s Name…….Index No……./……

School……Adm No……Stream……

Date……Sign……..

233/2
CHEMISTRY
Paper 2
(THEORY)
NOVEMBER/DECEMBER 2021
TIME: 2 HOURS

SAMIA SUB-COUNTY JOINT EXAMINATION-2021

Kenya Certificate of Secondary Education (K.C.S.E) Trial Examination

CHEMISTRY

PAPER 2

MARKING SCHEME

INSTRUCTIONS TO CANDIDATES

- *Write your **name**, **School** and **Index Number** in the spaces provided above.*
- ***Sign** and **write date** of examination in the spaces provided above.*
- *Answer **ALL** questions in the spaces provided.*
- *Mathematical tables and silent non-programmable electronic calculators may be used.*
- *All working **MUST** be clearly shown where necessary.*
- *Candidates should answer the questions in **English***
- *Candidates should check the question paper to ascertain that all pages are printed as indicated and that no questions are missing*
- *This paper contains 9 printed pages*

For Examiner's Use Only

Questions	Maximum score	Candidate's Score
1	12	
2	10	
3	13	
4	11	
5	11	
6	11	
7	12	
Total	80	

1.

a. The information below relates to element N, P,Q, Rand S . Study it and answer the questions that follow. The letters are not the actual symbols for the elements.

Element	Atomic radius(mm)	Ionic radius(mm)	Formula of oxide	Melting point of oxide
N	0.364	0.421	N_2O	-119
P	0.830	0.711	PO_2	837
Q	0.592	0.485	Q_2O_3	1466
R	0.381	0.446	R_2O_5	242
S	0.762	0.676	SO	1054

i. Name the elements that are metal. **Give** a reason. (2mks)

- PQRS; Ionic radius is smaller than atomic radius

ii. Compare the melting points of the oxides of S and R in terms of structure and bonding. (2mks)

- S has higher melting point than R; SO has a simple molecular structure(or in terms of bonds)

iii. Name the pair of elements that would react most vigorously with each other?
Explain (2mks)

- P and N; P is a metal with the smallest atomic radius ;
- N is a non-metal with the smallest atomic radius

b. The table below has information about chlorides of elements in period 3 of the periodic table:
Sulphur to sulphur

Chloride	NaCI	$MgCI_2$	$AICI_3$	$SiCI_4$	PCI_5
Melting point (^oC)	801	712	Sublimes at 183	-70	-80

What are the possible PH values of the solutions formed when the following chlorides are dissolved in water? Explain

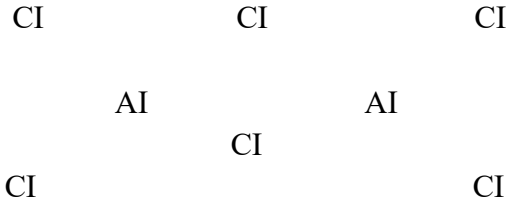
$MgCI_2$ (1mk)

- PH 7.0; a chloride of group II element.

$AICI_3$ (1mk)

- PH 3.0; It hydrolyses in water to form HCI acid.

c. The molecular formula of Aluminum chloride is AI2CI6. Draw the structural (not dot and cross diagram) of Aluminum chloride indicating clearly the different types of bonds present. (2mks)



d. Using dot ( ) and cross (×), draw a diagram to show bonding in sodium chloride. (Na=11, CI=17) (2mks)

2.

a. What is the molar enthalpy of neutralization? (1mk)

- The enthalpy change/ heat change when one mole of H^+ ions react with one mole of OH^- ions to form one mole of water; OWTTE

b. In order to determine the molar heat of neutralization of sodium hydroxide, 100cm^3 of 1M sodium hydroxide and 1M of hydrochloric acid both at the initial temperature were mixed and stirred continuously using a thermometer. The temperature of the resulting solution was recorded after every 30seconds until the highest temperature was attained. Thereafter the temperature of the solution was recorded for a further two minutes.

i. Why was it necessary to stir the mixture of the two solutions? (1mk)

- To obtain a uniform mixture of reagents; uniform distribution of heat;

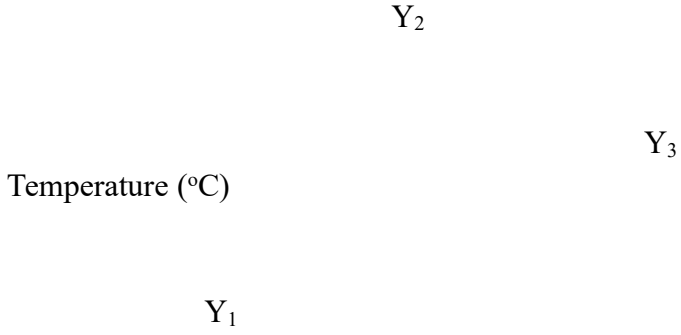
ii. Write an ionic equation for the reaction that took place. (1mk)

$H^+_{(aq)} + OH^-_{(aq)} \quad H_2O_{(I)}$

$H_3O^+_{(aq)} + OH^-_{(aq)} \quad 2H_2O_{(l)}$

Penalise ½mk for missing SS

iii. The sketch below was obtained when temperature of the mixture was plotted against time. Study it and answer the questions that follow.



Explain the temperature changes between points

Y_1 and Y_2 (1mk)

Reaction is taking place ; producing heat;/Reaction is exothermic;

Y_2 and Y_3 (1mk)

Reaction has come to an end; the mixture is cooling;

iv. If the initial temperature for both solution was 25^{o}C and the highest temperature was 31.4^{o}C for the mixture. **Calculate;**

Heat change for the reaction (Specific heat capacity of solution=42$Hg^{-1}K^{-1}$, Density of the solution =1gcm^{-3}) (2mks)

DT=31.4-25=6.4^{o}C

Heat change =200×6.4×4.2

=5376J//5.376KJ

Molar heat of neutralization of sodium hydroxide. (2mks)

Moles of NaOH $= \frac{100}{1000} \times 1 = 0.1$Moles

1.1 moles=5376

1mole$= \frac{5376}{1.1} \times \frac{1}{1000}$

=53.76KJ/Mole

v. **Explain** how the molar heat of neutralization obtained in this experiment would compare with

one that would be obtained using 1.0M ethanoic acid and 100cm^3 of 1M sodium hydroxide solution. (2mks)

- Lower; Ethanoic acid is partially ionized/dissociated;//week acid// fewer H^+ions thus some energy is used to change the unionised molecules into ions first;

Draw an Energy level diagram for the reaction represented by reaction between hydrochloric acid and sodium hydroxide solution. (3mks)

$H^+_{(aq)} + OH^-_{(aq)}$

DH neutr. = +53.76KJMole$^-$

Energy (KJ)

$H_2O_{(l)}$

Reaction path

3.

a. Give the name of **one** reagent which when reacted with concentrated hydrochloric acid produces chlorine gas. (1mk)

- Potassium manganite(vii)//Manganese(iv)oxide//Lead (iv)oxide//Calcium hypochlorite ALC $KMnO_4$//MnO_2/PbO_2/$CaOCI_2$

b. The set up below was used to prepare iron (III) chloride using the apparatus shown in the diagram below.

Guard tube

Iron fillings

Dry chlorine gas Iron(III) Chloride

Heat

i. State **one** precaution that should be taken in carrying out the above experiment. (1mk)

- The experiment should be carried out in a fume cupboard; CI_2 should not be allowed to escape into the environment since it's poisonous/toxic.

ii. Explain why

Calcium oxide would be preferred to calcium chloride in the guard tube. (2mks)

CaO absorbs CI_2 and moisture; while $CaCI_2$ only absorb moisture;

CaO absorbs only CI_2 award 1mark

$CaCI_2$ absorbs only moisture

It is necessary to pass chlorine gas through the apparatus before heating begins. (2mks)

- To remove all air/oxygen; which would react with iron //form Iron (III) oxide; instead of Iron (III) Chloride.

iii. Write a **chemical** equation for the reaction that took place in the guard tube.(1mk)

$CaO_{(s)} + H_2O(l)$ $Ca(OH)_{2(s)/(aq)}$

$//CaO_{(s)} + CI_2(g)$ $CaOCI_2(s)$

$//Ca(OH)_{2(s)} + CI_{2(g)}$ $CaOCI_2.H_2O_{(s)}$

iv. What property of Iron (III) chloride makes it possible to be collected as shown in the diagram? (1mk)

- It sublimes

v. During the reaction in the combustion tube, the total mass of iron (III) chloride formed was found to be 1.5g. **Calculate** the volume of chlorine gas that reacted with iron. (Fe=56.0, CI=35.5 and molar gas volume at 298k is 24,000cm^3) (3mks)

$2Fe_{(s)} + 3CI_{2(g)}$ $2FeCI_{3(s)}$ Ignore ss

RFM of $FeCI_3$=162.5

Moles of $FeCI_3 = \frac{1.5}{16.3} = 0.0092$

Moles of $CI_2 = 3/2 \times 0.0092 = 0.0138$

Volume of $CI_2 = 0.0138 \times 24000$

$= 332.31cm^3$

$// 2Fe_{(s)} + 3CI_2$ $2FeCI_3(s)$

$3 \times 24000 = 162.5 \times 2$

$\frac{3 \times 24000 \times 15}{162.5 \times 2} = 332.31cm^3$

c. **Draw** and **name** the structure of the compound formed when excess chlorine gas is reacted with

ethane gas. (2mks)

CI CI

CI C C CI Account any other possible structure

CI CI Reject condense S.F

d. State **one** use of chlorine gas. (1mk)

- Manufacture of hydrochloric acid
- Treatment of Cvuter
- Manufacture of PVC Any other possible use

4.

a. Give the systematic names for the following compounds

$HCOOCH_2CH_3$ (1mk)

- Propanoic acid/Propan –l-IOC acid

$CH_3CH_2CH_2CHCH_2$ (1mk)

- Pent -l-eneRj. Structural formular/ 1-pentene

CH C CH_2 CH_3 (1mk)

- But-l-yne RjS.F/l-Butyne

b. Study the flow chart below and use it to answer the questions that follow

Pro-l-ene CI2(g) M

Step I

Sodium metal

Propan-ol Products

Step III

Step II

$Na_2CO_3(s)$

$CH_3CH_2COONa(q)$ $H_2O(i)$

Mixture of Na OH and $Ca(OH)_2$

Organic compound K

i. Identify the organic compound **K** (1mk)
Ethane

ii. Write the formula of **M** (1mk)

C3H6CI2 // H C C C H

H CI CI
Any other correct S.F

iii. Give **one** reagent that can be used in
Step I (1mk)
- Water/steam/conc. Sulphuric (vi) acid; Rej. Dillute Sulphuri (vi)acid
- Sulphuric acid award ½ mark only

Step II (1mk)
- Acidified Potassium manganite (vii)/Acidified potassium chromate(vii)

$H^{+(aq)}/KMnO_{4(aq)}$ $H^{+}_{(aq)}/K_2CrO_{7(aq)}$

iv. Write the equations for the reaction in **step II** (1mk)
$2CH_3CH_2CH_2OH + 2Na \rightarrow 2CH_3CH_2CH_2ONa + H_2$
Ignore SS unless wrongly committed

c. The structure below represents a type of cleansing agent.

$SO_3^-Na^+$

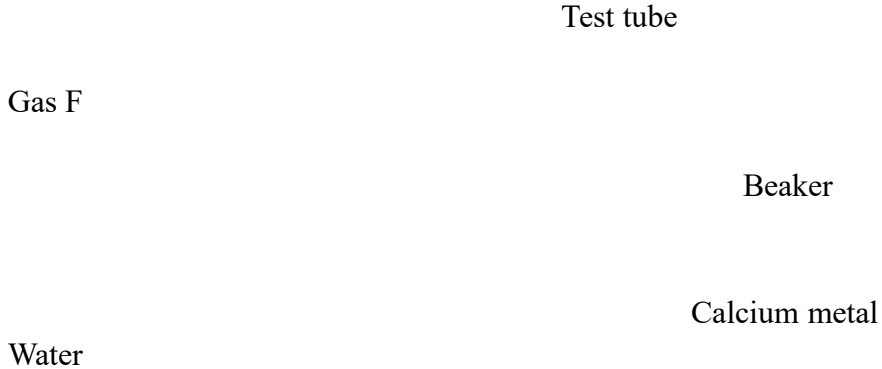
R

Describe how the cleansing agent removes grease from a piece of cloth. (3mks)

- Cleansing agent has a polar end / hydrophilic; and non-polar/hydrophobic end; polar end/ hydrophilic end; is attracted to water while non-polar/hydrophobic end; to grease; Results in formation of micelles//lower surface tension of water//emulsification of grease;

5.

a. The set up below was used to collect gas F, produces by the reaction between water and calcium metal



i. Name gas **F** (1mk)

Hydrogen;

ii. At the end of the experiment, the solution in the beaker was found to be a week base. **Explain** why the solution is a weak base. (2mks)

- $Ca(OH)_2$ formed is slightly soluble in water hence only a few OH^- ions are produced in solution

iii. Give **one** laboratory use of the solution formed in the beaker (1mk)

- Used for testing the presence of CO_2 gas.

b. When excess calcium metal was added to 50cm3 of 2 M aqueous copper (II)nitrate in a beaker, a brown solid and bubbles of gas were observed.

i. Write **two** equations for the reactions which occurred in the beaker. (2mks)

$Ca_{(s)} + 2H_2O_{(l)}$ $Ca(OH)_{2\,(aq)} + H_{2(g)}$

$Ca(s) + Cu(NO_3)_{2(l)}$ $Ca(NO_3)_2(aq) + Cu(s)$

// $Ca(s) + Cu2+(aq)$ $Ca^{2+}_{(aq)} + Cu_{(s)}$

ii. **Explain** why it is not advisable to use sodium metal for this reaction. (2mks)

- The reaction is explosive /highly enothermic;
- Advice; sodium is more reactive than calcium

c. **Calculate** the mass of calcium metal reacted with copper(II)nitrate solution (Relative atomic mass of Ca=400 (2mks)

Moles of $Cu(NO3)2 = \frac{50 \times 2}{1000} = 0.1$moles

Moles ratio from equation above= 1:1

Moles of Ca=0.1

Moles of $Ca = 0.1 \times 40$

$= 4g$

6.

a. Write the **formula** of the complex Ion formed in each of the reactions below.

i. Lead metal dissolves in hot alkaline solution. (1mk)

$Pb(OH)_4^{2-}$

ii. Zinc hydroxide dissolves ammonia solution. (1mk)

$Zn(NH_3)_4^{2+}$

b. Give the name of each of the processes described below which takes place when the salts are exposed to air for some time.

i. Anhydrous copper (II) sulphate becomes wet. (1mk)

- Hygrosiopy

ii. Iron (III) chloride forms an aqueous solution. (1mk)

- Deliquence

iii. Fresh crystals of sodium carbonate decahydrate become covered with a powder of solution of carbonate monohydrate. (1mk)

- Efflorence

c. A certain hydrate salt has the following composition by mass. Iron 20.2%, sulphur 11.5%, water 45.5% and the rest oxygen. Its relative formula mass is 278.

i. **Determine** the formula of the hydrated salt (Fe=56,S=52, O=16, H=1) (3mks)

Element	Fe	S	O	H_2O
% Composition	20.2	11.5	22.8	45.5
R.A.M	56	32	16	18
Ratio %	$\frac{20.2}{56}=0.36$ $\frac{0.36}{0.36}=1$	$\frac{11.5}{32}=0.36$ $\frac{0.36}{0.36}=1$	$\frac{22.8}{16}$ $\frac{1.43}{0.36}=4$	$\frac{45.5}{18}=2.5$ $\frac{2.5}{0.36}=7$

$FeSO\ 4.7H_2O$

ii. 6.95g of the hydrated salt were dissolved in distilled water and the total volume made to 250cm^3 of solution. **Calculate** the concentration of the salt solution. (2mks)

6.95g in 250cm^3

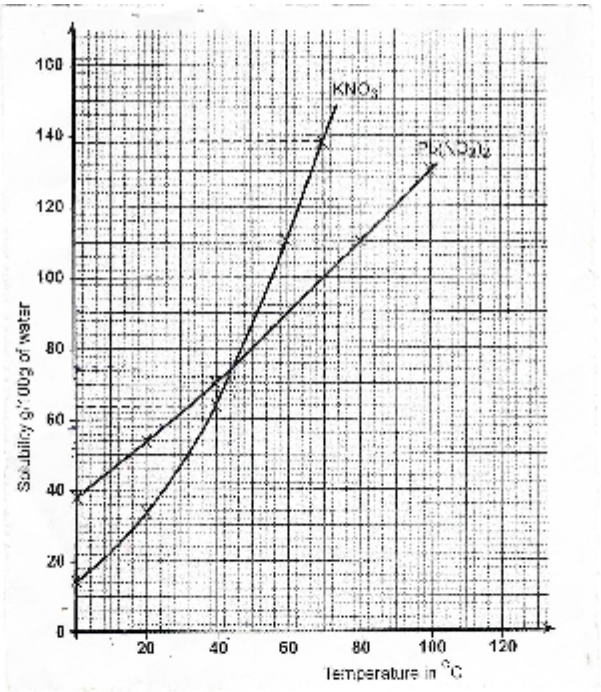
X=1000cm^3

$= \frac{6.95 \times 4000cm^3}{250cm^3 \times 278}$ =0.1M

7. The table below shows solubility of potassium nitrate and lead nitrate

Temperature ^oC	**0**	**20**	**40**	**60**	**80**	**100**
Solubility of KNO_3 in 100g of H_2O	12.5	32.5	62.5	110.0	137.5	
Solubility of $Pb(NO_3)$in 100g of H_2O	37.5	52.5	69.0	87.5	110.0	131.0

i. Draw the solubility curves for both salts on the same axis. (Temperature on the x-axis) (3mks)


160
140
120
100
80
60
40
20
0
20
40
60
80
100
120
Solubility (g/100g of water
Temperature in °C
KNO3
Pb(NO3)2

ii. A solution of lead nitrate contains 90g of the salt dissolved in 100g of water at 100°C. This solution is allowed to cool to 25°C

At what temperature will crystals first appear? (1mk)

60°C

What mass of crystals will be present at **25°C** (1mk)

90g-58=32g

Correct value of solubility at 25°C

iii. Which of the **two** salts is more soluble at 30°C (1mk)

- Lead nitrate $Pb(NO_3)_2$

iv. Determine the concentration of lead nitrate in moles per litre when the solubility of the two salts are the same. **(Pb=207.0, O=16.0, K=39.0, N=14.0)** (3mks)

Solubility of $Pb(NO_3)_2$ =75g/100water

Value read from the graph

Mass of $P(NO_3)_2$ in $100cm^3 = \frac{75 \times 100}{100}$

$\frac{\text{Value from graph} \times 100}{100}$

=75g

Molar mass of $Pb(NO_3)_2$ =331

Conc. Of $Pb(NO_3)_2$ $= \frac{75}{331} = 0.2266M$ // $\frac{\text{answer (i)}}{331}$ =answer(ii) M