RADIANT 2026

Physics

Current Electricity

One Shot

By - Akash Shravan Sir

Topics *to be covered*

1. One Shot
2. ....
3. ....


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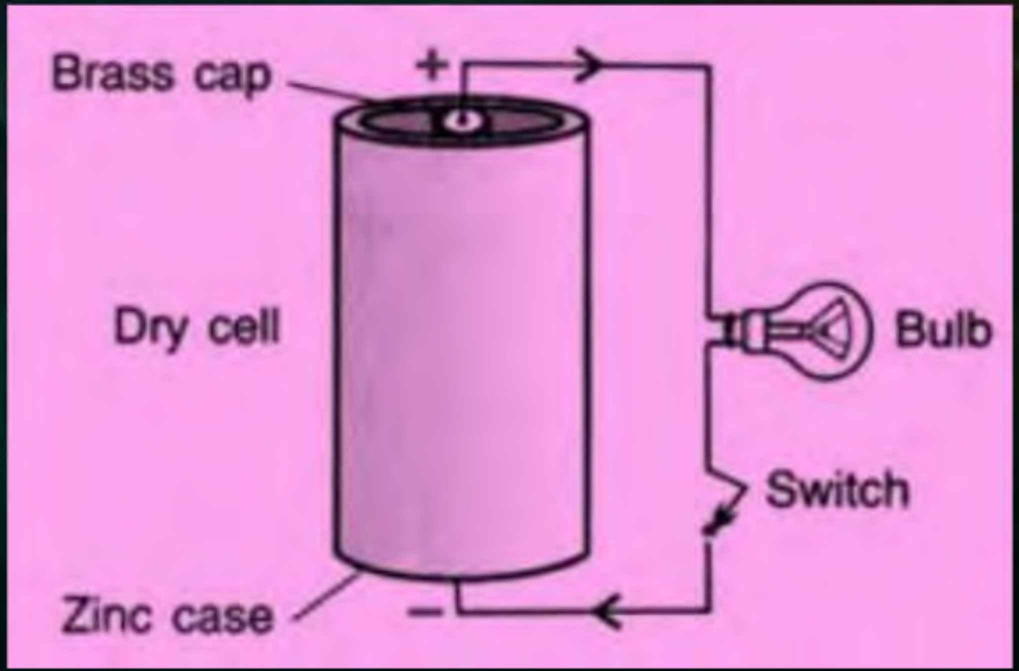
Sources of Direct Current

+/−
AC/DC → (+)

In a cell, chemical energy changes into the electrical energy when it sends current in a circuit. A cell basically consists of two conducting rods, called the electrodes, at some separation placed immersed in a solution (or jelly), called the electrolyte, kept in a vessel.

Direct current (*d.c.*) is a current of constant magnitude flowing in one direction.



Kinds of cells

Chemical
↓
Electricity

The cells are of two kinds:

(1) The primary cells, and

(2) The secondary cells or accumulators.

1. Primary cells:

These cells provide current as a result of irreversible chemical reaction. The cells are discarded after use when entire chemical energy in them has converted into the electrical energy. Thus these are 'use and throw' type of cells and cannot be recharged. Depending upon the material of electrodes and electrolyte, we have different types of primary cells e.g. simple voltaic cell, Leclanche cell, Daniel cell, dry cell, etc.

Kinds of cells

Chemical ⇄ Electrical

2. **Secondary cells or accumulators:**

Secondary cells also provide current as a result of chemical reaction. In these cells, chemical reaction is reversible and so they can be recharged after use. After taking the electrolyte and electrodes in a vessel, the cell is first charged by connecting it to a direct current source.

Difference between the primary cell and secondary cell

	Primary cell		Secondary cell
1.	Chemical reaction is irreversible.	1.	Chemical reaction is reversible.
2.	Chemical energy is converted into electrical energy when current is drawn from it.	2.	Electrical energy converts into chemical energy when current is passed in it (i.e., during charging), chemical while energy converts into electrical energy when current is drawn from it (i.e., during discharging).
3.	It can not be recharged.	3.	It can be recharged.
4.	Its internal resistance is high.	4.	Its internal resistance is low.
5.	It is capable of giving weak current only.	5.	It can provide low as well as high current.
6.	It is light and cheap. Examples: Simple voltaic cell, Leclanche cell, Daniel cell, dry cell. Its internal resistance is low.	6.	It is heavy and costly. Examples: Lead (or acid) accumulator, Ni-Fe (or alkali) accumulator, Li-H battery.

Electric Current (As Rate of Flow of Electric Charge)

Current is the rate of flow of charge across a cross-section normal to the direction of flow of current.

If charge Q flows through the cross-section of a conductor in time t, then

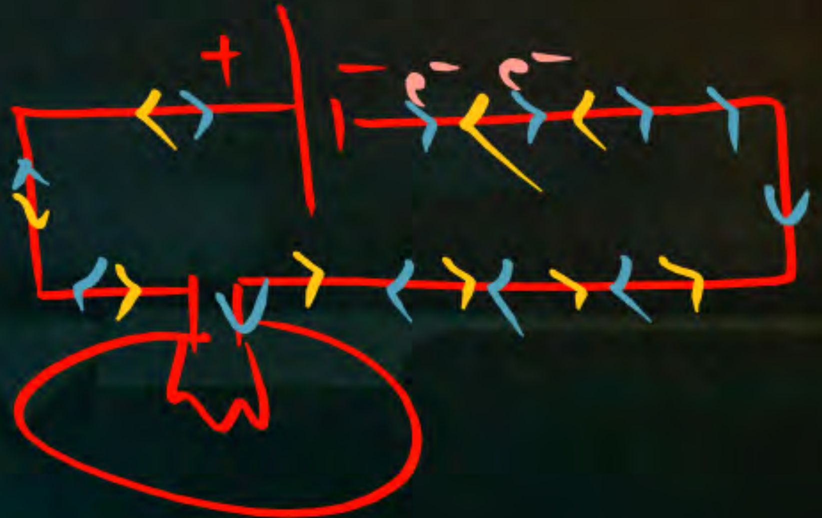
$$\boxed{\text{Current (I)} = \frac{\text{Charge(Q)}}{\text{time(t)}}}$$

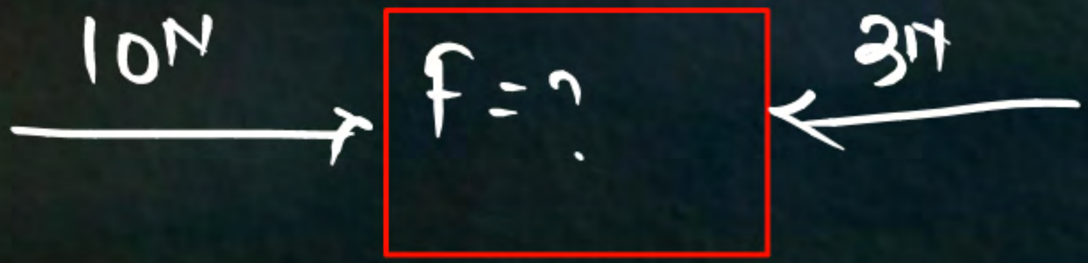
$$I = \frac{Q}{t}$$

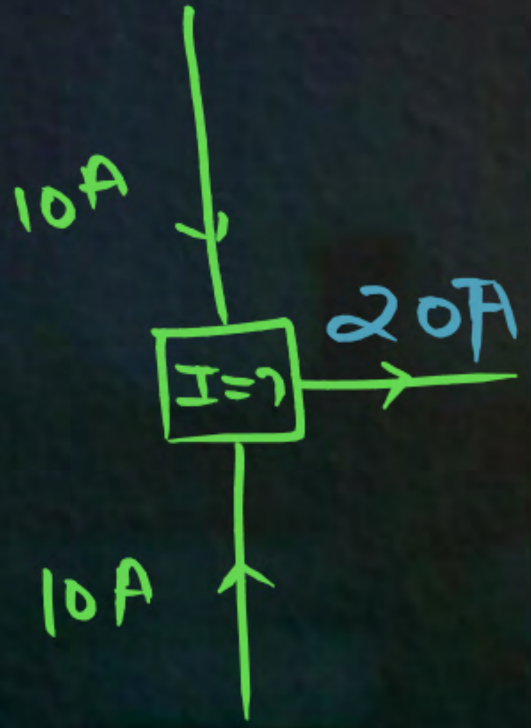
The current is a **scalar** quantity.

$I \rightarrow +ve$ to $-ve$

$e^- \rightarrow -ve$ to $+ve$




10N
F = ?
3N


10A
I = ?
20A
10A

Electric Current (As Rate of Flow of Electric Charge)

In metals (or conductors), current flows due to the movement of electrons, while in electrolytes, current flows due to the movement of both, the positive and negative ions. An electron carries a negative charge equal to $-e$, where $e = 1.6 \times 10^{-19}$ coulomb is the electronic charge.

Electric Current (As Rate of Flow of Electric Charge)

If n electrons pass through the cross section of a conductor in time t, then

$Q = ne$

$n \rightarrow$ no. of e^-

Total charge passed $Q = n \times e$

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

$\boxed{e^- \rightarrow -1.6 \times 10^{-19} C}$

$\boxed{p^+ \rightarrow +1.6 \times 10^{-19} C}$

and current in conductor $I = \frac{Q}{t} = \frac{ne}{t}$

Unit of Current

SI → ampere or A

$1A = ?$

$Q = 1C \quad t = 1sec$

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

From relation Unit of current = $I = \frac{Q}{t}$

Unit of charge $\frac{\text{unit of charge}}{\text{Unit of time}}$.

The S.I. unit of charge is coulomb and S.I. unit of time is second, so the S.I. unit of current is coulomb per second which is called ***ampere***. It is denoted by the symbol A. Thus.

$$\boxed{1 \text{ ampere (A)} = \frac{1 \text{ coulomb (C)}}{1 \text{ second (s)}}}$$

Unit of Current

Thus current is 1 A, if the rate of flow of charge is 1 coulomb per second. Since 1 coulomb of charge is carried by $\frac{1}{1.6 \times 10^{-19}} = 6.25 \times 10^{18}$ electrons, therefore if 1 ampere current flows through a conductor, it means that 6.25×10^{18} electrons pass in 1 second across that cross section of conductor.

$I = 1\,\text{Amp}$ $\quad Q = 1\,C$ $\quad t = 1\,\text{sec}$

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

$$1 = \frac{n \times 1.6 \times 10^{-19}}{1}$$

$$n = \frac{10}{16 \times 10^{-19}}$$

$$= \frac{\cancel{10}}{\cancel{16}} \times 10^{+19}$$

$$\boxed{n = .625 \times 10^{19}}$$

$$\boxed{n = 6.25 \times 10^{18}}$$

$$\simeq 6 \times 10^{18}$$

Unit of Current

Note:

Weak current is measured in units milli-ampere (mA) and micro-ampere (μA) where

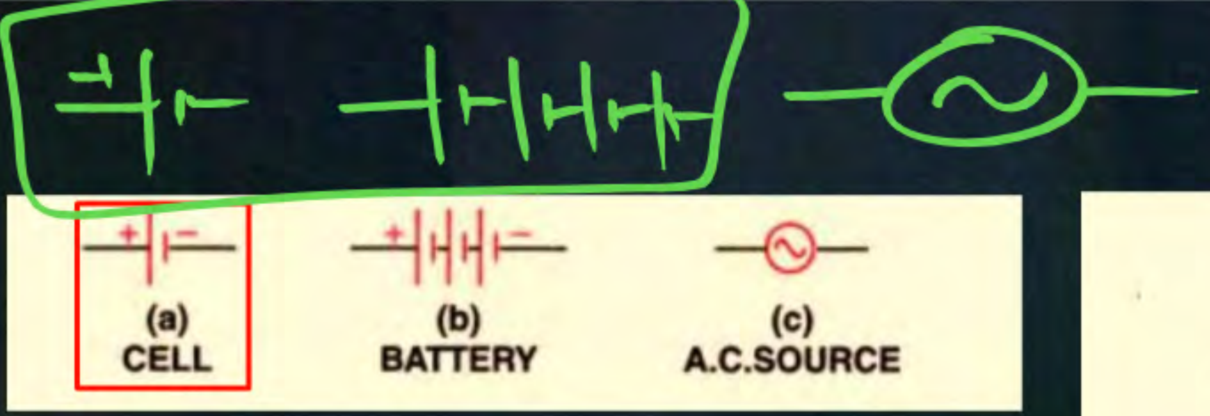
1 milli-ampere (mA) = 10^{-3} ampere (A), and

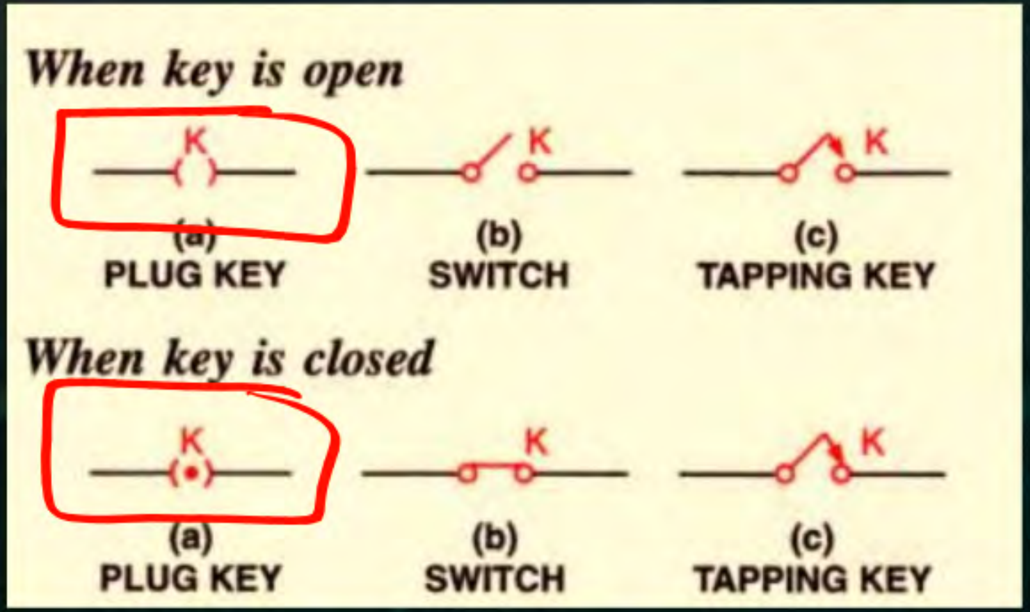
1 micro-ampere (μA) = 10^{-6} ampere (A).

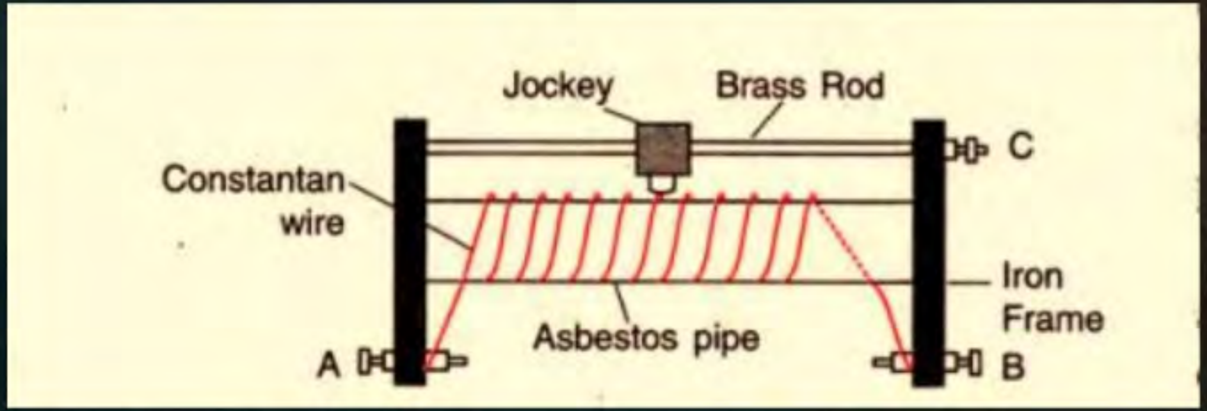
Symbols Used In Circuit Diagrams

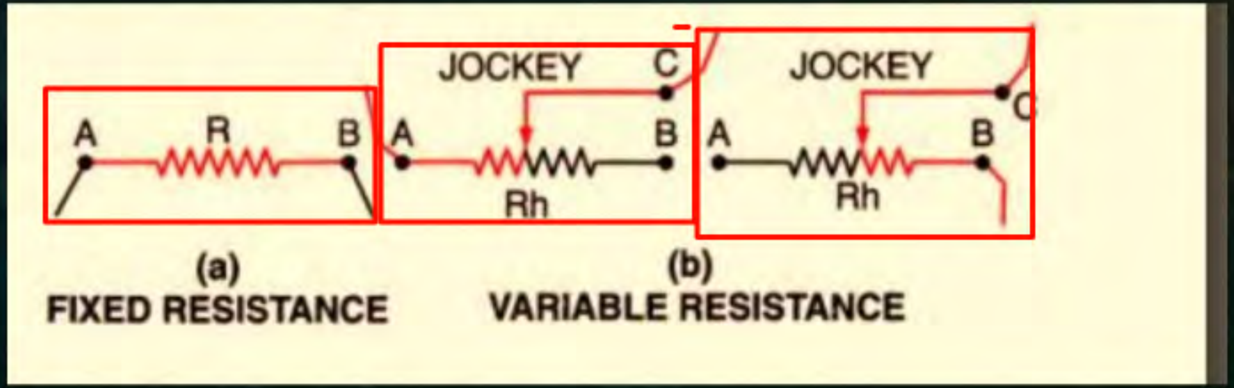
Symbols Used In Circuit Diagrams

DC

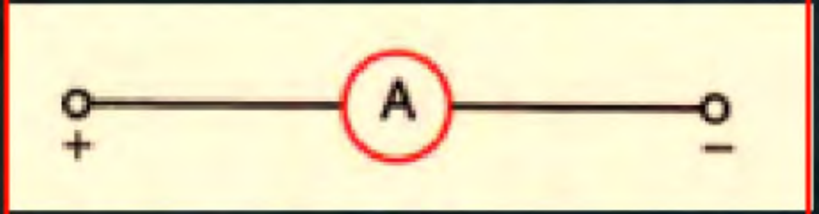


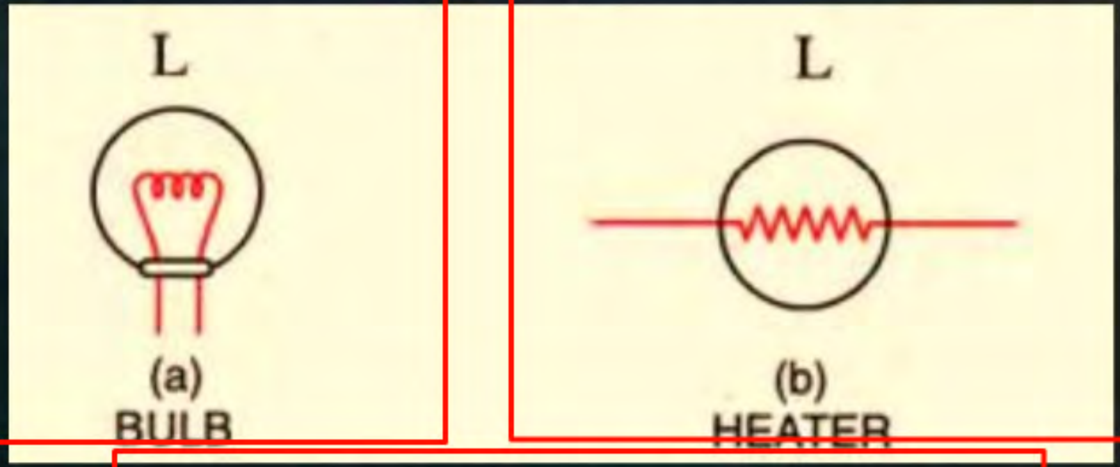






Symbols Used In Circuit Diagrams





Question

A cell is used to:

(A) measure current in a circuit

(B) provide current in a circuit

(C) limit current in a circuit

(D) prevent current in a circuit.

Question

The unit of current is:

(A) $\boxed{\text{ampere}}$

(B) volt

(C) ohm

(D) coulomb → [charge]

Question

The unit of current is:

(A) ampere

(B) volt

(C) ohm

(D) coulomb

Answer (A) ampere

Question

A charge 0.5 C passes through a cross section of a conductor in 5 *s*. Find the current.

$Q = 0.5\,C$

$t = 5\,sec$

$I = \frac{Q}{t} = \frac{0.5}{5 \times 10}$

$I = \frac{1}{10}\,A$

Question

A current of 1.5 A flows through a conductor for 2.0 *s*. What amount of charge passes through the conductor?

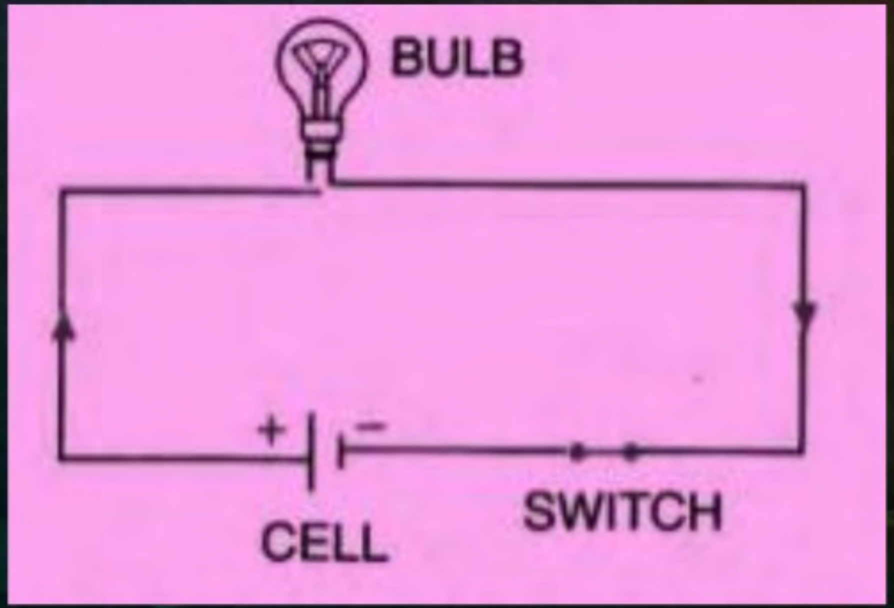
$I = 1.5\,A \quad t = 2\,sec$

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

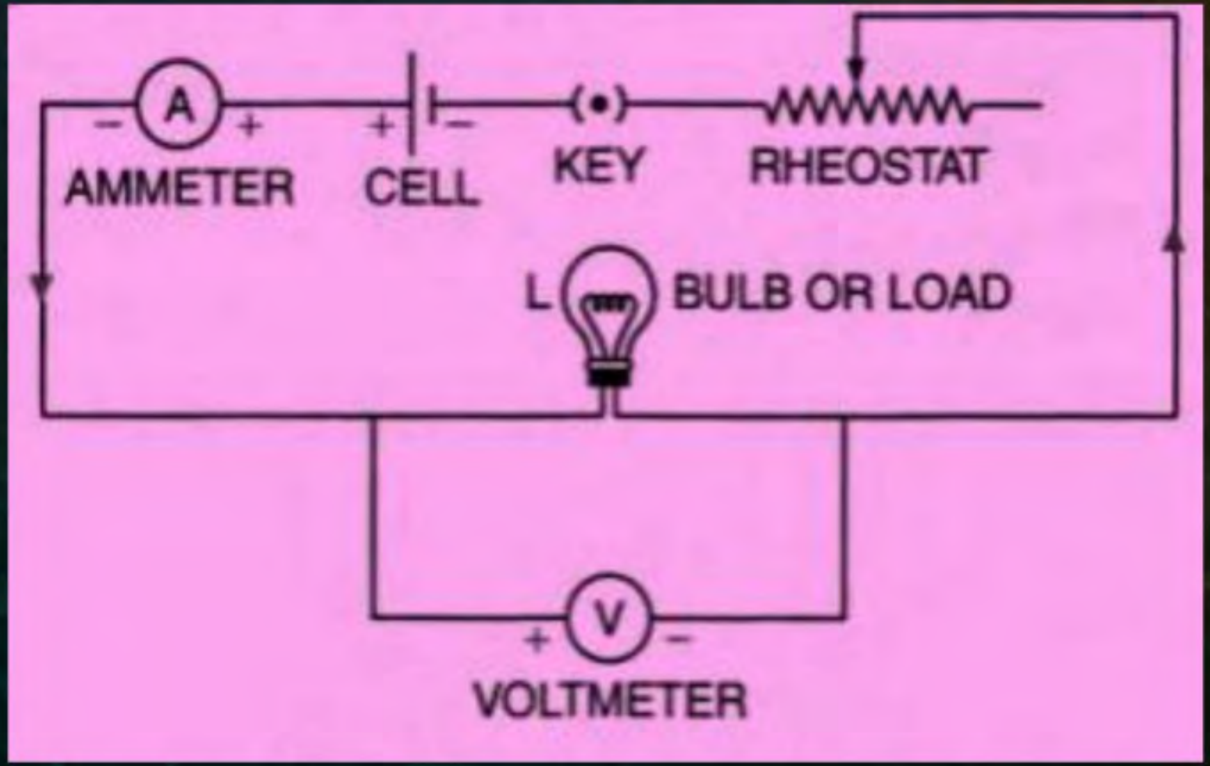
$1.5 = \frac{Q}{2}$

$Q = 3C$

Simple Electric Circuit



Simple Electric Circuit



Insulators and Conductors

Insulators:

The substances which do not allow the current to flow through them, are called the insulators. They almost have no free electrons and they offer a very high resistance in the path of current. Some examples of insulators are cotton, rubber, plastic, wood, paper, glass, leather, pure water asbestors, chinaclay, *etc*.

Insulators and Conductors

Conductors:

The substances which allow the current to flow through them easily, are called the conductors. All metals such as copper, aluminium, silver, iron, brass and steel are conductors. They have a large number of free electrons and they offer a very small resistance in the path of current. The human body also allows current to flow through it, so it is also a conductor. The impure water (or acidulated water) and mercury are also the conductors of electricity.

Closed and Open Circuits

The path along which current flows, is called a circuit. Current flows only if the circuit is complete (or *closed*). If the circuit is open (or *incomplete*), current does not flow.

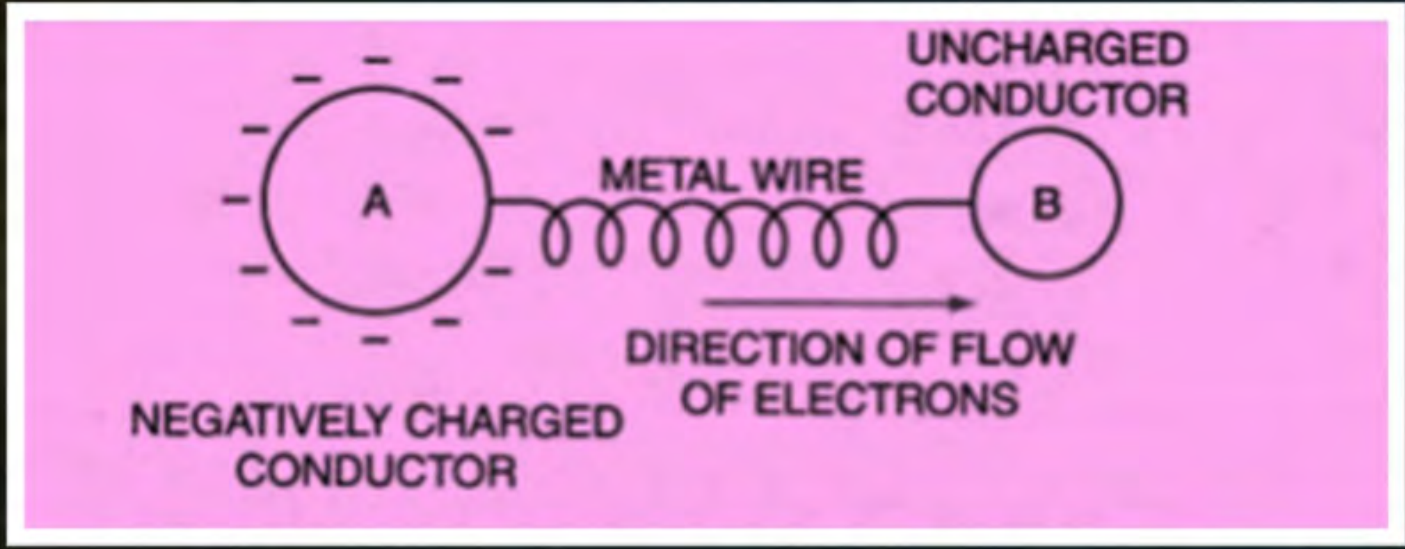
For an electric circuit to be complete, each component of it must pass current through it i.e. it should be conducting. If there is an insulator in the path (or if the circuit is broken), the circuit is incomplete (or open) and the current will not flow through it.

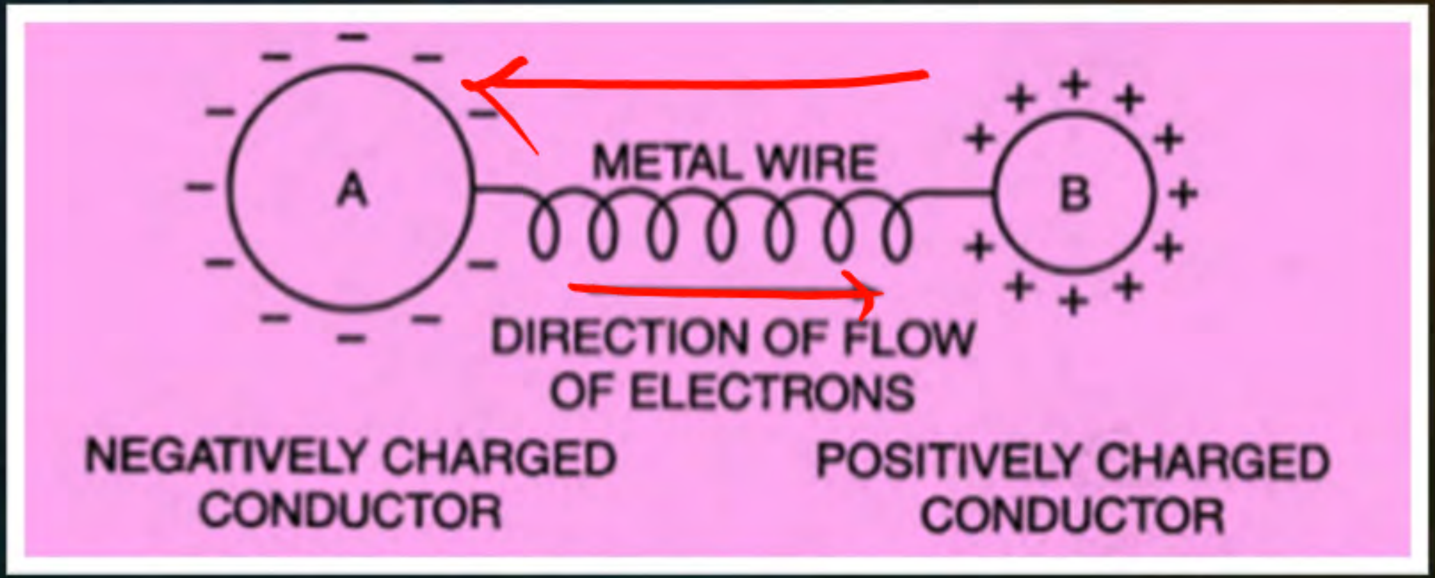
Flow of Electrons Between the Conductors

When two charged conductors are joined by a metallic wire (or they are placed in contact), free electrons flow from a conductor having higher concentration of electrons to the conductor having lower concentration of electrons.

The movement of electrons stops when concentration of electrons in both becomes equal. This can be understood by the following examples.

Flow of Electrons Between the Conductors





Direction of the Electric Current Conventional And Electronic Flow

1Volt $= \frac{1J}{1C}$

$$V = \frac{W'}{q}$$

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

Potential is $\boxed{\text{a } \textbf{scalar}}$ quantity. Its S.I. unit is $\boxed{\text{joule/coulomb}}$ or $\boxed{\text{volt (symbol V).}}$ Similarly the potential difference between two conductors is measured in terms of the work done in transferring the charge from one conductor to the other, through a metallic wire.

The potential difference between two conductors is equal to the work done in transferring a unit positive charge from one conductor to the other conductor.

Direction of the Electric Current Conventional And Electronic Flow

If work W is done in transferring a test charge q from one conductor to the other, the potential difference between them is

$$V_1 - V_2 = \frac{W}{q}$$

Potential difference is a **scalar** quantity.

Unit of potential difference

From relation $V = \frac{W}{q}$

Unit of potential difference = $\frac{\text{Unit of work}}{\text{Unit of charge.}}$

The S.I. unit of work is joule and that of charge is coulomb (C), so the potential difference is measured in joule per coulomb which is named as volt (abbreviated as V). Thus

$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$ or $1 \text{ V} = \frac{1 \text{ J}}{1 \text{ C}}$

Direction of the Electric Current Conventional And Electronic Flow

Potential difference between two points is said to be 1 volt if work done in transferring 1 coulomb of charge from one point to the other point is 1 joule.

Electrical Resistance

The obstruction offered to the flow of current by the wire is called its electrical resistance.

R

Unit:- ohm

$R \propto l$

$R \propto 1/A$

$R \propto T$

Ohm's law

According to Ohm's law*, if a current I flows through a wire when potential difference across the ends of the wire is V, the resistance offered by the wire to the flow of current is the ratio of potential difference across it to the current flowing in it. *i.e.*,

Resistance of wire (R)

$$= \frac{\text{Potential difference across the wire (V)}}{\text{Current flowing in the wire (I)}}$$

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

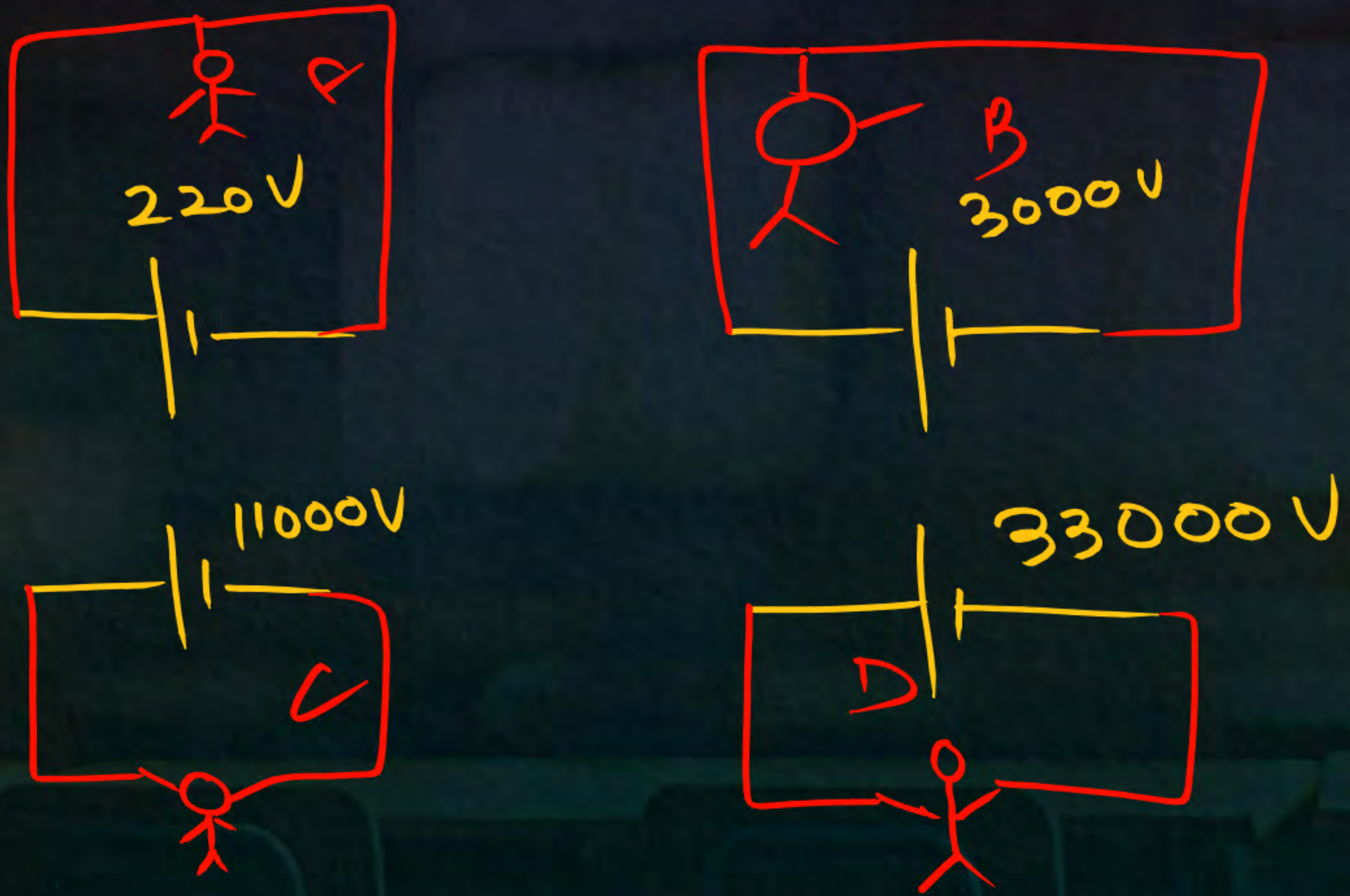
Resistance is a **scalar** quantity

$V \propto I$

$V = RI$

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

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


A
220V
B
3000V
11000V
C
33000V
D

Ohm's law

Unit of resistance:

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

$$\text{Unit of resistance} = \frac{\text{Unit of potential difference}}{\text{Unit of current}}$$

The S.I. unit of potential difference is volt (V) and that of current is ampere (A), hence S.I. unit of resistance is volt per ampere which is named as ohm (symbol Ω). Thus,

$$1\ \text{ohm} = \frac{1\ \text{volt}}{1\ \text{ampere}}\ \text{or}\ 1\ \Omega = \frac{1\ \text{V}}{1\ \text{A}}$$

The resistance of a conductor is said to be 1 ohm if a current of 1 ampere flows through it when the potential difference across its end is I volt.

Factors affecting the resistance of a conductor

(1) The material of wire:

The resistance of a wire depends on the number of collisions which the electrons moving through it suffer with the other electrons and fixed positive ions of the wire. In different materials, the concentration of electrons and the arrangement of atoms are different, therefore, **the resistance of wires of same length, same area of cross section, but of different materials differ depending on their material.** Good conductors having higher concentration of free electrons (such as metals) offer less resistance.

Factors affecting the resistance of a conductor

(2) The length of wire: $R \propto l$

The number of collisions suffered by the moving electrons will be more if they have to travel a longer distance in wire, therefore, **a long wire offers more resistance than a short wire** (*i.e.*, resistance of a wire length of wire).

Factors affecting the resistance of a conductor

(3) The area of cross section of wire: $R \propto l/A$

In a thick wire, electrons get a larger area of cross section to flow as compared to a thin wire, therefore, **a thick wire offers a less resistance** (*i.e.*, resistance of wire $\propto$ 1/area of cross section of wire).

Factors affecting the resistance of a conductor

(4) **The temperature of the wire**

If the temperature of wire increases, ions in it vibrate more violently. As a result, the number of collisions increases and hence the resistance of wire increases **(i.e., the resistance of a wire increases with the increase in its temperature).**

Question

The unit of potential difference is :

(A) ampere

(B) $\boxed{\text{volt}}$

(C) ohm

(D) coulomb

Question

On increasing the resistance in a circuit, the current in it:

(A) decreases

(B) increases

(C) remains unchanged

(D) nothing can be said

Question

In a cell, ______ energy changes into ______ energy when it sends current in a circuit.

(A) mechanical, electrical

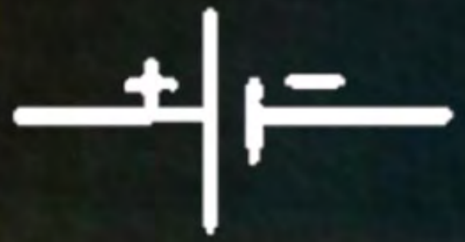
(B) heat, chemical

(C) $\boxed{\text{chemical, electrical}}$

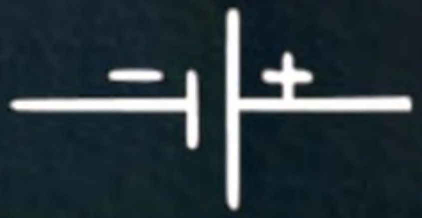
(D) electrical, chemical

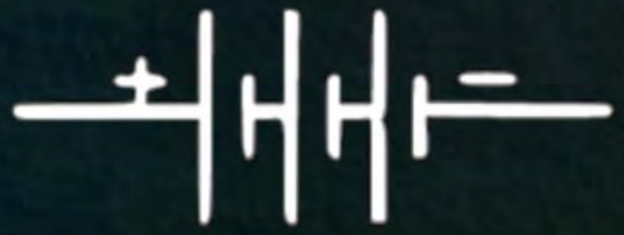
Question

A battery is correctly represented by:

(A) 

(B) 

(C) 

(D) 


Thank You