Vision

To be the centre of excellence in the field of technical education.

Program Code:- First Semester – All Program

Course Name:- Basic Science (PHYSICS)

Course Code : - BSC (22102)

Course coordinator: Mr. S. K. Rawat

Course Name:- Basic Science (PHYSICS)

Unit No:2

Unit Name: Electric current and Ohm’s law.

Unit Outcomes (UO2d): Apply laws of series and parallel combination in the given electric circuits.

Learning Outcomes (LOs):

LO5: Student will be able to define electric current and state Ohm's law.

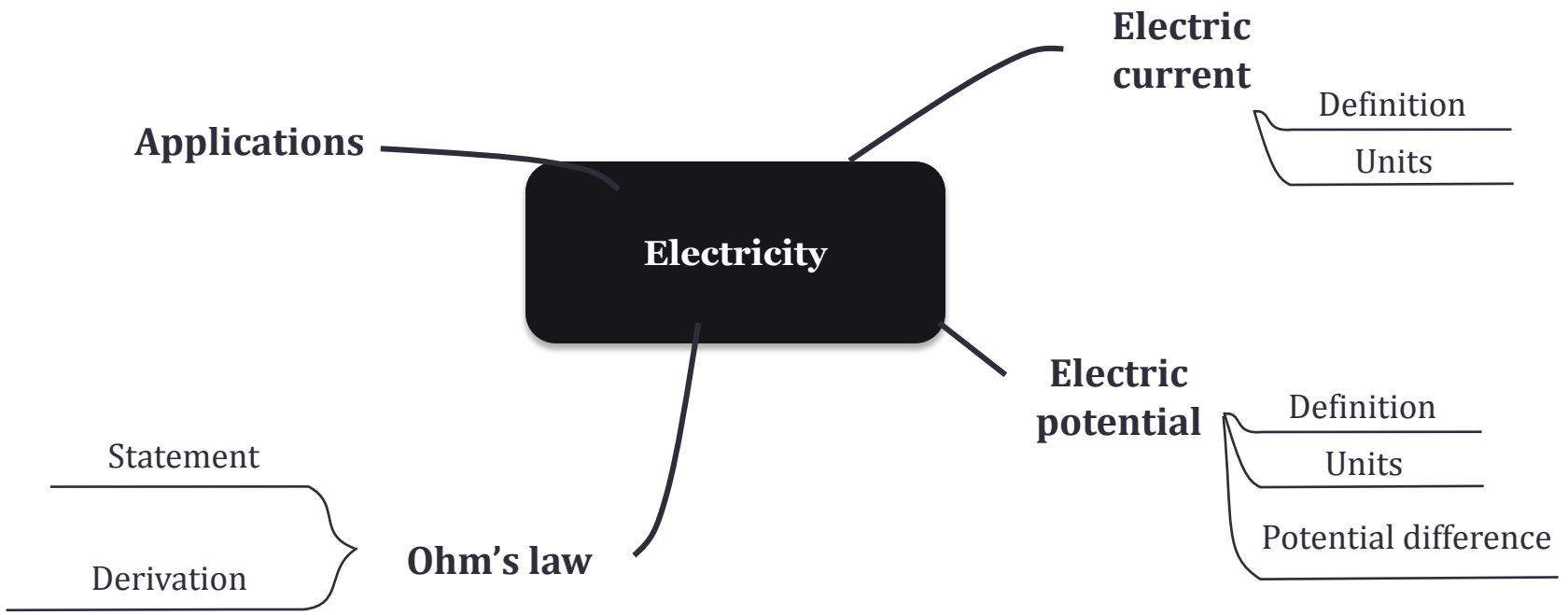
CONTENT

- Electric current
- Electric potential
- Ohm’s law

LEARNING OBJECTIVES

- Student will be able to define electric current and state Ohm's law.

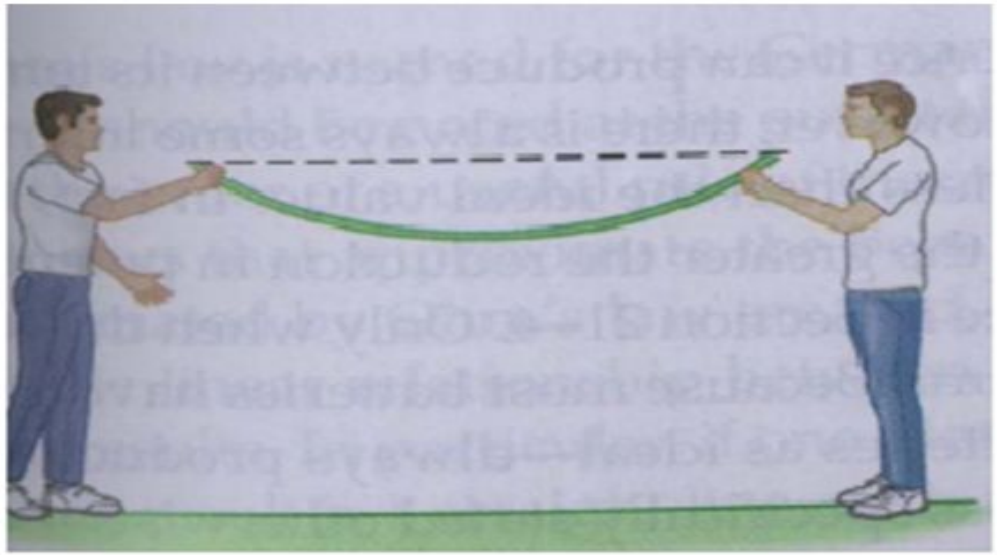
Concept Map

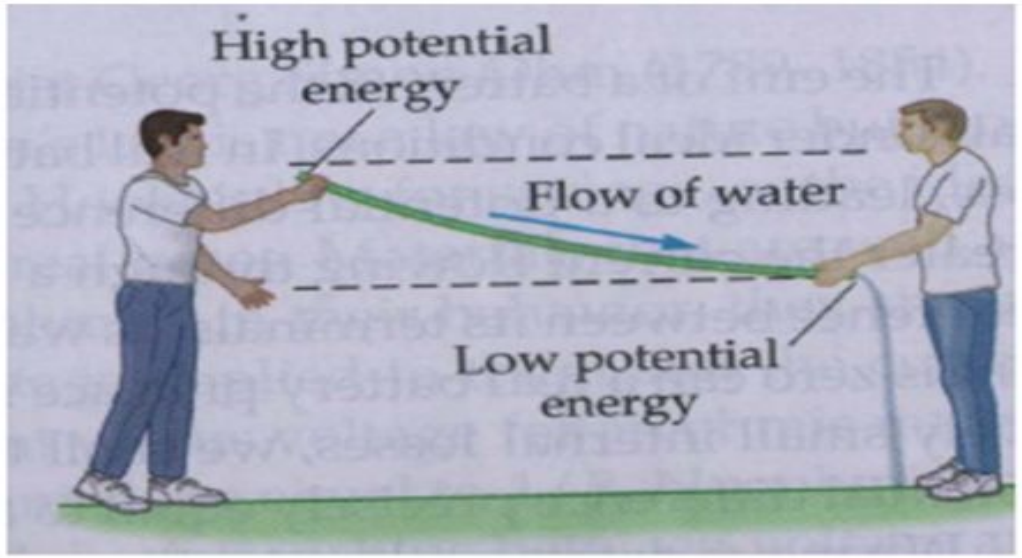

Electricity
Electric current
Definition
Units
Applications
Electric potential
Definition
Units
Potential difference
Ohm's law
Statement
Derivation

Concept of ELECTRICITY

Key Question:

1. What do we mean by electric charge?
2. What do we mean by electric potential ?
3. How do electric charges are related to electric potential?





Electric current

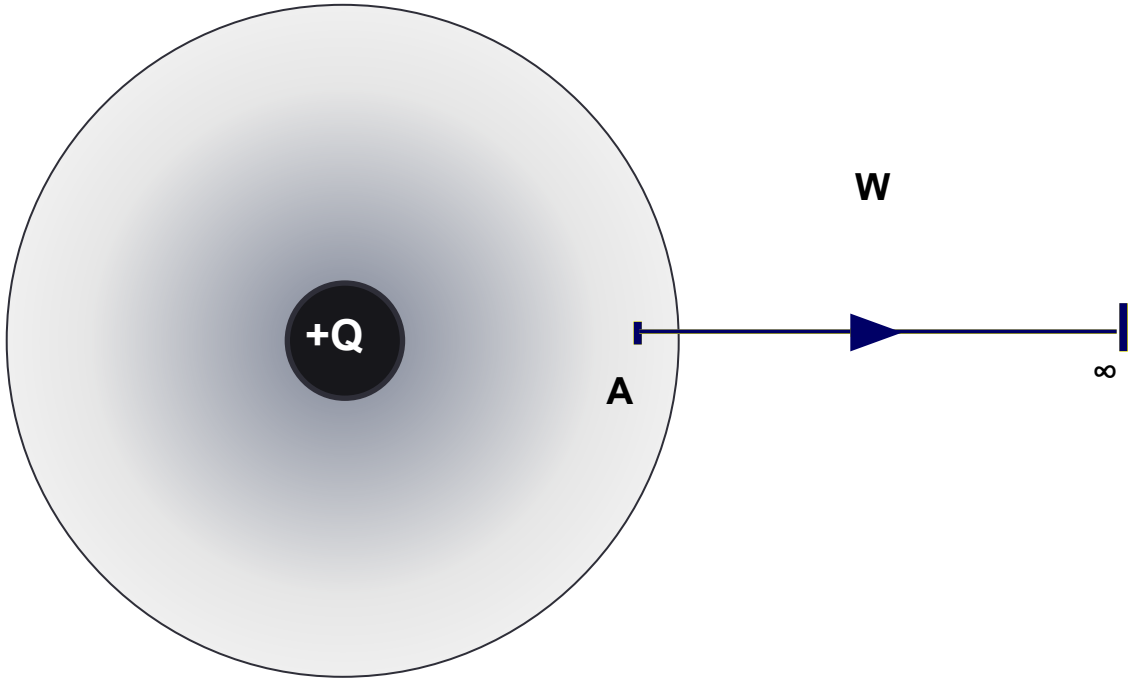
- The electric current is the rate of flow of charge. Current is denoted by symbol I.
- If Q = charge, t = time and I = current, then the current flowing through conductor is $I = \frac{Q}{t}$
- SI Unit: ampere (A). (1mA = 10^{-3} A, 1 A = 10^{-6} A).
- One ampere (1A): If one coulomb of charge flows through conductor in one second then the current flowing is said to be one ampere.
- 1 ampere (1A) = $\frac{1 \text{ coulomb (1C)}}{1 \text{ second (1s)}}$

Electric Potential

- Electrical Potential is defined as amount of work done in bringing a unit positive charge from infinity to that point.
- i.e., $V = \frac{W}{Q}$
- Potential Difference is defined as difference in potential of two charged bodies.
- SI Unit: Electric Potential or Potential Difference is denoted by V & measured in volt (V).
- One volt (1V): If one joule of work is done in bringing a charge of one coulomb then the potential is said to be one volt.
- i.e., 1 volt $= \frac{1 \text{ joule}}{1 \text{ coulomb}}$

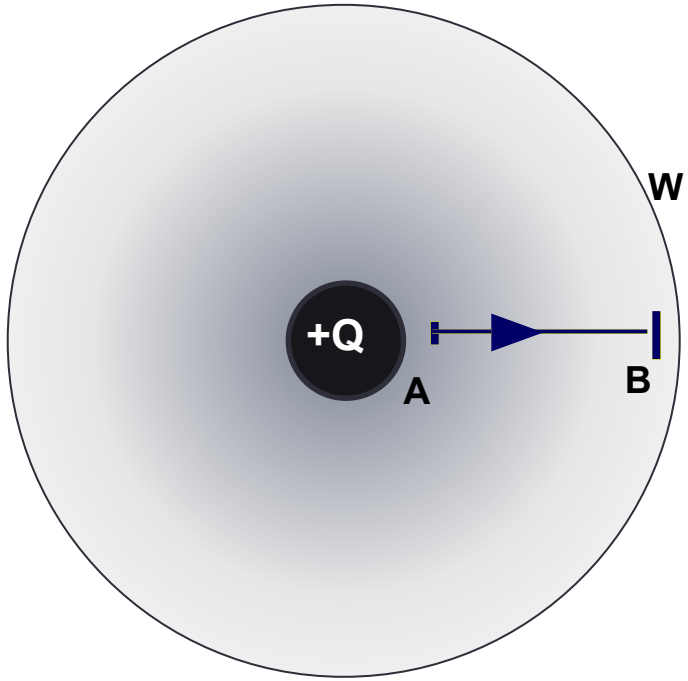
ABSOLUTE Potential

- **Absolute Potential:** It is defined as amount of work done in bringing a unit positive charge from infinity to any point inside electric field.



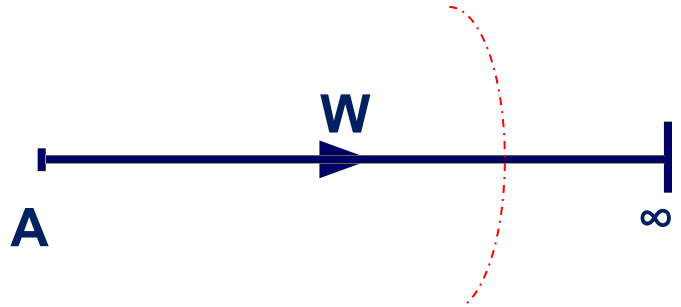
Potential DIFFERENCE

- **Potential Difference:** It is defined as amount of work done in bringing a unit positive charge from one point to another point inside electric field.



Definition & Unit of Potential

- **Electric Potential:** It is defined work done (W) in bringing a charge (+Q) from infinity to a given point.
- **Electric potential (V) =** $\frac{\text{Work (W)}}{\text{Charge (Q)}}$

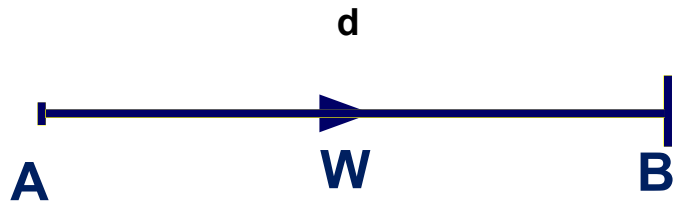


- **Note:** If W = 1J, Q = 1C, then 1 volt = $\frac{1 \text{ joule}}{1 \text{ coulomb}}$
- **1 volt:** If 1 joule of work is done in bringing a charge of 1 coulomb from infinity to any point against the electric field, then the potential is said to be 1 volt

Potential due to point charge

- Let a point charge q moves from point B to A, i.e., AB = d.
- By def'n Electric Potential (V) = $\frac{\text{Work (W)}}{\text{Charge (q)}}$
- We know work done (W) = Force (F) × distance (d)
- Hence according to Coulomb's law, W = $\left(\frac{1}{4\pi\epsilon_0 k}\frac{Qq}{d^2}\right) \times d$
- ∴ Electric Potential V = $\frac{\frac{1}{4\pi\epsilon_0 k}\frac{Qq}{d}}{q} = \frac{1}{4\pi\epsilon_0}\frac{Q}{kd}$

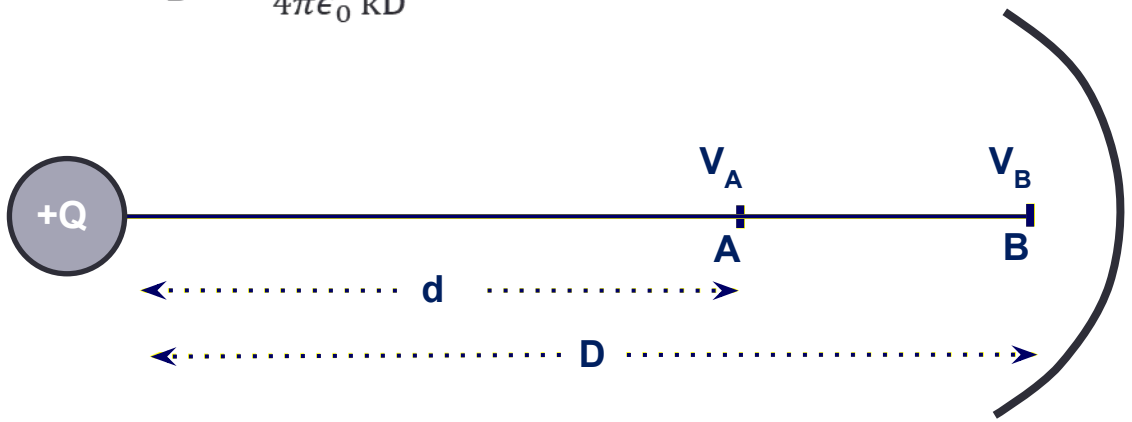
$$\therefore V = \frac{1}{4\pi\epsilon_0}\frac{Q}{kd}$$



P.D between two points

- Potential Difference between two points is defined as the work done in carrying unit positive charge from one point to another point against electric field.
- P.D between points 'A' & 'B' is defined as the work done in carrying a unit positive charge from B to A, which is given by VAB
- i.e., VAB = VA – VB

- P.D between points 'A' & 'B' is $V_{AB} = V_A - V_B$
- We know potential at A is $V_A = = \frac{1}{4\pi\epsilon_0}\frac{Q}{kd}$ and potential at B is $V_B = = \frac{1}{4\pi\epsilon_0}\frac{Q}{kD}$
- $\therefore V_{AB} = V_A - V_B = \frac{1}{4\pi\epsilon_0}\frac{Q}{kd} - \frac{1}{4\pi\epsilon_0}\frac{Q}{kD} = \frac{Q}{4\pi\epsilon_0 k}\left(\frac{1}{d} - \frac{1}{D}\right)$
- $VAB = 9 \times 10^9 \frac{Q}{k}\left(\frac{1}{d} - \frac{1}{D}\right)$



Problems on Potential

Formulas:

- Electric Potential $\mathbf{V = \frac{W}{Q}}$
- Potential due to point charge $\mathbf{V = 9 \times 10^9 \frac{Q}{kr}}$
- P.D between two points $\mathbf{V = 9 \times 10^9 \frac{Q}{k}\left[\frac{1}{d} - \frac{1}{D}\right]}$
- Absolute Potential $\mathbf{V = 9 \times 10^9 \frac{Q}{kx}}$

Problems on Potential

Calculate the potential if work done to move a charge of 25 C is 1600 J.

- Data: Q = 25 C, W = 1600 J
- Formula: $\mathbf{V = \frac{W}{Q}}$
- Solution: $\mathbf{V = \frac{W}{Q} = \frac{1600}{25}}$ = 64 volt

Problems on Potential

Calculate the potential due to charge of 0.05μC at a point 0.4m in a dielectric of 2.5.

- Data: Q =0.05 μC = 50×10^{-9}C, r = 0.4m, k = 2.5
- Formula: $\mathbf{V = 9 \times 10^{9} \frac{Q}{kr}}$
- Solution: $V = 9 \times 10^{9} \frac{Q}{kr} = 9 \times 10^{9} \frac{50 \times 10^{-9}}{0.4 \times 2.5}$ = 450 volt

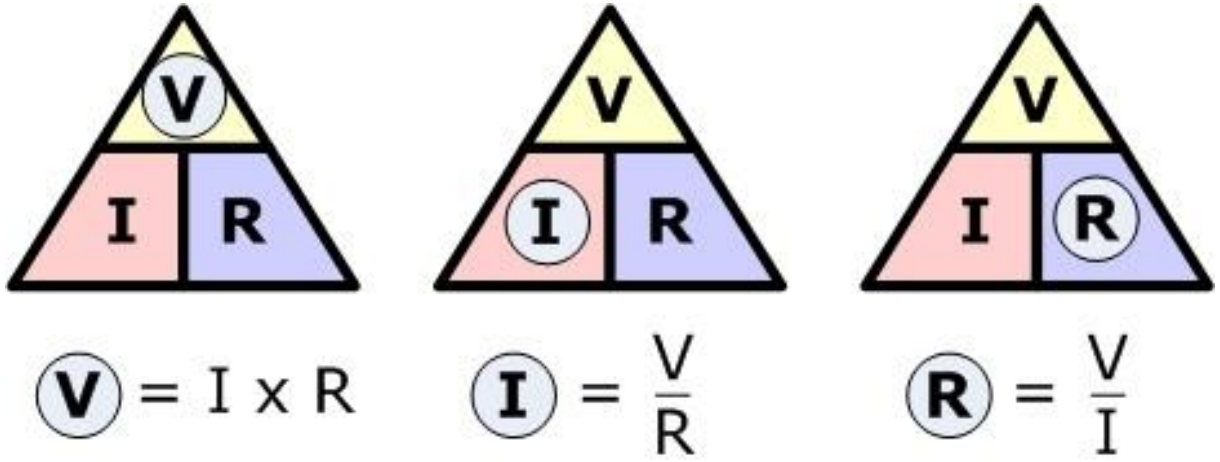
Attempt Set 1 MCQs

Question No	Question No. 1	Question No. 2	Question No. 3
Statement of Question	Which of the following correctly represents the relation among (Q), (V) and (W)	The Potential Difference between two terminals can be measured by _____	On which of the following no “plus” or “minus” sign is marked
Level of Question	Remembering	Understanding	Applications
Option (a)	V = W × Q	an ammeter	a battery
Option (b)	W = V / Q	a voltmeter	an ammeter
Option (c)	V = Q / W	an ohm-meter	a voltmeter
Option (d)	V = W / Q	a rheostat	a resistor
Correct Option	**V = W / Q**	**a voltmeter**	**a resistor**

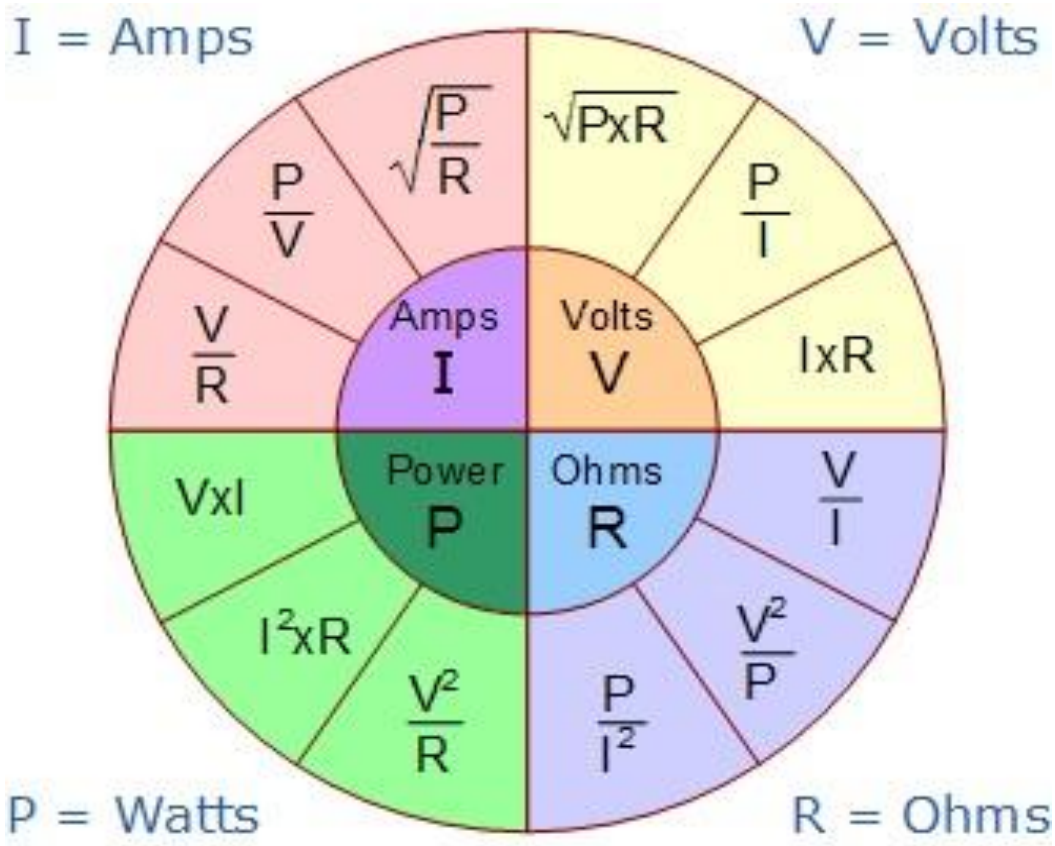
START

Ohm's law

- Ohm's law states that "the potential difference (V), across the end of the conductors is directly proportional to the current (I) flowing through it, provided its temperature remains the same".
- According to Ohm's law, $V \alpha I$
  - or $\frac{V}{I}$ = constant or $\frac{V}{I} = R$
  - or $V = IR$
- where R is called resistance and is constant for a given material.



OHM'S LAW PIE CHART



Applications

- Entertainment
- Today, the modern sources of entertainment starting from listening to music from MP3 players, watching Television, playing movies in DVDs or VCDs or VCRs runs on electricity.
- Healthcare
- We can see the use of electricity for operating modern technologies every day. These surgical operations won't even start without electricity. For example, the doctors need a powerful light during an operation on a patient and without electricity, the light won't function, and operation can prove fatal.
- Engineering
- Constructions of buildings and structures for the convenience of people require electricity in every step. Building houses, installing gates and windows, welding of materials require current electricity to operate the machines.
- Transport and Communication
- Reaching places or communicating from a different corner of the world is only possible because of electricity. A power cut during airline travel can be dangerous.

Applications

- Outdoors
- The street lights on the road use electricity to function, even the pool requires electricity to heat the water in colder regions. The lawnmower, which is used to cut grass uses electricity to operate. The water sprinkler for the grass on the lawn uses electricity as well.
- Household
- Starting from toaster to refrigerator, microwave, washing machine, dishwasher, electrical chimney, and many more appliances which are simple to use and made for the convenience of day to day activities use electricity to function.
- Commercial purposes
- For the production of various materials, the factory uses heavy machinery which always runs on electricity. Even the magnets which are of a giant like structures require electricity to keep it charged for lifting heavy metals.

Applications

- Offices
- We go to work in offices in which most things run on electricity. The lights, lifts, AC, coffee machine, ID card reader, biometric scanners and everything else require electricity.
- Fuel
- Electrical energy comes under renewable energy, and we can produce it using most of the natural resources available to us. Today, things which were running on fossil fuels such as cars and bikes, are now made in such a way that it runs on electricity (like solar-powered), which will be more convenient in the future.
- Space
- The satellites and probes which are sent from the earth for space expeditions run on electricity. The electricity is generated with the help of a generator or is battery powered. The Apollo mission for the landing of humans on the moon, would not have been possible without the use of electricity.

Attempt Set 2 MCQs

Question No	Question No. 1	Question No. 2	Question No. 3
Statement of Question	According to Ohm's law, _____ increases with increase in _____.	Two charged bodies having equal potential are connected through a conducting wire, in this case current	What will be the potential of a body, if work done to move a charge of 25 C is 1600 J.
Level of Question	Understanding	Understanding	Application
Option (a)	resistance, current	will flow	15.6 mV
Option (b)	resistance, voltage	will not flow	40 kV
Option (c)	current, voltage	If capacitor connected	64 V
Option (d)	resistance & current, voltage	if resistor connected	6.4 V
Correct Option	**current, voltage**	**will not flow**	**64 V**

START