



Dr. Bbosa Science

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545/2

S4 CHEMISTRY

Exam 6: marking guide

PAPER 2

DURATION: 2 HOUR

Instructions:

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

FOR EXAMINER'S USE ONLY														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	TOTAL

SECTION A: (50 MARKS)

(Answer all questions in this section)

1. The full symbol of an atom of an element X is ${}_{19}^{39}\text{X}$,

(a) State the;

(i) Number of protons in the nucleus of X (½ mark)

19

(ii) Number of neutrons in the nucleus of X (½ mark)

$39 - 19 = 20$

(b). Write the

(i) Electronic configuration of the ion that can be formed by X (1 mark)

X: 2.8.8

(ii) Formula of the ion that can be formed by X (1 mark)

X^+

(b) The number neutrons in the nucleus of another atom of X is 22.

(i) Write the full symbol of the second atom of X (1 mark)

${}_{19}^{41}\text{X}$

(ii) State what the second atom of X and ${}_{19}^{39}\text{X}$ are called. (1 mark)

Isotope

2. Lead (II) ions react with hydroxide ions to form a precipitate of lead (II) hydroxide according to the following equation.



300cm³ of a 0.1M lead (II) nitrate solution was added to 200cm³ of a 0.1M magnesium hydroxide solution the mixture was stirred, filtered and the residue dried.

(a) Calculate the

(i) Number of moles of lead (II) ions that was used. (1 mark)

$$\text{Moles of Pb}^{2+} = \frac{300 \times 0.1}{1000} = 0.03 \text{ moles}$$

(ii) Number of moles of hydroxide ions that was used. (1 mark)

$$\text{Mole of } OH^- \text{ ions} = 2 \times \text{moles of } Mg(OH)_2 = \frac{2 \times 200 \times 0.1}{1000} = 0.04 \text{ moles}$$

(iii) The maximum mass of the dried residue that was obtained

(H = 1, O = 16, Pb = 207)

(2 marks)

$$\text{Formula mass of } Pb(OH)_2 = 207 + 2(1 + 16) = 241$$

$$\text{moles of } Pb(OH)_2 \text{ precipitates} = \frac{1}{2} \times \text{moles } OH^- = \frac{1}{2} \times 0.04 = 0.02 \text{ moles}$$

$$\text{mass of } Pb(OH)_2 \text{ precipitates} = 0.02 \times 241 = 4.82 \text{ g}$$

(b) Determine;

(i) Which one of the two ions; hydroxide or lead (II) was **not** all precipitated. (½ mark)

Pb^{2+}

(ii) The number of moles of the ion, which you have stated in (b) (i) above, that was not precipitated. (1 mark)

$$0.03 - 0.02 = 0.01 \text{ mole}$$

3. (a) Define the term “electrolyte” (1 mark)

An electrolyte is an ionic salt that conducts electricity in molten or solution form but not in solid form and is decomposed into elements by electricity

(b) Name the particles by means of which electric current is conducted in

(i) molten lead (II) bromide. (½ mark)

Ions (Pb^{2+} and I^-)

(ii) graphite

Electrons

(c) Give a reason why

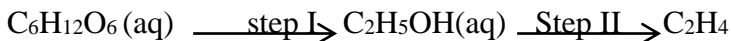
(i) Molten lead (II) bromide when melted conducts electricity but when in solid state, it does not (1 mark)

Molten lead (II) bromide contains mobile ions while solid lead (II) bromide does not

- (ii) Electrolysis of concentrated sodium chloride solution is done using graphite as anode but not a metal like iron. (1 mark)

Graphite does not react with chlorine while iron does

4. Ethanol obtained from glucose can be converted to ethene as shown below



(a) Name

- (i) The process that takes place in step I (½ mark)

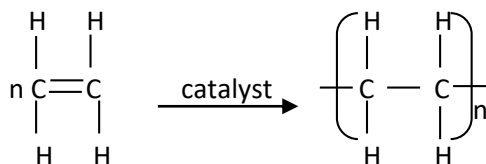
Fermentation

- (ii) The reagent used in step II (½ mark)

Hot concentrated sulphuric acid

- (b) Ethene can be converted to a polymer J of relative molecular mass 16,800.

- (i) Write equation for the reaction showing the conversion of ethene to polymer J (1 mark)



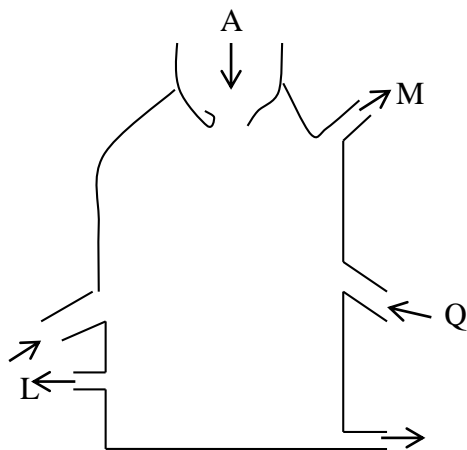
- (ii) Determine the number of ethene molecules that make up one molecule of J (2 marks)

Formula mass of ethene $\text{C}_2\text{H}_4 = 12 \times 2 + 1 \times 4 = 26$

$$\text{moles} = \frac{16,800}{26} = 646 \text{ moles}$$

5. (a) Name one ore from which iron can be extracted (1 mark)
hematite, Fe_2O_3 and magnetite, Fe_3O_4 , and from the siderite, FeCO_3 , or Iron pyrites, FeS_2 ,

(b) The diagram below shows a blast furnace used for the extraction of iron from its ore.



During the extraction, iron ore, coke and limestone are fed into the furnace at point A while hot air is fed at point Q.

(i) State the purpose of adding coke and limestone. (2 marks)

Coke is oxidized to CO that reduces the oxide of iron to iron

Lime stone is decomposed to CaO, reacts and removes silicon dioxide impurity from the ore

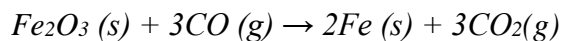
(ii) Name the substances that are collected at points L and M

L : slag (½ mark)

M: CO₂, SO₂ (½ mark)

(c) Write equation showing how chemical reduction leads to the formation of iron.

(1 ½ marks)



6 (a) Ammonium sulphate, (NH₄)₂SO₄, sodium chloride, NaCl and sodium ethanoate, CH₃CO₂Na were dissolved separately in water and pH of their solutions taken. Identify the salt that would form a solution with a pH

(i) Equal to 7

(½ mark)

NaCl

(ii) Less than 7 (½ mark)

Ammonium sulphate

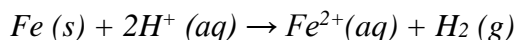
(iii) Above 7 (½ mark)

Sodium ethanoate

(b) State what would be observed if dilute sulphuric acid was added to

(i) Iron wire (1 ½ marks)

Effervescence

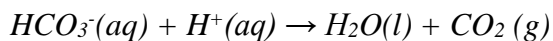


(ii) Calcium oxide (1 ½ marks)

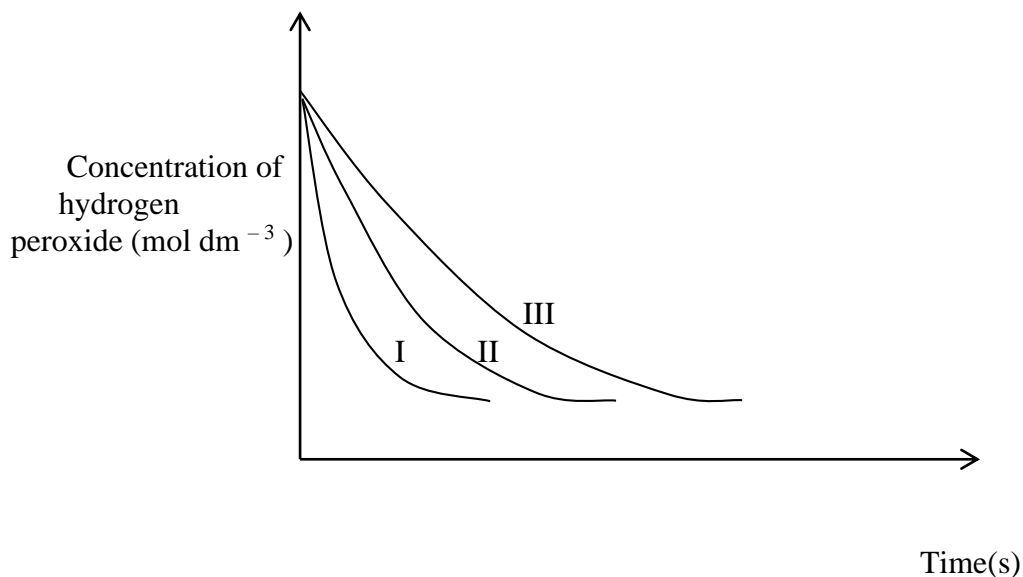
White ppt.

(d) Dilute nitric acid was added to aqueous magnesium hydrogen carbonate.

Write ionic equation for the reaction that took place. (1 ½ marks)



7. The sketch graphs I, II, III in the diagram below, show variations in concentrations of hydrogen peroxide with time when a standard solution of the hydrogen peroxide was decomposed under different conditions ;



- (a) Identify which one of the sketch graphs, shows decomposition of the hydrogen peroxide
(i) at room temperature without a catalyst. (1 mark)

III, the rate of reaction is slowest

- (ii) When heated in the presence of a catalyst. (1 mark)

I, the rate of reaction is fastest

- (iii) at room temperature in the presence of a catalyst. (1 mark)

II

- (b) Hydrogen peroxide decomposes to give oxygen according to the following equation.



Calculate the volume of oxygen measured at s.t.p that would be given off if 250cm³ of a 1M hydrogen peroxide decomposed. (1 mole of a gas occupies 22.4dm³ at s.t.p)

(2 marks)

$$\text{Moles of H}_2\text{O}_2 = \frac{250 \times 1}{1000} = 0.25 \text{ moles}$$

2 moles of H₂O₂ produce 22.4dm³ of O₂

$$0.25 \text{ moles of H}_2\text{O}_2 \text{ produce } \frac{22.4 \times 0.25}{2} = 2.8 \text{ dm}^3 \text{ of O}_2$$

8. When a mixture of a compound R and concentrated sulphuric acid was warmed, effervescence took place and brown fumes are given off, that condense into a yellow liquid, W. Aqueous W liberated carbon dioxide from sodium carbonate solution

- (a) (i) Name W (1mark)

Nitric acid

- (ii) Suggest a possible identity of the anion in R. (1 mark)

Potassium nitrate, KNO₃

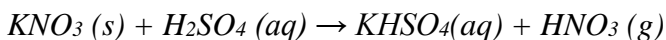
- (iii) Name a reagent(s) which would be used to confirm the identity of the anion which you have suggested in (ii). (1 mark)

Iron (II) sulphate and concentrated sulphuric acid

- (iv) State what would be observed if the reagent(s) you have named in (iii) was used to confirm the identity of the anion in R (½ mark)

Brown ring

- (b) Write equation for the reaction that led to the formation of brown fumes (1 ½ marks)



9. Combination of sulphur and iron can result into formation of a mixture or a compound called iron (II) sulphide, which have different properties.

- (a) State how a mixture of sulphur and iron differs from iron (II) sulphide with respect to
(i) Colour (1 mark)

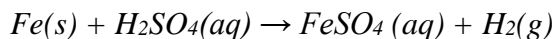
Mixture is a mixture of yellow powder and grey crystals

Iron (II) sulphide is black crystals

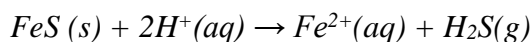
- (ii) When placed close to a magnet (1 ½ marks)

Mixture; magnet attracts grey iron crystals but not

- (b) Write ionic equation to illustrate a reaction that can occur when dilute sulphuric acid is added to a sample of
(i) a mixture of sulphur and iron (1 ½ marks)



- (ii) iron (II) sulphide (1 ½ marks)



- (c) The product of the reaction in (b) (ii) can cause environmental pollution. Give a reason. (½ mark)

H₂S has awful smell and is acidic

10. The molar masses and enthalpies of combustion of ethanol and methane are given in the table below.

Substance	Molar mass	Enthalpy of combustion (kJmol ⁻¹)
Ethanol	46	-1367
Methane	16	-890.4

- (a) Define the term “molar enthalpy of combustion” (1 mark)

Molar enthalpy of combustion is the amount of heat liberated when 1 mole of a substance is completely burnt in oxygen.

- (b) Calculate the amount of energy given out per gram of
(i) Ethanol (1 mark)

46g of ethanol produces 1367kJ of heat

1g of ethanol produces $\frac{1367}{46} = 29.7J$ of heat

(ii) Methane

(1 mark)

66g of methane produces 890.4kJ of heat

1g of ethanol produces $\frac{890.4}{16} = 118.2J$ of heat

- (c) Using your answers in (b) suggest which one of the two compounds is a better fuel and give a reason for your answer. (2 marks)

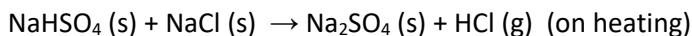
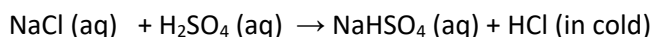
Methane because it produces much heat per gram on combustion

SECTION B: (30 MARKS)

Answer any two questions from this section.

11. (a) Briefly explain how a dry sample of hydrogen chloride can be prepared in the laboratory and write equation to illustrate your answer. (No diagram is required) (5 marks)

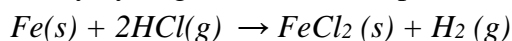
Sodium chloride reacts with concentrated sulphuric acid to form hydrogen chloride gas. The gas is dried by concentrated sulphuric acid and collected by downward delivery because it is denser than air.



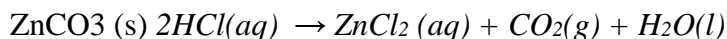
- (b) Draw a labeled diagram of the setup of apparatus that can be used to prepare a solution of hydrogen chloride in water. (2 marks)

- (c) Write equation for the reaction that would take place if

(i) dry hydrogen chloride was passed over strongly heated iron wire. (1½ marks)



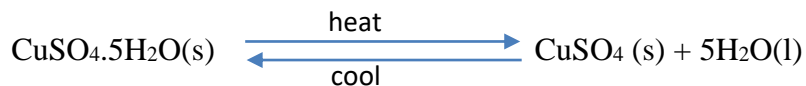
(ii) a solution of hydrogen chloride was added to zinc carbonate. (1½ marks)



- (d) The product from (c) (i) was dissolved in water, and chlorine bubbled through the aqueous solution
- (i) State what was observed. (1 mark)
A green solution turns brown
- (ii) Write equation for the reaction that took place. (1 ½ marks)
 $2FeCl_2(aq) + Cl_2(g) \rightarrow 2FeCl_3(aq)$
- (e) To the mixture in (c) (ii) was added silver nitrate solution. State what was observed and write ionic equation for the reaction that took place (2 marks)
 White ppt.
 $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
- (f) Aqueous ammonia was added to the product in (e) until there was no further change. State what was observed. (½ mark)
The white precipitate dissolves

12. (a) Using copper (II) sulphate – 5 – water, explain the term “reversible reaction” (8 marks)

When copper (II) sulphate – 5 – water is heat it loses its water of hydration and blue crystals turn into white powder. Addition of water to the white powder blue crystals form.



(b) In decomposing hydrogen peroxide to prepare oxygen, manganese (IV) oxide is added as a catalyst.

- (i) Define the term catalyst (1 mark)
A catalyst is a substance that speed up chemical reaction without taking part in the reaction
- (ii) Briefly describe how it can be shown experimentally that manganese (IV) oxide is a catalyst during the decomposition of hydrogen peroxide. (4 marks)
When a given mass of manganese (IV) oxide is added to a solution of hydrogen peroxide, the rate of evolution of a gas increases. At the end of the reaction the mass of manganese (IV) oxide is found to be the same as before

(c) State two factors other than manganese (IV) oxide catalyst that can affect the rate of decomposition of hydrogen peroxide, and indicate how each of the factors that you have stated affects the rate of decomposition of hydrogen peroxide. (2 marks)

- *Increasing temperature increases the rate of reaction/evolution of a gas*
- *increasing the concentration of hydrogen peroxide increases the rate of reaction/evolution of a gas*

13.(a) The atomic numbers of hydrogen, oxygen, sodium and chlorine are 1, 8, 11 and 17 respectively.

- (i) Write the electronic configurations of hydrogen, oxygen, sodium and chlorine. (2 marks)

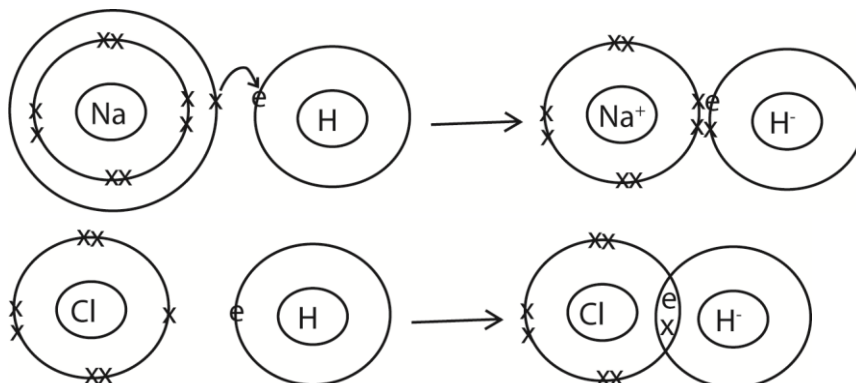
H: 1

O: 2.6

Na: 2.8.1

Cl: 2.8.7

- (ii) Using outer most energy level of electrons only, describe how hydrogen can bond with sodium and chlorine. (5 marks)



- (iii) State one difference between the compounds formed in (a) (ii) NaH is ionic while HCl is a covalent compound (1 mark)

(b) Sodium, magnesium, aluminium, phosphorus and sulphur are some of the elements in period 3 of the periodic table. State;

- (i) in each case the class of the oxide of the elements. (2 ½ marks)

MgO is acidic

Al₂O₃ is amphoteric

P₂O₅ is acidic

SO₂ is acidic

- (ii) the trend in the metallic character of elements of period 3 of the periodic table and explain your statement basing your answer on the oxides whose classes you have stated in (b) (i) (2 marks)

The metallic character decreases from left to right of the period

- (c) (i) Name one reagent that can be used to distinguish aluminium ions from magnesium ions in solution (½ mark)

Sodium hydroxide solution

- (ii) State what would be observed if the reagent you have named in (c) (i) was treated separately with aluminium and magnesium ions (2 marks)

Aluminium ions form white precipitate with sodium hydroxide solution soluble in excess while magnesium ions form a white precipitate insoluble in excess

- 14.(a) (i) State what is meant by the terms “**solubility**” and “**saturated solution**”

Solubility is the mass of a solute that saturate 100g of water

A saturated solution is one that cannot dissolved any more of the solute

- (ii) State two factors that can affect solubility of a substance and in each case indicate how the factor you have stated can affect solubility. (3 marks)

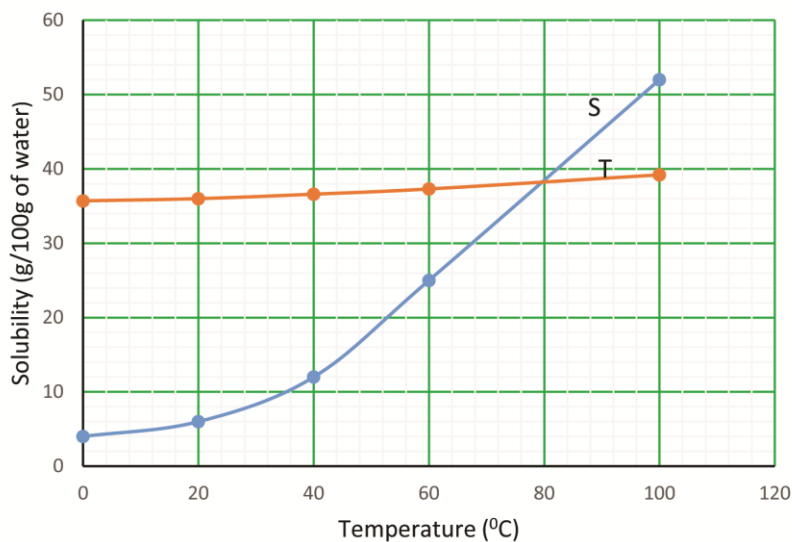
- Temperature: usually increasing temperature increases solubility of a solute
- Nature of solvents: ionic salts are soluble polar solvents like water while nonpolar solutes are soluble in non-polar solvents

- (b) The solubility of some two compounds S and T at various temperatures are shown in the table below

Temperature (°C)	0	20	40	60	100
Grams of S per 100g of water	4.0	6.0	12.0	25.0	52.0
Grams of T per 100g of water.	35.7	36.0	36.6	37.3	39.2

- (i) Plot on the same axes, the solubility curves for S and T. (6 marks)

Solubility against temperature



- (ii) Using the solubility curves you have plotted in (b) (i) state which one of the two compounds dissolves more rapidly as temperature increases, (½ marks)
S
- (iii) If a saturated solution containing both S and T at 100°C was prepared, describe how a pure sample of T would be obtained. (2 marks)
When a saturated solution is cooled the crystals formed will contain S while the filtrates will contain T
- (iv) Determine the mass of dry crystals that would be collected if a saturated solution of S at 90°C was cooled to 50°C. (1 ½ marks)
Solubility of S at 90°C = 46g per 100g of water
Solubility of S at 50°C = 18g per 100g of water
Mass of crystals formed = 46 – 18 = 28g of S

END