CHAPTER#14 CURRENT ELECTRICITY

CONCEPTUAL QUESTIONS

QUESTION#1

Can current flow through a circuit without potential difference?

Answer: No, current can't flow through a circuit without potential difference.

By Ohm's Law:-

$$V = IR$$

$$\Rightarrow \quad I = \frac{V}{R}$$

$$I = \frac{0}{R} \quad \Rightarrow \quad \boxed{I = 0}$$

QUESTION#2

If aluminum and copper wires of the same length have the same resistance, which has the larger diameter? Why?

Answer: For same length and resistance $D \propto \sqrt{\rho}$, so that wire will have larger diameter whose resistivity is higher. Since resistivity of aluminum is greater than resistivity of copper, therefore diameter of aluminum wire is greater than that of copper.

$$R = \rho\frac{L}{A} = \rho\frac{L}{\pi r^2} = \rho\frac{L}{\pi\left(\frac{D}{2}\right)^2}$$

$$R = \rho\frac{L}{\frac{\pi D^2}{4}} = \frac{4\rho L}{\pi D^2}$$

According to given condition

$$R_{Al} = R_{Cu} \Rightarrow \frac{4(\rho_{Al})L}{\pi(D_{Al})^2} = \frac{4(\rho_{Cu})L}{\pi(D_{Cu})^2}$$

$$\frac{\cancel{4}(\rho_{Al})\cancel{L}}{\cancel{\pi}(D_{Al})^2} = \frac{\cancel{4}(\rho_{Cu})\cancel{L}}{\cancel{\pi}(D_{Cu})^2}$$

$$\frac{(D_{Cu})^2}{(D_{Al})^2} = \frac{\rho_{Cu}}{\rho_{Al}} \Rightarrow \frac{D_{Cu}}{D_{Al}} = \sqrt{\frac{\rho_{Cu}}{\rho_{Al}}}$$

$$\Rightarrow D \propto \sqrt{\rho}$$

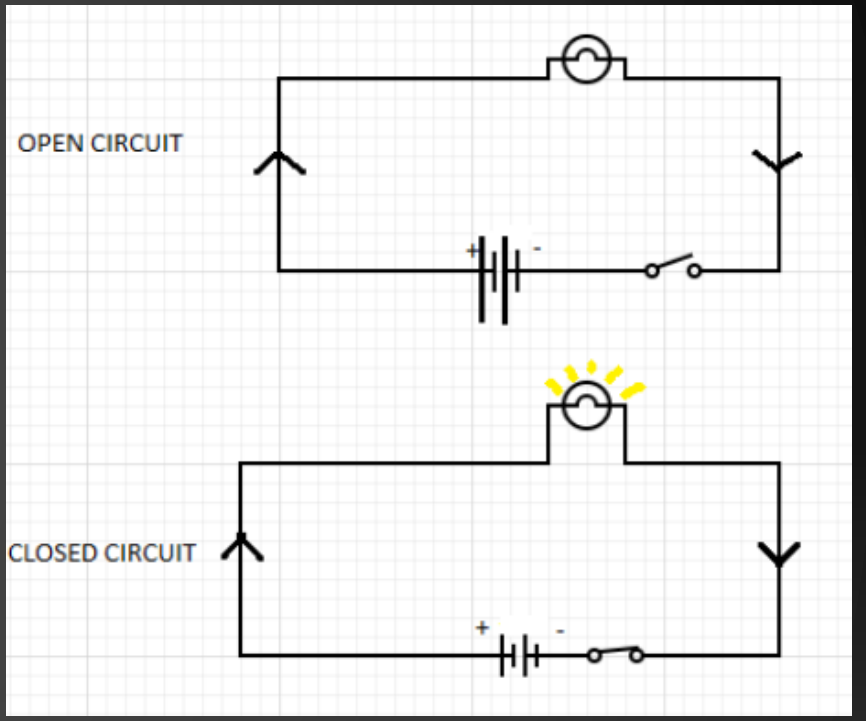
$$\rho_{Cu} = 1.72 \times 10^{-8}\ \Omega m$$
$$\rho_{Al} = 2.63 \times 10^{-8}\ \Omega m$$

QUESTION#3

What is resistance across open switch and close switch of a circuit?

Answer: A closed switch has resistance of zero while an open switch has the resistance of infinity. Closed switch represents ON state while open switch represents OFF state.

When the switch of a circuit is open, there is no path available for the flow of charges, so we can say that resistance of the circuit is infinity. When the switch of a circuit is closed, charges can flow through it easily, so we can say that resistance of the circuit is nearly zero.



QUESTION#4

A bird is sitting on a high voltage transmission line, but it is not electrocuted. Why? When it tries to fly, it touches another bird that is sitting on second transmission line of the pole. Now, it is heavily electrocuted. Why?

Answer: When the bird is sitting alone on a single transmission line, it is sitting on a constant potential line. Constant potential means potential difference is zero due to which no current flows through its body.

$$V = constant \Rightarrow \Delta V = 0$$

$$\Rightarrow I = \frac{\Delta V}{R} = \frac{0}{R} = 0$$

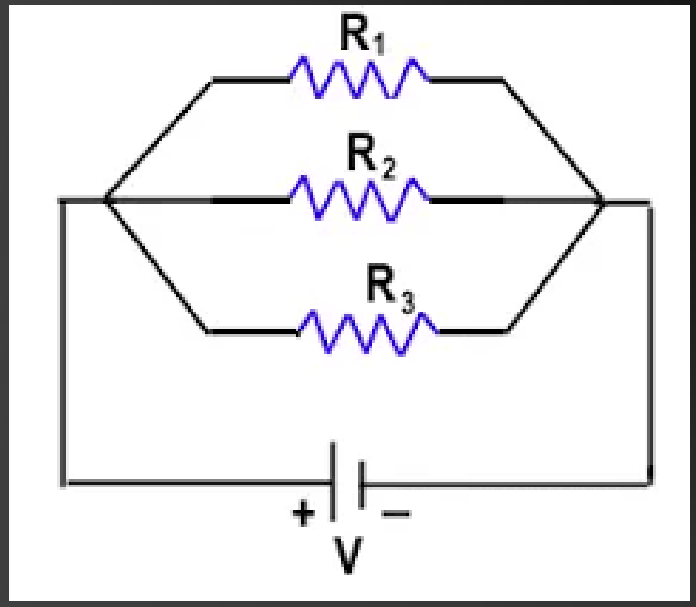
But when the bird touches another bird, then potential difference will develop between both birds, so current will flow through the bodies of both birds. So, they will be heavily electrocuted.

QUESTION#5

You are given five resistances of different magnitudes. But you are asked to form a circuit whose resistance is smaller than any given resistance. How can you make such circuit with given resistances?

Answer: I will connect those five resistances in parallel because in parallel, the equivalent resistance is smaller than any of the individual resistance.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$$



QUESTION#6

You are given n wires, each of resistance R. What is the ratio of maximum to minimum resistances obtainable from these wires?

Answer: The ratio of maximum to minimum resistances obtained is n^2.

Maximum resistance is obtained when every resistance R is connected in series.

$$R_{eq} = R_1 + R_2 + R_3 + \cdots + R_n$$
$$R_{eq} = R + R + R + \cdots \; n \; times$$
$$\Rightarrow \boxed{R_{max} = nR}$$

Minimum resistance is obtained when every resistance R is connected in parallel.

$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \cdots + \frac{1}{R_n} \quad \Rightarrow \quad \boxed{R_{min} = \frac{R}{n}}$$

Now, the ratio is: $$\frac{R_{max}}{R_{min}} = \frac{nR}{\frac{R}{n}} = n^2 \left(\frac{\cancel{R}}{\cancel{R}}\right) = n^2$$

QUESTION#7

Two electric bulbs marked 100 W, 220 V and 200 W,220 V have tungsten filaments of the same length. Which bulb will have thicker filament?

Answer: The bulb of 200 watts will have thicker filament.

$$P_1 = \frac{V^2}{R_1}$$

$$R_1 = \frac{V^2}{P_1}$$

$$R_1 = \frac{220^2}{100}$$

$$\boxed{R_1 = 484\ \Omega}$$

$$P_2 = \frac{V^2}{R_2}$$

$$R_2 = \frac{V^2}{P_2}$$

$$R_2 = \frac{220^2}{200}$$

$$\boxed{R_2 = 242\ \Omega}$$

- From $R = \rho\frac{L}{A} = \frac{4\rho L}{\pi D^2} \Rightarrow \quad R \propto \frac{1}{D^2}$
- Hence R_2 will have thicker filament (greater diameter) as this resistance is low.

QUESTION#8

Why we are advised "not to touch electric switches with wet hand, first dry your hands"?

Answer:

Moisture on hands increases conductivity, making it easier for electric current to flow through the body, increasing the risk of electric shock. Therefore, we are advised "not to touch electric switches with wet hand, first dry your hands".

QUESTION#9

Why is it dangerous to touch live wire while standing on earth bare footed?

Answer:

Touching a live wire while standing barefoot on the earth creates a path for electric current to flow through the body, resulting in an electric shock due to potential difference between the wire and the ground. Therefore, it is dangerous to touch live wire while standing on earth bare footed.

QUESTION#10

Sometimes, if your one of the car's head lamps is burnt or not working but second lamp still gives light. What do you conclude about connection of head lamps from this observation?

Answer:

From this observation, we can conclude that the headlamps are most likely connected in parallel. This means that each headlamp operates independently, so if one lamp is burnt or not working, the other lamp can still function properly.

QUESTION#11

Show that volt ampere is equal to watt (SI unit of power).

Answer:

$$P = \frac{W}{t}$$
$$P = \frac{qV}{t}$$
$$P = V\left(\frac{q}{t}\right)$$
$$P = VI$$

In S.I. system of units,

watt = (volt)(ampere)