



Dr. Bbosa Science

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545/2

S4 CHEMISTRY

Exam 11 marking guide

PAPER 2

DURATION: 2 HOUR

Instructions to Candidates:

- Section **A** consists of 10 structured questions. Attempt **all** questions in this section. Answers to these questions must be written in the spaces provided
- Section **B** consists of 4 semi-structured questions. Attempt any **two** questions from this section.
- Answers to the questions must be written in the answer booklets provided.
- In both sections all working **must** be clearly shown

For Examiner's use only													
1	2	3	4	5	6	7	8	9	10	1	12	13	14

- Write the chemical name of rust
Hydrated iron III oxide $Fe_2O_3 \cdot xH_2O$. (1mark)
 - State conditions necessary for rusting to occur. (1 mark)
Air (oxygen)
Water
 - When iron is galvanized before it is exposed to air, it does not rust even when the zinc layer is broken. Explain (1 ½ marks)
When galvanized before it is exposed to air, iron is protected from air, when zinc layer is broken, zinc reduces iron III ions to iron
 - Rust was dissolved in dilute sulphuric acid and the resultant solution treated with excess sodium hydroxide

(i) state what was observed (1 mark)
Brown ppt. insoluble in excess

(ii) Write an ionic equation for the reaction that took place (1 ½ marks)
 $Fe^{3+}(aq) + 3OH^{-}(aq) \rightarrow Fe(OH)_3(s)$

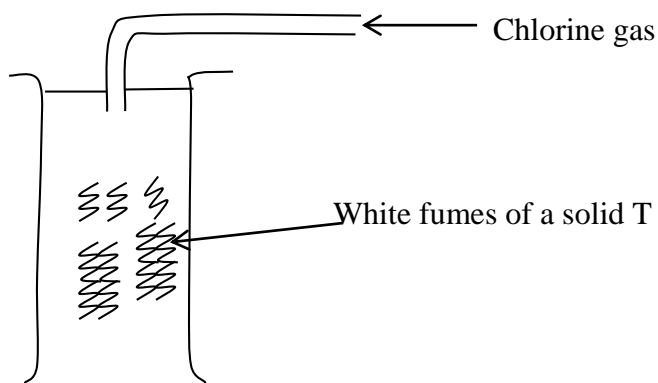
2. When a mixture of calcium hydroxide and ammonium sulphate was heated, in a dry test tube, a gas R was produced

(a) (i) Name gas R (1 mark)
Ammonia (NH₃)

(ii) State how gas R was identified (1 mark)
Ammonia turns red litmus blue

(b) R was dissolved in water and the solution added to an aqueous solution containing aluminium ions. State what was observed (1 mark)
White ppt. is insoluble in excess

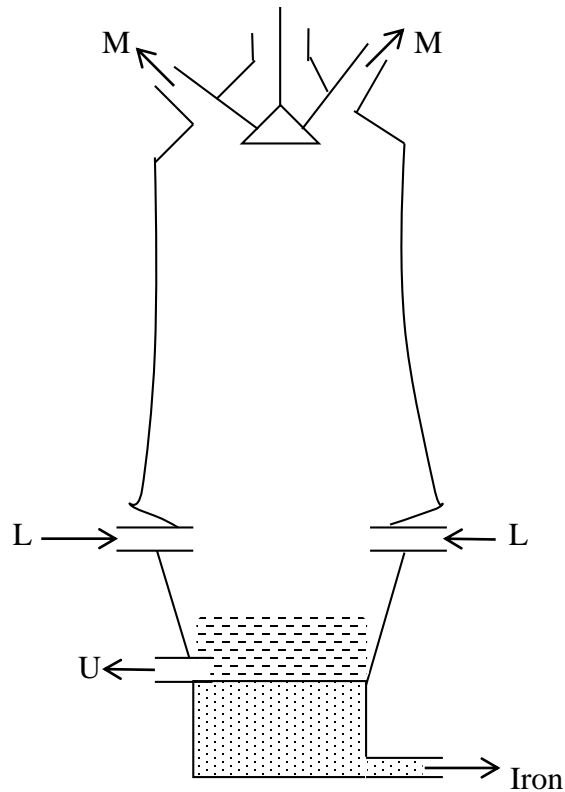
(c) Chlorine gas burns in dry gas R as shown in the diagram below



(i) Identify solid T (½ mark)
Ammonium chloride

(ii) Write equation for the burning of chlorine in gas R (1½ marks)
 $2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$
 $NH_3(aq) + HCl(g) \rightarrow NH_4Cl(s)$

3. The diagram below shows a blast furnace which can be used for extracting iron from Haemitite



- (a) Name the substance that is collected at
- M
Used gas (½ mark)
 - U
Slag (½ mark)
- (b) State (i) the name and role of the substance that is fed in at L during the extraction of an iron
- Name
hot air
 - The role of substance U
Oxidizes carbon to carbon dioxide (½ marks)
- (c) Write an equation showing how chemical reduction leads to the formation iron
 $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$
- (d) Name one alloy of iron (1 mark)
Steel
4. Part of the periodic table is shown in the figure below. The letters do not represent the actual symbols of the elements.

I	II	III	IV	V	VI	VII	VIII
			G	M	R		
Q					L		
T	U						

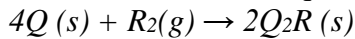
(a) (i) State an element that can form an ion with a charge of 2^- (1/2 marks)
R and L

(ii) State the type of bond that exists in the compound formed when it reacts with G
covalent

(1/2 marks)

(b) 2.5g of Q reacts completely with 600cm³ of gas R at s.t.p

(i) Write a balanced equation for the reaction between Q and R (1 1/2 marks)



(ii) Determine the atomic mass of Q (molar gas volume at s.t.p = 22,400cm³) (2 1/2 marks)

$$\text{Moles of } R_2 = \frac{600}{22400} = 0.02679 \text{ moles}$$

$$\text{Moles of } Q = 0.02679 \times 4 = 0.1072 \text{ moles}$$

$$0.1072 \text{ mole of } Q \text{ weigh } 2.5\text{g}$$

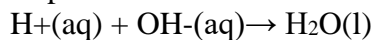
$$1 \text{ mole of } Q \text{ weight } \frac{2.5}{0.1072} = 23.3$$

5. (a) Define the term molar heat of neutralization' (1 1/2 marks)

It is heat energy liberated when 1mole of water is formed from 1mole of aqueous hydrogen and 1 mole of aqueous hydroxyl ions at standard conditions

(b) In an experiment to determine the molar heat of neutralization, 50cm³ of 1 M sulphuric acid was reacted with 100cm³ of 1M sodium hydroxide and the temperature of the solution changed by 9°C.

(i) Write an ionic equation for the neutralization of sodium hydroxide with sulphuric acid (1 1/2 marks)



(ii) Calculate the molar heat of neutralization of sodium hydroxide by sulphuric acid. (Enthalpy capacity of water = 4.2J g⁻¹ °C⁻¹, density of solution = 1.0g cm⁻³) (2 marks)

$$\text{Heat liberated} = mc\theta = 150 \times 4.2 \times 9 = 5670\text{J}$$

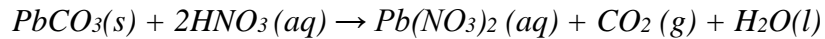
$$\text{Moles of water formed} = \text{moles of NaOH (aq)} = \frac{100 \times 1}{1000} = 0.1 \text{ moles}$$

Formation of 0.1mole of water produce 5670J

Formation of 0.1mole of water produce $\frac{5670}{0.1} = 56700\text{Jmol}^{-1}$

6. 2.67g of lead (II) carbonate was reacted with excess of 1M nitric acid solution at 24°C. The time for the carbonate to disappear completely was noted and the volume of the gas evolved was measured at the same temperature

(a) (i) Write equation for the reaction that took place



(ii) Calculate the maximum volume of the gas that would be evolved in the reaction.

(Pb = 207, O = 16, C = 12, 1 mole of a gas occupies 24dm³ at 24°C). (2 marks)

Formula mass of PbCO₃ = 207 + 12 + 16 x 3 = 267

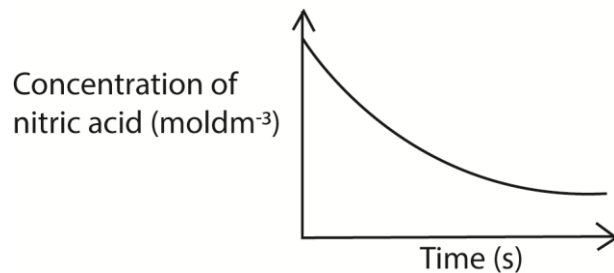
267g of PbCO₃ liberate 24dm³ of CO₂

267g of PbCO₃ liberate 24dm³ of CO₂

2.67g of PbCO₃ liberate 0.24dm³ of CO₂

(b) Sketch a graph to show how the concentration of nitric acid varies with time.

(1 ½ marks)



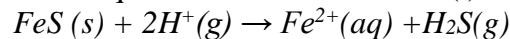
7. A mixture of iron filings and sulphur was heated strongly in hard test tube and the residue treated with dilute hydrochloric acid.

(i) State what was observed when hydrochloric was added to the residue

A gas with pungent smell is liberated

(1 ½ marks)

(ii) Write equation for the reaction in (i) above



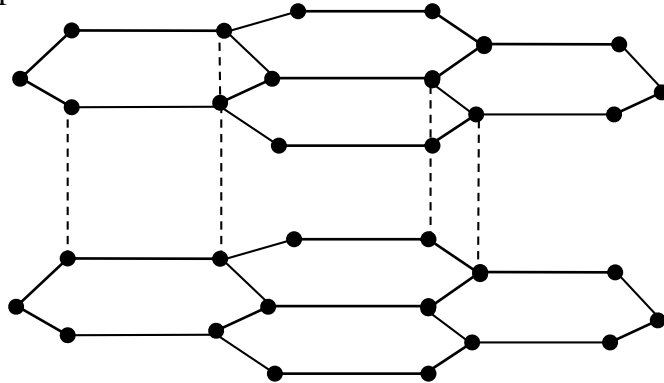
(1 ½ marks)

(iii) State what would be observed if excess sodium hydroxide solution was added to the solution of residue and hydrochloric in (i)

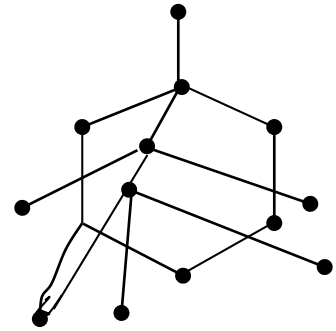
A green ppt. insoluble in excess turns brown on exposure to air

8. The following diagrams show the structures of two allotropes of carbon.

Allotrope T



Allotrope M



(i) Name allotrope

M: *diamond*

(1 mark)

T: *graphite*

(ii) State one use of allotrope M

making glass cutter, ornaments

(1 mark)

(1 mark)

(iii) Which allotrope conducts electricity? Explain.

T has free mobile electrons

(2 marks)

9. 2.67g lead (II) carbonate was heated in hard test tube strongly until no further change

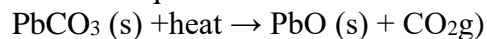
(a) State what was observed

(1 ½ marks)

White powder turn to orange with liberation of colorless gas that forms white ppt. with lime water

(b) Write an equation for the reaction that took place

(1 ½ marks)



(c) Calculate the mass of the residue formed (Pb = 207, c = 12, O = 16)

(2 marks)

$$\text{Formula mass of PbCO}_3 = 207 + 12 + 16 \times 3 = 267$$

$$\text{Formula mass of PbO} = 207 + 16 = 223$$

267g of PbCO₃ liberate 223g of PbO

∴ 2.67g of PbCO₃ liberate 2.23g of PbO

10. A mixture of zinc sulphate and zinc carbonate was shaken with water and filtered
- (a) Name the filtrate (1 mark)
Zinc sulphate solution
- (b) State what would be observed if
- (i) a solution of lead (II) nitrate was added to the filtrate (1 mark)
A white ppt. is formed
- (ii) write an ionic equation for the reaction in b (i) above (1 ½ marks)
 $Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$
- (iii) the residue was dried and heated strongly until no further change state what was observed and write an equation for the reaction that took place
White powder turns yellow when hot and white when cold
 $ZnCO_3(s) + heat \rightarrow ZnO(s) + CO_2(g)$
- (1 ½ marks)

SECTION B:

Attempt any **two** questions only.

11. (a) Explain what is meant by the term hard water. (1 ½ marks)
Hard water does not form lather easily with soap
- (b) Name and write the formula of one compound which when dissolved in water can cause:
- (i) temporary hardness of water (1 ½ marks)
*Magnesium hydrogen carbonate, $Mg(HCO_3)_2$
or calcium hydrogen carbonate, $Ca(HCO_3)_2$*
- (ii) permanent hardness of water (1 ½ marks)
*Magnesium sulphate, $MgSO_4$
or calcium sulphate, $CaSO_4$*
- (c) Explain giving ionic equations, how boiling can only remove temporary hardness whereas addition of sodium carbonate can remove both temporary and permanent hardness of water (7 ½ marks)
boiling decompose hydrogen carbonate ions to carbonate ions
 $2HCO_3^-(aq) \rightarrow H_2O(l) + CO_3^{2-}(aq)$
carbonate ions react with Ca^{2+} and Mg^{2+} in water to form insoluble salt
 $Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$
 $Mg^{2+}(aq) + CO_3^{2-}(aq) \rightarrow MgCO_3(s)$
- (d) State (2 marks)
- (i) two advantages of hard water
*contain calcium that strengthen teeth and bones
coat with and protect lead water pipes*

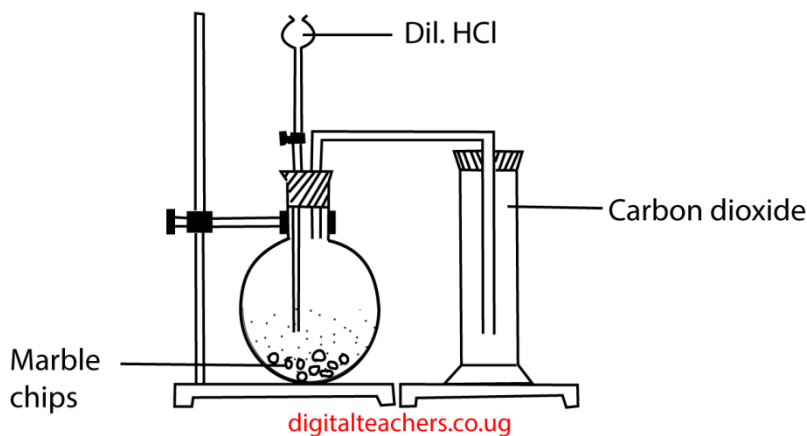
- (ii) one disadvantage of using hard water for laundry work (1 mark)
wastes soap

12. Carbon dioxide can be prepared by the action of dilute hydrochloric acid on calcium carbonate.

- (a) Write the equation for the reaction (1 ½ marks)

$$\text{CaCO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{CaCl}_2(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l)$$
- (b) Why is hydrochloric acid used rather than sulphuric acid? (2 marks)
Sulphuric acid liberate little carbon dioxide because it form insoluble calcium sulphate that prevents further reaction
- (c) Draw a fully labelled diagram of apparatus that can be used to prepare and collect a pure dry sample of carbon dioxide gas. (3 marks)

Laboratory preparation of carbon dioxide



- (d) State what is observed and write equation for the reaction that takes place when carbon dioxide gas is
- (i) passed over heated magnesium (2 ½ marks)
White powder and black specs of carbon are formed

$$2\text{Mg}(s) + \text{CO}_2(g) \rightarrow 2\text{MgO}(s) + \text{C}(s)$$
- (ii) bubbled over calcium hydroxide solution for a long time (4 marks)
A white ppt. dissolves n excess

$$\text{Ca}(\text{OH})_2(aq) + \text{CO}_2(g) \rightarrow \text{CaCO}_3(s) + \text{H}_2\text{O}(l)$$

Then

$$\text{CaCO}_3(s) + \text{H}_2\text{O}(l) + \text{CO}_2(g) \rightarrow \text{Ca}(\text{HCO}_3)_2(aq)$$
- (e) Copper (II) carbonate reacts with dilute hydrochloric acid according to the equation

$$\text{CuCO}_3(s) + 2\text{HCl}(aq) \longrightarrow \text{CuCl}_2(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l)$$

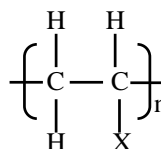
 Calculate the mass of copper (II) carbonate that would react with excess acid to produce 1.12dm³ of carbon dioxide (H = 1 C = 12 Cu = 64. 1 mole of a gas occupies 22.4dm³ at s.t.p)
Formula mass of CuCO₃ = 64 + 12 + 16 x 3 = 124
22.4dm³ of CO₂ require 124g of Cu
1.12dm³ of CO₂ require $\frac{124 \times 1.12}{22.4} = 6.2\text{g}$ of Cu

13. Alkenes can undergo polymerization

- (a) Explain what is meant by the term **Polymerization** (2 marks)

Polymerization is the formation of a big molecule called polymer by combination of very many small molecules called monomer

- (b) The fundamental structure of a polymer is



where X can be hydrogen atom or CH₃ – radical

Name the monomer and its polymer when x is

- (i) Hydrogen atom *polythene* (2 marks)
 (ii) CH₃ radical *polypropene* (2 marks)
- (c) State two important differences in physical properties between the alkene in b(i) and its polymer. (2 marks)
polymer have very high molecular masses and melting point compared to alkenes
- (d) Explain the difference between a thermosetting plastic and thermosoftening plastic (3 marks)

Thermoplastic polymers are those that soften and can be remolded into new shape. E.g. polythene

Thermosetting polymers are those that decompose on heating and cannot be remoulded on heating for example vulcanized rubber, melamine, Bakelite.

- (e) (i) Name two natural polymers and their monomers (2 marks)
starch – glucose
proteins – amino acids
- (ii) State two advantages of synthetic polymers over natural polymers (2 marks)
Synthetic polymer has high tensile strength and are cheaper than natural polymers

14. (a) Briefly describe how crystals of iron (II) sulphate heptahydrate, FeSO₄ · 7H₂O can be prepared in the laboratory.

Preparation of iron (II) sulphate-7-water (FeSO₄ · 7H₂O)

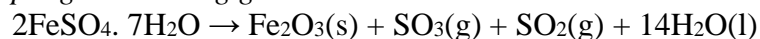
- Add warm dilute sulphuric acid to iron filling in a beaker
- Add more iron fillings to saturate the solution
- Filter to remove the un dissolved iron filings
- Warm the filtrate slightly to concentrate it
- Cool to room temperature
- Filter the crystals of iron (II) sulphate-7-water

- Wash the crystals with cold distilled water
- Dry the crystals between filter papers

(b) State what is observed when

(i) crystals of iron (II) sulphate, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ are heated strongly. Write equations for the reaction(s) that occur. (4½ marks)

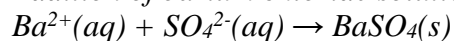
Green crystal loss water of crystallization and turn white then brown with liberation of pungent smelling gas



(ii) Concentrated nitric acid is added to a solution of iron (II) sulphate (1½ marks)
green solution turn brown

(c) Describe a chemical test you would carry out to show that $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ solution contains sulphate ions. (1 ½ marks)

Addition of barium chloride solution form a white ppt.



END