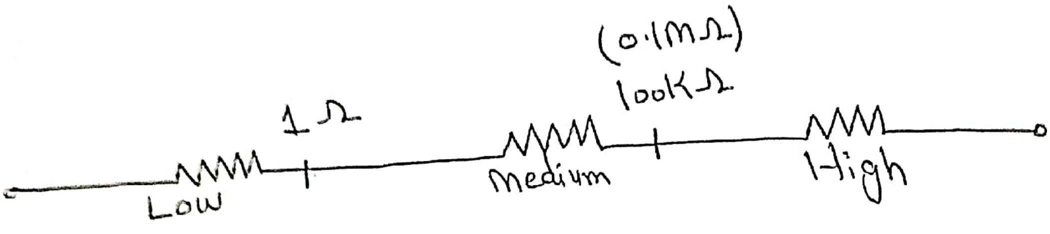
Classification of Resistance:-

1) Low Resistance => (0.1Ω – 1Ω)

2) medium Resistance => (1.1Ω – 0.1MΩ)

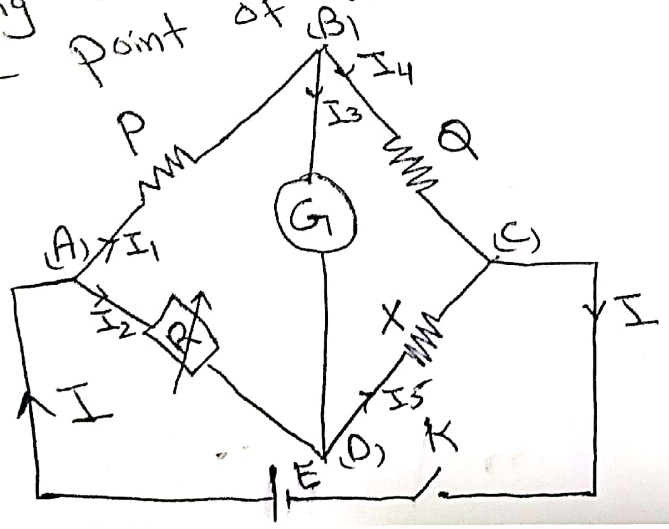
3) High Resistance => (greater than 0.1 MΩ)



Wheat Stone Bridge:-

The Wheatstone bridge was invented by Samuel Hunter Christie in 1833 and improved by Sir Charles Wheatstone in 1843. It is used to measure an unknown electrical resistance (medium value)

The Wheatstone bridge is the combination of 4 resistances forming a bridge. The four resistances in the circuit are refered as arms of bridge. The unknown resistance is connected with 2 Known resistors, one variable resistor and a galvanometer. To find the value of unknown resistor, the deflection on galvanometer is made zero by adjusting the variable resistor. The point is known as balance point of Wheatstone bridge.



where P, Q are Known Resistances
R is a variable Resistance
X is unknown Resistance
E is battery
K is battery

By KCL at node A:- $I = I_1 + I_2$

$\therefore$ $I_4 = I_1 - I_3$ (at node B)

at node D :- $I_5 = I_2 + I_3$

at node C :- $I = I_4 + I_5$
$= (I_1 - \cancel{I_3}) + (I_2 + \cancel{I_3})$

Hence $I = I_1 + I_2$

In order to find the value of unknown Resistor (X), we have to make the deflection of galvanometer equal to zero i.e $I_3 = 0A$. This condition is called balanced condition of galvanometer.

When $I_3 = 0$

$I_5 = I_2$
and $I_4 = I_1$

Now $V_{AB} = V_A - V_B = I_1 P$ —① (IR)

$V_{BC} = V_B - V_C = I_1 Q$ —②

$V_{AD} = V_A - V_D = I_2 R$ —③

$V_{DC} = V_D - V_C = I_2 X$ —④

} → from ohm's law $V = IR$

at balance condition i.e when no current flows through G, the potential difference b/w point B and D is zero.

In other words as $I_3 = 0$

So $V_{BD} = V_B - V_D = I_3 G$ (where G = Resistance of Galvanometer)

$V_{BD} = (0)(G) = 0V$

Hence $V_B - V_D = 0$

or $\boxed{V_B = V_D}$

Now putting $V_B = V_D$ in eq (1) & (2)

$$V_{AB} = V_A - V_D = I_1 P \quad \text{--- (1)}$$

(1) => $V_{AB} = V_A - V_D = I_1 P$ --- (1)

(2) => $V_{BC} = V_D - V_C = I_1 Q$ --- (2)

& $V_{AD} = V_A - V_D = I_2 R$ --- (3)

$V_{DC} = V_D - V_C = I_2 X$ --- (4)

Now comparing eq (1) & eq (3)

$$I_1 P = I_2 R \quad \text{--- (5)}$$

& eq (2) with eq (4)

$$I_1 Q = I_2 X \quad \text{--- (6)}$$

Dividing eq (6) by eq (5)

$$\frac{I_1 Q}{I_1 P} = \frac{I_2 X}{I_2 R}$$

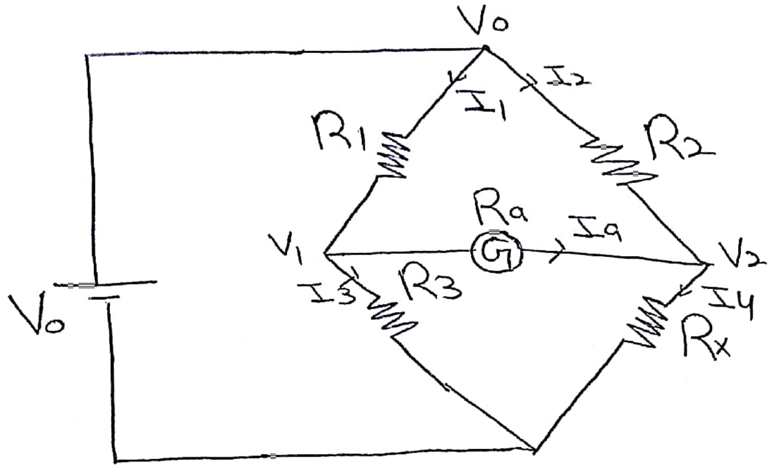
$$\frac{Q}{P} = \frac{X}{R}$$

or $$\boxed{X = \left(\frac{Q}{P}\right) R}$$

(4)

Q:- For the W.S.B Show in below fig, solve the following problems:-

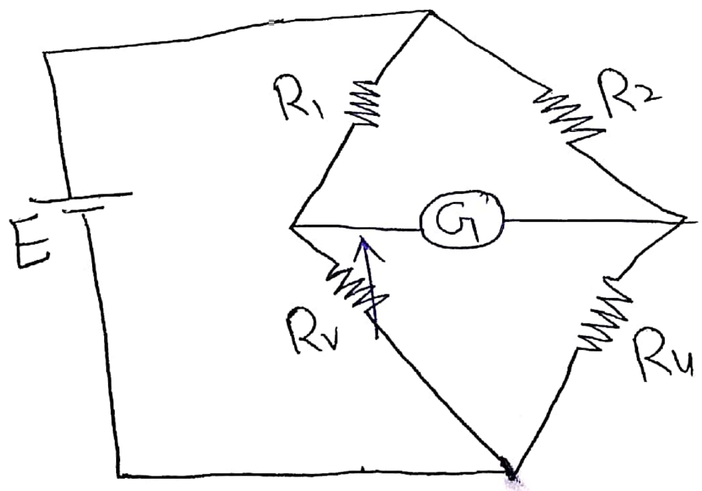
(a):- If $R_1 = 1\Omega$, $R_2 = 2\Omega$ and $R_x = 3\Omega$, to what value should R_3 be adjusted so as to acheive a balanced condition?



$$\frac{R_3}{R_1} = \frac{R_x}{R_2}$$

$$R_3 = \frac{R_1 R_x}{R_2} = \frac{1 \times 3}{2} = \boxed{1.5\Omega}$$ Ans:-

Q:- A circuit consists of two Resistors $R_1 = 6\Omega$ and $R_2 = 1.5\Omega$, a variable resistor (R_v) and an unknown Resistor (R_u) and a 9v battery. are connected as shown in the fig below. when R_v is adjusted to 12Ω, there is zero current through the galvanometer. Find the value of R_u.



Sol:- $\frac{R_2}{R_1} = \frac{R_u}{R_v}$

or $R_u = \frac{R_2 R_v}{R_1}$

$R_u = \frac{(1.5)(12)}{6}$

$\boxed{R_u = 3\Omega}$ Ans:-