# Magnetic Susceptibility by Quincke's Method

**Aim :** To determine the magnetic susceptibility (mass and molar) of a diamagnetic/paramagnetic salt. Find out if it is a diamagnetic or paramagnetic salt.

## Apparatus

1) Quincke's tube with stand
2) Sample : $MnSO_4$/ ~~$CuSO_4$~~
3) Glassware like beaker, glass tubes
4) Travelling microscope
5) Weighing balance
6) Electromagnet (max 9.5 KG@ 10 mm air gap
7) Hall Probe/Gauss meter
8) Constant Current Power Supply

## Procedure

### Sample Preparation

1) Weigh the given salt (~ 15-20 g)
2) Obtain the mass of empty, clean and dry beaker
3) Take water ~ 15-20 cc in the beaker and note the mass
4) Dissolve the salt in the beaker containing water and weigh it.
5) The salt is now ready for pouring in the Quincke's tube.

> You may prepare 3 different solutions with low, medium and large normality and use.

## Calibration of the Magnetic field of the Electromagnet

1) Adjust the gap between the pole pieces such that the Quincke's tube fits in the gap comfortably. However, more the gap, smaller will be the field and smaller will be the changes we wish to measure. Check that the electromagnet is connected to the constant current power supply.
2) Set the Hall probe at the centre of the magnetic pole pieces and switch on the Gauss meter.
3) If necessary adjust the zero field knob to get zero field in the Gaussmeter.
4) Switch on the electromagnet with variable current switch on zero.
5) Slowly increase the current through the electromagnet so that magnetic field appearance is indicated by the gauss meter.
6) Make a table of current versus magnetic field. Get the magnetic field values upto ~ 8 KG.
7) Plot Current versus Magnetic Field.

## Procedure

1) Check that the constant current source is switched off with current adjusting knob at the minimum position.
2) Set the Quincke's tube filled with solution symmetrically in the pole pieces of the electromagnet, such that the meniscus of the liquid is at the centre when observed through the microscope.
3) Switch on the constant current source but the current should be zero, so that magnetic field (H) is zero. Note down the reading of the microscope, in mm.
4) Make the table as follows.

| Sr. No. | Current (A) | H (KG) | H$^2$ (KG) | Height of liquid level in mm | Rise of liquid (h) in mm |
|---------|-------------|--------|------------|------------------------------|--------------------------|
| 1. | 0.0 | | | | 0.0 |
| 2. | 1.0 | | | | |
| 3. | 1.5 | | | | |
| . | . | | | | |
| . | . | | | | |
| . | . | | | | |
| . | . | | | | |
| . | . | | | | |

## Graphs and Calculations

1) Plot a graph of  h versus H$^2$
2) Obtain the density of the liquid
3) Magnetic susceptibility of the liquid is

$$\chi = \frac{2\rho g h}{H^2}$$

4) Mass susceptibility of the liquid is

$$\chi'_{sol} = \frac{\chi}{\rho}$$

5) More accurate value of the susceptibility of salt would be obtained after subtracting the contribution of water, which we used to dissolve the salt,

$$\chi'_{sol} = \frac{m_s}{m_s + m_w} \chi'_{salt} + \frac{m_w}{m_s + m_w} \chi'_{water}$$

$$\chi'_{salt} = \left( \chi'_{sol} - \frac{m_w}{m_s + m_w} \chi'_{water} \right) \frac{m_s + m_w}{m_s}$$

6) Molar susceptibility is given by

$$\chi''_{salt} = \chi'_{salt} \times \text{molecular weight of } M_nSO_4.H_2O$$

(If you use any other salt use corresponding molecular weight)