CLASS X
PHYSICS
CHAPTER 8 - ELECTRICITY

NOTES

- Electricity is the most important, convenient and controllable form of energy.
- The continuous and closed path of an electric current is called an electric circuit.

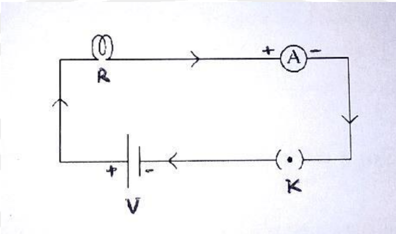


Fig. A schematic diagram of an electric circuit.

- The electric current is the rate of flow of electric charges through a conductor.

  If a charge Q flows through a conductor in time t, the electric current through the conductor is given by

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

- The SI unit of electric charge is the coulomb(C).
- The SI unit of electric current is the ampere (A).
- 1 ampere of current is constituted by the flow of one coulomb of charge per second. That is,

$$1A = \frac{1C}{1s}$$

Direction of electric current: Conventional direction is from positive terminal of a cell to negative terminal through the external circuit but electron flow is from negative terminal to positive terminal opposite to that of the conventional current.

- The electric current in a circuit is measured by an instrument called ammeter. It is always connected in series in a circuit.

- The electric potential difference between two points in an electric circuit carrying current is defined as the amount of work done to move a unit charge from one point to the other. Thus,

$$Potential\ difference\ (V) = \frac{Work\ done\ (W)}{Charge\ (Q)}$$

$$i.e. V = \frac{W}{Q} = \frac{W}{It}$$

- The SI unit of potential difference is volt (V).

- One volt is the potential difference between two points in a current carrying conductor when one joule of work is done to move a charge of one coulomb from one point to another point. Thus,

$$1\ volt = \frac{1\ joule}{1\ coulomb} = 1\ JC^{-1}$$

- The potential difference is measured by means of an instrument called voltmeter. It is always connected parallel to across the points where potential difference is to be measured.

Ohm's law: At a constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its ends.

If I is the current flowing through a conductor and V is the potential difference across its ends, then according to Ohm's law,

$$I \propto V$$

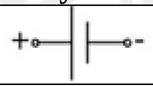
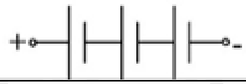
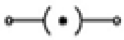
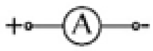
or, $V \propto I$

or, $\frac{V}{I} = R$; where R is a constant of proportionality.

or, $V = I\,R$

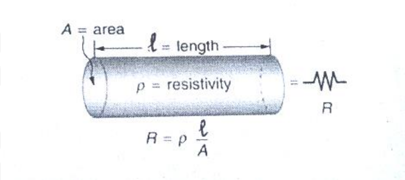
The constant R is called the electrical resistance of the conductor.

- The SI unit of resistance is the ohm (Ω).
- Resistance is the property of a material component due to which it opposes the flow of current through it.
- Rheostat is a device used to regulate the quantity of current in a circuit without changing the voltage of the source. It is used to change the resistance in the circuit.
- Symbols of some commonly used components in electrical circuit diagram.

Sl. No.	Components	Symbol
1	An electric cell	
2	A battery (a combination of cells)	
3	An open switch	
4	A closed switch	
5	An open plug	
6	A closed plug	
7	Electric blub	
8	A resistor of fixed resistance	
9	A variable resistor or rheostat	
10	Ammeter	
11	Voltmeter	

- Resistor is a device used in an electric circuit to offer high or appreciable resistance.
- Factors on which the resistance of a conductor depends:
  - Length of the conductor (ℓ)
  - Area of the cross section of the conductor (A)
  - Nature of the material of the conductor
  - Temperature of the conductor

Resistivity:



The resistance of a conductor is directly proportional to its length (l)

$$i.e., R \propto l \qquad (1)$$

The resistance of a conductor is inversely proportional to its cross section (A)

$$i.e., R \propto \frac{1}{A} \qquad (2)$$

Combining equations (1) and (2) provides

$$R \propto \frac{l}{A}$$

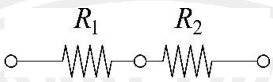
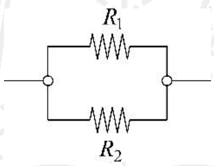
$$\text{or,} \quad R \propto \rho \frac{l}{A}$$

where ρ (rho) is a constant known as resistivity of the material of the conductor. Thus,

$$\rho = \frac{RA}{l}$$

- The SI unit of resistivity is ohm-metre($\Omega\ m$).
- For a conductor of length $l = 1$ m and cross section $A = 1\ m^2$, $\rho = R$. Thus, resistivity (ρ) is defined as the resistance of a conductor of length 1 m and cross section of 1 m^2.

Combination of resistors: It can be of two types - series combination and parallel combination.

Type of combination	Circuit diagram	Effective resistance
Series combination of resistances R_1 and R_2		$\boldsymbol{R_s = R_1 + R_2}$
Parallel combination of resistances R_1 and R_2		$\boldsymbol{\frac{1}{R_s} = \frac{1}{R_1} + \frac{1}{R_2}}$

- In series combination of resistors, the following conditions apply:
  - The same current flows through all the resistors.
  - The potential difference across each resistor is / may be different, but their sum is equal to the total applied voltage.
- In parallel combination of resistors, the following conditions apply:
  - The potential difference across each individual resistor is the same.
  - The current flowing through each resistor is / may be different, but their sum is equal to the total current flowing in the circuit.

- **Disadvantages of series combination in household circuit:**
  i. It is impracticable to connect different appliances in series, since each of them needs different current to operate properly.
  ii. The total resistance will increase with the increasing number of appliances and smaller current will flow through the series arrangement. Thus, none of the appliances will operate properly.
  iii. When one of the appliances get fused, the circuit is broken and none of the appliances will work
- **Advantages of parallel combination in household circuit:**
  i. When different appliances are connected in parallel, the total current is divided to the appliances and hence they operate properly as the same value of p.d. is maintained across each appliance.
  ii. The total resistance is decreased with the increasing number of appliances and more and more current will be drawn from the source.
  iii. When one of the appliances gets fused, the other appliances are not affected.
- **Heating effect of current:** When an electric current is passed through a conductor for a certain period of times, heat is produced in it.
- **Joule's heating effect:** The amount of heat H produced in time t is

$$H = V\,I\,t\ = I^2\,R\ \ t$$

- An electric fuse is used to protect an electric circuit. When the current in the circuit rises, the fuse wire gets heated to such an extent that it melts and breaks the circuit.
- The fuse wire is connected in series.
- Properties of the material of the fuse wire:
  - It should have a low melting point
  - It should have high resistivity

Electric power(P) : The rate of doing work is power. It is also the rate at which electrical energy is consumed to as useful work. Thus,

$$P = V\,I \;= I^2\,R$$

The SI unit of power is the watt (W).

$$1\,watt \;= 1\,volt \;\times\; 1\,ampere$$

- Commercial unit of electrical energy is the kilowatt hour (kWh) and is known as one unit of energy.

$$\mathbf{1\,kWh} = 1000\,watt \times (60 \times 60)\,second$$

$$= 3.6 \times 10^6\,watt\,second$$

$$= \;\; \mathbf{3.6 \times 10^6\,joule\,(J)}$$