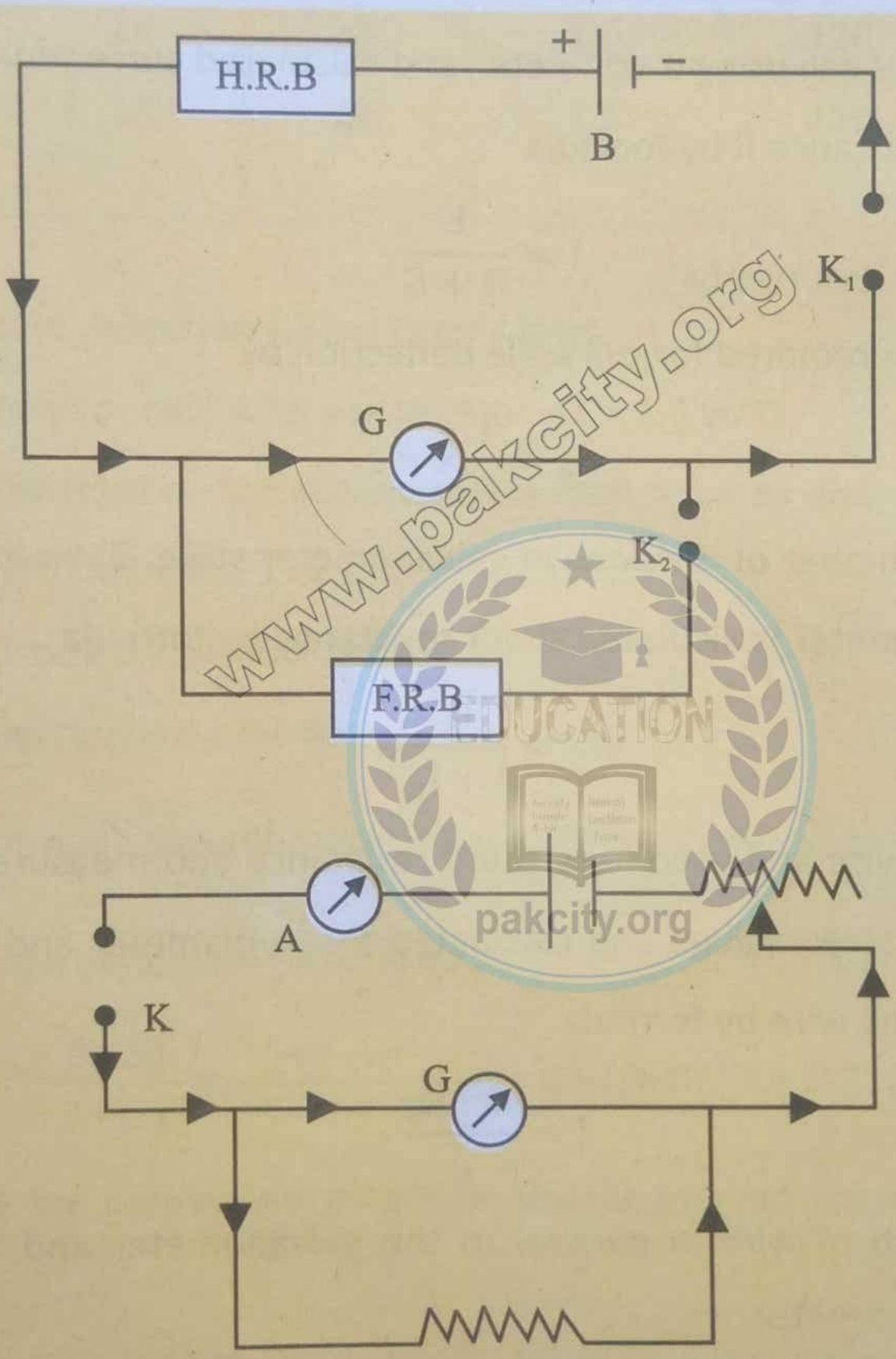
EXPERIMENT NO. 5

To convert a Weston – type galvanometer into an ammeter reading up to 1.0 ampere (0 – 1.0 amp. Range)

APPARATUS: A moving coil galvanometer (Weston type), high resistance box (H.R.B), voltmeter, ammeter of 1.0 amp range, fractional resistance box (F.R.B), rheostat, two plug keys, screw gauge, battery (2 – 3 cells), sand paper and connecting wires, shunt wire (copper).

DIAGRAM:



PROCEDURE:

I drew circuit diagram and made tight connections according to diagram. I connected H.R.B, battery, key K_1 and galvanometer in series which forms a loop. Then I connected

F.R.B along with K_2 in parallel to galvanometer. I closed K_1 and opened K_2. I plug out suitable resistance from H.R.B and obtained even number deflection on galvanometer. Now I also closed K_2 and observed that deflection on galvanometer becomes zero. Then I plug out shunt resistance S from F.R.B which makes deflection on galvanometer half. I calculated resistance of galvanometer by formula

$$G = \frac{RS}{R-S}$$

I took two more observations by changing values of R by same method. I calculated mean value of resistance of galvanometer.

Then I noted the emf of cell using a voltmeter and calculated current passing through the galvanometer with resistance R by formula

$$I = \frac{E}{R+G}$$

I calculated the current required for full scale deflection by

$$I_g = \frac{I}{\theta} \times n$$

Where n is the total number of divisions in galvanometer scale. Then in order to convert galvanometer into ammeter I calculated shunt resistance by formula

$$R_S = \frac{I_g}{I - I_g} G$$

Then I took a copper wire and used it as shunt resistance and measured its diameter at different points using screw gauge and calculated mean diameter and radius (r). Then I calculated length l of the wire by formula

$$l = \frac{\pi r^2 R_s}{\rho}$$

I connected this length of wire in parallel to the galvanometer and this arrangement worked as converted ammeter.

I connected ammeter in series to galvanometer according to circuit diagram and I took out a suitable resistance from H.R.B and noted the reading on both meters. Then I converted the galvanometer into ammeter and calculated the difference between two readings which came out nil.

OBSERVATIONS AND CALCULATIONS:

No. of Obs.	Resistance taken out from H.R.B R (Ω)	Deflection in Galvanometer θ		Half deflection $\frac{\theta}{2}$ (divs.)	Resistance taken out from F.R.B S (Ω)	Galvanometer Resistance $G=\frac{RS}{R-S}$ (Ω)
		Observed (divs.)	Corrected (divs.)			
1	4000	30	30	15	120	123.7
2	4800	28	28	14	120	123.1
3	5500	26	26	13	120	122.7

Mean value of G = 123.2 Ω

Current for full scale defection (using Ohm's law):

E.M.F. of the battery (or cell) with a voltmeter = E = 1.3 volts

Total number of divisions on the galvanometer scale = n = 30 divs.

From observation No. 01 (take 1 or 2 or 3),

Resistance R = 4000 Ohms.

Deflection = θ = 30 divs.

Current passing through galvanometer = $I = \frac{E}{R+G}$ (Ohm's law)

Current for full scale deflection (30 div) = $I_g = \frac{I}{\theta} \times n$

Hence $I_g = \frac{E \times 30}{(R+G)\theta} = \frac{1.3 \times 30}{(4000+123.2)30}$ A = 0.315×10^{-3} A = 0.315 mA

Shunt resistance for conversion of galvanometer into an ammeter of range 0 – 1.0 amperes:

The range of ammeter for conversion i.e. I = 1.0 A

The shunt resistance = $R_S = \frac{I_g}{I-I_g} G$

$$R_S = \frac{0.315 \times 10^{-3}}{1-0.315 \times 10^{-3}} 123.2$$

= 0.0388 Ω

Calculation of length of shunt wire (Copper):

Least count of screw gauge = 0.01 mm

Zero correction = zero

Observed diameter = (i) 0.40 mm (ii) 0.40 mm (iii) 0.40 mm

Mean diameter = $\frac{0.40+0.40+0.40}{3}$ = 0.40 mm

Radius of the copper wire = r = d/2 = 0.40/2 = 0.20 mm = 0.020 cm

Specific resistance of copper wire = ρ = 1.72 x 10^{-6} Ω-cm

Length of wire used as shunt = $l = \frac{\pi r^2 R_S}{\rho}$

$$l = \frac{3.14x\,(0.02)^2 x 0.0388}{1.72\,x\,10^{-6}} = 28.33\ cm$$

Verification:

Checking the accuracy of converted galvanometer

Total number of divisions of galvanometer = n = 30 divs.

So, the value of each division of shunted galvanometer = $\frac{I}{n}\theta = \frac{1.0}{30}\ \theta$

No. of Obs.	Reading of Shunted galvanometer		Standard Ammeter Reading	Difference (Error)
	Deflection θ (div.)	Current = $\frac{1.0}{30}\theta$ (A)	(A)	(A)
1	16	0.53	0.52	0.01
2	22	0.73	0.72	0.01
3	27	0.90	0.89	0.01

RESULT:

It is found that to convert the galvanometer into an ammeter reading up to 1.0 ampere, the galvanometer should be shunted with a resistance of 0.0388 Ω.

PRECAUTIONS

- All the connections should be neat and tight.
- The shunt wire should be connected in such a way that not portion of the calculated length of the wire should be under the binding screw of the galvanometer.
- Large currents should be passed to produce large deflection when checking

the accuracy of the galvanometer. This reduces the percentage in observation.

- The wire used as a shunt should have a convenient length.
- The diameter of the wire should measure carefully in two mutually perpendicular directions at each point.

VIVA VOCE:

Q: What is ammeter?

Ans: It is a device used to measure the flow of current.

Q: How ammeter is formed from galvanometer?

Ans: Shunt is connected in parallel with the galvanometer.

Q: How range of ammeter is increased?

Ans: By decreasing the shunt which is connected in parallel with the galvanometer.

Q: Why ammeter is connected in series?

Ans: It is connected in series to provide a single path of flow of current, so that the exact value of current does not change.

Q: Why resistance of ammeter must be very low?

Ans: Ammeter is connected in series to measure the current. If resistance of ammeter is high then it will change the value of current which is to be measured.

Q: What is the difference between an ammeter and a galvanometer?

Ans: When a galvanometer is shunted, it becomes an ammeter. Galvanometer detects while ammeter measures the flow of current.

Q: How voltmeter is different from ammeter?

Ans: Voltmeter is used to measure potential difference while ammeter measures the current.

Q: How much is the value of "g" at the centre of earth?

Ans: Zero.