To Compare The EMF Of Two Given Primary Cells Using Potentiometer.

Aim

To compare the EMF of two given primary cells using potentiometer.

Apparatus

Potentiometer, a Leclanche cell, a Daniel cell, an ammeter, a voltmeter, a galvanometer, a battery (or battery eliminator), a rheostat of low resistance, a resistance box, a one way key, a two way key, a jockey, a set square, connecting wires and a piece of sand paper.

Theory

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

where, E_1 and E_2 are the e.m.f. of two given cells and l_1 and l_2 are the corresponding balancing lengths on potentiometer wire.

Circuit diagram

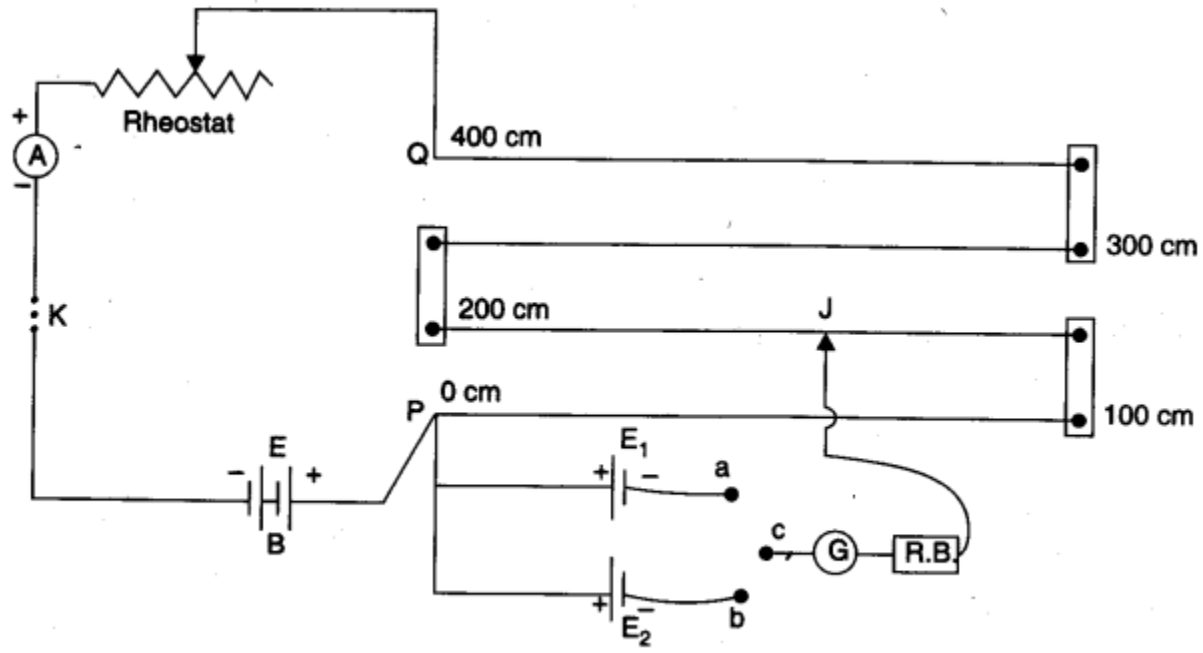

Fig. Comparison of the e.m.f. of two cells.

Procedure

1. Arrange the apparatus as shown in circuit diagram figure.
2. Remove the insulation from the ends of the connecting copper wires with a sand paper.
3. Measure the e.m.f. (E) of the battery and the e.m.fs. (E_1 and E_2) of the cells. See that $E > E_1$ and also $E > E_2$.
4. Connect the positive pole of the battery (a battery of constant e.m.f.) to the zero end (P) of the potentiometer and the negative pole through a one-way key, an ammeter and a low resistance rheostat to the other end (Q) of the potentiometer.
5. Connect the positive poles of the cells E_1 and E_2 to the terminal at the zero end (P) and the negative poles to the terminals a and b of the two way key.
6. Connect the common terminal c of the two-way key through a galvanometer (G) and a resistance box (R.B.) to the jockey J.
7. Take maximum current from the battery making rheostat resistance zero.
8. Insert the plug in the one-way key (K) in circuit and also in between the terminals a and c of the two-way key.
9. Take out a 2,000 ohms plug from the resistance box (R.B.).
10. Press the jockey at the zero end and note the direction of deflection in the galvanometer.
11. Press the jockey at the other end of the potentiometer wire. If the direction of deflection is opposite to that in the first case, the connections are correct. (If the deflection is in the same direction then either connections are wrong or e.m.f. of the auxiliary battery is less).
12. Slide the jockey gently over the potentiometer wires till you obtain a point where galvanometer shows no deflection.
13. Put the 2000 ohms plug back in the resistance box and obtain the null point position accurately, using a set square.
14. Note the length l_1 of the wire for the cell E_1 Also note the current as indicated by the ammeter.
15. Disconnect the cell E_1 by removing the plug from gap ac of two-way key and connect the cell E_2 by inserting plug into gap be of two-way key.
16. Take out a 2000 ohms plug from resistance box R.B. and slide the jockey along potentiometer wire so as to obtain no deflection position.
17. Put the 2000 ohms plug back in the resistance box and obtain accurate position of null point for second cell E_2 .
18. Note the length l_2 of wire in this position for the cell E_2 . However, make sure that ammeter reading is same as in step 14.
19. Repeat the observations alternately for each cell again for the same value of current.
20. Increase the current by adjusting the rheostat and obtain at least three sets of observations in a similar way.
21. Record your observations as given below

Observations

1. Range of voltmeter = ...
   Least count of voltmeter = ...
   E.M.F. of battery (or battery eliminator), E = ...
   E.M.F. of Leclanche cell, E_1 = ...
   E.M.F. of Daniel cell, E_2 = ...
2. Least count of the ammeter = ...
   Zero error of the ammeter = ...
3. **Table for lengths**

Serial No. of Obs.	*Corrected ammeter reading (A)*	*Balance point when E_1 (Leclanche cell) in the circuit l_1 (cm)*			*Balance point when E_2 (Daniel cell) in the circuit l_2 (cm)*			$\frac{E_1}{E_2} = \frac{l_1}{l_2}$
(1)	*(2)*	*1 (3a)*	*2 (3b)*	*Mean l_1 (3c)*	*1 (4a)*	*2 (4b)*	*Mean l_2 (4c)*	*(5)*
1.	.....	.....	.....	.....	.....	.....	.....	.....
2.	.....	.....	.....	.....	.....	.....	.....	.....
3.	.....	.....	.....	.....	.....	.....	.....	.....

Calculations

1. For each observation find mean l_1 and mean l_2 and record in column 3c and 4c.
2. Find E_1/E_2 for each set, by dividing mean l_1 (column 3c) by mean l_2 (column 4c).
3. Find mean E_1/E_2 .

Result

The ratio of E.M.Fs., $\frac{E_1}{E_2} \cong$ .....

Precautions

1. The connections should be neat, clean and tight.
2. The plugs should be introduced in the keys only when the observations are to be taken.
3. The positive poles of the battery E and cells E_1 and E_2 Should, all be connected to the terminal at the zero of the wires.

4. The jockey key should not be rubbed along the wire. It should touch the wire gently.
5. The ammeter reading should remain constant for a particular set of observation. If necessary, adjust the rheostat for this purpose.
6. The e.m.f. of the battery should be greater than the e.m.f.'s of the either of the two cells.
7. Some high resistance plug should always be taken out from resistance box before the jockey is moved along the wire.

Sources of error

1. Same as in previous experiments.
2. The auxiliary battery may not be fully charged.
3. The potentiometer wire may not be of uniform cross-section and material density throughout its length.
4. End resistances may not be zero.