ELECTRICITY
ELECTRIC CURRENT

ELECTRIC CURRENT:

The electric current is a flow of electric charges (called electrons) in a conductor. The magnitude of electric current in a conductor is the amount of electric charge passing through a given point of the conductor in one second. If a charge of **Q** coulombs flow through a conductor in time **t** seconds, then the magnitude of the electric current **I** flowing through it is given by :

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

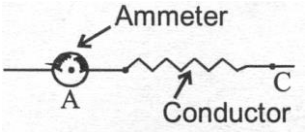
The nit of charge, in S.I. system is coulomb, which is equivalent to the charge of nearly 6.25×10^{18} electrons.
If charge is measured in coulomb, then the flow of 1 coulomb/second gives us the unit of current, which is called ampere named in the honour French scientist, Andre - Marie Ampere (1775 - 1836).

Definition of ampere:

When 1 coulomb of charge flows through any cross - section of a conductor 1 second, the electric current flowing through it, is said to be 1 ampere.

$$1\ mA = \frac{1}{1000} A$$

Current is measured by an instrument called ammeter. The ammeter is connected in series with the circuit through which the current is to be measured. An ammeter should have very low resistance.

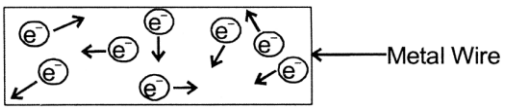


(a) Direction of Electric Current:

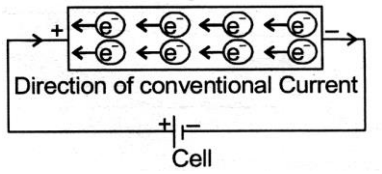
When electricity was invented a long time back, it was known that there are two types of charges : positive charges and negative charges, but the electron had not been discovered at that time. So, electric current was considered to be a flow of positive charges and the direction of flow of the positive charges was taken to be the direction of electric current. Thus, the conventional direction of electric current is from positive terminal of a cell (or battery) to the negative terminal through the circuit.

(b) How the Current Flows in a Wire:

As electric current is the flow of electrons in a metal wire (or conductor) when a cell or battery is connected across its ends. A metal wire has plenty of free electrons in it. When the metal wire has not been connected to a source of electricity like a cell or a battery, then the electrons present in it move at random in all the directions between the atoms of the metal wire as shown in figure below.



When a source of electricity like a cell or a battery is connected between the ends of the metal wire, then and electric force acts on the electrons present in the wire. Since the electrons are negatively charged, they start moving from negative end to the positive and of the wire and this flow of electrons constitutes the electric current in the wire.



(c) How to get a Continuous flow of Electric Current:

It is due to the potential difference two points that an electric current flows between them. The simplest way to maintain a potential difference between the two ends of a conductor so as to get a continuous flow of current is to connect the conductor between the terminals of a cell or a battery. Due to the chemical reactions going on inside the cell or battery, a potential difference is maintained between its terminals and this potential difference drives the current in a circuit.

MEASUREMENT OF CURRENT:

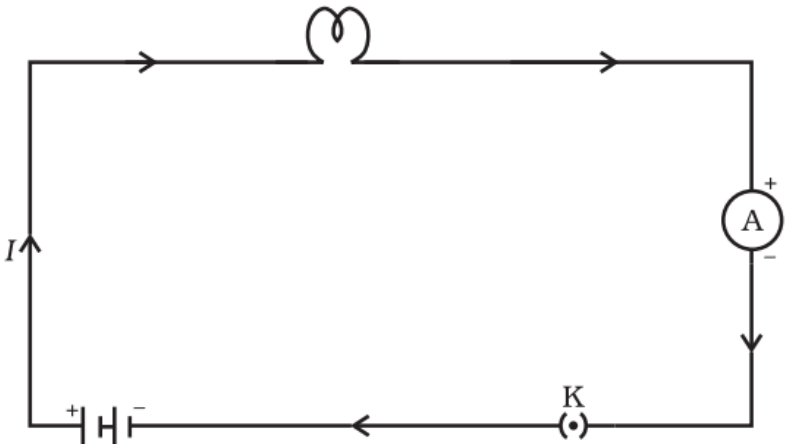
The charge passing per unit time through a given place (area) is the magnitude of the electric current at that place. Thus,

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

Here Q is the charge that passes through a place in time t.

Unit of current From Equation, we find that current is charge divided by time. The SI unit of charge is the coulomb and that of time is the second. The SI unit of current, therefore, is coulomb/second. This unit is called the ampere, whose symbol is A. Thus, if one coulomb of charge passes through a place in one second, the current there is 1 ampere.

The SI unit of electric charge is coulomb (C), which is equivalent to the charge contained in nearly 6 × 1018 electrons. (We know that an electron possesses a negative charge of 1.6 × 10–19 C.) The electric current is expressed by a unit called ampere (A), named after the French scientist, Andre-Marie Ampere (1775–1836). One ampere is constituted by the flow of one coulomb of charge per second, that



is, 1 A = 1 C/1 s. Small quantities of current are expressed in milliampere (1 mA = 10–3 A) or in microampere (1 μA = 10–6 A). An instrument called ammeter measures electric current in a circuit. It is always connected in series in a circuit through which the current is to be measured. Figure 12.1 shows the schematic diagram of a typical electric circuit comprising a cell, an electric bulb, an ammeter and a plug key. Note that the electric current flows in the circuit from the positive terminal of the cell to the negative terminal of the cell through the bulb and ammeter.

Example:

A current of 0.5 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

Solution:

We are given, I = 0.5 A; t = 10 min = 600 s., we have Q = It = 0.5 A × 600 s = 300 C

Definition of ampere:

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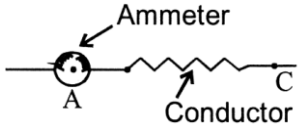
Current is measured by an instrument called ammeter. The ammeter is connected in series with the circuit through which the current is to be measured. An ammeter should have very low resistance.



CONDUCTOR AND INSULATORS:

Materials that conduct electricity easily are called good conductors or simply, conductors, And, materials that do not conduct electricity easily are called insulators.

All metals conduct electricity because they have some loosely bound free electrons, which flow when a potential difference is applied. However, some metals conduct electricity better than others, Silver is the best conductor.

But because of the high cost of silver, electric wires are made of copper, or in some cases aluminum.

Most nonmetallic solids do not conduct electricity. Although diamond and graphite are both forms of carbon (a nonmetal,) graphite is a conductor while diamond is an insulator. Insulators do conduct electricity because their electrons are tightly bound to the atoms. Rubber, plastics, wood glass and porcelain are some examples of insulators. Insulators have many uses. For example, they are used as protective covers on electric wires and electrician's tools. Certain liquids also conduct electricity. while distilled water is an insulator, addition of certain slats, acids or bases allows it to conduct electricity. Under normal circumstances, gases do not conduct electricity.

ELECTRIC CIRCUITS AND MEASURING INSTRUMENTS:

A closed path in which a current can flow is called an electric circuit. An electric circuit may have one or more electric elements such as bulbs (or lamps), cells, switches (or plug keys), metal wires, etc. Each element of a circuit has a specific function to play. For example, wires can be used to connect one element to the next. And a plug key or a switch can be used to either complete or break the closed path, thereby starting or stopping the current in the circuit .

Some common circuit elements and their symbols are shown in Figure.

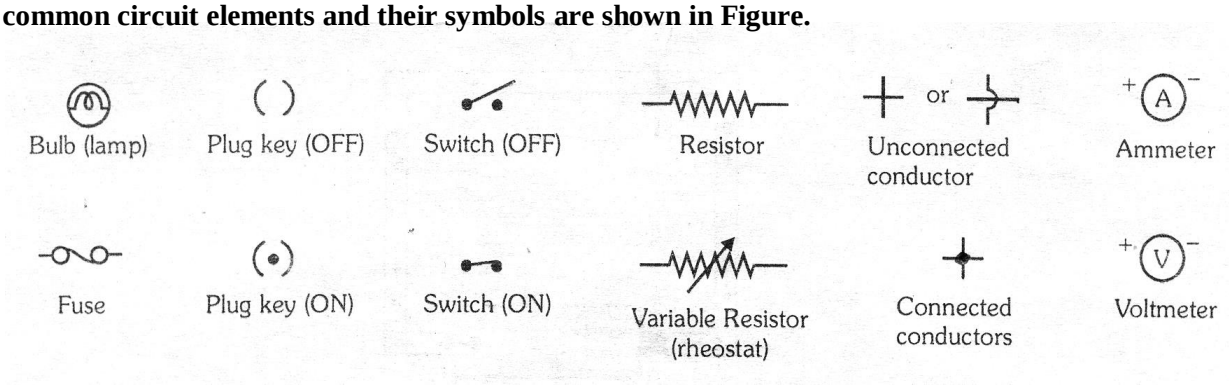


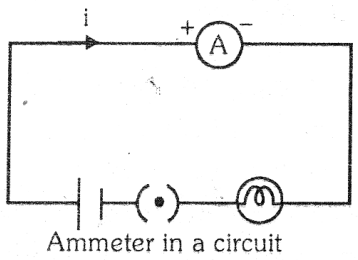
Fig. Some symbols used in circuit diagrams

COMMON MEASURING INSTRUMENTS:

The electric current in a circuit is measured by an instrument called the ammeter, and the potential difference between two points in it is measured by a voltmeter (in voltage stabilizers). In these meters, a needle moving over a graduated scale gives the value of the measured quantity. Each meter has two terminals. The terminal marked '+' is connected by a wire to the higher-potential side of a circuit, while the terminal marked '-' is connected to the lower-potential side.

USING AN AMMETER TO MEASURE CURRENT:

To measure the current through an element of a circuit, an ammeter is connected in such a way that the current flowing through it also flows through the element. Such a connection is called a series connection. In Figure, the current I flowing through the lamp also flows through the ammeter. The reading of the ammeter gives the current through the lamp. Note that if the ammeter is removed , there will be a gap, and the current through the circuit will stop .



Ammeter in a circuit

Two or more electric elements are said to be connected in series if the current flowing through one also flows through the rest.
An ammeter is always connected in series in a circuit.