CHAPTER NO. 13 (CURRENT ELECTRICITY)

Question 13.1:- A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of free electrons by (i) increasing the potential difference (ii) decreasing the length and the temperature of the wire.

Answer:- (i) The drift velocity of electrons through a uniform cylindrical conductor is given as $\mathbf{v_d} = \frac{I}{nAq}$ which can be rewritten as $\mathbf{v_d} = \frac{V}{nAqR}$ as I = V/R. The drift velocity of electrons will increase by increasing the potential difference because drift velocity is directly proportional to the potential difference.

(ii) We know that R = ρ $\frac{L}{A}$, therefore, drift velocity in terms of length is $\mathbf{v_d} = \frac{V}{nq\rho L}$. The drift velocity of electrons will increase when we decrease the length of the conductor as drift velocity is inversely proportional to length.

The drift velocity will decrease when temperature of conductor will increase. Increasing the temperature increases the resistivity and resistance of the conductor, collisions between electrons and lattice atoms becomes more frequent and drift velocity decreases.

Question 13.2:- Do bends in a wire affect its electrical resistance? Explain.

Answer:- The resistance of a cylindrical conductor of length L. cross sectional area A and resistivity ρ is given as R = ρ $\frac{L}{A}$. It indicates that resistance of the conductor is directly proportional to its length and inversely proportional to cross sectional area. There are two cases:-

(i) Small bends in a wire do not change the area and length of the wire and hence do not affect the electrical resistance of the conductor.

(ii) Large bends (twists) change the area and effective length of the conductor, therefore, affect the electrical resistance of the conductor.

Question 13.3:- What are the resistances of the resistors given in the figure A and B? What is tolerance of each? Explain what is meant by the tolerance?

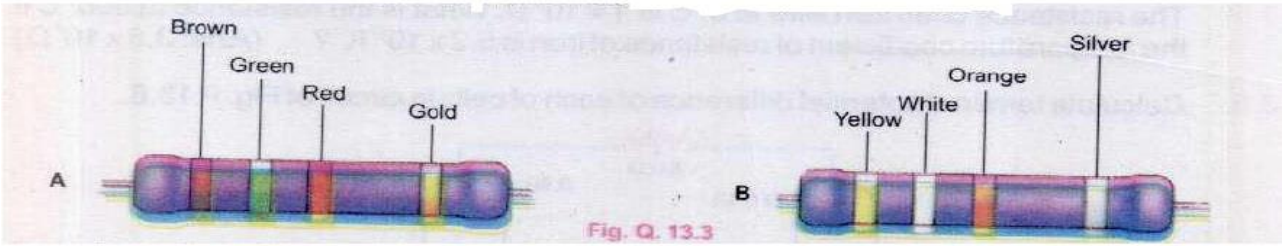


Fig. Q. 13.3

Answer:- The coding sequence of the carbon film resistors is as under:-

First band = First digit, Second band = Second digit, Third band = Multiplier (No. of zeros), Forth band = Tolerance

FIGURE A	FIGURE B
First band = Brown = 1	First band = Yellow = 4
Second Band = Green = 5	Second Band = White = 9
Third Band = Red = 00	Third Band = Orange = 000
Nominal value of resistance = 1,500 Ω	Nominal value of resistance = 49,000 Ω
Tolerance Band = Gold = ± 5 % = $\frac{5}{100}$ x 1500 = 75 Ω	Tolerance Band = Silver = ± 10 % = $\frac{10}{100}$ x 49000 = 4,900 Ω
Range of resistance (1500 ± 75) Ω.	Range of resistance (49,000 ± 4,900) Ω.
1,425 Ω to 1,575 Ω	44,100 Ω to 53,900 Ω

Tolerance:- The possible variation in the resistance of carbon film resistor from its nominal / marked value due to change in operating and environmental conditions is called tolerance of resistance.

Question 13.4:- Why does the resistance of the conductor rise with temperature?

Answer:- The opposition offered by the atoms of the conductor to the flow of drifting electrons upon applying a potential difference due to collisions between the vibrating atoms of the lattice and electrons is called resistance.

When temperature of the conductor rises, the amplitudes of vibration of the atoms of the lattice increase which increase the frequency of their collisions with drifting electrons and resistance of the conductor increases.

Question 13.5:- What are the difficulties in testing whether the filament of a lighted bulb obeys Ohm's law?

Answer:- According to Ohm's law, the current flowing through a conductor is directly proportional to the potential difference applied across the terminals of the conductor provided that its physical state such as temperature does not change.

When potential is applied across filament bulb, its temperature does not remain constant due to passage of current through it and hence Ohm's law cannot be applied to filament bulb. The change in temperature of the filament with the passage of current is main difficulty in testing of Ohm's law on it.

Question 13.6:- Is the filament resistance lower or higher in a 500 W, 220 V light bulb than in a 100 W, 220 V bulb?

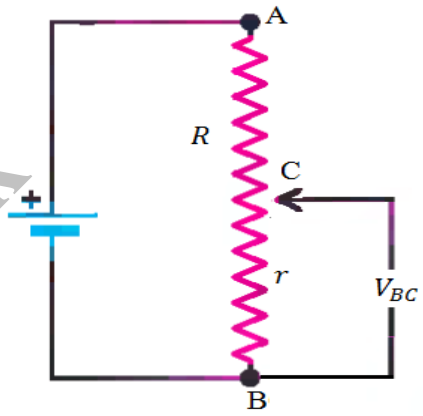
Answer:- The relation for power drop across a resistive load is P = $\frac{V^2}{R}$, so R = $\frac{V^2}{P}$.

We can calculate resistance of each bulb as under:-

P = 500 W V = 220 V R = $\frac{V^2}{P}$ = $220^2/500$ = 96.8 Ω	P = 100 W V = 220 V R = $\frac{V^2}{P}$ = $220^2/100$ = 484 Ω

Hence the filament resistance of 500 W, 220 V rated bulb is less than filament resistance of 100 W, 220 V rated bulb.

Question 13.7:- Describe a circuit which will give a continuously varying potential?



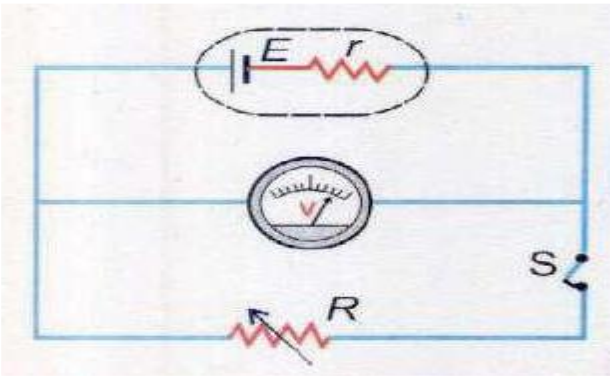
Answer:- Rheostat and potentiometer are electrical devices which can be used to provide varying potential difference.

In a rheostat, potential difference V is applied across the fixed terminal A and B with the help of a battery. If R is total resistance of the wire, the current passing through it is I = V/R.

The potential difference across portion BC of the wire is V_{BC} = I x R_{BC} = $\frac{V}{R}$ x r = $\frac{r}{R}$ x V as R_{BC} = r which can be varied between 0 to R.

One fixed terminal B and the sliding terminal C of the rheostat are inserted in the circuit. The potential can be varied from 0 to V by moving the sliding contact between B and A.

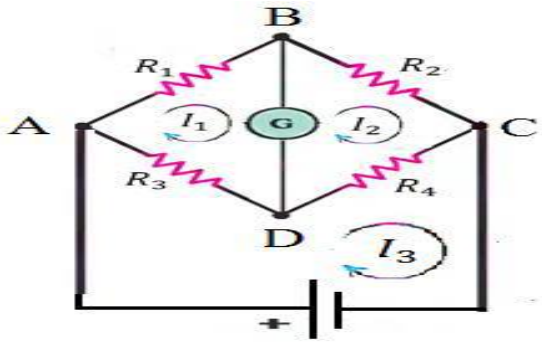
Question 13.8:- Explain why the terminal potential difference of a battery decreases when the current drawn from it is increased?



Answer:- In a closed loop circuit, the terminal potential difference V_T and emf E of the battery are related as V_T = IR = E – Ir where r is internal resistance of battery and R is external load resistance. When current drawn from the battery is increased (by decreasing the value of R), the

term Ir (voltage drop across internal resistance) increases which decreases terminal potential difference.

Question 13.9:- What is Wheatstone bridge? How can it be used to determine an unknown resistance?



Answer:- The Wheatstone bridge is an electrical circuit which can be used to find the unknown resistance of a wire. The circuit of Wheatstone bridge is shown in the figure.

It consists of four resistances connected in the form of a bridge (mesh), a galvanometer, a battery and a switch. When the switch is closed and bridge is made to operate balanced condition by varying the known resistances, no current passes through the galvanometer and following condition is satisfied:-

$\frac{R_1}{R_2} = \frac{R_3}{R_4}$ => $R_4 = \frac{R_2 R_3}{R_1}$

If the values of R_1, R_2 and R_3 are known, we can find the value of unknown resistance R_4 once the bridge is in balanced condition.