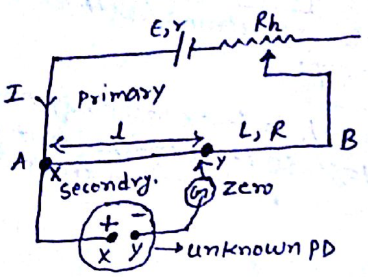
'ELECTRICAL MEASURING INSTRUMENT'

*** Imp.

- Current → Galvanometer/Ammeter
- Voltage → Voltmeter/potentiometer
- Resistance → meter bridge/post office box
- Emf of battery/Internal Resistance → potentiometer.

Potentiometer :→

- * Ideal voltmeter
- * use to measure potential difference.
- * Based on zero deflection method.
- * It is not based on Wheat stone Bridge.
- * It doesn't draw any current from ckt under mesurment so measure acurate value & behave like voltmeter.
- * Its principle based on the concept that no current will flow b/w two points if points are at the same potential.



|1|→ Primary cell/ckt

$$I = \frac{E}{R+Rh+r}$$

$$V_{AB} = IR$$

* Potential Gradient (x) – potential / unit length of wire

$L \longrightarrow V_{AB}$

$1 \longrightarrow \frac{V_{AB}}{L}$

$$x = \frac{V_{AB}}{L}$$

|2|→ Secondry ckt →

→ unknown PD connection in secondry ckt b/w 'X' & 'Y' & balanced length obtained by moving a Jokey on potentiometer wire.

If balance length $= l$

then unknown voltage $(V) = \boxed{xl}$ *

|3|→ Range →

Range $= V_{AB}$
$= xL$

* $\boxed{\text{Range} \propto x}$

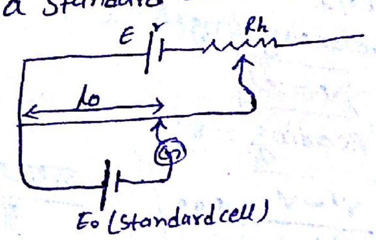
|4|→ Sensivity (S) :→

$$S \propto \frac{1}{x}$$

*** NOTE → Rheostate (Rh) use in primary to adjust (x) so that –

- * $x(\uparrow)$, Range $(\uparrow)$, Sensitivity $(\downarrow)$
- * $x(\downarrow)$, Range $(\downarrow)$, Sensitivity $(\uparrow)$

|5|→ Standardisation of potentiometer :→ In this process is for finding Aqurate (x) by balancing a Standard cell on potentiometer wire.

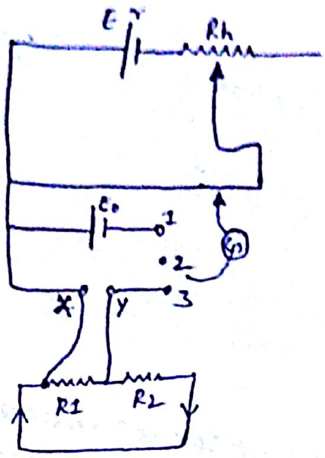


$\because E_0 = x l_0$

$$x = \frac{E_0}{l_0}$$

Application of potentiometer:

|1|→ To Measure P.D across current carrying Resistance →

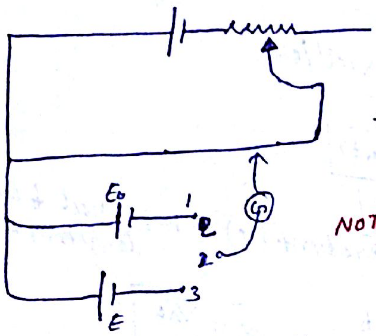


1 − 2 $x = \frac{E_0}{l_0}$

2 − 3 If balance length $= l$

$V_{R1} = xl$

|2|→ To Measure EMF of a cell →

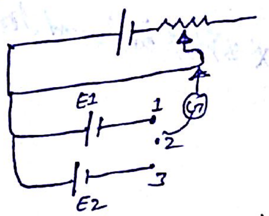


* If we connect 1−2, $x = E_0/l_0$
* If we connect 2−3, If balance length $= l$

$E = xl$

NOTE → * This balance length is for EMF only not for terminal voltage so it is independent of x.
* Balance length is independent from Internal Resistance

|3|→ To compair EMF of cell: →



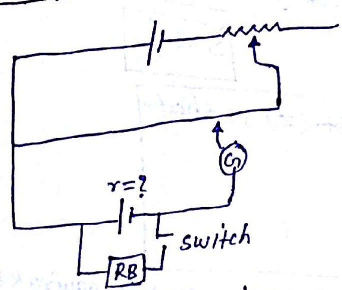
1 − 2 , $E_1 = x l_1$ −(I)

2 − 3 , $E_2 = x l_2$ −(II)

$\frac{(I)}{(II)} \quad \frac{E_1}{E_2} = \frac{l_1}{l_2}$

NOTE → Standardisation not Require.

|4|→ To Measure internal Resistance of cell →



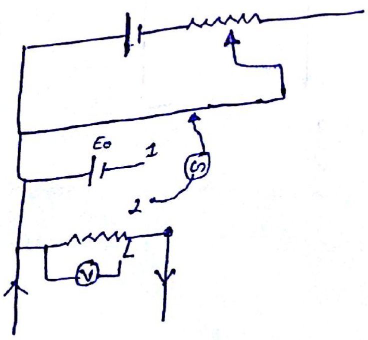
* Switch off $E = x l_1$
* Switch on $V = x l_2$

$r = \left(\frac{l_1 - l_2}{l_2}\right)(R_B)$

NOTE → Standardisation Not Require.

|5|→ Calibration of voltmeter: →

→ To Find error in voltmeter



1 − 2 $x = E_0/l$

2 − 3 If balancing length $= l$

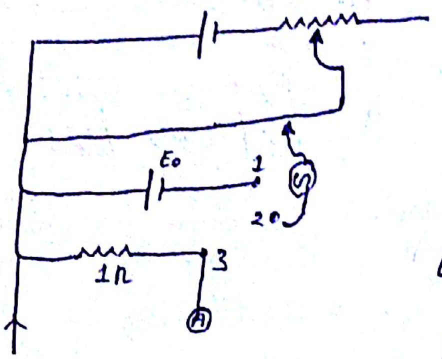
$V = xl$

If voltmeter Reading $= V'$

$\% \text{Error} = \frac{V' - V}{V} \times 100$

$\frac{\text{अशुद्ध} - \text{शुद्ध}}{\text{शुद्ध}} \times 100$

161 → calibration of Ammeter →



1-2 $\quad x = E_0/l_0$

2-3 $\quad V_{1\Omega} = xl$

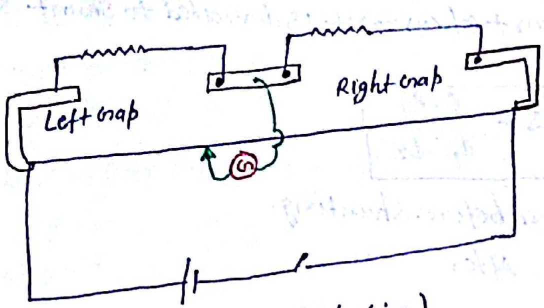
$$\boxed{I = xl}$$

Let (A) Reading $= I'$

$$\boxed{\%\ Error = \frac{I' - I}{I} \times 100}$$

Meter Bridge

* Based on Wheat stone Bridge.
* use to Measure Resistance.
* Based on zero deflection Method.
* unknown Resistance is Measured by comparing with known Resistance.



In balance condition (Null deflection)

$$\boxed{\frac{P}{q} = \frac{R}{S}}$$

$$\boxed{\frac{l}{100-l} = \frac{R}{S}}$$

$$\boxed{S = \left(\frac{100-l}{l}\right)R}$$

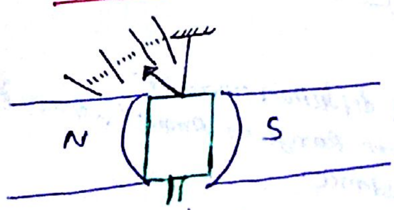
NOTE → *Formula use करना है। $\frac{P}{q} = \frac{R}{S}$

* Left में 'P' होता है और उसके Gap में 'R', Right में 'q' होता है, और Gap में 'S' है!
* जिसका Resistance ज्यादा तो उसकी wire ki Length भी ज्यादा !

Moving coil Galvanometer (G) :

Deflection ∝ current

$$\boxed{\phi \propto I}$$



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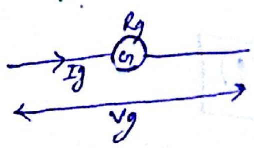


I_g ⇒ Full deflection current
V_g ⇒ Full deflection voltage
R_g ⇒ Resistance of Galvenometer

$$\boxed{V_g = I_g R_g}$$

* Galvanometer is Ammeter of I_g Range & voltmeter of V_g Range.
* Resistance of Galanometer ($10\Omega - 1000\Omega$)

Current sensitivity (Cs)

Deflection for unit current.

$I \rightarrow \phi$

$1 \rightarrow \frac{\phi}{I}$

$C_s \rightarrow \frac{\phi}{I}$

Voltage sensi…

$V \rightarrow \phi$

$1 \rightarrow \frac{\phi}{V}$

$V_s \rightarrow \frac{\phi}{V}, \frac{\phi}{I R_g} = \frac{C_s}{R_g}$

Figure of merit / Gal. const.

It is Inverse of Cs.

$F_M = \frac{1}{C_s} = \frac{I}{\phi}$

Shunting

→ Means parallel.

→ To apply small Resistance in || of Galvanometer.

$\phi \propto I$

→ Due to shunting some part of current is deviated to shunt so deflection ∝ Cs is Reduced.

→ Required shunt $S = \frac{\phi_2 R_g}{\phi_1 - \phi_2}$

$\phi_1 \rightarrow$ deflection before shunting.

$\phi_2 \rightarrow$ " After "

NOTE → * Galvanometer is type of Ammeter also at Range of I_g.

* Galvanometer is type of voltmeter also at Range of V_g.

Ammeter

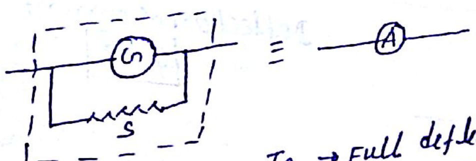
→ Always connected in series.

→ It Resistance is small.

→ Resistance of Ideal Ammeter is zero.

(G) to (A) conversion →

Small shunt is applied || to Galvanometer.



$S = \frac{I_g R_g}{I - I_g}$

I_g → Full deflection current.

I → जितना Range का Ammeter बनाना है,

R_g → Resistance.

* $S (\downarrow) \Rightarrow$ Range $(\uparrow)$

Voltmeter

- → Always connected in || to calculate PD.
- → Its Resistance is high.
- → Resistance of Ideal voltmeter is ∞.

Ⓖ to Ⓥ conversion

→ High Resistance is connected in Series with Galvanometer.

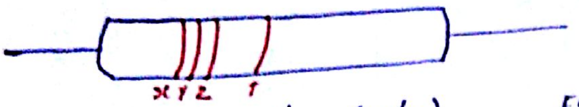
* $$R = \frac{V}{I_g} - R_g$$

V = Require Range of voltmeter

**

- * $R(\uparrow) \Rightarrow$ Ⓥ Range $(\uparrow)$
- * $R_{Ⓥ} \Rightarrow R_g + R$
- * $R_A < R_g < R_V$

colour coding of carbon Resistance



1st three colour (value)

(Black) B – 0

(Brown) B – 1

R – 2

O – 3

Y – 4

Green → G → 5

Blue → B → 6

V → 7

Grey → G → 8

White → W → 9

Fourth colour

Golden ± 5%

Silver ± 10%

$$R = xy \times 10^{z} \pm T$$