MARKING SCHEME

THE ROYAL EXAM SERIES

Kenya Certificate of Secondary Education

233/1 – CHEMISTRY – Paper 1

1. The pH values of some solutions labeled **E** to I are given in the table **below**. Use the information to answer the questions that follow.

pH	14.0	1.0	8.0	6.5	7.0
Solution	E	F	G	H	I

(a) Identify the solution with the highest concentration of hydroxide ions. Explain **(1 mark)**

E, Strong base

(b). Which solution can be used as a remedy for acid indigestion in the stomach? Explain **(1 mark)**

G, Magnesium Hydroxide

(c) Which solution would react Explosively with Potassium metal? **(1 mark)**

F, Dilute acids reacts with Alkali Metals Explosively/strong acid

2. a) Distinguish between ionization energy and electron affinity (2mk)

Ionization energy is the energy required to lose/donate an electron in an atom of an element in its gaseous state while electron affinity is the energy required to gain/acquire extra electron by an atom of an element in its gaseous state.

***Electron affinity is the energy required to gain an electron in an atom of an element in* gaseous state.**

b) The table below shows first ionization energies of metals represented by letters A, B, C and D. The metals are in the same group of the periodic table.

Metal	A	B	C	D
1st ionization energy (kJ/mole	402	496	520	419

Which of the metals has the largest atomic radius? Explain. (2mks)

C, has the smallest atomic radius, hence stronger nuclear force of attraction holding the outermost electron

3. An element is represented as : $^{23}_{11}M$

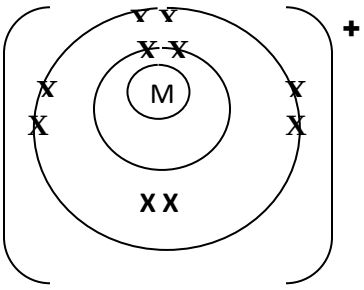
(a) To which chemical family does it belong? **(1/2mark)**

Alkali metals

(b) Write the electron arrangement of the atom **.(1/2mark)**

2.8.1

(c) Draw the structure of its ion. **(1mark)**



4. (a) Define electrolysis. (1 mark)

Process by which an electrolyte gets decomposed when an electric current is passed through it.

(b) During the electrolysis of molten aluminium oxide, write the equations at the;

Anode - $6O^{2-}_{(l)} \rightarrow 3O_{2(g)} + 12e$ (1 mark)

Cathode $4Al^{3+}_{(l)} + 12e \rightarrow 4Al_{(l)}$ (1 mark)

5. In an experiment to determine the % purity of Sodium carbonate produced in the Solvay process ,2.15g of the sample reacted with exactly 40.0cm^3 of 0.5M Sulphuric(VI)acid. determine the % purity of sodium carbonate in the sample.

$$Na_2CO_{3(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + CO_{2(g)} + H_2O_{(l)}$$

$$\text{Mole ratio } Na_2CO_3 : H_2SO_4 \Rightarrow 1:1$$

$$\text{Moles } H_2SO_4 = \frac{\text{Molarity x Volume}}{1000}$$

$$\Rightarrow \frac{0.5 \times 40.0}{1000} = 0.02 \text{ Moles}$$

$$\text{Moles of } Na_2CO_3 = 0.02 \text{ Moles}$$

$$\text{Molar mass of } Na_2CO_3 = 106g$$

$$\text{Mass of } Na_2CO_3 = \text{moles x Molar mass} \Rightarrow 0.02 \times 106 = 2.12 \text{ g}$$

$$\%\ \text{of } Na_2CO_3 = \left(\frac{2.12 \text{ g} \times 100}{2.15}\right) = 98.6047\%$$

6. **Y** is a product of gaseous reaction which results in an equilibrium mixture being formed.

Reactants $\rightleftharpoons$ **Y**

The percentage of **Y** in equilibrium at various temperatures and pressure is shown in the following table.

Temperature (^{0}C)	1 atm	100 atm	200 atm
550	**0.77**	**6.70**	**11.9**
650	**0.032**	**3.02**	**5.71**
750	**0.016**	**1.54**	**2.99**
850	**0.09**	**0.87**	**1.68**

Use this data to deduce, giving a reason for each case;

a) Whether production of Y is exothermic or endothermic. (2 marks)

Exothermic. An increase in temperature reduces the yield of Y; favours the backward endothermic reaction

b) Whether production of Y **involves** an increase or a decrease in number of moles of gas present. (2 marks)

Decrease in the number of moles. Increase in pressure increases the yield of Y; favours forward reaction that reduces moles/volume/molecules of gas present

7. **a**) State and explain what is observed when moist red flowers are dropped in a gas jar containing Sulphur (IV) oxide. (2marks)

When moist red flowers are dropped into a gas jar containing sulphur(IV) oxide, the flowers are bleached/turn white. Sulphur(IV) oxide combines with moisture, forming sulphuric(IV) acid which combines with oxygen from the dye to form sulphuric(VI) acid. When the dye loses oxygen it becomes colourless/white/bleached, the dye undergoes reduction while the sulphuric(IV) acid is oxidised.

$$SO_{2(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3(aq)}$$
$$H_2SO_{3(aq)} + Dye \longrightarrow H_2SO_{4(aq)} + Colourless\ material.$$

8. A sample of water from River Gucha is suspected to contain sulphate ions. Describe an experiment that can be carried out to determine the presence of the sulphate ions.(3 marks)

Add from $Pb(NO_3)_{2(aq)}$/$Ba(NO_3)_{2(aq)}$; followed by acidify with dilute $HNO_{3(aq)}$ A white precipitate which persist on addition of the acid is formed; showing presence of SO_4^{2-} ion;

7. During distillation in a laboratory the distillate can be collected either by a beaker or a conical flask.

(a) Define the term distillate. (1 mark)

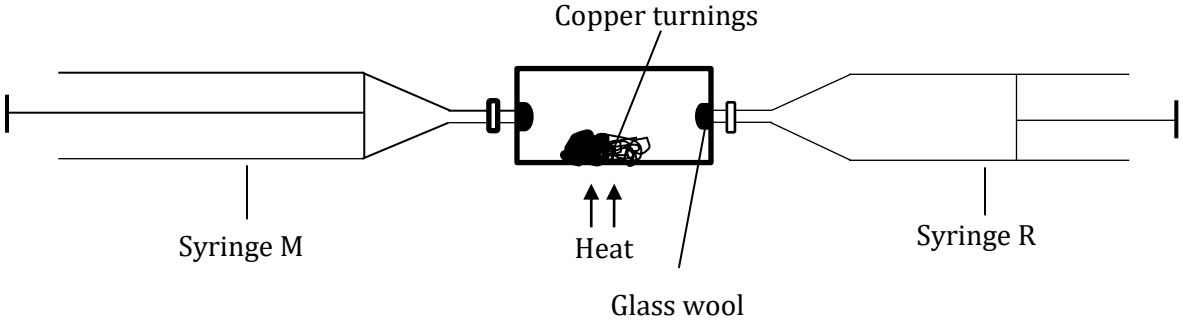
condensed liquid collects in the receiver

(b) Explain why a conical flask is the most preferred apparatus for the collection of the distillate. (1 mark)

The narrow mouth ensures no spillage.

(c) Draw the diagram of a graduated conical flask. (1 mark)

10. In an experiment to determine the proportion of oxygen in air, copper turnings were packed in excess in a long combustion tube connected to two syringes of 110cm^3 each in volume. At the beginning of the experiment, syringe R contained 110cm^3 of air while syringe M was closed and empty as shown.



Air was passed over the heated copper slowly and repeatedly until there was no further change in volume. 97.5cm^3 of air remained in syringe M.

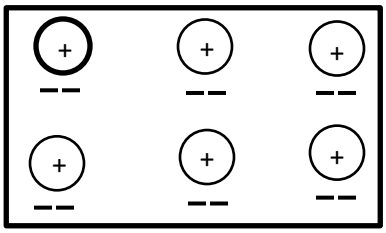
(a) State and explain the observation made in the combustion tube. (2 marks)

A black solid due to the formation of copper (ii) oxide

(b) If the volume of air in the **combustion tube** at the beginning of the experiment was 23.8cm^3 and at the end of the experiment reduced to 10cm^3, calculate the percentage of the active part of air. (2 marks)

0.579831 x 100 = 57.9831%

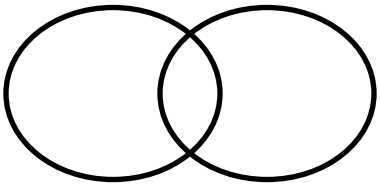
11. Below is a structure of an element X. Use it to answer the questions that follow.



(a) Name the chemical family to which element X belongs. Give a reason. (2 marks)
Alkaline- Earth metal. Has two valence electrons

(b) (i) Define covalent bond. (1 mark)
Bond which involves sharing of electrons contributed by both atoms

(ii) Using dots (●) of cross (**x**) diagram, show bonding in Carbon (II) Oxide.(1 mark)



12. (a) (i) State ***two*** crystalline allotropes of Carbon. (1mark)

Carbon-diamond

Carbon-graphite

(ii) Explain the differences their densities. (2 marks)

Diamond has very high density than graphite because; it has a very closely packed giant tetrahedral structure joined by strong covalent bonds

(b) (i) Name the process used for large scale production of Sodium Carbonate using brine as raw material. (1 mark)

Solvay Process.

(ii) Write the overall chemical equation for the reaction in the carbonator. (1 mark)

$$CO_{2(g)}+H_2O_{(l)}+NaCl_{(aq)}+NH_{3(g)} \rightarrow NaHCO_{3(s)}+NH_4Cl_{(aq)}$$

(iii) Name two gases recycled in the above process (1 mark)

Ammonia gas , Carbon(IV)Oxide

13. Name the following compounds using the IUPAC system. (3 marks)

(i) $CH_3\,CH_2\,CH_2\,CH_2\,C(Br) = CH(CH_3)$ ***3-bromohept-2-ene***

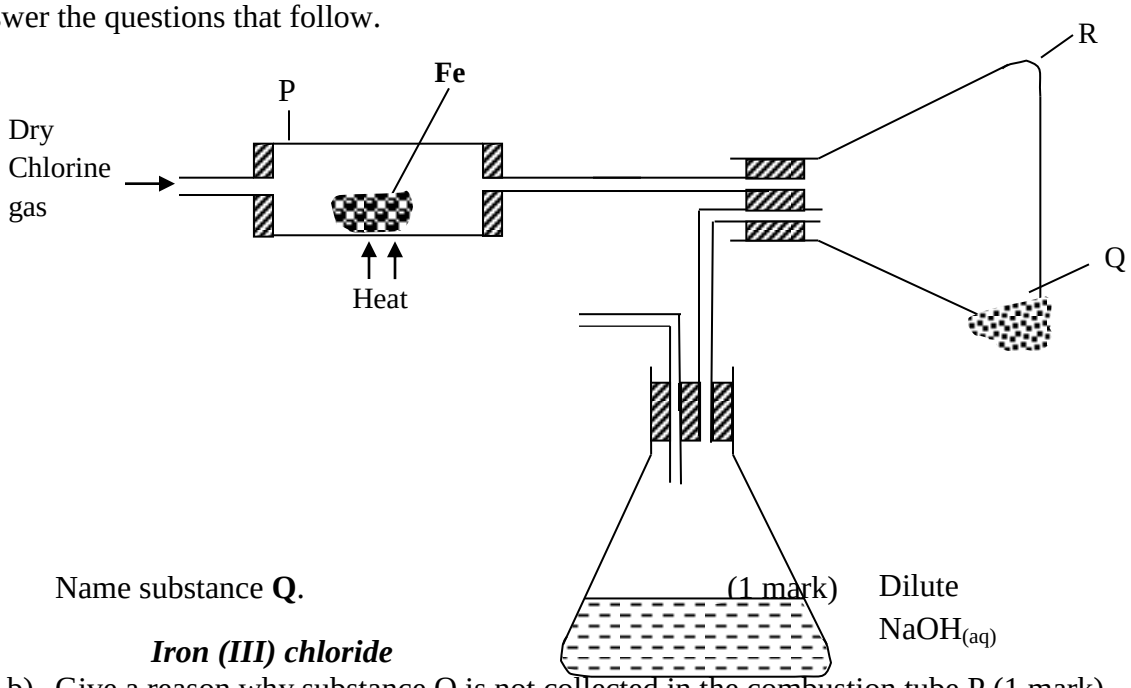
(ii) CH_3CH_2OH ***Ethan-1-ol/ethanol***

(iii) $CH_3CH(CH_3)CH(Cl)CH(Cl)CH_3$ ***2,4-dicloro-3-methylpentane***

14. Describe how to prepare Methane gas starting with soda lime (3marks)

Sodium ethanoate and an equal mass of soda lime is put in a hard glass test tube, upon mixing them thoroughly in a mortar. The mixture is heated thoroughly in the test-tube. ***A colorless gas collects over water/syringe***

15. The diagram below shows how chlorine reacts with metals in the laboratory. Study it and answer the questions that follow.



(a) Name substance **Q**. (1 mark)

Iron (III) chloride

b) Give a reason why substance Q is not collected in the combustion tube P.(1 mark)

Iron (III) chloride sublimes on heating; the black solid changes to red-brown fumes on heating.

(c) Write chemical equation for the reaction that occurs in the conical flask containing Sodium hydroxide. (1 mark)

$$Cl_{2(g)} + 2NaOH_{(l)} \longrightarrow NaCl_{(aq)} + NaClO_{(aq)} + H_2O_{(l)}$$

16. (a) Water sample is found to contain Mg^{2+},Cl^-, SO_4^{2-} , and Ca^{2+}. Identify the type of water hardness (1mks)

Permanent water hardness

(b) Which type of detergent is more suitable with the water sample above. Give a reason (2marks)

Soapless Detergent, does not form scum with water

(c) Permanent water hardness cannot be removed by boiling. Explain (1mks)

- ***The soluble sulphates and chlorides of Mg and Ca do not decompose upon boiling hence cannot be precipitated out.***

17. Starting with lead metal, write procedure on preparation of lead(II) nitrate crystals (3mks)

- ***Measure dilute Nitric(V) acid and transfer it into a beaker.***
- ***Add Lead powder a little at a time as you stir with a glass rod. Continue adding lead powder until it is in excess.***
- ***Filter the solution and pour the filtrate into an evaporating basin.***
- ***Heat to Evaporate the filtrate to saturation***
- ***Allow the now saturated solution to cool .***

18. The following chemical equations show the effects of heat on nitrates.

$2B(NO_3)_{2(s)} \longrightarrow 2BO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

$2ANO_{3\,(s)} \longrightarrow 2ANO_{2(s)} + O_{2(g)}$

$2CNO_{3(s)} \longrightarrow 2C_{(s)} + 2NO_{2(s)} + O_{2(g)}$

a) Arrange elements A, B and C from the most reactive to the least reactive. ($1^1/_2$mks)

A,B,C

b) Give one example of element A, B and C. ($1^1/_2$mks)

A Sodium/Potassium

B Magnesium/Zinc/Lead/Iron/Copper

C Silver/Mercury

19. Copper (II) sulphate crystals, a boiling tube, a test-tube, a beaker and other necessary requirements were used in an experiment to determine the type of change that occurred when the crystals were heated.

(a) Draw a labelled diagram to represent the set-up at the end of the first part of the experiment. (3mks)

(b) After the second part of the experiment was done, state the conclusion that was made about the type of change undergone by copper (II) sulphate crystals when heated. (1mks)

Chemical change

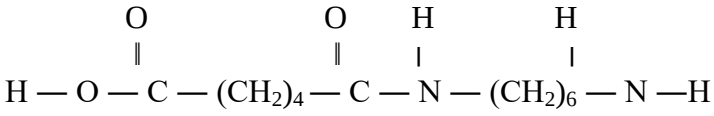
20. (a). Distinguish between chromatography and a chromatogram. (1mk)

Chromatography is a method of separating components of a solution mixture by passing it through a medium where the different components move at different rates while Chromatogram is the medium through which the solution mixture is passed

(c) State the role of chromatography in the administration of international athletics competitions. (1mk)

To test for the presence of illegal drugs

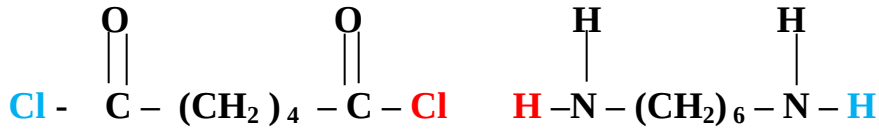
21. Study the polymer shown below.



a) Name the polymer. (1mk)

Nylon 6,6

b) Identify two monomers that make up the polymer. (2 mks)



hexan-1,6-dioyl dichloride ***hexan-1,6-diamine.***

C) Give one use of the polymer (1mark)

to make clothes, plastic ropes and carpets.

22. (a) State Charles law. (1mk)

Volume of a given mass of gas is directly proportional to absolute temperature at constant pressure

(b) A gas occupies 450cm^3 at 27^{0}C. What volume would the gas occupy at 177^{0}C if its pressure remains constant? (2mks)

450 x 450 =202,500

202,500 ÷300 = 675cm^3

23. A colourless liquid was suspected to be water. State two ways to confirm.

(i) Purity of the water. (1mk)

boils at 100^{0}c/ freezes at 0^{0}c

(ii) That the liquid was water. (2mks)

either use anhydrous copper (ii) sulphate which changes from white to blue or anhydrous cobalt (ii) chloride it changes from blue to pink.

24. Use the following information to answer the questions that follow

$\Delta H_{lattice}$ $MgCl_2$ = +2493 kJ/ mol $^{-1}$

$\Delta H_{hydration}$ Mg^{2+} = - 1920 kJ/ mol

$\Delta H_{hydration}$ Cl^- = -364 kJ/ mol

a) Calculate the heat of solution of magnesium chloride. (2mks)

$MgCl_2$ --breaking the crystal into free ions--> $Mg^{2+}_{(g)} + 2Cl^-_{(g)}$ ΔH_l = +2493 kJ
Hydrating the ions;

$Mg^{2+}_{(g)} + aq \longrightarrow Mg^{2+}_{(aq)}$ ΔHh = - 1920 kJ

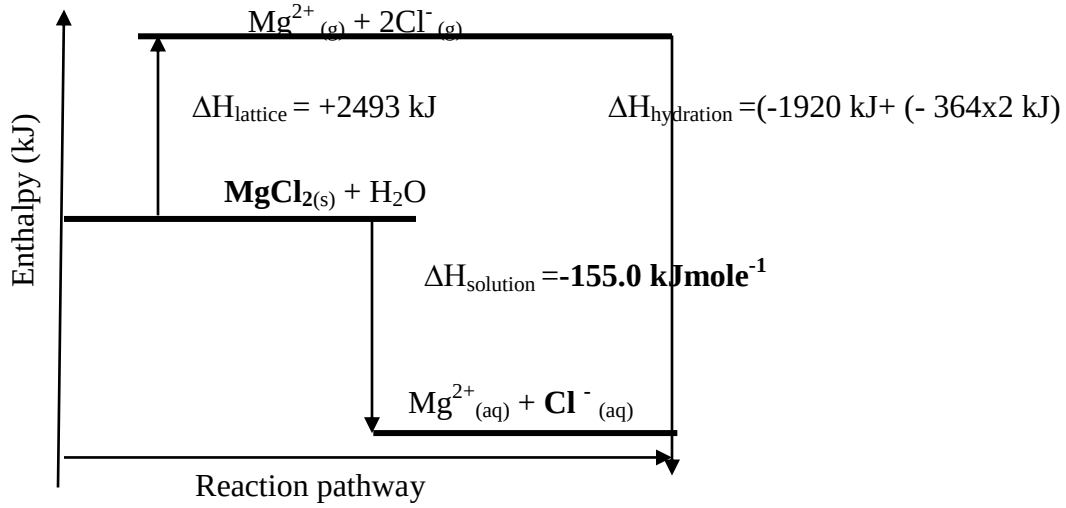
$2Cl^-_{(g)} + aq \longrightarrow 2Cl^-_{(aq)}$ ΔHh = (- 364 x 2) kJ

$\Delta H_s = \Delta H_h + \Delta H_s \longrightarrow$

(-1920 kJ + (- 364x2 kJ)) + (+2493) kJ

= **-155.0 kJmole^{-1}**

b) Draw an energy level diagram for the dissolving of magnesium chloride (2mks)



25. i) A solution of aqueous sodium hydroxide is added to a gas jar of nitrogen (IV) oxide and shaken. State and explain the observation made (2marks)

- ***The brown fumes disappear. Nitrogen (IV) oxide is an acidic gas because it can react with an alkali Forming sodium nitrate and sodium nitrite.***

ii) Write the chemical equation for the reaction above (1 mark)

$2NaOH_{(aq)} + 2NO_{2(g)} \longrightarrow 2NaNO_{3(g)} + NaNO_{2(aq)} + H_2O_{(l)}$