic acid.   (1 mark)

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(iv)   moles of sodium hydroxide that reacted with 25.0cm³ of salt **B** in solution **B**;

(2 marks)

(v)   Given that 1 mole of salt **B** reacts with 2 moles of sodium hydroxide, calculate the:

I.   number of moles of salt **B** in 25.0cm³ of solution **B**;   (1 mark)

II.   concentration in moles per litre of salt **B** in solution **B**;   (1 mark)

III.   relative molecular mass of salt **B**;   (2 marks)

2   (a)   You are provided with solid **D**. Carry out the following tests and write your observations and inferences in the spaces provided.

(i)   Place about one half of solid **D** in a test-tube and heat it strongly. Test any gases produced with both red and blue litmus papers.

Observations	Inferences
(2 marks)	(1 mark)

(ii)   Place the rest of solid **D** in a boiling tube. Add about 10cm³ of distilled water. Shake well.

To a 2cm³ portion of the solution, add about 1cm³ of hydrogen peroxide and shake well. To the resulting mixture, add aqueous sodium hydroxide dropwise until in excess.

Observations	Inferences
(1 mark)	(1 mark)

(b)   You are provided with solution **E**. Carry out the following tests and write your observations and inferences in the spaces provided.
Divide solution **E** into **two** portions.

(i)   To one portion of solution **E** in a test-tube, add 3 drops of barium nitrate.
Retain the mixture for use in test (ii) below.

Observations	Inferences
(1 mark)	(2 marks)

(ii)   To the mixture obtained in (i) above, add about 5 cm³ of 2M nitric (V) acid.

Observations	Inferences
(1 mark)	(1 mark)

(iii)   To portion two of solution E in a test-tube, add 2 drops of acidified potassium dichromate (VI) and warm the mixture.

3   You are provided with liquid F. Carry out the following tests and record your observations and inferences in the spaces provided.

(a)   Place five drops of liquid F on a clean dry watch glass and ignite it.

Observations	Inferences
(1 mark)	(1 mark)

(b)   Place about 2cm³ of liquid F in a clean dry test-tube, add all the sodium hydrogen carbonate provided.

Observations	Inferences
(1 mark)	(1 mark)

(c)   Place about 2cm³ of liquid F in a test-tube, add about 1cm³ of acidified potassium dichromate (VI) and warm the mixture.

Observations	Inferences
(1 mark)	(1 mark)