Measurement of volume and surface resistivity:

The **direct deflection method** is often used for measurement of insulation resistance of insulating material samples available in sheet form. In such cases, we are interested in the measurement of volume resistivity and the surface resistivity of the material.

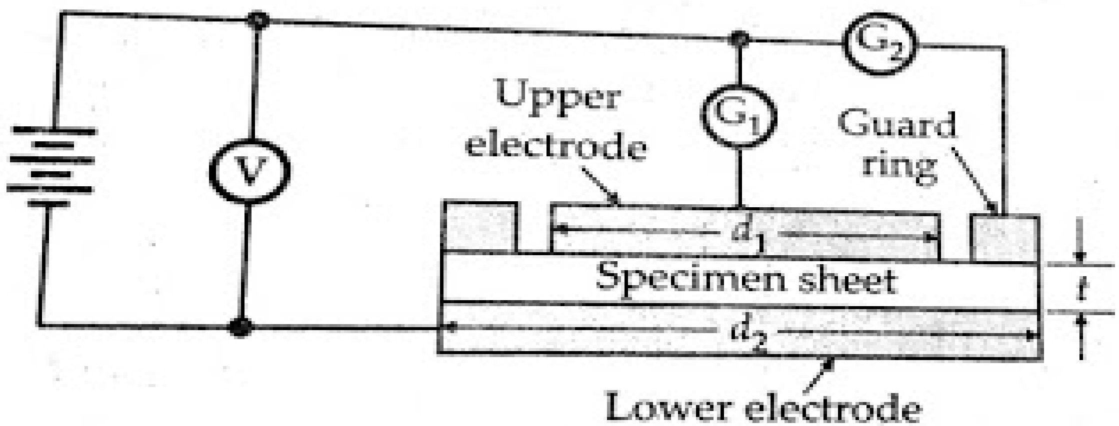
The figure below shows the schematic diagram for measurement of volume and surface resistivities of a specimen of insulating material. The specimen is provided with tin foil or colloidal graphite electrodes; the upper electrode having a guard ring. For measurement of volume resistivity (which in fact is the specific resistance), readings of the voltage applied and the current through the galvanometer are taken. Leakage currents over the edge of the specimen will flow between the guard ring and the lower electrode and hence will not introduce error into the measurement. The volume resistivity, p, can be calculated as follows:

Let d_1 = diameter of the upper electrode d_1,

r= thickness of the specimen sheet,

V_1 = reading of voltmeter,

and I = current through galvanometer G_1.



∴ Resistance of specimen

$$R = V_1 / I_1. \quad \text{But } R = \rho t / \pi d_1^2$$

∴ Volume resistivity of specimen,

$$\rho = \frac{\pi d_1^2}{t} = \frac{\pi d_1^2 V_1}{t I_1}$$

The resistivity of a thin layer of dielectric materials is different from volume resistivity, not only because of an adherent humidity layer but also because of contamination, chemical alterations, absorption of gases, or structural modification.The resistance Rt between two electrodes embedded in or attached to a dielectric medium is composed of volume resistance Rv and surface resistance Rs with $(1 / R_t) = (1/ R_v) + (1 / R_s)$

The volume resistance, R_v can be measured separately from surface resistance R_s with the help of guard rings as shown in the figure above. If we want to measure surface resistivity, the galvanometer is placed in position G2. In this position, the galvanometer measures the leakage current, and the current flowing between upper and lower electrodes will be eliminated from the measurement. Let

d_2 = diameter of lower electrode disc,

V_2 = reading of voltmeter

And I_2 = current through galvanometer G_2.

Surface resistance, $R_s = V_2/I_2$

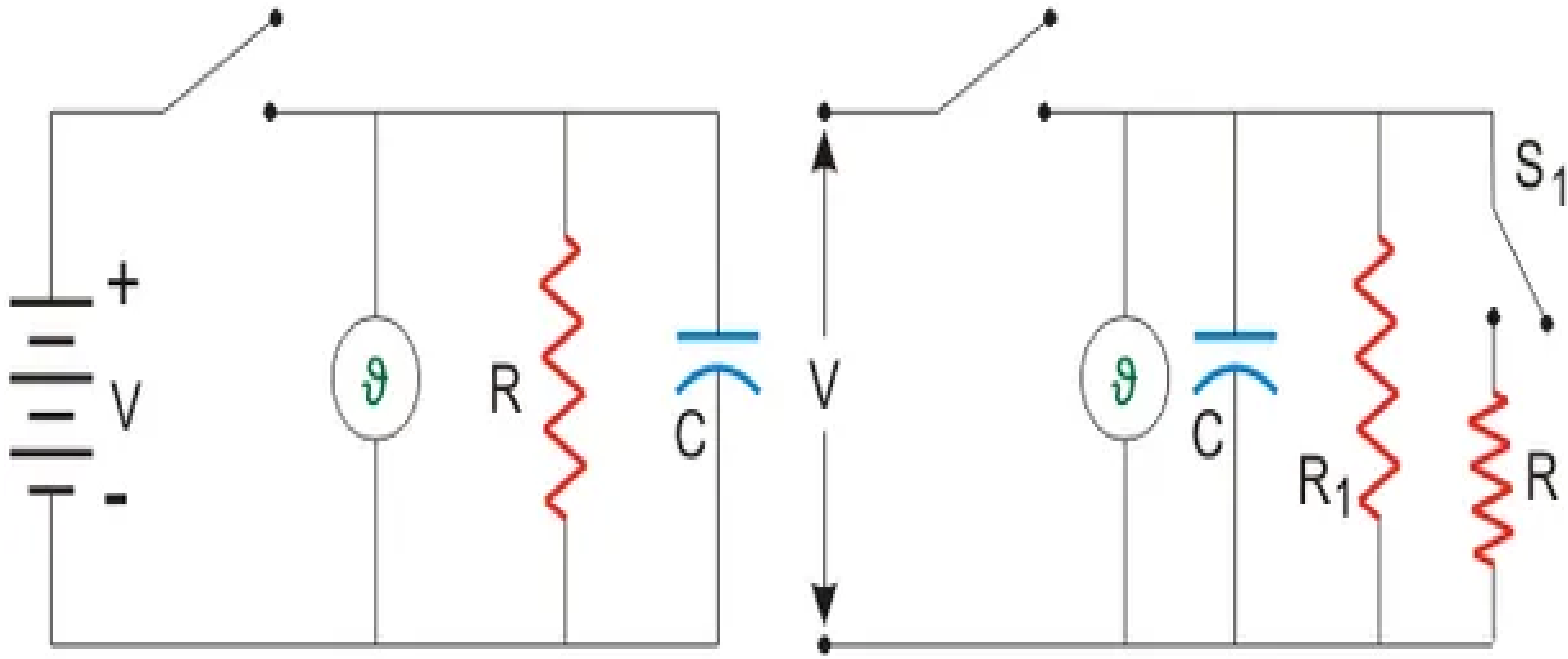
The leakage current flows along a path of length t and width πd_2 and therefore, surface resistivity,

$$\rho_s = \frac{R_s \times \pi d_2}{t} = \frac{\pi d_2}{t} \cdot \frac{V_2}{I_2}$$

Other forms of specimen and electrodes are also used. For example, the electrodes and guard ring may be mercury, either placed in specially machined recesses, in moulded insulating materials or retained by metal rings on the surface of sheet materials.

Loss of Charge Method

In this method we utilize the equation of voltage across a discharging capacitor to find the value of unknown resistance R. Figure below shows the circuit diagram and the equations involved are-



Loss of Charge Method

$$v = Ve^{\frac{-t}{RC}}$$

$$R = \frac{0.4343t}{C\ log_{10}V/v}$$

However the above case assumes no leakage resistance of the capacitor. Hence to account for it we use the circuit shown in the figure below. R_1 is the leakage resistance of C and R is the unknown resistance.

We follow the same procedure but first with switch S_1 closed and next with switch S_1 open. For the first case we get

$$R' = \frac{0.4343t}{C\ log_{10}V/v}$$

$$Where,\ R' = \frac{RR_1}{R + R_1}$$

For second case with switch open we get

$$R_1 = \frac{0.4343t}{C \, log_{10} V / v}$$

Using R_1 from above equation in equation for R' we can find R.