THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

032/2C **CHEMISTRY 2C**

(ACTUAL PRACTICAL C)

(For Both School and Private Candidates)

Time: 2:30 Hours **ANSWERS** **Year: 2010**

Instructions

1. This paper consists of two questions.

2. Answer all questions.

1. You are provided with the following:
B1: a solution made by dissolving 21.2 g of a metal carbonate in 1000 cm^3 of solution
B2: an acid which contains 3.6 g of HCl per litre of solution
B3: Methyl orange indicator

Procedure
Pipette 25.0 cm^3 of B1 into a clean conical flask and add 2–3 drops of B3. Put B2 into the burette. Titrate the solution B1 against B2. The reaction equation is given as:
$X_2CO_3 + 2HCl \text{ ----> } 2XCl + H_2O + CO_2$
The end point is when you get a colourless solution. Note the burette reading. Repeat the procedure to obtain three more readings and record the results as in the following table.

(a)
(i) Burette readings

Titration	Final volume (cm^3)	Initial volume (cm^3)	Volume used (cm^3)
Pilot	24.90	0.00	24.90
1	25.00	0.00	25.00
2	24.80	0.00	24.80
3	24.80	0.00	24.80

(ii) The volume of the pipette used is 25.00 cm^3
(iii) 25.00 cm^3 of B1 reacted completely with 24.87 cm^3 of B2

(b) Calculate the mass concentration of B1 in grams per litre.
Mass of solute used = 21.2 g in 1000 cm^3
Mass concentration = 21.2 g/dm^3

(c)
(i) Molarity of B1
Molar mass of X_2CO_3 = M (to be found later in d)
Let's first find moles of HCl in 24.87 cm^3
Mass of HCl in 1 dm^3 = 3.6 g
Molar mass of HCl = 36.5 g/mol
Moles = 3.6 ÷ 36.5 = 0.09863 mol/dm^3
Moles in 24.87 cm^3 = 0.09863 × 0.02487 = 0.002454 mol
From equation: 2 mol HCl reacts with 1 mol X_2CO_3
So moles of X_2CO_3 = 0.002454 ÷ 2 = 0.001227 mol
Volume of B1 used = 25.00 cm^3 = 0.025 dm^3
Molarity = 0.001227 ÷ 0.025 = 0.04908 mol/dm^3

(ii) Molarity of B2
Already calculated above: 0.09863 mol/dm^3

(d) Calculate the relative formula mass of X_2CO_3
Mass in 1 dm^3 = 21.2 g
Moles = 0.04908 mol
Molar mass = 21.2 ÷ 0.04908 = 432.1
X_2CO_3 = 2X + 12 + 48 = 2X + 60
2X + 60 = 432.1
2X = 432.1 − 60 = 372.1
X = 186.05
So element X is likely barium (Ba = 137), making compound $BaCO_3$ impossible, but the value is too high
So recheck: if 21.2 g gives 0.04908 mol then molar mass = 432.1 g/mol
Which fits for compound with two heavy atoms (e.g., Pb or Ba)

Assuming approximate value, compound could be Pb_2CO_3
Pb = 207, Pb_2CO_3 = 207×2 + 60 = 474 g/mol (close enough)
So X = Pb
Therefore, metal carbonate is Pb_2CO_3

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2. You are provided with substance W. Substance W contains one cation and one anion. Carry out the following experiments on W and identify the cation and anion. Record all your observations and appropriate inferences in the space as shown in the following Table:

(a) Appearance of sample W
Observation: White crystalline solid
Inference: Colourless ionic compound

(b) Heat a little of sample W and identify the gas given out
Observation: Colourless gas evolved that turns limewater milky
Inference: CO_2 gas released; indicates presence of carbonate ion

(c) To a little sample W add dilute HCl
Observation: Effervescence, gas evolved turns limewater milky
Inference: CO_3^{2-} confirmed

(d) Dissolve W in water. Divide the solution into four portions and do the following:

(i) Add silver nitrate till excess to the first portion
Observation: White precipitate forms
Inference: Cl^- present

(ii) Add NaOH till excess to the second portion

Observation: White precipitate, soluble in excess
Inference: Zn^{2+} present

(iii) Add $MgSO_4$ till excess to the third portion
Observation: No precipitate
Inference: No SO_4^{2-}

(iv) Add NH_4OH till excess to the fourth portion
Observation: White precipitate, soluble in excess
Inference: Zn^{2+} confirmed

Conclusion
(a)
(i) The cation in substance W is Zn^{2+} and the anion is CO_3^{2-}
(ii) Substance W is zinc carbonate ($ZnCO_3$)

(b) Write balanced chemical equations for the reaction taking place in:

(c) $ZnCO_3 + 2HCl$ ----> $ZnCl_2 + CO_2 + H_2O$
(d)(ii) $Zn^{2+} + 2OH^-$ ----> $Zn(OH)_2(s)$; $Zn(OH)_2 + 2OH^-$ ----> $[Zn(OH)_4]^{2-}$
(d)(iv) $Zn^{2+} + 2NH_3 + 2H_2O$ ----> $Zn(OH)_2(s) + 2NH_4^+$; $Zn(OH)_2 + 4NH_3$ ----> $[Zn(NH_3)_4]^{2+} + 2OH^-$

3. You are provided with substance R. Substance R contains one cation and one anion. Analyse substance R systematically and identify the anion and the cation. Present your results as shown in the following table:

Experiment: Add NaOH
Observation: Reddish-brown precipitate
Inference: Fe^{3+} present

Experiment: Add $BaCl_2$
Observation: White precipitate that persists in dilute HNO_3
Inference: SO_4^{2-} confirmed

Conclusion
(a) The cation in R is Fe^{3+} and the anion is SO_4^{2-}
(b) The compound R is iron(III) sulfate, $Fe_2(SO_4)_3$