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EXPERIMENT NO. 2

AIM :

To determine the mass susceptibility of paramagnetic solution hydrous Manganese Chloride ($MnCl_2 \cdot 4H_2O$) by Quincke's Method.

APPARATUS :

Quincke's tube fitted on stand, Travelling Microscope, Experimental Solution, Electromagnet with supply.

FORMULA USED :

Mass susceptibility is given by $\chi_m = 2\mu_0 g \frac{h}{B^2}$ m^3/kg

where $\mu_0 = 4\pi \times 10^{-7}$ Vs/Am, g is in m/s^2, h is in meters and B is in Wb/m^2.

PROCEDURE :

1. Put the tube on stand and fix it with a clamp.
2. Insert the narrow limb of the quincke's tube vertically between the pieces of the uniform magnetic field or in the center of the poles and the wide limb is placed outside the field.
3. Adjust the crosswire of the eyepiece of travelling microscope on the meniscus and note the reading of the microscope. It will be the initial position of the meniscus. Record this reading (h_1) in table.
4. Switch on the electromagnet power supply and adjust the current at 1.40A. Bring the cross wire again on the meniscus and also record this reading (h_2) in table.
5. Increase the power supply current in steps of 0.1A i.e. say

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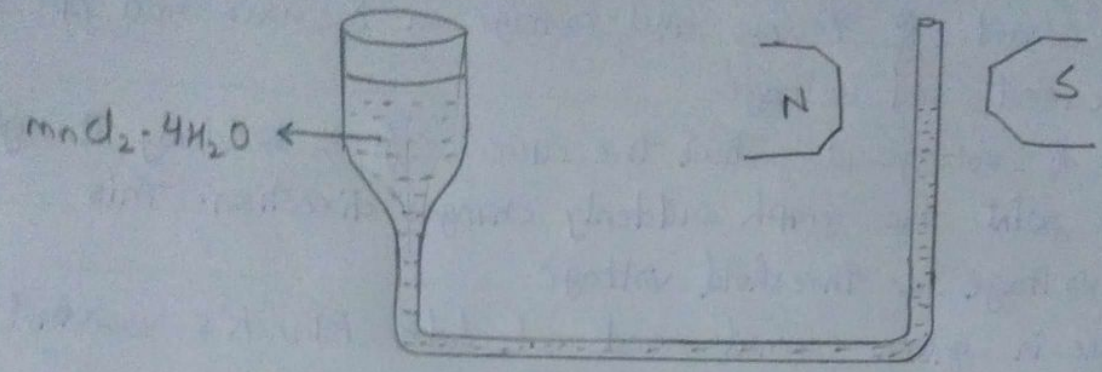

• QUINCK's SETUP

OBSERVATIONS :

Least count of travelling microscope = 0.01 mm = 0.001 cm

• For 30 % soln.,

S.No.	I (A)	B (T)	h_1 (cm)	h_2 (cm)	Δh (cm)
1.	1.4	0.499	3.129	3.239	0.110
2.	1.5	0.533	3.129	3.260	0.131
3.	1.6	0.570	3.129	3.284	0.155

• For 15 % soln.,

S.No.	I (A)	B (T)	h_1 (cm)	h_2 (cm)	Δh (cm)
1.	1.4	0.499	4.083	4.085	0.002
2.	1.5	0.533	4.083	4.087	0.004
3.	1.6	0.570	4.083	4.090	0.007

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1.5 A and note the corresponding position (h_2) of the level of the liquid. Note all these readings in a table.

6. Repeat the experiment for different concentration of solution.

PERCENTAGE ERRORS :

For 30% →

$$\frac{\Delta X_m}{X_m} = \pm \left(\frac{\Delta h}{h} + \frac{\Delta B^2}{B^2} \right)$$

$$= \pm \left(\frac{0.019}{0.129} + \frac{0.035}{0.284} \right)$$

$$= \pm (0.147 + 0.123) \times 1.35 \times 10^{-7}$$

$$\Delta X_m = \pm 0.364 \times 10^{-7} \, m^3/kg$$

Thus

$$X_m = (1.35 \pm 0.364) \times 10^{-7} \, m^3/kg$$

For 15% →

$$\frac{\Delta X_m}{X_m} = \pm \left(\frac{\Delta h}{h} + \frac{\Delta B^2}{B^2} \right)$$

$$= \pm \left(\frac{0.002}{0.004} + \frac{0.035}{0.284} \right)$$

$$= \pm (0.5 + 0.123) \times 1.25 \times 10^{-8}$$

$$= \pm 0.778 \times 10^{-8} \, m^3/kg$$

Thus,

$$X_m = (1.25 \pm 0.778) \times 10^{-8} \, m^3/kg$$

RESULT :

The following table shows X_m of solution of $MnCl_2 \cdot 4H_2O$ with different concentrations.

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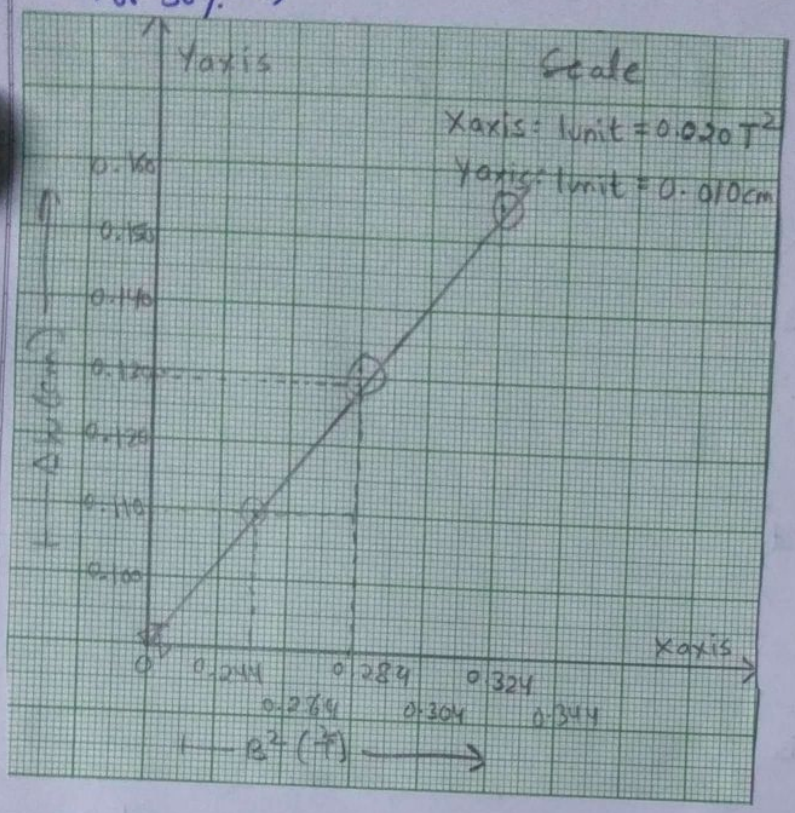
For 30% →



Slope of graph = $\frac{\Delta h}{\Delta B^2}$

$= \frac{0.129 - 0.110}{0.284 - 0.249} = \frac{0.019}{0.035}$

$= 0.54 \text{ cm}/T^2$

$= 0.0054 \text{ m}/T^2$

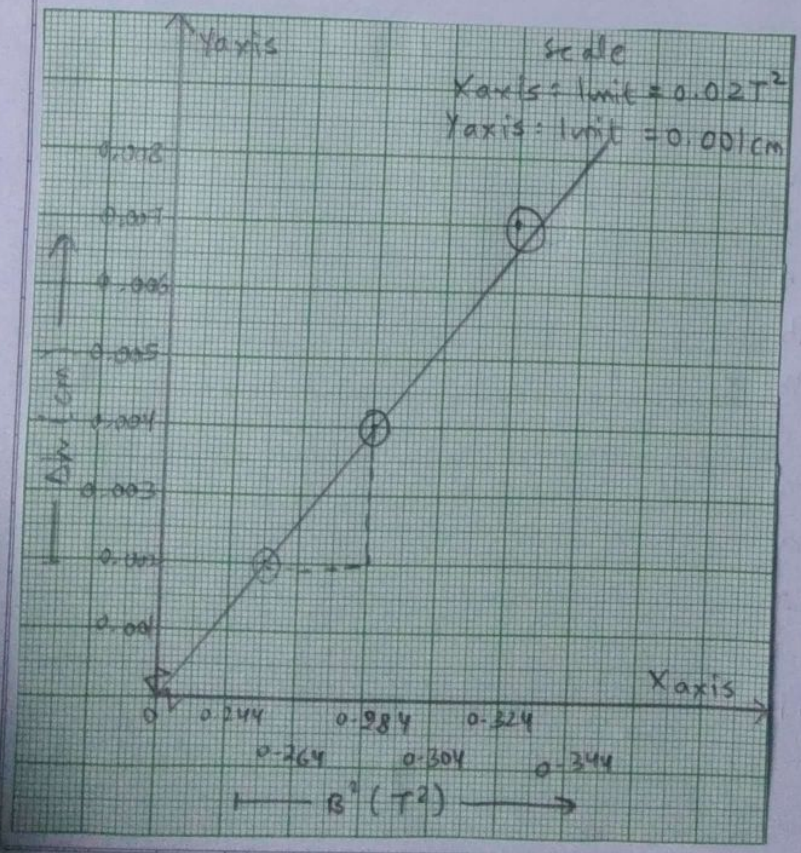
We know,

$X_m = 2\mu_0 g \left(\Delta h / \Delta B^2\right)$

$= 2 \times 4\pi \times 10^{-7} \times 10 \times 0.0054$

$= 1.35 \times 10^{-7} \text{ m}^3/\text{kg}$

For 15% →



Slope of graph = $\frac{\Delta h}{\Delta B^2}$

$= \frac{0.004 - 0.002}{0.284 - 0.249} = \frac{0.002}{0.035}$

$= 0.057 \text{ cm}/T^2$

$= 0.0005 \text{ m}/T^2$

Now,

$X_m = 2\mu_0 g \left(h/B^2\right)$

$= 2 \times 4\pi \times 10^{-7} \times 10 \times 0.0005$

$= 0.0125 \times 10^{-6}$

$= 1.25 \times 10^{-8} \text{ m}^3/\text{kg}$

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S.N.	Concentration	$X_m \pm \Delta X_m$
1.	30%	$(1.35 \pm 0.364) \times 10^{-7}$
2.	15%	$(1.25 \pm 0.778) \times 10^{-7}$

PRECAUTIONS :

1. Handle the Quincke's tube carefully.
2. Note the reading of the travelling microscope cautiously.
3. Make the solution carefully.

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