NEET Important Questions with Solutions from Current Electricity

Q.1. The length of a wire of a potentiometer is $100\ \mathrm{cm}$ and the emf of its standard cell is E volt. It is employed to measure the emf of a battery whose internal resistance is $0.5\ \Omega$. If the balance point is obtained at $l = 30\ \mathrm{cm}$ from the positive end, the emf of the battery is

A) $\frac{30E}{(100)}$

B) $\frac{30E}{100-0.5}$

C) $\frac{30E}{100.5}$

D) $\frac{30(E-0.5i)}{100}$

where, i is the current in the potentiometer.

Answer: $\frac{30E}{(100)}$

Solution: As in the primary circuit, driver cell is directly connected to the potentiometer. So,

$x = \frac{V_w}{L_w} = \frac{E}{1}$

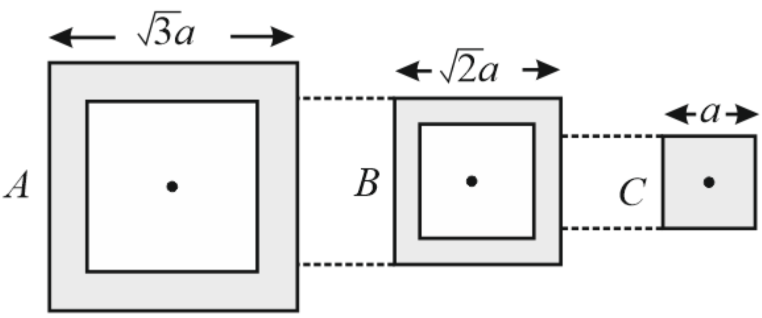
where, $V_{\mathrm{w}}, L_{\mathrm{w}}$ are the potential difference across a wire and the length of wire, respectively.

We know,

$E_{unknown} = x \times l$

$E_{unknown} = \frac{E}{1} \times \left(0.3\right) = \frac{30E}{100}$

Q.2. The following figure shows cross-sections through three long conductors of the same length and material, with a square cross-section of edge lengths as shown. Conductor B will fit snugly within conductor A, and conductor C will fit snugly within conductor B. Relationship between their end to end resistance is



A) $R_A = R_B = R_C$

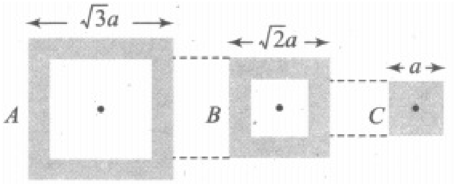
B) $R_A > R_B > R_C$

C) $R_A < R_B < R$

D) information is not sufficient

Answer: $R_A = R_B = R_C$

Solution:



The resistance of wire given as,

$R=\frac{\rho l}{A}$

Resistance is inversely proportional to the area of the wire,

$\Rightarrow R\propto\frac{1}{A}$

Now comparing their area of the cross-section. For conductor A, the area is,

$S_A=\left(\sqrt{3a}\right)^2-\left(\sqrt{2a}\right)^2=a^2$

For conductor B, the area is,

$S_B=\left(\sqrt{2a}\right)^2-a^2=a^2$

For conductor C, the area is,

$S_C=a^2$

The cross-sectional area of all three conductors is the same.

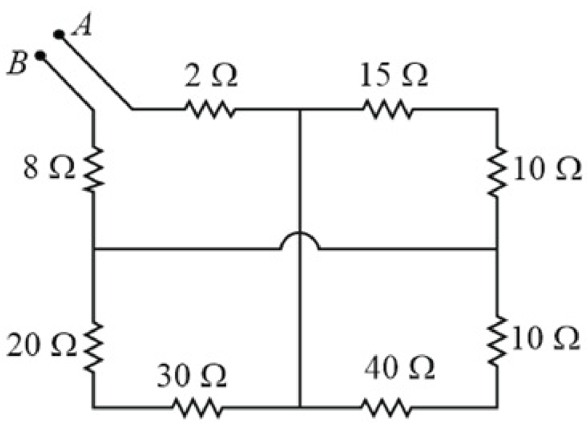
The material of all conductors is the same, then resistivity will be also the same. The length of the conductors given is the same. Then,

$R=\rho\frac{l}{A}$

The resistance of each conductor will be the same. Hence,

$R_A=R_B=R_C$

Q.3. The equivalent resistance between points A and B is:



A) $\frac{65}{2}\,\Omega$

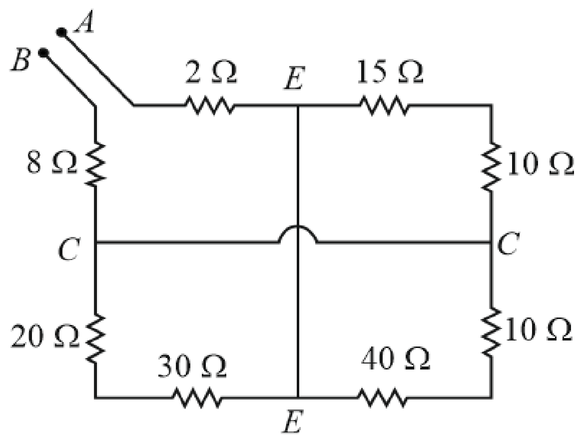
B) $\frac{45}{2}\,\Omega$

C) $\frac{5}{2}\,\Omega$

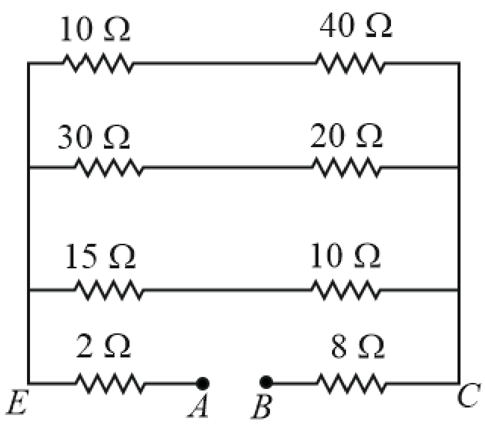
D) $\frac{91}{2}\,\Omega$

Answer: $\frac{45}{2}\ \Omega$

Solution: The given diagram is redrawn as below with additional labels.



It can be redrawn as below.



Hence, the resistance R_{CE} between CE can be calculated by using parallel combination of resistances after combining the resistances in series in each branch.

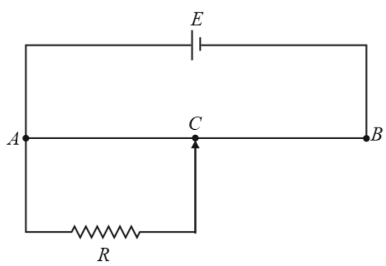
$$\frac{1}{R_{CE}}=\frac{1}{25}+\frac{1}{50}+\frac{1}{50}=\frac{2}{25}$$

$$\Rightarrow R_{CE}=\frac{25}{2}\ \Omega$$

Now the resistance between AB can be considered to be resistances in series,

$$R_{AB}=2+\frac{25}{2}+8=\frac{45}{2}\ \Omega$$

Q.4. Figure shows a potentiometer. Length of the potentiometer wire AB is $100\ \mathrm{cm}$ and its resistance is 100Ω. EMF of the battery E is $2\ \mathrm{V}$. A resistance R of 50Ω draws current from the potentiometer. What is the voltage across R when the sliding contact C is at the mid-point of AB ?



A) $2/3\ \mathrm{V}$

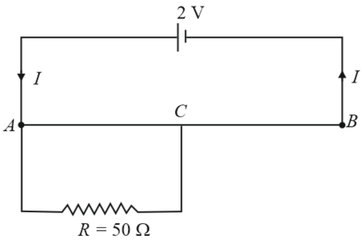
B) $1\ \mathrm{V}$

C) $4\ /\ 3\ V$

D) $3/2\ \mathrm{V}$

Answer: $2/3\ \mathrm{V}$

Solution: Given, $E=2\ \mathrm{V}, R_{AB}=100\Omega$
$l_{AB}=100\ \mathrm{cm}$and $R=50\Omega$
Circuit according to the question,



$AC=CB=\frac{l_{AB}}{2}=50\ \mathrm{cm}$

$R_{AB}=100\Omega$

$R_{AC}=R_{CB}=\frac{R_{AB}}{2}=\frac{100}{2}$

$\therefore\ \ R_{AC}=R_{CB}=50\Omega$

$\therefore$ Net resistance of the circuit, $R_{\text{net}}\ =R_{CB}+\frac{R \cdot R_{AC}}{R+R_{AC}}$

$=50+\frac{50\times50}{50+50}=50+25$

$R_{\text{net}}\ =75\Omega$

$\therefore$Current from the battery, $I=\frac{E}{R_{\text{net}}}=\frac{2}{75}\ \mathrm{A}$
Using KVL in mesh 1

$E-V_{AC}-V_{CB}=0$

$\Rightarrow V_{AC}+V_{CB}=2$

$\Rightarrow\ V_{AC}+IR_{CB}=2$

$\Rightarrow\ \ V_{AC}=2-\frac{2}{75}\times50 \Rightarrow\ \ V_{AC}=2-\frac{4}{3}=\frac{6-4}{3}=\frac{2}{3}\ \mathrm{V}$

Q.5. Electric resistance is defined as the ratio of voltage to current. Its dimensional formulae is given by

A) $\mathrm{M^2LT^{-3}A^{-2}}$

B) $\mathrm{ML^2T^{-3}A^{-2}}$

C) $\mathrm{ML^{-3}T^{-2}A^{-1}}$

D) $\mathrm{M^{-2}L^{-2}T^2A^{-1}}$

E) $\mathrm{ML^{-3}T^{-2}A^{-2}}$

Answer: $\mathrm{ML^2T^{-3}A^{-2}}$

Solution: Electric resistance R in terms of voltage V and current I,

$R=\frac{V}{I}\quad\ldots(1)$

Also, heat, $H=\frac{V^2t}{R}\quad\ldots(2)$

From the first and second equation, $R=\frac{H}{I^2t}=\frac{\mathrm{ML^2T^{-2}}}{\mathrm{A^2T}}$

$=\mathrm{ML^2T^{-3}A^{-2}}$

Q.6. A battery of internal resistance 2Ω is connected to a variable resistor whose value can vary from 4Ω to 10Ω. The resistance is initially set at 4Ω. If the resistance is now increased then

A) power consumed by it will decrease.

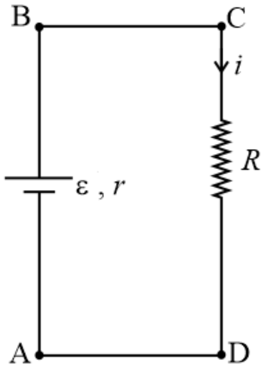
B) power consumed by it will increase.

C) power consumed by it may increase or may decrease.

D) power consumed will first increase then decrease.

Answer: power consumed by it will decrease.

Solution:



Current in circuit is,

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

Power output is,

$P=i^2R$

$\Rightarrow P=\left(\frac{\varepsilon}{r+R}\right)^2R$

Condition for maximum power supply,

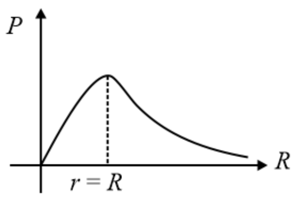
$\frac{dP}{dR}=0$

$\Rightarrow \frac{d}{dR}\left[\left(\frac{\varepsilon}{r+R}\right)^2R\right]=0$

$\Rightarrow \frac{\varepsilon^2}{(r+R)^3}(R+r-2R)=0$

$\Rightarrow R=r$

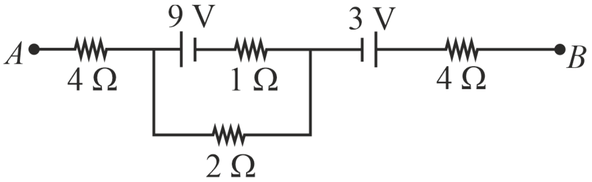
Graph between power and resistance



Power maximum when $r=R$

So, power consumed by it will decrease for $R>r$.

Q.7. In the circuit shown in the figure potential difference between points A and B is $16\ \mathrm{V}$ the current passing through $2\ \Omega$ resistance will be



A) $25\ \mathrm{A}$

B) $3.5\ \mathrm{A}$

C) $4.0\ \mathrm{A}$

D) zero

Answer: $3.5 \mathrm{~A}$

Solution: Let the current i_1 and i_2 coming towards junction p then the current leaving out of the junction will be i_1+i_2.

So, along path $ApqrsB$,

$4i_1+2(i_1+i_2)-3+4i_1=16 \mathrm{~V} \quad \ldots$(i)

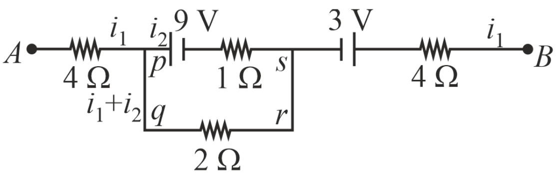
Using Kirchhoffs' second law in the closed loop $pqrs$, we have,

$9-i_2-2(i_1+i_2)=0 \quad \ldots$(ii)

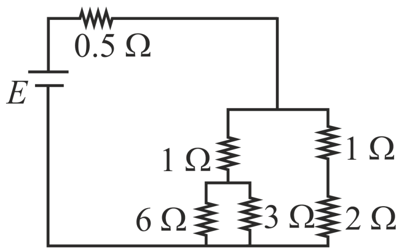
Solving equations (i) and (ii), we get,

$i_1=1.5 \mathrm{~A}$ and $i_2=2 \mathrm{~A}$

$\therefore$ Current through 2Ω resistor $=2+1.5=3.5 \mathrm{~A}$.



Q.8. In the given circuit diagram, current in 2Ω resistor is $2 \mathrm{~A}$, then the current in 6Ω resistor will be



A) $\frac{3}{2} \mathrm{A}$

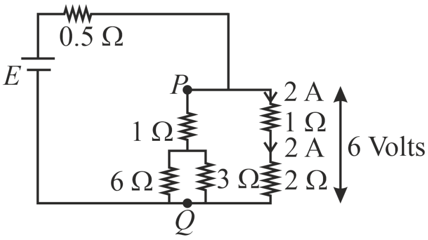
B) $\frac{2}{3} \mathrm{~A}$

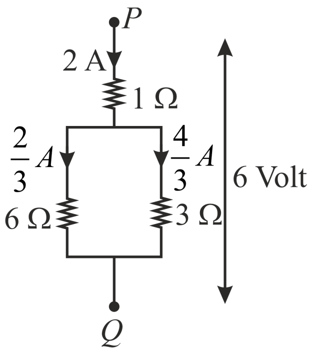
C) $\frac{1}{3} \mathrm{~A}$

D) $2 \mathrm{~A}$

Answer: $\frac{2}{3} \mathrm{~A}$

Solution:





As in the above branch potential across PQ is $6\ \mathrm{V}$ and equivalent resistance is $3\ \Omega$, therefore current in this branch should be $2\ \mathrm{A}$. Therefore voltage across $6\ \Omega$ is $4\ \mathrm{V}$ and hence current in it is $\frac{2}{3}\ \mathrm{A}$.

Q.9. Two cells each of emf E and internal resistance r_1 and r_2 respectively are connected in series with an external resistance R. The potential difference between the terminals of the first cell will be zero when R is equal to

A) $\frac{r_1+r_2}{2}$

B) $\sqrt{r_1^2-r_2^2}$

C) r_1-r_2

D) $\frac{r_1 r_2}{r_1+r_2}$

Answer: r_1-r_2

Solution: It is given that two cells each of emf E and internal resistance r_1 and r_2 respectively are connected in series with an external resistance R.

The total current through the circuit would be,

$I=\frac{E+E}{R+r_1+r_2}=\frac{2E}{R+r_1+r_2}$

The potential across the terminal of the first cell,

$V_1=E-I\times r_1$

This will be zero when,

$E=Ir_1=\frac{2E}{R+r_1+r_2}\times r_1$

Simplifying and rearranging the equation,

$R+r_1+r_2=2r_1$

$\Rightarrow R=r_1-r_2$

Q.10. $50\ \mathrm{V}$ battery is supplying a current of $10\ \mathrm{amp}$ when connected to a resistor. If the efficiency of battery at this current is 25%. Then internal resistance of the battery is:

A) 2.5Ω

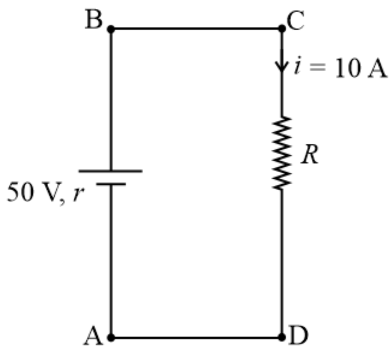
B) 3.75Ω

C) 1.25Ω

D) 5Ω

Answer: 3.75Ω

Solution:



Using Kirchoff's voltage law in the loop

$50 = 10\,[R + r]$

$R + r = 5\Omega \quad \ldots(1)$

Efficiency of battery

$\eta = \frac{P_{\text{out}}}{P_{\text{total}}} = \frac{i^2 R}{i^2 (R+r)}$

$\Rightarrow \eta = \frac{R}{R+r}$

$\Rightarrow 0.25 = \frac{R}{R+r}$

$\Rightarrow R + r = 4R$

$\Rightarrow r = 3R \quad \ldots(2)$

From equations (1) & (2), we get

$R = \frac{5}{4} = 1.25\Omega$, and $r = 3.75\Omega$

Q.11. Three resistors $1\ \Omega$, $2\ \Omega$ and $3\ \Omega$ are connected to form a triangle. Across $3\ \Omega$ resistor a 3 V battery is connected. The current through $3\ \Omega$ resistor is

A) 0.75 A

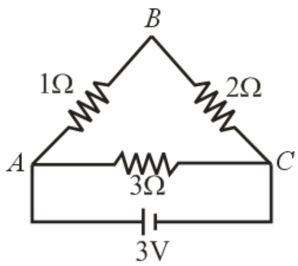
B) 1 A

C) 2 A

D) 1.5 A

Answer: 1 A

Solution: The arrangement is shown in the figure.



Here, two resistance of $1\ \Omega$ and $2\ \Omega$ are in series, which is equivalent to $3\ \Omega$ which is in parallel with $3\ \Omega$ resistance. Therefore, the effective resistance is,

$R_{eq}=\frac{R_1R_2}{R_1+R_2}\frac{3\times3}{3+3}=\frac{3}{2}\ \Omega.$

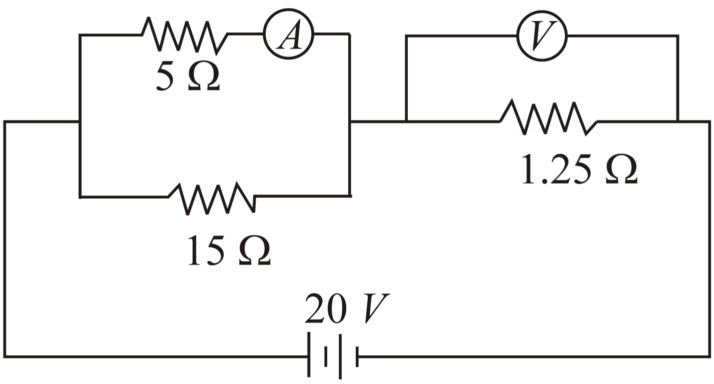
$\therefore$ Current supplied by the battery in the circuit,

$I=\frac{3}{\left(\frac{3}{2}\right)}=2\ \mathrm{A}.$

As both branches has equal resistance of $3\ \Omega$ each, so current in each of them will be equal to $\frac{I}{2}$

$\therefore$ Current in $3\ \Omega$ resistor $=\frac{I}{2}=1\ \mathrm{A}.$

Q.12. An ideal ammeter (zero resistance) and an ideal voltmeter (infinite resistance) are connected as shown in the figure. The ammeter and the voltmeter readings are



A) $6.25\ \mathrm{A},\ 3.75\ \mathrm{V}$

B) $3.00\ \mathrm{A},\ 5\ \mathrm{V}$

C) $3.00\ \mathrm{A},\ 3.75\ \mathrm{V}$

D) $6.25\ \mathrm{A},\ 6.25\ \mathrm{V}$

Answer: $3.00\ \mathrm{A},\ 5\ \mathrm{V}$

Solution: As $5\ \Omega$ and $15\ \Omega$ resistance are in parallel, so the equivalent resistance r of this combination is:

$r=\frac{5\times15}{5+15}\ \Omega$

$r=3.75\ \Omega$

Resistance r and $1.25\ \Omega$ are in series, so the equivalent resistance R of the circuit is:

$R=r+1.25$

$R=(3.75+1.25)\ \Omega$

$R=5\ \Omega$

The current I from the battery to the circuit is:

$I=\frac{V}{R}\ \text{A}=\frac{20}{5}\ \text{A}=4\ \text{A}$

As $5\ \Omega$ and $15\ \Omega$ are in parallel to each other, the current through any of the two resistance is inversely proportional to its resistance.

Hence, the current through $5\ \Omega$ is $\frac{15}{20}\times4\ \text{A}=3\ \text{A}$

Voltmeter reading $=$ Potential drop across $1.25\ \Omega$

$=I\times1.25=4\times1.25\ \text{V}=5\ \text{V}$

Q.13. Two resistances R_1 and R_2 are made of different materials. The temperature coefficient of the material of R_1 is α and of the material of R_2 is $-\beta$. The resistance of the series combination of R_1 and R_2 will not change with temperature, if $\frac{R_1}{R_2}$ equals,

A) $\frac{\alpha}{\beta}$

B) $\frac{\alpha+\beta}{\alpha-\beta}$

C) $\frac{\alpha^2+\beta^2}{\alpha\beta}$

D) $\frac{\beta}{\alpha}$

Answer: $\frac{\beta}{\alpha}$

Solution: Using temperature resistance relation, for resistor R_1,

$R_1'=R_1[1+\alpha\Delta T]$ ......(1)

For resistor R_2,

$R_2'=R_2[1+(-\beta)\Delta T]$ ....(2)

We know that, when the resistance is connected in series, then the net resistance is equal to the total sum of all resistance. So, the total resistance is,

$R_1'+R_2'$

As the condition is given in the question if, $R_1'+R_2'=R_1+R_2$ ....(3)

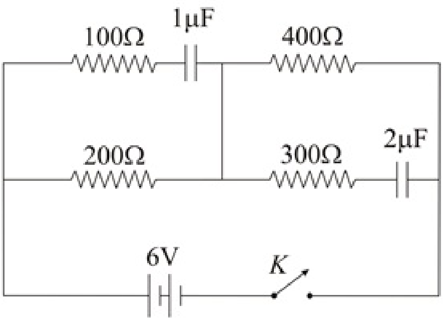
Using (1) and (2) in (3), we get,

$R_1[1+\alpha\Delta T]+R_2[1-\beta\Delta T]=R_1+R_2$

$R_1\alpha=R_2\beta$

$\frac{R_1}{R_2}=\frac{\beta}{\alpha}$

Q.14. What will be current through the $200\ \Omega$ resistor in the given circuit, a long time after the switch K is made on?



A) Zero

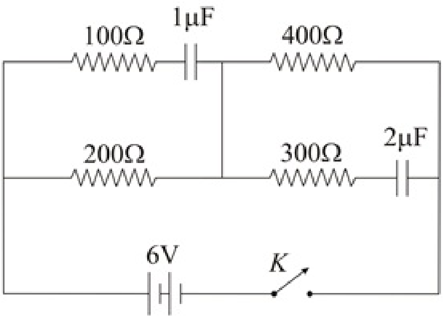
B) $100\ \mathrm{mA}$

C) $10\ \mathrm{mA}$

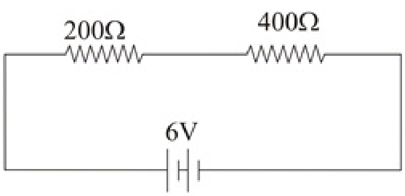
D) $1\ \mathrm{mA}$

Answer: $10\ \mathrm{mA}$

Solution:



In steady state, arm having capacitors does not flow current. So, we can neglect them.
$\therefore$ The given circuit reduces to



$\therefore \quad R_{\text{net}} = 200 + 400 = 600\Omega$

$\therefore$ Current in circuit,

$I = \frac{V}{R} = \frac{6}{600} = 0.01\ \mathrm{A}$

$= 10\ \mathrm{mA}$

Q.15. A cell of constant emf first connected to resistance R_1 and then connected to resistance R_2. If power delivered in both cases is same then the internal resistance of the cell is:

A) $\sqrt{R_1 R_2}$

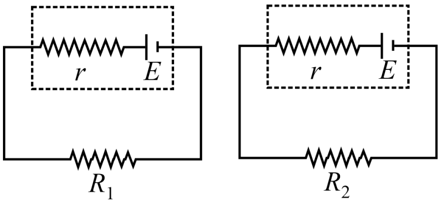
B) $\sqrt{\frac{R_1}{R_2}}$

C) $\frac{R_1-R_2}{2}$

D) $\frac{R_1+R_2}{2}$

Answer: $\sqrt{R_1R_2}$

Solution:



Power delivered in 1^{st} case $P_1 = I_1{}^2R_1$

Power delivered in 2^{nd} case $P_2 = I_2{}^2R_2$

According to question, Power delivered in both case will be same.

$\therefore I_1^2R_1 = I_2^2R_2$

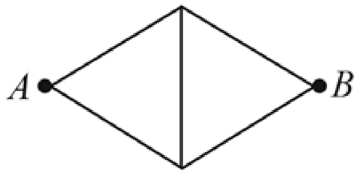
$\therefore \left(\frac{E}{R_1+r}\right)^2 R_1 = \left(\frac{E}{R_2+r}\right)^2 R_2$

or $R_2^2R_1 + R_1r^2 + 2R_1R_2r = R_1^2R_2 + R_2r^2 + 2R_1R_2r$

or $(R_1 - R_2)r^2 = (R_1 - R_2)R_1R_2$

$\therefore r^2 = R_1R_2 \Rightarrow r = \sqrt{R_1R_2}$

Q.16. A uniform wire of resistance R is stretched uniformly n times and then, cut to form five identical wires. These wires are arranged as shown in the figure. The effective resistance between A and B will be,



A) $\frac{nR}{5}$.

B) $\frac{R}{5n^2}$.

C) $\frac{n^2R}{5}$.

D) $\frac{n^2R}{2}$.

Answer: $\frac{n^2R}{5}$.

Solution: We know that the resistance of the wire is given by,

$R=\frac{\rho L}{A} \quad \ldots(1)$

The volume of the wire is given by $V=LA$, and it is constant,

$L=$length of the wire, $A=$area of the wire.

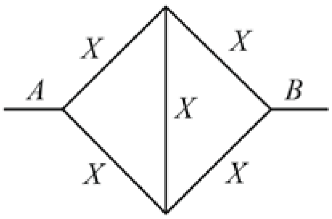
If the length $L'=nL$, then, the area will be $A'=\frac{A}{n}$.

Hence, from the equation (1), the resistance of the wire becomes $R'=\frac{\rho(nL)}{\left(\frac{A}{n}\right)}=\frac{n^2\rho L}{A}=n^2R$.

So, the resistance of each $\left(\frac{1}{5}\right)^{\text{th}}$ part is

$x=\frac{R'}{5}=\frac{n^2R}{5}$,

where, x is the resistance of each part of the wire. Here, we can see that the circuit diagram is a balanced Wheatstone bridge. Hence, we can redraw it.



Since the circuit is balanced, the middle resistance is neglected.

The equivalent resistance is calculated by, $\frac{(2x)(2x)}{2x+2x}=x$

(because x and x resistances are in series and its equivalent is $x+x=2x$).

And finally, $x=\frac{n^2R}{5}$.

Q.17. Two wires of resistance R_1 and R_2 have a temperature coefficient of resistance α_1 and α_2, respectively. These are joined in series. The effective temperature coefficient of resistance is

A) $\frac{\alpha_1+\alpha_2}{2}$

B) $\sqrt{\alpha_1\alpha_2}$

C) $\frac{\alpha_1R_1+\alpha_2R_2}{R_1+R_2}$

D) $\frac{\sqrt{R_1R_2\alpha_1\alpha_2}}{\sqrt{R_1^2+R_2^2}}$

Answer: $\frac{\alpha_1R_1+\alpha_2R_2}{R_1+R_2}$

Solution: Resistance depends on temperature then, the resistance of wire 1 is,

$R_1' = R_1[1+\alpha_1(\Delta T)]$ ...... (1)

The resistance of wire 2 is,

$R_2' = R_2[1+\alpha_2(\Delta T)]$ .... (2)

For series combination, net resistance is the sum of two resistance then,

$R_e = R_1' + R_2' = (R_1+R_2)[1+\alpha_{eff}(\Delta T)]$ ...... (3)

Using (1) and (2) in (3),

$R_1[1+\alpha_1 \Delta T] + R_2[1+\alpha_2 \Delta T] = (R_1+R_2)[1+\alpha_{eff}\Delta T]$

$(R_1\alpha_1 + R_2\alpha_2)\Delta T = (R_1+R_2)\alpha_{eff}(\Delta T)$

$\alpha_{eff} = \frac{R_1\alpha_1+R_2\alpha_2}{R_1+R_2}$

Q.18. Four resistors, $100\ \Omega$, $200\ \Omega$, $300\ \Omega$ and $400\ \Omega$ are connected to form four sides of a square. The resistors can be connected in any order. What is the maximum possible equivalent resistance across the diagonal of the square?

A) $210\ \Omega$

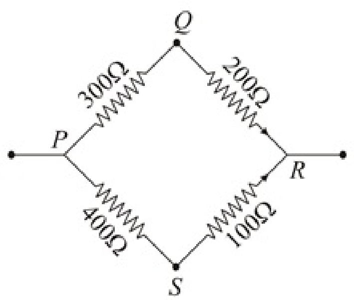
B) $240\ \Omega$

C) $300\ \Omega$

D) $250\ \Omega$

Answer: $250\ \Omega$

Solution: For maximum equivalent resistance across the diagonal of the square, the given resistors connected as



Resistance of PQR arm, $R_1 = 300+200 = 500\Omega$

Resistance of PSR arm, $R_2 = 400+100\Omega = 500\Omega$

The equivalent resistance between P and R.

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{500} + \frac{1}{500} = \frac{1+1}{500}$

$\therefore\ R_{eq} = \frac{500}{2} = 250\Omega$

Q.19. The specific resistance of a wire is ρ, its volume is $3\ \mathrm{m}^3$ and its resistance is $3\ \Omega$, then its length will be

A) $\sqrt{\frac{1}{\rho}}$

B) $\frac{3}{\sqrt{\rho}}$

C) $\frac{1}{\rho}\sqrt{3}$

D) $\rho\sqrt{\frac{1}{3}}$

E) $\sqrt{\frac{3}{\rho}}$

Answer: $\frac{3}{\sqrt{\rho}}$

Solution: For any conductor of length l and area of cross$-$section A, the volume V is

$V = Al$

$\Rightarrow A = \frac{V}{l}$

Since the resistance R of the same conductor.

$R = \rho\frac{l}{A}, \rho = \text{specific resistance}$

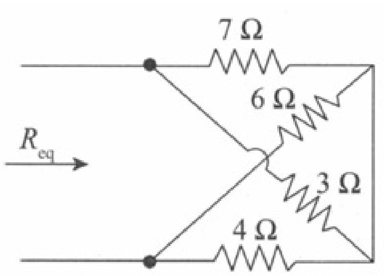
$\therefore\ R = \rho\frac{l}{\frac{V}{l}} = \rho\frac{l^2}{V} \ \Rightarrow l^2 = \frac{RV}{\rho}$

Given $V = 3\ \text{m}^3$, $R = 3\ \Omega$, then

$\therefore\ l^2 = \frac{9}{\rho}$

$\Rightarrow l = \frac{3}{\sqrt{\rho}}$

Q.20. In the given network of four resistors, the equivalent resistance is,



A) $20\ \Omega$

B) $5.4\ \Omega$

C) $12\ \Omega$

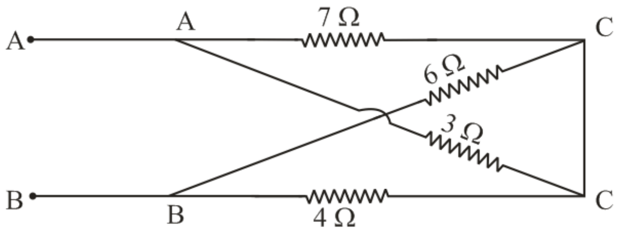
D) $4.5\ \Omega$

Answer: $4.5\ \Omega$

Solution: By point-potential method, we know that two points having same potential can be taken as a single point.

So, we now redraw the circuit and name the points. We have to find the equivalent resistance between A and B.

In the last branch, both the points are at the same potential. Hence, replace the branch with a single point C and redraw the circuit as shown below.



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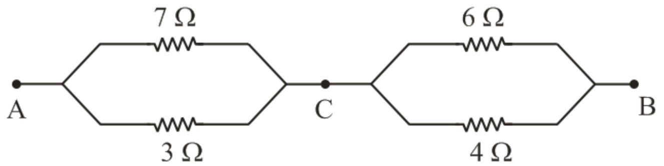


Now, we can see that $7\ \Omega$ and $3\ \Omega$ are in parallel between A and C and $6\ \Omega$ and $4\ \Omega$ are in parallel between C and B.

The equivalent resistance between A and B is equal to the series equivalent of resistances between A and C and B and C.

Now, parallel equivalent of two resistances R_1 and R_2 is given by, $\frac{R_1 R_2}{R_1+R_2}$.

Series equivalent is given by R_1+R_2.

Thus, equivalent resistance between A and C is, $\frac{7\times3}{7+3}=\frac{21}{10}=2.1\ \Omega$.

The equivalent resistance between C and B is, $\frac{6\times4}{6+4}=\frac{24}{10}=2.4\ \Omega$.

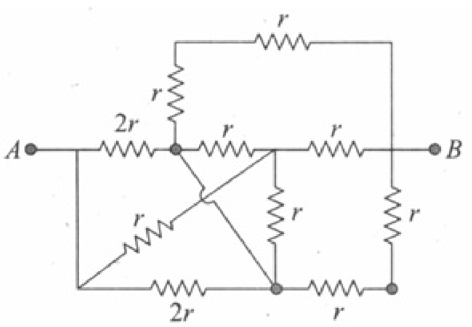
Now, equivalent resistance between A and B is $R_{\mathrm{AB}}=R_{\mathrm{AC}}+R_{\mathrm{BC}}$.

$R_{\mathrm{AB}}=2.1\ \Omega+2.4\ \Omega$

$R_{\mathrm{AB}}=4.5\ \Omega$.

Thus, the equivalent resistance of the network is $4.5\ \Omega$.

Q.21. The equivalent resistance between A and B in the arrangement of resistances as shown is



A) $4r$.

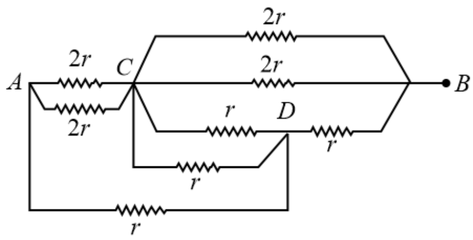
B) $3r$.

C) $2.5r$.

D) r.

Answer: r.

Solution: We can simplify the complex circuit diagram, as shown below.



We can see that between A & C, the terminal $2r$ and $2r$ resistances are in parallel combination, and we can calculate using the following relation $\left(R_{\text{eq}}=\frac{R_1\times R_2}{R_1+R_2}\right)$.

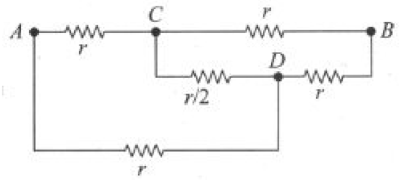
Hence, we get, $\frac{2r\times 2r}{2\text{r}+2r}=r$.

Similarly, we can calculate the parallel combination of resistances which are connected between B & C terminal $\frac{2r\times 2r}{2r+2r}=r$.

Again, we can calculate the parallel combination of resistances which are connected between C & D terminal by using the following relation, $\left(R_{\text{eq}}=\frac{R_1\times R_2}{R_1+R_2}\right)$.

Hence, we get, $\frac{r\times r}{r+r}=\frac{r}{2}$.

And now, we can redraw it.



Hence, it satisfies the relation $\frac{P}{Q}=\frac{R}{S}$,

where, $P=Q=R=S=r\,\Omega$

$\Rightarrow \frac{r}{r}=\frac{r}{r}$.

Hence, no current will be drawn from
$\frac{r}{2}\,\Omega$ resistance because the potential drop across the terminal will be zero.

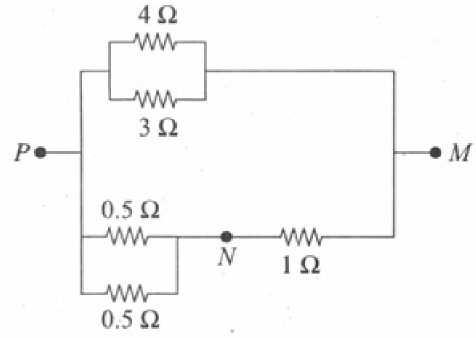
Thus, this circuit is an example of a Wheatstone bridge.

The equivalent resistance is
$\frac{2r\times 2r}{2r+2r}=r$

.

(because r and r are in series combination, so $r+r=2r$).

Q.22. In the circuit shown, the current through the $4\ \Omega$ resistor is $1\ \text{A}$ when the points P and M are connected to a DC voltage source. The potential difference between the points M and N is



A) $1.5\ \text{V}$

B) $1.0\ \text{V}$

C) $0.5\ \text{V}$

D) $3.2\ \text{V}$

Answer: $3.2\ \text{V}$

Solution: Let us suppose the voltage of points P, M and N are V_P, V_M and V_N, respectively. Here, the current through $4\ \Omega$ resistance is $1\ \text{A}$. So, the voltage drop across it will be, $V = IR$

$\Rightarrow V = 1\ \text{A} \times 4\ \Omega = 4\ \text{V}$

Since the $4\ \Omega$ resistance is connected between the points P and M, so,

$V_\text{P} - V_\text{M} = 4\ \text{V}$

The equivalent resistance between P and N will be,

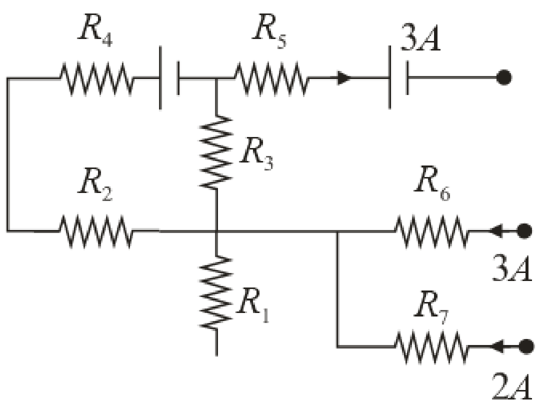
$R_\text{eq} = \frac{0.5 \times 0.5}{0.5 + 0.5} = 0.25\ \Omega$

Now, by applying voltage division law, the voltage drop across $1\ \Omega$ resistance will be,

$V = \left(\frac{1}{1 + 0.25}\right) \times 4\ \text{V} = 3.2\ \text{V}$

So, $V_\text{N} - V_\text{M} = 3.2\ \text{V}$

Q.23. In the given circuit, if I_1 and I_2 be the current in resistances R_1 and R_2, respectively, then



A) $I_1 = 2\ \text{A}$ and I_2 cannot be determined with given data.

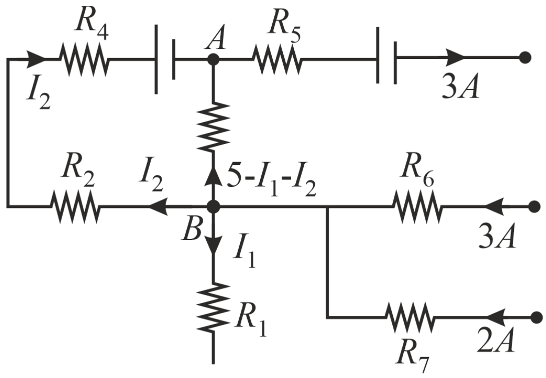
B) $I_1 = 0$, $I_2 = 2\ \text{A}$

C) $I_1 = 3\text{ A}, I_2 = 2\text{ A}$

D) None of these

Answer: $I_1 = 2\text{ A}$ and I_2 cannot be determined with given data.

Solution:



Applying Kirchhoff's first law at the junction B, we can write

$I_1 + I_2 + I_{\text{AB}} = 5 \Rightarrow I_{\text{AB}} = 5 - I_1 - I_2 \ \ldots(1)$.

Applying Kirchhoff's first law at the junction A, we can write

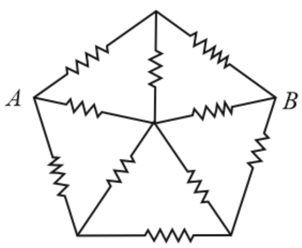
$I_2 + I_{\text{AB}} = 3 \Rightarrow I_2 + 5 - I_1 - I_2 = 3 \Rightarrow I_1 = 2\text{ A}$.

From (1), we have,

$I_{\text{AB}} = 5 - 2 - I_2 = 3 - I_2$.

Since, the value of I_{AB} is unknown, I_2 can not be determined by given data.

Q.24. The effective resistance between A and B in the network shown, where the resistance of each resistor is R, is,



A) $\frac{8R}{11}$

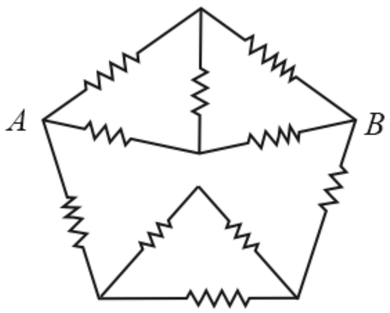
B) $\frac{6R}{11}$

C) $\frac{6R}{5}$

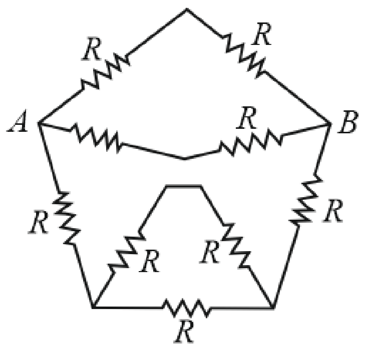
D) None of these.

Answer: $\frac{8R}{11}$

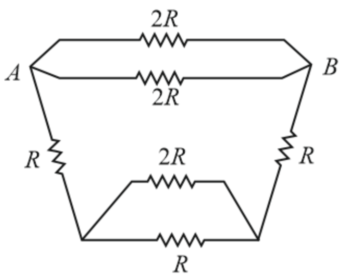
Solution: The equivalent resistance can be obtained like below:

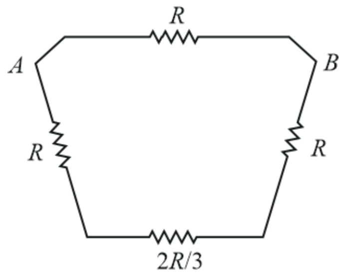


The upper part is the example of a Wheatstone bridge. It means the resistance at the middle of the upper part is shunted.



It means the new circuit is,





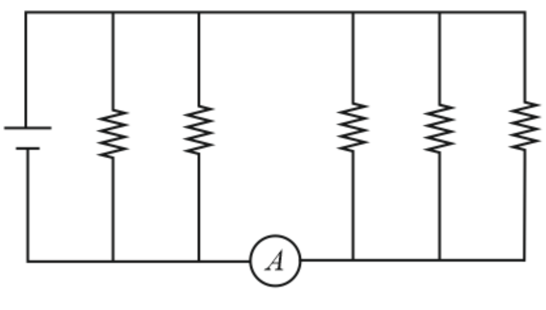
Now, the new resistance,

$\Rightarrow R' = R + R + \frac{2R}{3} = \frac{8R}{3}$.

Then, the net resistance is,

$R_{\mathrm{AB}} = \frac{R' \times R}{R' + R} = \frac{8(R/3) \times R}{8(R/3) + R} = \frac{8\left(R/3\right)}{\left(11/3\right)} = \frac{8}{11}R.$

Q.25. Five identical resistors, each of value $1100\ \Omega$ are connected to a $220\ \mathrm{V}$ battery as shown in figure. The reading of the ideal ammeter A is



A) $\frac{1}{5}$ A

B) $\frac{2}{5}$ A

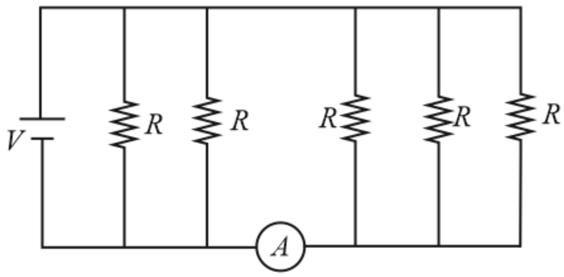
C) $\frac{3}{5}$ A

D) $\frac{4}{5}$ A

E) 1 A

Answer: $\frac{3}{5}$ A

Solution:



Total resistance of five identical resistors in parallel,

$R_{\text{parallel}} = \frac{R}{5} = \frac{1100}{5} = 220\ \Omega$

Total current on the circuit $= \frac{V}{R_{\text{parallel}}} = \frac{220}{220} = 1$ A

As current divides in inverse ratio of resistance for resistors in parallel,

$I_1 : I_2 : I_3 : I_4 : I_5 = \frac{1}{1100} : \frac{1}{1100} : \frac{1}{1100} : \frac{1}{1100} : \frac{1}{1100}$

Here each given current is current flowing through one resistance each.

Current through each resistor $= \frac{1}{5}$ A

The ammeter will give reading of current through three resistors, due to Kirchoff's current law.

Thus, current as shown by ammeter $= 3 \times \frac{1}{3} = \frac{3}{5}$ A

Practice more on Current Electricity