TERM 2 - 2023

CHEMISTRY – PAPER 3 (233/3)

FORM THREE (3)

MARKING SCHEME

1. You are provided with:

- **Solution R** – a solution containing 15.75g of $M(OH)_2.8H_2O$ per litre.
- **Solution Q** – a solution of sodium carbonate solution containing 1.325 g in 250 cm^3.
- **Solution J** – a monobasic acid **HA**
- Methyl orange indicator.

You are required to:

a) Standardise **solution J.**

b) Determine the relative atomic mass of element M in $M(OH)_2.8H_2O$

Procedure 1

I. Fill the burette with solution J.

II. Pipette 25cm^3 of solution Q into a clean 250ml conical flask and add 2 drops of methyl orange indicator.

III. Titrate solution Q with solution J and record your results in **Table 1** below.

IV. Repeat the procedure and complete the **table 1**.

N/B: Retain the solution J in the burette for use in procedure II.

(4 marks)

CT-1
DP-1
AC-1
PA-1
FA-1
5

Table 1	**I**	**II**	**II**
Final burette reading (cm^3)			
Initial burette reading (cm^3)			
The volume of solution J (cm^3) used.			

Determine the:

(a) Average volume of solution J used. (1 mark)

20.8cm^3

(b) Number of moles of solution Q in moles per litre. (Na = 23, C = 12, O = 16)

(1 mark)

$1.325g \rightarrow 250cm^3$
$? \rightarrow 1000cm^3$

$\frac{\cancel{1000}^{4} \times 1.325}{\cancel{250}} = 5.3g/l$

MM = 23+23+12+(16×3)
= 106

$\frac{5.3}{106} = 0.05M$

(c) Number of moles of solution Q used. (1 mark)

0.05 moles $\rightarrow 1000cm^3$
$? \rightarrow 25cm^3$

$\frac{25 \times 0.05}{1000} = 0.00125$ moles

(d) Write the equation for the reaction between solution J and solution Q (1 mark)

$2HA_{(aq)} + Na_2CO_{3(aq)} \rightarrow 2NaA_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

(e) Number of moles of solution J used. (1 mark)

MR HA : Na_2CO_3
2 : 1
0.00125 moles

$\frac{0.00125 \times 2}{1}$
= 0.0025 moles

(f) The molarity of solution J. (1 mark)

0.0025 mole $\rightarrow 20.8cm^3$
$? \rightarrow 1000cm^3$

$\frac{1000 \times 0.0025}{20.8} = 0.12M$

Procedure 2

I. Using a 25cm^3 measuring cylinder, transfer 25cm^3 of solution R into a clean 250 ml conical flask.
II. Using a 100ml measuring cylinder, transfer 75cm^3 of solution Q into the conical flask with solution R.
III. Boil the mixture for about 5 minutes. After cooling, filter the mixture into a conical flask and transfer the filtrate into a clean 100 ml measuring cylinder. Add distilled water to make exactly 100cm^3 of solution. Label this solution S.
IV. Pipette 25cm^3 of solution S into a clean conical flask and titrate with solution J from the burette using two drops of methyl orange indicator. Record your results in **table 2** below.
V. Repeat procedure IV two more times and complete **table 2**.

Table 2

Table 2	I	II	II
Final burette reading (cm^3)			
Initial burette reading (cm^3)			

CT = 1
DP = 1
AC = 1
PA = 1
FA = 1
5

The volume of solution J (cm^3) used.			

(4 marks)

(a) Calculate the average volume of solution J used. (1 mark)

$13.895cm^3$

(b) Determine the number of moles of:

i. Solution J in the average volume. (1 mark)

$0.12mole \rightarrow 1000cm^3$
$13.895cm^3$

ii. Sodium carbonate in $25cm^3$ of solution S. (1 mark)

MR $\frac{13.895 \times 0.12}{1000} = 0.0016674$ moles

HA : Na_2CO_3
2 : 1

$\frac{0.0016674}{2} = 0.0008337$ moles.

iii. Sodium carbonate in $75cm^3$ of solution S (1 mark)

$0.0008337 moles \rightarrow 25cm^3$
$? \rightarrow 75cm^3$

$\frac{0.0008337 \times 75}{25} = 0.002501$ moles

iv. Sodium carbonate in the original $75cm^3$ of solution Q. (1 mark)

$0.05 moles \rightarrow 1000cm^3$
$? \rightarrow 75cm^3$

$\frac{75 \times 0.05}{1000} = 0.00375$ moles

v. Sodium carbonate that reacted with solution R. (1 mark)

$0.00375 - 0.002501 = 0.001249$ moles

vi. $M(OH)_2.8H_2O$ in $25cm^3$ of solution R. (1 mark)

(1 mole of $M(OH)_2.8H_2O$ reacts with 1 mole of sodium carbonate.)

0.001249 moles

(c) Determine:

i. Concentration of solution R in moles per litre. (1 mark)

$0.001249\text{ moles} \rightarrow 25cm^3$
$? \rightarrow 1000$

$\frac{1000 \times 0.001249}{25} = 0.04996$

ii. Relative formula mass of $M(OH)_2.8H_2O$. (1 mark)

$\frac{15.75}{0.04996} = 315.3$

iii. The relative atomic mass of M. (O = 16, H = 1) (1 mark)

$M + (16+1) \times 2 + 18 \times 8 = 315.3$
$M + 178 = 315.3$ * Give allowance of ± 10
$M = 137.3$

2. You are provided with solid G. Carry out the following tests and write your observations and inferences in the spaces provided.

(a) Place all solid G in a boiling tube. Add 10 cm^3 of distilled water and shake. Divide the resulting solution into four equal portions.

Observations	Inferences
Solid dissolves to form a colourless solution. (1 mark)	**Solid is soluble** **Cu^{2+}, Fe^{2+}, Fe^{3+} absent** (1 mark)

(b) To the first portion, add 2M sodium hydroxide solution dropwise until in excess.

Observations	Inferences
No white precipitate (1 mark)	**Zn^{2+}, Pb^{2+}, Al^{3+} Mg^{2+}, Ca^{2+} absent** (1 mark)

(c) To the second portion, dip a clean glass rod in the solution and burn it directly in a non-luminous flame.

Observations	Inferences
The solution burns with a yellow flame (1 mark)	**Na^+ present** (1 mark)

(d) To the third portion, add three drops of barium nitrate solution.

Observations	Inferences
A white precipitate is formed. (1 mark)	SO_4^{2-}, SO_3^{2-} , CO_3^{2-} present (1 mark)

(e) To the mixture in (d) above, add 3 cm^3 of 2M nitric (V) acid and shake.

Observations	Inferences
White precipitate dissolves. (1 mark)	SO_3^{2-} , CO_3^{2-} present (1 mark)

3. You are provided with **solid F.**
Carry out the tests below and write your observations and inferences in the spaces provided

a. Place about half of solid F in a metallic spatula and burn it in a non-luminous flame.

Observations	Inferences
Solid burns with a yellow sooty flame (1 mark)	$>C=C<$, $-C\equiv C-$ present (1 mark)

b. Place the remaining solid F in a boiling tube, add about 6 cm^3 of distilled water, and shake the boiling tube. Divide the solution into two portions of 2 cm^3 each. To the first portion, add 2 drops of bromine water.

Observations	Inferences
Yellow bromine water changes to colourless. (1 mark)	$>C=C<$, $-C\equiv C-$ present (1 mark)

c. To the second portion, Test for the pH using universal indicator.

Observations	Inferences
pH is 3 (1 mark)	Strongly acidic (1 mark)

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