MARKING SCHEME

QUESTION 1 **(20 MARKS)**

You are provided with:

- Solution **H**, which is acidified potassium manganate (VII) solution.($KMnO_4$)
- Solution **X**, containing 5.0g/l of a dibasic acid, $H_2A.2H_2O$
- Solution **N**, containing 24.5g/l of ammonium iron (II) sulphate solution. $(NH_4)_2Fe(SO4)_2.\ 6H2O$

You are required to:

i) Standardize solution H using solution N.

ii) Use the standardized solution H to determine the concentration of the dibasic acid, $H_2A.2H_2O$, solution **X** and then the formula mass of **A**

Procedure 1

1. Fill the burette with solution H.
2. Pipette 25cm^3 of solution N and transfer it into a conical flask.
3. Titrate solution N against solution H until a permanent pink colour just appears.
4. Record the results in table 1 below.
5. Repeat the titration two more times to complete the table.

a) Table 1

	I	II	III
Final burette reading (cm^3)	20.0	40.0	20.0
Initial burette reading (cm^3)	0.0	20.0	0.0
Volume of solution H used (cm^3)	20.0	20.0	20.0

(3marks)

b) Determine the average volume of solution H used. (1mark)

$\frac{20.0+20.0+20.0}{3} = \frac{60.0}{3} = 20.0\ cm^3$

c) Calculate;

i) The concentration of solution N in moles per liter (RFM of N is 392) (1mark)

$\text{Concentration} = \frac{\text{Mass in g/L}}{\text{RFM}}$

$= \frac{24.5}{392} = 0.0625\ M$

f) Calculate;

i) The number of moles of the manganate (VII) ions in the average volume of solution H above. (1marks)

0.015625 ⟶ 1000cm³
⟵ 25.4cm³

$\frac{0.015625 \times 25.4}{1000}$ = 0.00039685 moles

ii) Given that 2 moles of manganate (VII) ions react with 5 moles of the dibasic acid $H_2A.2H_2O$. Calculate the number of moles of the dibasic acid $H_2A.2H_2O$ in the $25cm^3$ of solution X (1mark),

2 ⟶ 0.00039685
5 ⟶ ?

$= \frac{5 \times 0.00039685}{2}$ = 0.00099219 moles

iii) The concentration of solution X in moles per litre. (1marks)

$Concentration = \frac{Moles \times 1000}{volume}$

$\frac{0.00099219 \times 1000}{25}$

= 0.0397 M

iv) Calculate the formula mass of A in the dibasic acid. $H_2A.2H_2O$(H=1, O=16.0) (2marks)

$RFM = \frac{Mass\ in\ g/L}{Concentration}$

$= \frac{5.0}{0.0397} = 126$

$H_2A \cdot 2H_2O = 126$

$2 + A + 2(18) = 126$

$2 + A + 36 = 126$

$A + 38 = 126$

$A = 88$

2. You are provided with:
- A solution of sodium hydroxide labeled B.
- A solution of sulphuric(vi)acid labeled C.

You are required to determine the concentration of the alkali using the following procedure.

PROCEDURE:

(i) Place $40cm^3$ of sodium hydroxide solution into a 250 ml plastic beaker.
(ii) Measure $60cm^3$ of sulphuric (vi) acid solution.
(iii) Determine the temperature of sodium hydroxide solution at half a minute intervals for two minutes and record it in the table below.
(iv) At 2 ½ minutes, place the $60cm^3$ of solution C into the plastic beaker while stirring and resume taking the temperature in the 3rd minute.

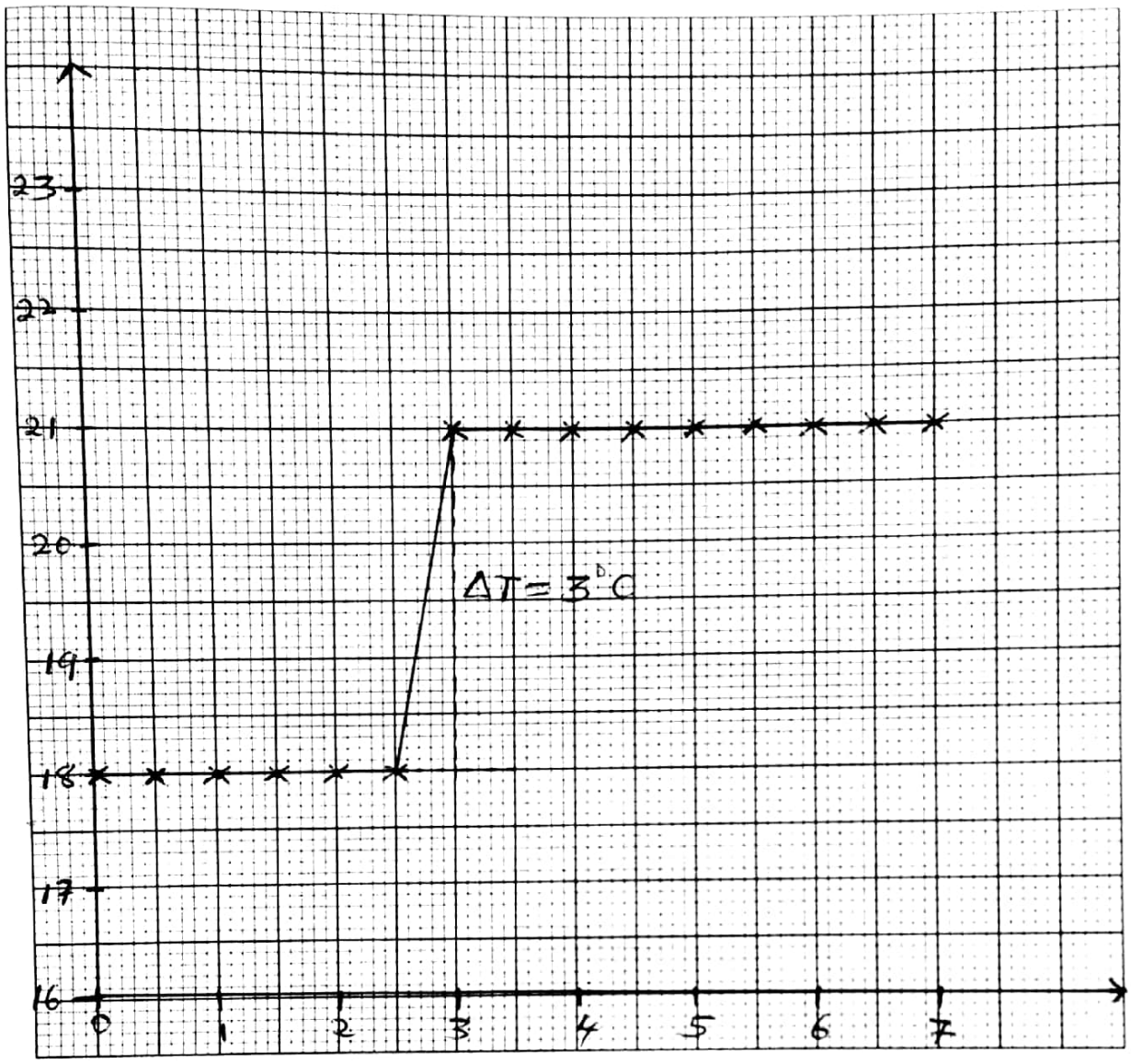
(v) Complete the table below.

Time in minutes	0	½	1	1 ½	2	2 ½	3	3 ½	4
Temperature in ^0C	18·0	18·0	18·0	18·0	18·0	X	21·0	21·0	21·0

Time in minutes	4 ½	5	5 ½	6	6 ½	7
Temperature in ^0C	21·0	21·0	21·0	21·0	21·0	21·0

(2 marks)

(a) Plot a graph of temperature against time. (3 marks)



(b) From the graph, determine the highest temperature change. (1 mark)

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..... $\Delta T = 3^{\circ}C$ .....

.....

(c) Determine the heat evolved in this experiment (Density of solution = 1 g/cm^3 specific heat capacity of solution = 4.2 Jg^{-1} K^{-1}) (1 marks)

$\Delta H = mc\Delta T$

$= \frac{100}{1000} \times 4.2 \times 3$ $= -1.26$ kJ

(d) Given that the molar heat of neutralization is 56KJ/mole, determine the number of moles of sodium hydroxide used in the neutralization reaction above. (1 marks)

Heat of neutralization = 56kJ/mol

1mole $\longrightarrow$ 56 kJ

? $\longleftarrow$ 1.26

$\frac{1.26 \times 1}{56} = 0.0225$ moles

(e) Determine the molarity of sodium hydroxide. (2 marks)

$\text{Molarity} = \frac{\text{Moles} \times 1000}{\text{volume}}$

$= \frac{0.0225 \times 1000}{40}$

$= 0.5625$ M

a). You are provided with $10cm_3$ of solution of liquid M, carry out the tests bellow and write the observations and inferences in the space provided.

(i) To about $1cm^3$ of solution M add 2M $NaOH_{(aq)}$

Observation	Inferences
No White ppt (1mark)	Zn^{2+}, Al^{3+}, Pb^{2+}, Ca^{2+}, Mg^{2+} absent (1 mark)

(ii) To to $1cm^3$ of solution M and 3 drops of $Ba(NO_3)_2$ (aq)

Observation	Inferences
White precipitate formed (1mark)	SO_4^{2-}, SO_3^{2-}, CO_3^{2-} Present (1mark)

(iii) To the mixture in (ii) above add HCl dropwise until excess

Observations	Inferences
White ppt dissolves effervescence (1mark)	SO_3^{2-}, CO_3^{2-} Present (1mark)

(iv) To $1cm^3$ of solution M add $H^+/K_2Cr_2O_7$

Observation	Inferences
orange $H^+/K_2Cr_2O_7$ turns to green (1mark)	SO_3^{2-} Present (1mark)