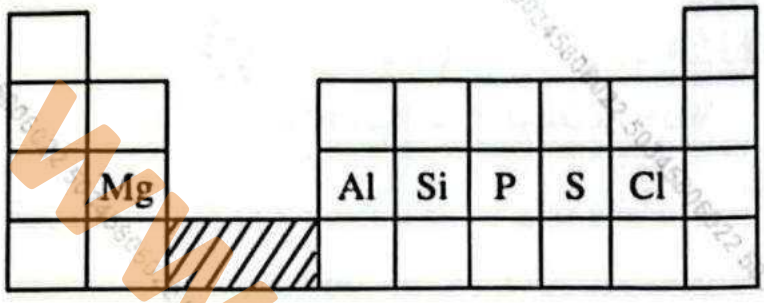
Table 1 shows part of the periodic table of elements.

Table 1



(a) Explain each of the following:

(i) Atomic radius of the elements decreases from magnesium to chlorine. (1 mark)

.....

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.....

(ii) Ionisation energy of the elements increases from magnesium to chlorine. (1 mark)

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(b) Explain each of the following in terms of structure and bonding.

(i) The melting point of aluminium is higher than that of magnesium. (1 mark)

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.....

.....

(ii) The melting point of phosphorus is higher than that of chlorine. (1 mark)

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.....

(c) Complete **Table 2** by giving the formula of the oxides of the elements and their acid-base character.

Table 2

Elements	Mg	Al	Si	P
Formula of oxide				
Acid-base character				

(2 marks)

(2 marks)

(d) Sulphur forms the chloride, S_2Cl_2.

(i) Name the type of bond in the chloride. (1 mark)

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.....

(ii) Determine the oxidation number of sulphur in the chloride. (1 mark)

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(e) Silicon tetrachloride fumes in air.

Write an equation for the reaction. (1 mark)

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(f) Silicon is a metalloid.

(i) State what is meant by the term *metalloid*. (1 mark)

.....

.....

(ii) State **one** use of silicon as a metalloid. (1 mark)

.....

2 (a) State the names of the following compounds.

(i) $CH_3(CH_2)_3CH_3$ (1 mar

.....

(ii) $CH_3(CH_2)_3C \equiv CH$ (1 mar

.....

(b) **Figure 1** shows extraction of copper from copper pyrites, $CuFeS_2$.

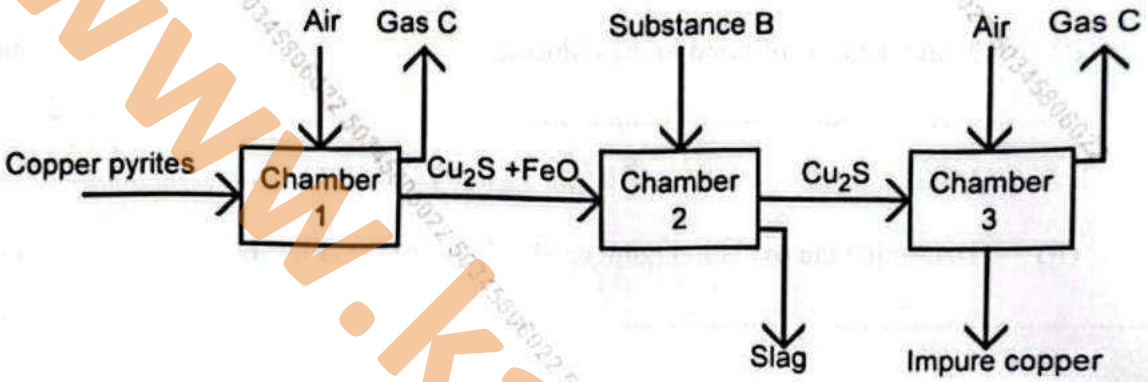

Figure 1

(a) Identify gas C. (1 ma

.....

(b) Write an equation for the reaction that takes place in chamber 1. (1 ma

.....

.....

(c) Identify substance B. (1 mar

.....

(d) Give the formula of the main compound in the slag. (1 mar

.....

(e) Write equations for the two reactions that take place in Chamber 3. (1 mark

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(f) Describe the process that is used to purify the impure copper. (2 mark

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(h) When left exposed for a long time in air, copper coins turn green. Explain this observation. (1 ma

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3 (a) State what is meant by *standard enthalpy of formation of a compound.* (1 m

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(b) Table 3 gives enthalpy of formation of some compounds.

Table 3

Compound	ΔH_f^{θ} ($kJmol^{-1}$)
CO_2	−393
H_2O	−286
C_3H_8	−104

(i) Write the thermochemical equations for the formation of:

I. CO_2; (1 m

.....

.....

II. H_2O.

.....

.....

(ii) Study the energy level diagram in Figure 2 and answer the questions using th data in Table 3.

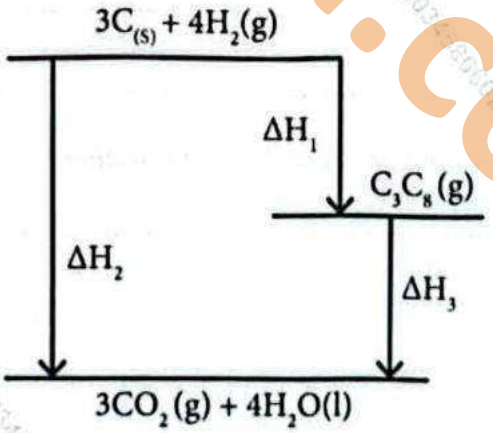

Figure 2

I. Give the value of ΔH_1. (1 ma

.....

.....

II. Calculate the values of:

ΔH_2 (2 marks)

ΔH_3 (1 mark)

(iii) When a sample of butane (C_4H_{10}) was burned, the heat produced raised the temperature of 500 g of water by 35 °C (Specific heat capacity of water = 4.2 $Jg^{-1}K^{-1}$).

Calculate the:

I. heat change for the reaction. (1 mark)

II. mass of butane that was burned given that the heat of combustion of one mole of butane is $-2880\ kJmol^{-1}$ (C = 12.0; H = 1.0). (2 marks)

4 (a) Describe how a sample of chlorine gas can be prepared using the following compounds: solid sodium chloride, solid manganese(IV) oxide and concentrated sulphuric(VI) acid. (3 marks)

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(b) Figure 3 is a flowchart showing some reactions of chlorine.

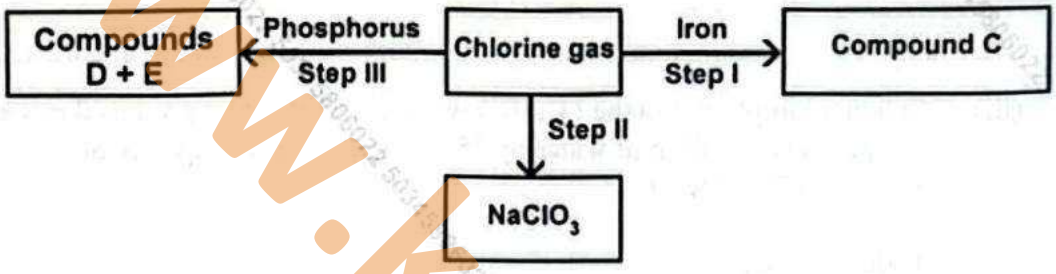

Figure 3

(i) Give the name of compound C formed in step I. (1 mark)

.....

(ii) State the reagent and the conditions necessary for the reaction in step II. (1 mark)

Reagent:

.....

Conditions.

.....

(iii) Two compounds are formed in the reaction in step III. Give the formulae of each of the two compounds. (2 marks)

I. D; .....

II. E. .....

(c) Write an equation for the reaction that takes place when chlorine gas reacts with aqueous hydrogen sulphide. (1 mark)

.....

.....

(d) State the observation made when:

(i) chlorine gas is bubbled into aqueous potassium iodide. (1 mark)

.....

.....

(ii) moist red litmus paper is placed in a gas jar of chlorine gas. (1 mark)

.....

.....

(e) Write an ionic equation for the reaction that takes place when aqueous lead(II) nitrate is added to aqueous potassium chloride. (1 mark)

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.....

(f) State the reason why chlorine is used in water treatment. (1 mark)

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5 (a) **Figure 5** shows the Down's cell used in the extraction of sodium from molten sodium chloride.

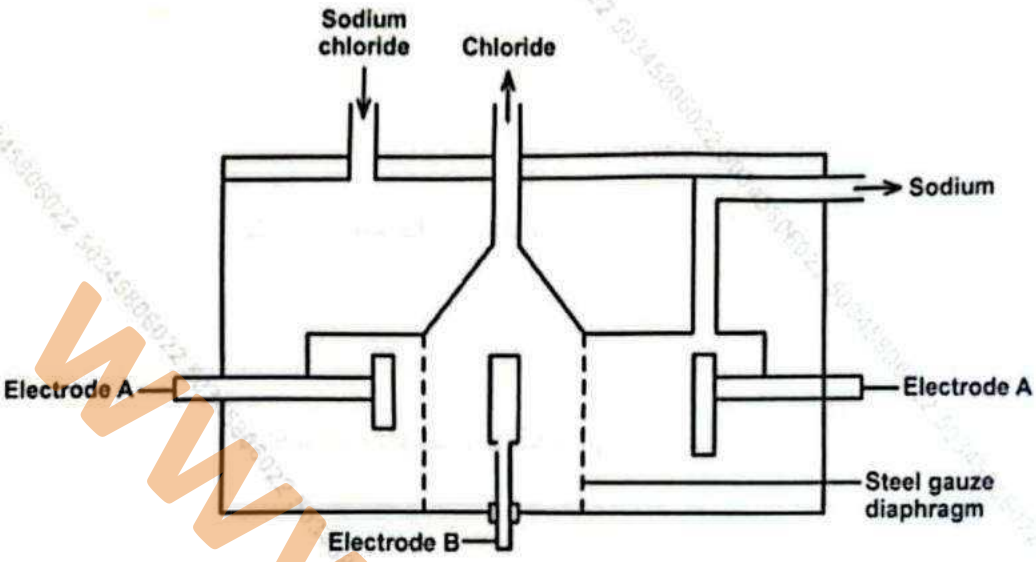

Figure 5

(i) Identify the anode and cathode in the cell. Give a reason. (2 marks)

Anode:

.....

Reason:

.....

.....

Cathode:

.....

Reason:

.....

.....

(ii) State the purpose of the steel gauze diaphragm. (1 mark)

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.....

(b) **Table 4 shows the melting point and boiling point of sodium and sodium chloride.**

Table 4

Substance	Melting point (°C)	Boiling point (°C)
Sodium	97.8	890
Sodium chloride	801	1467

(i) Given that the Down's cell is operated at 600 °C, state how this temperature is achieved. (2 marks)

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(ii) State the advantage of operating at 600 °C. (1 mark)

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(iii) State the physical state in which sodium is obtained from the cell. Give a reason. (2 marks)

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(c) Starting with 1000 kg of sodium chloride, calculate the mass of sodium produced (Na = 23.0; Cl = 35.5). (2 marks)

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(d) Explain how a sample of solid sodium should be stored in the laboratory. (2 marks)

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(e) State **one** industrial use of sodium. (1 mark)

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6 The products of electrolysis depend on the conditions used.

(a) (i) State the conditions, if the products of electrolysis of aqueous copper(II) sulphate are:

I. oxygen and copper. (1 mark)

.....

II. copper. (1 mark)

.....

(ii) During electrolysis of an electrolyte containing aqueous A^{3+} ions, 19.4 g of A were obtained when a current of 15 amperes was passed through it for 2 hours.

I. Write the half equation for the reaction that took place. (1 mark)

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.....

II. Determine the relative atomic mass of A.
(1 Faraday = 96,500 coulombs). (2 marks)

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(b) Study the following cell representation diagram and answer the questions that follow.

$Ni(s) / Ni^{2+}(aq) // Ag^{+}(aq) / Ag(s)$

(i) State what the symbol // represents in the diagram. (1 mark)

.....

(ii) Write an equation for the reaction that occurs in the cell. (1 mark)

.....

.....

(iii) Given that the E^{θ} of $Ag^{+}(aq)/Ag(s)$ half cell is $+0.80\ V$, calculate the E^{θ} of the $Ni^{2+}(aq)/Ni(s)$ half cell. (1 mark)

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(iv) State how e.m.f of a cell can be used to predict whether a reaction is feasible. (1 mark)

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(c) Corrosion of a metal involves formation of an oxide layer on the metal surface. Explain why corrosion of aluminium is protective while that of iron is destructive. (2 marks)

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Tu

7 (a) State and explain how the rate of reaction, $A(g) + B(g) \longrightarrow AB(g)$ is affected by an increase in:

(i) pressure; (2 marks)

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(ii) temperature. (2 marks)

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(b) The rate of reaction between ethanoic acid and copper(II) carbonate can be monitored by measuring the volume of the gas produced. The results obtained using 75.0 cm^3 of 0.1 M ethanoic acid and excess copper(II) carbonate are shown in **Table 5.**

Table 5

Time, seconds	0	5	15	25	35	45	55	70	80
Volume of gas, cm^3	0	20	41	50	56	59	61	63	63

(i) Write an equation for the reaction that took place. (1 mark)

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(ii) Give a reason why excess copper(II) carbonate was used. (1 mark)

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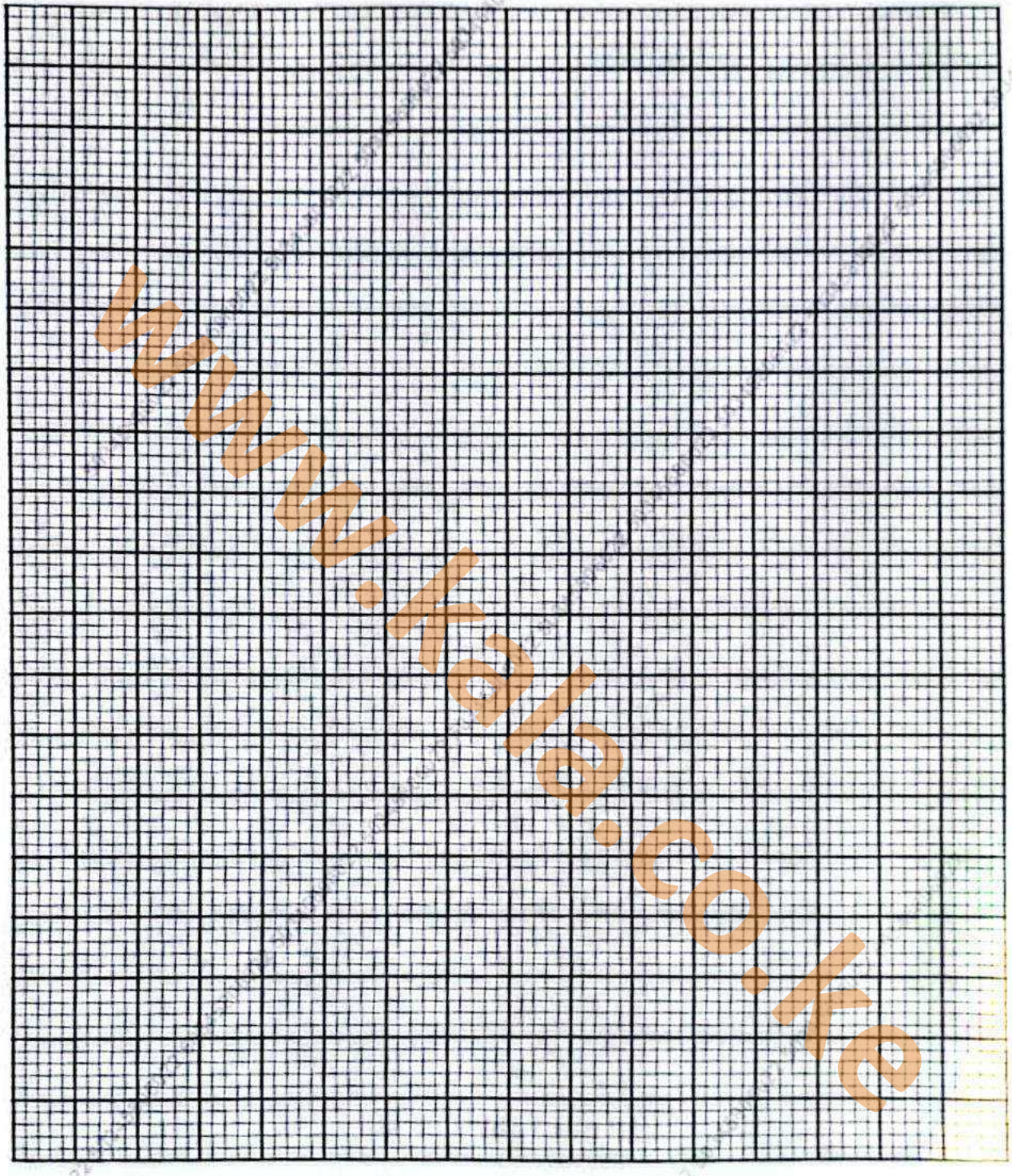
(iii) On the grid provided, draw a graph of the results obtained. (3 marks)



(iv) Use the graph to determine the rate of reaction at:

I. 10 seconds; (1 mark)

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II. 40 seconds. (1 mark)

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(v) Give a reason for the difference between the two average rates calculated in (iv). (1 mark)

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