1.1 VOLTAGE

According to the structure of an atom, we know that there are two types of charges: positive and negative. A force of attraction exists between these positive and negative charges. A certain amount of energy (work) is required to overcome the force and move the charges through a specific distance. All opposite charges possess a certain amount of potential energy because of the separation between them. The difference in potential energy of the charges is called the *potential difference*.

Potential difference in electrical terminology is known as voltage, and is denoted either by V or v. It is expressed in terms of energy (W) per unit charge (Q); i.e.

$$V = \frac{W}{Q} \quad \text{or} \quad v = \frac{dw}{dq}$$

dw is the small change in energy, and

dq is the small change in charge.

where energy (W) is expressed in joules (J), charge (Q) in coulombs (C), and voltage (V) in volts (V). One volt is the potential difference between two points when one joule of energy is used to pass one coulomb of charge from one point to the other.

1.2 CURRENT

There are free electrons available in all semiconductive and conductive materials. These free electrons move at random in all directions within the structure in the absence of external pressure or voltage. If a certain amount of voltage is applied across the material, all the free electrons move in one direction depending on the polarity of the applied voltage, as shown in Fig. 1.1.

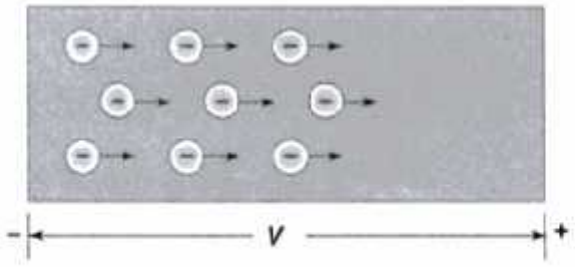

Fig. 1.1

This movement of electrons from one end of the material to the other end constitutes an electric current, denoted by either I or i. The conventional direction of current flow is opposite to the flow of – ve charges, i.e. the electrons.

Current is defined as the rate of flow of electrons in a conductive or semiconductive material. It is measured by the number of electrons that flow past a point in unit time. Expressed mathematically,

$$I = \frac{Q}{t}$$

where I is the current, Q is the charge of electrons, and t is the time, or

$$i = \frac{dq}{dt}$$

where dq is the small change in charge, and dt is the small change in time.

1.3 POWER AND ENERGY

Energy is the capacity for doing work, i.e. energy is nothing but stored work. Energy may exist in many forms such as mechanical, chemical, electrical and so on. Power is the rate of change of energy, and is denoted by either P or p. If certain amount of energy is used over a certain length of time, then

$$\text{Power } (P) = \frac{\text{energy}}{\text{time}} = \frac{W}{t}, \text{ or}$$

$$p = \frac{dw}{dt}$$

where dw is the change in energy and dt is the change in time.

We can also write

$$p = \frac{dw}{dt} = \frac{dw}{dq} \times \frac{dq}{dt}$$

$$= v \times i = vi \quad \text{W}$$

Energy is measured in joules (J), time in seconds (s), and power in watts (W).