PHYSICS

The following questions given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

Q.1 **Assertion :** 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

Reason : Power consumed by a resistor of constant resistance R is maximum when current through it is maximum: **[B]**

Sol. Both Assertion & Reason are true. In Assertion R is varied while in Reason. R is kept constant. Hence both are independent

Q. 2 **Assertion:** The coil of a heater is cut into two equal halves and only one of them is used into heater. The heater will now require half the time to produce the same amount of heat.

Reason : The heat produced is directly proportional to the square of current.

Sol. **[B]**

Both the assertion and reason are true but reason is not the correct explanation of assertion.

Since, in the given case voltage is same, therefore,

$H = \frac{V^2}{R} t$ = constant. when R is halved, t must be halved.

Q. 3 **Assertion:** Current carrying wire should be charged.

Reason : Current in the wire is due to flow of free electrons in a definite direction.

Sol. **[D]**

A – wrong

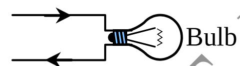
R – True.

Q.4 **Assertion :** Electrical power go off when a short circuit happens.

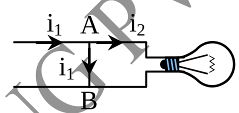
Reason : When short circuit happens, then resistance of circuit become very high.

Sol. **[C]**

A-True, R-False.



If these two wire come in contact we say short circuit happen.



$R_{AB} <<< R_{Bulb}$

$\therefore$ $i_1 >>>> i_2$

So Bulb will stop glowing.

Q.5 **Assertion** : Electrons move away from a region of higher potential to a region of lower potential.

Reason : Since an electron has a negative charge. **[A]**

Q.6 **Assertion** : The resistance of a copper wire varies directly as the length and inversely as the diameter.

Reason : Because the resistance varies directly as the area of the cross-section. **[D]**

Q.7 **Assertion** : Material used in the construction of a standard resistance is constantan or manganin.

Reason : Its temperature coefficient of resistance is very small. **[A]**

Q.8 **Assertion** : The total resistance in series combination of resistors increases and in parallel combination of resistors decreases.

Reason : In series combination of resistors, the effective length of resistors increases and in parallel combination of resistors, the area of cross-section of the resistors increases. **[A]**

Q.9 **Assertion** : When cells are connected in series to the external load the effective e.m.f. increases. **[A]**

Reason : The cells help each other in sending the current to the external load.

Q.10 **Assertion** : The resistance of super-conductor is zero.

Reason : The super-conductors are used for the transmission of electric power. **[B]**

Q.11 **Assertion** : The bending of an insulated wire increases the resistance of wire.

Reason : The drift velocity of electrons in bent wire decreases. **[D]**

Q.12 **Assertion** : The connecting wires are of copper.

Reason : The electrical conductivity of copper is high. **[A]**

Q.13 **Assertion** : In a simple battery circuit the point at the lowest potential is positive terminal of the battery.

Reason : The current flows towards the point of the lowest potential, as it does in such a circuit from negative to the positive terminal. **[D]**

Q.14 **Assertion** : Electric appliances with metallic body; eg heaters, presses etc, have three pin connections, where as an electric bulb has a two pin connection.

Reason : Three pin connections reduce heating of connecting cables. **[C]**

Q.15 **Assertion** : A domestic electrical appliance, working on a three pin, will continue working even if the top pin is removed.

Reason : The third pin is used only as a safety device. **[A]**

Q.16 **Assertion** : In parallel combination of electrical appliances, total power consumption is equal to the sum of the powers of the individual appliances.

Reason : In parallel combination, the voltage across each appliance is the same, as required for the proper working of electrical appliance.

[A]

Q.17 **Assertion** : In series combination of electric bulbs the bulb of lower power emits more light than that of higher power bulb.

Reason : The lower power bulb in series gets more current than the higher power bulb. **[C]**

Q.18 **Assertion** : Each bulb in a frill of 20 bulbs in series when connected to supply voltage will emit more light than each bulb in a frill of 19 bulbs in series when connected to same supply voltage.

Reason : Each bulb in a frill of 20 bulbs in series will get more voltage than that in a frill of 19 bulbs. **[D]**

Q.19 **Assertion** : When the cell is in the open circuit there is no force on a test charge inside the electrolyte of the cell.

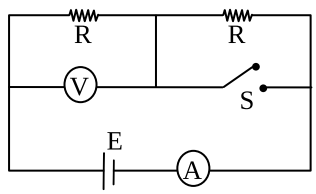
Reason : There is no field inside the cell, when the cell is in open circuit. **[C]**

Q.20 **Assertion** : When cells are connected in parallel to the external load, the effective e.m.f. increases.

Reason : All the cells will be sending the current to the external load in the same direction.

[D]

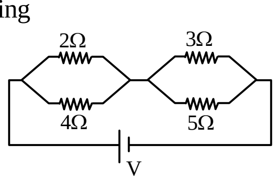
Q.1 In the circuit shown battery, ammeter and voltmeter are ideal and the switch S is intially closed as shown. When switch S is opened, match the parameter of column I with the effects in column II :



Column I	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

A → Q ; B → R ; C → R ; D → R

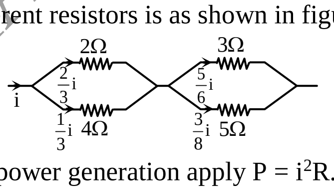
Q.2 In the circuit shown in figure, match the following



Column I	Column II
(A) Minimum current will flow through	(P) 2Ω
(B) Maximum current will flow through	(Q) 4Ω
(C) Maximum power will be generated across	(R) 3Ω
(D) Minimum power will be generated across	(S) 5Ω

Sol. **A → Q ; B → P ; C → R ; D → Q**

In parallel current distributes in inverse ratio of resistor. Hence, distribution of current in different resistors is as shown in figure.

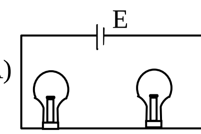
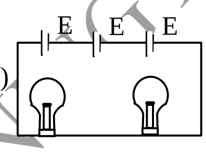
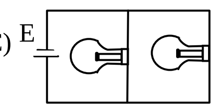
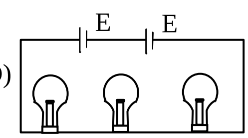


For power generation apply $P = i^2R$.

$$i_{R_3} = \frac{PD}{R} = \frac{10}{4} = 2.5 \text{ A}$$

$$i_{R_4} = \frac{PD}{R} = \frac{5}{2} = 2.5 \text{ A}$$

Q.3 In the circuits drawn in column I of the following table, all the bulbs are identical. Match the entries of column I with the entries of column II

Column I	Column II
(A) 	(P) Current drawn from the battery is maximum
(B) 	(Q) Current drawn from the battery is the least
(C) 	(R) Bulbs will lit the brightest
(D) 	(S) Bulbs will lit with brightness lying between maximum and minimum value

Sol. **A → S ; B → R ; C → P ; D → Q**

For A : $I = \frac{E}{2R}$ $P_1 = P_2 = \frac{E^2}{4R}$

For B : $I = \frac{3E}{2R}$; $P_1 = P_2 = \frac{9E^2}{4R}$

For C : $I = \frac{2E}{R}$; $P1 = P2 = \frac{2E^2}{R}$

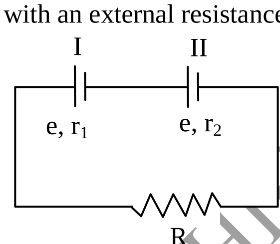
For D : $I = \frac{2E}{3R}$; $P_1 = P_2 = P_3 = \frac{4E^2}{9R}$

Q.4 Match the following

Column I	Column II
(A) Current in the circuit	(P) depend on current in the circuit
(B) Maximum power that can be developed by given cell	(Q) depend on load resistance
(C) terminal potential difference of cell in the circuit	(R) depend on the internal resistance of cell
(D) Potential drop across the load resistance.	(S) depend on emf of cell

Ans. A $\rightarrow$ Q, R, S ; B $\rightarrow$ Q ; C $\rightarrow$ P, Q, R, S ; D $\rightarrow$ P, Q, R, S

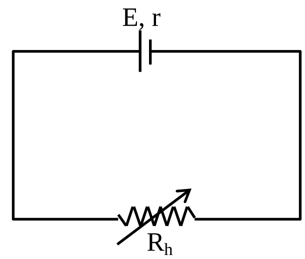
Q.5 Two cells of the same emf 'e' but different internal resistances, r_1 & r_2 are connected in series with an external resistance R.



Column I	Column II
(A) value of current through R	(P) potential drop across second cell is zero
(B) when external resistance R is $r_1 - r_2$	(Q) $\frac{2e}{R + r_1 + r_2}$
(C) when external resistance R is $r_1 + r_2$	(R) potential drop across first cell is zero
(D) when external resistance R is $r_2 - r_1$	(S) maximum power output across resistance R

Ans. A $\rightarrow$ Q ; B $\rightarrow$ R ; C $\rightarrow$ S ; D $\rightarrow$ S

Q.6 Referring to the circuit shown in Fig. match Column-I with Column-II



Column I	Column II
(A) Terminal potential difference across the cell will be maximum	(P) r > R
(B) Power transferred to resistance R is less than the maximum possible	(Q) r < R
(C) Power dissipated in the cell is maximum	(R) R = ∞
(D) Faster drift of ions in the electrolyte in the cell will be for	(S) R = 0

Ans. A $\rightarrow$ R ; B $\rightarrow$ P, Q, R, S ; C $\rightarrow$ S ; D $\rightarrow$ S

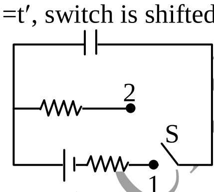
Q. 7 **Column II** gives certain systems undergoing a process. **Column I** suggests changes in some of the parameters related to the system. Match the statements in **Column I** to the appropriate process(es) from **Column II**. **[IIT -JEE 2009]**

Column I	Column II
(A) The energy of the system is increased	(P) **System :** A capacitor, initially uncharged **Process :** it is connected to a battery
(B) Mechanical energy is provided to the system, which is converted into energy of random motion of its parts	(Q) **System :** A gas in an adiabatic container fitted with an adiabatic piston. **Process :** The gas is compressed by pushing the piston
(C) Internal energy of	(R) **System :** A gas in a

	the system is converted into its mechanical energy	rigid container **Process :** The gas gets cooled due to colder atmosphere surrounding it
(D)	Mass of the system is decreased	(S) **System :** A heavy nucleus, initially at rest **Process :** The nucleus fissions into two fragments of nearly equal masses and some neutrons are emitted
		(T) **System :** A resistive wire loop **Process :** The loop is placed in a time varying magnetic field perpendicular to its plane

Ans. **A → P, Q, S, T ; B → Q ; C → S ; D → S**

Q.8 In the circuit shown in figure, the capacitor is initially uncharged. At t = 0, the switch is closed at position (1) and remain closed for long time. Then at t =t′, switch is shifted to position (2).



Column I	Column II
(A) As the capacitor charges from t = 0 to t = t′	(P) Current in the circuit falls exponentially
(B) As the capacitor discharge i.e. for t > t′	(Q) Current in the circuit grows exponentially
(C) Maximum current in the circuit depends on	(R) R, C
(D) Time to achieve 50% charging of the capacitor depends on	(S) R

Sol. **A → P ; B → P ; C → S ; D → R**

(A) $i = \frac{V}{R}e^{-t/RC}$

$\therefore$ A → P

(B) During discharging current in circuit fall exponentially

$\therefore$ B → P

(C) $I_{max} = \frac{V}{R}$ $\therefore$ C → S

(D) It depends on value of RC that circuit is delaying by how much, therefore

$\therefore$ D → R

Q.9 Ammeter A_2 reads 4.8 A in fig. then:

Column-I	**Column-II**
(A) Potential drop across 10 Ω =….V	(P) 307.2
(B) A_1 reads ….. A	(Q) 3.2
(C) A_3 reads …..A	(R) 8.0
(D) Power in 30 Ω resistor = …..W	(S) 80

Sol. **(A) → (S), (B) → (R), (C) → (Q), (D) → (P)**

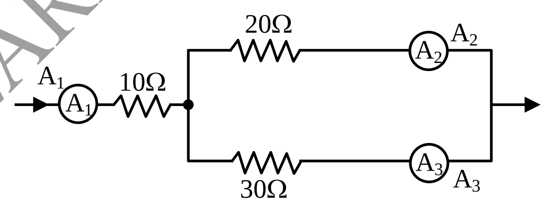
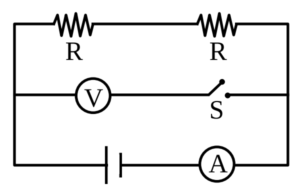


Fig.

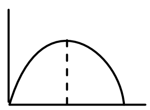
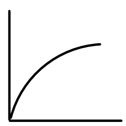
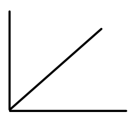
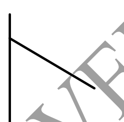
Q.10 In the circuit shown, battery, ammeter and voltmeter are ideal and the switch S is opened, match the parameter of column-I with the effects in column-II -



Column-I	**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

Ans. A → Q ; B → R ; C → R ; D → R

Q.11 Battery shown in figure, has emf E and internal resistance r. Current in the circuit can be varies by changing external load resistance R. If at an instant current flowing through the circuit is i, potential difference between terminal of cell is V, thermal power generated in external load resistance is P and thermal power generated in the cell is equal to 'h' fraction of total electrical power generated in it.

Column – I (Quantities)	**Column - II (Graph)**
(A) V-y axis, i-x axis	(P) 
(B) P-y axis, i-x axis	(Q) 
(C) h-y axis, i-x axis	(R) 
(D) P-y axis, V-x axis	(S) 

Sol. **A→ S; B → P; C → S; D → Q**

For option A :

$V = \varepsilon - ir$

Straight line with negative slope.

For option B :

$P = V \times i$

$= (\varepsilon - ir)\, i$

$P = \varepsilon i - i^2 r$

Parabolic variation.

For option C :

$h = \frac{vi}{\varepsilon i} = \frac{\varepsilon - ir}{\varepsilon}$

$h = 1 - \frac{ir}{\varepsilon}$

Straight line with negative slope.

For option D :

$P = V \times i = \frac{V \times (V - \varepsilon)}{r}$

$\Rightarrow P = \frac{V^2}{r} - \frac{\varepsilon V}{r}$

Q.12 A potential difference V is applied across a copper wire of diameter d and length ℓ. In column I the information about the change in one of the physical quantity is given and the effect of this change are mention in column II. Match the entries of column I with the entries of column II.

Column –I	**Column-II**
(A) Potential difference V is doubled across wire	**(P)** Current in wire increase
(B) Only length ℓ is doubled keeping potential	**(Q)** Electric field inside conductor difference constant decrease
(C) Only diameter d is doubled keeping potential difference constant	**(R)** Drift speed of electron increase
(D) Temperature of the wire is increased keeping potential difference constant	**(S)** Resistance of wire will increase
	(T) Drift speed of electron will decrease

Sol **A → P,R,S ; B → Q,S,T ; C → S ; D → Q,S,T**

When V double I increase current density J increase

$\therefore E = \rho J$, E also increase

$i = neAV_d$ as $i\uparrow \Rightarrow V_d$ also increase

R is independent of V and I $\therefore$ R remain same

length double $\therefore$ Resistance R increase

$i = \frac{V}{R}$ as R increases $\therefore$ i decrease

as $J = \frac{i}{A}$ $\therefore J\downarrow$ as $E = \rho J$ $\therefore E\downarrow$

$i = neAV_d$ as $i\downarrow$ V_d also decrease.

$A = \frac{\pi}{4} d^2$ as $d\uparrow$ Area $\downarrow$

$R = \rho \frac{L}{A}$ $\therefore R\uparrow$ and $i = \frac{V}{R}$ $\therefore i\downarrow$

$i = neAV_d \Rightarrow \frac{V}{R} = neAV_d \Rightarrow \frac{V}{\frac{\rho L}{A} \times A} = neV_d$

V_d is independent of area.

$E = \frac{V}{L} \Rightarrow \frac{V}{L}$ = constant

Temperature $\uparrow \Rightarrow$ Resistance R $\uparrow$

$i = \frac{V}{R}$ as R$\uparrow$ i$\downarrow$ $\qquad$ $J = \frac{i}{A}$ as i$\downarrow$ $\quad$ J$\downarrow$

$E = \rho J$ as J$\downarrow$ $\;$ E$\downarrow$ and $\rho\downarrow$

$i = neAV_d$ $\qquad$ i$\downarrow$ V_d also $\downarrow$

Q.13 Regarding a conducting wire across which constant potential difference is applied match the following -

	Column I		Column II
(A)	With increase in temperature of conducting wire	(P)	Drift velocity will decrease
(B)	With increase in length of conductor only	(Q)	Resistance will increase
(C)	With increase in area of cross section of conductor only	(R)	Resistance will decreases
(D)	With increase in volume of conductor	(S)	Number of free electrons or conduction electron will increase
		(T)	current will increase

Sol. A $\rightarrow$ P, Q ; B $\rightarrow$ P, Q, S ; C $\rightarrow$ R, S, T; D $\rightarrow$ S

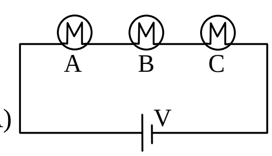
Q.14 Match the following -

Column-I	Column-II
(A) Electrical conductivity of a conductor depends upon	(P) Dimension (length and area of cross section
(B) conductance of a conductor depend upon	(Q) Temperature
(C) For a given conductor conductor and at given temperature current density depends on	(R) Nature of conductor i.e. resistivity of conductor
(D) For a given potential difference applied across a conductor current in it will depend on	(S) Electric field strength

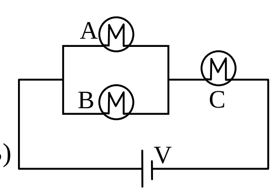
Sol. A $\rightarrow$ Q,R $\quad$ B $\rightarrow$ P,Q,R $\quad$ C $\rightarrow$ R,S $\quad$ D $\rightarrow$ P,Q,R

Q.15 Three bulbs A, B & C are having rated power P_A, P_B & P_C respectively, each bulb is designed to operate at rated voltage V. It is given that $P_A > P_B > P_C$. In column-I the three bulbs are arranged in different configuration, while in column-II the information about intensities of bulbs are mentioned. Match the entries of column-I with the entries of column-II. Neglect the variation in resistance due to change in temperature.

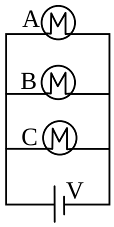
Column-I $\qquad$ **Column-II**

(A) 

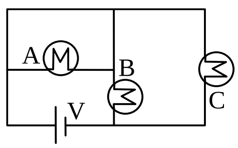
(P) A is having minimum intensity

(B) 

(Q) C is glowing with maximum brightness

C) 

(R) B is glowing with minimum brightness

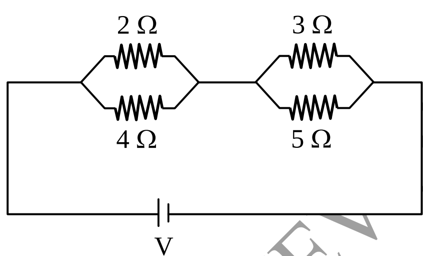
(D) 

(S) A is glowing with maximum brightness

(T) Glowing of bulb is neither maximum nor minimum

Sol. A → P,Q,T; B → Q,R; C → S,T; D → P

Q.16 From the circuit shown in figure match the entries of column-I with entries in column II.



	Column-I	*Column-II*
a.	Minimum current will flow through	***p.*** *2Ω*
b.	Maximum current will flow through	***q.*** *4Ω*
c.	Maximum power will be generated across	***r.*** *3Ω*
d.	*Minimum power will be generated across*	***s*** *. 5Ω*

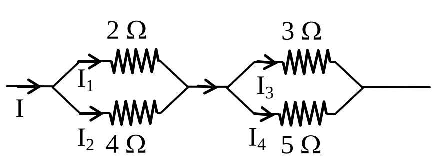
(A) a → q, b → p, c → r, d → q

(B) a → p, b → p, c → r, d → q

(C) a → p, b → q, c → r, d → s

(D) a → s, b → p, c → r, d → q

Sol. [A]



($I_1 > I_3 > I_4 > I_2$) because

$I_1 = \frac{I\times 4}{6} = 2/3\ I,\ I_3 = \frac{I\times 5}{8}$

$I_2 = \frac{I\times 2}{6} = I/3\ ,\ I_4 = \frac{I\times 3}{8}$

Hence Minimum current will flow through 4Ω & Maximum current will flow through 2Ω.

$P_{2\Omega} = I_1^2 \times R_1 = \frac{4}{9} I^2 \times 2 = \frac{8}{9} I^2$

$P_{4\Omega} = I_2^2 \times R_2 = \frac{I^2}{9} \times 4 = \frac{4}{9} I^2$

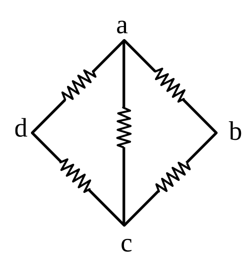
$P_{3\Omega} = I_3^2 \times R_3 = \frac{I^2 \times 25}{64} \times 3 = \frac{75}{64} I^2$

$P_{5\Omega} = I_4^2 \times R_4 = \frac{I^2 \times 9}{64} \times 5 = \frac{45}{64} I^2$

$P_{3\Omega} > P_{2\Omega} > P_{5\Omega} > P_{4\Omega}$

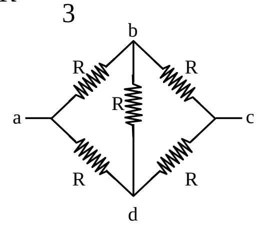
∴ Maximum power is dissipated across 3Ω and minimum power is dissipated across 4Ω.

Q.17 In the figure shown, the value of each resistance is R. Match the entries of column I with the entries of column II.



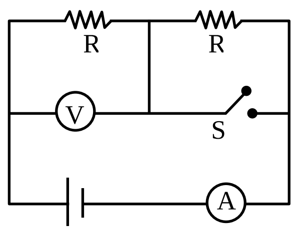
Column-I	**Column-II**
(a) Resistance between a and b	(p) R/2
	(q) 5/8 R
	(r) R
	(s) None

Sol. [B] $\frac{2R}{3} + R = \frac{5R}{3}$



$$R_{ab} = \frac{R \times \frac{5R}{3}}{R + \frac{5R}{3}} = \frac{5R}{8}$$

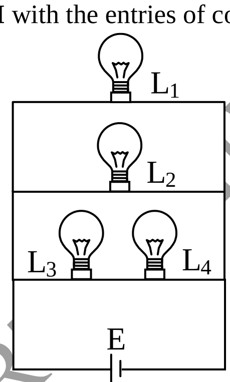
Q.18 In the circuit shown, battery, ammeter and voltmeter are ideal and the switch S is opened. Match the parameter of column I with the effects in column II.



Column-I	**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
	(T) Becomes constant after sufficient time

Sol. **A $\rightarrow$ Q,T ; B $\rightarrow$ R,T ; C $\rightarrow$ R,T ; D $\rightarrow$ R,T**

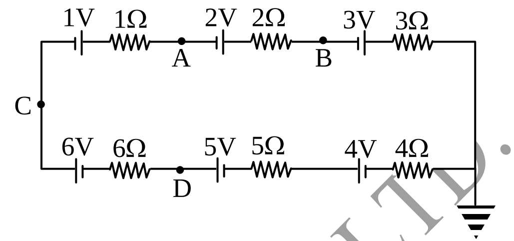
Q.19 In the shown circuit diagram, alll the electric bulbs are identical. Then, match the entries of column **I** with the entries of column **II.**



Column -I	Column-II
(A) Current drawn by L_1 is	(P) maximum
(B) Intensity of L_1 and L_2 is	(Q) minimum
(C) Intensity of L_3 and L_4 is	(R) same
(D) Intensity of L_1 and L_4 is	(S) different

Sol. A–P; B–P,R; C –Q,R; D – S

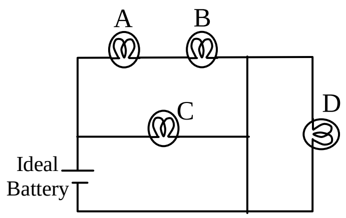
Q.20 Six batteries of increasing e.m.f. and increasing internal resistance are connected in a circuit as shown in the given figure. Match the entries of column I with the entries of column II.



Column -I	Column-II
(A) Potentiial of point A	**(P) Zero**
(B) Potential of point B	**(Q) 2 V**
(C) Potential of point C	**(R) 4V**
(D) Potential of point D	**(S) 6 V**

Sol. A–P, B–P, C –P, D – P

Q.1 Four identical bulbs A, B, C, D are connected in a circuit as shown in figure. Now whenever any bulb fails, then it cannot conduct current through it. Then –



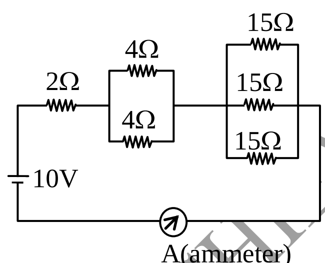
(A) Brightness of bulb C is highest

(B) If C fails, brightness of bulb D increases

(C) If C fails, brightness of all bulbs remain same

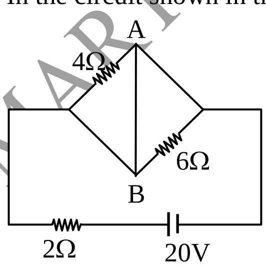
(D) If A fails, B will not glow **[A,C,D]**

Q.2 Reading of ammeter is 1 A. If each of the 4 Ω resistor is replaced by 2 Ω resistor, then the internal resistance of cell and the reading of ammeter will become nearly –



(A) 1 .11 A (B) 1.25 A
(C) 1 Ω (D) 2 Ω **[A,C]**

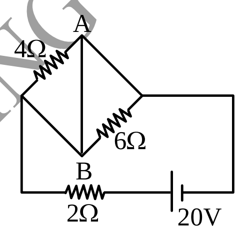
Q.3 In the circuit shown in the fiugre :



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

Sol. **[A,C]**
4Ω and 6Ω resistances are short circuited. Therefore, no current will flow through these two 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) = 200 Watt
Potential difference across 4 Ω resistance
= Potential difference across 6Ω resistance
= 0

Q.4 In the circuit shown in figure –



(A) power supplied by the battery is 200 W

(B) current flowing in the circuit is 5 A

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

(D) Current in wire AB is zero

Sol. **[A,C]**

4Ω and 6Ω resistance are short circuited. Therefore, no current will flow through these two resistances. Current passing through the battery is

$$i = \frac{20}{2} = 10 \text{ A}$$

This is also the current passing in wire AB from B to A.

Power supplied by the battery P = E i

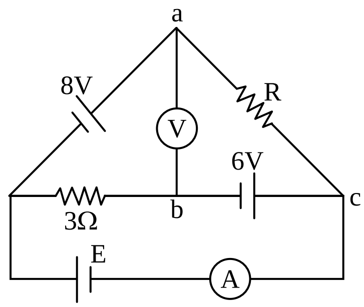
= (20) (10)

= 200 W

Potential difference across 4Ω resistance

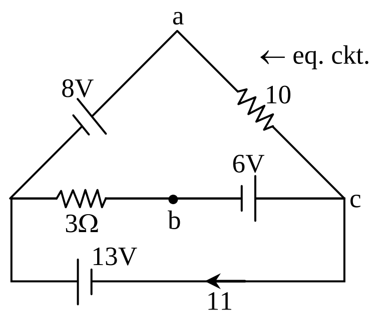
= potential difference across 6Ω resistance = 0

Q.5 R = 10Ω & E = 13 V and voltmeter & Ammeter are ideal then -



(A) Reading of Ammeter is 2.4 A
(B) Reading of Ammeter is 8.4 A
(C) Reading of voltmeter is 8.4 V
(D) Reading of voltmeter is 27 V

Sol. **[B,D]**



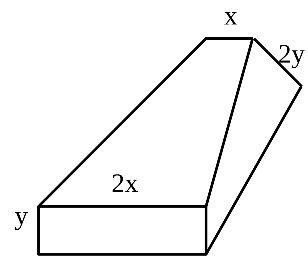
Using Kirchoff's Law Solve the circuit.

Q.6 When no current is passed through a conductor–

(A) the free electrons do not move
(B) the average speed of free electrons over a large period of time is zero
(C) the average velocity of free electrons over a large period of time is zero
(D) the average of the velocities of all the free electrons at an instant is zero **[C,D]**

Q.7 A current passes through a wire of non-uniform cross-section. Which of the following quantities are independent of the cross-section–
(A) the charge crossing in a given time interval
(B) drift velocity
(C) current density
(D) free-electron density **[A,D]**

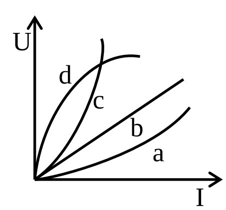
Q.8 A conductor is made of an isotropic material (resistivity ρ) has rectangular cross-section. Horizontally dimension of the rectangle decreases linearly from 2x at one end to x at the other end and vertical dimension increases from y to 2y as shown in figure. Length of the conductor along the axis is equal to ℓ. A battery is connected across this conductor then –



(A) rate of generation of heat per unit length is maximum at the ends of conductor
(B) rate of generation of heat per unit length is maximum at middle cross-section
(C) drift velocity of conduction electrons is minimum at middle section
(D) at the ends of the conductor, electric field intensity is same **[C,D]**

Q.9 Mark out the correct options–
(A) An ammeter should have small resistance
(B) An ammeter should have large resistance
(C) An voltmeter should have small resistance
(D) A voltmeter should have large resistance
[A,D]

Q.10 Which of the following plots may represent the thermal energy produced in a resistor in a given time as a function of electric current -



(A) a (B) b
(C) c (D) d **[A,C]**

Q.11 Two resistors having equal resistances are joined in series and a current is passed through the combination. Neglect any variation of resistance as a temperature change. In a given time interval–
(A) equal amounts of thermal energy must be produced in the resistors
(B) unequal amounts of thermal energy may be produced
(C) the temperature must rise equally in the resistors
(D) the temperature may rise equally in the resistors **[A,D]**

Q.12 Two fuse wire of 10 A and 20 A are connected in different type. Then –

(A) In parallel combination works as a fuse of 30 A

(B) In parallel combination works as a fuse of 10 A

(C) In series combination works as a fuse of 10 A

(D) In series combination works as a fuse of 20 A

[A,C]

Q.13 In a conductor charge with respect to time is given as $Q = at - \frac{1}{2}bt^2 + \frac{1}{6}ct^3$, where a, b,c, are positive constants. Then current –

(A) Initial value is 'a'

(B) minimum value after time $\frac{b}{c}$

(C) maximum value after time $\frac{b}{c}$

(D)maximum and minimum value is $\left(a - \frac{b^2}{c}\right)$

[A,B,D]

Q.14 In a potentiometer wire experiment the emf of a battery in the primary circuit is 20 Volt and its internal resistance is 5 Ω. There is a resistance box (in series with the battery and the potentiometer wire) whose resistance can be varied from 120 Ω to 170 Ω. Resistance of the potentiometer wire is 75 Ω. The following potential difference can be measured using this potentiometer-

(A) 5V (B) 6V

(C) 7V (D) 8V **[A,B,C]**

Q.15 When a potential difference is applied across, the current passing through – **[IIT- JEE 99]**

(A) an insulator at 0 K is zero

(B) a semiconductor at 0 K is zero

(C) a metal at 0 K is finite

(D) a p-n diode at 300 K is finite, if it is reverse biased **[A,B,C]**

Q.16 A parallel plate capacitor is charged to a potential difference of 50 V. It is discharged through a resistance. After 1 second, the potential difference between plates becomes 40 V. Then - **[REE-99]**

(A) fraction off stored energy after 1 second is 16/25

(B) potential difference between the plates after 2 second will be 32 V

(C) potential difference between the plates after 2 seconds will be 20 V

(D) fraction of stored energy after 1 second is 4/5 **[A,B]**

Q.17 A micro ammeter has a resistance of 100Ω and full scale range of 50μA. It can be used as a voltmeter or as a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combinations – **[IIT-JEE 1991]**

(A) 50 V range with 10 KΩ resistance in series

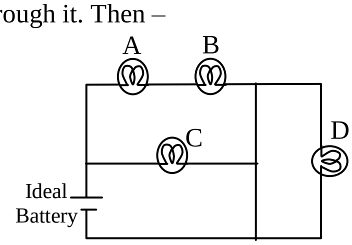
(B) 10 V range with 200 KΩ resistance in series

(C) 5 mA range with 1 Ω resistance in parallel

(D) 10 mA range with 1 Ω resistance in parallel

[B,C]

Q.18 Four identical bulbs A, B, C, D are connected in a circuit as shown in figure. Now whenever any bulb fails, then it cannot conduct current through it. Then –



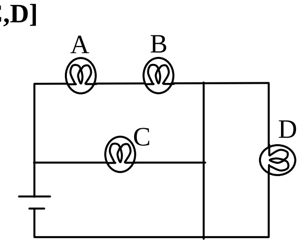
(A) Brightness of bulb C is highest

(B) If C fails, brightness of bulb D increases

(C) If C fails, brightness of all bulbs remain same

(D) If A fails, B will not glow

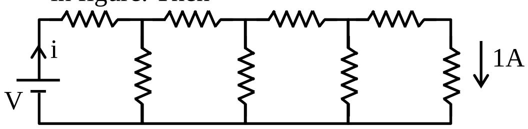
Sol. **[A,C,D]**



Potential difference across D is zero so it will not glow at all. Potential across C is maximum.

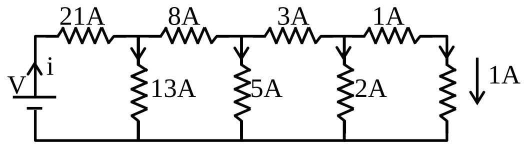
∴ It will glow maximum and if C fuses then also potential across each bulb will remain same. Brightness of each bulb will remain same.

Q.19 Each resistance in the circuit is of 1Ω. Current of 1A flows through the last resistance as shown in figure. Then -



(A) v is 21 volt
(B) total current (i) through battery is 21 amp
(C) V is 34 volt
(D) equivalent resistance is 1.62 Ω **[B,C,D]**

Sol.

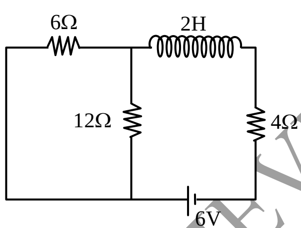


V = 21 × 1 + 13 × 1 = 34 volt
Total current through battery is 21A

$R_{eq} = \frac{V}{I}$

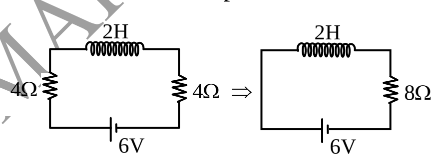
$= \frac{34}{21} = 1.619\ \Omega = 1.62\ \Omega$

Q.20 For the circuit shown in figure, which of the following statements are correct ?



(A) Its time constant is 0.25 sec
(B) In steady state, current through inductance will be equal to zero
(C) In steady state, current through the battery will be equal to 0.75 amp
(D) None of the above **[A,C]**

Sol. 6 Ω and 12 Ω are in parallel



Time constant = $\frac{L}{R} = \frac{2}{8} = 0.25$ sec

In steady state inductor behave as conducting as conducting wire.

$\therefore\ i = \frac{6}{8} = 0.75$ amp

Option (C) is correct.

Q.1 A 30 V storage battery is charged from 120 V direct current supply mains with a resistor being connected in series with battery to limit the charging current to 15 amp. If all the heat produced in circuit, could be made available in heating water, the time it would take to bring 1 kg of water from 15ºC to the 100ºC is.......... minute[Neglect the internal resistance of the battery]

Sol. **[0004]**

As the voltage across the charging battery,

$V = E + Ir = 30 + 15 \times 0 = 30V$

So the potential difference across the resistance

$V_R = 120 - 30 = 90$ V

So the power wasted in heating the circuit

$P = VI = 90 \times 15 = 1350$ W

So the energy wasted as heat in time t

$H = P \times t = (1350 \times t)$ joule $= \dfrac{1350}{4.2} \times t$ calorie

Now if this heat changes the temperature of 1 kg of water from 15ºC to 100ºC

$\dfrac{1350\,t}{4.2} = mc\Delta\theta = 1 \times 10^3 \times 1 \times (100 - 15)$

i.e., $t = \dfrac{85 \times 4.2 \times 100}{135} = 264.4$ s = 4.4 minute

Q.2 A block of metal is heated directly by dissipating power in the internal resistance of block. Because of temperature rise, the resistance increases exponentially with time and is given by $R(t) = 0.5\, e^{2t}$, where t is in second. The block is connected across a 110 V source and dissipates 7644 J heat energy over a certain period of time. This period of time is...............$\times 10^{-1}$ sec.

Sol. **[0005]**

Let t be the required time. As power is

$P = \dfrac{dU}{dt} = \dfrac{V^2}{R(t)}$

$dU = \dfrac{V^2}{R(t)}\, dt$

$U = \displaystyle\int_0^t \frac{V^2}{R(t)}\, dt$

$\dfrac{(110)^2}{0.5}\displaystyle\int_0^t e^{-2t}\, dt$

$= \dfrac{(110)^2}{2 \times 0.5}\left(e^{-2t}\right)_0^t = (110)^2\,(1 - e^{-2t})J$

According to problem,

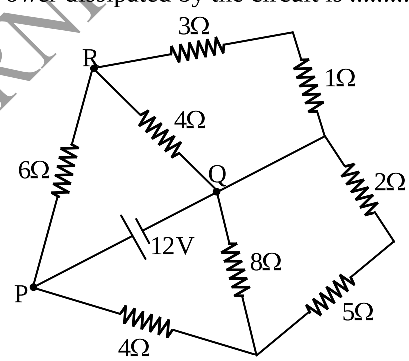
U = 7644J

Thus $1 - e^{-2t} = \dfrac{7644}{(110)^2} = 0.632$

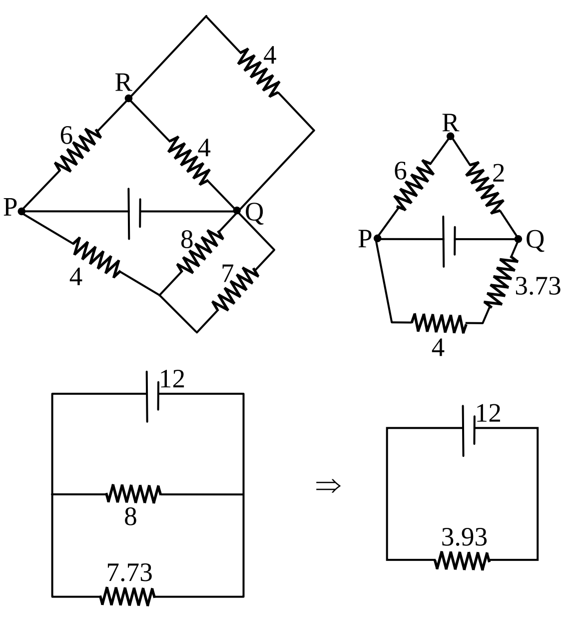
or $e^{-2t} = 0.367$

or $-2\ln e = \ln 0.367$ or $-2t = -1$ or $t = 0.5$ s

Q.3 Power dissipated by the circuit is .... watt.

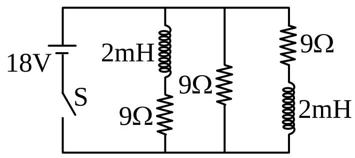


Sol.

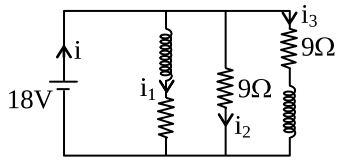


Power dissipated $= \dfrac{(12)^2}{3.93} = 36$ watt

Q.4 Consider the circuit shown in figure. What is the current through the battery just after the switch is closed.



Sol.



Just after closing of switch S

i_1 and i_3

(current through inductor is zero)

$\therefore \quad i = i_2$

$$i_2 = \frac{18}{9} = 2 \text{ amp}$$

Q.5 A 15 amp circuit breaker trips in home when the current through it reaches 15 Amp. What is the minimum number of 100 watt light bulb operated at 120 volts in home that will cause it to the trip.

[0018]

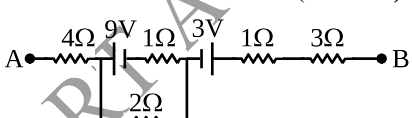
Sol. Current through one bulb $= \dfrac{100}{120}$

$$15 = N \times \frac{100}{120}$$

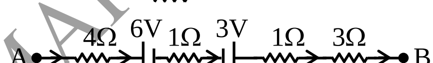
N = 18

Where N number of bulbs.

Q.6 Potential difference between the points A and B in the circuit shown is 16 V, then potential difference across 2Ω resistor is …. volt. ($V_A > V_B$)



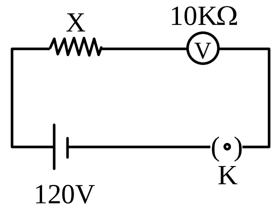
Sol.[6]



$$E_{eq} = \frac{\frac{9}{1}+\frac{0}{2}}{\frac{1}{1}+\frac{1}{2}} = 9 \div \frac{3}{2} = 6 \text{ volt}$$

P.d. across 2Ω = 6 V

Q.7 A D.C. supply of 120 V is connected to a large resistance X. A voltmeter of resistance 10 kΩ placed in series in the circuit reads 20 V. This is an unusual use of voltmeter for measuring very high resistance. The value of X is ………× 10 kΩ (approx).



Sol. [5]

$$I = \frac{20}{10\times10^3} = 20 \times 10^{-4}$$

$$\text{But } 20 \times 10^{-4} = \frac{120}{x+10^4}$$

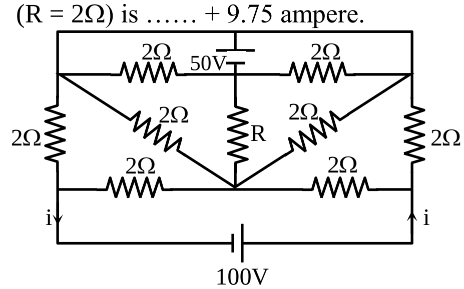
or $20 \times 10^{-4}x + 20 = 120$

$$\therefore \quad x = \left(\frac{120-20}{20}\right)\times10^4$$

$= 5 \times 10^4\ \Omega$

$= 50$ kΩ

Q.8 Each resistance is of 2Ω. Current in resistance R (R = 2Ω) is …… + 9.75 ampere.



Sol. **[9]**

At y according to Kirchoff's junction law

$$\frac{y-x}{2}+\frac{y-x-100}{2}+\frac{y-50}{2}+\frac{y}{2}+\frac{y-50}{2}=0$$

$5y - 2x = 200$ …(1)

similarly at x

$$i = \frac{50-x}{2}+\frac{y-x}{2} \quad \text{…(2)}$$

at x + 100

$$i = \frac{x+100-50}{2}+\frac{x+100-y}{2} \quad \text{…(3)}$$

we get $y - 2x = 50$ …(4)

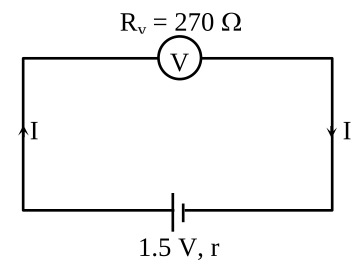
from (1) and (4)

y = 37.5 V

So current through R is 18.75 A.

Q.9 As a cell ages, its internal resistance increases. A voltmeter of resistance 270Ω connected across an old dry cell reads 1.44 V. However, a potentiometer at the balance point, gives a voltage measurement of the cell as 1.5 V. Internal resistance of the cell is……… + 5.25 Ω.

Sol. **[6]**



Voltage measured by potentiometer, at the balance point, is the emf. This is because current drawn from the cell, at the balance point is zero.

Hence E = 1.5 V

If a voltmeter of resistance 270Ω is connected across the cell as shown,

$$I = \frac{1.5}{270+r}$$

and voltage measured by the voltmeter

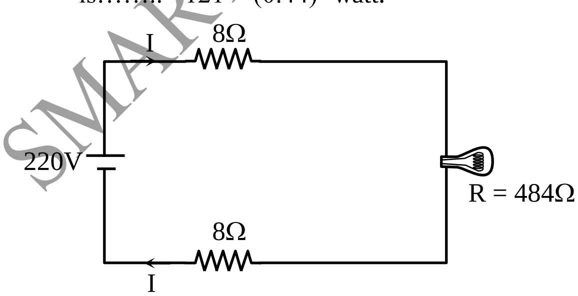
$V = IR_V$ (also $V = E - Ir = 1.5 - Ir$)

or $V = \left(\frac{1.5}{270+r}\right) 270$ but V = 1.44 V (given)

$\therefore \left(\frac{1.5}{270+r}\right) 270 = 1.44$

or = 11.25Ω

Q.10 Using a long extension cord in which each conductor has a resistance 8Ω, a bulb marked as '100 W, 200 V' is connected to a 220 V dc supply of negligible internal resistance as shown in figure. Power delivered to the bulb is……..× 121 × $(0.44)^2$ watt.



Sol. **[4]**

The circuit can be shown as in the figure. The bulb is marked 100W, 220V.

Hence the resistance of filament of bulb.

$$R = \frac{V^2}{P} = \frac{220 \times 220}{100} = 484\Omega$$

Current in the given circuit

$$I = \frac{220}{484+8+8}$$

= 0.44 A

Power delivered to the bulb

$I^2R_{bulb} = (0.44)^2 (484)$

= 93.7 W

Q.11 A 15 Amp circuit breaker trips in home when the current through it reaches 8 Amp. What is the minimum number of 100 watt light bulb operated at 100 volts in home that will cause it to the trip.

Sol. **[8]**

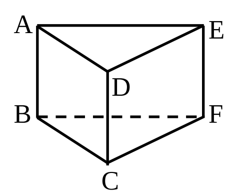
Current through one bulb = $\frac{100}{100}$

$8 = N \times \frac{100}{100}$

N = 8

where N – Number of bulbs.

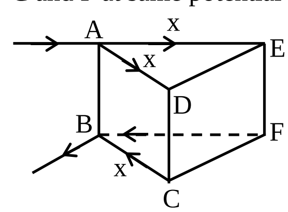
Q.12 Nine wires each of resistance 5Ω are connected to make a prism as shown in figure. Find the equivalent resistance of the arrangement across AB.

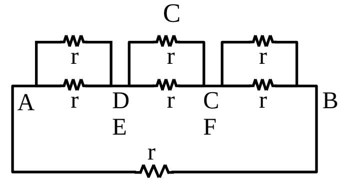


Sol. **[3]**

D and E at same potential

C and F at same potential

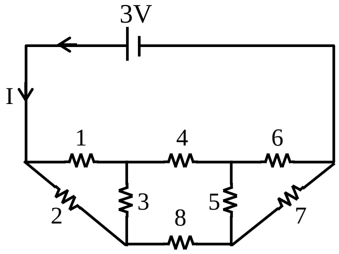




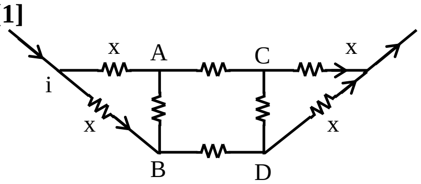
r = 5Ω

$$r_{eq} : = \frac{\frac{3r \times r}{2}}{r + \frac{3r}{2}} = \frac{3r}{5} = 3\ \Omega$$

Q.13 Figure show a network of eight resistors numbered 1 to 8, each equal to 2Ω, connected to a 3V battery of negligible internal resistance. The current I in the circuit in ampere is -

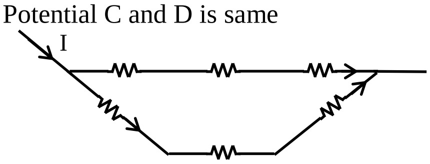


Sol. [1]



Potential of A and B is same

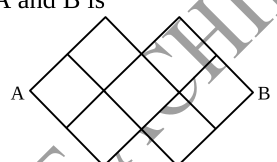
Potential C and D is same



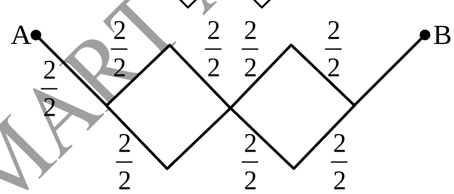
$R_{eq} = \dfrac{6\times6}{6+6} = 3\Omega$

$I = \dfrac{3V}{3\Omega} = 1$ amp

Q.14 In the shown wire frame, each side of a square (the smallest square) has a resistance 2Ω. The equivalent resistance of the circuit between the points A and B is



Sol.[4]



$= R_{eq} = 1 + 1 + 1 + 1 = 4\Omega$

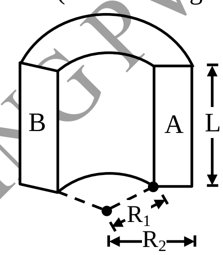
Q.15 Two long parallel wires are located in a poorly conducting medium with resistivity ρ. The distance between the axes of the wires is equal to ℓ, the cross-section radius of each wire equals a. In the case a << ℓ find.

(a) the current density at the point equally removed from the axes of the wires by a distance r if the potential difference between the wires is equal to V ;

(b) the electric resistance of the medium per unit length of the wires.

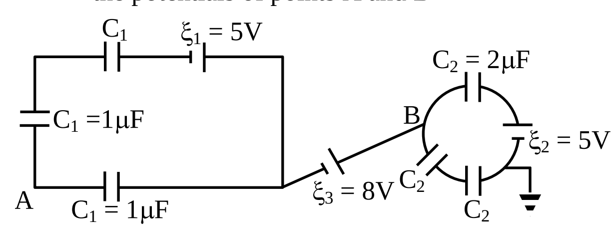
Sol. (a) $j = \dfrac{\ell V}{2\rho r^2}\ell n\left(\dfrac{\ell}{a}\right)$ (b) $R_1 = \dfrac{\rho}{\pi}\ell n\left(\dfrac{\ell}{a}\right)$

Q.16 A resistor is formed in the shape of a hollow quarter cylinder from a material of resistivity ρ. The inner and outer radii of the cylinder is R_1 and R_2. Find the resistance of this resistor between faces A and B (Shown in figure.)



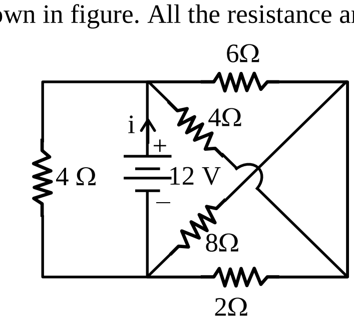
Sol. $\dfrac{\rho\pi}{2L\ell n\dfrac{R_2}{R_1}}$

Q.17 In the circuit shown in figure, cells are ideal. Find the potentials of points A and B



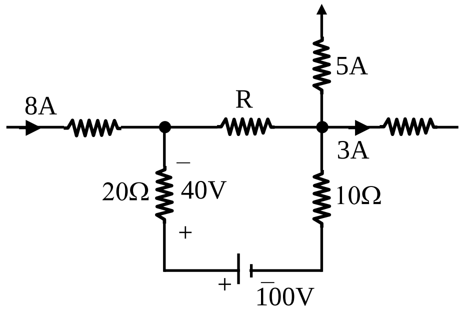
Sol. –8V, $\dfrac{10}{3}$V

Q.18 Compute the value of battery current in the circuit shown in figure. All the resistance are in ohm.



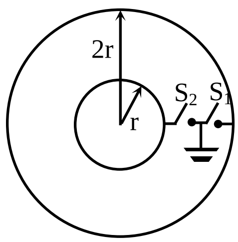
Sol. 6A

Q.19 In the circuit shown in figure, find the value of unknown resistor R.



Sol. 4Ω

Q.20 There are two concentric spherical shells of radii r and 2r. Initially a charge Q is given to the inner shell. Now, switch S_1 is closed and opened then S_2 is closed and opened and the process is repeated n times for both the keys alternatively. Find the final potential difference between the shells.



Sol. $\frac{1}{2^{n+1}}\left[\frac{Q}{4\pi\varepsilon_0 r}\right]$

Q.1 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 4 Ω only

(B) (5/13) of the deflection when shunted with 4 Ω only

(C) (3/4) of the deflection when shunted with 4 Ω only

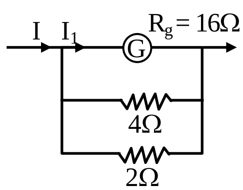
(D)(3/13) of the deflection when shunted with 4 Ω only **[A]**

Sol. Case I

$$R_g \times \frac{I}{5} = \left(I - \frac{I}{5}\right) \times 4$$

$\Rightarrow R_g = 16\ \Omega$

Case II

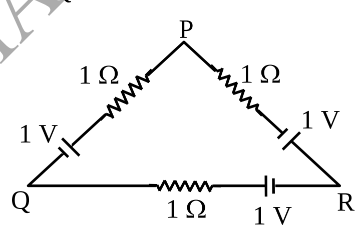


$16\ I_1 = \frac{4 \times 2}{6}\ (I - I_1) \Rightarrow I_1 = I/13$

So decrease in current to previous current

$$= \frac{I/5 - I/13}{I/5} = \frac{8}{13}$$

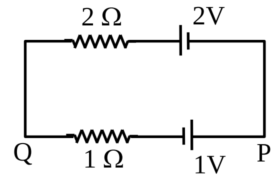
Q.2 Three batteries of emf 1V and internal resistance 1 Ω each are connected as shown. Effective emf of combination between the points PQ is –



(A) Zero (B) 1V (C) 2V (D) $\frac{2}{3}$ V

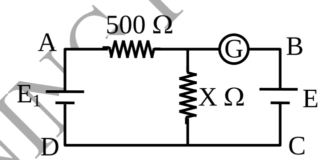
[A]

Sol.



$$E_{net} = \frac{E_1 r_2 - E_2 r_1}{r_1 + r_2} = \frac{2-2}{2+1} = 0$$

Q.3 In an experiment according to set up, when E_1 = 12 volt and internal resistance zero, E = 2 volt. The galvanometer reads zero, then X would be-



(A) 200 (B) 500

(C) 100 (D) 10 **[C]**

Sol. Voltage across X is 2V

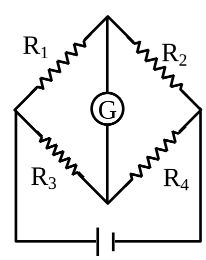
So $\left(\frac{E_1}{500 + X}\right) X = 2$

$\Rightarrow \left(\frac{12}{500 + X}\right) X = 2$

$\Rightarrow 12X = 1000 + 2X$

$\Rightarrow 10X = 1000$ $X = 100\Omega$

Q.4 The resistances in wheat stone's bridge circuit shown in the fig. have different values. The current through, the galvanometer is zero. If all the thermal effects are negligible. The current through the galvanometer will not be zero. When –



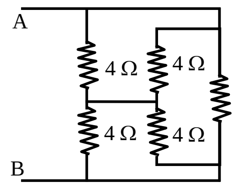
(A) the battery emf is doubled

(B) the battery and galvanometer are interchanged

(C) all resistance in the circuits are doubled

(D) resistance R_1 and R_2 are interchanged **[D]**

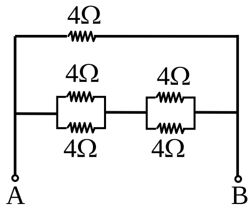
Q.5 Equivalent resistance between the points A and B is –



(A) 1Ω (B) 2Ω

(C) 3Ω (D) 4Ω **[B]**

Sol.

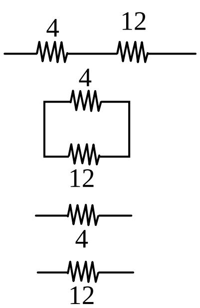


Q. 6 By using only two resistors—single, in series or in parallel — you are able to obtain resistances 3, 4, 12 and 16 Ω. What are the separate resistances of the resistors ?

(A) 3 Ω, 4 Ω (B) 4 Ω, 12 Ω

(C) 12 Ω, 16 Ω (D) 3 Ω, 16 Ω **[B]**

Sol.



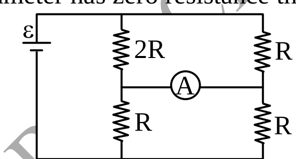
= 16 Ω

= 3 Ω

= 4 Ω

= 12 Ω

Q. 7 If ammeter has zero resistance then –



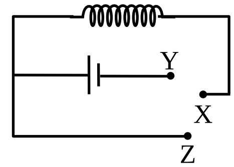
(A) Reading of ammeter is $\frac{\varepsilon}{6R}$

(B) Reading of ammeter is $\frac{\varepsilon}{7R}$

(C) Reading of ammeter is $\frac{\varepsilon}{8R}$

(D) Reading of ammeter is $\frac{\varepsilon}{9R}$ **[B]**

Q.8 In the circuit shown, the coil has inductance and resistance. When X is joined to Y, the time constant is τ during growth of current. When the steady state is reached, rate of production of heat in the coil is "P" joule/sec. X is now joined to Z, and after long time of joining X to Z –



(A) the total heat produced in the coil is $P\tau$

(B) the total heat produced in the coil is $\frac{1}{2}$ $P\tau$

(C) the total heat produced in the coil is $2P\tau$

(D) the data given is not sufficient to reach a conclusion

Sol.1[B]

Let L and R be the inductance and the resistance of the coil respectively

Let E = e.m.f. of the cell.

τ = Time constant, $I_0 = E/R$

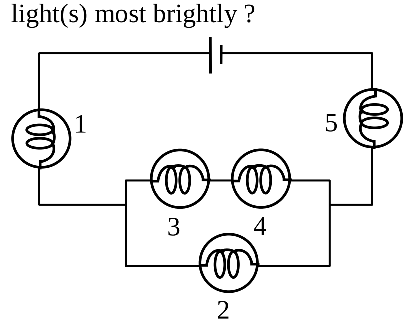
$$P = I_0^2 R = \frac{E^2}{R}$$

$$\text{Energy stored in the coil} = \frac{1}{2} L I_0^2 = \frac{1}{2} L \left(\frac{E^2}{R^2}\right)$$

$$= \frac{1}{2}\left(\frac{L}{R}\right)\left(\frac{E^2}{R}\right) = \frac{1}{2}\tau P$$

= total heat produced in the coil

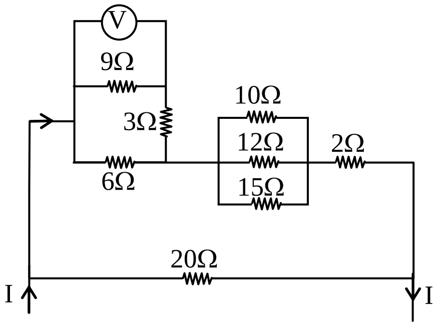
Q. 9 All the bulbs below are identical. Which bulb(s) light(s) most brightly ?



(A) 1 only (B) 2 only

(C) 3 and 4 (D) 1 and 5 **[D]**

Q. 10 In the given circuit, the voltmeter reading is 4.5 V. Assuming that the voltmeter is ideal, current through 12Ω resistance is -

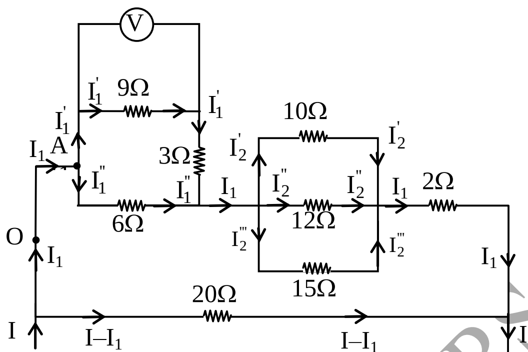


(A) 1 A (B) 0.5 A

(C) 0.25 A (D) 0.1 A

Sol. **[B]**

The voltmeter is ideal, its resistance $R_v \to \infty$ Fig. shows the current distribution in the circuit . Voltmeter will not draw any current.



Potential difference across 9 Ω resistance = 4.5 V (given) Hence, current in 9Ω resistance

$= \frac{4.5}{9} = 0.5$ A $(I = \frac{V}{R})$

i.e., $I_1' = 0.5$ A

The same current (I_1') passes through 3Ω. Obviously, 9 Ω and 3 Ω are in series and their equivalent, i.e., 12Ω is in parallel with 6 Ω between A and B. Dividing the current in the inverse ratio of resistances between A and B,

$$\frac{I_1'}{I_1''} = \frac{6}{12} = \frac{1}{2}$$

$$I_1'' = 2I_1' = 2 \times 0.5 = 1 \text{ A}$$

and $I_1 = I_1' + I_1'' = 0.5 + 1 = 1.5$ A

at junction C, I_1 divides into three parts. Since the resistances 10Ω, 12Ω, 15 Ω are in parallel between C and D, current will distribute in the inverse ratio of resistances.

$$\therefore I_2' : I_2'' : I_2''' = \frac{1}{10} : \frac{1}{12} : \frac{1}{15}$$

$= 6 : 5 : 4$

$$I_2' = \frac{5}{15} \times 1.5 = 0.5 \text{ amp}$$

So $I_2' = 6k$, $I_2'' = 5k$, $I_2''' = 4k$

(k being a constant of proportionality)

and $I_1 = I_2' + I_2'' + I_2''' = 15k$

but $I_1 = 1.5$ A

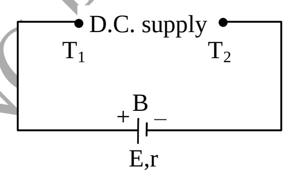
$\therefore$ 15 k = 1.5

or k = 0.1

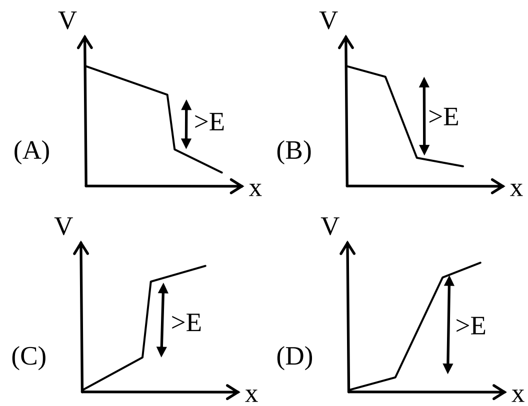
so $I_2'' = 5k = 0.5$ A

Thus current through 12Ω resistance is 0.5 A

Q. 11 An accumulator battery B of e.m.f E and internal resistance r being charged from a DC supply whose terminals are T_1 and T_2 The connecting wires have uniform resistance.

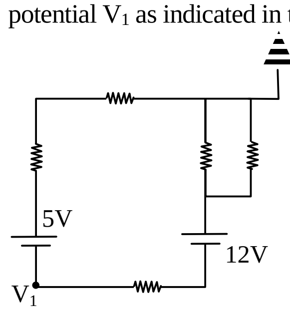


Moving from T_1 to T_2 through B, the potential V is plotted against distance x. The correct curve is -



[A]

Q.12 In the circuit shown, each resistance is 2Ω. The potential V_1 as indicated in the circuit, is equal to –



(A) 11 V (B) – 11V

(C) 9 V (D) – 9 V

Sol. **[D]**

$i = \frac{7V}{7\Omega} = 1$ A

Current flows in anticlockwise direction in the loop. Therefore $0 - 1 \times 2 - 1 \times 2 - 5 = V_1$

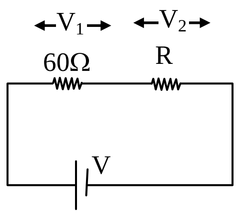
$V_1 = -9V$

Q.13 Two resistances, a 60 ohm and an unknown one are connected to a power source in a series arrangement. This way the power of the unknown resistance is 60 watt. What is the least voltage of the power source ?

(A) 60 Volt (B) 120 Volt

(C) 140 Volt (D) 180 Volt

Sol. **[B]**



$\frac{V_1}{V_2} = \frac{60}{R}$ ....(1)

$V_1 + V_2 = V$ ....(2)

from (1) & (2) ⇒ $V_2 = \frac{VR}{60+R}$ ....(3)

$\frac{V_2^2}{R} = 60$ watt ....(4)

from (3) & (4) $V^2R = 60\,(60 + R)^2$

$V^2R = 60(3600 + R^2 + 60R)$

$0 = 60R^2 + 3600\,R - V^2R + 60 \times 3600$

$(3600 - V^2 - 60 \times 60 \times 2)$

$(3600 - V^2 + 60 \times 60 \times 2) > 0$

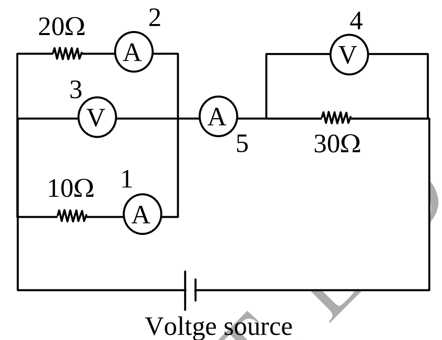
$(3 \times 3600 - V^2)\,(-3600 - V^2) > 0$

$3 \times 3600 - V^2 < 0$

$60 \times 3600 < V^2$

$60 \times \sqrt{3} < V$

Q. 14 If all meters are ideal and reading of voltmeter 3 is 6V. Power supplied by voltage source is -



(A) 10 Watt (B) 38 Watt

(C) 20 Watt (D) 30 Watt

Sol. **[D]**

Current through 20W = $\frac{6}{20}$

current through 10W = $\frac{6}{10}$

Total current supplied by voltage source

$= \frac{6}{10} + \frac{6}{20}$

= 27 Volt

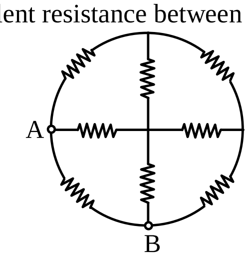
Voltage of battery = 6 + 27 = 33 volt

Power supplied = $\frac{9}{10} \times 33$

= 29.7 or 30 Watt

Potential difference across 30 W = $\left(\frac{6}{10} + \frac{6}{20}\right) \times 30$

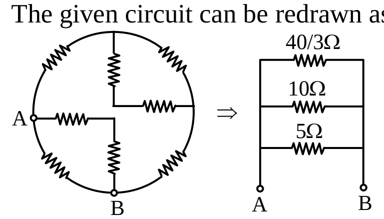
Q.15 Eight resistances each of resistance 5Ω are connected in the circuit as shown in figure. The equivalent resistance between A and B is –



(A) $\frac{8}{3}\Omega$ (B) $\frac{16}{3}\Omega$ (C) $\frac{15}{7}\Omega$ (D) $\frac{19}{2}\Omega$

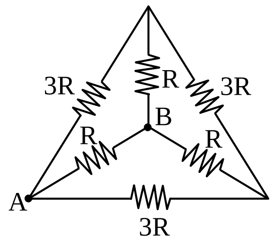
Sol. **[A]**

The given circuit can be redrawn as



$\therefore R_{AB} = \dfrac{8}{3}\Omega$

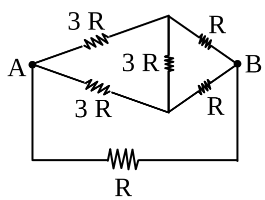
Q. 16 Six resistances are connected as shown here. The effective resistance between points A and B is –



(A) R (B) $\dfrac{1}{2}$R

(C) $\dfrac{1}{3}$R (D) $\dfrac{2}{3}$R **[D]**

Sol. Just disconnect 'R' between A & B unfold the ckt. and reconnect 'R' between A & B



Now it is balanced wheat stone bridge

Q. 17 Two wires A and B of the same material, having radii in the ratio 1 : 2 and carry currents in he ratio 4 : 1. The ratio of drift speed of electrons in A and B is -

(A) 16 : 1 (B) 1 : 16

(C) 1 : 4 (D) 4 : 1 **[A]**

Sol. $I = neAv_d$

$V_d \propto \dfrac{I}{r^2}$

Q.18 In copper, each copper atom releases one electron. If a current of 1.1 A is flowing in the copper wire of uniform cross-sectional area of diameter 1 mm, then drift velocity of electrons will approximately be-

(Density of copper = 9×10^3 kg /m^3, Atomic weight of copper = 63)

(A) 10.3 mm/s (B) 0.1 mm/s

(C) 0.2 mm/s (D) 0.2 cm/s **[B]**

Q.19 If a copper wire is stretched to make it 0.1% longer, then the percentage change in resistance is approximately -

(A) 0.1% (B) 0.2% (C) 0.4% (D) 0.8%

Sol. **[B]**

$R = \dfrac{\rho\ell}{A}$, $m = A\,\ell\,d$

$\therefore R = \dfrac{\rho\ell(\ell d)}{m}$ $\quad \therefore R \propto \ell^2$

$\therefore \dfrac{\Delta R}{R} \times 100 = 2\dfrac{\Delta\ell}{\ell} \times 100 = 2 \times 0.1 = 0.2\%$

Q.20 A potential difference V exists between the ends of a metal wire of length ℓ. The drift velocity will be doubled if -

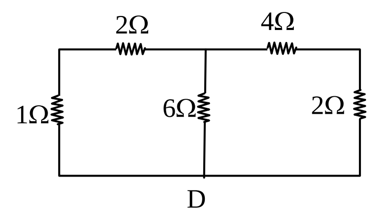
(A) V is doubled

(B) ℓ is doubled

(C) The diameter of the wire is doubled

(D) The temperature of the wire is doubled **[A]**

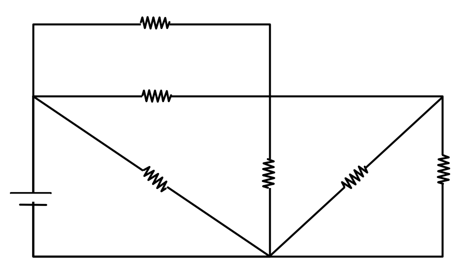
Q.21 Equivalent resistance between point C and D in the combination of resistance shown is –



(A) 3 Ω (B) 1 Ω

(C) 1.5 Ω (D) 0.5 Ω **[C]**

Q.22 In the figure shown each resistor is of 20 Ω and the cell has emf 10 volt with negligible internal resistance. Then rate of joule heating in the circuit is (in watts) -



(A) 100/11 (B) 10000/11

(C) 11 (D) None of these

[C]

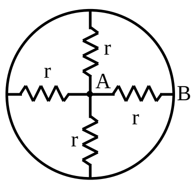
Q.23 The dimensions of a block are 1 cm × 1 cm × 100 cm. If the specific resistance of its material is 2×10^{-7} ohm × metre, then the resistance between the opposite rectangular faces is -

(A) 2×10^{-9} ohm (B) 2×10^{-7} ohm

(C) 2×10^{-5} ohm (D) 2×10^{-3} ohm **[B]**

Sol. $R = \frac{\rho \ell}{A} = \frac{\rho(1\text{cm})}{(1\text{cm} \times 100\text{ cm})}$

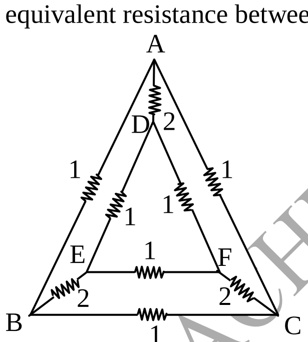
Q.24 The equivalent resistance between point A and B is -



(A) 4 r (B) 2r

(C) r (D) $\frac{r}{4}$ **[D]**

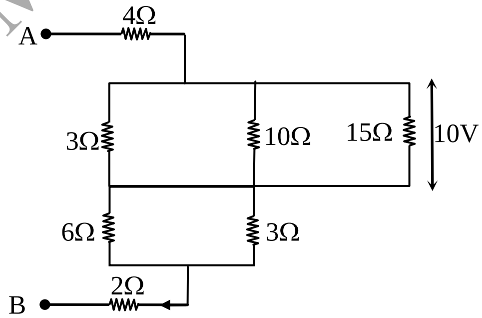
Q.25 A network of nine conductors connects six points A, B, C, D, E and F as shown below. The digits denote resistances in Ω. Find the equivalent resistance between A and D -



(A) 2 Ω (B) 3 Ω

(C) 1 Ω (D) 5 Ω **[C]**

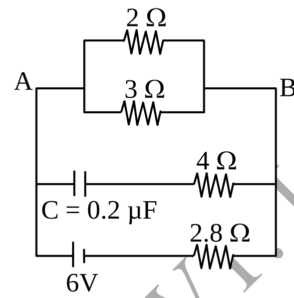
Q.26 Calculate the potential difference between points A and B and current flowing through the 10 Ω resistor in the part of the network below -



(A) 20 V, 2A (B) 50 V, 1A

(B) 40 V, 1A (D) 30 V, 1A **[B]**

Q.27 In Figure the steady state current in 2 Ω resistance is –



(A) 1.5 A (B) 0.9 A

(C) 0.6 A (D) zero **[B]**

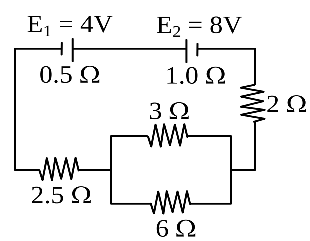
Sol. R–C Ckt so no current in capacitor path.

$I = \frac{6}{1.2 + 2.8} = 1.5$ A

$\therefore I_2 : I_3 =$ 1/2 : 1/3 = 3.2

$I_2 = 3/5 \times 1.5 = 0.9$ A

Q. 28 In the circuit shown in the figure below the cells E_1 and E_2 have e.m.f. 4V and 8 V and internal resistance 0.5 ohm and 1.0 ohm respectively. Then the potential difference across cell E_1 and E_2 will be-



(A) 3.75 V, 7.5 V (B) 4.25 V, 7.5 V

(C) 3.75 V, 3.75 V (D) 4.25 V, 4.25 V

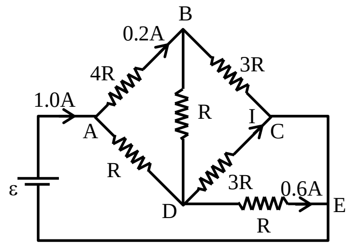
[B]

Sol. $I = \frac{8-4}{8} = 0.5$ A

$V_{8V} = E - Ir = 8 - (0.5)(1) = 7.5$ V

$V_{4V} = E + Ir = 4 + (0.5)(0.5) = 4.25$ V

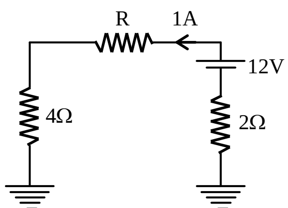
Q.29 The current I in the circuit shown in the figure is -



(A) 0　　(B) 0.1 A

(C) 0.4 A　　(D) 0.2 A　　**[D]**

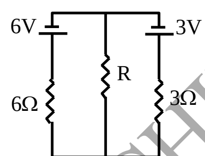
Q.30 In the circuit shown in figure the value of R is-



(A) 8 Ω　　(B) 6 Ω

(C) 10 Ω　　(D) 12 Ω　　**[B]**

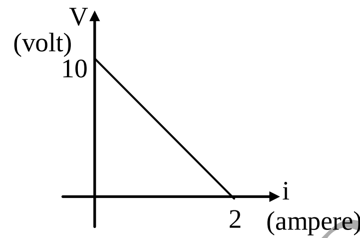
Q.31 In the circuit, the value of R is so chosen that thermal power generated in it is maximum, then value of R is –



(A) 2 Ω　　(B) 3 Ω

(C) 6 Ω　　(D) 9 Ω　　**[A]**

Q.32 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 5Ω

(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　　**[A]**

Q.33 four wires of same material and same diameter, have lengths in the ratio 1 : 2 : 3 : 4. These wires are connected in parallel. If a battery is connected across this combination, then the currents in the wires will be in the ratio -

(A) 4 : 3 : 2 : 1　　(B) 1 : 2 : 3 : 4

(C) 12 : 6 : 4 : 3　　(D) None of these　　**[C]**

Sol. $I \propto \frac{1}{R} \propto \frac{1}{\ell}$

$I_1 : I_2 : I_3 : I_4 = \frac{1}{1} : \frac{1}{2} : \frac{1}{3} : \frac{1}{4}$

$= 12 : 6 : 4 : 3$

Q.34 A uniform wire of resistance R Ω is divided into 10 parts and all of them are connected in parallel. The equivalent resistance will be -

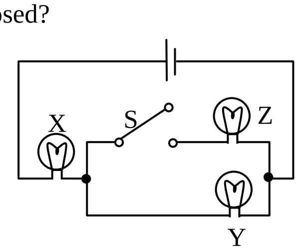
(A) 0.01 R　　(B) 0.1 R

(C) 10 R　　(D) 100 R　　**[A]**

Sol. 10 parallel resistance each of value R/10

$\Rightarrow R_{eq} = \frac{R/10}{10} = 0.01\ R$

Q.35 If X, Y, and Z in figure are identical lamps, which of the following changes to the brightnesses 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 **[B]**

Q.36 If σ_1, σ_2 and σ_3 are the conductances of three conductors, then their equivalent conductance, when they are joined in series will be -

(A) $\sigma_1 + \sigma_2 + \sigma_3$ (B) $\frac{1}{\sigma_1} + \frac{1}{\sigma_2} + \frac{1}{\sigma_3}$

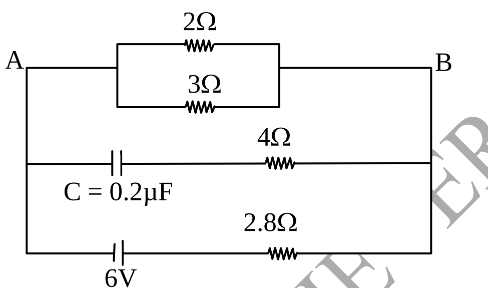
(C) $\frac{\sigma_1\sigma_2\sigma_3}{\sigma_1+\sigma_2+\sigma_3}$ (D) None of these **[D]**

Sol. $R = R_1 + R_2 + R_3$

$$\frac{1}{\sigma} = \frac{1}{\sigma_1} + \frac{1}{\sigma_2} + \frac{1}{\sigma_3}$$

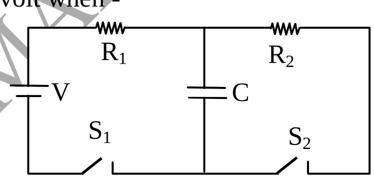
$$\Rightarrow \sigma = \left(\frac{1}{\sigma_1}+\frac{1}{\sigma_2}+\frac{1}{\sigma_3}\right)^{-1}$$

Q.37 In figure, the steady state current in 2Ω resistance is –



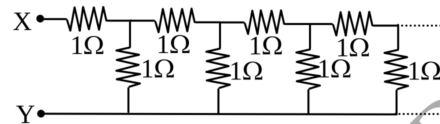
(A) 1.5 A (B) 0.9 A
(C) 0.6 A (D) zero **[B]**

Q.38 A battery of emf V volt, resistance R_1 and R_2, a capacitance C and switches S_1 and S_2 are connected in an electrical circuit as shown in figure. The capacitor C gets fully charged to V volt when -



(A) S_1 and S_2 are both closed
(B) S_1 and S_2 are both open
(C) S_1 closed and S_2 open
(D) S_2 closed and S_1 open **[C]**

Q.39 Figure shows an infinite ladder network of resistance. The equivalent resistance between points X and Y is –



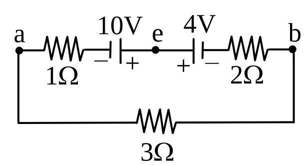
(A) infinite (B) 3 Ω
(C) 8.62 Ω (D) 1.62 Ω **[D]**

Sol. Use approximate method by solving first two blocks only.

$R_{approx} = 5/3 = 1.66\ \Omega$

R_{eq} is slightly less than 1.66 Ω

Q.40 In the circuit diagram show below, the magnitude and direction of the flow of current respectively would be –



(A) 7/3 amp. from a to b via e
(B) 7/3 amp. from b to a via e
(C) 1.0 amp. from b to a via e
(D) 1.0 amp. from a to b via e **[D]**

Sol. $I = \frac{10-4}{1+2+3} = 1$ A (Clockwise so a to b via e)

Q.41 A 1m long metallic wire is broken into two unequal parts A and B. The part A is uniformly extended into another wire C. The length of C is twice the length of A and resistance of C is equal to that of B. The ratio of resistances of parts A and C is -

(A) 4 (B) $\frac{1}{4}$

(C) 2 (D) $\frac{1}{2}$ **[B]**

Sol. let L_A and L_B be length of parts A and B

Then $\frac{R_A}{R_B} = \frac{L_A}{L_B}$ [as cross-section is same]

Now $L_c = 2 L_A$ and $(volume)_c = (volume)_P$

i.e. $L_c \times A_c = 2 L_A \times A_c = L_A \times A_A$

where $A_c = A_A$ are cross-sectional area of part C and A.

$\therefore$ $A_c = A_A/2$

$$\therefore \frac{R_A}{R_C} = \frac{\rho L_A / A_A}{\rho L_c / A_c} = \frac{L_A}{L_C} \times \frac{A_C}{A_A}$$

$$= \frac{L_A}{2L_A} \times \frac{A_A/2}{A_A} = \frac{1}{4}$$

Q.42 A resistance R carries a current I. The rate of heat loss to the surroundings is λ (T – T_0) where λ is a constant. T is the temperature of the resistance and T_0 is the temperature of the atmosphere. If the coefficient of linear expansion is α, the strain in the resistance is –

(A) proportional to the length of the resistance wire

(B) equal to $\frac{\alpha}{\lambda} I^2R$

(C) equal to $\frac{1}{2} \frac{\alpha}{\lambda} I^2R$

(D) equal to $\alpha\lambda$ (IR) **[B]**

Q.43 Resistivity of iron is 1×10^{-7} ohm-metre. The resistance of the given wire of a particular thickness and length is 1 Ω. If the diameter and length of the wire both are doubled, the resistivity will be -

(A) 1×10^{-7} (B) 2×10^{-7}

(C) 4×10^{-7} (D) None of these **[A]**

Sol. Resistivity does not depend on length & cross section area

Q.44 For a metallic wire, the ratio V/I (V = applied potential difference, I = current flowing)-

(A) increases or decreases as the temperature rises, depending upon the metal

(B) decreases as the temperature rises

(C) independent of temperature

(D) increases as the temperature rises **[D]**

Sol. $\frac{V}{I} = R$

and for metals R ↑, on ↑ the temperature.

Q.45 An electric fan and a heater are marked as 100 watt-220 volt and 1000 watt-220 volt respectively. The resistance of heater is -

(A) zero

(B) greater than that of the fan

(C) less than that of the fan

(D) equal to that of the fan **[C]**

Sol. $R_{fan} = \frac{(220)^2}{100}$, $R_{heater} = \frac{(220)^2}{1000}$

$\therefore R_{fan} > R_{heater}$

Q.46 A potential difference of 30 V is applied between the ends of a conductor of length 100 m and resistance 0.5 Ω and uniform area of cross-section. The total linear momentum of free electrons is -

(A) 3.4×10^{-6} kg/s

(B) 4.3×10^{-6} kg/s

(C) 3.4×10^{-8} kg/s

(D) 4.3×10^{-8} kg/s **[C]**

Sol. Current, $I = \frac{V}{R} = \frac{30}{0.5} = 60$ A

Total no. of free e^- s, $N = nA\ell$

and linear momentum of each e^-s, $P = mv_\alpha$

$\therefore$ Total momentum of all free e^-s,

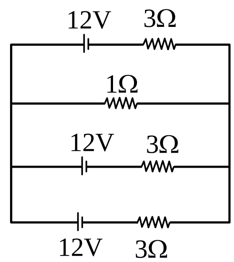
$P = (nA\ell)(m\upsilon_\alpha)$

But $I = neA\upsilon_\alpha$, so $nA\upsilon_\alpha = \frac{I}{e}$

$$\therefore P = \frac{I\ell m}{e} = \frac{60 \times 100 \times 9.1 \times 10^{-31}}{1.6 \times 10^{-19}}$$

3.4×10^{-8} kg/s

Q.47 In adjacent circuit, current flowing in 1Ω resistance will be -



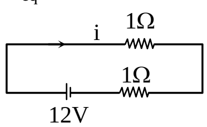
(A) 3A (B) 4A

(C) 5A (D) 6A **[D]**

Sol. All the three given cells are in parallel

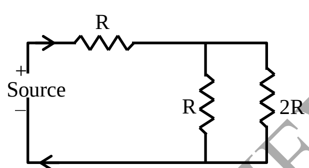
$\therefore\ r_{eq} = \frac{r}{3} = \frac{3}{3} = 1\Omega$

$E_{eq} = 12V$



$i = \frac{12}{1+1} = 6A$

Q.48 The charge supplied by source varies with time t as $Q = at - bt^2$. The total heat produced in resistor 2R is : (Assume direction of current is not changing)

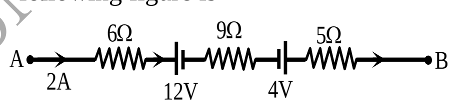


(A) $\frac{a^3R}{6b}$ (B) $\frac{a^3R}{27b}$

(C) $\frac{a^3R}{3b}$ (D) None of these

[B]

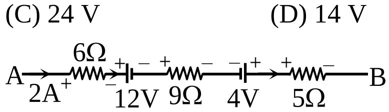
Q.49 The potential difference between A and B in the following figure is -



(A) 32 V (B) 48 V

(C) 24 V (D) 14 V **[B]**

Sol.



$V_A - 2 \times 6 - 12 - 2 \times 9 + 4 - 2 \times 5 = V_B$

$\therefore\ V_A - V_B = 48\ V$

Q.50 At room temperature, copper has free electron density of $8.4 \times 10^{28}\ m^{-3}$. The electron drift velocity in a copper conductor of cross-sectional area $10^{-6}\ m^2$ and carrying a current of 5.4 A, will be -

(A) $4\ ms^{-1}$ (B) $0.4\ ms^{-1}$

(C) $4\ cms^{-1}$ (D) $0.4\ mms^{-1}$ **[D]**

Sol. Use $i = neAv_d$

$\therefore\ v_d = \frac{i}{neA}$

PHYSICS

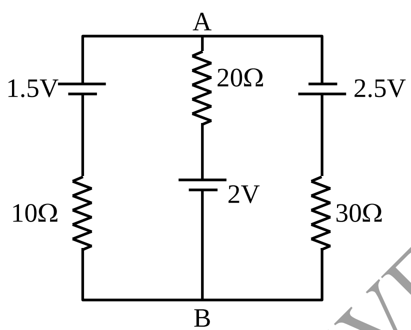
Q.1 The equation for an instantaneous current in a material is given by $i = 5e^{-t}$ (A). Calculate the amount of total charge flown through the material during the time interval $t_1 = 0$ s to $t_2 = \infty$ s.

Ans. [5 C]

Q.2 A current of 5 ampere is passing through a metallic wire of cross-sectional area 4×10^{-6} m^2. If the density of the charge carries in the wire is 5×10^{26}/m^3, find the drift speed of the electrons.

Ans. 1.56×10^{-2} m/s

Q.3 In the circuit shown below, the source e.m.f.^{s} and resistances are given. The internal resistances of the sources are negligible. Find the current through 10 Ω and the p.d. between A and B.



Ans. [0.06 A, 0.9 V]

Q.4 An electric kettle has two coils. When one coil is switched on it takes 15 minutes to boil water and when the second coil is switched on, it takes 30 minutes. How long will it take to boil water when both the coils are used in (i) series and (ii) parallel?

Ans. 45 min, 10 min

Q.5 (a) What are the magnitude and sense of the current in a hydrogen discharge tube in which 3.1×10^{18} electrons and 1.1×10^{18} protons move past a cross sectional area of the tube each second?

(b) A straight copper wire of length l = 1000 m and cross-sectional area S = 1.0 mm^2 carries a current I = 4.5 A. Assuming that one free electron corresponds to each copper atom, find:

(i) the time it takes an electron to displace from one end of the wire to the other;

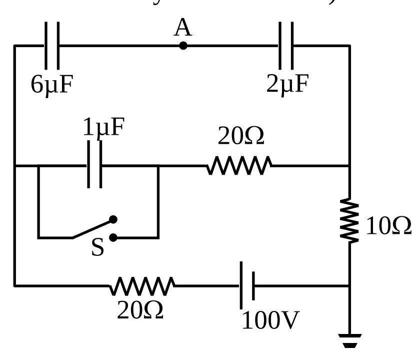
(ii) the sum of electric forces acting on all free electrons in the given wire.

Ans. [(a) 0.67A (b) (i) t = 3, (ii) F = 1.0 MN]

Q.6 A homogeneous proton beam accelerated by a potential difference V= 600 kV has a round cross-section of radius r = 5.0 mm. Find the electric field strength on the surface of the beam and the potential difference between the surface and the axis of the beam, if the beam current is equal to I = 50 mA.

Ans. [E = 32V/m, Δϕ = 0.8 V]

Q.7 In fig. shown, when switch S is closed, what will be the voltage across capacitor 2μF ? Also find the voltage 1μF capacitor in the same condition. (consider steady state condition)



Ans. [30 V, 0 V]

Q.8 The air between two closely located plates is uniformly ionized by uv radiation. The air volume between the plates is equal to V = 500 cm^3, the observed saturation current is equal to $I_{sat} = 0.48$ μA.

Find :

(a) the number of ion pairs produced in a unit volume per unit time,

(b) the equilibrium concentration of ion pairs if the recombination coefficient for air ions is equal to r = 1.67×10^{-6} cm^3/s.

Ans. [(a) 6×10^9 cm^{-3} s^{-1} (b) 6×10^7 cm^3]

Q.9 The area of cross-section, length and density of a piece of a metal of atomic weight 60 are 10^{-6} m^2, 1.0 m and 5×10^3 kg/m^3 respectively. Find the number of free electrons per unit volume of every atom contributes one free electron. Also find the drift velocity of electrons in the metal when a current of 16 A passes through it.
(Given: Avogadro number 6×10^{23}/ mol)

Ans. 5×10^{28}/m^3, 2×10^{-3} m/s

Q.10(a) The resistances of an iron wire and a copper wire at 20ºC are 3.9 Ω and 4.1 Ω respectively. At what temperature will the resistances be equal ? Temperature coefficient of resistivity for iron is 5.0×10^{-3} K^{-1} and for copper it is 4.0×10^{-3} K^{-1}. Neglect any thermal expansion.

(b) A semicircular ring of Cu has an inner radius of 8 cm, radial thickness 4 cm and axial thickness 6 cm. Calculate the resistance of the ring at 50ºC between its two end faces. Resistivity of Cu at 20ºC = 1.724×10^6 Ω-cm. Resistance-temperature coefficient of Cu at 0ºC = 0.0043/C.

Ans. [(a) 84.5ºC (b) 2.5×10^{-6} Ω]

Q.11(A) It is desired to make a long cylindrical conductor whose temperature coefficient of resistivity at 20ºC will be close to zero. Calculate the expression in terms of α_c & α_{fe}.

(a) If such a conductor is made by assembling alternate disks of iron and carbon, what is the ratio of the thickness of a carbon disk to that of an iron disk ? Assume that the temp. remains essentially the same in each disk.

(b) What is the ratio of the rate of Joule heating in a carbon disk to that in an iron disk?

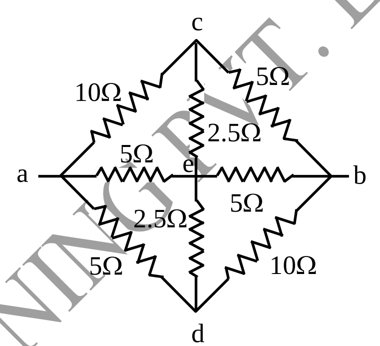
(B) A silver wire of length 10 m and cross-section 10^{-8} m^2 is suspended vertically and a weight of 10 N is attached to it. Calculate the increase in its resistance, given that Young's Modulus for silver is 7×10^{10} Nm^{-2}, and the resistivity of silver of silver remains constant during the stretching process. Calculate the expression in terms of α_c & α_{fe}

Ans. [(a) $\frac{t_c}{t_{fe}} = \frac{-\ell_{fe20}}{\ell_{c20}} \times \frac{\alpha_{fe}}{\alpha_c}$,(b) $\frac{t_c}{t_{fe}} = \frac{-\ell_{fe20}}{\ell_{c20}} \times \frac{\alpha_{fe}}{\alpha_c}$]

Q.12(a) Show that p, the power per unit volume transformed into Joule heat in a resistor, can be written as $p = j^2\rho$ or $p = E^2/\rho$.

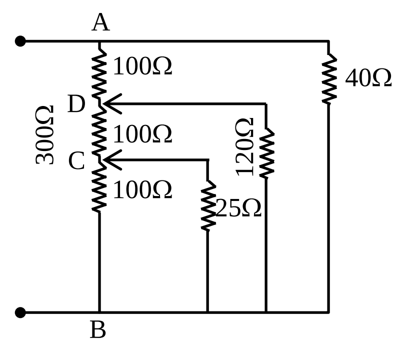
(b) Consider an external resistance R connected to a battery with e.m.f. E and internal resistance r. Show that power delivered to R is maximum when R = r.

Q.13 Find the equivalent resistance of the network shown in figure between the points a and b.



Ans. [R = 4.1Ω]

Q.14 A long resistor between A and B as shown in fig. has resistance of 300 Ω and is tapped at one third points.



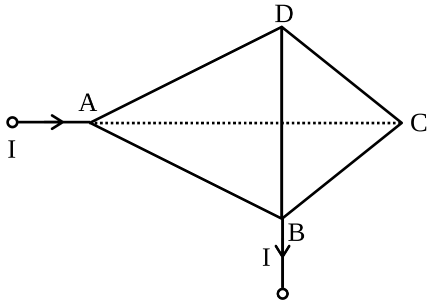
(a) What is the equivalent resistance between points A and B ?

(b) If the p.d. between A and B is 320 V, what will be the p.d. between B and C ?

(c) Will the answer of part (b) change if the 40Ω resistor is disconnected ?

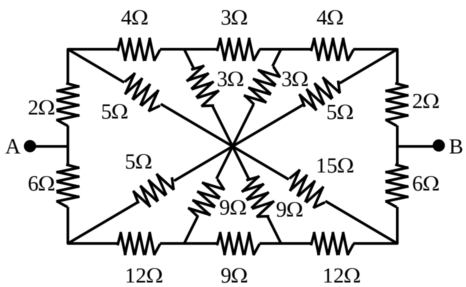
Ans. [(a) 32 Ω (b) 20 V (c) 20 V]

Q.15 A wire frame in the form of a tetrahedron ABCD is connected to a dc source (Fig.). The resistances of all the edges of the tetrahedron are equal. Indicate the edge of the frame that should be eliminated to obtain the maximum change in the current ΔI_{max} in the circuit, neglecting the resistance of the leads.



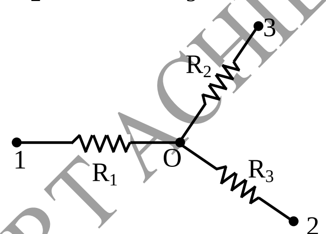
Ans. [Edge *AB*]

Q.16 Calculate equivalent resistance between A and B of the circuit shown in figure.



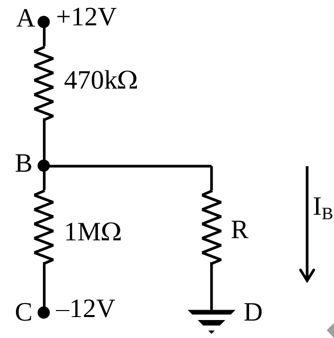
Ans. [6.75 Ω]

Q.17 Find the current flowing through the resistance R_1 of the circuit shown in fig if the resistance are equal to R_1 = 10 Ω, R_2 = 20 Ω and R_3 = 30 Ω and potentials of points 1, 2 and 3 are equal to V_1 = 10 V, V_2 = 6 V and V_3 = 5 V.



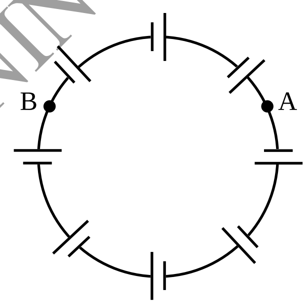
Ans. [0.2A]

Q.18 In the circuit shown below, I_B = 10μA. Find the value of R.



Ans. [0.113 MΩ]

Q.19(a) N sources of current with different emf's are connected as shown in fig. The emfs of the sources are proportional to their internal resistances, i.e. E = αR, where α is an assigned constant. The lead wire resistance is negligible, find:



(i) the current in the circuit;

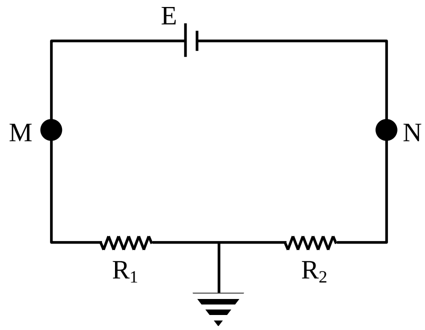
(ii) the potential difference between points A and B dividing the circuit in n and N - n links.

(b)The internal resistance of an accumulator battery of emf 6 V is 10 Ω when it is fully discharged. As the battery gets charged up, its internal resistance decreases to 1 Ω. The battery in its completely discharged state is connected to a charger which maintains a constant potential difference of 9 V. Find the current through the battery (a) just after the connections are made and (b) after a long time when it is completely charged.

Ans. [(a) (i) I = α, (ii) $\phi_A - \phi_B$ = 0, (b) (i) 0.3 A (ii) 3A]

Q.20(a) In the given figure, calculate the potential of the points M and N if E = 12V, R_1 = 3Ω, R_2 = 2Ω and r = 1Ω.

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



Ans. [(a) 6 V and –4 V, (b) 90%]