233/1
CHEMISTRY
PAPER 1
JULY / AUGUST 2011
2 HOURS

KANGUNDO DISTRICT FORM FOUR MULTILATERAL EXAM.
Kenya Certificate of Secondary Education
CHEMISTRY
PAPER 1
2 HOURS.

1. An isotope of element E has 34 neutrons and its mass number is 64. E forms a cation with 28 electrons. Write the formula of the cation indicating the mass and atomic number. (1 **mark**)

2. When 8.53g of Sodium Nitrate were heated in an open test-tube, the mass of oxygen produced was 0.83g. Given the reaction as

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

Calculate the percentage of Sodium Nitrate that was converted to Sodium Nitrite.
(Na = 23.0, N = 14.0, O = 16.0) (3 **marks**)

3. Classify the following processes as either chemical or physical. (3 **marks**)

Process	Type of change
(a) Heating copper (II) sulphate crystals	
(b) Obtaining kerosene from crude oil	
(c) Souring of milk	

4. starting with red roses, describe how;

a) A solution containing the red pigment may be prepared. (2 **marks**)

b) The solution can be shown to be an indicator. (2 **marks**)

5. When a hydrated sample of calcium sulphate $CaSO_4.Xh_2O$ was heated until all the water was lost, the following data was recorded.

(i) Mass of crucible = 30.296g
(ii) Mass of crucible + hydrated = 33.111g
(iii) Mass of crucible + anhydrous salt = 32.781g
(Ca = 40, S = 32, O = 16, H = 1)
Determine the value of X and hence write the formula of the hydrated salt. (3 **marks**)

6. Zinc reacts with both concentrated and dilute sulphuric acid. Write an equation for the two reactions. (2 **marks**)

7. (a) State Graham's law of diffusion. (1 **mark**)

(b) The molar masses of gases W and X are 216.0 and 44.0 respectively. If the rate of diffusion of W through a porous material is $12cm^3/s$. Calculate the rate of diffusion of X through the same material. (3 **marks**)

8. Complete the following table by filling in the missing test and observation. (3 **marks**)

No	Gas	Test	Observation
I	Chlorine	Put a moist red litmus into a gas jar	
II	Sulphur (II) Oxide		Solution turns green
III	Butene	Add a drop of bromine	

9. Carbon (IV) Oxide reacts with hydrogen to form methanol and oxygen under certain condition.
The reaction is represented by the equation below.

$2CO_{2\,(g)} + 4H_{2(g)} \rightleftharpoons 2CH_3OH + O_2;\ \Delta H = +1422$

What would be the effect on the yield of methanol if the temperature of the reaction of the mixture is increased? Explain. (2 **marks**)

10. (a) Thorium – 232 delays the emission of beta and alpha particles. Part of the decay series is shown below. Indicate the atomic mass and atomic number of E and D.

$$^{232}_{90}Th \xrightarrow{\beta} E \xrightarrow{\alpha} D \longrightarrow$$

(2 **marks**)

(b) 1g of radio active molebdenum decays to $^1/_8$ g in 200hours. What is the half-like of molebdenum. (2 **marks**)

11. In a sample of element X, the percentage abundance of $^{69}_{31}X$ is 60% and $^{71}_{31}X$ is 40%.

(a) Calculate the R.A.M of X. (2 **marks**)

(b) Explain why the two isotopes have the same chemical properties? (1 **marks**)

12. In the manufacture of blue band margarine, nickel is used as catalyst. An addition reaction involving vegetables, oils and hydrogen takes place.

a) What is an addition reaction? (1 **mark**)

b) What type of bond must be present in the vegetables oils for this reaction to occur? (1 **mark**)

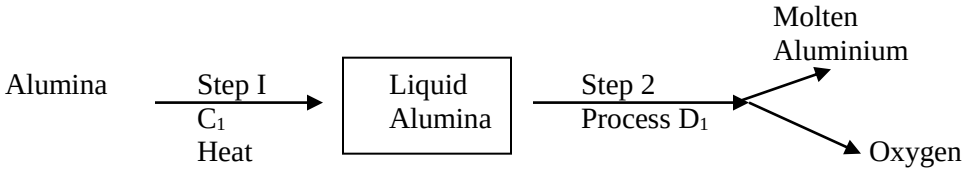
13. Use the half cell reaction and standard electrode potentials given below to show that chlorine can displace iodine from a solution containing iodine ions. (2 **marks**)

Half cell reactions

$Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-_{(aq)} + 1.36V$

$I_{2(g)} + 2e^- \longrightarrow 2I + 0.54\ V$

14. During the extraction of aluminium from its ores, the ore is first purified to obtain alumina. The chart below shows the stages in the extraction of aluminium from alumina.



a) Name

(i) Substance C_1 (1 **mark**)

(ii) Process D_1 (1 **mark**)

b) Give two reasons why aluminium is used extensively in making of cooking pan. (1 **mark**)

15. Solid A dissolves in water forming a colourless solution. The solution was divided into two portions.
To the second portion ammonia solution was added until excess. In both a white precipitate was formed which dissolved in excess sodium hydroxide solution forming a colourless solution.

(a) Write an equation between solution A and ammonia solution. (2 **marks**)

(b) Name the complex ion formed when solution A reacts with

(i) Ammonia solution in excess. (1 **mark**)

(ii) Sodium hydroxide solution in excess. (1 **mark**)

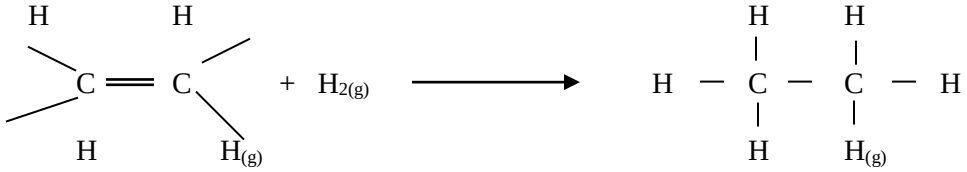
16. Use the bond energies given below to determine whether the reaction given below is exothermic or endothermic. (3 **marks**)

C – C = 346 kJmol$^-$

C – H = 413 kJmol$^-$

C = C = 610 kJmol$^-$

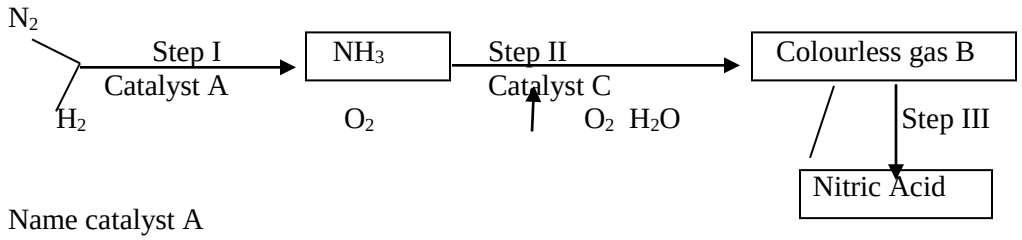
H – H = 435 kJmol$^-$



17. Study the diagram below and answer the questions that follow.

(a) Write a chemical equation for the reaction taking place in the combustion tube. (1 **mark**)
(b) Give two reasons why it is necessary to heat the water first before heating magnesium ribbon. (2 **marks**)

18. Study the flow chart below and answer the questions that follow.



(a) Name catalyst A (1 **mark**)
(b) Name gas B (1 **mark**)
(c) Apart from catalyst A, what other condition facilitates reaction in step II. (1 **mark**)
(d) Write an equation for the reaction in step III. (1 **mark**)

19. State two differences between compounds and mixture. (2 **marks**)

20. A student wanted to determine the solubility of potassium nitrate. He obtained the following results.
Mass of evaporating dish = 14.32g
Mass of evaporating dish + solution = 35.70g
Mass of evaporating dish + salt = 18.60g
Calculate the solubility of potassium nitrate from the above results. (3 **marks**)

21. Why is solid carbon (IV) Oxide dry ice preferred in cool boxes to normal ice that is solid water. (2 **marks**)

22. Explain how electro-plating prevents rusting. (2 **marks**)

23. The volume of a sample of nitrogen at temperature of 291k and 1.0×10^5 pascals is 3.5×10^{-2} m^3.
Calculate the temperature at which the volume of the gas would be $2.8 \times 10^{-2} m^3$ at 1.0×10^5 pascals. (3 **marks**)

24. Butane is a hydrogen which shows only branching isomerism. Draw and name two possible structures of the isomers of butane. (3 **marks**)

25. Name two methods that can be used to remove permanent hardness from water. (2 **marks**)

26. Use the information given below to answer the questions that follow.

Solution	pH
A	1.5
B	7.0
C	9.8

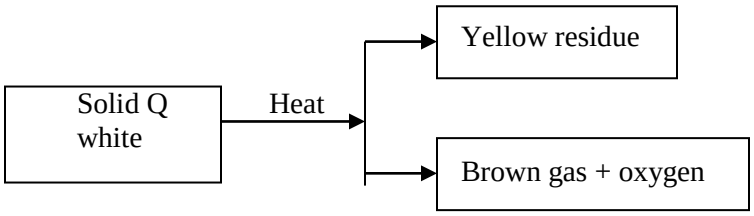
Which of the above solutions will not affect the colour of red litmus paper. Explain. (2 **marks**)

27. The diagram below shows the combustion of propane gas.
Gas P to suction pum

(a) Identify substance X _____ (1 **mark**)
(b) Write the equation for the complete combustion of propane gas. (1 **mark**)
(c) What is the purpose of ice cold water in the experiment? (1 **mark**)

(d) The pH of substance X was found to be less than 7. Explain this observation. (1 **mark**)

28. Study the scheme below and answer the questions that follow.



(a) Name

(i) Solid Q (1 **mark**)

(ii) The yellow residue (1 **mark**)

(b) Write an equation for the decomposition of solid Q. (1 **mark**)

29. Draw the structure and name the alkanol with six carbon atoms. (1 **mark**)

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MARKING SCHEME

1. Mass number = P + N = 64

P + 34 = 64
P = 64 -34
P = 30 √ ½
Electrons = 30
Cation = 28 electrons lost $2e^-$ thus E^{2+} √ ½

2. $2NaNO_{3(s)} \rightarrow 2NaNO_{2(s)} + O_{2(g)}$
Mole ratio 2 2 1
0.05188 0.05188 0.02594

Moles of O_2 = 0.83 / 32 = 0.02594 √1

R.F.M $NaNO_3$ = 23 + 14 + 48
= 85
Mass of 0.05188 moles of $NaNO_3$ = 0.05188 x 85 √1 = 4.4098g
Percentage of $NaNO_3$ = 4.4098 x 100 / 8.53
= 51.88% √1

3. (a) Physical change √1
(b) Physical change √1
(c) Chemical change √1

4. (a) (i) Transfer the pieces of red rose into a mortar. √ ½
(ii) Add a mixture of distilled water and acetone / propanone √ ½
(iii) Crash to a thick paste using a pestle. √ ½
(iv) Squeeze the mixture to obtain red pigment, filter using a filter paper and funnel to remove the residue. √ ½

(b) Put 2 drops of the pigment into 2ml of NaOH √ ½ and 2 drops of pigment into 2ml of dilute hydrochloric √ ½ acid. Observe the difference in distinct colours. √1

5. Mass of crucible = 30.296g
Mass of crucible + hydrated salt = 33.111g
Mass of crucible + anhydrous salt = 32.781g

	Anhydrous salt	Water
Mass	2.485	0.340
Moles	2.485 / 136 = 0.018 √ ½	0.340 / 18 = 0.01889 √ ½

Mole ratio 0.018 / 0.018 = 1 √ ½ 0.018 / 0.018 = 1 √ ½ ∴ x = 1

Hence empirical formula of salt is $CaSO_4.H_2O$ √1

6. $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$ √1

$Zn_{(s)} + 2H_2SO_{4(l)} \rightarrow ZnSO_{4(aq)} + SO_{2(g)} + H_{2(g)}$ √1

7. (a) Graham's law states that:
The rate of diffusion of a gas is inversely proportional to the square root of its density at constant condition of pressure and temperature. √1

(b) Gas Mass Rate

W 16 12
X 44 ?

$\frac{R_w}{R_x} = \frac{\sqrt{M_x}}{\sqrt{M_w}}$ $\sqrt{1}$

$\frac{12}{R_x} = \frac{\sqrt{44}}{\sqrt{16}}$

$144 = \frac{44}{(R_x)^2}$ $\frac{}{16}$

$(Rx)^2 = \frac{144 \times 16}{44}$ $\sqrt{1}$

$R_x = \sqrt{\frac{144 \times 16}{44}}$

$R_x = 7.24 cm^3/s$ $\sqrt{1}$

8.

No.	Gas	Test	Observation
I	Chlorine	Put a moist red litmus paper into gas jar	It was decolourised √1
II	Sulphur (IV) oxide	Bubble gas through $K_2Cr_2O_{7(aq)}$ √1	Solution turns green
III	Butene	Add a drop of bromine	Bromine is decolourised √1

9. The yield of methanol will <u>increase</u> since the forward reaction rate is favoured by increase in temperature. √1

10. (a) $^{232}_{90}Th \xrightarrow{\beta} E \xrightarrow{\alpha} D$

$^{0}_{-1}\beta$, $^{4}_{2}\alpha$

Mass number $232 \xrightarrow{\sqrt{1}} 228$ √1

E , D

Atomic number $91 \xrightarrow{} 89$

(b) $\frac{1}{2^n} = \frac{M_2}{M_1}$ $T_{½}$ = Time taken / number of half –life

$\frac{1}{2^n} = \frac{1}{8}$ = 200

$2^n = 2^3$ = 66 $^1/_3$ hrs √1

n = 3 √1

11. (a) Calculate the R.A.M of X

R.A.M = $\frac{(69 \times 60) + (71 \times 40)}{100}$ √½

= $\frac{4140 + 2840}{100}$ √½

= $\frac{6980}{100}$

= 69.8 √1

12. (a) Addition reaction involve molecule joining together to form larger molecules √1

(b) Carbon – carbon double bond √1 / triple bond.

13. $Cl_{2(g)} + 2e^- \rightarrow 2Cl^-_{(aq)}$ + 1.36V √ ½
$2I^-_{(aq)} \rightarrow I_{2(g)} + 2e$ - 0.54V √ ½
$Cl_{2(s)} + 2I^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + I_{2(g)}$; E_v = + 0.82 √ ½

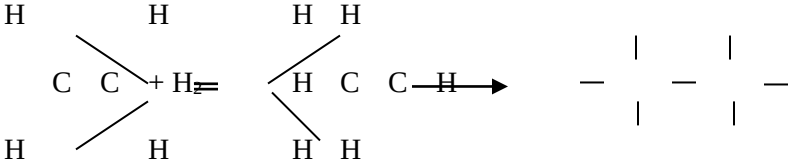
Resultant e.m.f is positive hence reaction can take place / occur. √ ½

14. (a) (i) Cryolite (Na_3AlF_6) √1
(ii) Electrolysis √1
(b) - Good conductor of heat energy √
- Does not rust √
- Relatively cheap √
- Highly abundant in earth's crust

Mark any two correct @ 1 **mark**

15. (a) $Zn(OH)_{2(s)} + 4NH_{3(aq)} \rightarrow [Zn(NH_3)4]^{2+}_{(aq)} + 2OH^-_{(aq)}$ √2
(b) (i) Tetra – ammonia zincate ion √1
(ii) Tetra hydroxyl zincate ion √1

16.



C – C 413 x 4 = 652kj C – C = 346 x 1 = 346 √1
C = C 610 = 610 kj H – C = 413 x 6 = 2478
H – H 435 = 435 -2824
2697 kj √1

ΔH = -2824
2697
-127 kJmol^{-1} √1

17. (a) $Mg_{(s)} + H_2O_{(g)} \rightarrow MgO_{(s)} + H_{2(g)}$ √1
(b) (i) To clear the air in the combustion tube and delivery tube. √1
(ii) To generate steam √1
18. (a) Platinum √1
(b) $NO_{(g)}$ √1
(c) High temperature 400^{0}C √1
19.

Compound	Mixtures
- Not separated by physical means √ ½	- Can be separated by physical means √ ½
- Large amount of energy changes √ ½	- Not accompanied by great energy changes √ ½
- Properties of compound different from those of constituent elements	- Properties are average of the components in mixture

Mark any 2 correct 1 (maximum 2 **marks**)

20. Mass of solution = 35.70 – 14.32 = 21.38g
Mass of salt = 18.60 – 14.32 = 4.28g
Mass of water = 21.38 – 4.28 = 17.1g √1
Solubility of salt (KNO_3) = 4.28g in 17.1g of water
Xg in 100g of water √
∴ solubility = $\frac{100 \times 4.28\text{g}}{17.1}$ / 100g of water
= 25.03g / 100g of water √1
21. - Does not make surface wet √1
- Lighter than ice √1
22. The outer covering metal is inert √1 and does not rust √1

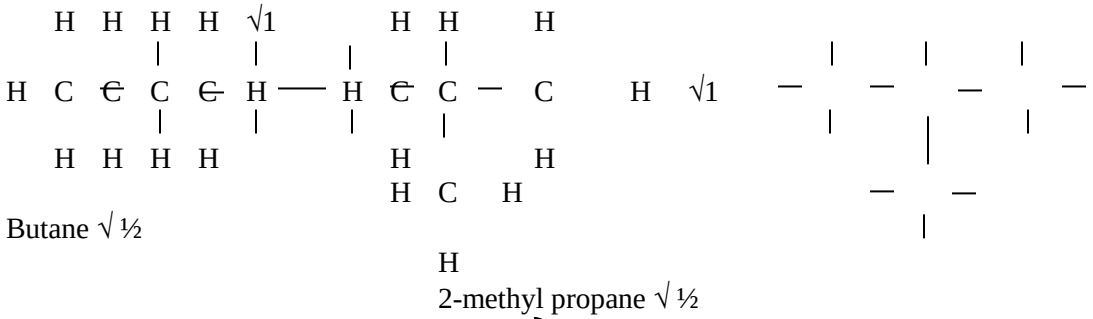
23. $T_1 = 291k$ $T_2 = ?$
$P_1 = 1.0 \times 10^5$ Pa $V_2 = 2.18 \times 10^{-2} m^3$
$V_1 = 3.5 \times 10^{-2} M^3$ $P_2 = 1.0 \times 10^5$ Pa

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ √1 But $P_1 = P_2$ ∴ $V_1 = V_2$

∴ $T_2 = V_2 \times T_1 = \frac{2.8 \times 10^{-2} \times 291}{3.5 \times 10^{-2}}$ √1 = 232.8/ √1
V_1

$= -40.2^0C$

24.



Butane √ ½

2-methyl propane √ ½

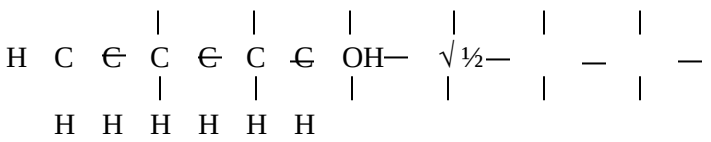
25. (i) Use of ion exchange resin
(ii) Distillation Any 2 correct answers @ 1 **mark**
(iii) Addition of sodium carbonate

26. (i) Substance B because it is neutral and has no effect on litmus paper. √1
(ii) Solution A since it is acidic and thus does not affect red litmus paper √1

27. (a) Water √1
(b) $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)}$ √1
(c) CO_2 gas is slightly soluble in water making it slightly acidic hence pH less than 7. √1

28. (a) (i) Lead (II) Nitrate √1
(ii) Lead (II) Oxide √1
(b) $2Pb(NO_3)_{2(s)} \xrightarrow{\text{heat}} 2PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$ √1

29.



Hexan-1-OL √ ½

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2 HOURS.

1. Study the figure below and answer the questions that follow.

A B C

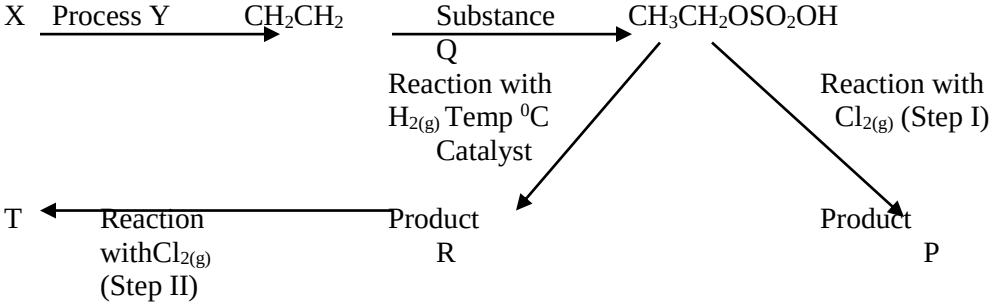
a) What is the name given to the above type of flame? (1 **mark**)
b) Indicate on the diagram by circling the hottest region. (1 **mark**)
c) Which region of the flame contains unburnt gases? (1 **mark**)
d) Describe two simple experiments to indicate that the flame contains a region of unburnt gases. (2 **marks**)
e) Which other type of flame does a Bunsen burner produce? (1 **mark**)
f) Give 3 differences between type of flame identified in (a) and (e) above. (3 **marks**)
g) State two reasons why most apparatus in the Chemistry laboratory are made of glass. (2 **marks**)

2. Study the table below and answer the questions below it. The letters used are not the actual symbols of the elements.

Element	Electron arrangement	Atomic radius	Symbols (^{0}C) M.P	(^{0}C) B.P
X	2 . 8. 1	0.157	98	890
Y	2 . 8. 2	0.136	650	1,110
Z	2. 8. 3	0.125	660	2,470
W	2. 8. 4	0.117	1,410	2,360
A	2. 8. 5	0.110	44	280
D	2. 8. 6	0.104	119	445
E	2. 8. 7	0.099	-101	-35
G	2. 8.8	-	-189	-186

a) (i) Explain the trend in the atomic radius across the period. (2 **marks**)
(ii) Why is it that the melting and boiling points of elements E and G are very low? (1 **mark**)
(iii) Which period of the periodic table do these elements belongs to? Give a reason for your answer. (2 **marks**)
b) Element Z reacts with E forming a compound. Draw dot (.) and cross (x) diagrams for this. (2 **marks**)
c) Write an equation to show the reaction of element X with:
(i) Oxygen gas (1 **mark**)
(ii) Water (1 **mark**)
d) Which element has the greatest tendency of forming covalent compounds? Explain. (2 **marks**)

3. Study the diagram below and answer the questions that follow.



(i) (a) Name the process represented by Y. (1 **mark**)
(b) Which reagent is used in this process Y? (1 **mark**)
(ii) State the names of products R and P. (2 **marks**)
(iii) Give the value of temperature and the catalyst used to form product R. (2 **marks**)
Temperature
Catalyst
(iv) (a) What is substance Q ? (1 **mark**)
(b) Name the product $CH_3CH_2OSO_3OH$. (1 **mark**)
(v) Give the name of step I and step II. (2 **marks**)

(vi) State any two uses of the compounds in the homologous series to which X belongs. (2 **marks**)

4. The following table gives some standard enthalpies of formation.

	C_3H_7OH	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(l)}$
ΔHf^0/n kJ/mol	-315	0	-394	-286

a) Explain why oxygen has an enthalpy of formation of zero. (1 **mark**)

b) (i) Use the data above to calculate the ΔH^0C of propan-1-ol (C_3H_7OH)

$C_3H_7OH_{(l)} + {}^9/_2O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(l)}$ (3 **marks**)

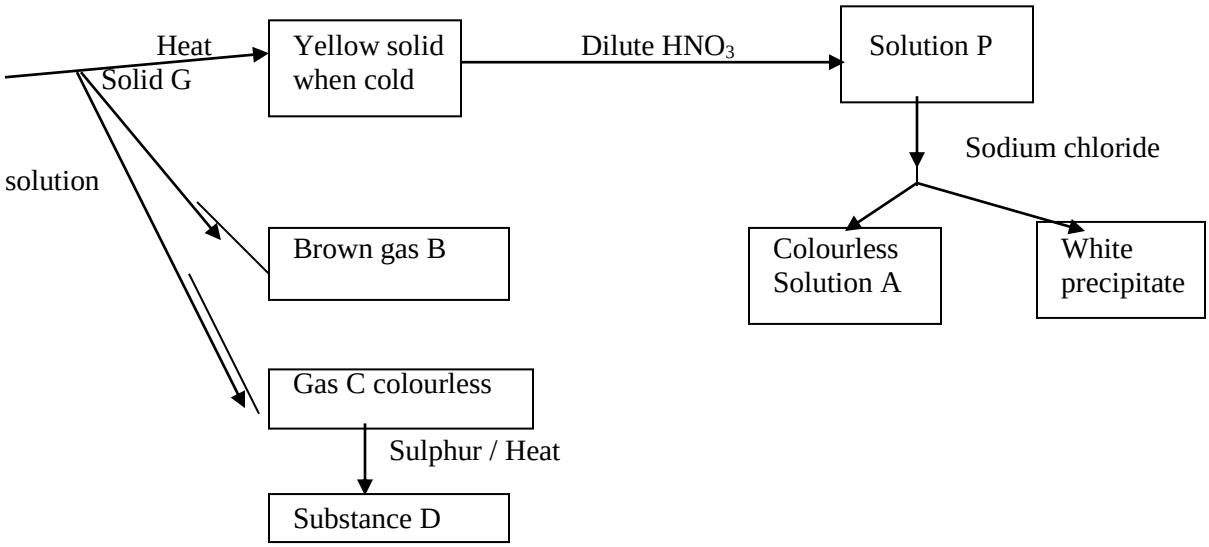
(ii) State how you would expect the value obtained in b(i) above to differ if gaseous water, rather than liquid water was formed. (1 **mark**)

c) (i) In an experiment 0.92g of propan-1-ol (C_3H_7OH) was burnt and the heat used to raise the temperature of 250cm^3 of water. The temperature rise was 16^0C. Calculate the enthalpy of combustion of 1 mole of propan-1-ol (Density of water = 1gm/cm^3, specific heat capacity of water = 4.2$jg^{-1}k^{-1}$ and C = 12, O = 16, H = 1) (3 **marks**)

(ii) Draw an energy level diagram for the change in c (i) above. (2 **marks**)

(iii) Suggest why the experimental value of the enthalpy of combustion obtained in d(i) above is less than the value obtained in c (ii). (2 **marks**)

5. Study the flow chart below and answer the questions that follow.



a) Write the formula of the ions present in solid G. (1 **mark**)

b) Identify: Solution P
Colourless solution A
White precipitate
Brown gas B
Gas C
Nature and state of substance D (3 **marks**)

c) In an experiment a white solid was put in a hard test tube and heated. During heating a glass rod with a drop of lime water was placed at the mouth of the test tube. The gas given off formed a white precipitate with lime water. The residue left after heating was yellow when hot and on cooling turned white.

(i) Write the formula of the anion present in the white solid. (1 **mark**)

(ii) Write the equation of the reaction that formed the white precipitate. (2 **marks**)

(iii) Using a suitable equation state and explain the observation made in c(ii) above if gas given off was in excess. (2 **marks**)

(iv) Write the equation for the reaction that formed the white residue. (1 **mark**)

(v) The residue was reacted with dilute nitric (V) acid and drops of sodium hydroxide added drop wise until in excess. State and explain the observations made. (2 **marks**)

6. (a) The label on a bottle of mineral water had the following information.

Ions present	Concentration (g litre -1)
Ca^{2+}	0.10
Mg^{2+}	0.20
Na^+	0.01
K^+	0.01
SO_4^{2-}	0.14
HCO_3^-	0.26

(i) Name a compound that causes temporary hardness in the mineral water. (1 **mark**)

(ii) Using an equation, explain how the mineral water can be softened by adding sodium carbonate. (2 **marks**)

b) Water hardness due to Ca^{2+} ions can be determined by titrating the water with a complexing agent H_2Y^{2-} which reacts as shown.

$$Ca^{2+}_{(aq)} + H_2Y^{2-}_{(aq)} \longrightarrow CaY^{2-}_{(aq)} + 2H^{+}_{(aq)}$$

In an experiment 50cm^3 of water sample was titrated with 0.01M solution of the complexing agent $H_2Y^{2-}_{(aq)}$ and a suitable indicator. 35cm^3 of the reagent were required to reach the end point.

(i) Calculate the concentration in moles per litre of the calcium ions in the water samples. (3 **marks**)

(ii) How many grammes of the complexing agent would be required to remove the hardness in 10 litres of water? (H = 1, Y = 54) (3 **marks**)

c) The structure shown below represents two cleansing agents, L_1 and L_2.

L_1 $R - CH_2 - CH_3$
$\|$
OSO_3Na^+

L_2 $R - COONa^+$

(i) Identify each of the two cleansing agents; L_1 and L_2 (1 **mark**)

(ii) What problem is posed by the use of each of the two cleansing agents? (2 **marks**)

7. Dry chlorine gas was collected using the set up below.

Moist blue litmus paper

(i) Name a suitable drying agent for chlorine gas. (1 **mark**)

(ii) State one property of chlorine gas which facilitates this method of collection. (1 **mark**)

(iii) State the observations on the moist blue litmus paper. (2 **marks**)

(iv) Chlorine gas was bubbled through distilled water. With the aid of an equation show the formation of chlorine water. (1 **mark**)

(v) Write the formula of the compounds formed when chlorine gas reacts with warm dry phosphorus. (2 **marks**)

(vi) Write the formulae of the compounds formed when chlorine gas reacts with warm dry phosphorus. (2 **marks**)

(vii) Chlorine gas is mixed with moist hydrogen sulphide gas. State and explain the observations. (2 **marks**)

(viii) Give one use of chlorine gas. (1 **mark**)

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MARKING SCHEME

1. (a) Non luminous √1 **mark**
   (b) A √1 1 **mark** Reject if not circled on the diagram
   (c) B √ 1 **mark**
   (d) - Place a long glass √ ½ tube in the region and ignite at the end – a small √ ½ flame is produced.

   - Place or insert a unused match √ ½ stick into the region – it does not get ignited. √ ½
   (e) Luminous √ 1 **mark**
   (f) Non luminous - Luminous
   - Air hole open - Air hole closed
   - Small and steady - Large and wavy
   - Produce a lot of heat and less light - Produce less heat and more light
   - Does not produce soot - Produce soot
   - Has 3 distinct regions - Has 4 distinct regions

   Any 3 correct responses for 3 **marks**
   (g) - Easy visibility
   - Non reactive and don't react with chemicals
   - Have high melting point (reject boiling point.)

   Max 11 **marks**

2. (a) (i) The atomic radius decreases √1 across the period from left to right due to an increase in the number of protons, and thus an increase in nuclear attraction √1.

   (ii) E occurs in molecules of two atoms covalently bonded but the molecules are held √ ½ together by weak vander Waal's forces. The atoms of G are √ ½ held by weak Van der Waal's forces.
   The van der waal's forces are √ ½ easily broken with low temperatures.

   (iii) Period - 3 √
   Reason – Have 3 energy levels like √1 all elements of period III.

   (b)

(c) (i) $2X_{(s)} + O_{2(g)} \rightarrow 2X_2O_{(s)}$ √1 **mark**

(ii) $2X_{(s)} + 2H_2O_{(l)} \rightarrow 2XOH_{(aq)} + H_{2(g)}$ √1
(Accept if correct element symbols are used)

(d) Element – W √1
Explanation – has 4 valency electrons which it can not lose but only share. √1

3. (i) (a) Dehydration √1
(b) Concentrated sulphuric (VI) acid √1 / concentrated H_2SO_4

(ii) R – Ethane √1
P – 1, 2-dichloroethane √1

(iii) Temperature : $150^0C – 250^0C$ √1 or $150^0C , 250^0C$
Catalyst – Nickel √1 (Any temperature between 150^0C and 250^0C)

(iv) (a) Concentrated sulphuric (VI) acid / concentrated H_2SO_4 √1
(b) Ethyl hydrogen sulphate √1

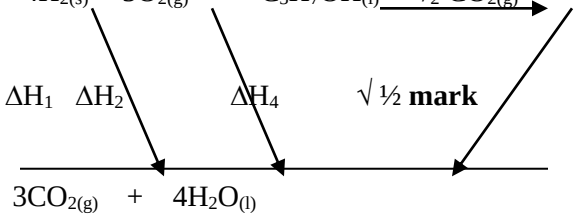
(v) I – Addition reaction √1
II – Substitution reaction √1

(vi) 1. As solvents √1
2. As fuels blended √1 with gasoline to form gasohol used in methylated spirit stores.
* In manufacture of synthetic fibres.
* As an antiseptic when used in specific concentrations.
* Pure ethanol can be used as an alcoholic drink only in lower concentrations.
(Any two correct uses)

2.

4. (a) Oxygen is an element √ ½ **mark**. An element is the simplest substance that cannot be √ ½ **mark** split into anything simpler by chemical means // or enthalpy of formation of a compound is the energy change when 1 mole of the compound is formed √ ½ **mark** from its constituent elements under standard conditions and oxygen is not formed. √ ½ **mark**

(b) (i) $3C_{(s)} + 4H_{2(s)} + 5O_{2(g)} \xrightarrow{\Delta H_3} C_3H_7OH_{(l)} + {}^9/_2\ CO_{2(g)}$



According to these $\Delta H_1 + \Delta H_2 = \Delta H_3 + \Delta H_4$
-394 x 3 √ ½ **mark** + (-286 x 4) √ ½ **mark** = ΔH_4 + -315
ΔH_4 = -394 x 3 + -286 x 3 + 315 √ ½ **mark**
= -1182 + -1144 + 315
= -2326 + 315
= -2011kJ mol-1 √ 1 **mark**
Or
$C + O_2 \rightarrow CO_2$ $\Delta Hf^{\theta} = -394 kJmol^{-1}$
$H_2 + ½\ O_2 \rightarrow H_2O$ $\Delta Hf^{\theta} = -286\ kJmol^{-1}$
$3C + 4H_2 + ½\ O_2 \rightarrow C_3H_7OH$ $\Delta Hf^{\theta} = -315 kJmol^{-1}$
Require

$C_3H_7OH_{(l)} + {}^9/_2\ O_{2(g)} \quad 3CO_{2(g)} + 4H_2O_{(l)} \quad \Delta He^\theta$

$C_3H_7OH \quad 3C + 4H_2 + 1/2\ O_2 \quad \Delta Hf^\theta = 315 kJmol^{-1}$ √ ½ **mark**

$3C + 3O_2 \quad 3CO_2 \quad \Delta Hf^\theta = -1182\ kJmoli^{-1}$

$C_3H_7OH + 2\ ½\ O_2 \quad 3CO_2 + 4H_2 \quad \Delta H^\theta = -867\ kJ\ mol^{-1}$ √ ½ **mark**

$4H_2 + 2O_2 \quad 4H_2O \quad \Delta H^\theta = -1144$ √ ½ **mark**

$C_3H_7OH + 4\ ½\ O_2 \quad 3CO_2 + 4H_2O \quad \Delta H_{c\theta} = -2011\ kJ\ mol^{-1}$ √ **mark**

(ii) The energy given out would be less than √ 1**mark** $2011 kJmol^{-1}$ for some energy would be used to vaporate the water (change water from liquid to gaseous form)

(c) (i) $\Delta H = M \times C \times DT$

= 250 x 4.2 x 16 √ ½ **mark**

= 16800J

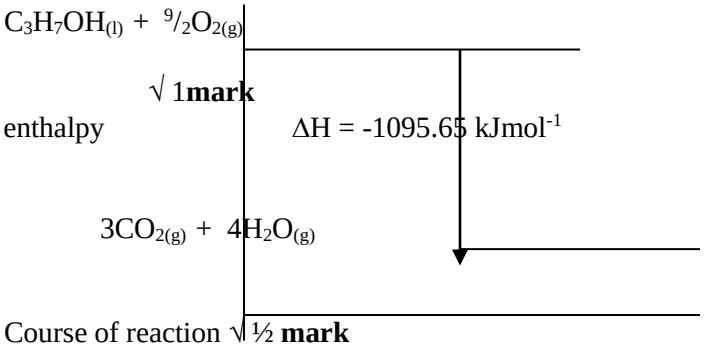
= 16.8J √ ½ **mark** Produced by 0.92g of propan-1-ol

1 mole = 60g √ ½ **mark**

60 g = 16.8 x 60 / 0.92 √ ½ **mark**

$\Delta Hc = 1095.65 kJmol^{-1}$ √ 1**mark**

(ii)



(iii) - Not all the heat given out when propan-1-ol burns is transferred to the water some of the energy is lost to the surroundings (Air, or container)

- In complete combustion of propan-1-ol
- Propan-1-ol evaporates as the burner cools. (Any 2 for 2 **marks**)

5. (a) Pb^{2+} √ ½ **mark** and NO_3^- ½ **mark**

(b) (i) Solution P – $Pb(NO_3)_2$ √ ½

Colourless solution A – $NaNO_3$ √ ½

White precipitate – $PbCl_2$ √ ½

Brown gas B – NO_2 √ ½

Gas C – O_2 √ ½

Acidic gas – substance D √ ½

(c) (i) CO_3^{2-} reject name √ 1 **mark**

(ii) $Ca(OH)_{2(aq)} + CO_{2(g)} \quad CaCO_{3(s)} + H_2O$ √ 2 **marks**

(iii) The white precipitate disappear as √ ½ $Ca(HCO_3)_2$ is formed

$CaCO_{3(s)} + H_2O_{(l)} + CO_{2(s)} \quad Ca(HCO_3)_2$ √ 1 **mark**

(iv) $ZnCO_{3(s)} \quad ZnO_{(s)} + CO_{2(s)}$ √√ 1 **mark**

(v) A white precipitate √ ½ **mark** was formed which dissolved in excess √ ½ **mark** NaOH to form a colourless solution.

$Zn^{2+}_{(aq)} + 2OH^-_{(aq)} \quad Zn(OH)2$ √ ½ **mark**

$Zn(OH)_{2(s)} + 2OH^-_{(aq)} \quad [Zn(OH)_4]^{2-}_{(aq)}$ √ ½ **mark**

6. (i) Calcium hydrogen carbonate √ 1 **mark** or magnesium hydrogen carbonate (reject formula)

(ii) Carbonate ions from the √ ½ **mark** sodium carbonate reacts with the magnesium // calcium ions thus precipitating $MgCO_3$ or $CaCO_3$

$Mg^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \quad MgCO_{3(s)}$ or $Ca^{2+}_{(aq)} + CO_3^{2-}O_{(aq)} \quad CaCO_{3(s)}$

Then filter √ ½ **mark** to get soft water as filtrate and the carbonate is left as residue.

(b) (i) Mole ratio 1 : 1

No of moles of complexing agent

$1000cm^3$ 0.01 moles ⟶
$35cm^3$?
35 x 0.01 = 0.00035 moles √ ½
1000
No. of moles of ions in hard water // moles of complexing or implication of mole ratio
Reagent = 0.00035 moles
$50cm^3$ 0.00035 moles ⟶
$1000cm^3$?
1000 x 0.00035
50 √ ½ = 0.007 moles √ 1 **mark**

(ii) 1 litre of water – 0.007 moles √1 **mark**
10 litre of water = 10 x 0.0007 = 0.07 moles √ ½
RMM of complexing agent = 2 + 54 = 56 √ ½ **mark**
1 mole = 56g
0.07 mole = ? = 0.07 x 56 = 3.92g √ 1 **mark**

(c) (i) L_1 soapless detergents √ ½ **mark**
L_2 soap √ ½ **mark**

(ii) L_1 – is nonbiodegradable and hence a longterm water pollutant leads to eutrophication 1 **mark**
L_2 – Forms scum √ 1 **mark** with water hence wastage of soap // cause furring in boiler (kettles) // destruction of fabrics.

7. (i) Concentrate sulphuric (VI) acid √1
(ii) It is denser than air √1
(iii) – It turns red √1
- It turns white √1 / It gets bleached
(iv) $Cl_{2(g)} + H_2O_{(l)} \longrightarrow HOCl_{(aq)} + HCl_{(aq)}$ √1
(v) PCl_3 √1
PCl_5 √1
(vi) - A yellow deposit of sulphur is formed √1 / seen.
- Chlorine oxidises sulphide ions to solid sulphur √1
(vii) - Manufacture of $HCl_{(aq)}$ √1
- Manufacture of bleaching agents such as chlorate used in the cotton and paper industries
- Chlorine is used in the treatment of water and sewage plants
- Manufacture of chloroform, an anaesthetic
- Manufacture of solvents such as trichloroethale
(Any 1 correct use)

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CHEMISTRY
PAPER 3
PRACTICAL
JULY / AUGUST 2011
2 ¼ HOURS

KANGUNDO DISTRICT FORM FOUR MULTILATERAL EXAM.
Kenya Certificate of Secondary Education
CHEMISTRY
PAPER 3
2 ¼ HOURS.

1. You are provided with:
Solution C (sulphuric acid) which contains 6.115g in $250cm^3$
0.5M sodium hydroxide, solution D
You are required to determine the
a) Concentration of sulphuric acid in moles per litre.

b) Determine the R.F.M of the acid.

Procedure:

Fill the burette with solution C. Pipette 25cm^3 of solution D into a clean conical flask. Add 2-3 drops of phenolphthalein indicator and titrate with solution C.

Repeat the procedure for two more times to get three consistent results and record your results in table I below.

TABLE I

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

(5 **marks**)

a) Determine the average volume of solution C used. (1 **mark**)

b) Calculate the number of moles of solution D, sodium hydroxide used. (1 **mark**)

c) Determine the number of moles of sulphuric acid that reacted. (2 **marks**)

d) Determine :

(i) The molarity of sulphuric acid in moles per dm^3. (2 **marks**)

(ii) Calculate the relative formula mass of solution C, sulphuric acid. (2 **marks**)

2. You are provided with a 2M solution of hydrochloric acid (A) and 0.4M solution of sodium thiosulphate (B).

(i) Using a pencil draw a cross X about 1cm by 1cm on a white sheet of paper.

(ii) Place 100ml beaker on top of the cross and add 10.0cm^3 of B check that the cross is visible through the solution looking from above.

(iii) Add 10.0cm^3 of A to the beaker containing B and start recording the time. Shake the beaker once and leave to stand on the cross. Look down at the cross(x) through the solution and record the time (t) in seconds taken for the cross to be no longer visible

(iv) Repeat the procedure using the solutions of B diluted with water as indicated in the table below,

(v) Complete the table of results by calculating and recording the values of ($^1/_t s^{-1}$) for each value of t

Mixture	Volume of $Na_2S_2O_3$	Volume of water	Volume of HCl	Concentration moles /dm^3	Time(t)	$^1/_t s^{-1}$
a	10(cm^3)	0cm^3	10cm^3			
b	7.5 (cm^3)	2.5(cm^3)	10cm^3			
c	6.0(cm^3)	4.0cm^3	10cm^3			
d	5.0(cm^3)	50cm^3	10cm^3			
e	2.5 (cm^3)	7.5cm^3	10cm^3			

(6 **marks**)

a) (i) Plot a graph of concentration of B in moles per dm^3 against $^1/_t$. (3 **marks**)

(ii) Comment on the shape of the graph. (1 **mark**)

3. You are provided with solid Q.

You are required to carry out the tests below to determine the identity of Q.

a) Put all the solid Q in a boiling tube and add 12cm^3 of distilled water and shake thoroughly. Divide the resulting solution into six portions

Observation (1 **mark**)	Inferences (1 **mark**)

b) To the first portion add NaOH dropwise till in excess

Observation (1 **mark**)	Inferences (1 **mark**)

c) Insert a Nichrome wire to the second and burn it in a non-luminous flame.

Observation (1 **mark**)	Inferences (1 **mark**)

d) To the third portion add lead (II) nitrate solution.

Observation (1 **mark**)	Inferences (1 **mark**)

e) To the fourth portion, add barium nitrate followed by dilute nitric acid.

Observation (1 **mark**)	Inferences (1 **mark**)

f) To the fifth portion add acidified potassium permanganate.

Observation (1 **mark**)	Inferences (1 **mark**)

g) To the sixth portion add acidified potassium dichromate

Observation (1 **mark**)	Inferences (1 **mark**)

h) Give the identity of Q. (1 **mark**)

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KANGUNDO DISTRICT FORM FOUR MULTILATERAL EXAM.
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PAPER 3

MARKING SCHEME

1. Table I

	I	II	III
Final burette reading (cm^3)	25.1	25.0	25.0
Initial burette reading (cm^3)	0.0	0.0	0.0
Volume of solution C used (cm^3)	25.1	25.0	25.0

Complete table (2 **marks**)
Decimal place (1 **mark**)
Accuracy (1 **mark**)
Consistency (1 **mark**)

(a) Average titre = $\frac{\text{Titre 1 + titre II + titre III}}{3}$

= $\frac{25.1 + 25.0 + 25.0}{3}$ √ ½

$=25.0333cm^3$ √ ½

(b) Moles of sodium hydroxide solution D

Moles = $\frac{\text{volume x molarity}}{1000}$

= $\frac{25 \times 0.5}{1000}$ √ ½

= 0.0125 moles √ ½

(c) Moles of sulphuric acid that reacted

$2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$ √ ½

Mole ratio $NaOH : H_2SO_4 = 2 : 1$ √ ½

Moles of sulphuric acid = $\frac{0.0125}{2}$

= 0.00625 moles √ 1

(d) Molarity of sulphuric acid in moles per dm^3

0.00625 $25.033cm^3$ →
? $1000cm^3$ ——

= 0.00625 x 1000 ——————
25.033 √1

= 0.2496m √1

(e) The relative formula mass of solution C, sulphuric acid.

R.F.M = Mass per litre ——————
Molarity

Mass per litre

6.115 $250cm^3$ →
? $1000cm^3$ →

= 6.115 x 1000 ——————
250 √ ½

= 24.46g/l √ ½

R.F.M = 24.46 ——
0.2496

= 97.9968g √1

≃ 98g

2. (a)

Mixture	Volume of $Na_2S_2O_3$	Volume of water	Volume of HCl	Concentration inmoles per dm^3	Time(t)	$^1/_t$s-1
a	$10cm^3$	$0cm^3$	$10cm^3$	0.40	14.50	0.069
b	7.5 cm^3	$2.5cm^3$	$10cm^3$	0.30	18.67	0.054
c	$6.0cm^3$	$4.0cm^3$	$10cm^3$	0.24	22.22	0.045
d	$5.0cm^2$	$5.0cm^3$	$100cm^3$	0.20	27.90	0.036
E	2.5 cm^3	$7.5cm^3$	$10cm^3$	0.10	53.00	0.019

Complete table (3 **marks**)
Decimals (1 **mark**)
Accuracy (1 **mark**)
Trend (increase) (1 **mark**)

(b) (i) Graph (½ **mark**)
Labelled axes (½ **mark**)
Scale / plot / shape (2 **marks**)
NB: Should be a straight line

(ii) Increase in concentration results to increase in rate of reaction / decrease in concentration results to decrease in rate of reaction. √1

0.5 0.4 0.3 0.2 0.1 1 2 3 4 5 6 7 8
$^1/_t$ s^{-1} ($x10^{-2}$)
Concentration of solution B in moles per dm^3

3.

	Observations	Inferences
(a)	Dissolves to form a colourless solution √1	Absence of Fe^{2+}, Fe^{3+}, Cu^{2+} √1 Two ions ½ **mark** Three ions 1 **mark** 1 ion zero
(b)	No white precipitate formed drop wise and in excess √1	NH_4^+ , K^+, Na^+ possibly present √1
(c)	Burns with a yellow flame √1	Presence of Na^+ √1
(d)	A white precipitate formed √1	SO_4^{2-} √ ½ , SO_3^{2-} √ ½ , Cl^- √ ½ , CO_3^- √ ½ presence
(e)	A white precipitate formed √1 which dissolves on addition of dilute nitric acid to form a colourless solution √1	Presence of SO_3^{2-} √ ½ , CO_3^{2-} √ ½
(f)	Decolourization of purple $KMnO_4$ √1	SO_3^{2-} confirmed present √1
(g)	Orange potassium dichromate turns green √1	SO_3^{2-} confirmed present √1

(h) Identify of Q

- Sodium sulphite / Na_2SO_3 √1

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KANGUNDO DISTRICT FORM FOUR MULTILATERAL EXAM.
Kenya Certificate of Secondary Education
CHEMISTRY
PAPER 3

CONFIDENTIAL

Requirements

Each candidate should be provided with:

- Burette
- Pipette
- 3 conical flasks
- 90cm^3 of solution C (sulphuric acid)
- 90cm^3 of solution D (0.5M NaOH)
- 60cm^3 of 2M hydrochloric acid (solution A)
- 50cm^3 of 0.4M sodium thiosulphate (solution B)
- 5 beakers (100ml)
- Stopwatch
- About 500ml of distilled water
- Phenolphthalein indicator
- White sheet of paper / white tile
- 6 test tubes in a rack
- 1 boiling tube
- Source of heat
- 1g of solid Q (Sodium sulphite, Na_2SO_3)
- 15cm of Nichrome wire

Each candidate should have access to:

- 2M sodium hydroxide
- 2M lead (II) nitrate solution
- Aqueous barium nitrate
- Acidified potassium permanganate
- Acidified potassium dichromate
- Dilute nitric acid

Preparation of solutions:

- Solution C is prepared by measuring 13.6cm^3 of 98% concentrated sulphuric acid (density 1.84g/cm^3) and diluting it to one litre.
- Solution D is made by dissolving 20g of sodium hydroxide in 250cm^3 of distilled water and diluting it to one litre.
- Solution A is prepared by measuring 167cm^3 of concentrated hydrochloric acid (38%) and transferring it to one litre volumetric flask and adding water upto the **mark**.