Centre Number	Candidate Number

Candidate Name _____

EXAMINATIONS COUNCIL OF ZAMBIA

Examination for School Certificate Ordinary Level

Chemistry 5070/3

Paper 3

Monday **28 NOVEMBER 2016**

Additional Information:
Mathematical tables/Calculators (non-programmable)

Time: 1 hour 30 minutes

Instructions to Candidates

Write your **name, centre number and candidate number** in the spaces at the top of this page.

There are **two (2) questions** in this paper. Answer **both** questions.

You should show the essential steps in any calculation and record all experimental results and observations in the spaces provided on the question paper.

If you are using semi-micro methods in Question **2**, you should modify the instructions to suit the size of apparatus and the techniques you are using.

Information for Candidates

The number of marks is shown in brackets [ ] at the end of each question or part question.

Both questions carry 50% of the total marks.

Mathematical tables are available. Non-programmable calculators can be used.

Qualitative Analysis notes for this paper are printed on page 6.

Periodic Table is printed on page 7.

Cell phones are not allowed in the examination room.

FOR EXAMINER'S USE	
1	
2	
TOTAL	

1 Volumetric Analysis (titration)

Group I metals (alkali metals) generally form hydrated carbonates of the formula $X_2CO_3.10H_2O$

P is a solution of hydrochloric acid, HCℓ, of concentration 0.4000 mol/dm^3.

Q is a solution of X_2CO_3 made by dissolving **31.80g** of the hydrate $X_2CO_3.10H_2O$ per dm^3 of its aqueous solution

You are required to

(i) determine the mole concentration of X_2CO_3 in **Q** and

(ii) use the mole ratio of X_2CO_3:H_2O to determine the molar mass, Mr of X_2CO_3 and thus identify element **X**.

Element **X** is suspected to be one of the following alkali metals;

Lithium, Li, Sodium, Na, Potassium, K or Rubidium, Rb.

(a) Put **P** into the burette. Pipette 25.0cm^3 (or 20.0cm^3) of **Q** into a clean conical flask. Add 3 drops of the indicator provided and titrate with **P** quickly to have your rough titre in the space below. [Indicate your initial and final readings]

Final reading/cm^3	
Initial reading/cm^3	
Rough titre/cm^3	

Repeat your titration procedure, but this time accurately as many times as you consider necessary to achieve consistent (concording) values which you must tick (✓) as your best results in the table below.
Show the average of the ticked values in the summary and use this mean (average) value for your calculations in **(b)**.
The results i.e. burette readings/cm^3.

Titration Number	1	2	
Final reading			
Initial reading			
Titre volume			
Best results (✓)			

Summary: Volume of **Q** pipetted = _____ cm^3

Average titre volume of **P** = _____ cm^3

[12]

(b) **P** is 0.4000 mol/dm^3 HCℓ. **Q** contains X_2CO_3. Use your titration results to calculate the concentration, in mol/dm^3, of X_2CO_3 in **Q**.
$2HCl + X_2CO_3 \rightarrow 2XCl + H_2O + CO_2$.

Concentration of X_2CO_3 in Q = _____ mol/dm^3 [2]

(c) **Q** is a solution of $X_2CO_3.10H_2O$. Use your answer to **(b)** and the mole ratio of X_2CO_3:H_2O to calculate the number of moles of water molecules in the sample used in this experiment.

$n(H_2O)$= _____ mol [1]

(d) The molar mass of H_2O is 18g/mol. Use your answer to **(c)** to calculate the mass of water in the hydrate used.

Mass H_2O = _____ g [1]

(e) **Q** contains **31.80 g** of $X_2CO_3.10H_2O$. Use your answer to **(d)** to calculate the mass of X_2CO_3 in the 31.80 g.

Mass of X_2CO_3 = _____ g [1]

(f) The mass you have calculated in **(e)** is contained in $1dm^3$ of solution **Q**. Use your answer to **(b)** and **(e)** to calculate the molar mass of the compound X_2CO_3.

Mr of X_2CO_3 = _____ g/mol [1]

(g) Hence identify element **X** in X_2CO_3 through its relative atomic mass, Ar.

Element **X** in X_2CO_3 is _____ [2]

Total 20 marks

2 Qualitative Analysis (Salt analysis)

You are provided with **R** which is a solution of one salt containing one anion and one cation both specified in the Qualitative Notes of this question paper.

Carry out the following tests on **R** and use your observations to determine the identity the ions in **R** and thus the salt in **R**.

NB: Add the reagents to **R** as stipulated in the notes.

Test No.	Test	Observation
1	Add aqueous sodium hydroxide little by little until in excess to a portion of **R** .	
2	To a portion of **R**, add aqueous ammonia little by little until in excess.	
3	To a portion of **R**, add acidified silver nitrate of equal volume.	
4	To a portion of **R**, add acidified barium nitrate or barium chloride of equal volume.	
5 (a)	To a portion of **R**, add drops of sodium chloride then silver nitrate solution.	
(b)	Allow the mixture in **(a)** to stand for 5 minutes and shake the contents.	

[15]

CONCLUSION

The formula of the anion in **R** is _____

The formula of the cation in **R** is _____

The formula and name of the salt in **R** is _____ and _____ respectively

In test **5(b)** the silver ions, Ag^+ undergo a change known as _____

_____ [5]

Total 40 marks

NOTES FOR USE IN QUALITATIVE ANALYSIS

Test for anions

anion	*test*	*test result*
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous lead (II) nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully	ammonia produced
sulphate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.

Test for aqueous cations (in solutions)

cation	*effect of aqueous sodium hydroxide*	*effect of aqueous ammonia*
aluminium (Al^{3+})	white ppt., soluble in excess giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt. or very slight white ppt
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., soluble in excess giving a colourless solution

Test for gases

gas	*test and test result*
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	"pops" with a lighted splint
oxygen (O_2)	relights a glowing splint
sulphur dioxide (SO_2)	turns aqueous potassium dichromate(VI) green

DATA SHEET

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Tchnetium 43	104 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mecury 80	204 Tl Thallium 81	207 Pb lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 +															

*58-71 Lanthanoid series
+90-103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key: a / X / b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
NA = 6.0 × 10^{23}/mol; 1F = 96500C.