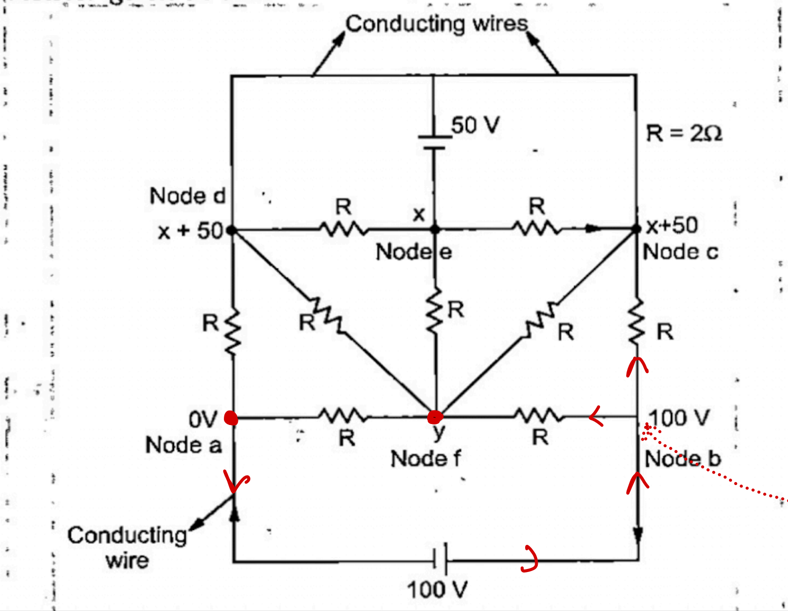
In the given circuit we wish to determine the current through resistor given in box.



This is the current from b-f & b→c which is same as current at d-b

Node f

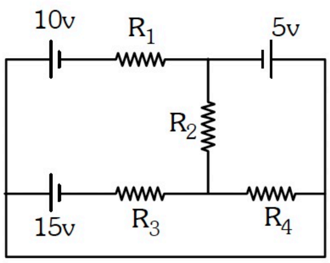
$$\frac{y-0}{R} + \frac{y-(x+50)}{R} \times 2 + \frac{y-x}{R} + \frac{y-100}{R} = 0$$

Node a

$$\frac{0-(x+50)}{R} + \frac{0-y}{R} + \frac{100-y}{R} + \frac{100-(x+50)}{R} = 0$$

$$x = \frac{25}{4} \qquad y = \frac{175}{4}$$

In the circuit shown :

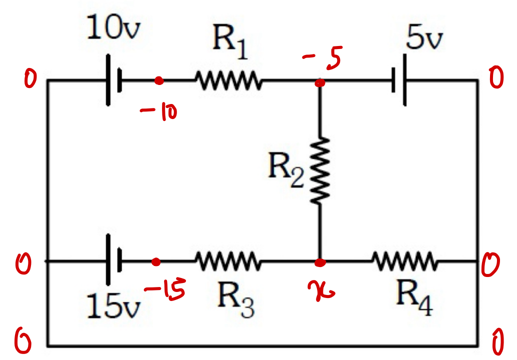


1 Current through R_2 is zero if $R_4 = 2\Omega$ and $R_3 = 4\Omega$. In this case :

(A) current through R_3 is 2.5 A
(B) current through R_4 is 3A
(C) A and B both are correct
(D) A and B both are wrong

For what ratio $\frac{R_2}{R_4}$ current through R_3 will be zero ?

(A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) Not possible



$$\frac{x+15}{R_3} + \frac{x-0}{R_4} + \frac{x+5}{R_2} = 0$$

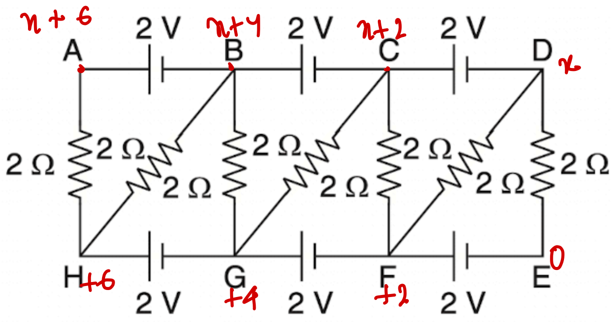
For Q 2

$$x = -15$$

$$\frac{-15}{R_4} + \frac{-15+5}{R_2} = 0$$

$$\frac{R_2}{R_4} = -\frac{2}{3}$$

In given circuit, 7 resistors 2 Ω each and 6 batteries of 2 V each, are joined together.



The current through branch BG is:

(*a*) 1 A (*b*) 0.2 A
(*c*) 0.4 A (*d*) 0.6 A

NODE D

$$\frac{x-0}{2} + \frac{x-2}{2} + \frac{x}{2} + \frac{x-2}{2} + \frac{x}{2} + \frac{x-2}{2} + \frac{x}{2} = 0$$

$$3\left(\frac{x}{2}-1\right) + 4\cdot\frac{x}{2} = 0$$

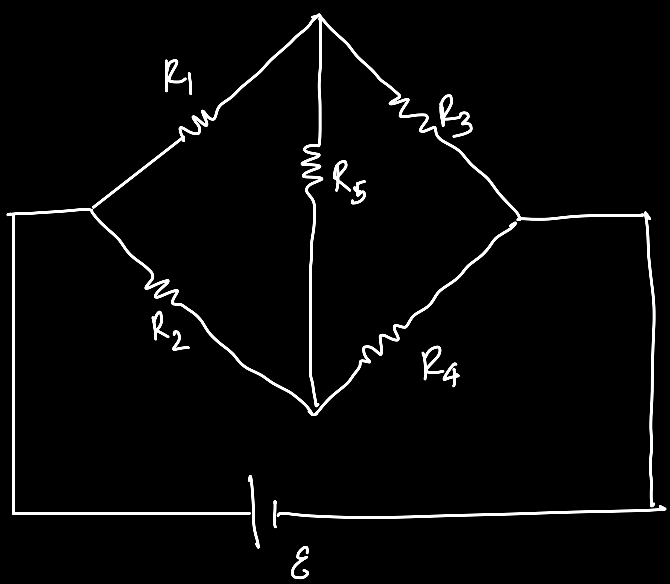
$$\frac{3x}{2} - 3 + 2x = 0$$

$$7x = 6$$

$$x = \frac{6}{7}$$

current in BG is $= \frac{x}{2} = \frac{3}{7}$ A

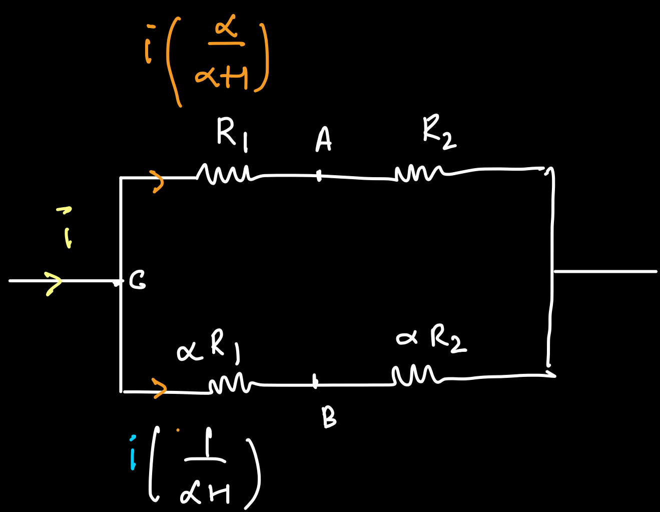
Wheatstone bridge



If $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

then current in $R_5 = 0$

At this condition the circuit is called balanced wheatstone bridge

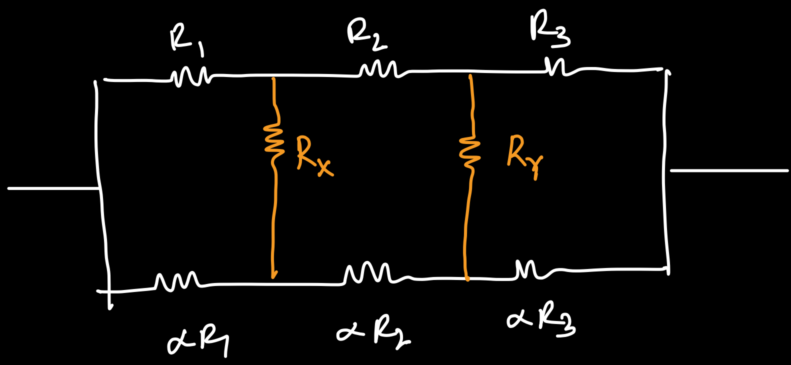


$$V_C - V_A = i\left(\frac{\alpha}{\alpha+1}\right)\cdot R_1$$

$$V_C - V_B = i\left(\frac{1}{\alpha+1}\right)\alpha R_1$$

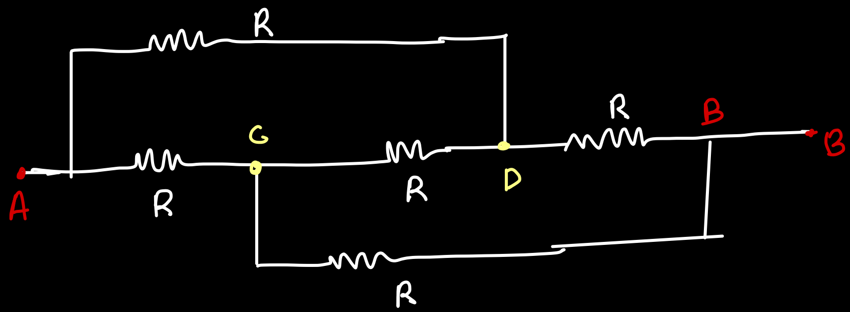
$\Rightarrow \quad V_A = V_B$

$\Rightarrow$ Any resistance connected between A & B will not carry any current

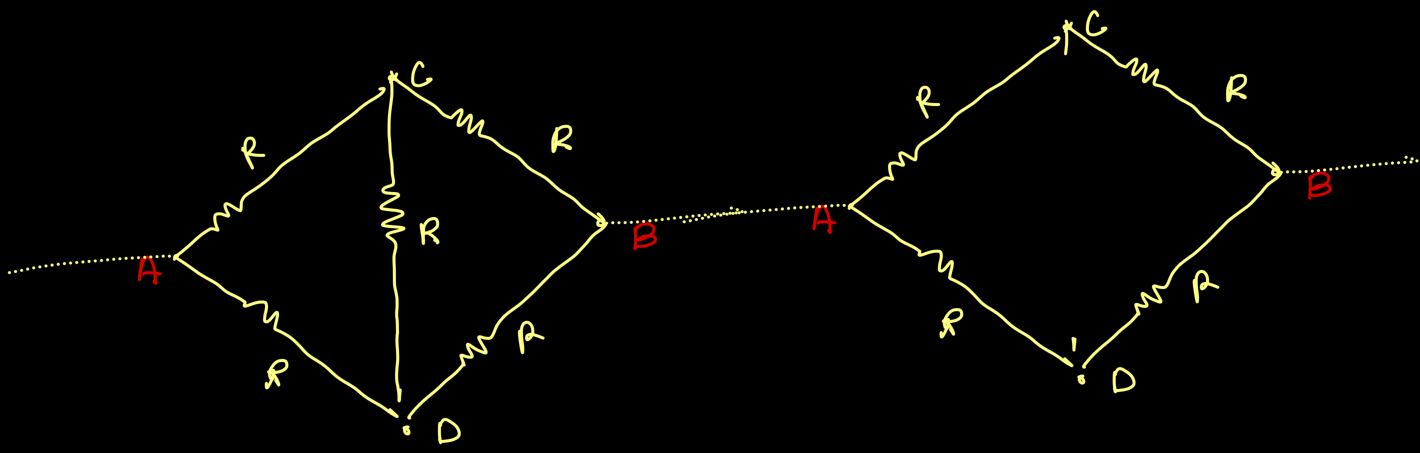


current through R_x & R_y is zero

Ex



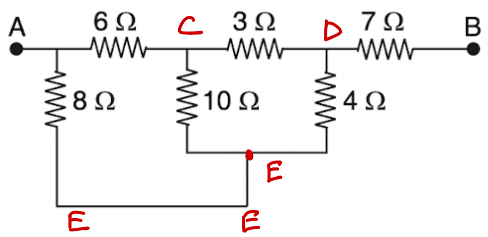
find equivalent resistance across A & B



Wheatstone bridge

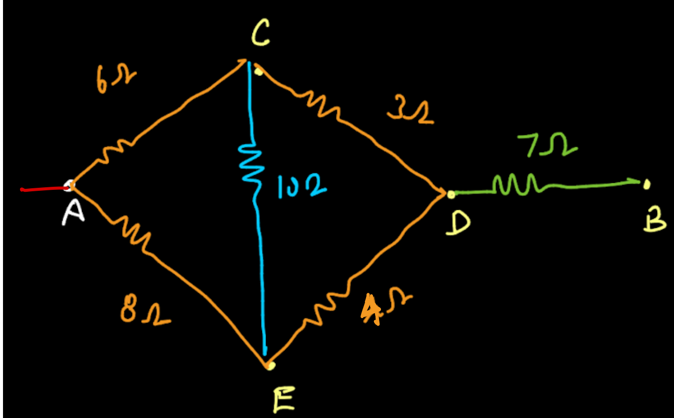
$R_{AB} = R$ Ans

The equivalent resistance between the points A and B is :

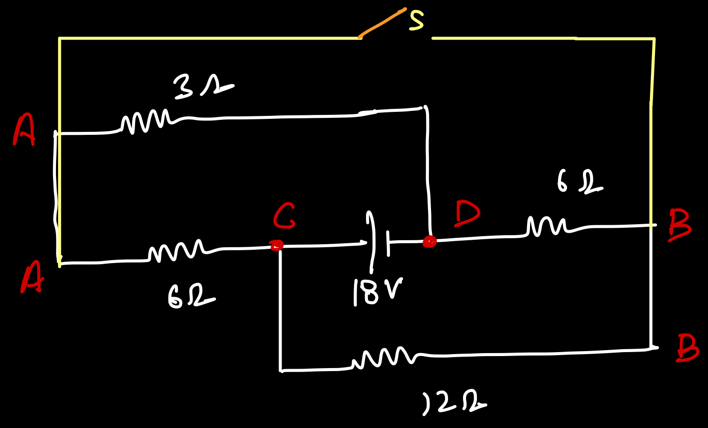


(*a*) $\frac{36}{7}\ \Omega$ (*b*) $10\ \Omega$

(*c*) $\frac{85}{7}\ \Omega$ (*d*) none of these

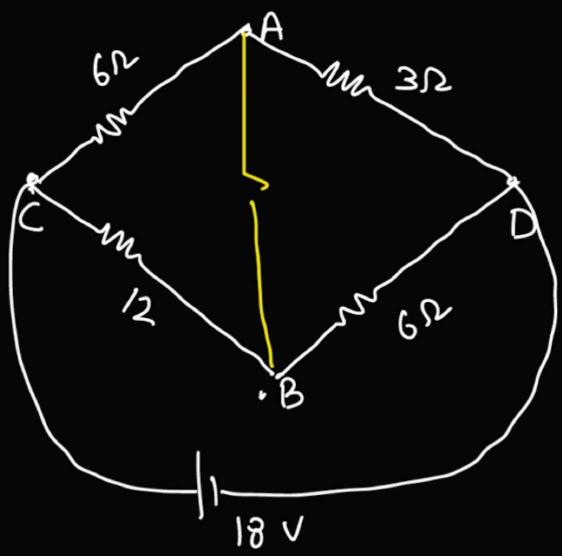


Ex



Find the current through the battery if switch is

(a) open (b) closed

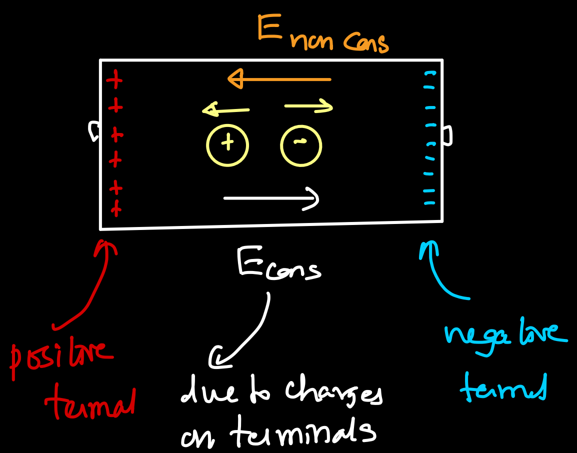


Balanced wheatstone bridge

$\Rightarrow$ It doesn't matter if switch is closed or open

$$i = \frac{18}{R_{eq}} = 3A$$

Batteries / cells



$$\varepsilon = \text{Emf of battery} = \int \vec{E}_{non\ cons} \cdot \vec{dl}$$

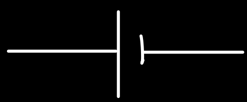
Work done per unit charge by the internal non cons electric field to take it from -ve to +ve terminal

ΔV = potential difference $= -\int \vec{E}_{cons} \cdot \vec{dl}$

For an ideal battery $\boxed{\Delta V = \varepsilon}$

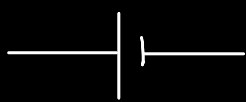
Non-ideal batteries

ε

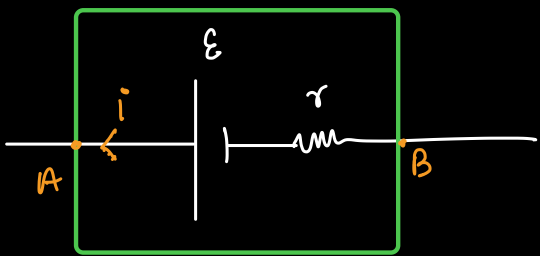


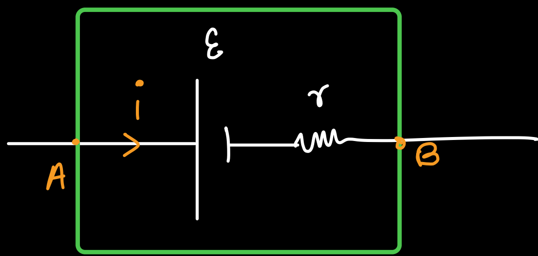
ideal battery

ε, r



non-ideal battery with internal resistance





$V_A - \varepsilon + iR = V_B$

$\boxed{V_A - V_B = \varepsilon - iR}$

Discharging

Battery is supplying energy to circuit

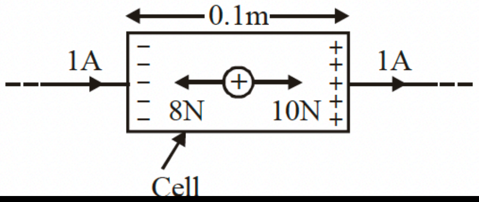
$V_A - \varepsilon - iR = V_B$

$\boxed{V_A - V_B = \varepsilon + iR}$

Charging

Battery is absorbing energy from circuit

Figure shows a cell in which unit positive charge experiences a constant non electric force of 10N and a constant electric force of 8N in directions shown in the figure. The internal resistance of the cell is r Ω. Fill 10r in OMR sheet.



Ans: 2

$$\Delta V = \varepsilon - iR$$

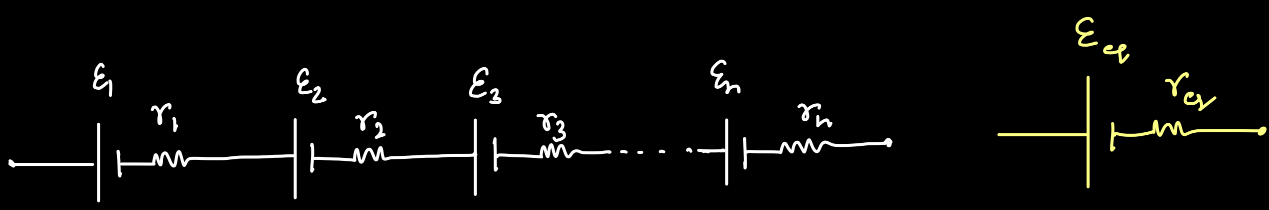
$$\varepsilon - \Delta V = iR$$

$$\int \bar{E}_{nonel} \cdot \bar{dl} + \int \bar{E}_{cons} \cdot \bar{dl} = ir$$

$$10 \times 0.1 - 8 \times 0.1 = ir$$

Combination of batteries

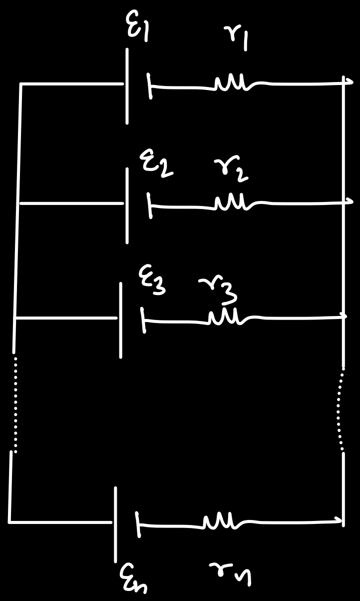
Batteries in series



$$\varepsilon_{eq} = \sum \varepsilon_i$$

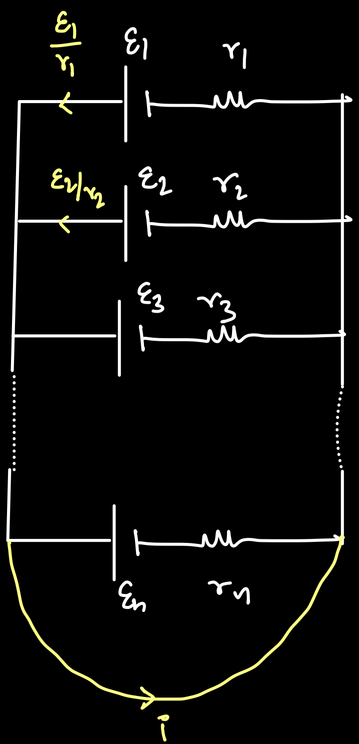
$$r_{eq} = \sum r_i$$

Batteries in parallel



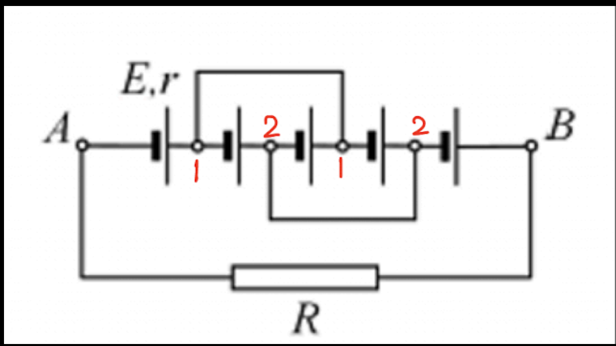
$$\varepsilon_{eq} = \frac{\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} + \dots + \frac{\varepsilon_n}{r_n}}{\frac{1}{r_1} + \frac{1}{r_2} + \dots + \frac{1}{r_n}}$$

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2} + \dots + \frac{1}{r_n}$$

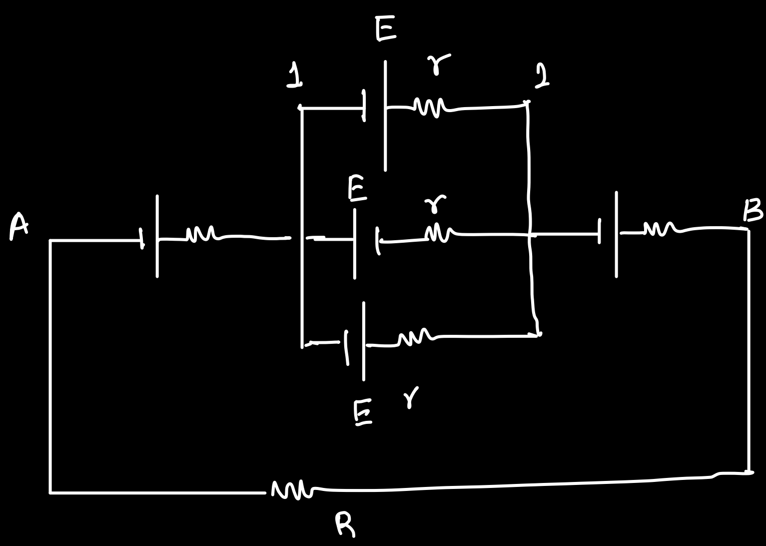


$$i = \frac{\varepsilon_{eq}}{r_{eq}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} + \dots + \frac{\varepsilon_n}{r_n}$$

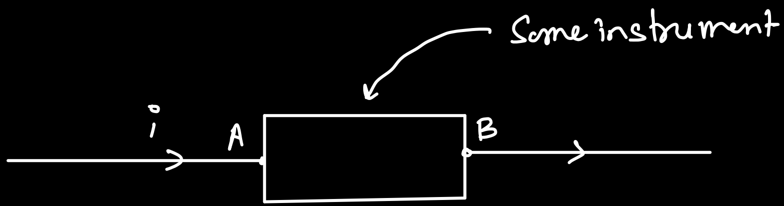
PROBLEM 12. (Moscow School of Electrical Engineering, 2017, 11) Find the current I through a resistor with a resistance $R = 5$ Ohm in the circuit shown in the figure. All sources are the same and have an EMF $E = 15$ V and an internal resistance $r = 2$ Ohm. Neglect the resistance of the connecting wires.



Ans: $\frac{7E}{3R+7r}$



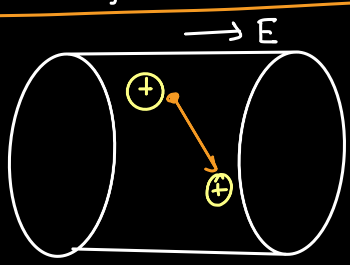
Power associated with electrical instruments



Power associated with the instruments

$$\boxed{P = i\,\Delta V} = i\,(V_A - V_B)$$

Thermal power dissipated in a resistor



$$P = \frac{dW}{dt} = \frac{q}{dt}\,\Delta V = i\,\Delta V$$

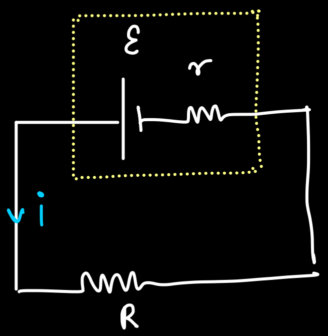
i

Δl

For a resistor $\Delta V = iR$

$$P = i\Delta V = i^2R = \frac{\Delta V^2}{R}$$

Maximum power theorem



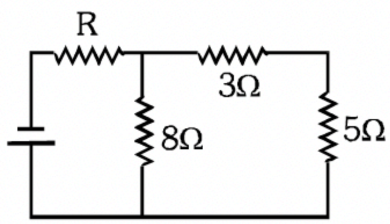
What is the condition so that rate of thermal power generated is R is maximum.

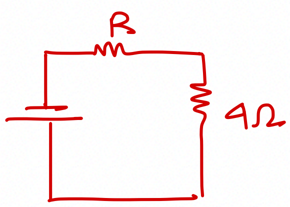
$$i = \frac{\varepsilon}{r+R}$$

$$P = i\Delta V = i^2R = \left(\frac{\varepsilon}{r+R}\right)^2 R \longrightarrow \text{thermal power generated in } R$$

$$\frac{dP}{dR} = 0 \qquad \boxed{r = R}$$

The value of R so that same amount of heat is dissipated in R and rest of the circuit, is :-





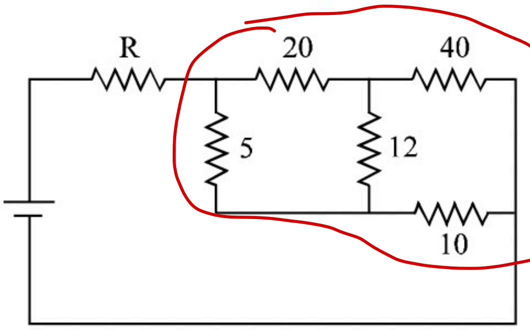
(A) 4 Ω ✓ (B) 8 Ω (C) 3 Ω (D) 5 Ω

$$P_R = P_{4\Omega}$$

$$i^2R = i^2(4) \qquad i \longrightarrow \text{same}$$

$$R = 4$$

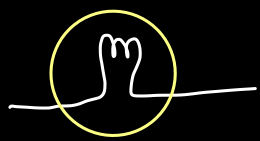
What should be the value of R so that the electric power consumed by it is maximum :



Balanced Wheatstone

✓(A) 12 Ω (B) 24 Ω (C) 6 Ω (D) none of these

Power associated with bulbs



P : power rating 100 W

V : voltage rating 220 V

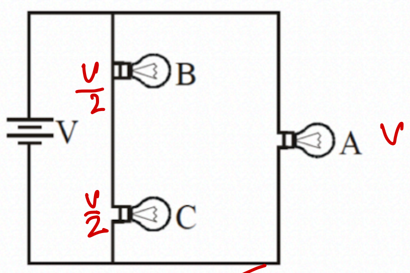
Imp

1. we use P & V to calculate resistance of bulb

$$\boxed{R = \frac{V^2}{P}}$$

2. Bulb will give an output power of P (power rating) if input voltage is V (voltage rating)

Wattage of three bulbs A, B and C rated at same voltage are W_A, W_B and W_C respectively. Their brightness are represented by P_A, P_B and P_C. If $P_A = P_B = P_C$, then correct ratio of their wattage ($W_A : W_B : W_C$) is :-



(A) 1 : 2 : 3 (B) 1 : 2 : 2 ✓(C) 1 : 4 : 4 (D) 2 : 2 : 1

$$\frac{(V/2)^2}{R_B} = \frac{(V/2)^2}{R_C} = \frac{V^2}{R_A}$$

$$W = \frac{V_0^2}{R}$$

$$W_A : W_B : W_C = \frac{1}{R_A} : \frac{1}{R_B} : \frac{1}{R_C}$$