Focus on understanding not on writing.

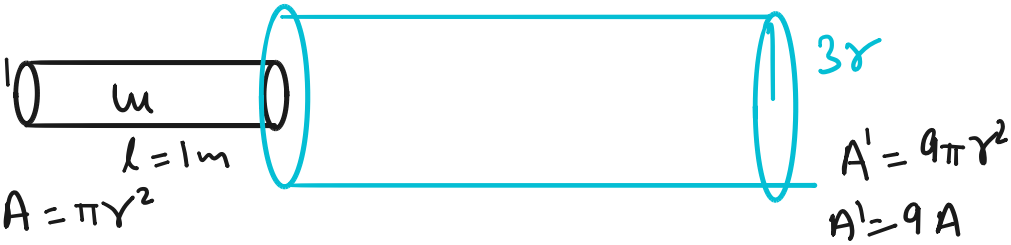
***Example*: 1** A copper wire of length $1m$ and radius $1mm$ is joined in series with an iron wire of length $2m$ and radius $3mm$ and a current is passed through the wire. The ratio of current densities in the copper and iron wire is

$J = \frac{i}{A}$

(a) 18 : 1 (b) 9 : 1

(c) 6 : 1 (d) 2 : 3

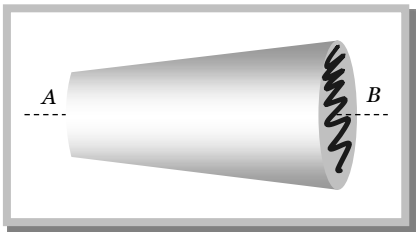
$\frac{J_{Cu}}{J_{Fe}} = \frac{A_{Fe}}{A_{Cu}} = \frac{9A}{A}$ $1mm = r$



$A = \pi r^2$ $A' = 9\pi r^2$ $A' = 9A$

***Example*: 2** A wire has a non-uniform cross-sectional area as shown in figure. A steady current i flows through it. Which one of the following statement is correct

$V_A > V_B$



$V_d \propto \frac{1}{\text{Area}}$

(a) The drift speed of electron is constant on moving from A to B

(b) The drift speed increases

(c) The drift speed decreases on moving from A to B

(d) The drift speed varies randomly

***Example*: 3** Two wires A and B of the same material, having radii in the ratio 1 : 2 and carry currents in the ratio 4 : 1. The ratio of drift speeds of electrons in A and B is

(a) 16 : 1 (b) 1 : 16

(c) 1 : 4 (d) 4 : 1

$(\text{Area})_B = \pi(2r)^2 = 4\pi r^2$

use $i = neAV_d$

$i_A = neAV_{d_A}$

$i_B = ne4AV_{d_B}$

$\frac{4}{1} = \frac{i_A}{i_B} = \frac{neAV_{d_A}}{ne4AV_{d_B}}$, $\frac{V_A}{V_B} = \frac{16}{1}$

***Example*: 4** A wire of length L and resistance R is streched to get the radius of cross-section halfed. What is new resistance

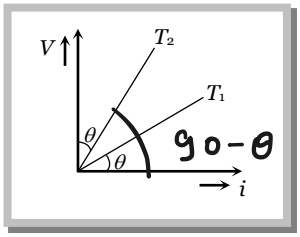
(a) $5R$ (b) $8R$
(c) $4R$ (d) $16R$

$$\frac{R}{R'} = \left(\frac{r'}{r}\right)^4 = \left(\frac{r/2}{r}\right)^4$$

$$16R = R'$$

***Example*: 5** The V-i graph for a conductor at temperature T_1 and T_2 are as shown in the figure. ($T_2 - T_1$) is proportional to

(a) $\cos 2\theta$
(b) $\sin\theta$
(c) $\cot 2\theta$
(d) $\tan\theta$



$R \propto$ temp.

$R_1 = \tan\theta$

$R_2 = \tan(90-\theta) = \cot\theta$

$T_2 - T_1 \propto R_2 - R_1$

$T_2 - T_1 \propto \cot\theta - \tan\theta$, $T_2 - T_1 \propto \cot 2\theta$

$\cot\theta - \tan\theta = \frac{\cos\theta}{\sin\theta} - \frac{\sin\theta}{\cos\theta} = \frac{\cos^2\theta - \sin^2\theta}{\sin\theta\cos\theta} \times \frac{2}{2} = \frac{\cos 2\theta}{\sin 2\theta} = \cot 2\theta$

***Example*: 6** If a copper wire is stretched to make it 0.1% longer, the percentage increase in resistance will be

[MP PMT 1996, 2000; UPSEAT 1998; MNR 1990]

(a) 0.2 (b) 2 (c) 1 (d) 0.1

$R \propto l^2$, up to 5% % Change in R = 2 × % Change in length

% change in resistance = 2×0.1
$= 0.2\ \%$

***Example*: 7** The temperature co-efficient of resistance of a wire is 0.00125/°C. At 300 K. It's resistance is 1Ω. The resistance of the wire will be 2Ω at

(a) 1154 K (b) 1127 K (c) 600 K (d) 1400 K

Resistance at T°C

$R = R_0(1+\alpha T)$

Resistance at 0°C

$T = 27^\circ$, $R = 1\Omega$

$R = R_0(1+\alpha T)$

$1 = R_0(1 + 0.00125 \times 27^\circ)$ — (A)

$R = R_0(1+\alpha T)$

A/B

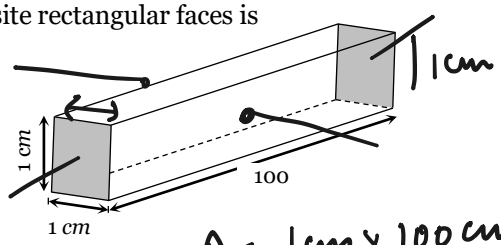
$\frac{1}{2} = \frac{(1+0.00125 \times T)}{(1+0.00125T)}$

$T = 854°C$

Example: 8 Dimensions of a block are 1 *cm* × 1 *cm* × 100 *cm*. If specific resistance of its material is 3 × 10^{-7} *ohm-m*, then the resistance between it's opposite rectangular faces is

(a) 3 × 10^{-9} *ohm* (b) 3 × 10^{-7} *ohm*

(c) 3 × 10^{-5} *ohm* (d) 3 × 10^{-3} *ohm*



$\rho = 3 \times 10^{-7}$ ohm meter.

$$R = \frac{\rho l}{A} = \frac{3 \times 10^{-7} \times 10^{-2}}{10^{-4}}$$

$$R = 3 \times 10^{-5} \text{ ohm}$$

$A = 1\text{cm} \times 100\text{cm}$

$A = 100\text{cm}^2$

$A = 100 \times 10^{-4}$

$l = 1\text{cm} = 10^{-2}\text{m}$.

Example: 9 In the following circuit reading of voltmeter *V* is

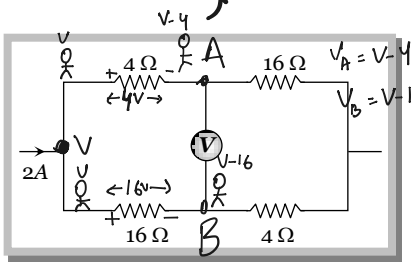
(a) 12 *V*

(b) 8 *V*

(c) 20 *V*

(d) 16 *V*

IDEL Voltmeter has ∞ resistance.

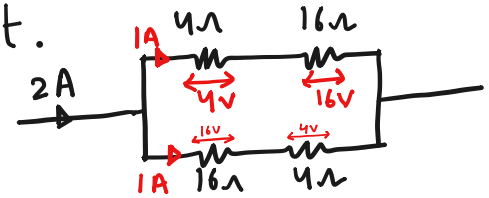


$V_A = V-4$

$V_B = V-16$

$V_A - V_B$
$= V-4-(V-16)$
$= 12\ V$

remove voltmeter because no current flowing through it.



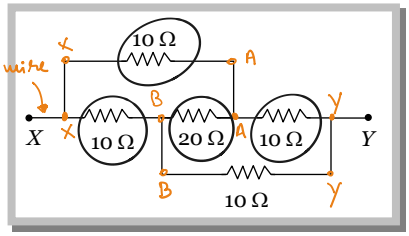
Example: 10 Five resistances are combined according to the figure. The equivalent resistance between the point *X* and *Y* will be

(a) 10 Ω

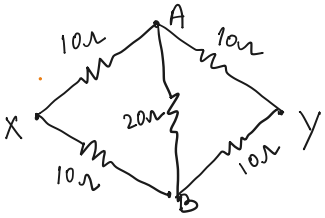
(b) 22 Ω

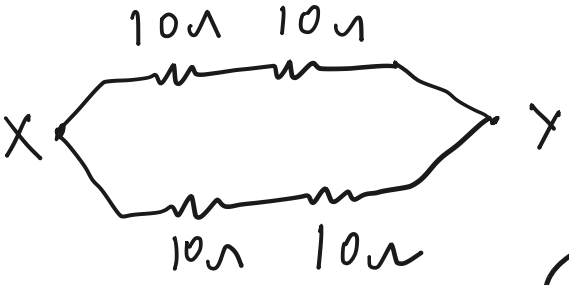
(c) 20 Ω

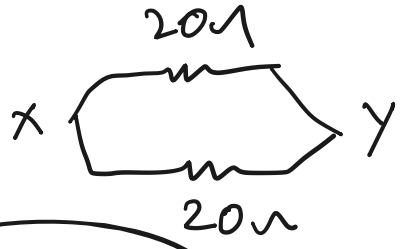
(d) 50 Ω



remove 20Ω

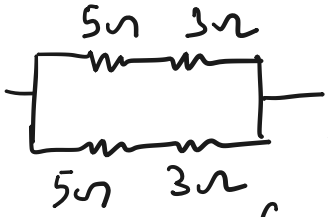






$R_{xy} = 10\Omega$

***Example*: 11** Seven resistances are connected as shown in figure. The equivalent resistance between A and B is **[MP PET 2000]**



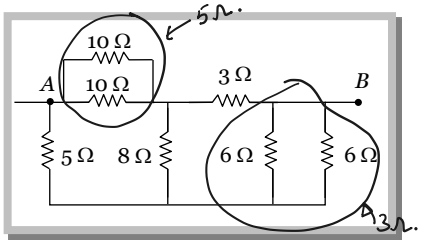
(a) 3 Ω

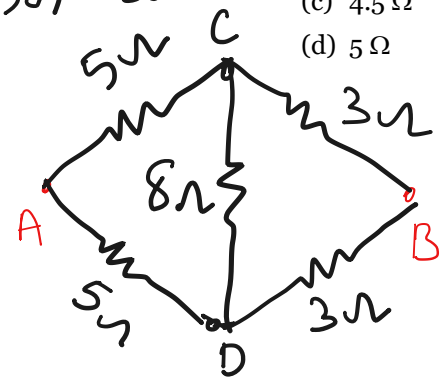
(b) 4 Ω

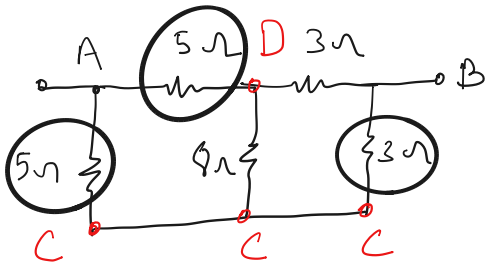
(c) 4.5 Ω

(d) 5 Ω

remove 8Ω.







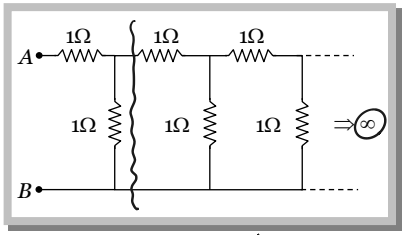
***Example*: 12** The equivalent resistance between points A and B of an infinite network of resistance, each of 1 Ω, connected as shown is

(a) Infinite

(b) 2 Ω

(c) $\frac{1+\sqrt{5}}{2}\Omega$

(d) Zero



In such Questions keep one repeating branch, assume rest of part is equal to x.

$R_{AB} = 1 + \frac{x}{1+x}$

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

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

$x(1+x) = 1+2x$

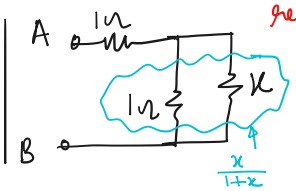
$x + x^2 = 1 + 2x$

$x^2 - x - 1 = 0$

$a=1,\ b=-1,\ c=-1$

$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4\times1\times-1}}{2\times1}$

$x = \frac{1 \pm \sqrt{5}}{2}$



resultant of ∞ branches we assumed x. If we add one more branch resultant still should be x.

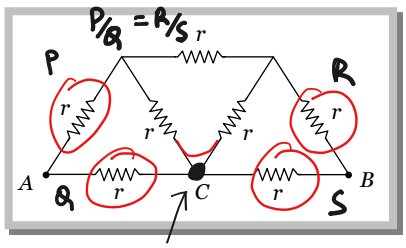
***Example*: 13** The equivalent resistance between A and B in the circuit shown will be

(a) $\frac{5}{4}r$

(b) $\frac{6}{5}r$

(c) $\frac{7}{6}r$

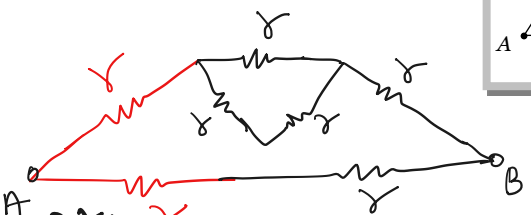
(d) $\frac{8}{7}r$

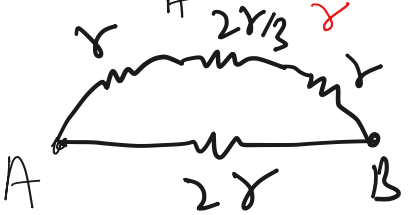


remove connection only.

$2r + \frac{2r}{3}$

$\frac{8r}{3}$





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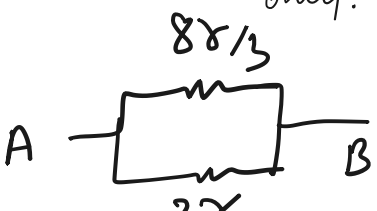
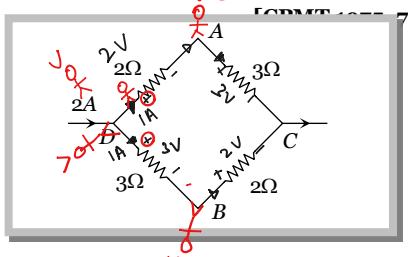


$\frac{\frac{8r}{3}\times 2r}{\frac{8r}{3}+2r}$

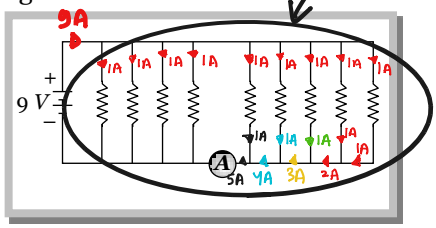
Example: 14 A current of 2 A flows in a system of conductors as shown. The potential difference $(V_A - V_B)$ will be

(a) $+2V$
(b) $+1V$
(c) $-1\,V$
(d) $-2\,V$



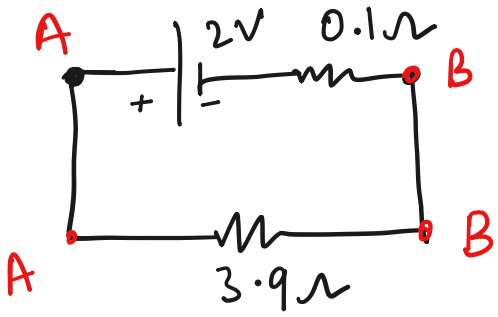
Example: 15 If each resistance in the figure is of 9 Ω then reading of ammeter is

(a) 5 A
(b) 8 A
(c) 2 A
(d) 9 A

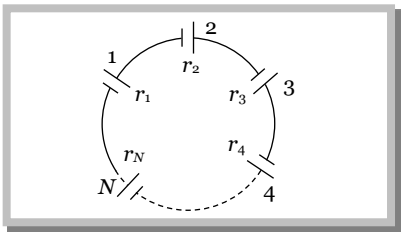


Example: 16 The internal resistance of a cell of emf 2V is 0.1 Ω. It's connected to a resistance of 3.9 Ω. The voltage across the cell will be

(a) 0.5 *volt* (b) 1 *volt* (c) 1.95 *volt* (d) 2 *volt*



***Example*: 17** A group of N cells whose emf varies directly with the internal resistance as per the equation $E_N = 1.5\ r_N$ are connected as shown in the following figure. The current i in the circuit is



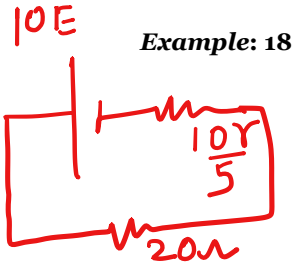
(a) 0.51 *amp*
(b) 5.1 *amp*
(c) 0.15 *amp*
(d) 1.5 *amp*

$E_{Net} = NE$

$r_{eq} = Nr \qquad i = \frac{E_N}{r_{eq}}$

$i = \frac{E_1 + E_2 + E_3 + \cdots}{r_1 + r_2 + r_3 + \cdots} = \frac{1.5r + 1.5r + 1.5r \cdots}{r + r + r \cdots}$

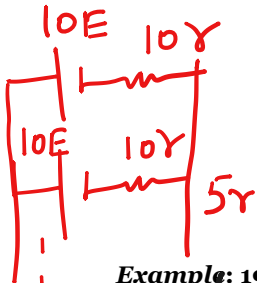
$= 1.5\,Nr/Nr = 1.5\ Amp.$

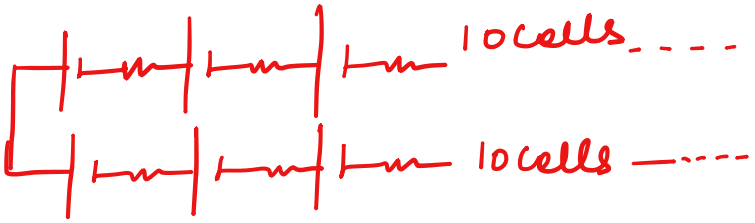


***Example*: 18** In a mixed grouping of identical cells 5 rows are connected in parallel by each row contains 10 cell. This combination send a current i through an external resistance of 20 Ω. If the emf and internal resistance of each cell is 1.5 *volt* and 1 Ω respectively then the value of i is **[KCET 2000]**

$i = \frac{10E}{20 + 2r} = \frac{10 \times 1.5}{20 + 2}$

(a) 0.14 (b) 0.25 (c) 0.75 (d) 0.68

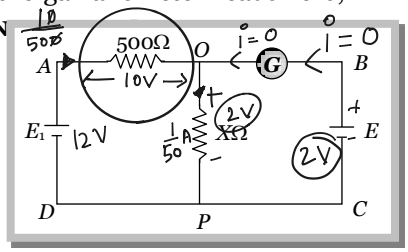




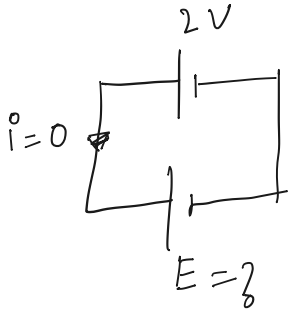
$i = \frac{15}{22}\ A$

5rows.

***Example*: 19** In the adjoining circuit, the battery E_1 has as emf of 12 *volt* and zero internal resistance, while the battery E has an emf of 2 *volt*. If the galvanometer reads zero, then the value of resistance X *ohm* is **[N**



(a) 10
(b) 100Ω
(c) 500
(d) 200

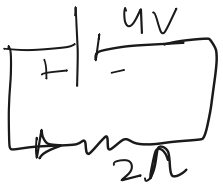


$V = IR = \frac{1}{50} \times x$

$+$

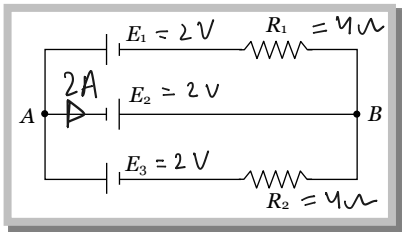
$2 = \frac{x}{50}$

$x = 100\Omega$



$i = 2\,A$

***Example*: 20** In the circuit shown here $E_1 = E_2 = E_3 = 2V$ and $R_1 = R_2 = 4\ \Omega$. The current flowing between point A and B through battery E_2 is

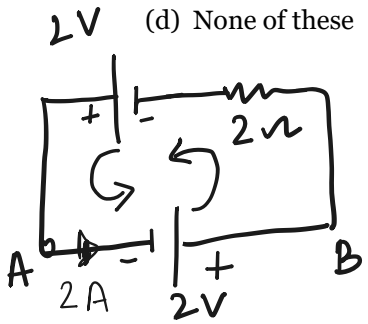


(a) Zero

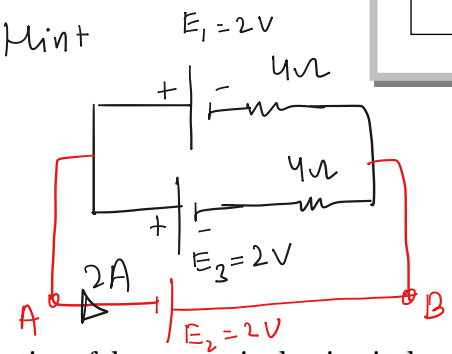
(b) 2 A from A to B

(c) 2 A from B to A

(d) None of these

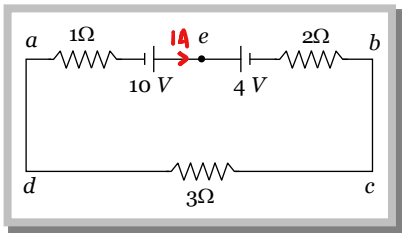


Hint



very good to all.

***Example*: 21** The magnitude and direction of the current in the circuit shown will be **[CPMT 1986,**



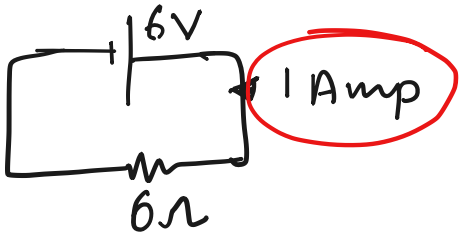
(a) $\frac{7}{3}A$ from a to b through e

(b) $\frac{7}{3}A$ from b and a through e

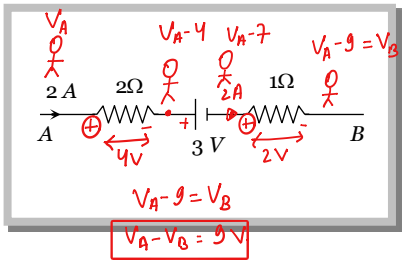
(c) 1.0 A from b to a through e

(d) 1.0 A from a to b through e

Hint



***Example*: 22** Figure represents a part of the closed circuit. The potential difference between points A and B ($V_A - V_B$) is



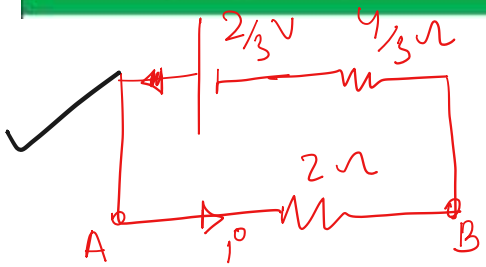
(a) + 9 V

(b) − 9 V

(c) + 3 V

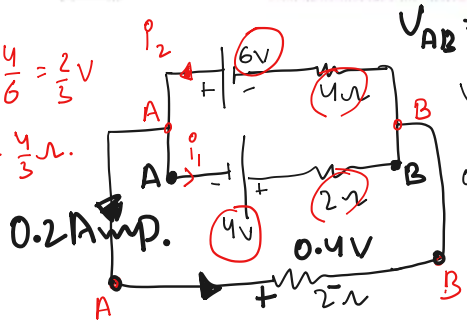
(d) + 6 V

$i = \frac{2/3}{\frac{4}{3}+2} = \frac{2/3}{\frac{10}{3}} = \frac{1}{5} = 0.2\ Amp.$



$E_{eq} = \frac{16-12}{6} = \frac{4}{6} = \frac{2}{3}V$

$r_{eq} = \frac{r_1 r_2}{r_1+r_2} = \frac{8}{6} = \frac{4}{3}\Omega.$



$V_{AB} = 0.4V$

$V_{AB} = E - ir$

$0.4 = 4 - i_1 \times 2$

$2i_1 = 3.6$

$i_1 = 1.8\ Amp.$

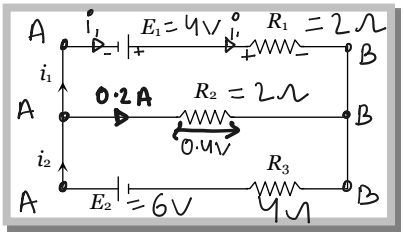
***Example*: 23** In the following circuit $E_1 = 4V$, $R_1 = 2\Omega$ $E_2 = 6V$, $R_2 = 2\Omega$ and $R_3 = 4\Omega$. The current i_1 is [MP PET 20

(a) 1.6 A

(b) 1.8 A

(c) 2.25 A

(d) 1 A

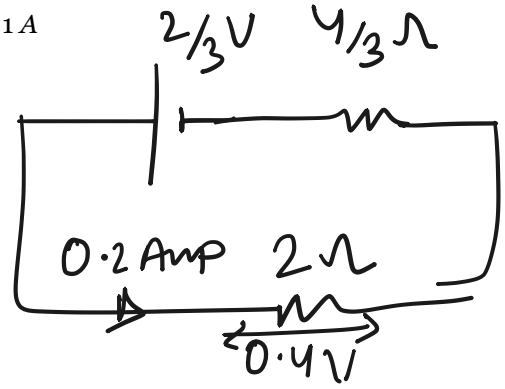


$V_{AB} = 0.4\ Volts.$

$E_1 - i_1 r_1 = V_{AB}$

$4V - i_1 \times 2 = 0.4$

$i_1 = 1.8\ Amp.$



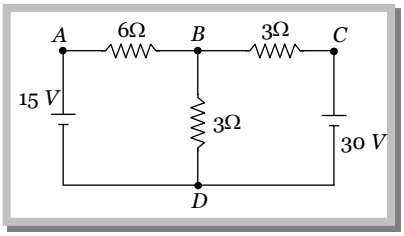
***Example*: 24** In the circuit shown in figure, find the current through the branch BD

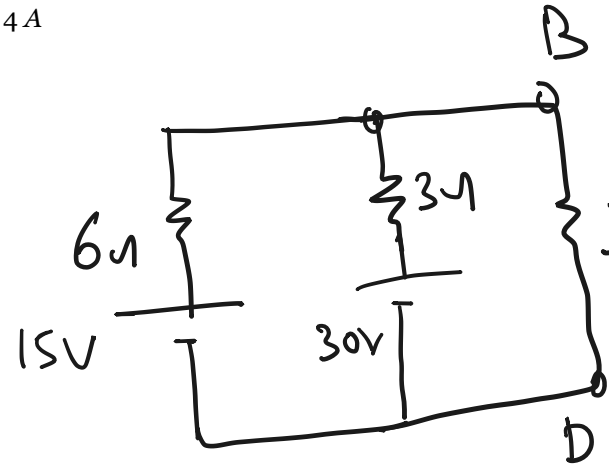
(a) 5 A

(b) 0 A

(c) 3 A

(d) 4 A

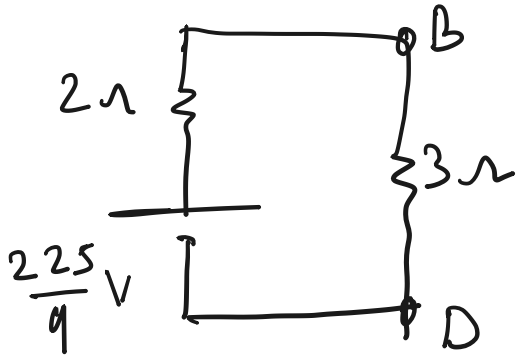




$\frac{30 \times 6 + 15 \times 3}{9}$

$\frac{180+45}{9}$

$\frac{225}{9} V$



$i = \frac{\frac{225}{9}}{5}$

$i = \frac{45}{9} = 5A$

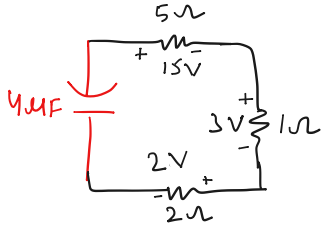
***Example*: 25** A part of a circuit in steady state along with the current flowing in the branches, with value of each resistance is shown in figure. What will be the energy stored in the capacitor C_0 **[IIT-JEE 1986]**

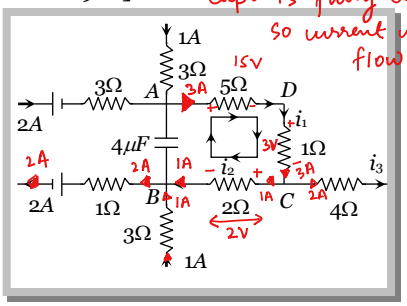
(a) $6 \times 10^{-4}\ J$

(b) $8 \times 10^{-4}\ J$

(c) $16 \times 10^{-4}\ J$

(d) Zero





Cap. is fully charged so current will not flow through cap

Voltage across capacitor is 20V yes or No.

$$U = \frac{CV^2}{2} = \frac{4 \times 10^{-6} \times 400}{2} = 800 \times 10^{-6} = 8 \times 10^{-4}\ J$$

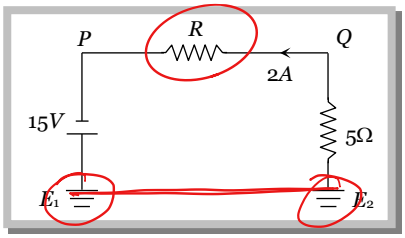
***Example*: 26** In the following circuit the potential difference between P and Q is

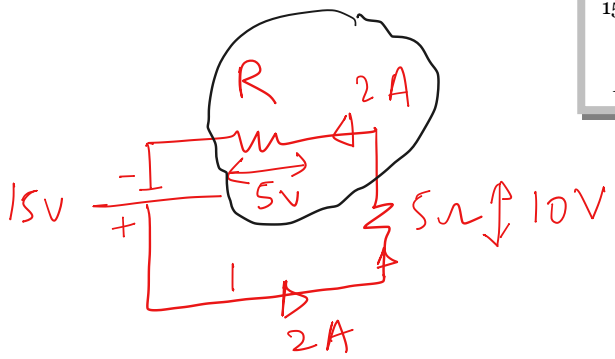
(a) 15 V

(b) 10 V

(c) 5 V

(d) 2.5 V





$V = IR$

$5 = 2R$

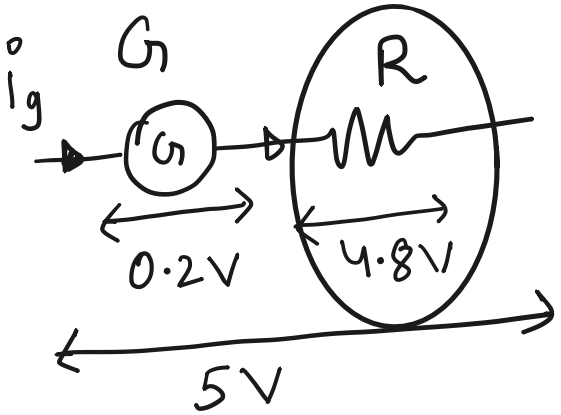
$R = 2.5\ \Omega$.

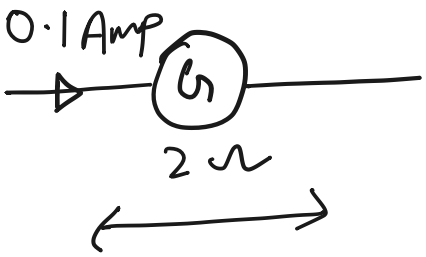
***Example*: 27** 100 *mA* current gives a full scale deflection in a galvanometer of resistance 2 Ω. The resistance connected with the galvanometer to convert it into a voltmeter of 5 *V* range is

(a) 98 Ω 48 Ω (b) 52 Ω (c) 80 Ω (d) 48Ω.

Full deflection current means $i_g = 100mA$

$i_g = 0.1$ Amp $G = 2\Omega$



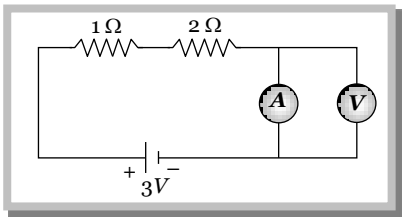


$V_G = I_g G = 0.1 \times 2 = 0.2\ V$

$\frac{4.8}{R} = 0.1$, $R = 48\Omega$

***Example*: 28** In the circuit shown in figure, the voltmeter reading would be

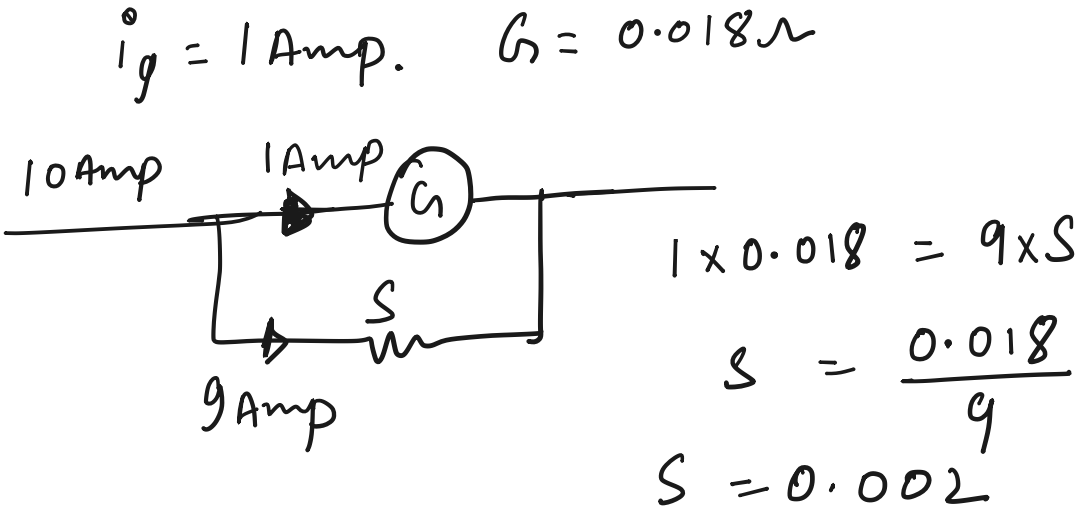
(a) Zero
(b) 0.5 *volt*
(c) 1 *volt*
(d) 2 *volt*



Ideal Ammeter has zero resistance.
That's why it will draw 0 volts.

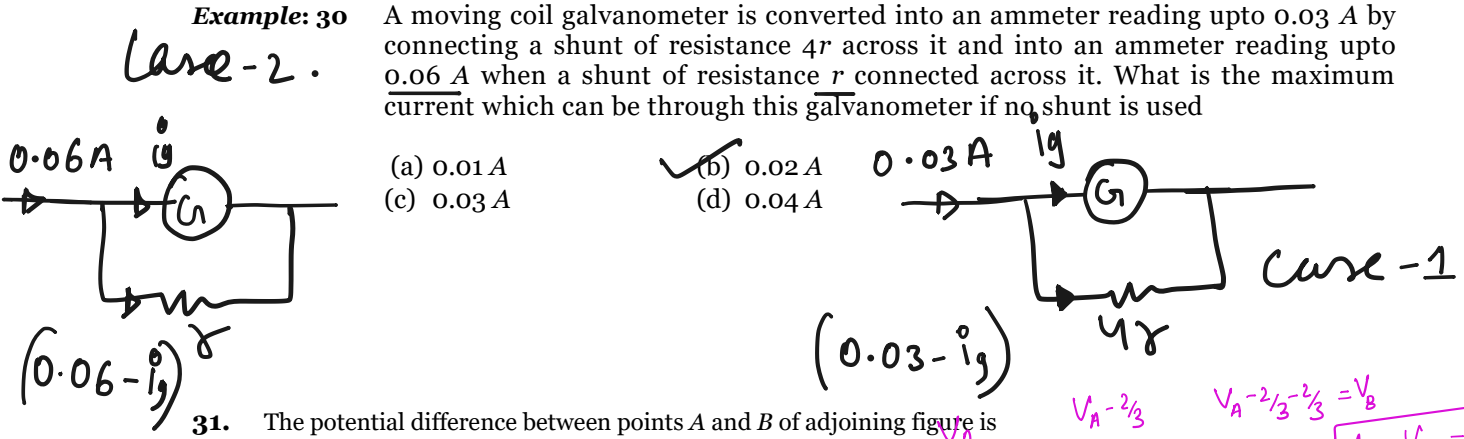
***Example*: 29** The resistance of 1 *A* ammeter is 0.018 Ω. To convert it into 10 *A* ammeter, the shunt resistance required will be

(a) 0.18 Ω (b) 0.0018 Ω (c) 0.002 Ω (d) 0.12 Ω



***Example*: 30** A moving coil galvanometer is converted into an ammeter reading upto 0.03 *A* by connecting a shunt of resistance $4r$ across it and into an ammeter reading upto 0.06 *A* when a shunt of resistance r connected across it. What is the maximum current which can be through this galvanometer if no shunt is used

(a) 0.01 *A* (b) 0.02 *A* (c) 0.03 *A* (d) 0.04 *A*



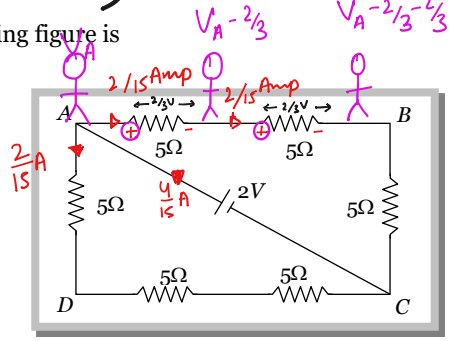
31. The potential difference between points *A* and *B* of adjoining figure is

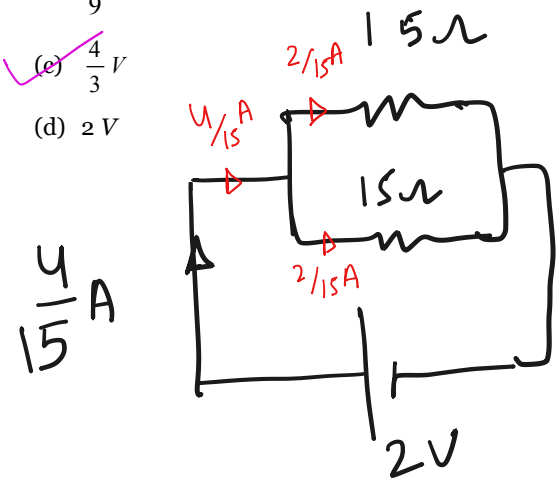
(a) $\frac{2}{3}$ *V*

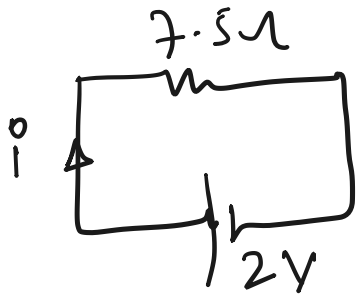
(b) $\frac{8}{9}$ *V*

(c) $\frac{4}{3}$ *V*

(d) 2 *V*







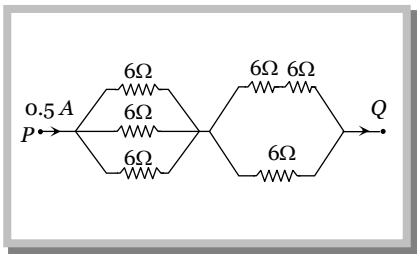
32. Resistances of 6 *ohm* each are connected in the manner shown in adjoining figure. With the current 0.5 *ampere* as shown in figure, the potential difference $V_P - V_Q$ is

(a) 3.6 *V*

(b) 6.0 *V*

(c) 3.0 *V*

(d) 7.2 *V*



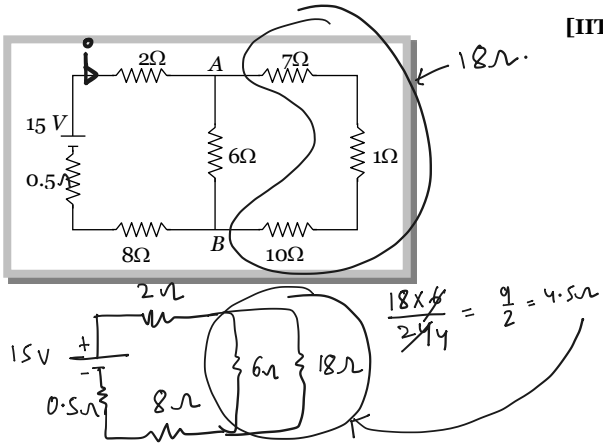
33. The current from the battery in circuit diagram shown is **[IIT-JEE 19**

(a) 1 *A*

(b) 2 *A*

(c) 1.5 *A*

(d) 3 *A*



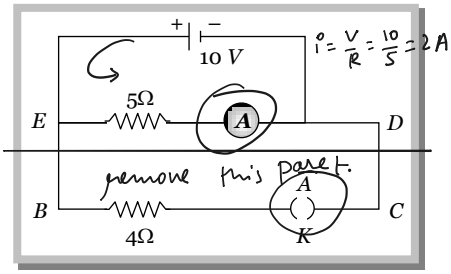
34. In the given figure, when key *k* is opened, the reading of the ammeter *A* will be **[MP PMT 19**

(a) 50 *A*

(b) 2 *A*

(c) 0.5 *A*

(d) $\frac{10}{9}$ *A*



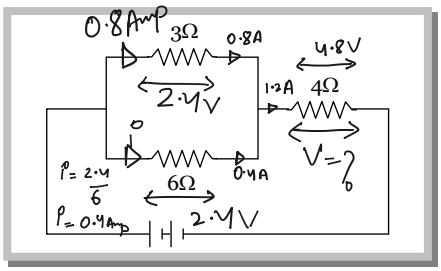
35. If the current through 3 Ω resistor is 0.8 *A* then the potential drop through 4 Ω resistor is **[AFMC 19**

(a) 9.6 *V*

(b) 4.8 *V*

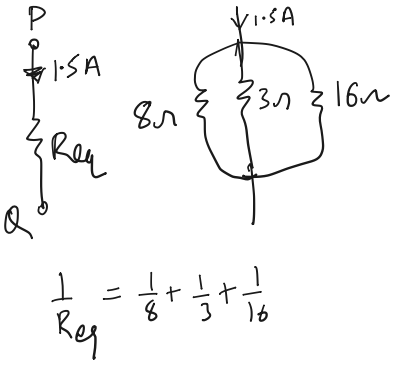
(c) 2.6 *V*

(d) 2.2 *V*



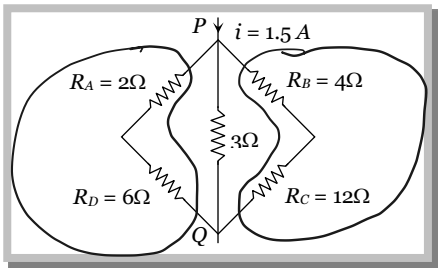
36. Potential difference between the points P and Q in the electric circuit shown is $V_P - V_Q = ?$ **[KCET (Engg./Med.) 19**

(a) 4.5 V
(b) 1.1 V
(c) 2.4 V
(d) 2.88 V



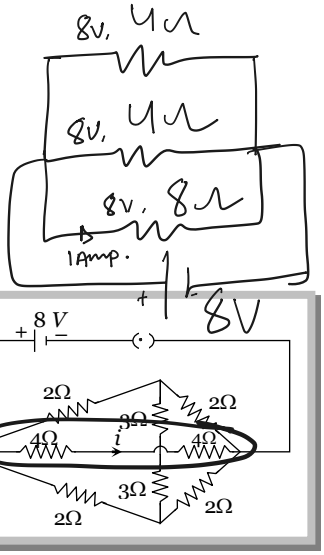
$$\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{3} + \frac{1}{16}$$

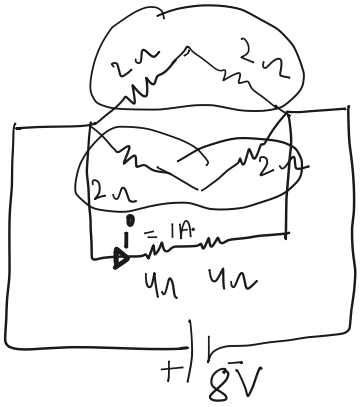
$$V_{PQ} = 1.5 \times R_{eq}.$$



37. The value of i in the following circuit diagram will be

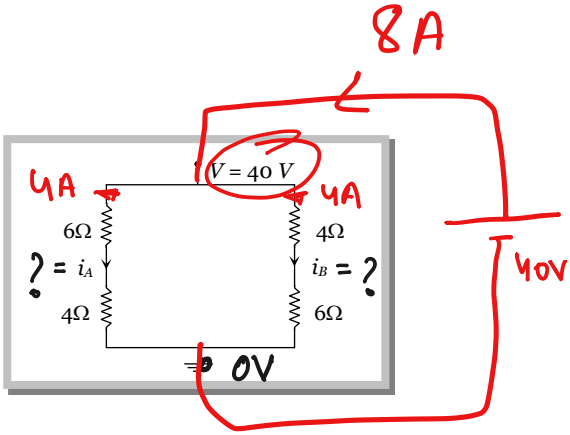
(a) $\frac{3}{2}A$
(b) $\frac{3}{4}A$
(c) $\frac{1}{2}A$
(d) 1 A

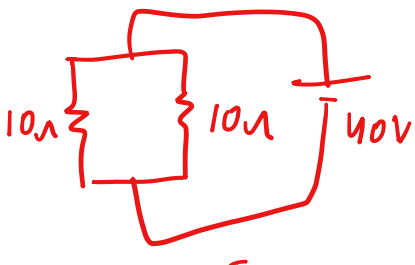


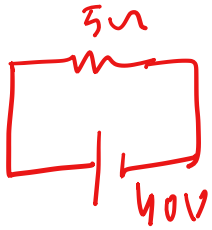


38. In the following circuit the value of currents i_A and i_B are

(a) 4 A, 3 A
(b) 3 A, 4 A
(c) 4 A, 4 A
(d) 3 A, 3 A



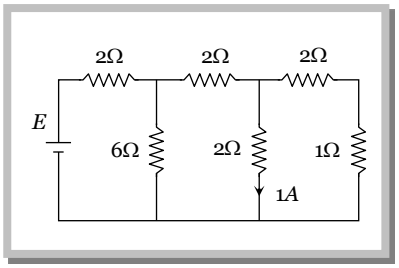




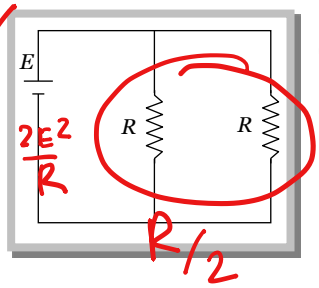
$i = 8$ A

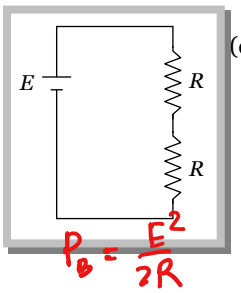
39. The emf of the battery shown in figure is

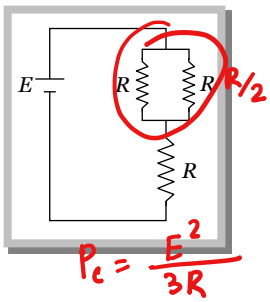
(a) 12 V
(b) 16 V
(c) 18 V
(d) 15 V

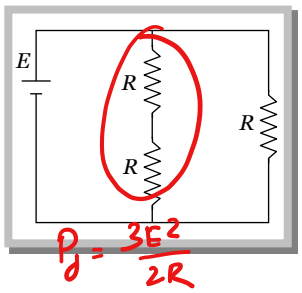


40. Consider four circuits shown in the figure below. In which circuit power dissipated s greatest ? (Neglect the internal resistance of the power supply)

(a)


(b)


(c)




41. In the steady state what will be the power dissipation in following circuit

(a) 1.5 W
(b) 2 W
(c) 1 W
(d) None of these