

CURRENT ELECTRICITY

1. ELECTRIC CURRENT

"The flow of charge in a definite direction constitutes the electric current and the time rate of flow of charge through any cross-section of a conductor is the measure of current".
i.e.,

$$\text{Electric current, } I = \frac{\text{net charge flown}}{\text{time taken}} = \frac{q}{t} = \frac{dq}{dt}$$

1. Though the "electric current represents the direction of flow of positive charge".
2. Yet it is treated as a scalar quantity.
3. Current follows, the laws of scalar addition and not the laws of vector addition.
4. Because the angle between the wires carrying currents does not affect the total current in the circuit.

2. CURRENT CARRIERS

(a) Current carriers in solid conductors :

1. In solid conductors like metals, the valence electrons of the atoms do not remain attached to individual atoms but are free to move throughout the volume of the conductor.
2. Under the effect of an external electric field, the valence electrons move in a definite direction causing electric current in the conductors.
3. Thus, valence electrons are the current carriers in solid conductors.

(b) Current carriers in liquids :

1. In an electrolyte like CuSO_4 , NaCl etc., there are positively and negatively charged ions (like Cu^{++} , SO_4^{--} , Na^+ , Cl^-).
2. These are forced to move in definite directions under the effect of an external electric field, causing electric current.
3. Thus, in liquids, the current carriers are positively and negatively charged ions.

(c) Current carriers in gases :

1. Ordinarily, the gases are insulators of electricity.
2. They can be ionized by applying a high potential difference at low pressure.
3. Thus, positive ions and electrons are the current carriers in gases.

3. DRIFT VELOCITY

"If $\vec{u}_1, \vec{u}_2, \vec{u}_3, \dots, \vec{u}_n$ are random thermal velocities of n free electrons in the metal conductor, then the average thermal velocity of electrons is

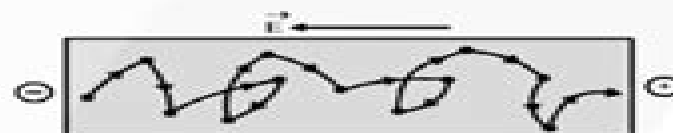
$$\frac{\vec{u}_1 + \vec{u}_2 + \vec{u}_3 + \dots + \vec{u}_n}{n} = \vec{0}$$

As a result, there will be no net flow of electrons of charge in one particular direction in a metal conductor, hence no current".

"Drift velocity is defined as the average velocity with which the free electrons get drifted towards the positive end of the conductor under the influence of an external electric field applied".

1. The drift velocity of electrons is of the order of 10^{-4} ms^{-1} .
2. If V is the potential difference applied across the ends of the conductor of length l , the magnitude of electric field set up is

$$E = \frac{\text{Potential difference}}{\text{length}} = \frac{V}{l}$$



3. Each free electrons in the conductor experience a force,

$$\vec{F} = -e\vec{E}$$

4. The acceleration of each electron is

$$\vec{a} = \frac{-e\vec{E}}{m}$$

5. At any instant of time, the velocity acquired by electron having thermal velocity $\vec{u}_1$ will be

$$\vec{v}_1 = \vec{u}_1 + \vec{a}\tau_1$$

where τ_1 is the time elapsed since it has suffered its last collision with ion/atom of the conductor.

Class Xii Physics Ch 3 Current Electricity Chapter Notes

Yan Bai



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