# Class Ten
# Worksheet
# Chapter- 11
# Current Electricity

## $1^{st}$ Week (lecture -1)

1) What is electric current?
2) What is the unit of current?
3) What are directions of the conventional current flow and electron flow?
4) What are conductor, insulator and semiconductor material?
5) State the Ohm's law.
6) Show that, V=IR.
7) Plot a graph of I versus V in a graph paper.
8) Define ampere?

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## $2^{nd}$ Week (lecture -2 )

9) What is resistance?
10) What is the unit if resistance?
11) How many types of resistoed?
12) What are fixed and variable resistors?
13) 7. Define specific resistance.
14) What is the unit of specific resistance?
15) Why does the resistance of conductor increase with increasing of temperature?
16) What do you understand by electromotive force and potential difference?
17) The resistance of a conductor depends on four factors (describe the four factors )
18) The specific resistance of the nichrome wire used in anelectrical heater is $100 \times 10^{-8}$ Ω m.What will be the resistance of 15 m long wire havingcross sectional area $2.0 \times 10^{-7} m^2$?

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## Note

chapter- 11

CURRENT ELECTRICITY

**Electric current:**

When two bodies of different potential are connected by a conducting wire, electrons flow from the body of low potential to that of higher potential. This flow of electron continues until the potential difference between the two bodies becomes zero. If by any process the potential difference between the two objects is maintained, then this flow of electron goes on continuously. This continuous flow of electrons is electric current.

*The amount of charge that flows in unit time through any cross section of a conductor is called electric current.* If through any cross section of a conductor, the quantity of chargeQ flows in time t, then the electric current will be I = Q/t.

**Direction of electric current and direction of electron flow:**

When current electricity was invented first, it was assumed that the electricity was produced due to the flow of positive charges. This positive charge flows from higher potential to lower potential. So, the direction of conventional current is taken to be from higher potential to lower potential or from positive plate to negative plate of an electric cell. But we know that actually electric current is the flow of negative charges or of electrons, so the actual direction of electric current is from lower potential to higher potential. That is from negative plate to positive plate of an electric cell. Therefore, the actual direction of electric current is opposite to that of conventional current. The arrow demonstrated in the diagram is indicating the direction of conventional current.

# Electromotive Force:

Electromotive force is defined as *the electric potential produced by either electrochemical cell or by changing the magnetic field.* EMF is the commonly used acronym for electromotive force.

Generator or a battery is used for the conversion of energy from one form to another. In these devices, one terminal becomes positively charged while the other becomes negatively charged. Therefore, an electromotive force is the work done on a unit electric charge

$$E = \frac{W}{Q}$$

The unit of Electromotive force is $JC^{-1}$

**Potential Difference**:

**Potential difference** is the amount of work energy required to move an electric charge from one point to another.

The unit of potential difference is volt

## Difference between Electromotive Force and Potential Difference

| **Electromotive Force** | **Potential Difference** |
|---|---|
| EMF is defined as the work done on a unit charge | Potential difference is defined as the energy which is dissipated as the unit charge pass through the components |
| EMF remains constant | Potential difference is not constant |
| EMF is independent of circuit resistance | The potential difference depends on the resistance between the two points during the measurement |
| Due to EMF, electric, magnetic, and the gravitational field is caused | Due to potential difference, only electric field is induced |
| It is represented by E | It is represented by V |

**Conductor:** The materials through which electric current can flow very easily are called conductors. Electrons can flow freely within these materials. In metal wires the charges are carried by electrons. So, the metallic materials are good conductors of electricity. Copper, silver, aluminium etc. are good conductors. Due to this reason, metallic wires are used as electric connectors.

**Insulator:** The materials through which electric current cannot flow are called insulators. Therefore, the materials where electrons are not free to move about are the insulators. For example: Plastic, rubber, wood, glass etc. There are no free electrons inside insulating materials.

**Semiconductor:** The materials whose current conduction capacity lies between that of conductors and insulators in normal temperature are called semiconductors. For example- germanium, silicon etc. The current conduction capacity of semiconductor can be increased by adding suitable impurities.

**Ohm's law :**

The current passing through a conductor at constant temperature is directly proportional to the potential difference between the two ends of the conductor.

Now at constant temperature, if the current passing through the conductor is I and potential difference v

Then according to ohm's law,

$I \propto V$

Or , $v = RI$ [Here R is resistance constant]

**Resistance**:

We know electric current is the flow of electrons. When the electrons move within the bulk of a conductor, they collide with the atoms and molecules of the conductor. Due to this their motion is resisted and electric current is obstructed. This property of a conductor is called resistance.

**Resistors:**

A resistor is a conductor used in a circuit that has a known value of resistance. The main objective of using resistors is to control the quantity of the current flowing in a circuit. There are two types of resistors that are used in a circuit. These are:

1. Fixed resistors
2. Variable resistors

**Fixed resistors:**

The fixed resistors are those who have fixed values of resistance. The fixed resistors that are generally used in laboratory .

**Variable resistors:**

The variable resistors are those whose value of the resistance can be changed according to the necessity. These are called rheostat too.

**The resistance of a conductor depends on four factors:**

1. Length of the conductor.
2. Cross sectional area of the conductor.
3. Materials of the conductor and.
4. Temperature of the conductor.

**Law of length:** The resistance of a conductor is directly proportional to its length when the cross sectional area, material and temperature of the conductor remain the same. If the length of the conductor is L, area of cross section is A, and its resistance is R, then according to this law, $R \propto L$ , when temperature, material and A is constant.

**Law of cross section:**

The resistance of a conductor is inversely proportional to its cross sectional area when the length, material and temperature of the conductor remain the same.

That is, $R \propto 1/A$ , when temperature, material and L is constant .

**Resistivity and Conductivity:**

At constant temperature, the resistance of a conductor of particular material varies proportionately with the length and inversely with the area of cross section. Therefore, we get from the laws of resistance, $R \propto L/A$ (when temperature and material remain the same.)

or, $R = \rho.L/A$

Here ρ is a constant, the value of which depends on the material of the conductor and its temperature. This constant is called the resistivity or specific resistance of the material at that temperature.

In equation, if L=1 unit, A=1 unit, then, $\rho = R$ .

Therefore, *at a particular temperature, the resistance of a conductor of unit length and unit cross sectional area is called the* ***specific resistance*** *of that material at that temperature.*

At a certain temperature, the resistance of a conductor depends on its physical conditions (e.g. length,cross section etc.). But the resistivity of a conductor depends only on its material.

**Significance:**

The resistivity of silver at 20 °C is 1.6×10-8 Ω m. Therefore, the resistance of a silver wire of length 1m and cross sectional area of 1m2 is 1.6×10-8 Ω. Table shows the values of the resistivity of some common materials.

Material Resistivity (Ω m)

Silver = 1.6×10-8(Ω m)

Copper = 1.7×10-8(Ω m)

Tungsten = 5.5×10-8(Ω m)

Nichrome = 100×10-8(Ω m)

From the table above we see that the materials with lower resistivities are good conductors of electricity. For example- copper is much better conductor of electricity than nichrome. Due to this, copper is widely used as connecting wires in electrical circuits.

Besides, materials with higher resistivities also have multiple uses. One example is the nichrome wire. The resistivity and melting point of nichrome is much higher than that of copper. Due to the high resistivity of nichrome, a lot of thermal energy is produced when a current flows through it. This property of nichrome causes water to boil very quickly in electric kettle. The filament of electric bulbs that are used in our houses is made of tungsten. Tungsten can convert electrical energy to light and thermal energy owing to its high resistivity and melting point.

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