OBJECTIVE - I

1. A metallic resistor is connected across a battery. If the number of collisions of the free electrons with the lattice is somehow decreased in the resistor (for example, by cooling it), the current will

(A*) increase (B) decrease (C) remain constant (D) become zero

Sol. **A**

The current will increase.

2. Two resistor A and B have resistance R_A and R_B respectively with $R_A < R_B$. The resistivites of their materials r_A and = r_B.

(A) $r_A < r_B$ (B) $r_A = r_B$ (C) $r_A > r_B$

(D*) The information is not sufficient to find the relation between r_A and r_B

Sol. **D**

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

Resistance is depend on Material, length & Area.

So $R_A < R_B$ is information is not sufficient to ding.

The relation between r_A and r_B.

3. The product of resistivity and conductivity of a cylindrical conductor depends on

(A) temperature (B) material (C) area of cross-section (D*) none of these

Sol. **D**

conductivity $\sigma = \frac{1}{\rho}$ Where r is resistivily.

Product of conductity and resistivity = 1

4. As the temperature of a metallic resistor is increased, the product of its resistivity and conductivity

(A) increases (B) decreases (C*) remains constant (D) may increase or decrease

s × r = constant

5. In an electric circuit containing a bettery, the charge (assumed positive) inside the battery

(A) always goes from the positive terminal to the negative terminal

(B*) may go from the positive terminal to the negative terminal

(C) always goes from the negative terminal to the positive terminal

(D) does not move.

,

Sol. **B**

The charge (Positive) inside the bottery may go from the positive terminal to the negative terminal.

6. A resistor of resistance R is connected to an ideal battery. If the value of R is decreased, the power dissipated in the resistor will -

(A*) increase (B) decrease (C) remain unchanged

Sol. **A**

$$\text{Power} = \frac{v^2}{R}, \quad R \downarrow \text{than power} \uparrow$$

Because Power $\propto \frac{1}{R}$.

7. A current passes through a resistor. Let K_1 and K_2 represent the average kinetic energy of the conduction electrons and the metal ions respectively.

(A) $K_1 < K_2$ (B) $K_1 = K_2$ (C*) $K_1 > K_2$ (D) Any of these three may occur

Sol. C

vd Þdrift velocity = $\frac{1}{2}\left(\frac{eE}{m}\right)\tau$

K.E. = $\frac{1}{2}mv_d^2 = \frac{1}{2}m\left(\frac{1}{4}\frac{e^2E^2\tau^2}{m^2}\right)$

K.E. = $\frac{1}{8}\frac{e^2E^2\tau^2}{m}$

Þ $K.E. \propto \frac{1}{m}$

Mass of electron < mass of metalions.

K.E. of electron > K.E. of metalions.

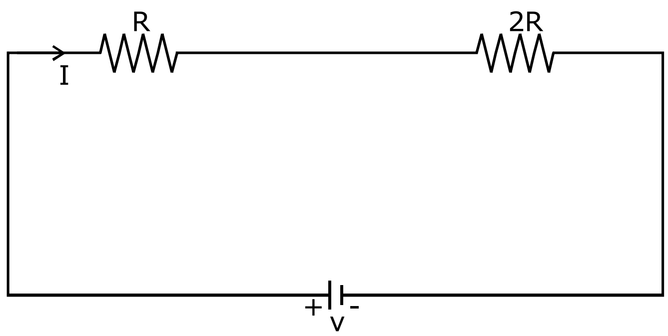
$K_1 > K_2$

8. Two resistance R and 2R are connected in series in an electric circuit.The thermal energy developed in R and 2R are in the ratio

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

Sol. **A**

Thermal Energy developed = I^2 Rt (Because in series, current is same)



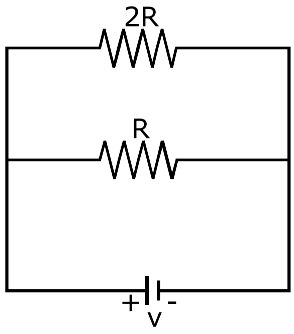
$$\frac{\text{Thermal Energy developed in "R"}}{\text{Thermal Energy developed in "2R"}} = \frac{I^2Rt}{I^2(2R)t} = \frac{1}{2}$$

9. Two resistance R and 2R are connected in parallel in an electric circuit. The thermal energy developed in R and 2R are in the ratio

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

Sol. **B**

Thermal Energy developed = $\frac{V^2}{R}t$ (Because in Parallel, voltage is same)



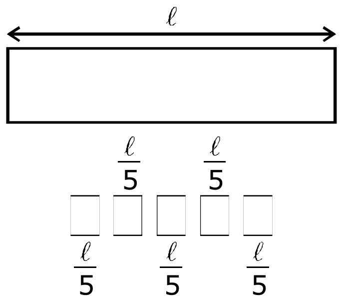
$$\frac{\text{Thermal Energy developed in "R"}}{\text{Thermal Energy developed in "2R"}} = \frac{\frac{V^2}{R}t}{\frac{V^2}{2R}t} = 2:1$$

10. A uniform wire of resistance 50W is cut into 5 equal parts. These parts are now connected in parallel.The equivalent resistance of the combination is

(A*) 2W (B) 10W (C) 250W (D) 6250W

Sol. **A**

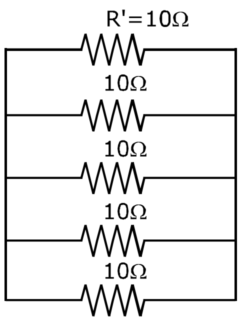
$$R = \frac{\rho l}{A} = 50$$



resistance of all '5' equal parts are same.

$$R' = \frac{\rho l / 5}{A} = \frac{50}{5} = 10\,\Omega$$

all '5' equal parts connect in parallel :-



$$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} = \frac{5}{10}$$

R_{eq} = 2W

11. Consider the following two statements :

(a) Kirchhoff's junction law follows from conservation of charge.

(b) Kirchhoff's loop law follows from consevative neature of electric field.

(A*) Both A and B are correct (B) A is correct but B is wrong

(C) B is correct but A is wrong (D) Both A and B are wrong

Sol. **A**

Þ Kirchhoff's Junction Law follows from conservation of charge.

Þ Kirchhoff's loop law fallows from conservation nature of electric field.

12. Two non-ideal batteries are connected in series. Consider the following statements:

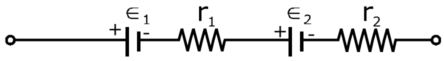
(a) The equivalent emf is larger either of the two emfs.

(b) The equivalent internal resistance is smaller than either of the two internal resistance.

(A) Each of A and B is correct (B*) A is correct but B is wrong

(C) B is correct but A is wrong (D) Each of A and B is wrong.

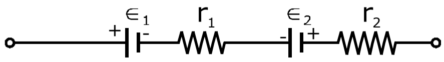
Sol. **B**



(i)

equivalent emf = $\hat{I}_1 + \hat{I}_2$

$R_{eq} = r_1 + r_2$



(ii)

equivalent emf = $\hat{I}_1 + \hat{I}_2$ $\{\hat{I}_1 > \hat{I}_2\}$

$R_{eq} = r_1 + r_2$

Þ The equivalent emf is may be larger than either of the two emfs.

Þ The equivalent internal resistance is mustbe larger than either of the two internal resistance.

13. Two non-ideal batteries are connected in parallel. Consider the following statements

(a) The equivalent emf is smaller than either of the two emfs.

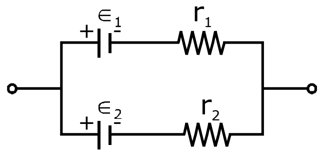
(b) The equivalent internal resistance is smaller than either of the two internal resistance.

(A) Both a and b are correct (B) a is correct but b is wrong

(C*) b is correct but a is wrong (D) Each of a and b is wrong

Sol. **C**

Equivalent emf $\in_0 = \dfrac{\in_1 r_1 + \in_2 r_2}{r_1 + r_2}$



Equivalent resistance = $r_0 = \dfrac{r_1 r_2}{r_1 + r_2}$

Þ The quivalent emf is larger than either of the two emfs.

Þ The quivalent internal resistane is smaller than either of the two internal resistance.

14. The net resistnace of an ammeter should be small to ensure that

(A) it does not get overheated (B) it does not draw excessive current

(C) it can measure large currents (D*) it does not appreciably change the current to be measured.

Sol. **D**

The net resistance of an ammeter should be small to ensure that it does not oppreciably change the current to be measured.

15. The net resistance of a voltmeter should be large to ensure that

(A) it does not get overheated (B) it does not draw excessive current

(C) it can measure large potential differences

(D*) it does not appreciably change the potential difference to be measured.

Sol. **D**

The net resistance of a voltmeter should be large to ensure that it does not apperciably change the potential difference to be measured.

16. Consider a capacitor-charging circuit. Let Q_1 be the charge given to the capacitor in a time interval of 10 ms and Q_2 be the charge given in the next time interval of 10 ms. Let 10 mC charge be deposited in a time interval t_1 and the next 10mC charge is deposited in the next time interval t_2.

(A) $Q_1 > Q_2$, $t_1 > t_2$. (B*) $Q_1 > Q_2$, $t_1 < t_2$. (C) $Q_1 > Q_2$, $t_1 > t_2$. (D) $Q_1 < Q_2$, $t_1 < t_2$.

Sol. **B**

Condition for charging capacitor :-

$Q = Q_0\,(1\text{-}e^{-t}/Rc)$

$Q = Q_0\,(1\text{-}e^{-10m}/Rc)$ ....(i)

$Q_1 + Q_2 = Q_0\,(1\text{-}e^{-(10m+10m)}/Rc)$

$Q_1 + Q_2 = Q_0\,(1\text{-}e^{-20m}/Rc)$ ....(ii)

from eq. (i) & (ii) we get :-

$Q_1 > Q_2$

Given

$Q = Q_0\,(1\text{-}e^{-t/RC})$

$10mc = Q_0\,(1\text{-}e^{-t/Rc})$ ....(iii)

$$10\mu c + 10\mu c = Q_0\left(1 - e^{-(t_1+t_2)/Rc}\right) \rightarrow$$

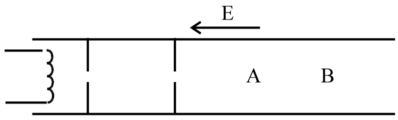
$$20\mu c = Q_0\left(1 - e^{-(t_1+t_2)/Rc}\right) \quad \text{....(iv)}$$

from eq. (iii) & (iv) we get

$t_2 > t_1$

OBJECTIVE - II

1. Electrons are emitted by a hot filament and are accelerated by an elecrtic field as shown in fig. The two stops at the left ensure that the electron beam has a uniform cross-section.



(A*) The speed of the electron is more at B than at A.

(B) The electric current is from left to right

(C) The magnitude of the current is larger at B than at A.

(D) The current density is more at B than at A.

Sol. **A**

Electric field goes higher potential to Lower potential. The drift velocity fo the electron at higher potentail is greater than the lower potential.

So the speed of the electron is more at B that at A.

2. A capacitor with no dielectric is connected to a battery at t = 0. Condiser a point A in the connecting wires and a point B in between the plates.

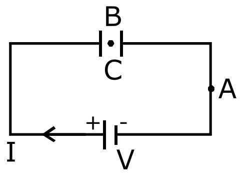
(A) There is no current through A

(B*) There is no current through b

(C*) There is a current through A as long as the charging is not complete.

(D) There is a current through B as long the charging is not complete.

Sol. **BC**



Þ Ther is no current through B

Þ There is a current through A as long as the charging is not complete.

3. When no current is passed through a conductor

(A) the free electrons do not move

(B) the average speed of a free electron over a large period of time is zero

(C*) the average velocity of a free electron over a large period of time is zero

(D*) the average of the velocities of all the free electrons at an instant is zero

Sol. **CD**

No current is passed through a conductor means. That the average velocity of a free elecron over a large period of time is zero or the average of the velocity of all the free electrons at an instant is zero.

4. Which of the following quanitites do not change when a resistor connected to a battery is heated due to the current ?

(A) drift speed (B) resistivity (C) resistance (D*) number of free electrons

Sol. D

When a resistor connected to a battery is heated due to the current that causes drift speed, resistivity & resistance may e change But number of free electrons remains same.

5. As the temperature of a conductor increases, its resistivity and conductivity change. The ratio of resistivity to conductivity

(A*) increases (B) decreases (C) remains constant

(D) may increase or decrease depending on the actual temperature.

Sol. **A**

Temperature of a cunductor increases that causes resistivity (r) is increases & due conductivity (s) is decrease.

$\therefore \quad \sigma = \frac{1}{\rho}$

$\Rightarrow \quad \text{ratio of } \frac{\text{resistivity}}{\text{conductivity}} = \frac{\rho}{\sigma} = \rho^2$ is increase

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

(A*) the charge corssing in a given time interval (B) drift speed

(C) current density (D*) free-electron density.

Sol. **AD**

$v_f = \left(\frac{e}{qm}\right)\tau \qquad E = \frac{i}{Ane}$

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

Vd $\rightarrow$ drift speed

j $\rightarrow$ current density

i $\rightarrow$ current

A $\rightarrow$ cross-section Area

7. Mark out the correct options.

(A*) An ammeter should have small resistance

(B) An ammeter should have large resistance

(C) A voltmeter should have small rsistance

(D*) A voltmeter should have large resistance

Sol. **AD**

Þ An ammeter should have small resistane. To measure the accurate reading of current in the circuit by Ammeter.

Þ A voltmeter should have large resistance. To measure the accurate reading of voltage across voltmeter.

8. A capacitor of capacitance 500 mF is connected to a battery through a 10 kW resistor. The charge stored on the capacitor in the first 5 s is larger than the charge stored in the next

(A*) 5 s (B*) 50 s (C*) 500 s (D*) 500

Sol. **ABCD**

$Q = CE\,(1-e^{-t/Rc})$

$C - 500 \times 10^{-6}$ F

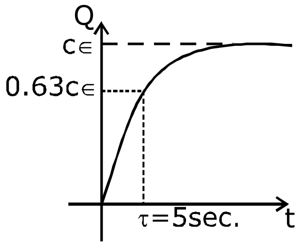
$R = 10^4$ W

$t = Rc = 10^4 \times 500 \times 10^{-6} = 5$

t = 5 sec.

$Q = c \in \left(1 - e^{-t/}\right) = c \in \left(1 - \frac{1}{e}\right) = 0.63c \in$

Thus, 63% of the maximum charge is deposited in one time constant.



with the help of the figure we can say that the capacitor in the first 5s is larger than the charge stored in the next any second.

$\Rightarrow$ at $t = \infty$

$$Q = Q_0\left(1 - e^{-\infty}\right) = Q_0 = c\in$$

$\therefore$ $t_\infty - t_5 = c\in - .63 = .37$

after t = 5 sec., maximum charge is deposited is only 37%.

9. A capacitor C_1 of capacitance 1mF and a capacitor C_2 of capacitance 2mF are separately charged by a common battery for a long time. The two capacitors are then separately discharged through equal resistors. Both the discharge circuits are connected at t = 0.

(A) The current in each of the two discharging circuits is zero at t = 0

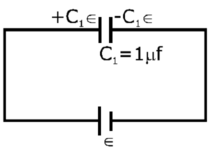
(B*) The currents in the two discharging circuits at t = 0 are equal but not zero.

(C) The currents in the two discharging circuits at t = 0 are unequal

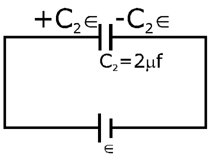
(D*) C_1 loses 50% of its initial charge sooner than C_2 loses 50% of its initial charge.

Sol. **BD**

Charging Þ

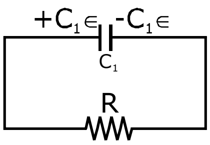


(i)

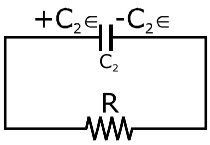


(ii)

Discharging Þ



(iii)



(iv)

$Q = C_1 \in e^{-t/Rc_1}$

$i_1 = \dfrac{dQ}{dt} = \dfrac{-C_1 \in}{RC_1} e^{-t/RC_1}$

$i_1 = \dfrac{-\in}{R} e^{-t/RC_1}$

at $t = 0$

$i_1 = \dfrac{-\in}{R}$

$Q = C_2 \in e^{-t/Rc_2}$

$i_2 = \dfrac{dQ}{dt} = \dfrac{-\in}{R} e^{-t/RC_2}$

at $t = 0$

$i_2 = \dfrac{-\in}{R}$