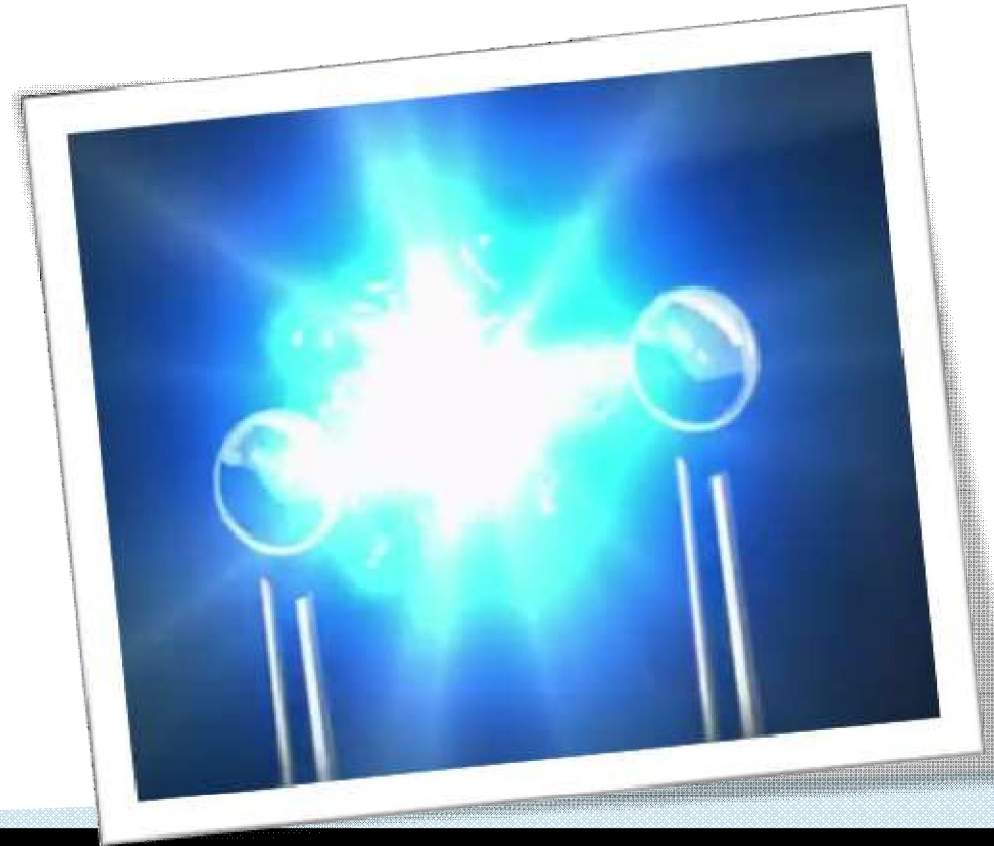


# PHYSICS

Class - X

***ELECTRICITY***

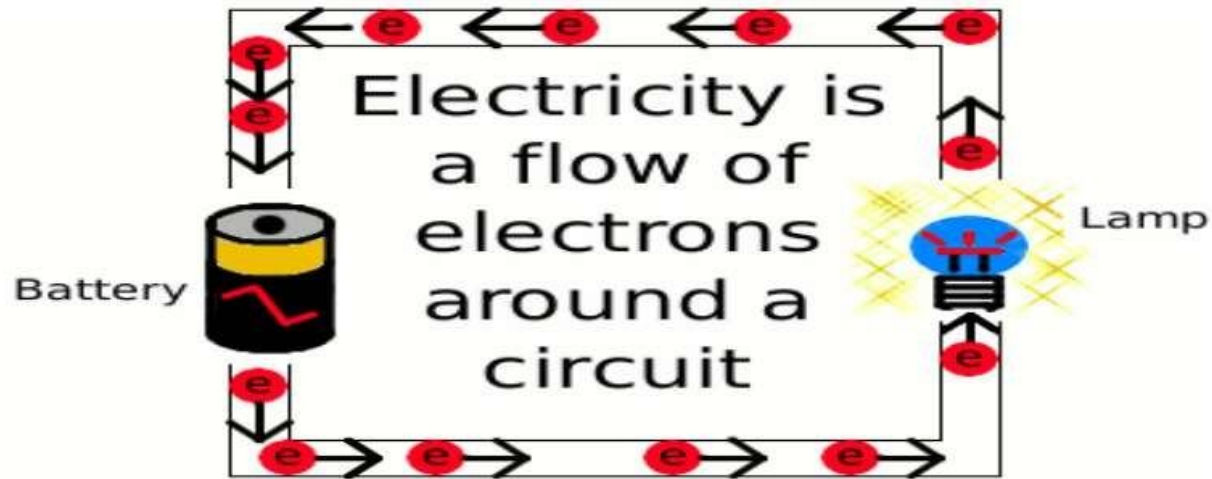


**पुर्णमा International School**

Shree Swaminarayan Gurukul, Zundal

# What is Electricity?

- ▶ Electricity is the flow of electrons around a closed circuit
- ▶ It was discovered by [William Gilbert](#)
- ▶ It consists of electrons in motion



Electron flow

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# Conductors

- ▶ Conductors are those materials that allow flow of electricity through them
- ▶ They can conduct electricity because of the presence of free electrons between the atoms of the substance
- ▶ All the metals are good conductors of electricity and graphite (the only non metal) can also conduct electricity

# Insulators

- ▶ Insulators are those materials that do not allow flow of electricity through them
- ▶ They cannot conduct electricity because they don't have free electrons between their atoms
- ▶ All the non metals (except graphite) are insulators

# Electric Charges

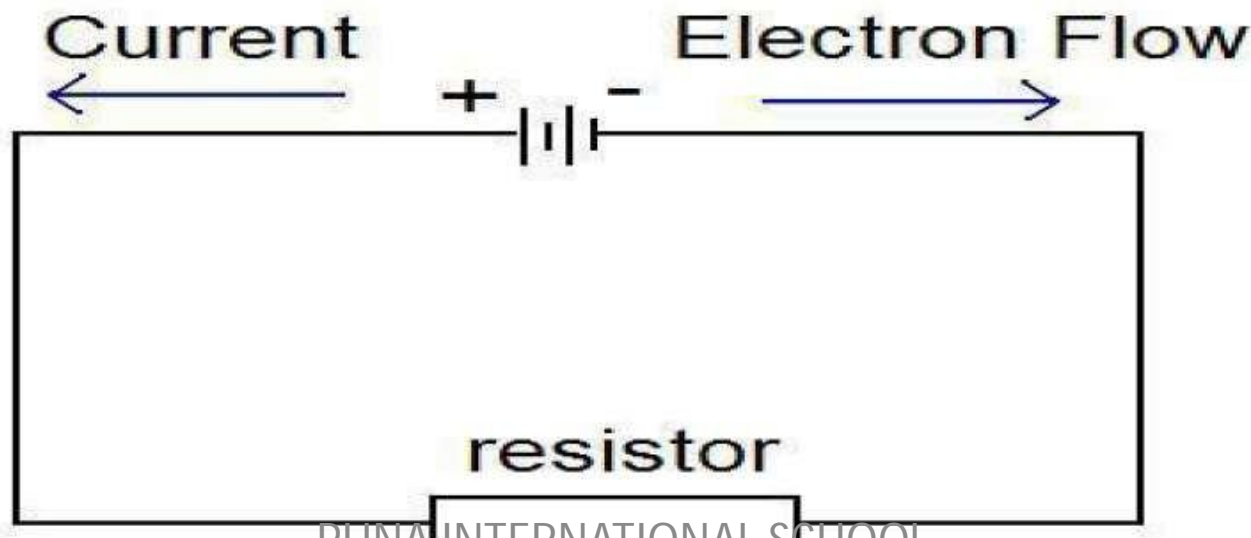
- ▶ When a glass rod is rubbed with a silk cloth, it acquires the ability to attract small particles of paper and is said to have acquired an 'Electric Charge'
- ▶ S.I. unit of electric charge is 'Coulomb'
- ▶ Symbol for coulomb is 'C'

# Electric Current

- ▶ Electric current is the flow of electrons through a conducting material (like copper, iron, etc.)
- ▶ The device that causes the flow of electrons is called a cell (or a battery if 2 or more cells are connected in a row)

# Flow of Electrons and Current in a Circuit

- ▶ Electrons flow from the **negative terminal** to the **positive terminal**
- ▶ By convention, electric current flows from **positive terminal** to the **negative terminal**



# How can Electric Current be Expressed?

- ▶ Electric current is expressed as the rate of flow of charge through a conductor per unit time, i.e.

$$\text{Electric Current (I)} = \frac{\text{Quantity of Charge (Q)}}{\text{Time (t)}}$$

- ▶ S.I. unit of electric current is **Ampere (A)** and

$$1 \text{ Ampere (A)} = \frac{1 \text{ Coulomb (C)}}{1 \text{ Second (s)}}$$

- ▶ Electric current is measured by **Ammeter**



# Electric Potential and Potential Difference

- ▶ Electric potential is the capability of a charge to move unit positive charge from one point to another
- ▶ Electric potential difference is the work done to bring unit positive charge from one point to another, i.e.

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

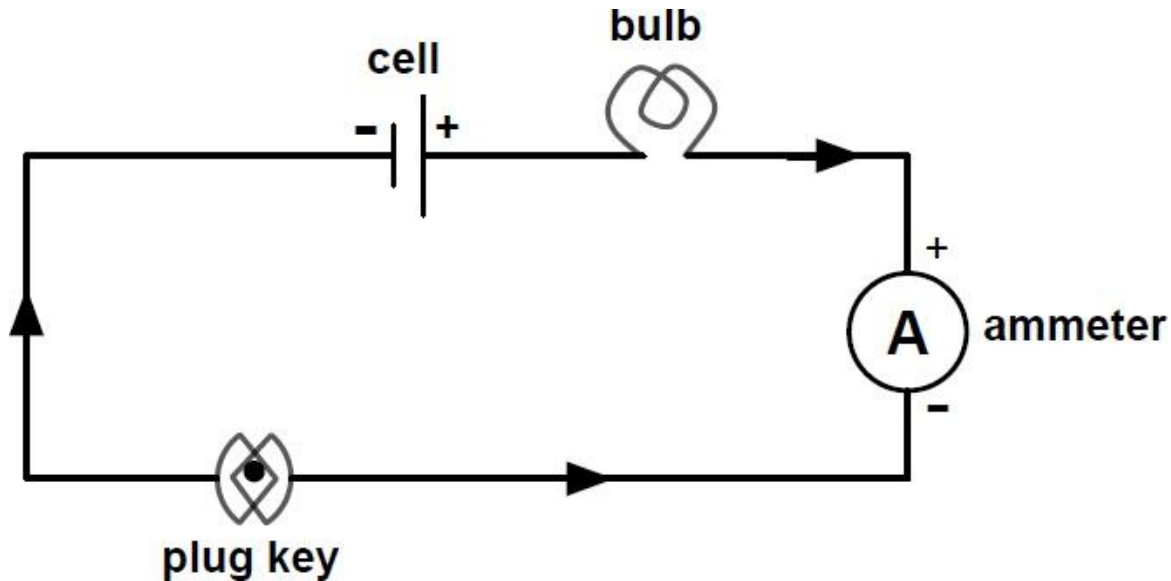
- ▶ S.I unit of potential difference is **Voltage (V)** and is measured by **Voltmeter**

# Why is Potential Difference important?

- ▶ Electric current will flow through a conductor only if there is a difference in the electric potential between the two ends of the conductor
- ▶ The potential difference in a circuit is provided by a cell or battery
- ▶ The chemical reaction in the cell produces a potential difference between the two terminals and sets the electrons in motion and produces electric current

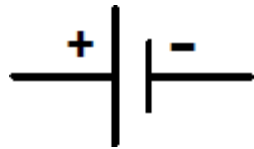
# Electric Circuit

- ▶ Electric circuit is a continuous and closed path of an electric current



A schematic diagram of an electric circuit comprising of a cell, electric bulb, ammeter and plug key

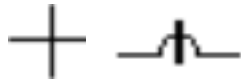
# Symbols of components used in Electric Circuits



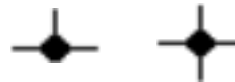
Cell



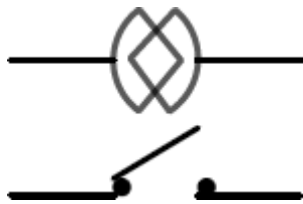
Battery or a combination of Cells



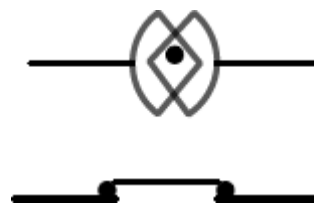
Crossing not connected



Crossing connected



Plug Key or Switch (Open)



Plug Key or Switch (Closed)

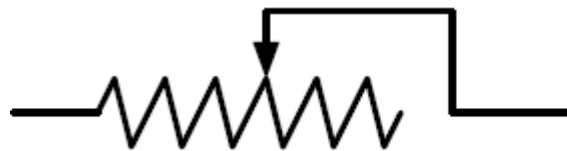


Electric Bulb

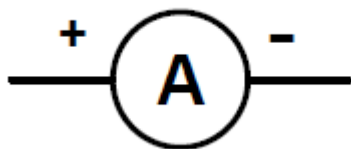


Resistor

Variable Resistance or Rheostat



or



Ammeter



Voltmeter

# Voltmeter

- ▶ Voltmeter is a device that measures the potential difference across the ends of any conducting material
- ▶ It is connected in parallel to the ends of the conducting material
- ▶ It has high resistance

# Ammeter

- ▶ Ammeter is a device that measures the current flowing through any conducting material
- ▶ It is connected in series to the conducting material
- ▶ It has low resistance

# Ohm's Law

- ▶ Ohm's law states that,

The current flowing through a conductor is directly proportional to the potential difference between its ends provided all the physical conditions remain the same, i.e.

$$I \propto V \text{ or } \frac{V}{I} = \mathbf{Constant} \text{ or } \frac{V}{I} = \mathbf{R}$$

- ▶ Here, the constant (R) stands for resistance for a given conductor wire at a given temperature

# Resistance

- ▶ Resistance is the property of a conductor to resist the flow of electrons through it.

- ▶ According to Ohm's law,

$$R = \frac{V}{I}$$

- ▶ The S.I. unit of resistance is Ohm ( $\Omega$ )
- ▶ If the potential difference around the two ends of the wire is 1 V and the current flowing through the wire is 1 A, then the resistance of the wire is said to be 1  $\Omega$



# Factors on which Resistance depends

- ▶ The resistance of a conductor is:
  1. directly proportional to the length of the wire
  2. inversely proportional to the area of the cross section of the wire
  3. dependent on the material of the conductor
  4. directly proportional to the temperature of the material, i.e.

$$\mathbf{R \propto l}$$

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

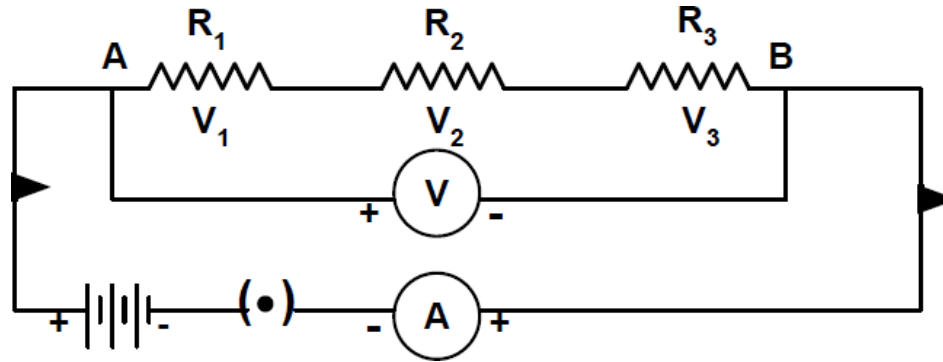
Or  $\mathbf{R = \rho \frac{l}{A}}$

- ▶ Here,  $\rho$  (rho) is the constant of proportionality called **Resistivity** of the material of the conductor.
- ▶ Its S.I. unit is **Ohm Metre ( $\Omega\text{m}$ )**

# Resistivity of substances

- ▶ Conductors like metals and alloys have low resistivity of  $10^{-8} \Omega\text{m}$  to  $10^{-6} \Omega\text{m}$
- ▶ Insulators like rubber, glass etc. have high resistivity  $10^{12} \Omega\text{m}$  to  $10^{17} \Omega\text{m}$ .
- ▶ Substances with low resistivity are better conductors of electricity than those with high resistivity

# Resistors in Series



- ▶ When three resistors  $R_1$ ,  $R_2$  and  $R_3$  are connected in series across AB

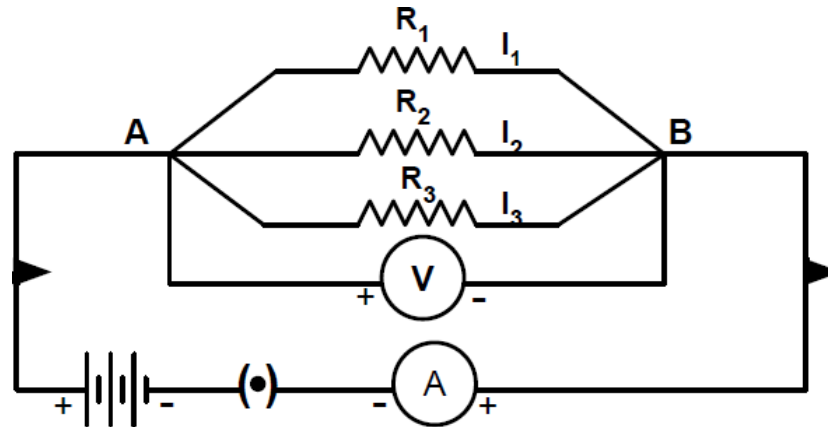
- The current in all the resistors is same
- The total voltage across the resistors is equal to the sum of the voltage across each resistor

$$V = V_1 + V_2 + V_3$$

- The equivalent resistance is the sum of the resistances of each resistor. This increases the total resistance

$$R_s = R_1 + R_2 + R_3$$

# Resistors in Parallel



- ▶ When three resistors  $R_1$ ,  $R_2$  and  $R_3$  are connected in parallel across AB
  - i. The voltage in all the resistors is same
  - ii. The total current in all the resistors is the sum of the current in each resistor

$$I = I_1 + I_2 + I_3$$

- iii. The reciprocal of the equivalent resistance is the sum of the reciprocals of resistances of each resistor. This decreases the total resistance

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

# Electrical Energy

- ▶ Electrical energy is the work done to maintain the flow of current in a conductor

$$W = Q \times V \text{ where, } Q = I \times t$$

$$\therefore W = VIt \text{ where, } V = IR$$

$$\therefore W = I^2Rt$$

- ▶ S.I. unit of electrical energy is Joule (J)

# Electric Power

- ▶ Electric power is the rate at which electric current is used

$$\text{Power (P)} = \frac{\text{Work Done (W)}}{\text{Time (t)}} \text{ where, } W = I R t$$

$$\therefore \text{Power} = \frac{I R t}{t} = I^2 R t$$

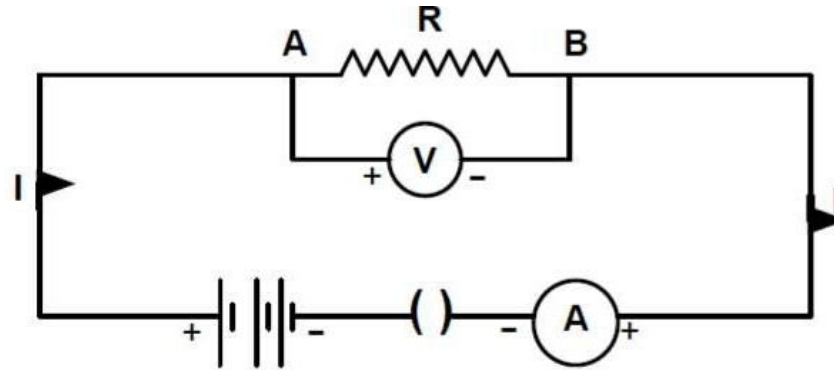
$$\text{Or, Power} = VI$$

- ▶ S.I. unit of power is **Watt (W)**
- ▶ An object has **1 Watt** of power when **1 Ampere** of current flows across a conductor with a potential difference of **1 Volt**

# Commercial Unit of Energy

- ▶ Commercial unit of energy is kWh (Kilowatt Hour)
- ▶ One kWh is the power consumed when 1W of power is used for 1 hour
- ▶ Relationship between Kilowatt hour and Joule:
  - $1 \text{ kWh} = 1 \text{ kW} \times 1 \text{ h}$
  - $1 \text{ kWh} = 1000 \text{ W} \times 3600 \text{ s}$
  - $1 \text{ kWh} = 3600000 \text{ J}$
  - $1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$

# Heating Effect of Electric Current



- ▶ If a current ' $I$ ' flows through a resistor of resistance ' $R$ ' and ' $t$ ' be the time for which a charge ' $Q$ ' flows through it, then the work done to move the charge through potential difference ' $V$ '

$$W = QV$$

$$P = \frac{W}{t} = \frac{QV}{t} \quad \text{and} \quad \frac{Q}{t} = I \quad \text{or} \quad P = IV$$

$$\text{or Heat Energy (H)} = Pt = VIt$$

According to Ohm's law,

$$V = IR$$

$$\therefore H = I^2Rt$$



JUST A NOTE TO SAY

THANK YOU!



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