

Name: Prathapani Satwika

Reg :- 20BCD7160

Title of the experiment:-

Magnetic susceptibility of a  
Paramagnetic material

Objective:-

To determine the magnetic  
susceptibility ( $\chi$ ) of the given paramagne-  
tic solution using Quincke's method

Apparatus:-

→ Electromagnet and power supply

→ Gauss meter and Hall probe

→ Paramagnetic salt ( $\text{MnSO}_4 \cdot \text{H}_2\text{O}$ )

→ Digital balance

→ Specific gravity bottle and distilled  
water

→ Quincke's tube

→ Travelling microscope

Formula:-

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

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



Table: 1 calibration of Electromagnet  
magnetic flux, B  
Gauss

S.No	current (I) amp	
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 <sup>2</sup>	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:

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

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

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



$m_1 = 17.0668 \text{ gm}$  Density value = 1.14

$m_2 = 40.849 \text{ gm}$

$m_3 = 44.2800 \text{ gm}$

Mass of empty specific gravity bottle,

$m_1 = 17.0668 \text{ gm}$

Mass of specific gravity bottle with water,

$m_2 = 40.849 \text{ gm}$

Mass of specific gravity bottle with salt

solution,  $m_3 = 44.2800 \text{ gm}$

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

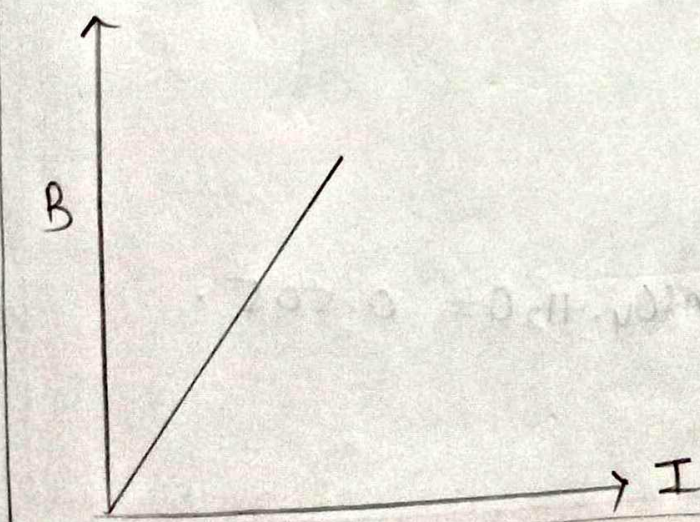
Density of solution  $\rho_{\text{sol}} = 1.144 \text{ kg/m}^3$

The paramagnetic susceptibility of salt solution

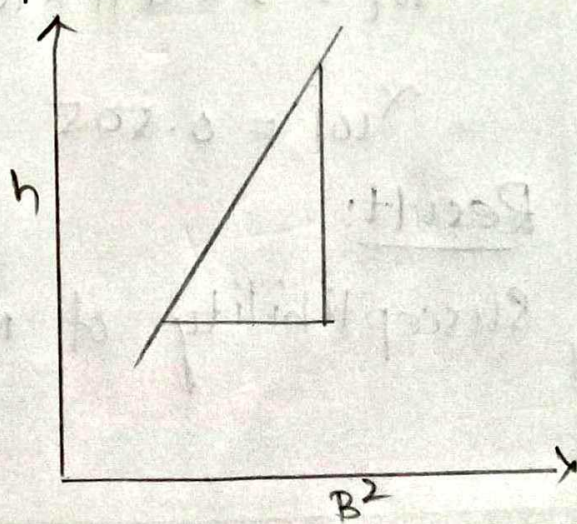
from the relation

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

Graph of  $B$  vs  $I$



Graph of  $h$  vs  $B^2$ .



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

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

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

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

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

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

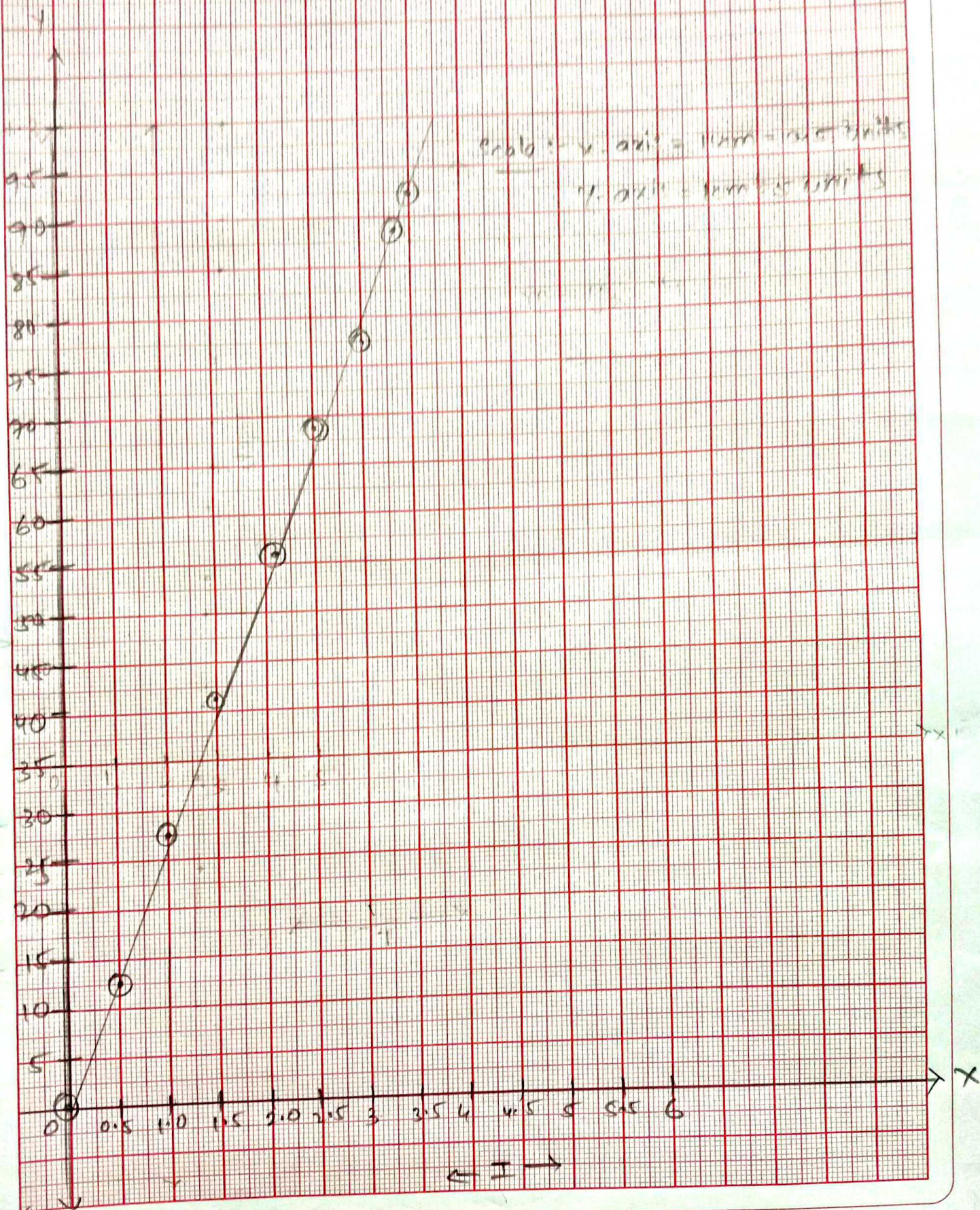
$$\chi_{\text{sol}} = 0.505$$

Result:

Susceptibility of  $\text{MnSO}_4 \cdot \text{H}_2\text{O} = 0.505$ .



← B →





1. 3. 2. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

