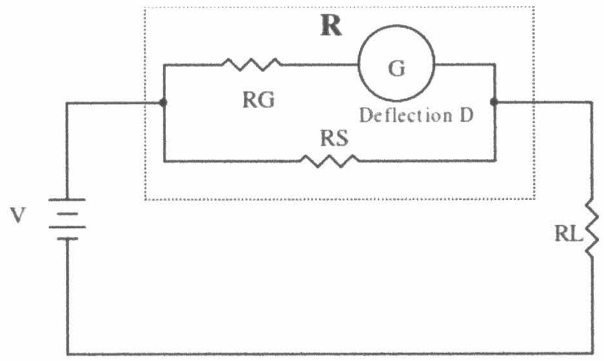
Experiments (14)

Conversion of a galvanometer into an ammeter

In the first part of the experiment, with the knowledge of the coil resistance and sensitivity of the galvanometer, one can convert a galvanometer into an ammeter by shunting a low resistance (smaller than the coil resistance) across its terminals as shown in Figure-3.

Figure-3: Conversion of a galvanometer into an ammeter using a shunt resistance



Taking $R_G = 100\Omega$ and sensitivity, s, as 20μA/div, the full scale current (FSC) = 20μAx30= 600μA.

This current can be converted to higher scale by the shunting resistance as shown in Figure-3, as given in Table-1.

Hence depending on the desired range of the ammeter, one can choose the shunt resistance value from this table and convert the galvanometer into an ammeter. The panel carrying the graduation marks can be suitably calibrated in terms of amperes or milli-amperes.

When a resistance is shunted across the terminals of the galvanometer, its effective coil resistance changes as shown in Table-1. Hence the sensitivity (S_A) and effective coil resistance (R_A) also change.

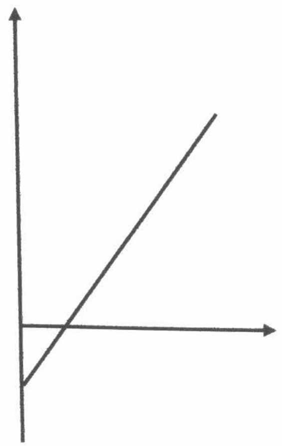
If R_A is the effective resistance of the current meter coil then

$R_A = R_S // R_G$ $$\frac{1}{R_S} = \frac{1}{R_A} - \frac{1}{R_G}$$

If V is voltage and I is current flowing in the circuit, then by the Ohm's law $V = (R_A + R_L)\, I$

If S_A is the sensitivity of the current meter and D_A is the number of divisions of deflection in current meter (in terms of number of divisions), then

$I = D_A S_A$ Substituting for I from the above in Equation



$V = (R_A + R_L)\, S_A D_A$ $$\frac{V}{S_A D_A} = R_A + R_L$$

Rearranging the above equation as following $$\frac{V}{S_A D_A} = R_A + R_L$$

$$R_L = \frac{V}{S_A D_A} - R_A \qquad R_L = \frac{V}{S_A}\frac{1}{D_A} - R_A$$

This equation represents a straight line between R_L and $1/D_A$, with

Slope $= \frac{V}{S_A}$; Y intercept $= -R_A$

Hence figures of merit of the ammeter can be determined.

By varying R_L, the number divisions of deflection in current meter are noted, from which the figures of merit of the current meter, R_A and S_A can be determined from which the coil resistance R_G and sensitivity s of the galvanometer also can be determined.

Experimental procedure

The experiment consists of three parts:

Part-I: Determination of figures of merit of a galvanometer (R_G, s)
Part-II: Determination of R_G by the half deflection method
Part-III: Conversion of a galvanometer into an ammeter and determination of its figures of merit (R_A, S_A)

Part-I: Determination of figures of merit of a galvanometer (R_G, s)

1. The milli-volt power supply, galvanometer and resistance boxes are connected in series as shown in Figures-1 and 5. The resistance in the box is set to 0Ω.
2. The voltage in the milli-volt power supply is slowly increased till the galvanometer shows full scale deflection (i.e. 30 divisions). The voltage that produces full scale deflection is noted using DMM.

Load variation and the deflection observed in the galvanometer

Load resistance R_L (Ω)	Deflection (No. of divisions) d	1/d
200	10	.1
100	15	.06
90	16	.062
80	17	.058
70	18	.055
60	19	.052
50	20	.05
40	21.5	.046
30	23	.043
20	25	.04
10	27	.037
5	28.1	.035
0	30	.033

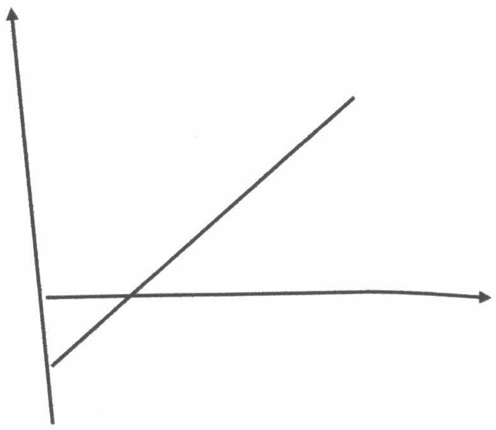
$$R_L = \frac{V}{sd} - R_G$$

$$R_L = \frac{V}{s}\frac{1}{d} - R_G$$

Y-intercept = $-R_G$

Slope = $\frac{V}{s}$

Sensitivity of the galvanometer $s = \frac{V}{slope}$



3. The resistance (R_L) in the box is now set to 200Ω and the deflection in the galvanometer is noted.

R_L = 200 Ω;
d = 10 divisions

4. The experiment is repeated by decreasing the resistance RL in the box and corresponding value of the galvanometer deflection is noted and recorded in Table-3

5. A graph is drawn with 1/d along X-axis and R_L along the Y-axis, as shown in Figure-6. From the graph the slope and Y-intercepts of the straight line are noted.

Part-II: Determination of R_G by the half deflection method

6. The resistance in the box is set to '0' and the value of the full scale deflection is observed. $R_L = 0$; Full scale Deflection =30 divisions
7. The resistance in the box is increased so that deflection in the galvanometer becomes 15 divisions (i.e. half of the original value of deflection)

$R_L = 100\Omega$, d =15divisions

Hence resistance of the coil $R_G = 100\ \Omega$

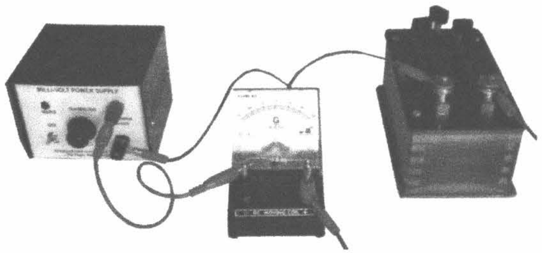
Part-III: Conversion of a galvanometer into an ammeter and determination of its figures of merit (R_A, S_A)

8. A 10Ω resistance now shunted across the galvanometer terminal as shown inthis and keeping RL=0, the milli-volt power supply is adjusted to the full scale.

$R_S = 1\Omega$ shunted across the input terminal of the galvanometer

$R_L = 0$; Full scale deflection =30 divisions

The full scale display voltage is measured using a DMM.



$V_{full} = 60mV$

Conversion of a galvanometer in to a milli ammeter

9. By varying the resistance R_L in box, the corresponding deflection is noted in Table-4. $R_L = 100\Omega$; $D_A = 2.5$divisions

Table-4: Load variation and the observed deflection in a galvanometer

Load resistance R_L (Ω)	Deflection (No. of divisions) D_A	$1/D_A$
100	2.5	0.4
70	3.5	0.28
40	5.2	0.192
20	9	0.111
10	14.5	0.074
4	20	0.05
3	22	0.045
2	22.5	0.044
1	26	0.038
0	30	0.033

$$R_L = \frac{V}{S_A D_A} - R_A$$

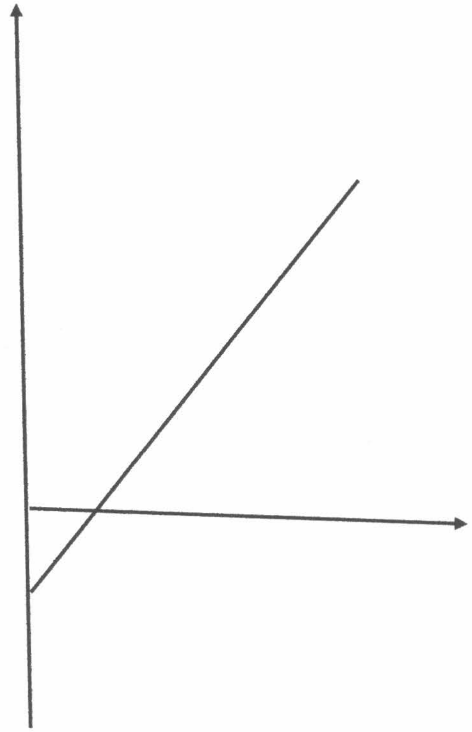
$$R_L = \frac{V}{S_A}\frac{1}{D_A} - R_A$$

Y-intercept = $-R_A$

$$\text{Slope} = \frac{V}{S_A} =$$

$$\frac{1}{R_G} = \frac{1}{R_A} - \frac{1}{R_S} :$$

$$\frac{1}{R_S} = \frac{1}{R_A} - \frac{1}{R_G}$$



10. A graph is now drawn taking R_L along Y-axis and $1/D_A$ along X-axis

Sensitivity of the milli-ammeter $S_A = \frac{V}{\text{slope}}$:

The slope of the straight line and the Y-intercept are noted from Figure

$$\textit{Full Scale Divisions (FSD)} = S_A \times 30\ mA$$

Hence by using the shunt resistance Rs= Ω, we have changed it into a milli-ammof 0- to FSD mA range, and the Sensitivity = S_A mA/div. This value corresponds to R_S =Ω in Table-1.