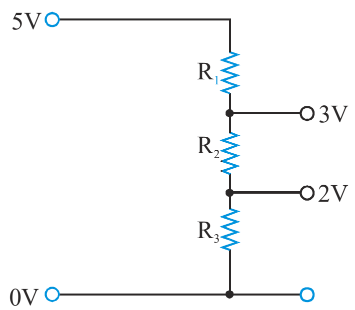
SOLVED EXAMPLES

Ex. 1 A potential divider is used to give outputs of 2V and 3V from a 5V source, as shown in figure. Which combination of resistances, R_1, R_2 and R_3 gives the correct voltages?

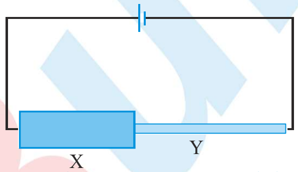


	R1	R2	R3
(A)	1 kΩ	1 kΩ	2 kΩ
(B)	2 kΩ	1 kΩ	2 kΩ
(C)	3 kΩ	2 kΩ	2 kΩ
(D)	3 kΩ	2 kΩ	3 kΩ

Sol. For resistors in series connection, current (I) is the same through the resistors. In other words, ratio of the voltage drop across each resistor with its resistance is the same.

That is $I = \frac{5-3}{R_1} = \frac{3-2}{R_2} = \frac{2}{R_3}$ i.e., $R_1 : R_2 : R_3 = 2 : 1 : 2$.

Ex. 2 Figure shows a thick copper rod X and a thin copper wire Y, joined in series. They carry a current which is sufficient to make Y much hotter than X. Which one of the following is correct?

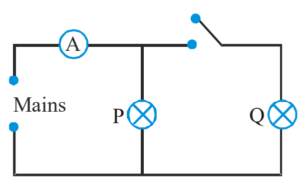


	Density of conduction electrons	Mean time between collisions of the electrons
(A)	Same in X and Y	Less in X than Y
(B)	Same in X and Y	Same in X and Y
(C)	Same in X and Y	More in X than Y
(D)	More in X than Y	less in X than Y

Sol. The number density n of conduction electrons in the copper is a characteristic of the copper and is about 10^{29} at room temperature for both the copper rod X and the thin copper wire Y.
Both X and Y carry the same current I since they are joined in series.
From $I = neAv_d$
We may conclude that rod X has a lower drift velocity of electrons compared to wire Y since rod X has larger cross-sectional area. This is so because the electrons in X collide more often with one another and with the copper ions when drifting towards the positive end. Thus, the mean time between collisions of the electrons is more in X and than in Y.

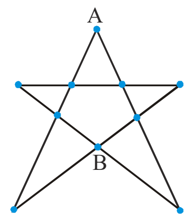
Ex. 3 How will the reading in the ammeter A of figure be affected if another identical bulb Q is connected in parallel to P as shown. The voltage in the mains is maintained at a constant value.

(A) The reading will be reduced to one-half
(B) The reading will not be affected
(C) The reading will be doubled of the previous one
(D) The reading will be increased four-fold



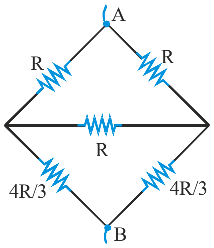
Sol. Resistance is halved . Current is doubled.

Ex. 4 The resistance of all the wires between any two adjacent dots is R. The equivalent resistance between A and B as shown in figure is



(A) $\frac{7}{3}$ R **(B)** $\frac{7}{6}$ R **(C)** $\frac{14}{8}$ R **(D)** None of these

Sol. Given circuit can be reduce to



$R_{AB} = \frac{7}{6}R$

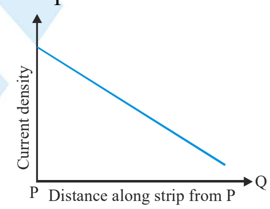
Ex. 5 An electric current flows along an insulated strip PQ of a metallic conductor. The current density in the strip varies as shown in the graph. Which one of the following statements could explain this variation?

(A) The strip is narrower at P than at Q

(B) The strip is narrower at Q than at P

(C) The potential gradient along the strip is uniform

(D) The resistance per unit length of the strip is constant

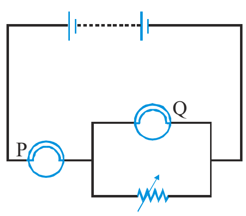


Sol. The current density at P is higher than at Q. For the same current flowing through the metallic conductor PQ, the cross-sectional area at P is narrower than at Q. The resistance per unit length r is given by $r = \frac{\rho}{A}$

where ρ is the resistivity and A is the cross-sectional area of the conductor PQ. Thus, r is inversely proportional to the cross-sectional area A of the conductor.

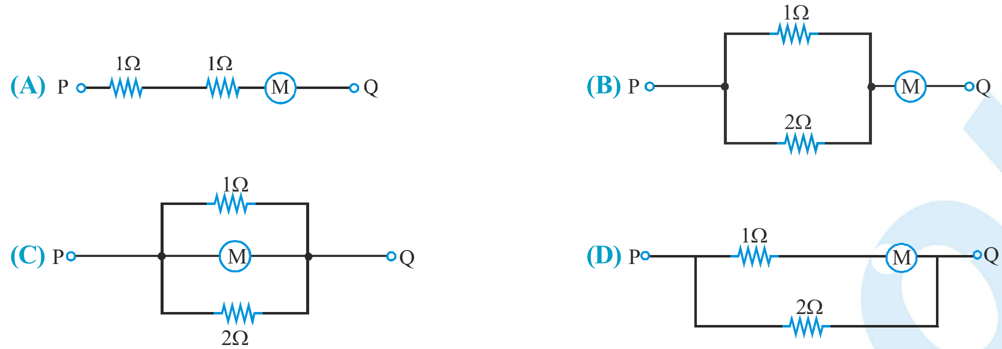
Ex. 6 The circuit shown in figure, contains a battery, a rheostat and two identical lamps. What will happen to the brightness of the lamps if the resistance of the rheostat is increased?

	Lamp P	**Lamp Q**
(A)	Less brighter	Brighter
(B)	Less brighter	Less brighter
(C)	Brighter	Less brighter
(D)	No change	Brighter



Sol. Consider two extreme cases. **(i)** When the resistance of the rheostat is zero, the current through Q is zero since Q is short-circuited. The circuit is then essentially a battery in series with lamp P. **(ii)** When the resistance of the rheostat is very large, almost no current flows through it. So, the currents through P and Q are almost equal. The circuit is essentially a battery in series with lamps P and Q.

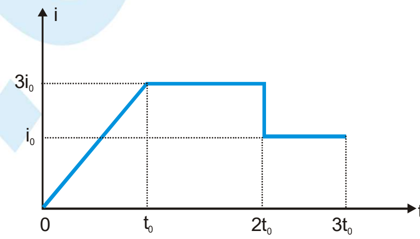
Ex. 7 In which one of the following arrangements of resistors does the ammeter M, which has a resistance of 2Ω, give the largest reading when the same potential difference is applied between points P and Q?



Sol. Let $V_{PQ} = E$

For **(A)**: $I = \frac{E}{4}$ For **(B)**: $I = \frac{E}{2/3 + 2} = \frac{E}{8/3}$ For **(C)**: $I = \frac{E}{2}$ For **(D)**: $I = \frac{E}{3}$

Ex. 8 A time varying current i is passed through a resistance R as shown in figure. The total heat generated in the resistance is



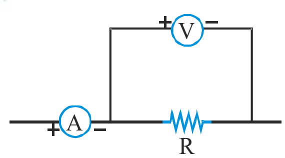
(A) $11 i_0^2 R t_0$ **(B)** $13 i_0^2 R t_0$

(C) $17 i_0^2 R t_0$ **(D)** $15 i_0^2 R t_0$

Sol. Total heat produced $= \int_0^{t_0} \left(\frac{3 i_0}{t_0} t\right)^2 R\,dt + (3 i_0)^2 R (2t_0 - t_0) + i_0^2 R (3t_0 - 2t_0) = 3 i_0^2 R t_0 + 9 i_0^2 R t_0 + i_0^2 R t_0 = 13 i_0^2 R t_0$

Ex. 9 A candidate connects a moving coil voltmeter V, a moving coil ammeter A and a resistance R as shown in figure. If the voltmeter reads 20 V and the ammeter reads 4A, R is

(A) equal to 5Ω
(B) greater than 5Ω
(C) less than 5Ω
(D) greater or less than 5Ω depending upon its material



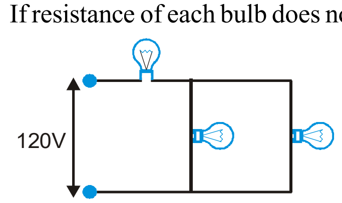
Sol. Let a current of x ampere passes through the voltmeter, then (4–x) ampere passes through the resistance R.

Therefore, voltmeter reading 20 = (40 – x) R $\therefore\ R = \frac{20}{4 - x}$, i.e., $R > 5\Omega$

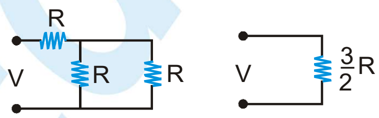
Ex. 10 Three 60W, 120V light bulbs are connected across a 120 V power source. If resistance of each bulb does not change with current then find out total power delivered to the three bulbs.

(A) 180 W **(B)** 20 W

(C) 40 W **(D)** 60 W



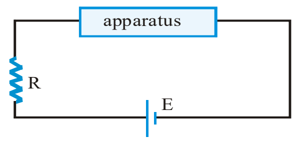
Sol.



Here $R = \frac{V^2}{P}$, Total power supplied

$= \frac{V^2}{3/2R} = \left(\frac{2}{3}\right)\left(\frac{V^2}{R}\right) = \frac{2}{3} \times 60 = 40\,W$

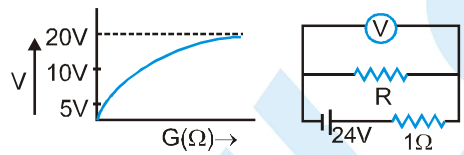
Ex. 11 An apparatus is connected to an ideal battery as shown in figure. For what value of current, power delivered to the apparatus will be maximum?



(A) $\frac{E}{R}$ **(B)** $\frac{E}{2R}$ **(C)** $\frac{E}{4R}$ **(D)** information insufficient

Sol. For maximum power $R_{ext} = R_{int} = R \therefore$ current $= \frac{E}{2R}$

Ex. 12 A cell of internal resistance 1Ω is connected across a resistor. A voltmeter having variable resistance is used to measure potential difference across resistor. The plot of voltmeter reading V against G is shown. What is value of external resistor R ? (G = Resistance of galvanometer)



(A) $5\,\Omega$ **(B)** $4\,\Omega$ **(C)** $3\,\Omega$ **(D)** can't be determined

Sol. When galvanometer resistance tends to infinity $G \to \infty$,

Potential difference across R is 20V $\Rightarrow 20 = 24 - i \times 1 \Rightarrow i = 4\,A$ also $20 = 4 \times R \Rightarrow R = 5\Omega$.

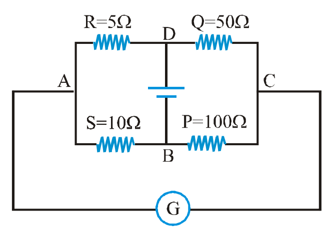
Ex. 13 Figure shows a balanced Wheatstone's bridge

(A) If P is slightly increased, the current in the galvanometer flows from C to A

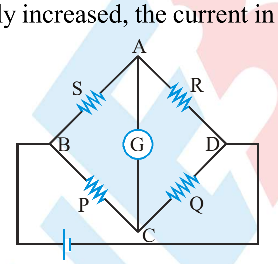
(B) If P is slightly increased, the current in the galvanometer flows from A to C

(C) If Q is slightly increased, the current in the galvanometer flows from C to A

(D) If Q is slightly increased, the current in the galvanometer flows from A to C

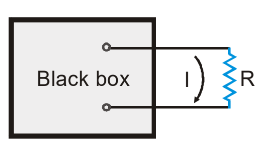


Sol.



If P is slightly increased, potential of C will decrease. Hence current will from A to C. If Q is slightly increased, potential of C will increases, hence current will flow from C to A.

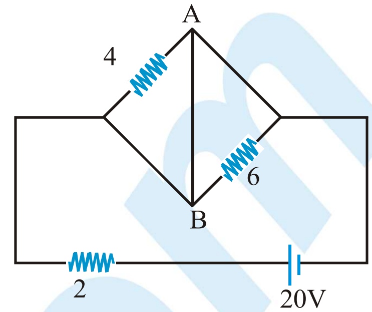
Ex. 14 In the given black box unknown emf sources and unknown resistances are connected by an unknown method such that (i) when terminals of 10 ohm resistances are connceted to box then 1 ampere current flows and (ii) when 18 ohm resistances are connected then 0.6 A current flows then for what value of resistance does 0.1 A current flow?



(A) $118\,\Omega$ **(B)** $98\,\Omega$ **(C)** $18\,\Omega$ **(D)** $58\,\Omega$

Sol. **(A,B)**

Ex. 15 In the circuit shown in figure.



(A) power supplied by the battery is 200W

(B) current flowing in the circuit is 5A

(C) potential difference across the 4Ω resistance is equal to the potential difference across the 6Ω resistance

(D) current in wire AB is zero.

Sol. **(ACD)**

4Ω and 6Ω resistor are short-circuited. Therefore, no current will flow through these resistances. Current passing through the battery is I = (20/2) = 10A. This is also the current passing in wire AB from B to A.
Power supplied by the battery P = EI = (20) (10) = 200W
Potential difference across the 4Ω resistance = potential difference across the 6Ω resistance.

Ex. 16 to 18

An ammeter and a voltmeter are connected in series to a battery with an emf of 10V. When a certain resistance is connected in parallel with the voltmeter, the reading of the voltmeter decreases three times, whereas the reading of the ammeter increases the two times.

16. Find the voltmeter reading after the connection of the resistance.

(A) 1V **(B)** 2V **(C)** 3V **(D)** 4V

17. If resistance of the ammeter is 2Ω, then resistance of the voltmeter is :–

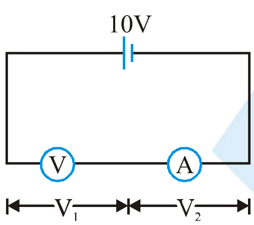
(A) 1Ω **(B)** 2Ω **(C)** 3Ω **(D)** 4Ω

18. If resistance of the ammeter is 2Ω, then resistance of the resistor which is added in parallel to the voltmeter is :–

(A) $\frac{3}{5}\Omega$ **(B)** $\frac{2}{7}\Omega$ **(C)** $\frac{3}{7}\Omega$ **(D)** None of these

Sol.

16.

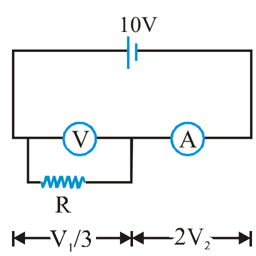


Initially $V_1 + V_2 = 10V$ ...**(i)**

Finally $\frac{V_1}{3} + 2V_2 = 10V$ ...**(ii)**

From equation **(i)** & **(ii)** We get $V_1 = 6$ volt, $V_2 = 4$ volt

$\therefore$ Final reading $= \frac{V_1}{3} = 2$ volt

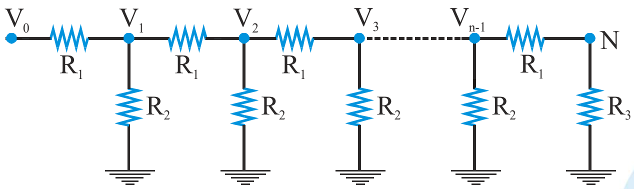


17. $\frac{V_1}{V_2} = \frac{R_A}{R_V} = \frac{4}{6}$ & $R_A = 2\Omega \Rightarrow R_V = 3\Omega$

18. $\frac{\frac{R_V R}{R_V + R}}{R_A} = \frac{\frac{V_1}{3}}{2V_2} = \frac{1}{4} \Rightarrow R = \frac{3}{5}\Omega$

Ex. 19 to 21

A network of resistance is constructed with R_1 and R_2 as shown in figure. The potential at the points 1, 2, 3.... N are V_1, V_2, V_3,.......V_N, respectively, each having a potential k times smaller than the previous one.



19. The ratio $\frac{R_1}{R_2}$ is

(A) $k^2 - \frac{1}{k}$ **(B)** $\frac{k}{k-1}$ **(C)** $k - \frac{1}{k^2}$ **(D)** $\frac{(k-1)^2}{k}$

20. The ratio $\frac{R_2}{R_3}$ is

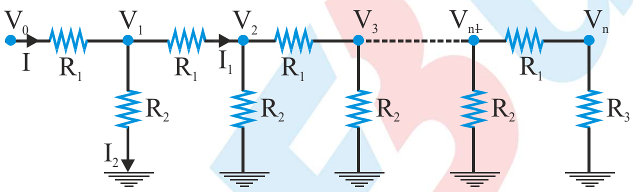
(A) $\frac{(k-1)^2}{k}$ **(B)** $k^2 - \frac{1}{k}$ **(C)** $\frac{k}{k-1}$ **(D)** $k - \frac{1}{k^2}$

21. The current that passes through the resistance R_2 nearest to the V_0 is

(A) $\frac{(k-1)^2}{k}\frac{V_0}{R_3}$ **(B)** $\frac{(k+1)^2}{k}\frac{V_0}{R_3}$ **(C)** $\left(k+\frac{1}{k^2}\right)\frac{V_0}{R_3}$ **(D)** $\left(k-\frac{1}{k^2}\right)\frac{V_0}{R_3}$

Sol.

19.



Given $V_1 = \frac{V_0}{k}, V_2 = \frac{V_1}{k}, V_3 = \frac{V_2}{k}; I = I_1 + I_2$

$$\frac{V_o - V_1}{R_1} = \frac{V_1 - V_2}{R_1} + \frac{V_1 - 0}{R_2} \Rightarrow \frac{V_0 - V_1/k}{R_1} = \frac{V_0/k - V_0/k^2}{R_1} + \frac{V_0/k}{R_2} \Rightarrow \frac{R_1}{R_2} = \frac{(k-1)^2}{k}$$

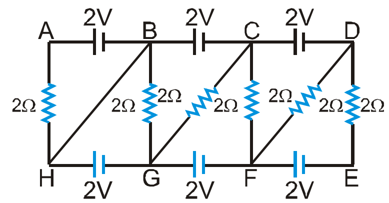
20. Current in R_1 and R_3 will be same : $\frac{V_{n-1} - V_n}{R_1} = \frac{V_n}{R_3} \Rightarrow \frac{V_{n-1} - \frac{V_{n-1}}{k}}{R_1} = \frac{V_{n-1}}{kR_3} \Rightarrow R_1 = R_3(k-1)$

Put the value of R_1 in **(i)** $\frac{R_2}{R_3} = \frac{k}{k-1}$

21. Current in R_2 nearest to V_0 : $I_2 = \frac{V_1}{R_2} = \frac{V_0/k}{R_3\left(\frac{k}{k-1}\right)} = \left(\frac{k-1}{k^2}\right)\frac{V_0}{R_3}$

Ex. 22 to 24

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



22. The potential difference $V_D - V_E$ is-

(A) $\frac{5}{6}$V **(B)** $\frac{6}{5}$V **(C)** $-\frac{5}{6}$V **(D)** $-\frac{22}{9}$V

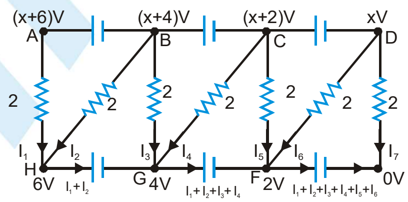
23. The current through branch BG is-

(A) 1A **(B)** 0.2A **(C)** 0.4A **(D)** 0.6A

24. The current through battery between A & B is-

(A) 0.6 A **(B)** 0.8 A **(C)** 0.4 A **(D)** 1 A

Sol.



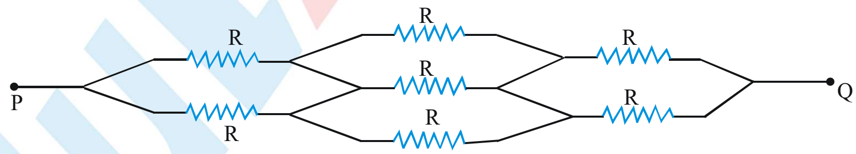
22. $I_1 + I_2 + I_3 + I_4 + I_5 + I_6 = I_7$

$$\Rightarrow \frac{x}{2} + \frac{x-2}{2} + \frac{x}{2} + \frac{x-2}{2} + \frac{x}{2} + \frac{x-2}{2} = \frac{x}{2} \Rightarrow x = \frac{6}{5}V$$

23. Current through branch BG : $I_3 = \frac{x}{2} = \frac{6}{10} = 0.6\,A$

24. Current through branch AB = $I_1 = \frac{x}{2} = 0.6\,A$

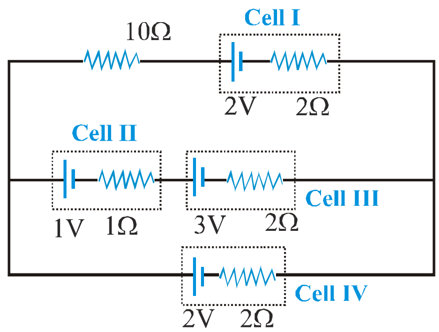
Ex. 25 Equivalent resistance for the given figure between P and Q is NR/3. Find value of N.



Sol.

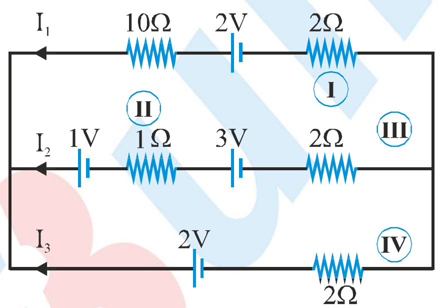
$R_{net} = \frac{4R}{3} \Rightarrow N = 4$

Ex. 26 For the circuit shown in figure, 4 cells are arranged. In column I, the cell number is given while in column II, some statements related to cells are given. Match the entries of column I with the entries of column II.



Column I	Column II
(A) Cell I	**(P)** Chemical energy of cell is decreasing.
(B) Cell II	**(Q)** Chemical energy of cell is increasing.
(C) Cell III	**(R)** Work done by cell is positive.
(D) Cell IV	**(S)** Thermal energy developed in cell is positive.
	(T) None of these

Sol. We have, $I_1 = -\frac{2}{33}A, I_2 = \frac{14}{33}A, I_3 = -\frac{12}{33}A$



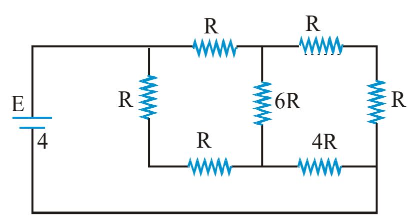
In each cell thermal energy will be dissipated due to internal resistance whether the chemical energy of the cell is increasing or decreasing.

(i) Cell I is getting charged, hence its chemical energy increases.

(ii) Cell II and III both are getting discharged, hence their chemical energy is decreasing. So, work done by both of them is positive.

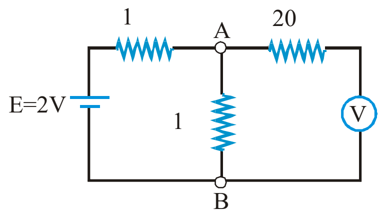
(iv) Cell IV is getting charged, hence its chemical energy increases.

Ex. 27 A battery of internal resistance 4Ω is connected to the network of resistances as shown in figure. In order that the maximum power can be delivered to the network, the value of R in Ω should be



Sol. For maximum power, external resistance is equal to internal resistance. Therefore, 2R = 4 or R =2

Ex. 28 In the given circuit, the voltmeter and the electric cell are ideal. Find the reading of the voltmeter (in volt)



Sol. The electric current through ideal voltmeter is zero.

According to loop rule, $E - 1 \times I - 1 \times I = 0 \Rightarrow I = \frac{E}{2} = \frac{2}{2} = 1\,A$

Reading of the voltmeter $= V_A - V_B = [1 \times I] = [1 \times 1] = 1V$

Ex. 29 A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross-section but of length 2L. The temperature of the wire is raised by the same amount ΔT in the same time t, the value of N is

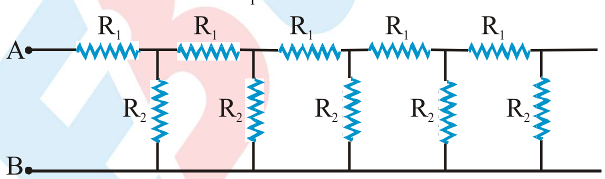
Sol. Let R be the resistance of wire. Let R' be the resistance of another wire so R'=2R ($\because$ Length is twice)

In case **(i)** Energy released in t second $= \frac{(3V)^2}{R} \times t$ In case **(ii)** $\therefore$ Energy released in t-seconds $= \frac{(N^2V^2)}{2R} \times t$

But $Q = mc\Delta T$ $\therefore mc\Delta T = \frac{(9V^2)}{R} \times t$ ...**(i)** Applying $Q' = m'c\Delta T \Rightarrow 2mc\Delta T = \frac{(N^2V^2)}{2R} \times t$...**(ii)**

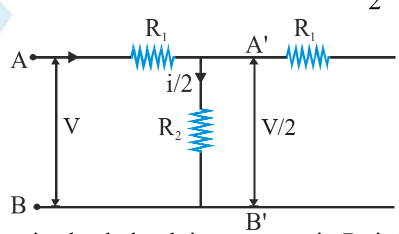
Dividing equation **(ii)** by equation **(i)** $\frac{mc\Delta T}{2mc\Delta T} = \frac{9V^2 \times t/R}{N^2V^2 \times t/2R}$ $\therefore \frac{1}{2} = \frac{9 \times 2}{N^2}$ $\Rightarrow N^2 = 18 \times 2$ $\therefore N = 6$

Ex. 30 Consider an infinite ladder of network shown in figure. A voltage is applied between points A and B. If the voltage is halved after each section, find the ratio of $\frac{R_2}{R_1}$.



Sol. Voltage across AB = V, Voltage across A'B' $= \frac{V}{2}$ i.e., Voltage across $R_2 = \frac{V}{2}$

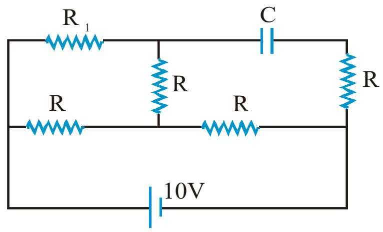
Now from Kirchhoff's law it is obvious that voltage across $R_1 = V - \frac{V}{2} = \frac{V}{2}$



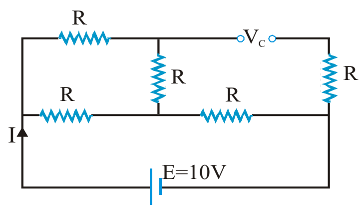
When the voltage is halved, current is also halved, i.e., current in R_2 is half of that in R_1.

So $R_1 i = R_2 \frac{i}{2} \Rightarrow \frac{R_2}{R_1} = 2$

Ex. 31 Find the potential difference across the capacitor in volts.

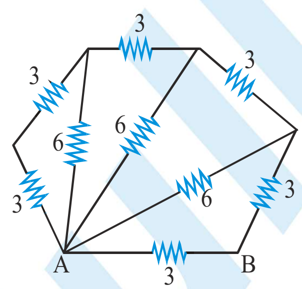


Sol.

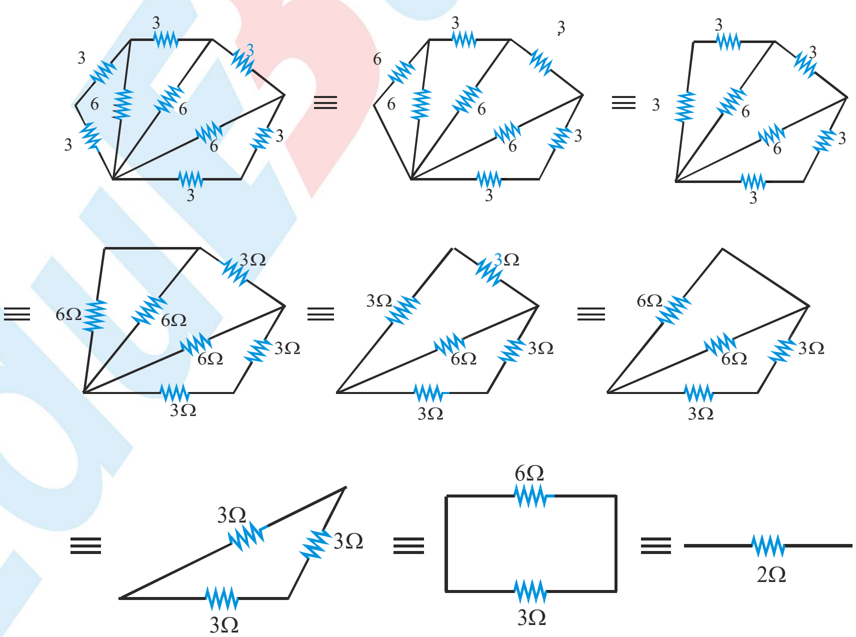


In steady state $I = \dfrac{E}{2\,R/3 + R} = \dfrac{3E}{5R}$; $V_C = E - \dfrac{IR}{3} = E - \dfrac{E}{5} = \dfrac{4E}{5} = 8$ Volts

Ex. 32 All resistances in the diagram below are in ohms. Find the effective resistance between the point A and B (in Ω).



Sol. The given system can be reduced as shown in figure.

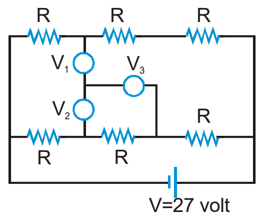


Ex. 33 How much time heater will take to increase the temperature of 100 g water by 50°C if resistance of heating coil is 484Ω and supply voltage is 220V a.c.

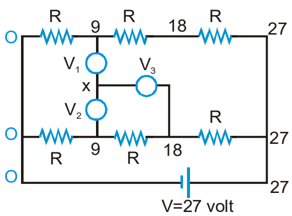
Sol. Heat given by heater = heat taken by water $\Rightarrow \frac{V^2}{R}t = ms\,J\Delta\theta \Rightarrow \frac{220\times220}{484}$

$t = (100\times10^{-3})(4.2\times10^{3})(50) \Rightarrow t = 210\text{ s}$

Ex. 34 In the circuit shown below, all the voltmeter identical and have very high resistance. Each resistor has the same resistance. The voltage of the ideal battery shown is 27 V. Find the reading of voltmeter V_3 (in volts).

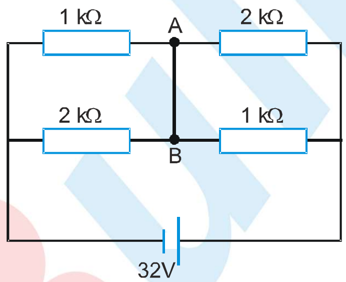


Sol.

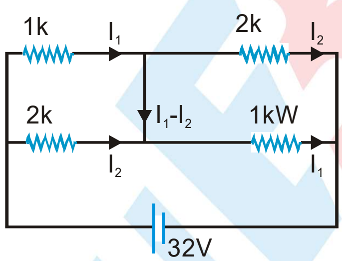


$\frac{x-9}{R_V}+\frac{x-9}{R_V}+\frac{x-18}{R_V}=0 \Rightarrow x = 12 \quad \therefore V_3 = 6\text{ volt}$

Ex. 35 In the given circuit, find the current (in mA) in the wire between points A and B.



Sol.



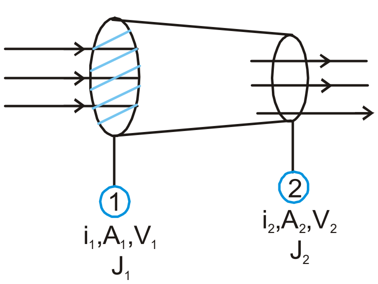
$I_1 = 16\text{ mA}; I_2 = 8\text{mA} \Rightarrow I_1 - I_2 = 8\text{mA}$

Ex. 36 Current is flowing from a conductor of non-uniform cross section area if $A_1 > A_2$ then find relation between

(A) i_1 and i_2 **(B)** j_1 and j_2

(C) v_1 and v_2 (drift velocity)

where i is current, j is current density and V is drift velocity.



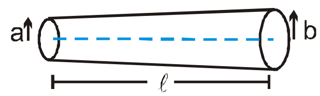
Sol. **(A)** i = charge flowing through a cross-section per unit time.

$\therefore i_1 = i_2$

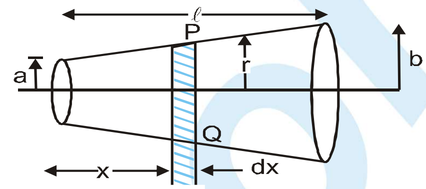
(B) $j = \frac{i}{A}$ as $A_1 > A_2$ then $j_1 < j_2$

(C) $j = nev_d \Rightarrow v_d = \frac{j}{ne}$ as $j_1 < j_2$ then, $v_1 < v_2$

Ex. 37 Figure shows a conductor of length ● having a circular cross-section. The radius of cross-section varies linearly from a to b. The resistivity of the material is ρ. Find the resistance of the conductor.



Sol. In this problem cross–section area is variable so we can't apply formula $\left(R = \frac{\rho l}{A}\right)$ directly.



So we assume elementary strip 'PQ' of thickness dx

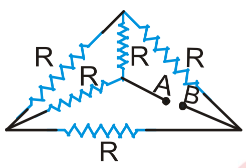
and radius r resistance of this strip is : $dR = \frac{\rho dx}{\pi r^2}$

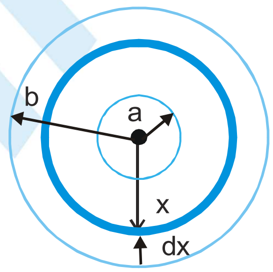
By geometry $= \frac{r-a}{x} = \frac{b-a}{l} \Rightarrow \quad r = \frac{b-a}{l}x + a$

resistance of conductor is

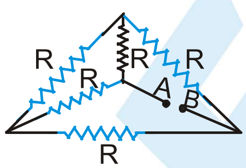
$$R = \int_0^l \frac{\rho dx}{\pi \left\{\frac{b-a}{l}x + a\right\}^2} \Rightarrow \quad R = \frac{\rho l}{\pi ab}$$ **Ans.**

Ex. 38. Find the equivalent Resistance between A and B

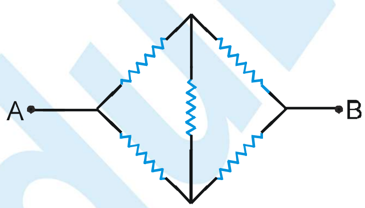


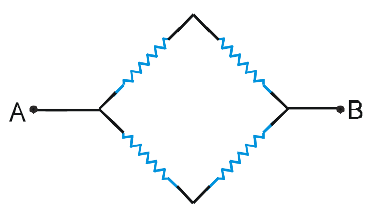


Sol.



Putting A out of the structure in the same plane





$$R_{eq} = \frac{2R \times 2R}{2R + 2R} = R$$ **Ans. : Req = R**

Ex. 39 A cylindrical tube of length ● has inner radius a while outer radius b. What is the resistance of the tube between **(A)** its ends **(B)** its inner and outer surfaces ? (the resistivity of its material is ρ)

Sol. **(A)** $A = \pi(b^2 - a^2)$

$$R = \frac{\rho l}{\pi(b^2 - a^2)}$$

(B) $d_R = \frac{\rho dx}{2\pi x l}$ for a section taken at distance x from centre.

$$d_R = \frac{\rho}{2\pi l} \cdot \frac{dx}{x} \quad \Rightarrow \quad R = \int dR = \frac{\rho}{2\pi l}\int_a^b \frac{dx}{x} = \frac{\rho}{2\pi l} \text{●n} \frac{b}{a}$$

Ex. 40 How can we convert a galvanometer with $R_g = 20\ \Omega$ and $i_g = 1.0$ mA into a voltmeter with a maximum range of 10 V ?

Sol. $v = i_g R_S + i_g R_g$

$$10 = 1 \times 10^{-3} \times R_s + 1 \times 10^{-3} \times 20$$

$$R_S = \frac{10 - 0.02}{1 \times 10^{-3}} = \frac{9.98}{10^{-3}} = \mathbf{9980\ \Omega}$$

Ex. 41 What shunt resistance is required to convert the 1.0 mA, 20Ω galvanometer into an ammeter with a range of 0 to 50mA ?

Sol. $i_g R_g = (i - i_g)S$

$i_g = 1.0 \times 10^{-3}$ A , $G = 20\Omega$

$i = 50 \times 10^{-3}$ A

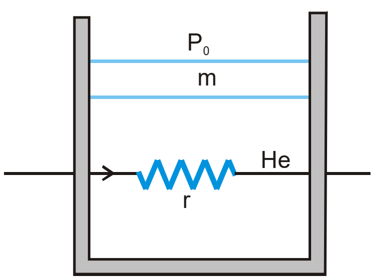
$$S = \frac{i_g R_g}{i - v_g} = \frac{1 \times 10^{-3} \times 20}{49 \times 10^{-3}} = 0.408\ \Omega$$

Ex. 42 A resistance coil of resistance r connected to an external battery, is placed inside an adiabatic cylinder fitted with a frictionless piston of mass m and same area A. Initially cylinder contains one mole of ideal gas He. A current I flows through the coil such that temperature of gas varies as $T = T_0 + at + bt^2$, keeping pressure constant with time t.

Atmosphere pressure above piston is P_0. Find

(A) current I flowing through the coil as function of time and

(B) speed of piston as function of time.



Sol. Heat produced by coil inside the cylinder in time dt is

$$dQ = I^2 r\, dt \qquad ....\text{(i)}$$

(A) As we know

$\Rightarrow$ $dQ = nC_p dT$ ...**(ii)**

$$I^2 r\, dt = \frac{5R}{2} dT \qquad \left(C_p = \frac{5R}{2}\right)$$

Here $T = T_0 + at + bt^2 \Rightarrow \frac{dT}{dt} = (a + 2bt)$

$$I = \sqrt{\left[\frac{5R}{2r}(2bt + a)\right]} \qquad \text{...(ii)}$$

$$\left(C_p = \frac{5R}{2}\right)$$

Pressure is constant

$PV = RT \Rightarrow \quad PdV = RdT$

$PA\, dx = RdT$

Velocity $v = \frac{dx}{dt} = \frac{R}{PA} \cdot \frac{dT}{dt} = \frac{R}{PA}(2bt + a)$ (here $P_0A + mg = PA$)

$$= \frac{R}{P_0 A + mg}(2bt + a)$$

Ex. 43 A Potentiometer wire of 10 m length and having 10 ohm resistance, emf 2 volts and a rheostat. If the potential gradient is 1 micro volt/mm, the value of resistance in rheostat in ohms will be :
(A) 1.99 **(B)** 19.9 **(C)** 199 **(D)** 1990

Sol. $d = 10$ m , $R = 10\Omega$,

$E = 2$volts , $\frac{dv}{dl} = 1\mu$ v/mm

$$\frac{dv}{dl} = \frac{1\times10^{-6}}{1\times10^{-3}} \text{ v/m} = 1 \times 10^{-3} \text{ v/m}$$

Across wire potential drop ,

$$\frac{dv}{dl} \times \bullet = 1 \times 10^{-3} \times 10 = 0.01 \text{ volts}$$

$$i = \frac{0.01}{10} = 0.001 = \frac{E}{R + R'} \quad (R' = \text{resistance of rheostat})$$

$$R' = \frac{E}{0.001} - R = \frac{2}{0.001} - 10 = 2000 - 10 = 1990\ \Omega$$

Exercise # 1 [Single Correct Choice Type Questions]

1. A current I flows through a uniform wire of diameter d when the mean electron drift velocity is v. The same current will flow through a wire of diameter d/2 made of the same material if the mean drift velocity of the electron is

(A) v/4 **(B)** v/2 **(C)** 2v **(D)** 4v

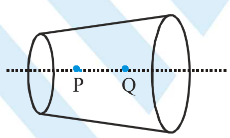
2. Two wires each of radius of cross section r but of different materials are connected together end to end (in series). If the densities of charge carries in the two wires are in the ratio 1:4, the drift velocity of electrons in the two wires will be in the ratio :

(A) 1:2 **(B)** 2:1 **(C)** 4:1 **(D)** 1:4

3. An insulating pipe of cross–section area 'A' contains an electrolyte which has two types of ions : their charges being –e and +2e. A potential difference applied between the ends of the pipe result in the drifting of the two types of ions, having drift speed = v (–ve ion) and v/4 (+ve ion). Both ions have the same number per unit volume = n. The current flowing through the pipe is

(A) nev A/2 **(B)** nev A/4 **(C)** 5nev A/2 **(D)** 3nev A/2

4. 45 A wire has a non–uniform cross–section as shown in figure. A steady current flows through it. The drift speed of electrons at points P and Q is v_P and v_Q



(A) $v_P = v_Q$ **(B)** $v_P < v_Q$ **(C)** $v_P > v_Q$ **(D)** data insufficient

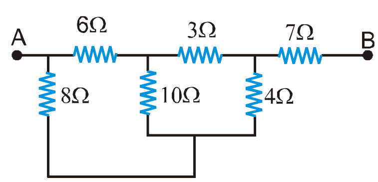
5. A wire of resistance R is stretched to double its length. Its new resistance is

(A) R **(B)** R/2 **(C)** 4R **(D)** R/4

6. Three copper wires have their lengths in the ratio 5 : 3 : 1 and their masses are in the ratio 1 : 3 : 5. Their electrical resistance will be in the ratio

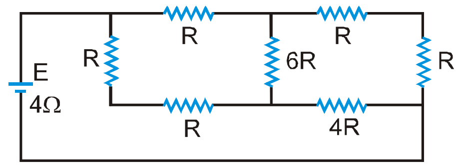
(A) 5 : 3 : 1 **(B)** 1 : 3 : 5 **(C)** 125 : 15 : 1 **(D)** 1 : 15 : 125.

7. The equivalent resistance between the points A and B is–



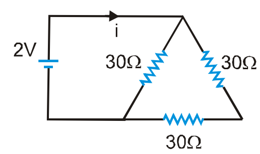
(A) $\frac{36}{7}\ \Omega$ **(B)** 10 Ω **(C)** $\frac{85}{7}\ \Omega$ **(D)** none of these

8. A battery of internal resistance 4Ω is connected to the network of resistance as shown. In order that the maximum power can be delivered to the network, the value of R in Ω should be :–



(A) $\frac{4}{9}$ **(B)** 2 **(C)** $\frac{8}{3}$ **(D)** 18

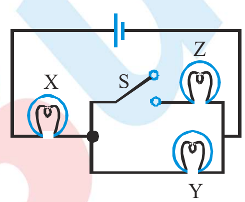
9. The current i in the circuit (see figure) is :



(A) $\frac{1}{45}$ A **(B)** $\frac{1}{15}$ A **(C)** $\frac{1}{10}$ A **(D)** $\frac{1}{5}$ A

10. A battery of internal resistance 2Ω is connected to a variable resistor whose value can vary from 4Ω to 10 Ω. 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

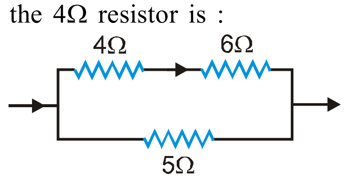
11. If X, Y and Z in figure are identical lamps, which of the following changes to the brightness of the lamps occur when switch S is closed?



(A) X stays the same, Y decreases **(B)** X increases, Y decreases
(C) X increases, Y stays the same **(D)** X decreases, Y increases

12. Two heating coils, one of fine wire and the other of thick wire made of same material and of same length are connected in series and then in parallel. Which of the following statements is correct
(A) In series fine wire liberates more energy while in parallel thick wire liberates more energy
(B) In series fine wire liberates less energy while in parallel thick wire liberates less energy
(C) In series thick wire liberates more energy while in parallel it liberates less energy
(D) Both wires liberates equal energies in series and in parallel

13. In the circuit shown in figure the heat produced in the 5Ω resistor due to the current flowing through it is 10 cal/s. The heat generated in the 4Ω resistor is :



(A) 1 cal/s **(B)** 2 cal/s **(C)** 3 cal/s **(D)** 4 cal/s

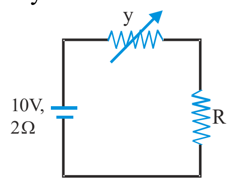
14. A storage battery is connected to a charger for charging with a voltage of 12.5 volts. The internal resistance of the storage battery is 1Ω.When the charging current is 0.5 A, the emf of the storage battery is

(A) 13 volts **(B)** 12.5 volts **(C)** 12 volts **(D)** 11.5 volts

15. A galvanometer has a resistance of 20Ω and reads full–scale when 0.2V is applied across it. To convert it into a 10A ammeter, the galvanometer coil should have a

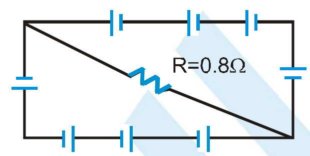
(A) 0.01 Ω resistor connected across it **(B)** 0.02 Ω resistor connected across it
(C) 200 Ω resistor connected in series with it **(D)** 2000 Ω resistor connected in series with it

16. In the figure shown the power generated in y is maximum when y=5Ω then R is



(A) 2Ω **(B)** 6Ω **(C)** 5Ω **(D)** 3Ω

17. A circuit is comprised of eight identical batteries and a resistor R = 0.8Ω. Each battery has an emf of 1.0 V and internal resistance of 0.2Ω. The voltage difference across any of the battery is

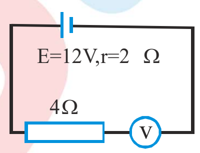


(A) 0.5 V **(B)** 1.0V **(C)** 0V **(D)** 2V

18. A galvanometer coil has a resistance 90Ω and full scale deflection current 10mA. A 910 Ω resistance is connected in series with the galvanometer to make a voltmeter. If the least count of the voltmeter is 0.1V, the number of divisions on its scale is

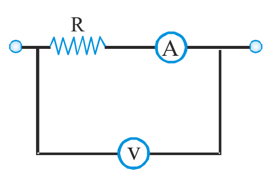
(A) 90 **(B)** 91 **(C)** 100 **(D)** None

19. By error, a student places moving–coil voltmeter V (nearly ideal) in series with the resistance in a circuit in order to read the current, as shown. The voltmeter reading will be



(A) 0 **(B)** 4V **(C)** 6V **(D)** 12V

20. In the circuit shown the resistance of voltmeter is 10,000 ohm and that of ammeter is 20 ohm. The ammeter reading is 0.10 Amp and voltmeter reading is 12 volt. Then R is equal to

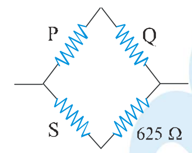


(A) 122 Ω **(B)** 140Ω **(C)** 116 Ω **(D)** 100Ω

21. The length of a potentiometer wire is ●. A cell of emf E is balanced at a length ●/3 from the positive end of the wire. If the length of the wire is increased by ●/2 at what distance will the same cell give a balanced point

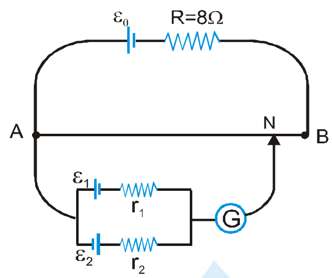
(A) $\frac{21}{3}$ **(B)** $\frac{1}{2}$ **(C)** $\frac{1}{6}$ **(D)** $\frac{41}{3}$

22. A Wheatstone's bridge is balanced with a resistance of 625Ω in the third arm, where P, Q and S are in the 1st, 2nd and 4th arm respectively. If P and Q are interchanged, the resistance in the third arm has to be increased by 51Ω to secure balance. The unknown resistance in the fourth arm is



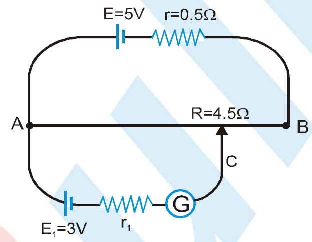
(A) 625 Ω **(B)** 650Ω **(C)** 676Ω **(D)** 600Ω

23. A battery of emf E_0 =12V is connected across a 4m long uniform wire having resistance $\frac{4\Omega}{m}$. The cells of small emfs ε_1=2V and ε_2=4V having internal resistance 2Ω and 6Ω respectively, are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to



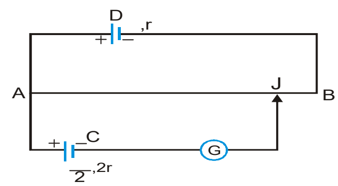
(A) $\frac{1}{6}$m **(B)** $\frac{1}{3}$m **(C)** 25cm **(D)** 50cm

24. In the given potentiometer circuit length of the wire AB is 3m and resistance is R=4.5Ω. The length AC for no deflection in galvanometer is



(A) 2m **(B)** 1.8m **(C)** dependent on r_1 **(D)** None of these

25. In the figure, the potentiometer wire AB of length L and resistance 9r is joined to the cell D of emf ε and internal resistance r. The cell C's emf is $\frac{\varepsilon}{2}$ and its internal resistance is 2r. The galvanometer G will show no deflection when the length AJ is



(A) $\frac{4L}{9}$ **(B)** $\frac{5L}{9}$ **(C)** $\frac{7L}{18}$ **(D)** $\frac{11L}{18}$

26. Two bulbs rated (25W– 220V) and (100W–220V) are connected in series to a 440 V line. Which one is likely to fuse?
(A) 25W bulb **(B)** 100 W bulb **(C)** both bulbs **(D)** None

27. A constant voltage is applied between the two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled if

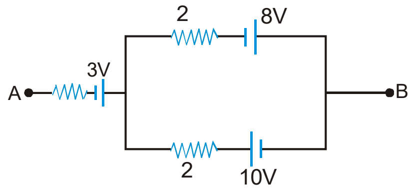
(A) both the length and the radius of the wire are halved

(B) both the length and the radius of the wire are doubled

(C) the radius of the wire is doubled

(D) the length of the wire is doubled

28. The net emf and internal resistance of three batteries as shown in figure is :

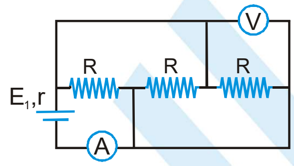


(A) 2V, 1Ω **(B)** 2V, 2Ω **(C)** 2V, 1.5Ω **(D)** 4V, 2Ω

29. If the length of the filament of a heater is reduced by 10%, the power of the heater will
(A) increase by about 9% **(B)** increase by about 11%
(C) increase by about 19% **(D)** decrease by about 10%

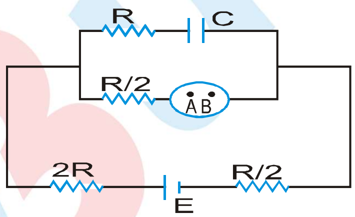
30. The equivalent resistance of a group of resistances is R. If another resistance is connected in parallel to the group, its new equivalent becomes R_1 and if it is connected in series to the group, it new equivalent becomes R_2 we have
(A) $R_1>R$ or $R_2>R$ **(B)** $R_1<R$ or $R_2>R$ **(C)** $R_1>R$ or $R_2<R$ **(D)** $R_1<R$ or $R_2<R$

31. In the circuit shown in figure, ammeter and voltmeter are ideal. If E = 4V, R = 9Ω and r = 1Ω, then readings of ammeter and voltmeter are



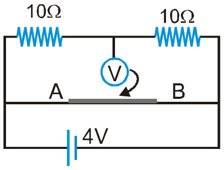
(A) 1A, 3V **(B)** 2A, 3V **(C)** 3A, 4V **(D)** 4A, 4V

32. A conducting solid sphere is joined in an electrical circuit as shown in figure. Two imaginary points A and B are taken inside the sphere. For given conditions-



(A) $V_A > V_B$ **(B)** $V_A < V_B$ **(C)** $V_A = V_B$ **(D)** Data insufficient

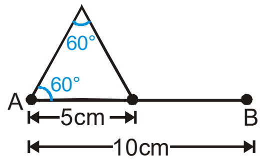
33. In the adjacent circuit, AB is a potentiometer wire of length 40 cm and resistance per unit length 50 Ω/m. As shown in the figure, the free end of an ideal voltmeter is touching the potentiometer wire. What should be the velocity of the jockey as a function of time so that reading in the voltmeter varies with time as (2 sin πt)?



(A) (10 π sin πt) cm/s **(B)** (10 π cos πt) cm/s **(C)** (20π sin πt) cm/s **(D)** (20 π cos πt) cm/s

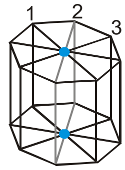
34. An electric bell has a resistance of 5Ω and requires a current of 0.25 A to work it. Assuming that the resistance of the bell wire is 1Ω per 15m and that the bell push is 90m distance from the bell. How many cells each of emf1.4V and internal resistance 2Ω, will be required to work the circuit-
(A) 3 **(B)** 4 **(C)** 5 **(D)** Can't be determined

35. A wire has resistance of 24 Ω is bent in the following shape. The effective resistance between A and B is-



(A) 24 Ω (B) 10 Ω (C) $\frac{16}{3}\Omega$ (D) None of these

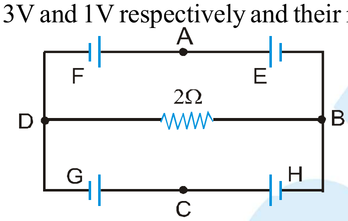
36. In the diagram shown, all the wires have resistance R. The equivalent resistance between the upper and lower dots shown in the diagram is



(A) R/8 (B) R (C) 2R/5 (D) 3R/8

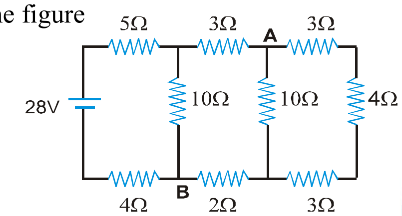
Exercise # 2 Part # I [Multiple Correct Choice Type Questions]

1. In the circuit shown E, F, G and H are cells of e.m.f. 2V, 1V, 3V and 1V respectively and their internal resistances are 2W, 1W, 3W and 1W respectively then-



(A) $V_D - V_B = -2/13V$
(B) $V_D - V_B = 2/13\ V$
(C) $V_G = 21/13V$ = potential difference across G
(D) $V_H = 19/13\ V$ = potential difference across H

2. Consider the circuit shown in the figure



(A) The current in the 5W resistor is 2A
(B) The current in the 5W resistor is 1A
(C) The potential difference $V_A - V_B$ is 7V
(D) The potential difference $V_A - V_B$ is 5V

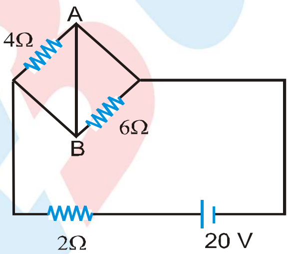
3. A current passes through a wire of nonuniform cross section. Which of the following quantities are independent of the cross–section?

(A) The charge crossing in a given time interval
(B) Drift speed
(C) Current density
(D) Free–electron density

4. The charge flowing through a resistance R varies with time as $Q = 2t - 8t^2$. The total heat produced in the resistance is (for $0 \le t \le \frac{1}{8}$)

(A) $\frac{R}{6}$ joules
(B) $\frac{R}{3}$ joules
(C) $\frac{R}{2}$ joules
(D) R joules

5. In the circuit shown in figure–

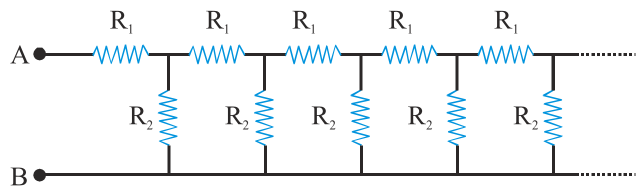


(A) Power supplied by the battery is 200 watt
(B) Current flowing in the circuit is 5 A
(C) Potential difference across 4 W resistance is equal to the potential difference across 6W resistance
(D) Current in wire AB is zero

6. In a potentiometer arrangement E_1 is the cell establishing current in primary circuit E_2 is the cell to be measured. AB is the potentiometer wire and G is a galvanometer. Which of the following are the essential condition for balance to be obtained

(A) The emf of E_1 must be greater than the emf of E_2
(B) Either the positive terminals of both E_1 and E_2 or the negative terminals of both E_1 and E_2 must be joined to one end of potentiometer wire
(C) The positive terminals of E_1 and E_2 must be joined to one end of potentiometer wire
(D) The resistance of G must be less than the resistance of AB

7. Consider an infinite ladder network shown in figure. A voltage V is applied between the points A and B. This applied value of voltage is halved after each section. Then-



(A) $\frac{R_1}{R_2} = 1$ **(B)** $\frac{R_1}{R_2} = \frac{1}{2}$ **(C)** $\frac{R_1}{R_2} = 2$ **(D)** $\frac{R_1}{R_2} = 3$

8. In a balanced wheat stone bridge, current in the galvanometer is zero. It remains zero when

(A) battery emf is increased **(B)** all resistances are increased by 10 ohms

(C) all resistances are made five times **(D)** the battery and the galvanometer are interchanged

9. A battery is of emf E is being charged from a charger such that positive terminal of the battery is connected to terminal A of charger and negative terminal of the battery is connected to terminal B of charger. The internal resistance of the battery is r

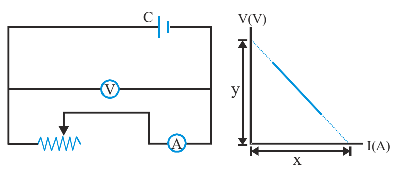
(A) Potential difference across points A and B must be more than E

(B) A must be at higher potential than B

(C) In battery, current flows from positive terminal to the negative terminal

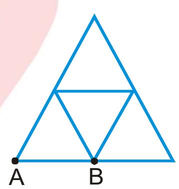
(D) No current flows through battery

10. The diagram besides shows a circuit used in an experiment to determine the emf and internal resistance of the cell C. A graph was plotted of the potential difference V between the terminals of the cell against the current I, which was varied by adjusting the rheostat. The graph is shown on the right; x and y are the intercepts of the graph with the axes as shown. What is the internal resistance of the cell?



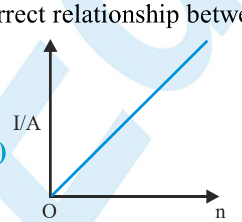
(A) x **(B)** y **(C)** $\frac{x}{y}$ **(D)** $\frac{y}{x}$

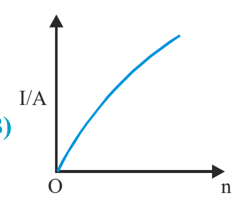
11. In the diagram resistance between any two junctions is R. Equivalent resistance across terminals A and B is

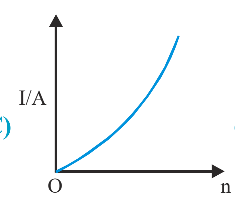


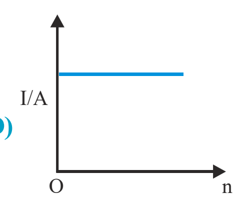
(A) $\frac{11R}{7}$ **(B)** $\frac{18R}{11}$ **(C)** $\frac{7R}{11}$ **(D)** $\frac{11R}{18}$

12. A battery consists of a variable number n of identical cells having internal resistance connected in series. The terminals of the battery are short circuited and the current I measured. Which one of the graph below shows the correct relationship between I and n?

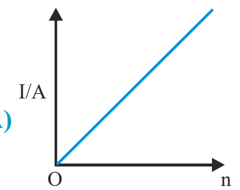
(A)


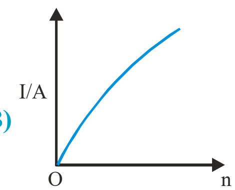
(B)


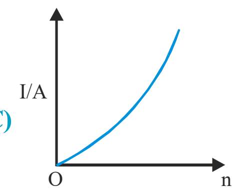
(C)


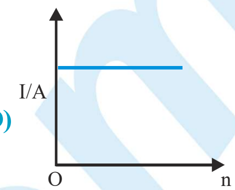
(D)


13. In previous problem, if the cell had been connected in parallel (instead of in series) which of the above graphs would have shown the relationship between total current I and n?

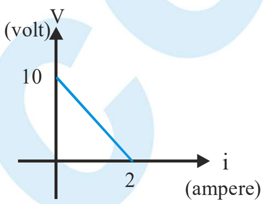
(A) 

(B) 

(C) 

(D) 

14. A battery of emf E and internal resistance r is connected across a resistance R. Resistance R can be adjusted to any value greater than or equal to zero. A graph is plotted between the current (i) passing through the resistance and potential difference (V) across it. Select the correct alternative(s)

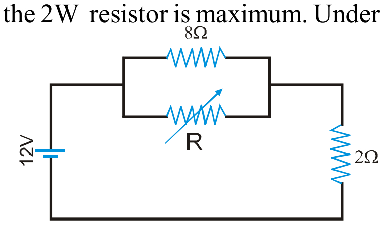


(A) Internal resistance of battery is $5\,\Omega$
(B) Emf of the battery is 20V
(C) Maximum current which can be taken from the battery is 4A
(D) V–i graph can never be a straight line as shown in figure

15. Two identical fuses are rated at 10A. If they are joined
(A) in parallel, the combination acts as a fuse of rating 20A
(B) in parallel, the combination acts as a fuse of rating 5A
(C) in series, the combination acts as a fuse of rating 10A
(D) in series, the combination acts as a fuse of rating 20A

16. A micrometer has a resistance of 100W and a full scale range of 50 mA. It can be used as a voltmeter or a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination(s).
(A) 50V range with 10 kW resistance in series.
(B) 10V range with 200 kW resistance in series.
(C) 5 mA range with 1 W resistance in parallel.
(D) 10 mA range with 1 kW resistance in parallel.

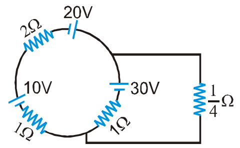
17. The value of the resistance R in figure is adjusted such that power dissipated in the 2W resistor is maximum. Under this condition



(A) R=0
(B) R= 8W
(C) power dissipated in the 2W resistors is 72W
(D) power dissipated in the 2W resistor is 8W

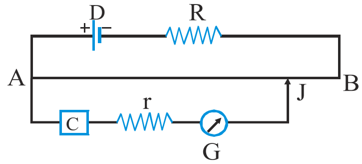
18. In a potentiometer wire experiment the emf of a battery in the primary circuit is 20V and its internal resistance is 5W. There is a resistance box in series with the battery and the potentiometer wire, whose resistance can be varied from 120W to 170W. Resistance of the potentiometer wire is 75 W. The following potential differences can be measured using this potentiometer.
(A) 5V (B) 6V (C) 7V (D) 8V

19. In the following circuit diagram, the current flowing through resistor of 1/4 W is



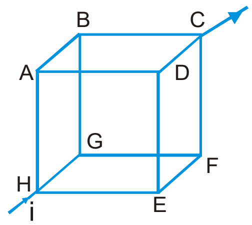
(A) 1 A (B) 60 A (C) 30 A (D) None of these

20. In the given potentiometer circuit, the resistance of the potentiometer wire AB is R_0. C is a cell of internal resistance r. The galvanometer G does not give zero deflection for any position of the jockey J. Which of the following cannot be a reason for this?



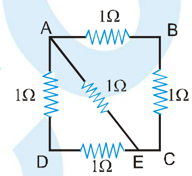
(A) $r > R_0$
(B) $R >> R_0$
(C) Emf of C > emf of D
(D) The negative terminal of C is connected to A

21. In the box shown current i enters at H and leaves at C. If $i_{AB} = \frac{i}{6}, i_{DC} = \frac{2i}{3}, i_{HA} = \frac{i}{2}, i_{GF} = \frac{i}{6}, i_{HE} = \frac{i}{6}$, Choose the branch in which current is zero



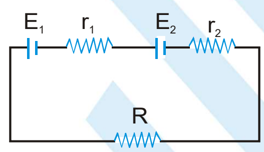
(A) BG　**(B)** FC　**(C)** ED　**(D)** None

22. ABCD is a square where each side is a uniform wire of resistance 1W. A point E lies on CD such that if a uniform wire of resistance 1W is connected across AE and constant potential difference is applied across A and C then B and E are equipotential. Then-



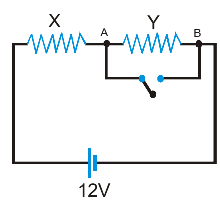
(A) $\frac{CE}{ED}=1$　**(B)** $\frac{CE}{ED}=2$　**(C)** $\frac{CE}{ED}=\frac{1}{\sqrt{2}}$　**(D)** $\frac{CE}{ED}=\sqrt{2}$

23. Under what condition current passing through the resistance R can be increased by short circuiting the battery of emf E_2. The internal resistances of the two batteries are r_1 and r_2 respectively.



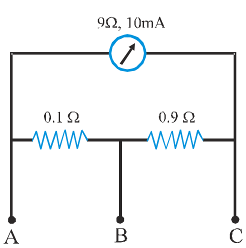
(A) $E_2r_1 > E_1(R+r_2)$　**(B)** $E_1r_2 > E_2(R+r_1)$　**(C)** $E_2r_2 > E_1(R+r_2)$　**(D)** $E_1r_1 > E_2(R+r_1)$

24. When an ammeter of negligible internal resistance is inserted in series with circuit it reads 1A. When the voltmeter of very large resistance is connected across X it reads 1V. When the point A and B are shorted by a conducting wire, the voltmeters measures 10V across the battery. The internal resistance of the battery is equal to



(A) zero　**(B)** 0.5W　**(C)** 0.2W　**(D)** 0.1W

25. A milliammeter of range 10mA and resistance 9W is joined in a circuit as shown. The metre gives full–scale deflection for current I when A and B are used as its terminals, i.e., current enters at A and leaves at B (C is left isolated). The value of I is

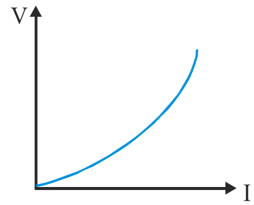


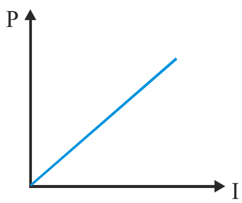
(A) 100 mA　**(B)** 900 mA　**(C)** 1A　**(D)** 1.1 A

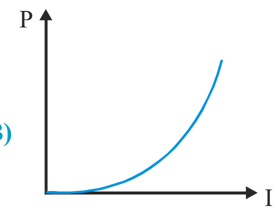
26. n identical cells are joined in series with its two cells A and B in the loop with reversed polarities. EMF of each cell is E and internal resistance r. Potential difference across cell A or B is (here n >4)

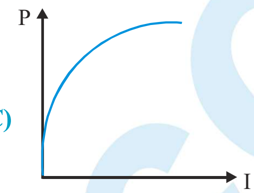
(A) $\frac{2E}{n}$　**(B)** $2E\left(1-\frac{1}{n}\right)$　**(C)** $\frac{4E}{n}$　**(D)** $2E\left(1-\frac{2}{n}\right)$

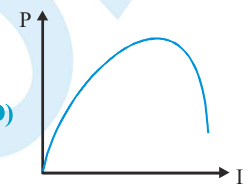
27. The variation of current (I) and voltage (V) is as shown in figure. The variation of power P with current I is best shown by which of the following graph



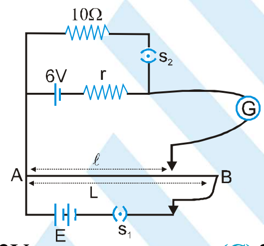
(A) 

(B) 

(C) 

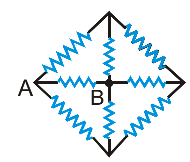
(D) 

28. In the arrangement shown in figure when the switch S_2 is open, the galvanometer shows no deflection for $l = \frac{L}{2}$. When the switch S_2 is closed, the galvanometer shows no deflection for $l = \frac{5L}{12}$. The internal resistance (r) of 6V cell, and the emf E of the other battery are respectively



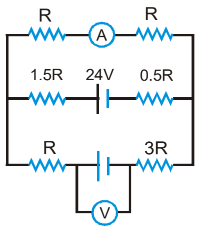
(A) 3W, 8V **(B)** 2W, 12V **(C)** 2W, 24V **(D)** 3W, 12V

29. In the circuit diagram each resistor of resistance 5W. The points A and B are connected to the terminals of a cell of electromotive force 9 volt and internal resistance 2/3W.



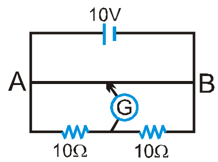
(A) The heat produced in the cell is 6W.
(B) The current in the resistor connected directly between A and B is 1.4A.
(C) The current in the resistor connected directly between A and B is 1.8 A.
(D) None of the above is correct.

30. If the reading of ammeter is 2A then the reading of voltmeter



(A) Depends on R
(B) Independent on R
(C) Zero for certain value of R
(D) can't be determined

31. The wire AB of a meter bridge changes linearly from radius r to 2r from left end to right end. Length of wire is 1m. Where should the free end of the galvanometer be connected on AB so that the deflection in the galvanometer is zero?



(A) $\frac{2}{3}$m from end B **(B)** $\frac{1}{3}$m from end A **(C)** $\frac{1}{4}$m from end A **(D)** $\frac{3}{4}$m from end B

Part # II [Assertion & Reason Type Questions]

In each of the following questions, a Assertion of Statement -1 and Statement - 2 of Reason.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is NOT a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.
(E) Both Statement are False

1. **Statement-1 :** The electric bulb glows immediately when switch is on.
Statement-2 : The drift velocity of electrons in a metallic wire is very high.

2. **Statement-1 :** When an external resistor of resistance R (connected across a cell of internal resistance r) is varied, power consumed by resistance R is maximum when R = r.
Statement-2 : Power consumed by a resistor of constant resistance R is maximum when current through it is maximum.

3. **Statement–1 :** Electric field inside a current carrying wire is zero.
Statement–2 : Net charge on wire is zero.

4. **Statement-1 :** In a chain of bulbs, 50 bulbs are joined in series. One bulb is fused now. If the remaining 49 bulbs are again connected in series across the same supply then light gets decreased in the room.
Statement-2 : The resistance of 49 bulbs will be more than 50 bulbs.

5. **Statement–1 :** A metal has resistance and gets often heated by flow of current.
Statement–2 : When free electrons drift through a metal they makes occasional collisions with the lattice. These collisions inelastic and transfer energy to the lattice as internal energy

6. **Statement–1 :** Kirchoff's loop rule indicates that electrostatic field is conservative.
Statement–2 : Potential difference between two points in a circuit does not depends on path.

7. **Statement-1 :** The coil of a heater is cut into two equal halves and only one of them is used into heater. The heater will new require half the time to produce the same amount of heat.
Statement-2 : Heat produced in a coil is directly proportional to square of the current, through it.

8. **Statement-1 :** Current is passed through a metallic wire, heating it red. When cold water is poured over half of its portion, rest of the portion becomes more hot.
Statement-2 : Resistance decreases due to decrease in temperature so current through wire increases.

9. **Statement-1 :** A steady current is flowing in a conductor hence there is an electric field within the conductor.
Statement-2 : In case of steady current, there can be no accumulation of charges, so no electric field can be established.

10. **Statement-1 :** A wire of uniform cross section and uniform resistivity is connected across an ideal cell. Now the length of the wire is doubled keeping volume of wire constant. The drift velocity of electrons after stretching the wire becomes one fourth of what it was before stretching the wire.
Statement-2 : If a wire (of uniform resistivity and uniform cross-section) of length l_o is stretched to length nl_o, then its resistance becomes n^2 times of what it was before stretching the wire(the volume of wire is kept constant in stretching process). Further at constant potential difference, current is inversely proportional to resistance. Finally drift velocity of free electron is directly proportional to current and inversely proportional to cross section area of current carrying wire..

Exercise # 3 Part # I [Matrix Match Type Questions]

1. Match the statements in Column I with the current element in Column II

	Column - I		Column - II
(A)	Current always flows from higher potential to lower potential	(P)	A Resistor
(B)	Energy dissipated in an element is always zero	(Q)	Ideal cell/Battery
(C)	Current flow through the element is always zero	(R)	Non-Ideal cell/Battery
(D)	Potential difference may/will be zero	(S)	Short-circuited resistor

2. **Match the following :**

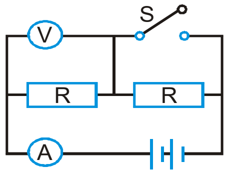
The following table gives the lengths of four copper rods at the same temperature, their diameters, and the potential differences between their ends.

Rod	Length	Diameter	Potential Difference
1	L	3d	V
2	2L	d	3V
3	3L	2d	2V
4	3L	d	V

Correctly match the physical quantities mentioned in the left column with the rods as marked.

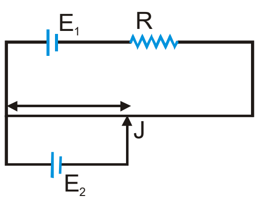
(A) Greatest Drift speed of the electrons. (P) Rod 1
(B) Greatest Current (Q) Rod 2
(C) Greatest rate of thermal energy produced (R) Rod 3
(D) Greatest Electric field (S) Rod 4

3. The diagram shows a circuit with two identical resistors. The battery has a negligible internal resistance. What will the effect on the ammeter and voltmeter be if the switch S is closed ?



	Column I		Column II
(A)	Ammeter reading	(P)	Increases
(B)	Voltmeter reading	(Q)	Decreases
(C)	Equivalent resistance of circuit	(R)	Does not change
(D)	Power dissipated across R in right branch	(S)	Becomes zero

4. In the potentiometer arrangement shown in figure, null point is obtained at length l.



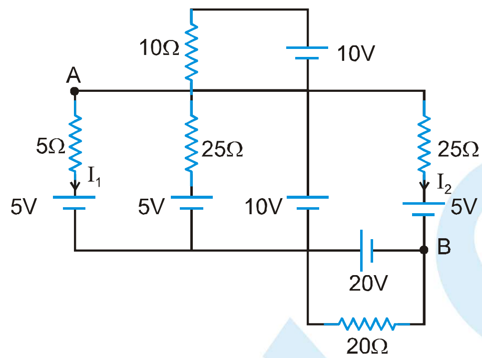
	Column I		Column II
(A)	If E_1 is increased	(P)	l should increase
(B)	If R is increased	(Q)	l should decrease
(C)	If E_2 is increased	(R)	l should remain the same to

Part # II [Comprehension Type Questions]

again get the null point

Comprehension # 1

The circuit consists of resistors and ideal cells. I_1 and I_2 are current through branches indicated in the figure. V_A and V_B is the potential at points A and B on the circuit.



1. The value of $\frac{I_2}{I_1}$ is :

(A) 1 **(B)** 2 **(C)** 3 **(D)** 4

2. The value of $V_A - V_B$ in volts is :

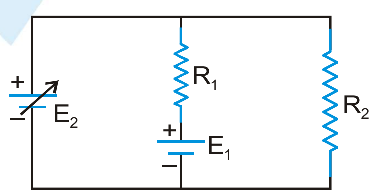
(A) 5 **(B)** 10 **(C)** 15 **(D)**30

3. The net power dissipated in the circuit in watts is :

(A) 55 **(B)** 15 **(C)** 62 **(D)** 61

Comprehension # 2

In the circuit given below, both batteries are ideal. Emf E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1.0 V and 10.0 V. The graph gives the currents through the two batteries as a function of E_2, but are not marked as which plot corresponds to which battery. But for both plots, current is assumed to be negative when the direction of the current through the battery is opposite the direction of that battery's emf. (direction of emf is from negative to positive)



1. The value of emf E_1 is

(A) 8 V **(B)** 6 V **(C)** 4 V **(D)** 2V

2. The resistance R_1 has value

(A) 10 W **(B)** 20 W **(C)** 30 W **(D)** 40 W

3. The resistance R_2 is equal to :

(A) 10 W **(B)** 20 W **(C)** 30 W **(D)** 40 W

Comprehension # 3

A galvanometer measures current which passes through it. A galvanometer can measure typically current of order of mA. To be able to measure currents of the order of amperes of main current, a shunt resistance 'S' is connected in parallel with the galvanometer.

Figure-I

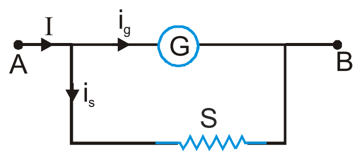


Figure-II

1. The resistance of the shunt 'S' and resistance 'G' of the galvanometer should have the following relation.

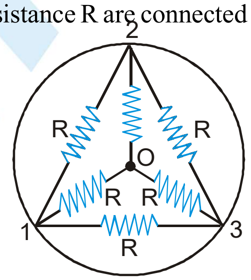
(A) S = G **(B)** S >> G **(C)** S << G **(D)** S < G

2. If resistance of galvanometer is 10W and maximum current i_g is 10mA then the shunt resistance required so that the main current ' I ' can be upto 1A is (in W)

(A) $\frac{99}{10}$ **(B)** $\frac{10}{99}$ **(C)** 990 **(D)** $\frac{99}{1000}$

Comprehension # 4

Inside a super conducting ring six identical resistors each of resistance R are connected as shown in figure.



1. The equivalent resistance(s)

(A) between 1 & 3 is zero

(B) between 1 & 3 is R/2

(C) between 1 & 2, 2 & 3, 3 & 1 are all equal

(D) None of these

2. The equivalent resistance (s)

(A) between 0 & 1 is R **(B)** between 0 & 1 is R/3

(C) between 0 & 1 is 0 **(D)** between 0 & 1, 0 & 2 and 0 & 3 are all equal

3. Imaging a battery of emf E between the point 0 and 1, with its positive terminal connected with O.

(A) The current entering at O is equally divided into three resistances

(B) The current in the other three resistances R_{12}, R_{13}, R_{23} is zero

(C) The resistances R_{02} and R_{03} have equal magnitudes of current while the resistance R_{01} have different current

(D) Potential $V_2 = V_3 > V_1$

Comprehension # 5

Electric fuse a protective device used in series with an electric circuit or an electric appliance to save it from damage due to overheating produced by strong current in the circuit or appliance. Fuse wire is generally made from an alloy of lead and tin which has high resistance and low melting point. It is connected in series in an electric installation. If a circuit gets accidentally short–circuited, a large current flows, then fuse wire melts

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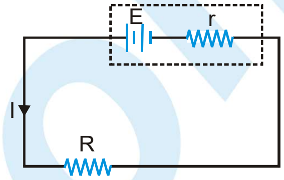
away which causes a break in the circuit.

The power through fuse (P) is equal to heat energy lost per unit area per unit time (h) (neglecting heat loses from ends of the wire). $P = I^2R = h \times 2prl$ ..... $\left[R = \frac{\rho l}{\pi r^2}\right]$ r and l are the length and radius of fuse wire.

A battery is described by it's Emf (E) and internal resistance (r) Efficiency of battery is defined as the ratio of the output power and the input power $h = \frac{\text{output power}}{\text{input power}} \times 100\ \%$



but $I = \frac{E}{R+r}$, input power = EI , output power = $EI - I^2r$

then $\eta = \left(\frac{EI - I^2r}{EI}\right) \times 100 = \left(1 - \frac{Ir}{E}\right) \times 100 = 1 - \left(\frac{E}{R+r}\right)\left(\frac{r}{E}\right) \times 100 = \left(\frac{R}{R+r}\right) \times 100$

We know that output power of a source is maximum when the external resistance is equal to internal resistance, i.e., R = r.

1. Two fuse wire of same material are having length ratio 1 : 2 and radius ratio 4 : 1. Then respective ratio of their current rating will be–

(A) 8 : 1 **(B)** 2 : 1 **(C)** 1 : 8 **(D)** 4 : 1

2. The maximum power rating of a 20.0 W fuse wire is 2.0 kW, then this fuse wire can be connected safely to a D.C. source (negligible internal resistance) of–

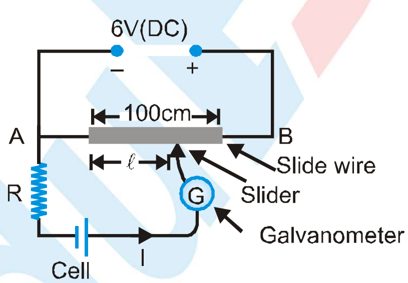
(A) 300 volt **(B)** 190 volt **(C)** 250 volt **(D)** 220 volt

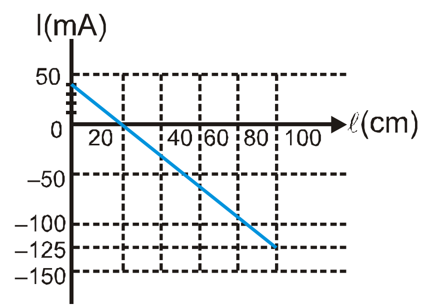
3. Efficiency of a battery (non–ideal) when delivering maximum power is–

(A) 100 % **(B)** 50 % **(C)** 90 % **(D)** 40 %

Comprehension # 6

In the circuit shown, the internal resistance of the cell is negligible. The distance of the jockey (slider) from left hand end of the wire is l. The adjoining graph shows the variation of current I (marked in figure) with length l of the slide wire.





1. For balancing condition of the instrument value of l is equal to-

(A) 40 cm **(B)** 20 cm **(C)** 100 cm **(D)** None of these

2. Value of the emf of cell, is-

(A) 0.98 V **(B)** 1.20 V **(C)** 1.86 V **(D)** 3 V

3. Value of the resistance R, is-

(A) 30 W **(B)** 40 W **(C)** 38 W **(D)** 45 W

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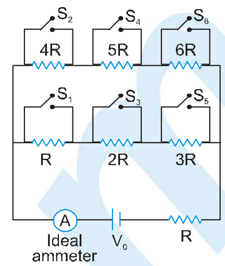
Comprehension # 7



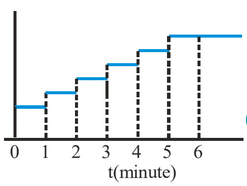
For the circuit shown, answer the following questions

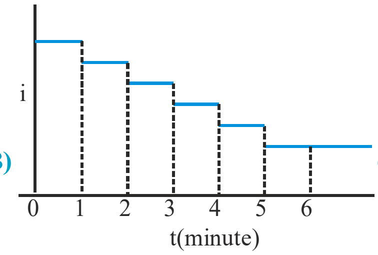
1. In which of the following case current shown by ammeter is maximum

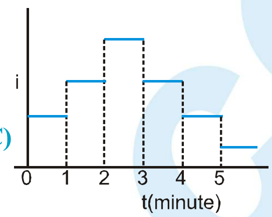
(A) S_1, S_2,S_3 closed **(B)** S_2, S_4,S_5 closed

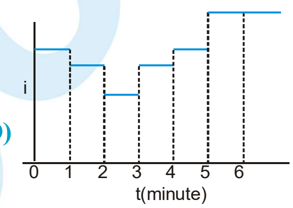
(C) S_1,S_3,S_5 closed **(D)** S_2, S_3,S_4 closed

2. Say switches S_1,S_2 and so on upto S_6 are closed at regular intervals of 1minute starting from t=0. The graph of current versus time is best represented as –

(A)


(B)


(C)


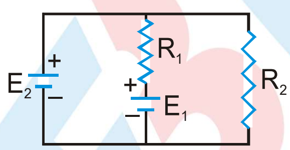
(D)


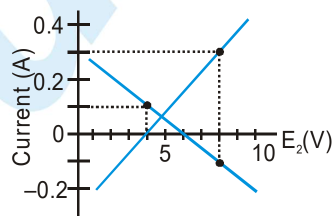
3. Ratio of power developed by battery when all switches are closed to that when all switches are open–

(A) $\frac{37}{7}$ **(B)** $\frac{7}{37}$ **(C)** $\left(\frac{37}{7}\right)^2$ **(D)** $\left(\frac{7}{37}\right)^2$

Comprehension # 8

In the circuit shown, both batteries are ideal. Electro motive force E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1 V and 10V. The graph gives the currents through the two batteries as a function of E_2, but are not marked as which plot corresponds to which battery. But for both plots, current is assumed to be negative when the direction of the current through the battery is opposite the direction of that battery's emf (direction from negative to positive).





1. The value of emf E_1 is–

(A) 8V **(B)** 6V **(C)** 4V **(D)** 2V

2. The resistance R_1 has value–

(A) 10W **(B)** 20W **(C)** 30W **(D)** 40W

3. The resistance R_2 is equal to–

(A) 10W **(B)** 20W **(C)** 30W **(D)** 40W

Comprehension # 9

A car battery with a 12V emf and an internal resistance of 0.04 W is being charged with a current of 50 A.

1. The potential difference V across the terminals of the battery are–

(A) 10V **(B)** 12V **(C)** 14V **(D)** 16V

2. The rate at which energy is being dissipated as heat inside the battery is–

(A) 100W **(B)** 500W **(C)** 600W **(D)** 700W

3. The rate of energy conversion from electrical to chemical is–

(A) 100W **(B)** 500W **(C)** 600W **(D)** 700W

Exercise # 4 [Subjective Type Questions]

[A] Definition of Current, Current densities & Drift velocities

1. The current through a wire depends on time as $i = i_0 + a \sin pt$, where $i_0 = 10$ A and $a = \frac{\pi}{2}$ A. Find the charge crossed through a section of the wire in 3 seconds, and average current for that interval.

2. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 1.0×10^{-7} m^2 carrying a current of 1.5 A. Assume that each copper atom contributes roughly one conduction electron. The density of copper is 9.0×10^3 kg m^{-3} and its atomic mass is 63.5 amu.

3. A current of 5 A exists in a 10 W resistance for 4 minutes.
(i) How many coulombs and
(ii) How many electrons pass through any cross section of the resistor in this time?
Charge of the electron = 1.6×10^{-19} C.

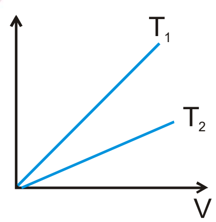
[B] Resistance

4. A cylindrical conducting wire of radius 0.2 mm is carrying a current of 20 mA . **(a)** How many electrons are transferred per second between the supply and the wire at one end? **(b)** Write down the current density in the wire.

5. A battery sets up an electric field of 25 N/C inside a uniform wire of length 2 m and a resistance of 5 W. Find current through the wire.

6. **(i)** A potential difference of 200 volt is applied to a coil at a temperature of 15ºC and the current is 10 A. What will be the temperature of the coil when the current has fallen to 9 A, the applied voltage being the same as before? temperature coefficient of resistance (A) = $\frac{1}{234}$ ºC^{-1}.
(ii) A platinum wire has resistance of 10 ohm at 0ºC and 20 ohm at 273 ºC. Find the value of temperature coefficient of resistance.

7. The current-voltage graphs for a given metallic wire at two different temperature T_1 and T_2 are shown in the figure. Which one is higher, T_1 or T_2

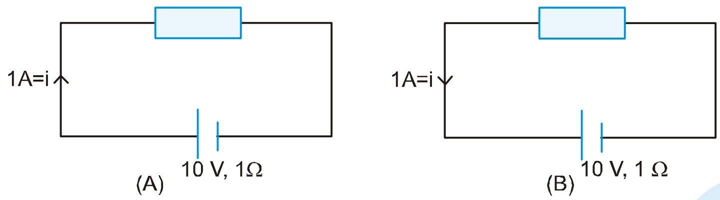


8. If a copper wire is stretched to make it 0.1% longer, what is the percentage change in its resistance?

9. A rectangular carbon block has dimensions 1.0 cm x 1.0 cm x 50 cm.
(i) What is the resistance measured between the two square ends?
(ii) Between two opposing rectangular faces?
Resistivity of carbon at 20º C is 3.5×10^{-5} Wm.

[C] Power, Energy, Battery, EMF, Terminal voltage & Kirchoff's laws

10. In following diagram boxes may contain resistor or battery or any other element



then determine in each case

(a) E.m.f. of battery

(b) Battery is acting as a source or load

(c) Potential difference across each battery

(d) Power input to the battery or output by the battery.

(e) The rate at which heat is generated inside the battery.

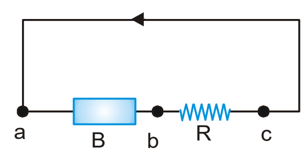
(f) The rate at which the chemical energy of the cell is consumed or increased.

(g) Potential difference across box

(h) Electric power output across box.

11. A resistor with a current of 3 A through it converts 500 J of electrical energy to heat energy in 12 s. What is the voltage across the resistor?

12. The figure shows the current I in a single-loop circuit with a battery B and resistance R (and wires of negligible resistance). Then find the order of following at the point a,b and c



(a) The magnitude of the current,

(b) The electric potential, and

(c) The electric potential energy of the charge carriers (electron), greatest first.

13. **(a)** A car has a fresh storage battery of emf 12 V and internal resistance 5.0×10^{-2} W. If the starter draws a current of 90 A, what is the terminal voltage of the battery when the starter is on?

(b) After long use, the internal resistance of the storage battery increases to 500 W. What maximum current can be drawn from the battery? Assume the emf of the battery to remain unchanged.

(c) If the discharged battery is charged by an external emf source, is the terminal voltage of the battery during charging greater or less than its emf 12 V?

14. 1 kW, 220 V electric heater is to be used with 220 V D.C. supply.

(a) What is the current in the heater.

(b) What is its resistance.

(c) What is the power dissipated in the heater.

(d) How much heat in calories is produced per second.

(e) How many grams of water at 100º C will be converted per minute into steam at 100º C with the heater. (latent heat of vaporisation of water = 540 cal/g)] [J = 4.2 J/cal]

15. Two electric bulbs, each designed to operate with a power of 500 watts in 220 volt line, are connected in series. Now they are connected with a 110 volt line. What will be the power generated by each bulb?

16. Two (non-physics) students, A and B living in neighboring hostel rooms, decided to economies by connecting their bulbs in series. They agreed that each would install a 100 W bulb in their own rooms and that they would pay equal shares of the electricity bill. However, both decided to try to get better lighting at the other's expense; A installed a 200 W bulb and B installed a 50 W bulb. Which student is more likely to fail the end-of-term examinations?

17. In following circuit potential at point 'A' is zero then determine

(a) Potential at each point

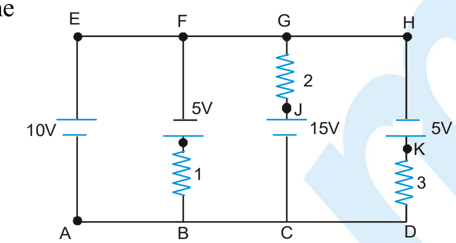
(b) Potential difference across each resistance

(c) Identify the batteries which act as a source

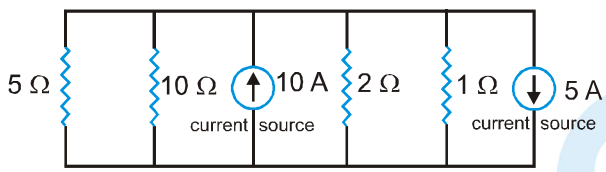
(d) Current in each battery

(e) Which resistance consumes maximum power

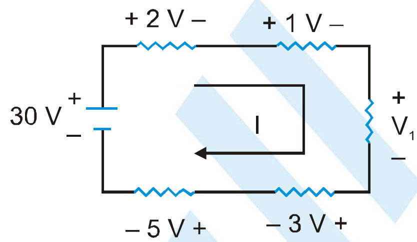
(f) Which battery consume or gives maximum power.



18. For the circuit shown in figure, find the voltage across 10 W resistor and the current passing through it.

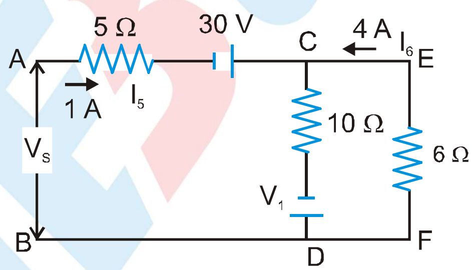


19. For the circuit shown in figure, determine the unknown voltage drop V_1 .



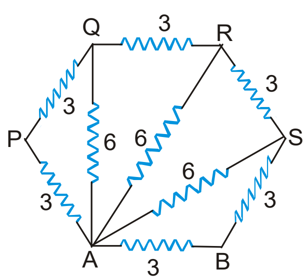
20. A resistor develops 400 J of thermal energy in 10 s when a current of 2 A is passed through it. **(a)** Find its resistance. **(b)** If the current is increased to 4 A, what will be the energy developed in 20 s.

21. Find the current in 10 W resistance, V_1, and source voltage V_s in the circuit shown in figure ($V_s = V_A - V_B$)

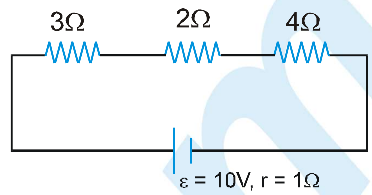


[D] Combination of Resistance

22. All resistance in diagram (fig.) are in ohms. Find the effective resistance between the points A and B.

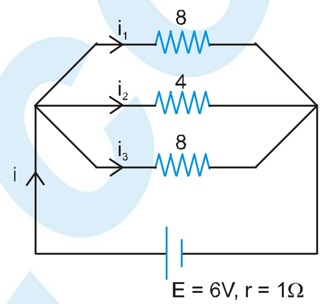


23. In the given circuit determine



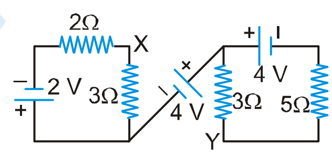
(a) Equivalent resistance (Including internal resistance).
(b) Current in each resistance
(c) Potential difference across each resistance
(d) The rate at which the chemical energy of the cell is consumed
(e) The rate at which heat is generated inside the battery
(f) Electric power output
(g) Potential difference across battery
(h) Which resistance consumes maximum power
(i) Power dissipated in 3 W resistance.

24. In given circuit determine

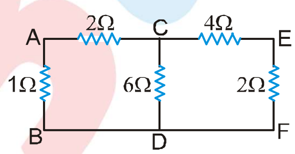


(a) Equivalent resistance (Including internal resistance).
(b) Current i, i_1, i_2 and i_3
(c) Potential difference across battery and each resistance
(d) The rate at which the chemical energy of the cell is consumed
(e) The rate at which heat is generated inside the battery
(f) Electric power output
(g) Which resistance consumes maximum power ?
(h) Power dissipated across 4W resistance

25. **(a)** Determine the potential difference between X and Y in the circuit shown in Figure.
(b) If intermediate cell has internal resistance r = 1W then determine the potential difference between X and Y.

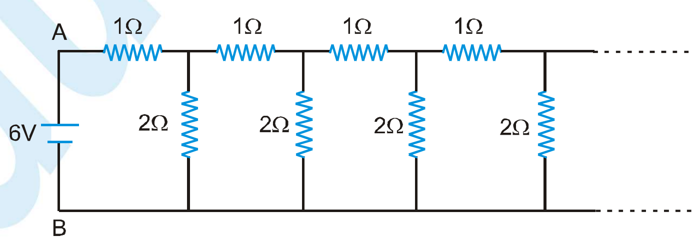


26. Find the equivalent resistance of the circuit given in figure between the following point:



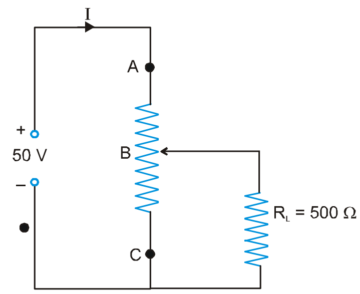
(i) A and B **(ii)** C and D **(iii)** E and F **(iv)** A and F **(v)** A and C

27. An infinite ladder network of resistance is constructed with 1W and 2W resistance, as shown in figure.



(i) Show that the effective resistance between A and B is 2W.
(ii) What is the current that passes through the 2W resistance nearest to the battery ?

28. As shown in figure a variable rheostat of 2 kW is used to control the potential difference across 500 ohm load. **(i)** If the resistance AB is 500 W, what is the potential difference across the load ? **(ii)** If the load is removed, what should be the resistance at BC to get 40 volt between B and C ?



29. ABCD is a square where each side is uniform wire of resistance 1 W. Find a point E on CD such that if a uniform wire of resistance 1 W is connected across AE and a potential difference is applied across A and C, the points B and E will be equipotential.

30. Suppose you have three resistors of 20 W, 50 W and 100 W. What minimum and maximum resistances can you obtain from these resistors ?

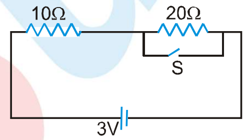
31. Three bulbs, each having a resistance of 180 W, are connected in parallel to an ideal battery of emf 60 V. Find the current delivered by the battery when

(a) all the bulbs are switched on,

(b) two of the bulbs are switched on and

(c) only one bulb is switched on.

32. Consider the circuit shown in figure. Find the current through the 10W resistor when the switch S is (a) opened (b) closed.



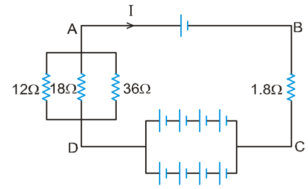
33. Six lead-acid type of secondary cells, each of emf 2.0 V and internal resistance 0.015 W, are joined in series to provide a supply to a resistance of 8.5 W. Determine : **(i)** the current drawn from the supply and **(ii)** its terminal voltage.

34. In the figure each cell has an emf of 1.5 V and internal resistance of 0.40 W. Calculate:

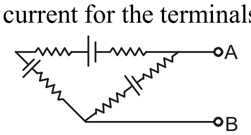
(i) current I

(ii) current in the 36 W resistor

(iii) potential difference across A and B.



35. In the circuit shown all five resistors have the same value 200 ohms and each cell has an emf 3 volts. Find the open circuit voltage and the short circuit current for the terminals A and B.



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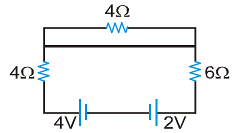
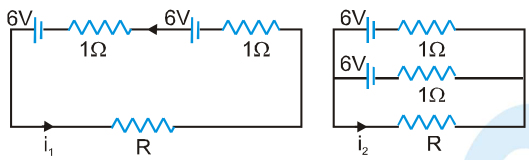
36. Find the currents through the three resistors shown in figure

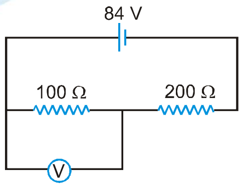


37. Find the value of i_1/i_2 in figure if **(a)** R = 0.1 W, **(b)** R = 1W **(c)** R = 10 W. Note from your answer that in order to get more current from a combination of two batteries they should be joined in parallel if the external resistance is small and in series if the external resistance is large as compared to the internal resistances.



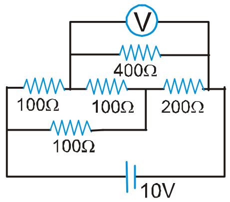
38. A galvanometer has a resistance of 30 ohm and a current of 2 mA is needed to give a full scale deflection. What is the resistance needed and how is it to be connected to convert the galvanometer.
(a) Into an ammeter of 0.3 ampere range ? **(b)** Into a voltmeter of 0.2 volt range ?

39. A voltmeter of resistance 400W is used to measure the potential difference across the 100W resistor in the circuit shown in the figure. **(a)** What will be the reading of the voltmeter ? **(b)** What was the potential difference across 100 W before the voltmeter was connected ?



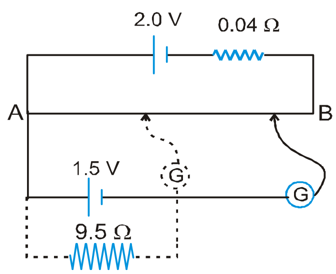
40. An ammeter and a voltmeter are connected in series to a battery with an emf e = 6.0 V. When a certain resistance is connected in parallel with the voltmeter, the reading of the voltmeter decrease h = 2.0 times, whereas the reading of the ammeter increase the same number of times. Find the voltmeter reading after the connection of the resistance.

41. An electrical circuit is shown in the figure. Calculate the potential difference across the resistance of 400 ohm, as will be measured by the voltmeter V of resistance 400 ohm, either by applying Kirchhoff's rules or otherwise.

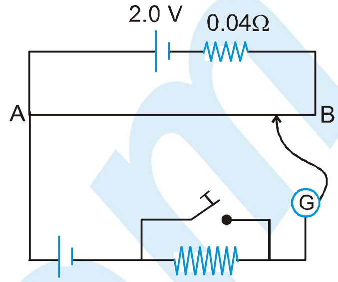


42. A battery of emf 1.4 V and internal resistance 2 W is connected to a resistor of 100 W through an ammeter. The resistance of the ammeter is 4/3 W. A voltmeter has also been connected to find the potential difference across the resistor.
(i) Draw the circuit diagram.
(ii) The ammeter reads 0.02 A. What is the resistance of the voltmeter ?
(iii) The voltmeter reads 1.10 V, what is the zero error in the voltmeter ?

43. Figure shows a 2.0 V potentiometer used for the determination of internal resistance of 1.5 V cell. The balance point of the cell without 9.5 W in the external circuit is 70 cm. When a resistor of 9.5 W is used in the external circuit of the cell, the balance point shifts to 60 cm length of the potentiometer wire. Determine the internal resistance of the secondary cell.



44. Figure shows a potentiometer with a cell of emf 2.0 V and internal resistance 0.04 W maintaining a potential drop across the potentiometer wire AB. A standard cell which maintains a constant emf of 1.02 V (for very moderate currents up to a few ampere) gives a balance point of 67.3 cm length of the wire. To ensure very low currents drawn from the standard cell, a very high resistance of 600 kW is put in series with it which is shorted close to the balance point. The standard cell is then replaced by a cell of unknown emf E and the balance point found similarly turns out to be at 82.3 cm length of the wire.



(a) What is the value of E ?

(b) What purpose does the high resistance of 600 kW have ?

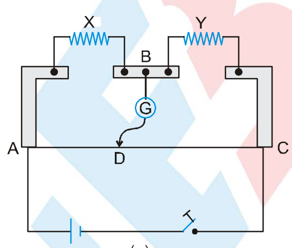
(c) Is the balance point affected by this high resistance?

(d) Is the balance point affected by the internal resistance of the driver cell?

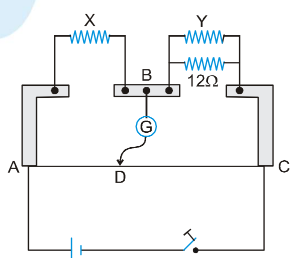
(e) Would the method work in the above situation if the driver cell of the potentiometer had an emf of 1.0 V instead of 2.0 V?

(f) Would the circuit work well for determining extremely small emf, say, of the order of few mV (such typical emf of thermocouple)?

45. Figure shows a metre bridge (which is nothing but a practical Wheatstone Bridge) consisting of two resistors X and Y together in parallel with a metre long constantan wire of uniform cross-section. With the help of a movable contact D, one can change the ratio of the resistances of the two segments of the wire until a sensitive galvanometer G connected across B and D shows no deflection. The null point is found to be at a distance of 30 cm from the end A. The resistor Y is shunted by a resistance of 12.0 W and the null point is found to shift by a distance of 10 cm. Determine the resistance of X and Y.



(a)



(b)

Exercise # 5 Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

1. If an ammeter is to be used in place of a voltmeter, then we must connect with the ammeter a- **[AIEEE - 2002]**

(1) low resistance in parallel (2) high resistance in parallel
(3) high resistance in series (4) low resistance in series

2. By increasing the temperature, the specific resistance of a conductor and a semiconductor- **[AIEEE - 2002]**

(1) increases for both (2) decreases for both
(3) increases, decreases respectively (4) decreases, increases respectively

3. The length of a wire of a potentiometer is 100 cm, and the emf of its stand and cell is E volt. It is employed to measure the emf of a battery whose internal resistance is 0.5 Ω If the balance point is obtained at ● = 30 cm from the positive end, the emf of the battery is- **[AIEEE - 2003]**

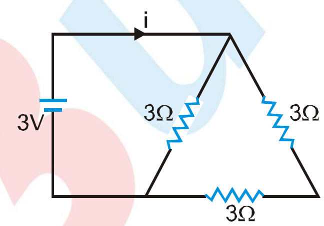
(1) $\frac{30E}{100.5}$ (2) $\frac{30E}{100-0.5}$

(3) $\frac{30(E-0.5i)}{100}$, where i is the current in the potentiometer wire (4) $\frac{30E}{100}$

4. An ammeter reads upto 1 A. Its internal resistance is 0.81 Ω. To increase the range to 10 A, the value of the required shunt is- **[AIEEE - 2003]**

(1) 0.03 Ω (2) 0.3 Ω (3) 0.9 Ω (4) 0.09 Ω

5. A 3V battery with negligible internal resistance is connected in a circuit as shown in the figure. The current I, in the circuit will be- **[AIEEE - 2003]**

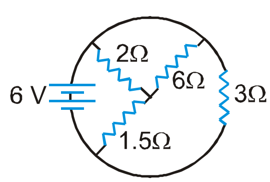


(1) 1 A (2) 1.5 A (3) 2 A (4) $\frac{1}{3}$ A

6. The length of a given cylindrical wire is increased by 100%. Due to the consequent decrease in diameter the change in the resistance of the wire will be- **[AIEEE - 2003]**

(1) 200 % (2) 100 % (3) 50 % (4) 300 %

7. The total current supplied to the circuit by the battery is- **[AIEEE - 2004]**



(1) 1 A (2) 2 A (3) 4 A (4) 6 A

8. The resistance of the series combination of two resistance is S. When they are joined in parallel, the total resistance is P. If S = nP, then the minimum possible value of n is- **[AIEEE - 2004]**

(1) 4 **(2)** 3 **(3)** 2 **(4)** 1

9. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. It the lengths and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be- **[AIEEE - 2004]**

(1) 3 **(2)** 1/3 **(3)** 8/9 **(4)** 2

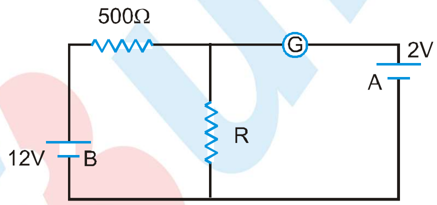
10. In a metre bridge experiment, null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If X < Y, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4X against Y ? **[AIEEE - 2004]**

(1) 50 cm **(2)** 80 cm **(3)** 40 cm **(4)** 70 cm

11. The thermistor are usually made of **[AIEEE - 2004]**

(1) metals with low temperature coefficient of resistivity
(2) metals with high temperature coefficient of resistivity
(3) metal oxides with high temperature coefficient of resistivity
(4) semiconducting materials having low temperature coefficient of resistivity

12. In the circuit, the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be- **[AIEEE - 2005]**



(1) 200 Ω **(2)** 100 Ω **(3)** 500 Ω **(4)** 1000 Ω

13. Two sources of equal emf are connected to an external resistance R. The internal resistances of the two sources are R_1 and R_2 ($R_2 > R_1$). If the potential difference across the source having internal resistance R_2, is zero, then- **[AIEEE - 2005]**

(1) $R = \frac{R_2 \times (R_1 + R_2)}{(R_2 - R_1)}$ **(2)** $R = R_2 - R_1$ **(3)** $R = \frac{R_1 R_2}{(R_1 + R_2)}$ **(4)** $R = \frac{R_1 R_2}{(R_2 - R_1)}$

14. An energy source will supply a constant current into the load, if its internal resistance is- **[AIEEE - 2005]**

(1) equal to the resistance of the load **(2)** very large as compared to the load resistance
(3) zero **(4)** non-zero but less than the resistance of the load

15. In a potentiometer experiment the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of 2Ω, the balancing length becomes 120 cm. The internal resistance of the cell is- **[AIEEE - 2005]**

(1) 1 Ω **(2)** 0.5 Ω **(3)** 4 Ω **(4)** 2 Ω

16. The kirchhoff's first law ($\Sigma i = 0$) and second law ($\Sigma iR = \Sigma E$), Where the symbols have their usual meanings, are respectively based on- **[AIEEE - 2006]**

(1) conservation of charge, conservation of momentum **(2)** conservation of energy, conservation of charge
(3) conservation of momentum, conservation of charge **(4)** conservation of charge, conservation of energy

17. A material 'B' has twice the specific resistance of 'A'. A circular wire made of 'B' has twice the diameter of a wire made of 'A'. Then for the two wires to have the same resistance, the ratio I_B / I_A of their respective lengths must be- **[AIEEE - 2006]**

(1) 1 **(2)** $\frac{1}{2}$ **(3)** $\frac{1}{4}$ **(4)** 2

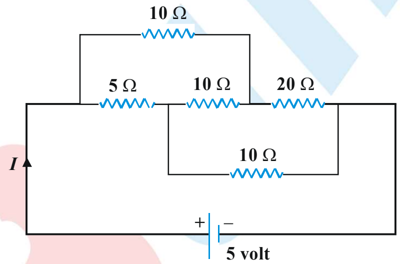
18. The resistance of bulb filament is 100 Ω at a temperature of 100°C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature of- **[AIEEE - 2006]**

(1) 300 °C **(2)** 400 °C **(3)** 500 °C **(4)** 200 °C

19. In a wheatstone's bridge, three resistances P, Q and R are connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for the bridge to be balanced will be- **[AIEEE - 2006]**

(1) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$ **(2)** $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1 S_2}$ **(3)** $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2 S_1 S_2}$ **(4)** $\frac{P}{Q} = \frac{R}{S_1 + S_2}$

20. The current I drawn from the 5 volt source will be- **[AIEEE - 2006]**

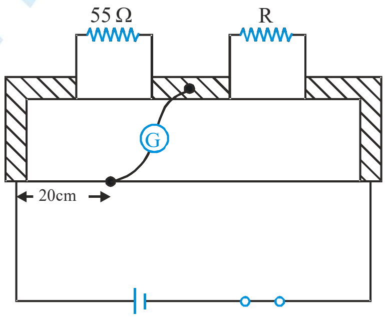


(1) 0.33 A **(2)** 0.5 A **(3)** 0.67 A **(4)** 0.17 A

21. The resistance of a wire is 5Ω at 50 °C and 6 Ω at 100 °C. The resistance of the wire at 0 °C will be- **[AIEEE - 2007]**

(1) 2 Ω **(2)** 1 Ω **(3)** 4 Ω **(4)** 3 Ω

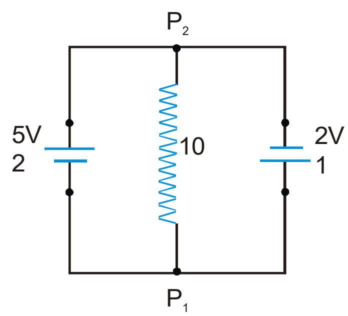
22. Shown in the figure below is a meter - bridge set up with null deflection in the galvanometer **[AIEEE - 2008]**



The value of the unknown resistor R is

(1) 13.75Ω **(2)** 220 Ω **(3)** 110Ω **(4)** 55Ω

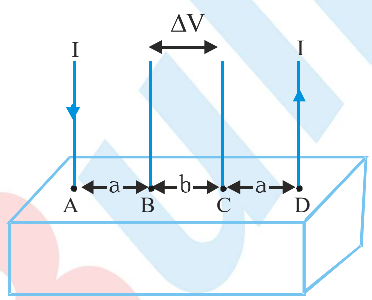
23. A 5V battery with internal resistance 2Ω and a 2V battery with internal resistance 1Ω are connected to a 10 Ω resistor as shown in the figure. The current in the 10Ω resistor is **[AIEEE - 2008]**



(1) 0.27 A P_2 to P_1 **(2)** 0.03 A P_1 to P_2 **(3)** 0.03 A P_2 to P_1 **(4)** 0.27 A P_1 to P_2

Directions : Question No. 24 and 25 are based on the following paragraph.

Consider a block of conducting material of resistivey $'\rho'$ shown in the figure. Current 'I' enters at 'A' and leaves from 'D'. We apply superposition prinicple to find voltage $'\Delta V'$ developed between 'B' and 'C'. The calculation is done in the following steps : **[AIEEE - 2008]**



(i) Take current 'I' entering from 'A' and assume it to spread over a hemispherical surface in the block.

(ii) Calculate field E(r) at distance 'r' from A by using Ohm's law $E = \rho j$, where j is the current per unit area at 'r'

(iii) From the 'r' dependence of E(r), obtain the potential V(r) at r.

(iv) Repeat **(i)**, **(ii)** and **(iii)** for current 'I' leaving 'D' and superpose results for 'A' and 'D'

24. For current entering at A, the electric field at a distance 'r' from A is

(1) $\frac{\rho I}{8\pi r^2}$ **(2)** $\frac{\rho I}{r^2}$ **(3)** $\frac{\rho I}{2\pi r^2}$ **(4)** $\frac{\rho I}{4\pi r^2}$

25. ΔV measured between B and C is

(1) $\frac{\rho I}{\pi a} - \frac{\rho I}{\pi(a+b)}$ **(2)** $\frac{\rho I}{a} - \frac{\rho I}{(a+b)}$ **(3)** $\frac{\rho I}{2\pi a} - \frac{\rho I}{2\pi(a+b)}$ **(4)** $\frac{\rho I}{2\pi(a+b)}$

26. **Statement–1 :** The temperature dependence of resistance is usually given as $R = R_0(1+\alpha\Delta t)$. The resistance of a wire changes from 100Ω to 150Ω when its temperature is increased from 27°C to 227°C. This implies that $\alpha = 2.5 \times 10^{-3}/°C$. [AIEEE - 2009]

Statement–2 : $R = R_0(1 + \alpha\Delta t)$ is valid only when the change in the temperature ΔT is small and $\Delta R = (R - R_0) << R_0$.

(1) Statement–1 is true, Statement–2 is true; Statement–2 is not the correct explanation of Statement–1
(2) Statement–1 is false, Statement–2 is true
(3) Statement–1 is true, Statement–2 is false
(4) Statement–1 is true, Statement–2 is true; Statement–2 is the correct explanation of Statement–1

27. Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly : [AIEEE - 2010]

(1) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$ (2) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (3) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$ (4) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$

28. If a wire is stretched to make it 0.1 % longer its resistance will :- [AIEEE - 2011]

(1) decrease by 0.2% (2) decrease by 0.05% (3) increase by 0.05% (4) increase by 0.2%

29. If 400 Ω of resistance is made by adding four 100 Ω resistance of tolerance 5%, then the tolerance of the combination is : [AIEEE - 2011]

(1) 20% (2) 5% (3) 10% (4) 15%

30. The current in the primary circuit of a potentiometer is 0.2 A. The specific resistance and cross-section of the potentiometer wire are 4×10^{-7} ohm metre and 8×10^{-7} m^2 respectively. The potential gradient will be equal to :- [AIEEE - 2011]

(1) 0.2 V/m (2) 1 V/m (3) 0.5 V/m (4) 0.1 V/m

31. Two electric bulbs marked 25W-220 V and100 W-220 V are connected in series to a 440 V supply. Which of the bulbs will fuse ? [AIEEE - 2012]

(1) Neither (2) Both (3) 100 W (4) 25 W

32. The supply voltage to a room is 120V. The resistance of the lead wires is 6Ω. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb? [AIEEE - 2013]

(1) zero Volt (2) 2.9 Volt (3) 13.3 Volt (4) 10.04 Volt

33. This question has Statement I and Statement II. Of the four choice given after the Statements, choose the one that best describes the two Statemens. [AIEEE - 2013]

Statement-I : Higher the range, greater is the resistance of ammeter.

Statement-II : To increase the ragne of ammeter, additional shunt needs to be used across it.

(1) Statement-I is true, Statement-II is true, Statement-II is the correct explanation of Statement-I
(2) Statement-I is true, Statement-II is true, Statement-II is not the correct explanation of Statement-I.
(3) Statement-I is true, Statement-II is false.
(4) Statement-I is false, Statement-II is true.

34. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be : **[JEE-Main 2014]**

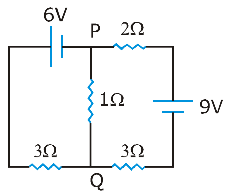
(1) 12 A **(2)** 14 A **(3)** 8 A **(4)** 10 A

35. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to : **[JEE-Main 2015]**

(1) $1.6 \times 10^{-6}\,\Omega m$ **(2)** $1.6 \times 10^{-5}\,\Omega m$ **(3)** $1.6 \times 10^{-8}\,\Omega m$ **(4)** $1.6 \times 10^{-7}\,\Omega m$

36. In the circuit shown, the current in the 1Ω resistor is : **[JEE-Main 2015]**

(1) 0.13 A, from Q to P
(2) 0.13 A, from P to Q
(3) 1.3 A, from P to Q
(4) 0A



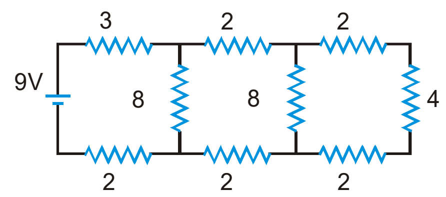
37. A galvanometer having a coil resistance of 100Ω gives a full scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10 A, is : **[JEE-Main 2016]**

(1) 2Ω **(2)** 0.1 Ω **(3)** 3 Ω **(4)** 0.01 Ω

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

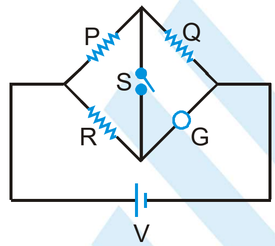
MCQ's (only one correct answers)

1. In the circuit shown in the figure, the current through : **[IIT-JEE 1998]**



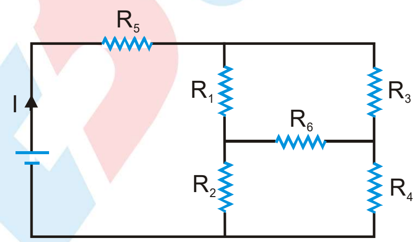
(A) the 3Ω resistor is 0.50 A **(B)** the 3Ω resistor is 0.25 A
(C) the 4Ω resistor is 0.50 A **(D)** the 4Ω resistor is 0.25 A

2. In the circuit shown $P \neq R$, the reading of galvanometer is same with switch S open or closed. Then **[IIT-JEE 1998]**



(A) $I_R = I_G$ **(B)** $I_P = I_G$ **(C)** $I_Q = I_G$ **(D)** $I_Q = I_R$

3. In the given circuit, it is observed that the current I is independent of the value of the resistance R_6. Then, the resistance values must satisfy :– **[IIT-JEE 2001]**



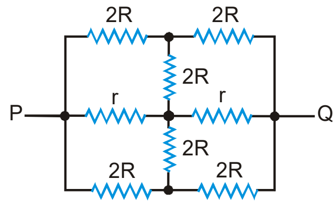
(A) $R_1R_2R_5 = R_3R_4R_6$ **(B)** $\frac{1}{R_5}+\frac{1}{R_6}=\frac{1}{R_1+R_2}+\frac{1}{R_3+R_4}$

(C) $R_1R_4 = R_2R_3$ **(D)** $R_1R_3 = R_2R_4$

4. A wire of length L and 3 identical cells of negligible internal resistance are connected in series. Due to the current, the temperature of the wire is raised by ΔT in a time t. A number N of similar cells is now connected in series with a wire of the same material and cross–section but of length 2L. The temperature of the wire is raised by the same amount ΔT in the same time. The value of N is :– **[IIT-JEE 2001]**

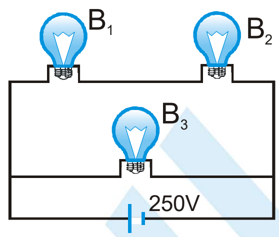
(A) 4 **(B)** 6 **(C)** 8 **(D)** 9

5. The effective resistance between points P and Q of the electrical circuit shown in the figure is :– **[IIT-JEE 2002]**



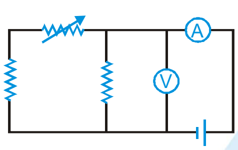
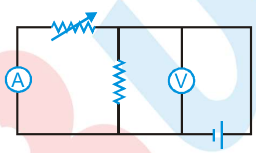
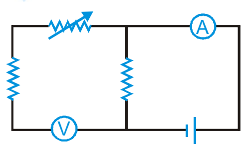
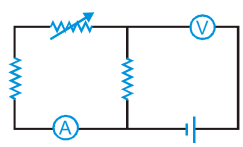
(A) $\frac{2Rr}{R+r}$ **(B)** $\frac{8R(R+r)}{3R+r}$ **(C)** $2r + 4R$ **(D)** $\frac{5R}{2} + 2r$

6. A 100 W bulb B_1, and two 60 W bulbs B_2 and B_3, are connected to a 250 V source, as shown in the figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3 respectively. Then **[IIT-JEE 2002]**

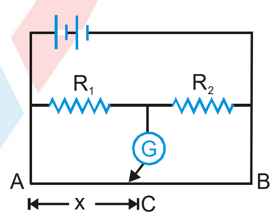


(A) $W_1 > W_2 = W_3$ **(B)** $W_1 > W_2 > W_3$ **(C)** $W_1 < W_2 = W_3$ **(D)** $W_1 < W_2 < W_3$

7. Express which of the following set–up can be used to verify Ohm's law (ammeter & voltmeter are ideal) **[IIT-JEE 2003]**

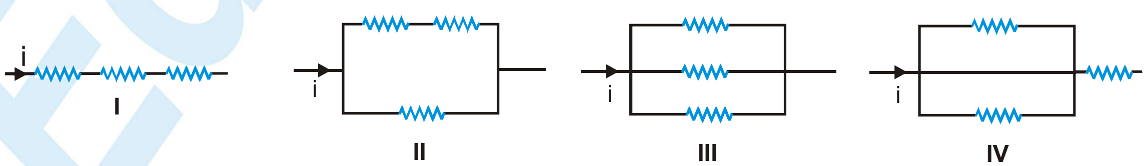
(A)  **(B)**  **(C)**  **(D)** 

8. In the shown arrangement of the experiment of the meter bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled? **[IIT-JEE 2003]**



(A) x **(B)** x/4 **(C)** 4x **(D)** 2x

9. The three resistance of equal value are arranged in the different combinations shown below. Arrange them in increasing order of power dissipation : **[IIT-JEE 2003]**



(A) III < II < IV < I **(B)** II < III < IV < I **(C)** I < IV < III < II **(D)** I < III < II < IV

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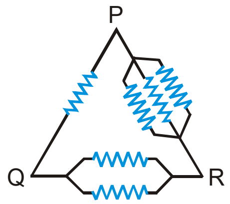
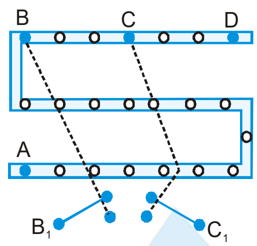
10. Six equal resistances are connected between points P,Q and R as shown in the figure. Then, the net resistance will be maximum between **[IIT-JEE 2003]**



(A) P and Q **(B)** Q and R **(C)** P and R **(D)** any two points

11. For the post office box arrangement to determine the value of unknown resistance, the unknown resistance should be connected between **[IIT-JEE 2004]**



(A) B and C **(B)** C and D **(C)** A and D **(D)** B_1 and C_1

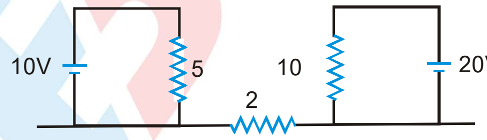
12. A moving coil galvanometer of resistance 100 Ω is used as an ammeter using a resistance 0.1Ω. The maximum deflection current in the galvanometer is 100 μA. Find the minimum current in the circuit, so that the ammeter shown maximum deflection. **[IIT-JEE 2005]**

(A) 100.1 mA **(B)** 1000.1 mA **(C)** 10.01 mA **(D)** 1.01 mA

13. A rigid container with thermally insulated walls contains a coil of resistance 100Ω, carrying current 1A. Change in internal energy after 5 min will be :– **[IIT-JEE 2005]**

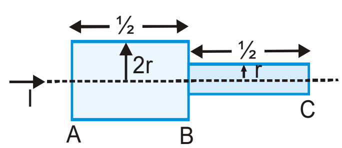
(A) zero **(B)** 10 kJ **(C)** 20 kJ **(D)** 30 kJ

14. Find out the value of current through 2Ω resistance for the given circuit :– **[IIT-JEE 2005]**



(A) 5A **(B)** 2 A **(C)** zero **(D)** 4 A

15. Two bars of radius r and 2r are kept in contact as shown. An electric current I is passed through the bars. Which one of following is correct :– **[IIT-JEE 2006]**

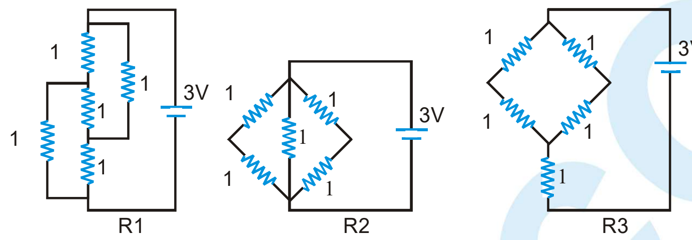


(A) Heat produced in bar BC is 4 times the heat produced in bar AB
(B) Electric field in both halves is equal
(C) Current density across AB is double that of across BC
(D) Potential difference across AB is 4 times that of across BC

16. A resistance of 2Ω is connected across one gap of a metre–bridge (the length of the wire is 100 cm) and an unknown resistance, greater than 2Ω, is connected across the other gap. When these resistances are interchanged, the balance point shifts by 20 cm. Neglecting any corrections, the unknown resistance is :–

(A) 3Ω **(B)** 4Ω **(C)** 5Ω **(D)** 6Ω **[IIT-JEE 2007]**

17. Figure shows three resistor configurations R_1, R_2 and R_3 connected to 3V battery. If the power dissipated by the configuration R_1, R_2 and R_3 is P_1, P_2 and P_3, respectively, then :- **[IIT-JEE 2008]**

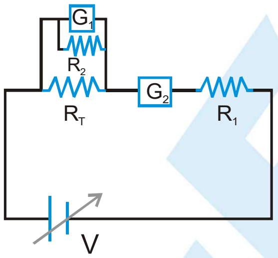


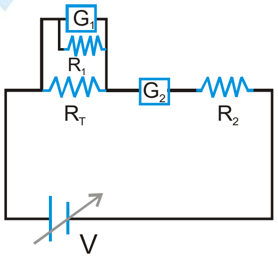
(A) $P_1 > P_2 > P_3$ **(B)** $P_1 > P_3 > P_2$ **(C)** $P_2 > P_1 > P_3$ **(D)** $P_3 > P_2 > P_1$

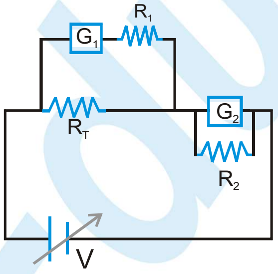
18. Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperature, 100 W, 60 W and 40 W bulbs have filament resistance R_{100}, R_{60} and R_{40}, respectively, the relation between these resistances is **[IIT-JEE 2010]**

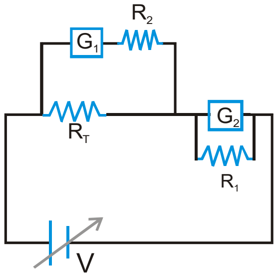
(A) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$ **(B)** $R_{100} = R_{40} + R_{60}$ **(C)** $R_{100} > R_{60} > R_{40}$ **(D)** $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$

19. To verify Ohm's law, a student is provided with a test resistor R_T, a high resistance R_1, a small resistance R_2, two identical galvanometers G_1 and G_2, and a variable voltage source V. The correct circuit to carry out the experiment is :– **[IIT-JEE 2010]**

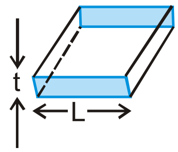
(A)


(B)


(C)


(D)


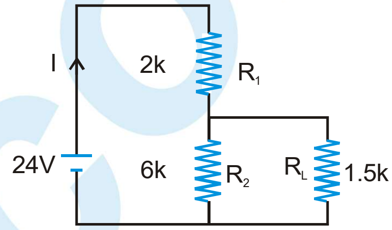
20. Consider a thin square sheet of side L and thickness t, made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is **[IIT-JEE 2010]**



(A) directly proportional to L
(B) directly proportional to t
(C) independent of L
(D) independent of t

MCQ's (one or more than one correct answers)

1. For the circuit shown in the figure **[IIT-JEE 2009]**



(A) the current I through the battery is 7.5 mA
(B) the potential difference across R_L is 18 V
(C) ratio of powers dissipated in R_1 and R_2 is 3
(D) If R_1 and R_2 are interchanged magnitude of the power dissipated in R_L will decrease by a factor of 9

Assertion-Reason

1. **STATEMENT–1 :** In a Meter Bridge experiment, null point for an unknown resistance is measured. Now, the unknown resistance is put inside an enclosure maintained at a higher temperature. The null point can be obtained at the same point as before by decreasing the value of the standard resistance.

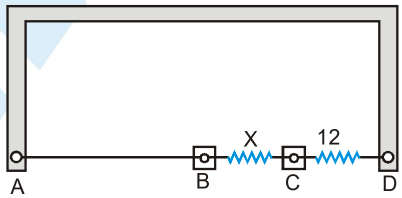
and **[IIT-JEE 2008]**

STATEMENT-2 : Resistance of a metal increases with increase in temperature.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is NOT a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

Subjective problems

1. A thin uniform wire AB of length 1m, an unknown resistance X and a resistance of 12Ω are connected by thick conducting strips, as shown in the figure. A battery and galvanometer (with a sliding jockey connected to it) are also available. Connections are to be made to measure the unknown resistance X using the principle of Wheatstone bridge. **[IIT-JEE 2002]**

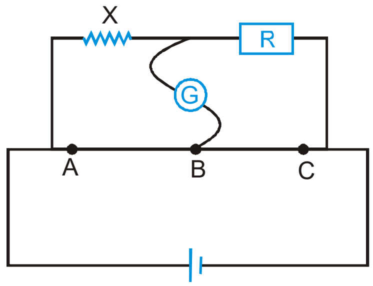


(i) Are there positive and negative terminals on the galvanometer ?
(ii) Copy the figure in your answer book and show the battery and the galvanometer (with jockey) connected at appropriate points.
(iii) After appropriate connections are made, it is found that no deflection takes place in the galvanometer when the sliding jockey touches the wire at a distance of 60 cm from A. Obtain the value of the resistance X.

2. Show by diagram, how can we use a rheostat as the potential divider ? **[IIT-JEE 2003]**

3. Draw the circuit for experimental verification of Ohm's law using a source of variable DC voltage, a main resistance of 100 Ω, two galvanometers and two resistances of values 10^6 Ω and 10^{-3} Ω respectively. Clearly show the positions of the voltmeter and the ammeter. **[IIT-JEE 2004]**

4. R_1, R_2, R_3 are different values of R. A, B, C are the null points obtained corresponding to R_1, R_2 and R_3 respectively. For which resistor, the value of X will be the most accurate and why ? **[IIT-JEE 2005]**



5. When two identical batteries of internal resistance 1Ω each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected in parallel across R, the rate is J_2. If $J_1 = 2.25\ J_2$ then the value of R in Ω is **[IIT-JEE 2010]**

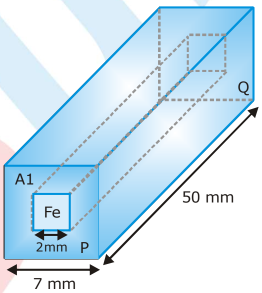
6. In an aluminum (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are 2.7×10^{-8}Ω m and 1.0×10^{-7} Ωm, respectively. The electrical resistance between the two faces P and Q of the composite bar is **[IIT-JEE 2015]**

(A) $\frac{2475}{64}$ μΩ

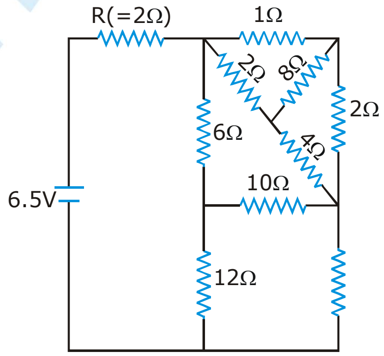
(B) $\frac{1875}{64}$ μΩ

(C) $\frac{1875}{49}$ μΩ

(D) $\frac{2475}{132}$ μΩ



7. In the following circuit, the current through the resistor R (=2Ω) is I amperes. The value of I is - **[IIT-JEE 2015]**



Comprehension for 8 & 9

Consider an evacuated cylindrical chamber of height h haivng rigid conducting plates at the ends and an insulating curved surface as shown in the figure. A number of spherical balls made of alight weight and soft material and coated with a conducting material are placed on the bottom plate. The balls have a radius r << h. Now a high voltage source (HV) is connected across the conducting plates such that the bottom plate is at + V_0 and the top plate at $-V_0$. Due to the their conducting surface, the balls will get charged, will become equipotential with the plate and are repelled by it. The balls will eventually collide with the top plate, where the coefficient of restitution can be taken to be zero due to the soft nature of the material of the balls. The electric field in the chamber can be considered to be that of a parallel plate capacitor. Assume that there are no collisions between the balls and the interaction between them is negligible. (Ignore gravity) **[IIT-JEE 2016]**

8. Which one of the following statements is correct? **[IIT-JEE 2016]**

(A) The balls will stick to the top plate and remain there

(B) The balls will bounce back to the bottom plate carrying the same charge they went up with

(C) The balls will bounce back to the bottom plate carrying the opposite charge they went up with

(D) The balls will execute simple harmonic motion between the two plates

9. The average current in the steady state registered by the ammeter in the circuit will be **[IIT-JEE 2016]**

(A) zero

(B) proportional to the potential V_0

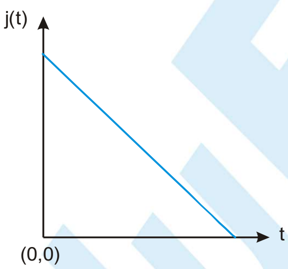
(C) proportional to $V_0^{1/2}$

(D) proportional to V_0^2

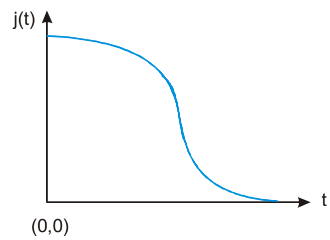
10. An infinite line charge of uniform electric charge density λ lies along the axis of an electrically conducting infinite cylindrical shell of radius R. At time $t = 0$, the space inside the cylinder is filled with a material of permittivity ε and electrical conductivity σ. The electrical conduction in the material follows Ohm's law. Which one of the following graphs best describes the subsequent variation of the magnitude of current density f(t) at any point in the material?

[IIT-JEE 2016]

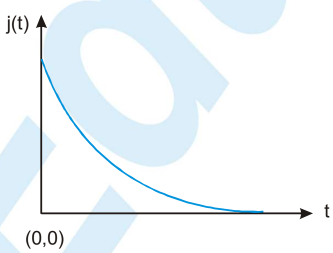
(A)



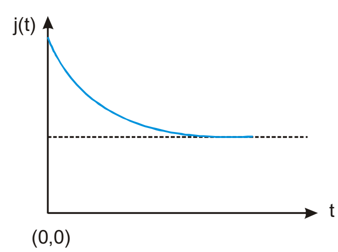
(B)



(C)



(D)



11. An incandescent bulb has a thin filament of tungsten that is heated to high temperature by passing an electric current. The hot filament emits black-body radiation. The filament is observed to break up at random locations after a sufficiently long time of operation due to non-uniform evaporation of tungsten from the filament. If the bulb is powered at constant voltage, which of the following statement(s) is(are) true? **[IIT-JEE 2016]**

(A) The temperature distribution over the filament is uniform

(B) The resistance over small sections of the filament decreases with time

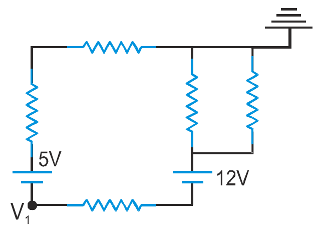
(C) The filament emits more light at higher band of frequencies before it breaks up

(D) The filament consumes less electrical power towards the end of the life of the bulb

MOCK TEST : BASIC MATHS

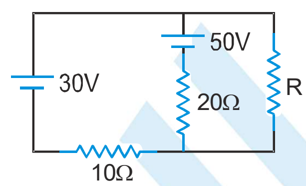
SECTION - I : STRAIGHT OBJECTIVE TYPE

1. In the circuit shown, each resistances is 2 W. The potential V_1 as indicated in the circuit, is equal to



(A) 11 V **(B)** – 11V **(C)** 9 V **(D)** – 9 V

2. In the circuit shown, the value of R in ohm that will result in no current through the 30 V battery, is :



(A) 10 Ω **(B)** 25 Ω **(C)** 30 Ω **(D)** 40 Ω

3. The maximum current in a galvanometer can be 10 mA. It's resistance is 10Ω. To convert it into an ammeter of 1 Amp. a resistor should be connected in

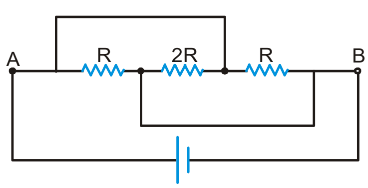
(A) series, 0.1Ω **(B)** parallel, 0.1Ω **(C)** series, 100 Ω **(D)** parallel, 100Ω.

4. When a galvanometer is shunted with a 4Ω resistance, the deflection is reduced to one - fifth. If the galvanometer is further shunted with a 2Ω wire, the further reduction (find the ratio of decrease in current to the previous current) in the deflection will be (the main current remains the same).

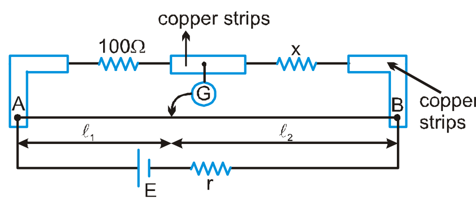
(A) (8/13) of the deflection when shunted with 4Ω only
(B) (5/13) of the deflection when shunted with 4Ω only
(C) (3/4) of the deflection when shunted with 4Ω only
(D) (3/13) of the deflection when shunted with 4Ω only

5. In the figure shown the current flowing through 2 R is :

(A) from left to right
(B) from right to left
(C) no current
(D) None of these



6. In a practical wheat stone bridge circuit as shown, when one more resistance of 100 Ω is connected is parallel with unknown resistance 'x', then ratio ●$_1$/●$_2$ become '2'. ●$_1$ is balance length. AB is a uniform wire. Then value of 'x' must be:



(A) 50 Ω **(B)** 100 Ω **(C)** 200 Ω **(D)** 400 Ω

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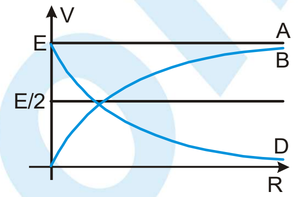
7. A battery of internal resistance 2 Ω is connected to a variable resistor whose value can vary from 4 Ω to 10 Ω. The resistance is initially set at 4 Ω. If the resistance is now increased then
(A) power consumed by it will decrease
(B) power consumed by it will increase
(C) power consumed by it may increase or may decrease
(D) power consumed will first increase then decrease.

8. A cell of emf E having an internal resistance 'r' is connected to an external resistance R. The potential difference 'V' across the resistance R varies with R as shown by the curve:



(A) A **(B)** B

(C) C **(D)** D

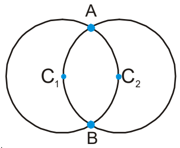
9. 'n' identical light bulbs, each designed to draw P power from a certain voltage supply are joined in series and that combination is connected across that supply. The power consumed by one bulb will be-

(A) n P **(B)** P **(C)** P/n **(D)** P/n^2

10. To get maximum current through a resistance of 2.5 Ω, one can use 'm' rows of cells, each row having 'n' cells. The internal resistance of each cell is 0.5 Ω. What are the values of n & m, if the total number of cells is 45.

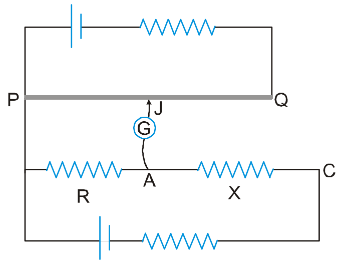
(A) 3, 15 **(B)** 5, 9 **(C)** 9, 5 **(D)** 15, 3

11. Two circular rings of identical radii and resistance of 36Ω each are placed in such a way that they cross each other's centre C_1 and C_2 as shown in figure. Conducting joints are made at intersection points A and B of the rings. An ideal cell of emf 20 volts is connected across AB. The power delivered by cell is



(A) 80 watt **(B)** 100 watt **(C)** 120 watt **(D)** 200 watt

12. Circuit for the measurement of resistance by potentiometer is shown. The galvanometer is first connected at point A and zero deflection is observed at length PJ = 10 cm. In second case it is connect at point C and zero deflection is observed at a length 30 cm from P. Then the unknown resistance X is



(A) 2R **(B)** $\frac{R}{2}$

(C) $\frac{R}{3}$ **(D)** 3R

13. Two long coaxial and conducting cylinders of radius a and b are separated by a material of conductivity σ and a constant potential difference V is maintained between them, by a battery. Then the current, per unit length of the cylinder flowing from one cylinder the other is :

(A) $\frac{4\pi\sigma}{\ln(b/a)}V$ **(B)** $\frac{4\pi\sigma}{(b+a)}V$ **(C)** $\frac{2\pi\sigma}{\ln(b/a)}V$ **(D)** $\frac{2\pi\sigma}{(b+a)}V$

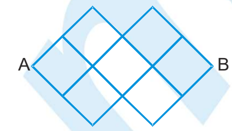
14. 50 V battery is supplying current of 10 amp when connected to a resistor. If the efficiency of battery at this current is 25%. Then internal resistance of battery is :

(A) 2.5 Ω **(B)** 3.75 Ω **(C)** 1.25 Ω **(D)** 5 Ω

15. A battery is supplying power to a tape-recorder by cable of resistance of 0.02 Ω. If the battery is generating 50 W power at 5V, then power received by tape-recorder is : (neglect internal resistance of battery)

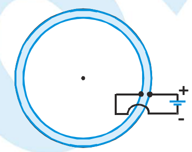
(A) 50 W **(B)** 45 W **(C)** 30 W **(D)** 48 W

16. In the shown wire frame, each side of a square (the smallest square) has a resistance R. The equivalent resistance of the circuit between the points A and B is :



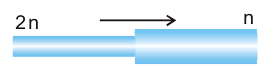
(A) R **(B)** 2R **(C)** 4R **(D)** 8R

17. A spherical shell, made of material of electrical conductivity $\frac{10^9}{\pi}(\Omega\text{-m})^{-1}$, has thickness t = 2 mm and radius r = 10 cm. In an arrangement, its inside surface is kept at a lower potential than its outside surface. The resistance offered by the shell is equal to -



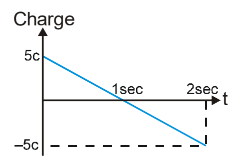
(A) $5\pi \times 10^{-12}\ \Omega$ **(B)** $2.5 \times 10^{-11}\ \Omega$ **(C)** $5 \times 10^{-12}\ \Omega$ **(D)** $5 \times 10^{-11}\ \Omega$

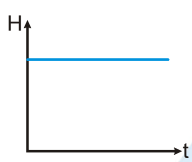
18. Two cylindrical rods of uniform cross-section area A and 2A, having free electrons per unit volume 2n and n respectively are joined in series. A current I flows through them in steady state. Then the ratio of drift velocity of free electron in left rod to drift velocity of electron in the right rod is $\left(\frac{v_L}{v_R}\right)$ is :

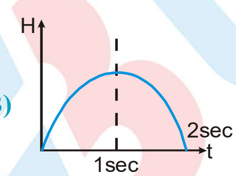


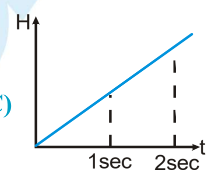
(A) $\frac{1}{2}$ **(B)** 1 **(C)** 2 **(D)** 4

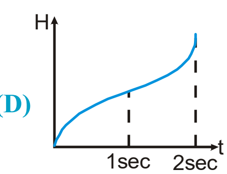
19. A charge passing through a resistor is varying with time as shown in the figure. The amount of heat generated in time 't' is best represented (as a function of time) by:



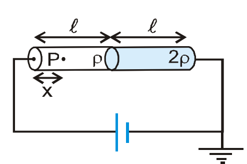
(A)


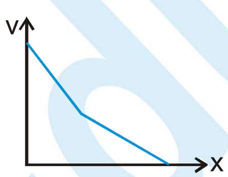
(B)


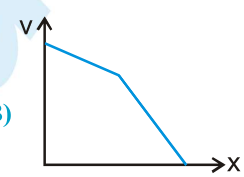
(C)


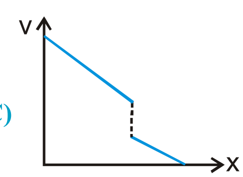
(D)


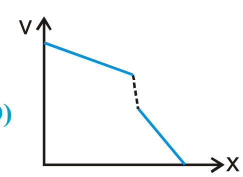
20. Two cylindrical rods of same cross-section area and same length are connected in series to an ideal cell as shown. The resistivity of left rod is ρ and that of right rod is 2ρ. Then the variation of potential at any point P distant x from left end of combined rod system is given by.



(A)


(B)


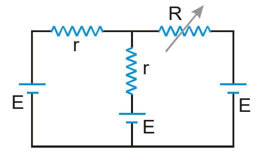
(C)


(D)


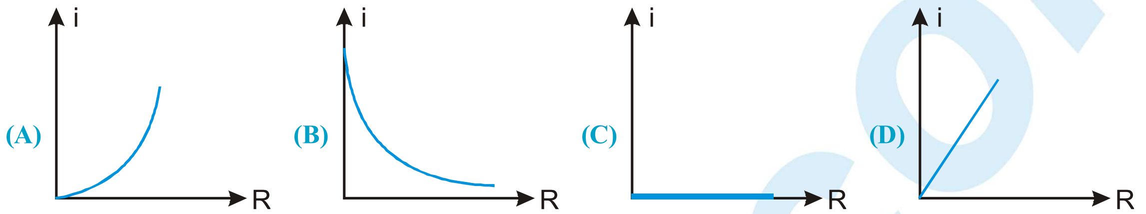
21. A copper sphere of 10cm diameter is lowered into a water filled hemispherical copper vessel of 20 cm diameter so that the sphere and the vessel becomes concentric. Electrical conductivity of water is $\sigma = 10^{-3}\ (\Omega - m)^{-1}$. The electrical resistance between the sphere and the vessel is :

(A) 1591.6 Ω **(B)** 1450 Ω **(C)** 1682.4 Ω **(D)** 1489.6 Ω

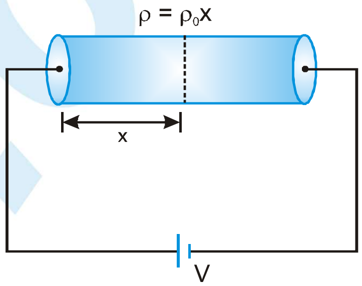
22. In the shown circuit the resistance R can be varied :



The variation of current through R against R is correctly plotted as :



23. A cylindrical solid of length L and radius a is having varying resistivity given by $\rho = \rho_0 x$ where ρ_0 is a positive constant and x is measured from left end of solid. The cell shown in the figure is having emf V and negligible internal resistance. The electric field as a function of x is best described by :



(A) $\frac{2V}{L^2} \times x$

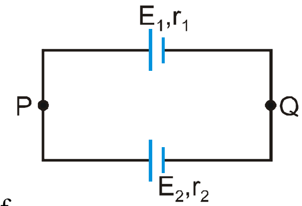
(B) $\frac{2V}{\rho_0 L^2} \times x$

(C) $\frac{V}{L^2} \times x$

(D) None of these

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

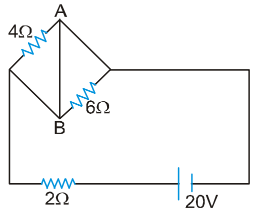
24. Two cells of unequal emfs E_1 and E_2 and internal resistances r_1 and r_2 are joined as shown in figure. V_P and V_Q are the potential at P and Q respectively.



(A) The potential difference across both the cells will be equal
(B) One of the cell, will supply energy to the other cell.
(C) The potential difference across one of the cells will be greater than its emf.

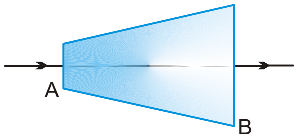
(D) $V_P - V_Q = \frac{E_1 r_2 + E_2 r_1}{r_1 + r_2}$

25. In the circuit shown in the figure



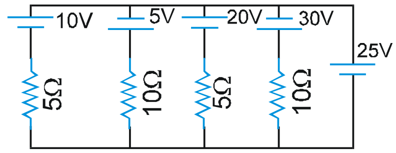
(A) power supplied by the battery is 200 watt
(B) current flowing in the circuit is 5 A
(C) potential difference across 4 Ω resistance is equal to the potential difference across 6Ω resistance
(D) current in wire AB is zero

26. In the figure a conductor of non–uniform cross-section is shown. A steady current I flows in it.



(A) The electric field at A is more than at B.
(B) The electric field at B is more than at A.
(C) The thermal power generated at A is more than at B in an element of small same width.
(D) The thermal power generated at B is more than at A in an element of small same width.

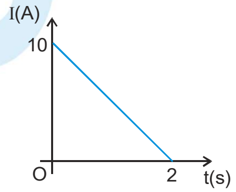
27. In the figure shown: (All batteries are ideal)



(A) current through 25 V cell is 20 A
(B) current through 25 V cell is 12.5 A
(C) power supplied by 20 V cell is 20 W
(D) power supplied by 20 V cell is – 20 W

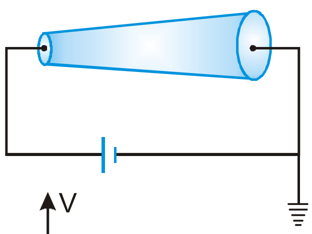
28. Consider a resistor of uniform cross sectional area connected to a battery of zero internal resistance. If the length of the resistor is doubled by stretching it then
(A) current will become four times.
(B) the electric field in the wire will become half.
(C) the thermal power produced by the resistor will become one fourth.
(D) the product of the current density and conductance will become half.

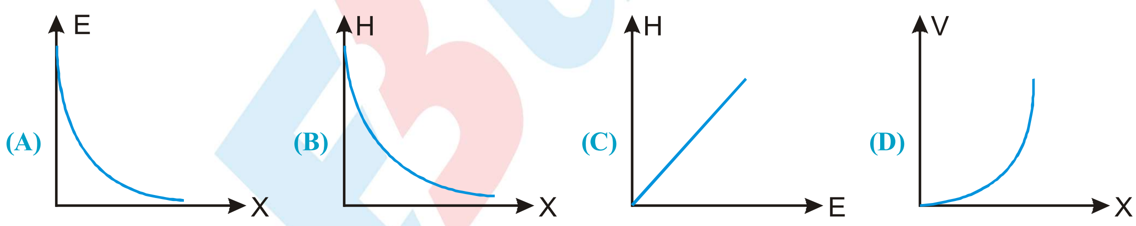
29. A variable current flows through a 1Ω resistor for 2 seconds. Time dependence of the current is shown in the graph.



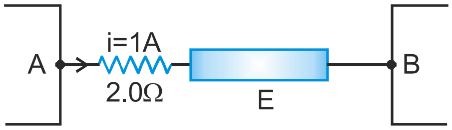
(A) Total charge flown through the resistor is 10 C.
(B) Average current through the resistor is 5A.
(C) Total heat produced in the resistor is 50 J.
(D) Maximum power during the flow of current is 100 W.

30. A conductor of truncated conical (frustum) is connected to a battery of emf ε as shown in the figure.
If at a section distant x from left end, electric field intensity, potential and rate of generation of heat per unit length are E, V and H respectively, then which of the following graph(s) is/are correct ?



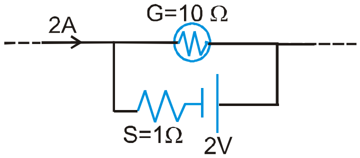


31. AB is part of a circuit as shown, that absorbs energy at a rate of 50 W. E is an emf device that has no internal resistance.



(A) Potential difference across AB is 48 V.
(B) Emf of the device is 48 V.
(C) Point B is connected to the positive terminal of E.
(D) Rate of conversion from electrical to chemical energy is 48 W in device E.

32. The galvanometer shown in the figure has resistance 10Ω .It is shunted by a series combination of a resistance S = 1Ω and an ideal cell of emf 2V. A current 2A passes as shown.



(A) The reading of the galvanometer is 1A
(B) The reading of the galvanometer is zero
(C) The potential difference across the resistance S is 1.5 V
(D) The potential difference across the resistance S is 2 V

SECTION - III : ASSERTION AND REASON TYPE

33. **Statement-1 :** When an external resistor of resistance R (connected across a cell of internal resistance r) is varied, power consumed by resistance R is maximum when R = r.

Statement-2 : Power consumed by a resistor of constant resistance R is maximum when current through it is maximum.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

34. **STATEMENT-1 :** The current density $\vec{J}$ at any point in ohmic resistor is in direction of electric field $\vec{E}$ at that point.

STATEMENT-2 : A point charge when released from rest in a region having only electrostatic field always moves along electric lines of force.

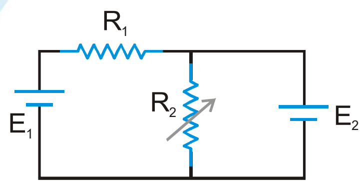
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

35. **Statement-1 :** A wire of uniform cross section and uniform resistivity is connected across an ideal cell. Now the length of the wire is doubled keeping volume of wire constant. The drift velocity of electrons after stretching the wire becomes one fourth of what it was before stretching the wire.

Statement-2 : If a wire (of uniform resistivity and uniform cross-section) of length ℓ_o is stretched to length $n\ell_o$, then its resistance becomes n^2 times of what it was before stretching the wire (the volume of wire is kept constant in stretching process). Further at constant potential difference, current is inversely proportional to resistance. Finally drift velocity of free electron is directly proportional to current and inversely proportional to cross section area of current carrying wire..

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

36. **Statement-1 :** In the circuit shown both cells are ideal and of fixed emf, the resistor of resistance R_1 has fixed resistance and the resistance of resistor R_2 can be varied(but R_2 is always non-zero). Then the electric power delivered to resistor of resistance R_1 is independent of value of resistance R_2.



Statement-2 : If potential difference across a fixed resistance is unchanged, the power delivered to the resistor remains constant.

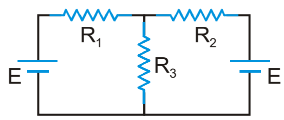
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

37. **Statement–1 :** The power delivered to a light bulb is more just after it is switched ON and the glow of the filament is increasing, as compared to when the bulb is glowing steadily, i.e., after some time of switching ON.

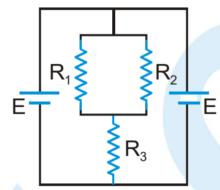
Statement–2 : As temperature increases, resistance of conductor increases.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True.

38. **Statement-1 :** For calculation of current in resistors of resistance R_1, R_2 and R_3 in the circuit shown in figure 1, the circuit can be redrawn as shown in figure 2 (this means that circuit shown in figure 2 is equivalent to circuit shown in figure 1). All the cells shown are ideal and identical.



(fig.1)



(fig.2)

Statement-2 : Whenever potential difference across two resistors is same, both resistors can be assumed as a combination of two resistors in parallel.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

SECTION - IV : COMPREHENSION TYPE

Comprehension # 1

Resistance value of an unknown resistor is calculated using the formula $R = \frac{V}{I}$ where V and I be the readings of the voltmeter and the ammeter respectively. Consider the circuits below. The internal resistances of the voltmeter and the ammeter (R_v and R_G respectively) are finite and non zero.

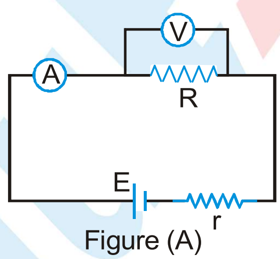


Figure (A)

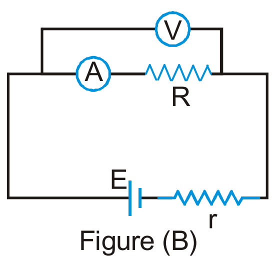


Figure (B)

Let R_A and R_B be the calculated values in the two cases A and B respectively.

39. The relation between R_A and the actual value R is
(A) $R > R_A$ **(B)** $R < R_A$
(C) $R = R_A$ **(D)** dependent upon E and r.

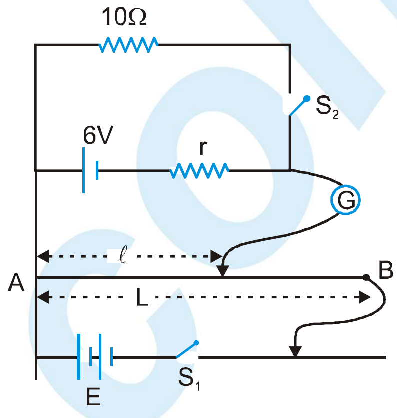
40. The relation between R_B and the actual value R is :
(A) $R < R_B$ **(B)** $R > R_B$ **(C)** $R = R_B$ **(D)** dependent upon E and r.

41. If the resistance of voltmeter is $R_v = 1\ k\Omega$ and that of ammeter is $R_G = 1\ \Omega$, the magnitude of the percentage error in the measurement of R (the value of R is nearly $10\,\Omega$) is :

(A) zero in both cases
(B) non zero but equal in both cases
(C) more in circuit A
(D) more in circuit B

Comprehension # 2

In the arrangement shown in the figure when the switch S_2 is open, the galvanometer shows no deflection for $\ell = L/2$. When the switch S_2 is closed, the galvanometer shows no deflection for $\ell = \frac{5}{12}L$. The internal resistance (r) of 6 V cell, and the emf E of the other battery are respectively. Wire AB is potentiometer wire and resistance of other conducting wires is negligible. (Internal resistance of cell E is negligible)



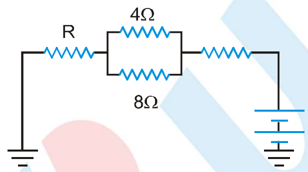
42. Calculate emf of cell E :

(A) 6 V **(B)** 5 V **(C)** 12 V **(D)** 10 V

43. Calculate the internal resistance 'r' :

(A) $1\,\Omega$ **(B)** $2\,\Omega$ **(C)** $3\,\Omega$ **(D)** zero

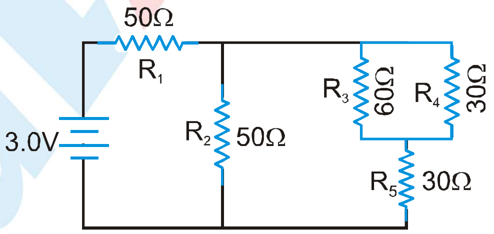
44. If the current in $8\,\Omega$ resistance is 2A then the current through resistance 'R' (in ampere) is :



(A) 6 **(B)** 7 **(C)** 8 **(D)** 9

Comprehension # 3

In the circuit shown, the resistances are given in ohms and the battery is assumed ideal with emf equal to 3.0 volts.



45. The resistor that dissipates maximum power.

(A) R_1 **(B)** R_2 **(C)** R_4 **(D)** R_5

46. The potential difference across resistor R_3 is

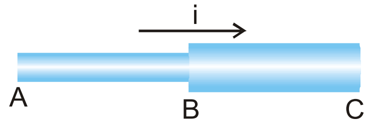
(A) 0.4 V **(B)** 0.6 V **(C)** 1.2 V **(D)** 1.5 V

47. The current passing through 3V battery is

(A) 10 mA **(B)** 30 mA **(C)** 40 mA **(D)** 60 mA

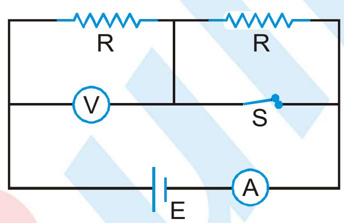
SECTION - V : MATRIX - MATCH TYPE

48. Column I gives physical quantities of a situation in which a current i passes through two rods I and II of equal length that are joined in series. The ratio of free electron density (n), resistivity (ρ) and cross-section area (A) of both are in ratio $n_1 : n_2 = 2 : 1$, $\rho_1 : \rho_2 = 2 : 1$ and $A_1 : A_2 = 1 : 2$ respectively. Column II gives corresponding results. Match the ratios in Column I with the values in Column II .



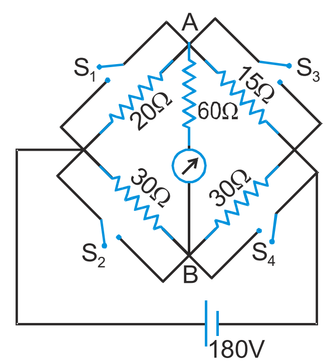
Column I	Column II
(A) $\dfrac{\text{Drift velocity of free electron in rod I}}{\text{Drift velocity of free electron in rod II}}$	**(P)** 0.5
(B) $\dfrac{\text{Electric field in rod I}}{\text{Electric field in rod II}}$	**(Q)** 1
(C) $\dfrac{\text{Potential difference across rod I}}{\text{Potential difference across rod II}}$	**(R)** 2
(D) $\dfrac{\text{Average time taken by free electron to move from A to B}}{\text{Average time taken by free electron to move from B to C}}$	**(S)** 4

49. In the circuit shown, battery, ammeter and voltmeter are ideal and the switch S is initially closed as shown. When switch S is opened, match the parameter of column I with the effects in column II .



(A) Equivalent resistance across the battery	**(p)** Remains same
(B) Power dissipated by left resistance R	**(q)** Increases
(C) Voltmeter reading	**(r)** decreases
(D) Ammeter reading	**(s)** Becomes zero.

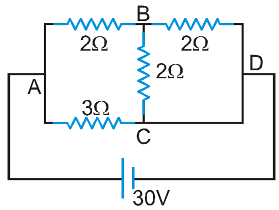
50. Consider the circuit shown. The resistance connected between the junction A and B is 60 Ω including the resistance of the galvanometer. The switches have no resistance when shorted and infinite resistance when opened. All the switches are initially open and they are closed as given in column I. Match the condition in column I with the direction of current through galvanometer and the value of the current through the battery in column II.



Column I	Column II
(A) Only switch S_1 is closed	**(P)** Current from A to B
(B) Only switch S_2 is closed	**(Q)** Current from B to A
(C) Only switch S_3 is closed	**(R)** Current through the battery is 12.0 A
(D) Only switch S_4 is closed	**(S)** Current through the battery is 15.6 A
	(T) Current through the Galvanometer is 1.2 A

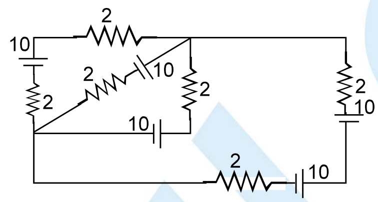
SECTION - VI : INTEGER TYPE

51. Find current in the branch CD of the circuit (in ampere).

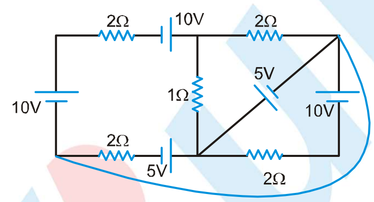


52. The circuit shown in the figure contains three resistors $R_1 = 100\Omega$, $R_2 = 50\Omega$ & $R_3 = 20\ \Omega$ and cells of emf's $E_1 = 2V$ & E_2. The ammeter indicates a current of 50mA. Determine the current(mA) in the resistor R_2

53. All batteries are having emf 10 volt and internal resistance negligible. All resistors are in ohms. Calculate the current in the right most 2Ω resistor.

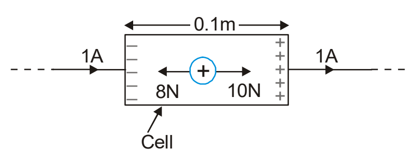


54. In the circuit diagram shown if the current through the 1 Ω resistor is $\frac{x}{2}$ A then x is.

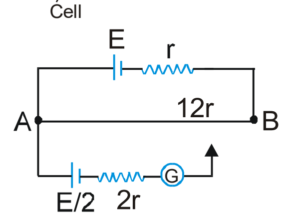


55. The efficiency of a cell when connected to a resistance R is 60%. What will be its efficiency (in%) if the external resistance is increased to six times.

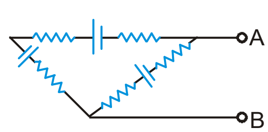
56. Figure shows a cell in which unit positive charge experience a constant non electric force of 10N and a constant electric force of 8N in directions shown in the figure. Find the emf of the cell, difference across the cell (in volt)



57. Consider the potentiometer circuit arranged as in figure. The potentiometer wire AB is 300 cm long. **(A)** At what distance from the point A should the jockey touch the wire to get zero deflection in the galvanometer ? **(B)** If the jockey touches the wire at a distance of 275 cm from A, what will be the current in the galvanometer?



58. In the circuit shown all five resistors have the same value 200 ohms and each cell has an emf 3 volts. if the open circuit voltage is $\frac{x}{10}$ volt then x is.



ANSWER KEY

EXERCISE - 1

1. D **2.** C **3.** D **4.** C **5.** C **6.** C **7.** C **8.** B **9.** C **10.** A **11.** B **12.** A **13.** B

14. C **15.** B **16.** D **17.** C **18.** C **19.** D **20.** D **21.** B **22.** B **23.** C **24.** A **25.** B **26.** A

27. B **28.** B **29.** B **30.** B **31.** A **32.** A **33.** D **34.** C **35.** B **36.** D

EXERCISE - 2 : PART # I

1. A,C,D **2.** A,C **3.** AD **4.** A **5.** A, C **6.** A, B **7.** B **8.** A,C,D **9.** A,B,C
10. D **11.** D **12.** D **13.** A **14.** A **15.** A,C **16.** B,C **17.** A,C **18.** A,B,C
19. C **20.** A **21.** B **22.** D **23.** B **24.** C **25.** C **26.** D **27.** B
28. B **29.** AB **30.** AC **31.** AB

PART # II

1. C **2.** B **3.** D **4.** E **5.** A **6.** A **7.** B **8.** A **9.** C **10.** D

EXERCISE - 3 : PART # I

1. $A \to P$; $B \to Q, S$; $C \to S$; $D \to P, R, S$ **2.** $A \to Q$; $B \to P$; $C \to P$; $D \to Q$
3. $A \to Q$; $B \to P$; $C \to P$ **4.** $A \to P$; $B \to P$; $C \to Q$; $D \to Q,S$

PART # II

Comp. # 1 : 1. A 2. D 3. D   **Comp. # 2 :** 1. B 2. B 3. D
Comp. # 3 : 1. C 2. B   **Comp. # 4 :** 1. A,C 2. B,D 3. A,B
Comp. # 5 : 1. A 2. B 3. B   **Comp. # 6 :** 1. B 2. B 3. A
Comp. # 7 : 1. C 2. A 3. B   **Comp. # 8 :** 1. B 2. B 3. D
Comp. # 9 : 1. C 2. A 3. C

EXERCISE - 4

1. 31 C, $\frac{31}{3}$ A   **2.** $\frac{1.5 \times 63.5 \times 10^{-3}}{1.6 \times 6 \times 9} = 1.1 \times 10^{-3}\ ms^{-1}$ or 1.1 mm s^{-1} **3.** (i) Q = 1200 C (ii) n = 75×10^{20}

4. **(a)** $n = \frac{2}{1.6} \times 10^{17} = 1.25 \times 10^{17}$ **(b)** $\frac{1}{2\pi} \times 10^{6}$ A/m^2.   **5.** 10 A.   **6.** **(i)** 41°C **(ii)** $\frac{\ell n 2}{273}$ °C^{-1}.

7. T_2 **8.** 0.2 %   **9.** **(i)** $R = \frac{0.35}{2} = 0.175\ \Omega$ **(ii)** $R = 7 \times 10^{-5}\ \Omega$

10. **(a)** E = 10 V each **(b)** (a) act as a source and (b) act as load **(c)** $V_A = 9V$, $V_B = 11$ V **(d)** $P_A = 9$ W, $P_B = 11$ W
(e) Heat rate = 1 W each **(f)** 10 W each **(g)** 9V, 11V **(h)** –9W, 11 W

11. $\frac{125}{9}$ V   **12.** **(a)** all equal   **(b)** b, then a and c equal **(c)** a, c equal, b

13. **(a)** 7.5 V, **(b)** 24 mA **(c)** greater than 12 V.

14. **(a)** $\frac{50}{11} = 4.55$ A **(b)** $\frac{22 \times 11}{5} = 48.4\ \Omega$ **(c)** 1000 W **(d)** 240 cal s^{-1} **(e)** 80/3 gm   **15.** $\frac{125}{4} = 31.25$ watt

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16. $P_A = 8$ W & $P_B = 32$ W, A is more likely to fail his examinations

17. **(a)** $V_A = V_B = V_C = V_D = 0$ V, $V_E = V_F = V_G = V_H = 10$ V, $V_I = V_J = V_K = 15$ V

(b) $V_1 = 15$ V, $V_2 = 5$V, $V_3 = 15$ V **(c)** each act as a source

(d) 17.5 A (↑), 15A(↓) 2.5 A (↑), 5A (↓) from left toright in given circuit. **(e)** 1 Ω resistance **(f)** left most battery.

18. $\frac{25}{9}$ V = 2.78 V, $\frac{5}{18}$ A = 0.278 A **19.** 19 V **20.** **(a)** 10 Ω. **(b)** 3200 J

21. 5 A, 74 V, 49 V (+ve terminal is connected at point B) **22.** $R_f = 2\Omega$.

23. **(a)** R = 10 Ω **(b)** 1A in each **(c)** $V_3 = 3$V, $V_2 = 2$V, $V_4 = 4$V **(d)** 10 W **(e)** 1 W **(f)** 9W **(g)** 9V **(h)** 4 Ω resistance **(i)** 3 W.

24. **(a)** R = 3 Ω **(b)** $i = 2A$, $i_1 = \frac{1}{2}$ A, $i_2 = 1A$, $i_3 = \frac{1}{2}$ A **(c)** V = 4V in each **(d)** 12 W **(e)** 4W **(f)** 8 W **(g)** 4Ω **(h)** 4W

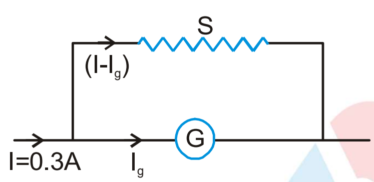
25. **(a)** 3.7 V **(b)** 3.7 V **26.** **(i)** $R_{AB} = 5/6\ \Omega$ **(ii)** $R_{CD} = 1.5\ \Omega$ **(iii)** $R_{EF} = 1.5\ \Omega$ **(iv)** $R_{AF} = 5/6\ \Omega$ **(v)** $R_{AC} = 4/3\ \Omega$

27. **(ii)** 1.5 A **28.** **(i)** $\frac{150}{7} = 21.43$ V, **(ii)** 1600 Ω **29.** CE: ED = $\sqrt{2}$: 1 **30.** 12.5 Ω, 170 Ω.

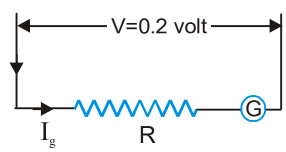
31. **(a)** 1 A **(b)** 2/3 A **(c)** 1/3 A **32.** **(a)** 0.1 A **(b)** 0.3 A **33.** **(i)** $\frac{12}{8.59} = 1.4$ A, **(ii)** $\frac{12 \times 8.5}{8.59} = 11.9$ V

34. **(i)** $\frac{1}{2} = 0.5$ A **(ii)** $\frac{1}{12} = 0.0833$ A **(iii)** $1.5 + \frac{1}{2} \times 0.4 = 1.7$ V **35.** $V_B - V_A = 21/5 = 4.2$ V, I = 35/2 mA = 17.5 mA (B to A)

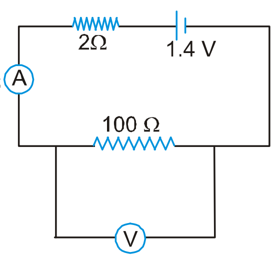
36. zero in the upper 4 Ω resistor and 0.2 A in the rest two. **37.** **(a)** $\frac{1.2}{2.1} = 0.57$ **(b)** 1 **(c)** $\frac{10.5}{6} = 1.75$

38. 

(A) $S = \frac{30 \times 2 \times 10^{-3}}{0.3 - 2 \times 10^{-3}} = 0.2013\ \Omega$ **(B)** R = 70 Ω



39. **(A)** 24 V, **(B)** 28 V **40.** $V = \varepsilon / (\eta + 1) = 2.0$ V. **41.** $\frac{20}{3}$ V **42.** **(i)** $\frac{4}{3}\Omega$



(ii) 200 Ω **(iii)** $1.1 - \frac{4}{3} = -0.23$ V **43.** $\left(\frac{70}{60} - 1\right) \times 9.5 = \frac{9.5}{6}$ ohm **44.** **(a)** 1.25 V,

(b) saving of galvanometer from damage and to prevent the cell discharging fast **(C)** No, **(D)** Yes, **(e)** No, **(f)** No

45. $x = \frac{20}{7}\ \Omega$, $Y = \frac{20}{3}\ \Omega$

EXERCISE - 5 : PART # I

1. 3	**2.** 3	**3.** 4	**4.** 4	**5.** 2	**6.** 4	**7.** 3	**8.** 1	**9.** 2	**10.** 1	**11.** 3	**12.** 2	**13.** 2
14. 2	**15.** 4	**16.** 4	**17.** 4	**18.** 2	**19.** 2	**20.** 2	**21.** 3	**22.** 2	**23.** 3	**24.** 3	**25.** 3	**26.** 2

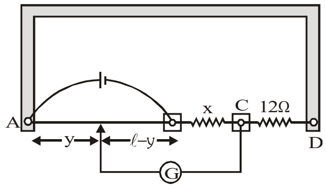
27. 1 **28.** 4 **29.** 2 **30.** 4 **31.** 4 **32.** 4 **33.** 4 **34.** 1 **35.** 2 **36.** 1 **37.** 4

PART # II

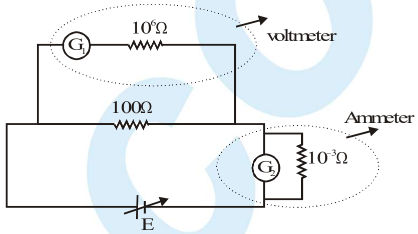
- **MCQ's One correct answers**

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	A	C	B	A	D	B	A	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	A	D	C	A	A	C	D	C	C

- **MCQ's one or more than one correct answers** **1.** A,D
- **Assertion-Reason** **1.** D
- **Subjective (i)** No, **(ii)**



(ii) 8Ω **3.**



4. $R_1 = R_2$. So B give more accurate value **5.** 4 **6.** B **7.** 1 Amp. **10.** C **11.** C,D

MOCK TEST

1. D **2.** C **3.** B **4.** A **5.** B **6.** B **7.** A **8.** B **9.** D
10. D **11.** B **12.** A **13.** C **14.** B **15.** D **16.** B **17.** D **18.** B
19. C **20.** B **21.** A **22.** C **23.** A **24.** B, C, D **25.** A, C **26.** A, C **27.** B,D
28. B, C **29.** A, B D **30.** A, B C **31.** B, D **32.** B, D **33.** B **34.** C **35.** D **36.** A
37. A **38.** C **39.** A **40.** A **41.** D **42.** C **43.** B **44.** A **45.** A,
46. A, **47.** C **48.** A → Q ; B → S ; C → S; D → Q **49.** A → Q; B → R ; C → R ; D → R
50. A → P, S, T ; B → Q, R ; C → Q, T; D → P **51.** 15 **52.** 20 **53.** 70 **54.** 5 **55.** 90

56. 0.8 volt , 1.0 volt r = 0.2 Ω **57.** (a) 157.5 cm (b) $\frac{3E}{32r}$ **58.** Inshort circuit