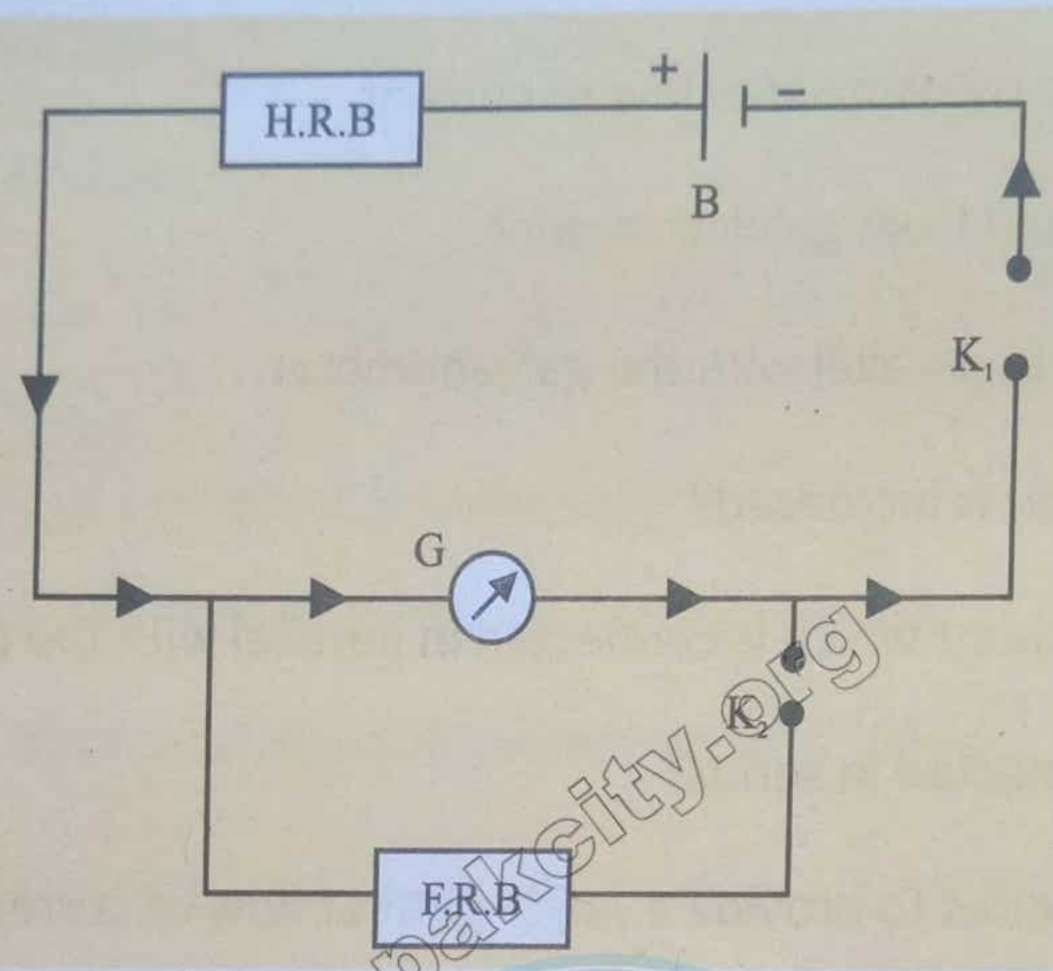
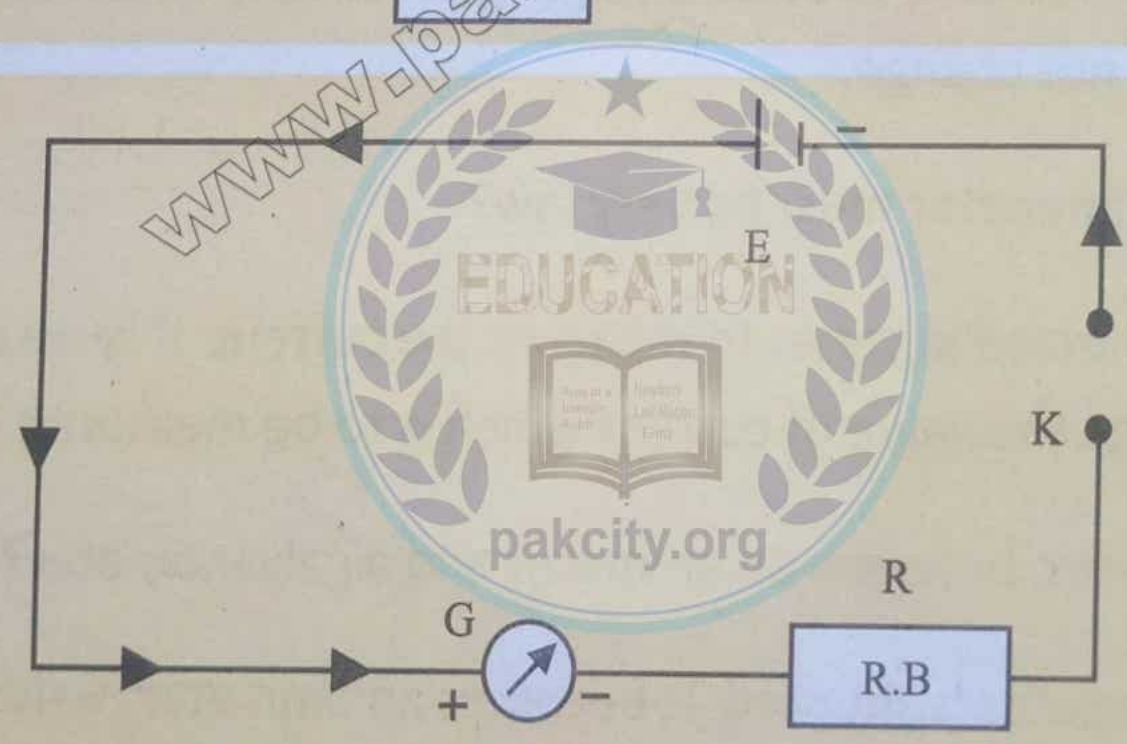
EXPERIMENT NO. 6

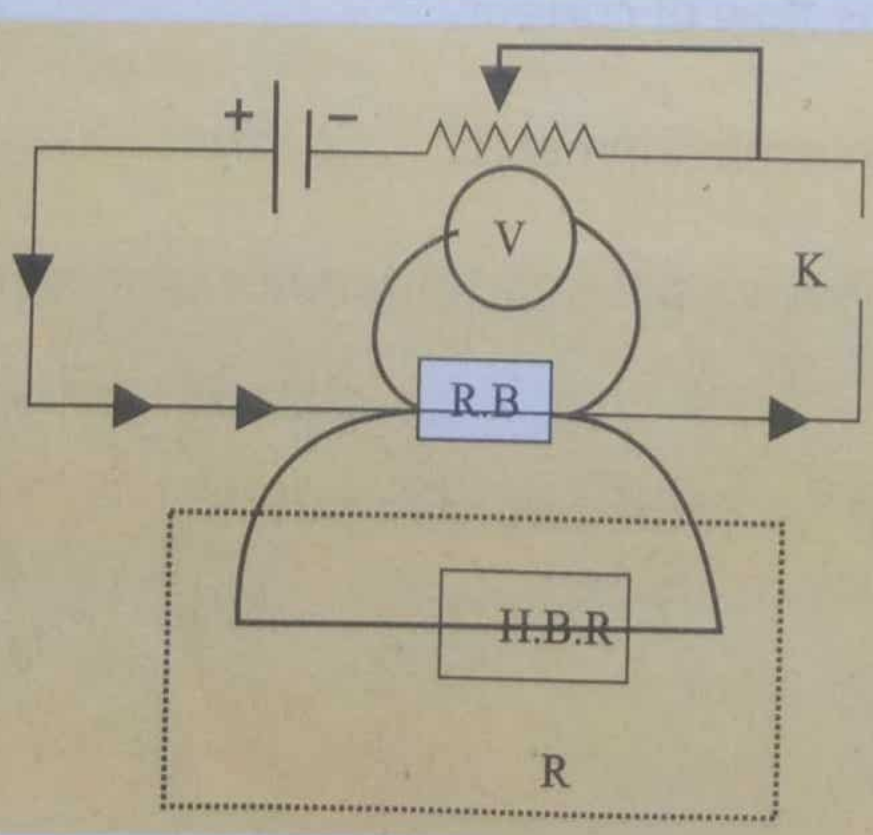
To convert a moving coil (Weston type) galvanometer into a voltmeter up to 3 volts (0 – 3 volts range).

APPARATUS: A moving coil (Weston type) galvanometer, voltmeter of 0 – 3 volts range, High resistance box, fractional resistance box, battery (of 2 or 3 cells), two plug keys, rheostat, connecting wires and sand papers.

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 and S 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. For conversion of galvanometer into a voltmeter up to 3 volt, I calculated the suitable high resistance required to convert galvanometer using formula

$$R_h = \frac{3.0}{I_g} - G$$

Then I connected a H.R.B, voltmeter and galvanometer according to circuit diagram (C) and noted the deflection θ on galvanometer and reading on voltmeter. The potential difference shown by converted galvanometer is equal to the reading on standard voltmeter. I took three number of readings by varying the rheostat.

OBSERVATIONS AND CALCULATIONS:

No. of Obs.	Resistance taken out from H.R.B R (Ω)	Deflection in Galvanometer θ		Half deflection $\frac{\theta}{2}$	Resistance taken out from F.R.B S	Galvanometer Resistance $G=\frac{RS}{R-S}$
		Observed (divs.)	Corrected (divs.)	(divs.)	(Ω)	(Ω)
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) = $I_g = \frac{I}{\theta}$ x n

Hence:

$$I_g=\frac{E\times 30}{(R+G)\theta}=\frac{1.3\ x30}{(4000+123.2)30}\ A = 0.315x10^{-3}\ A = 0.315\ mA$$

Range of voltmeter = 3V

High resistance which is to be connected with the galvanometer = $R_h = \frac{V}{I_g} - G$

$$R_h = \frac{3.0}{0.315x10^{-3}} - 123.2$$

$$R_h = 9524\ \Omega$$

Checking the accuracy of the converted galvanometer

Each scale division on the converted galvanometer = $\frac{V}{n}\ \theta = \frac{3}{n}\ \theta$

No. of Obs.	Resistance taken out from H.R.B. (Ω)	Readings of converted galvanometer		Standard voltmeter Reading (V)	Difference (error) (V)
		Deflection θ (div.)	Voltage in volts $\frac{3}{n}\ \theta$		
1	3000	10	1.0	1.0	0
2	3800	14	1.4	1.4	0
3	4300	19	1.9	1.9	0

RESULT:

In order to convert the galvanometer into voltmeter reading up to 3.0 volts, a high resistance R_h = 9524 ohms must be connected in series with the galvanometer.

PRECAUTIONS

- All the connections should be neat and tight.
- The positive marked terminal of standard voltmeter should go to the positive terminal of the battery.
- Both voltmeter i.e standard voltmeter and converted galvanometer should be connected parallel with the resistance box.
- Suitable resistance should be taken out from the resistance box to produce large deflection in both voltmeters.
- The rheostat used as potential divider should not have low resistance.

(Note: If the difference between the readings of converted galvanometer and voltmeter is large we should adjust the value of external resistance in the resistance box placed in series with the galvanometer unless the readings coincide.)

VIVA VOCE:

Q: What is voltmeter?

Ans: It is a device used to measure potential difference or voltage.

Q: How voltmeter is formed from galvanometer?

Ans: A high resistance is connected in series with the galvanometer.

Q: How range of voltmeter is increased?

Ans: By increasing the value of high resistance which is connected in series with the galvanometer.

Q: How voltmeter is connected in circuit?

Ans: It is connected parallel in circuit.

Q: Why voltmeter is connected in parallel?

Ans: So that the current in circuit will not change and it can measure the exact value of voltage.

Q: Why the resistance of voltmeter must be very high?

Ans: If the resistance of voltmeter is low then current will pass through it and the potential difference changes which is to be measured.

Q: How voltmeter is different from ammeter?

Ans: High resistance connected in series with the galvanometer makes a voltmeter while shunt connected in parallel with the galvanometer makes an ammeter.

Q: Can a D.C voltmeter or a D.C ammeter be used to measure alternating volatage or alternating current?

Ans: No, they cannot be used.