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Reg :- 20BCD7160

Title of the experiment:-

Magnetic susceptibility of a paramagnetic material

objective:-

To determine the magnetic susceptibility (χ) of the given paramagnetic solution using quincke's method

Apparatus:-

→ Electromagnet and power supply
→ Gauss meter and Hall probe
→ paramagnetic salt ($MnSO_4 \cdot H_2O$)
→ Digital balance
→ specific gravity bottle and distilled water
→ quincke's tube
→ Travelling microscope

Formula:-

$$\chi_{sol} = \frac{2\mu_0 \rho g h}{B^2} \quad ; \quad B = \mu_0 H$$

$$\rho_{sol} = \rho_{water}\left(\frac{\text{mass of solution}}{\text{mass of water}}\right) = \frac{m_3 - m_1}{m_2 - m_1}$$

Table: 1 Calibration of Electromagnet

S.No	current (I) amp	magnetic flux, B Gauss
1	0	0
2	0.5	-13.8
3	1	-28
4	1.5	-42.6
5	2	-55.3
6	2.5	-68.2
7	3	-78.9
8	3.5	-86.1
9	4	-94.5

Table: 2 Height of the solution for different magnetic flux.

S.No	current (I) amp	Magnetic flux, B Gauss	B^2	meniscus position for B=0, a cm	meniscus position for B≠0, b cm	change in height h = b-a cm	change in height h = b-a (cm)
1	1	-28	784	1.465	1.56	0.095	0.095
2	2	-55.3	3058.09	1.465	1.772	0.307	0.307
3	3	-78.9	6225.21	1.465	1.876	0.411	0.411
4	4	-94.5	8930.25	1.465	1.979	0.514	0.514

Calculations:

$$\rho_{sol} = \frac{m_3 - m_1}{m_2 - m_1} = \frac{44.2800 - 17.0668}{40.849 - 17.0668}$$

$$= \frac{27.2132}{23.7822}$$

$$= 1.1442 \text{ kg/m}^3$$

$m_1 = 17.0668\ gm$ Density value = 1.14

$m_2 = 40.849\ gm$

$m_3 = 44.2800\ gm$

Mass of empty specific gravity bottle,

$m_1 = 17.0668\ gm$

Mass of specific gravity bottle with water,

$m_2 = 40.849\ gm$

Mass of specific gravity bottle with salt solution, $m_3 = 44.2800\ gm$

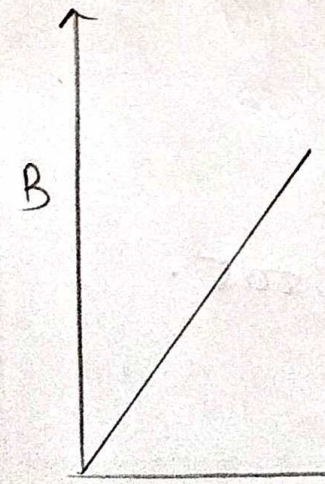
Density of water, $\rho_{water} = 1000\ kg/m^3$

Density of solution $\rho_{sol} = 1.144\ kg/m^3$

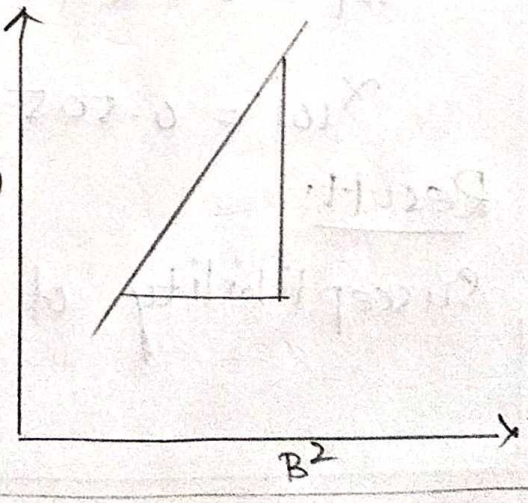
The paramagnetic susceptibility of salt solution from the relation

$$\chi_{sol} = \frac{2\mu_0 \rho_{sol} g h}{B^2}$$

Graph of B vs I



Graph of h vs B^2.



$$\rho_{sol} = 1.14 \text{ kg/m}^3$$

$$\chi_{sol} = \frac{2\mu_0 \rho_{sol} g h}{B^2}$$

$$\chi_{sol} = \frac{2 \times \mu_0 \times 1.14 \times 9.8 \times h}{B^2}$$

Slope $\left(\frac{h}{B^2}\right)$ from graph $= 18 \times 10^{3}$

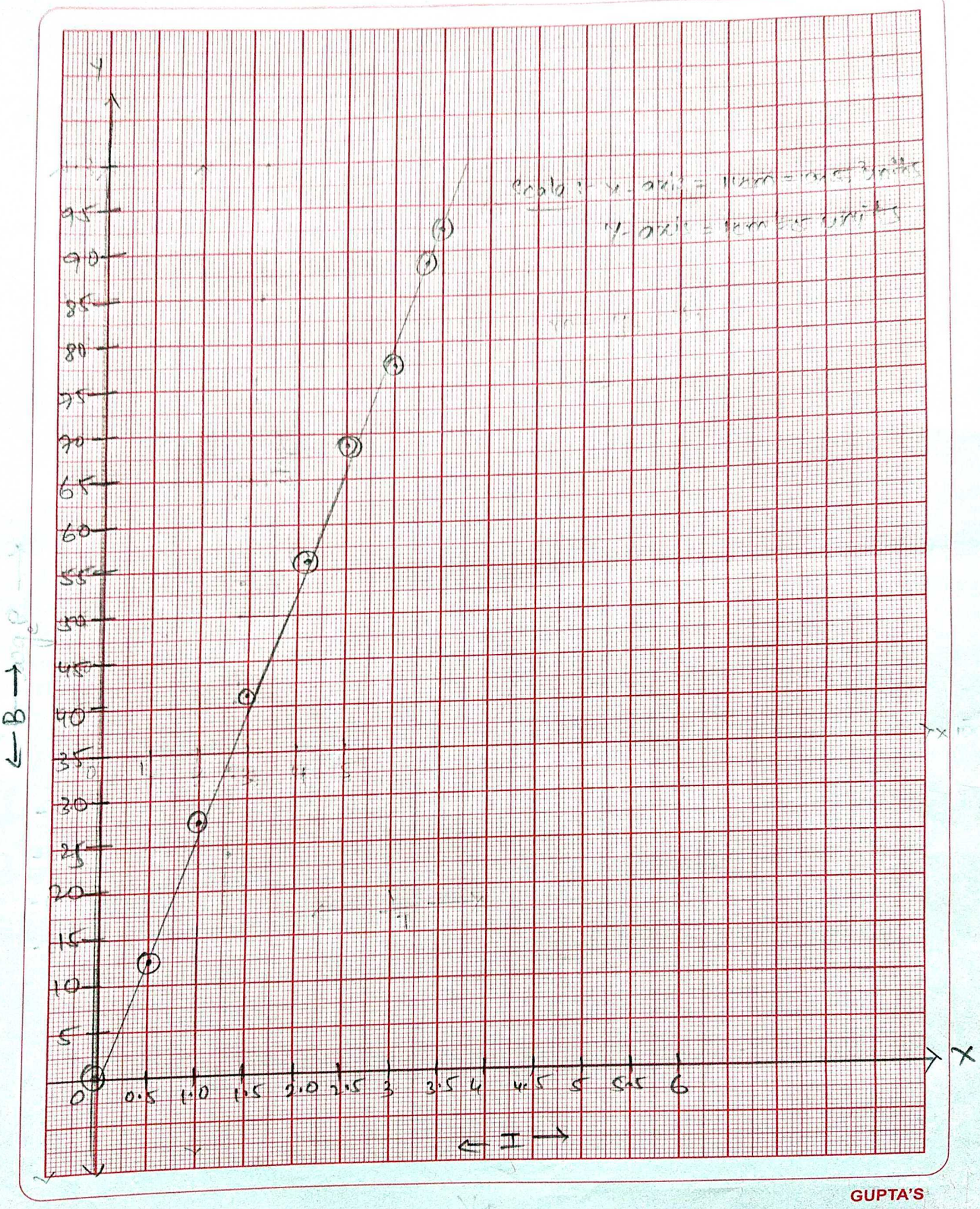
$$g = 9.8 \text{ m/s}^2 \; ; \; \mu_0 = 4\pi \times 10^{-7} \text{ H/m}$$

$$\chi_{sol} = 2 \times 4\pi \times 10^{-7} \times 1.14 \times 9.8 \times 18 \times 10^{3}$$

$$\chi_{sol} = 0.505$$

Result:

Susceptibility of $MnSO_4 \cdot H_2O = 0.505$.


Y
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← I →
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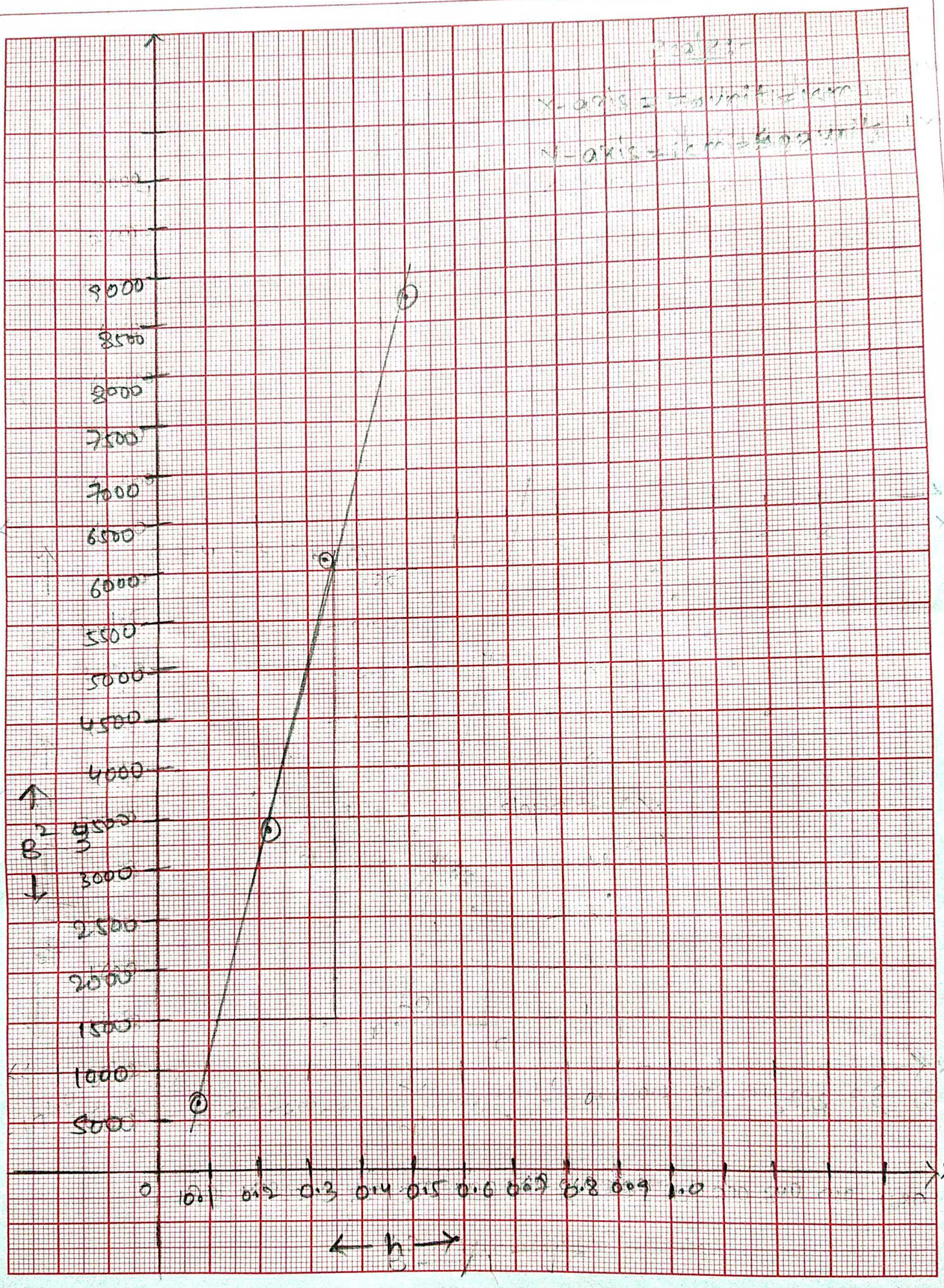
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0.2
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0.5
0.6
0.7
0.8
0.9
1.0
h