

CLASS 10 : SCIENCE
CHAPTER NUMBER 11

ELECTRICITY

STUDY NOTES

By Professor Phi

For more please visit professorphi.com
Or search 'Professor Phi' on [YouTube](#)



TOPIC OF THIS CHAPTER

1. Electric Terminologies

- Electric Current
- Potential Difference
- Electric Power

2. Electric Circuit Terminologies

3. Ohm's Law

- Ohm's law
- Concept of Resistance

4. Factors on which Resistance depends

5. Combinations of Resistance

- Resistance in Series
- Resistance in Parallel

6. Heating effect of electric current

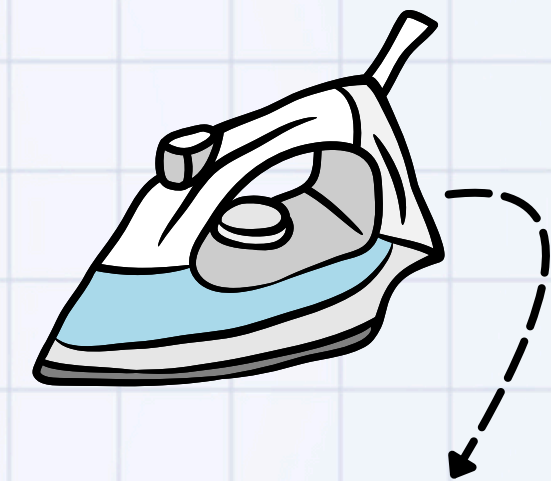
- Concept of Heat
- Applications of Heat



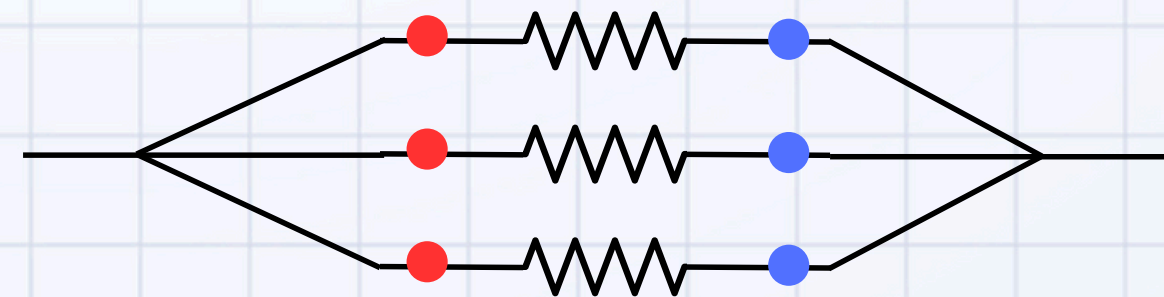
Georg Simon Ohm



Electric Current

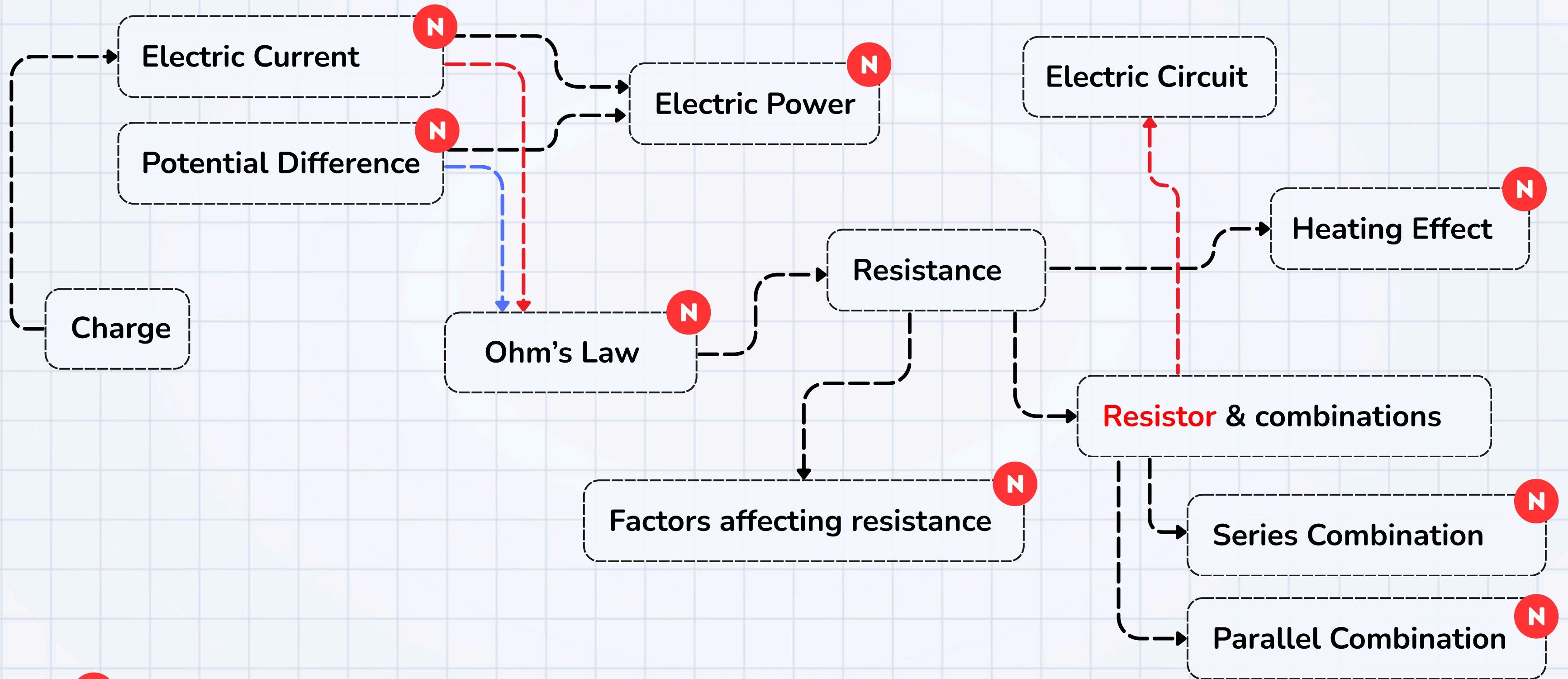


Heat Energy



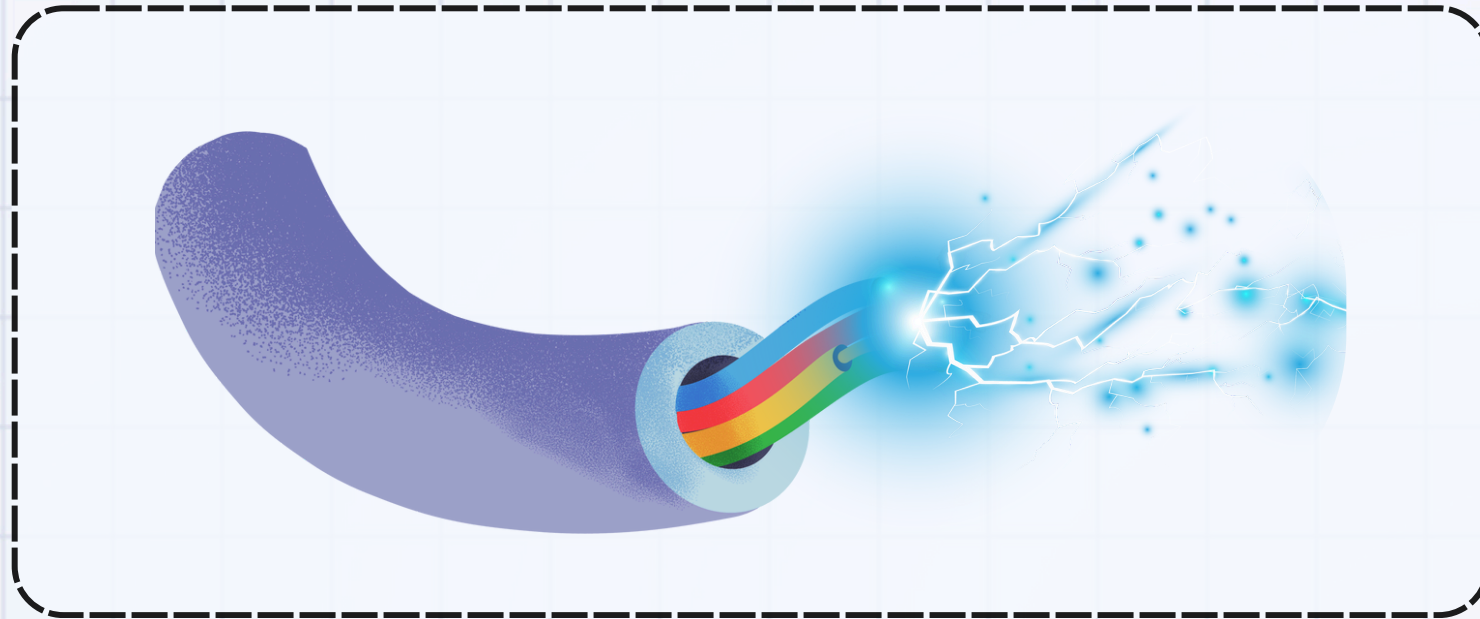
Resistance in Parallel

FLOWCHART OF CHAPTER



N Means this topic have numericals

WHAT IS ELECTRIC CURRENT?



Current always Flows through the conductors like metal wires

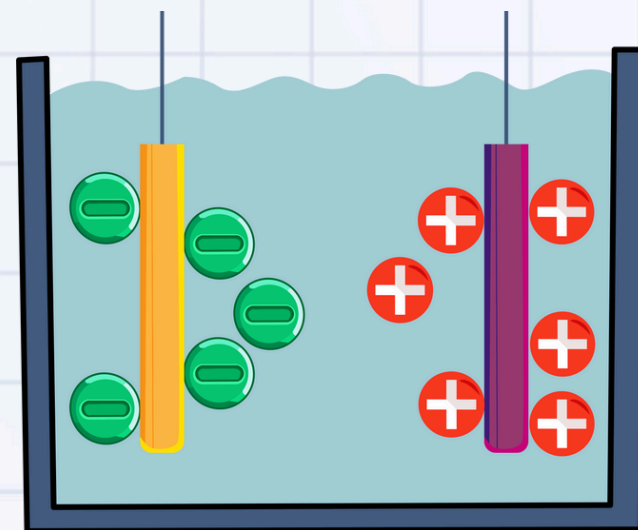
Electric current is the **rate of flow of electric charge**.

It is Given By :

$$I = \frac{Q}{t} = \frac{\text{(Coulomb)}}{\text{(Second)}} = \text{(Ampere) A}$$

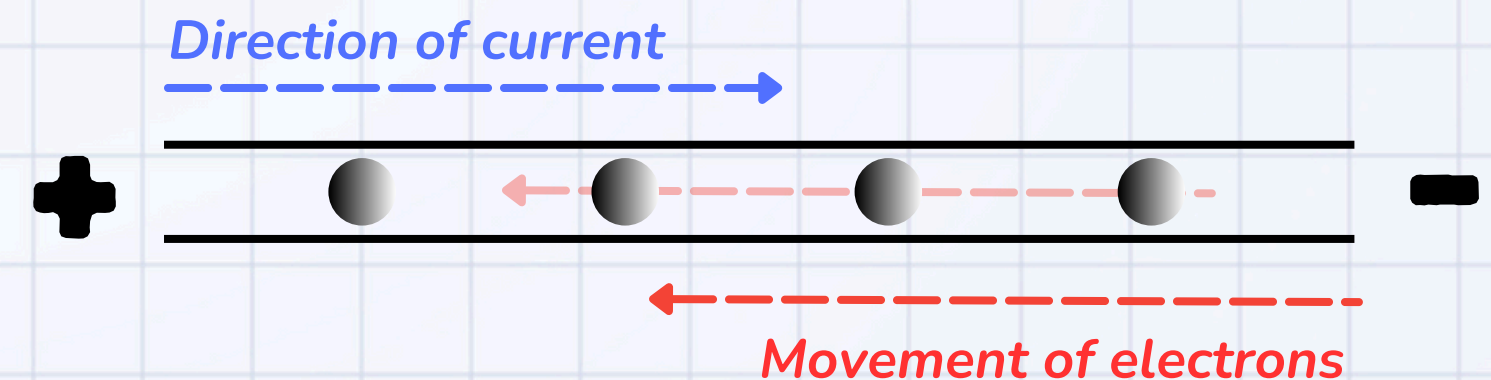
Charge

Time



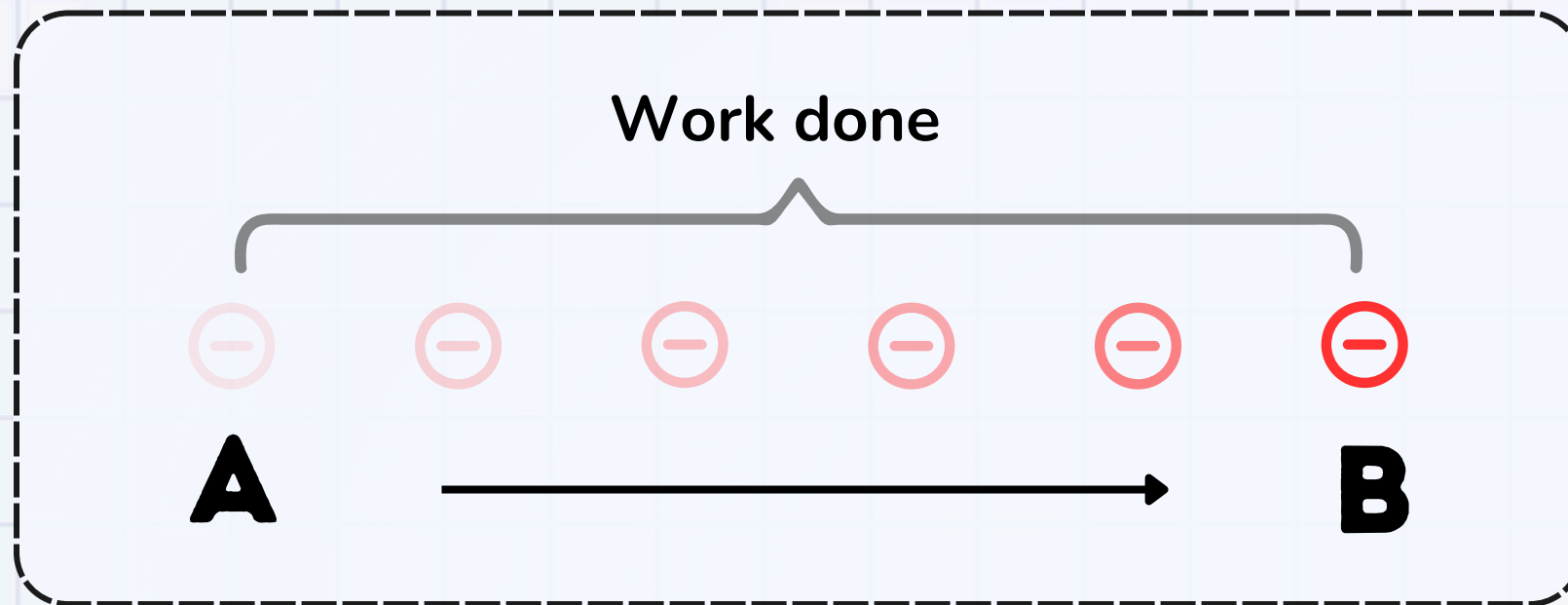
- In metals, electric charge is 'free electrons'
- In Electrolyte solution, electric charge are 'ions' (+/-)
- Electric current flows because of potential difference

Current (I) → Flow of charge (Q/t)



In electric circuit,
Electrons move from '-ve side to +ve side' **But**
Current is shown from '+ve side to -ve side'

WHAT IS POTENTIAL DIFFERENCE?



Charge is moved from point A to point B

The **work done in moving a unit charge from one point to another** in an electric field is called Potential Difference.

Given By :

$$V = \frac{W}{Q} = \frac{\text{(Joule)}}{\text{(Coulomb)}} = \text{(Volt) V}$$

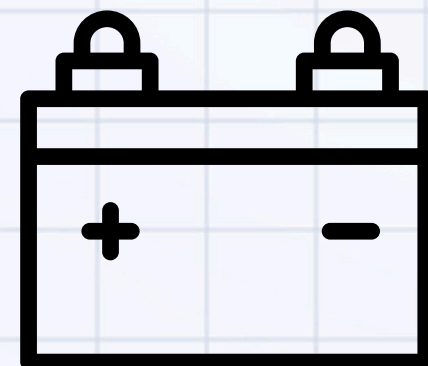
Work

Charge

Image

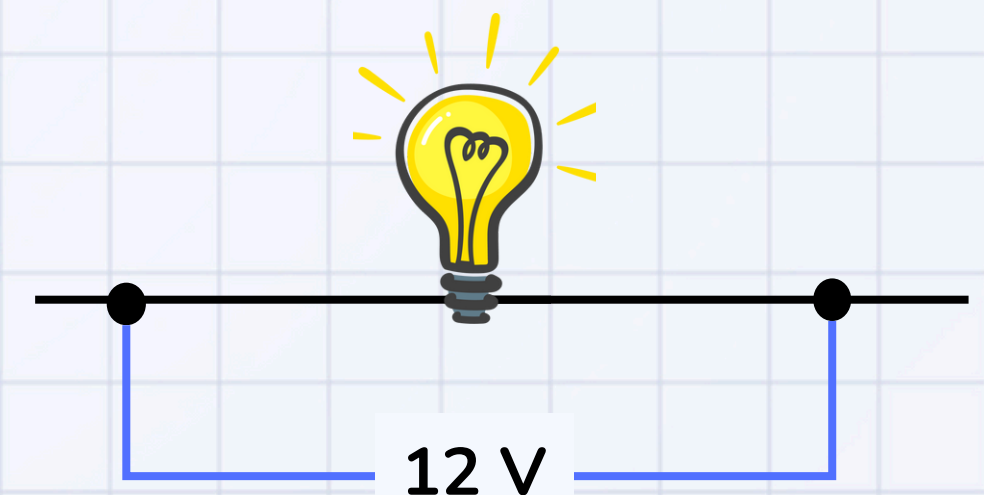


Diagram

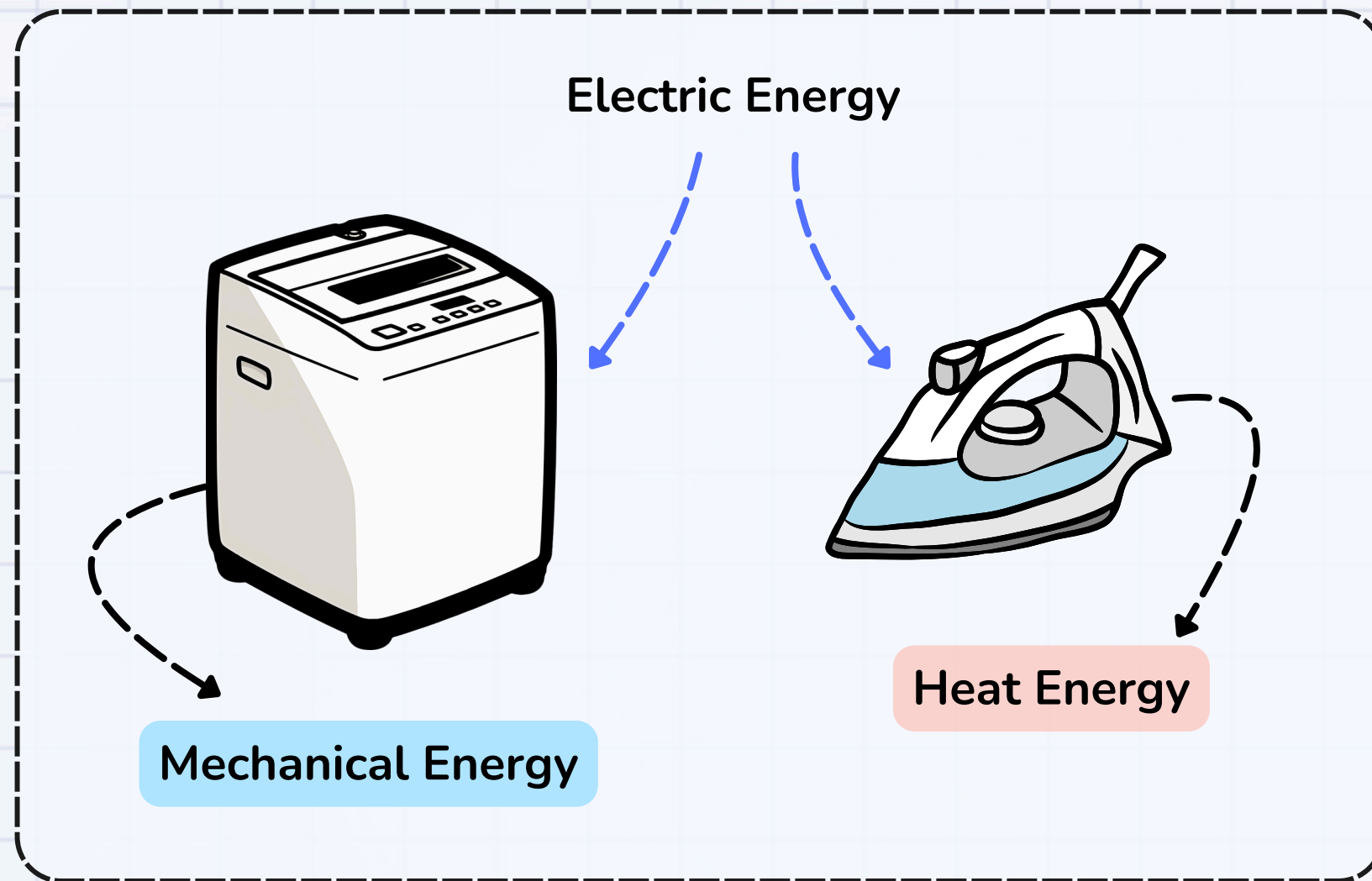


Due to **potential difference created between two terminals of battery**, electrons flow through wires

- Potential difference is always measured between **2 points**
- We use voltmeter to measure the potential difference



WHAT IS ELECTRIC POWER?



Devices *convert electric energy* to other forms of energy

- SI Unit → Watt (W)
- 1 Watt = Power consumed when 1 Ampere current flows through a circuit with 1 Volt potential difference.

Electric power is the **rate at which electrical energy is consumed or converted into other forms of energy** in an electrical circuit.

Given By :

$$\mathbf{P \text{ (power)} = V \text{ (volt)} \times I \text{ (ampere)}}$$

$$\mathbf{P \text{ (power)} = I \times R \times I}$$

Key Concepts

- If a device has **high current and high voltage**, it consumes more power.
- Example: A 60 W bulb uses less power than a 100 W bulb.

ELECTRIC POWER DERIVATION



Power is the always Work Done per Time

$$\mathbf{P} \text{ (power)} = \frac{\mathbf{W}}{\mathbf{t}} \begin{matrix} \text{(work)} \\ \text{(time)} \end{matrix}$$

Multiply and divide by charge 'Q'

$$\mathbf{P} \text{ (power)} = \frac{\mathbf{W}}{\mathbf{t}} \begin{matrix} \text{(work)} \\ \text{(time)} \end{matrix} \times \frac{\mathbf{Q}}{\mathbf{Q}} \begin{matrix} \text{(charge)} \\ \text{(charge)} \end{matrix}$$

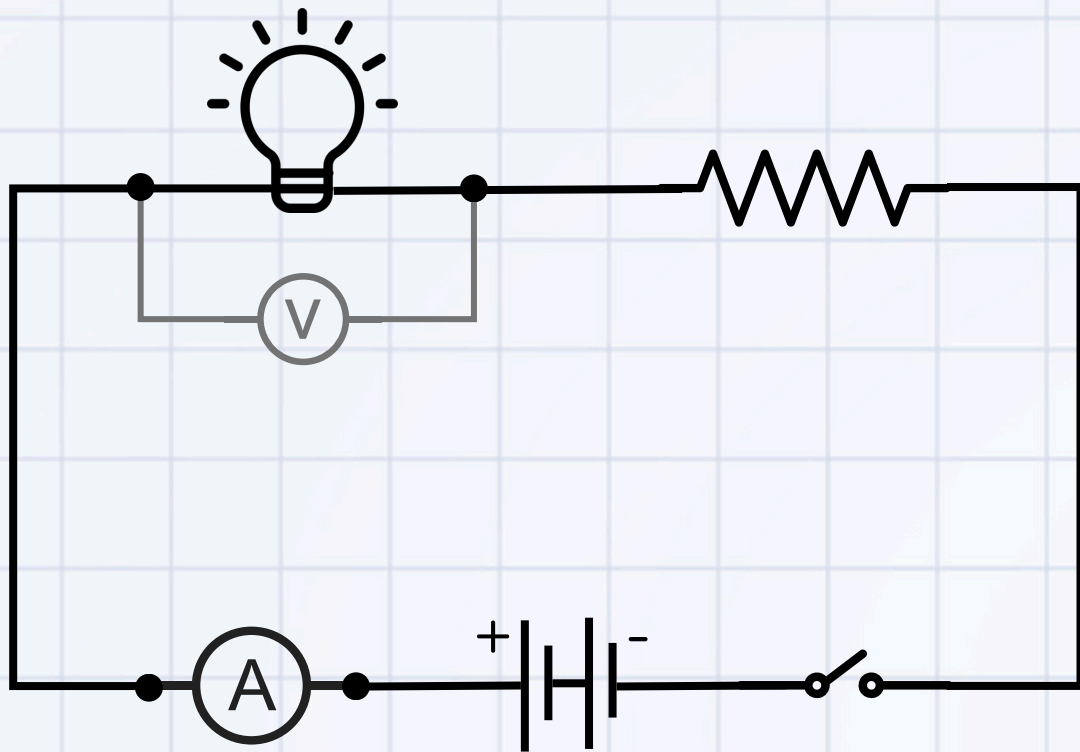
Rearrange them...

$$\mathbf{P} \text{ (power)} = \frac{\mathbf{W}}{\mathbf{Q}} \begin{matrix} \text{(work)} \\ \text{(charge)} \end{matrix} \times \frac{\mathbf{Q}}{\mathbf{t}} \begin{matrix} \text{(charge)} \\ \text{(time)} \end{matrix}$$

Convert them..

$$\mathbf{P} \text{ (power)} = \mathbf{V} \text{ (volt)} \times \mathbf{I} \text{ (ampere)}$$

CIRCUIT DIAGRAM



This is the typical diagram of an electric circuit

- Ammeter used to measure current in circuit.
- Voltmeter is used to measure voltage between 2 points.
- For more detail explanation please search 'Professor Phi : Electricity' **On YouTube**



This is symbol of **Electric Wire**



This is symbol of **Electric Bulb**



This is '**voltmeter**'.

It is **always Connected in parallel** to measure voltage.



This is '**Ammeter**'.

It is **always Connected in series** to measure voltage.



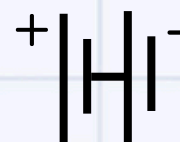
This is symbol of **Resistance**



This is symbol of **Open Switch** (No current flowing)



This is symbol of **Closed Switch** (current flowing)



This is symbol of **Battery**

OHM'S LAW

The current (I) flowing through a conductor is directly proportional to the voltage (potential difference) (V) applied across its ends, provided that the temperature and other physical conditions of the conductor remain constant

$$V \text{ (Voltage)} \propto I \text{ (Electric current)}$$

.... this is a relation given by 'ohm'

This means,

- If voltage is increased, the current will also increase
- and vice versa

After this, The relation is converted to the 'Equation'

$$V \text{ (Voltage)} = I \text{ (Electric current)} \times R \text{ (Constant)}$$

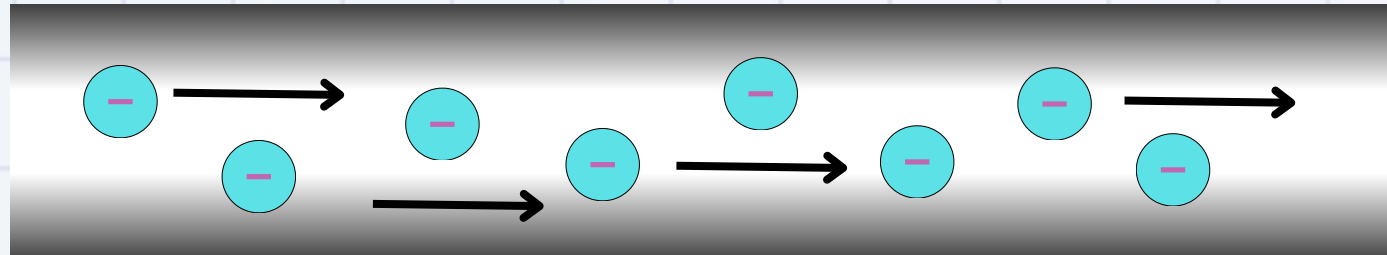
This constant is called as 'Resistance'



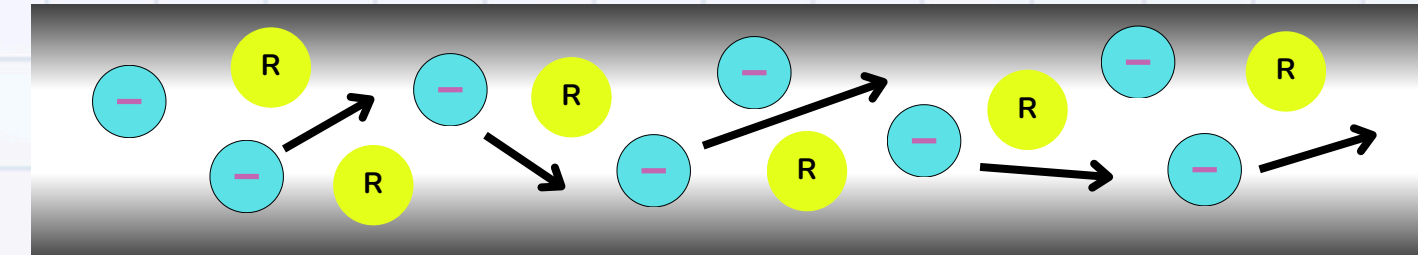
Georg Simon Ohm

CONCEPT OF RESISTANCE

Resistance is 'opposition to flow of electric current'.



We **think** this is how current flows, but nope..



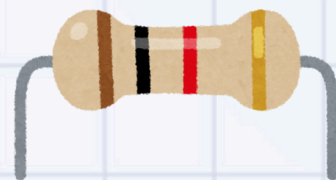
This is how **actually** current flows. Resistance is act as an obstacles.

R

- Resistance is **act as a obstacle** to 'electric current'.
- More resistance = Less Current.
- Denoted by 'R'.
- Unit of resistance is '**Ohm**' (Ω)



This is symbol of **Resistance**



This is how it looks in reality

Key Concepts

- Resistance is not bad, Sometimes it is useful.
- Resistance **does not depend on** 'current' and 'voltage'
- All wires has some resistance internally in them.
- Resistance **depends on** this things
 - Length of wire (l)
 - Area of wire (A)
 - Resistivity of wire (ρ)

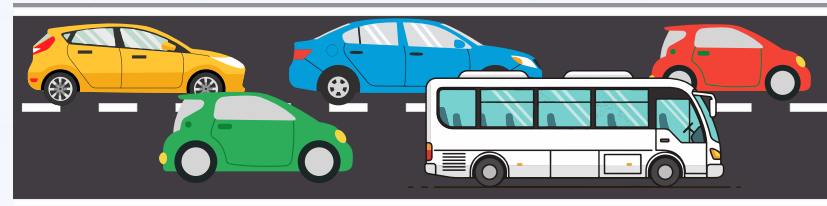
FACTORS ON WHICH RESISTANCE DEPENDS

Use this analogy to understand this concept



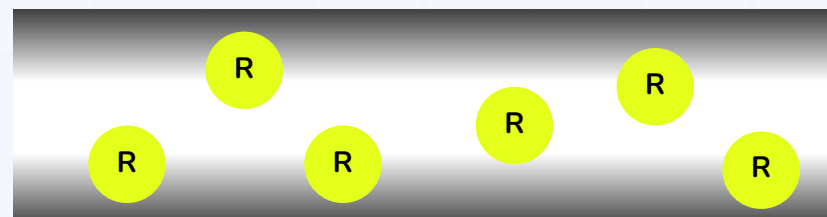
(Rider)

Traffic

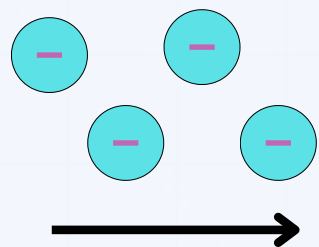


Road

Resistance



Wire



(Electric current)

- Conductor (wire) is like a **Road**,
- Current is like a **Rider**
- Resistance is like a **Traffic**,
- Resistivity is like a **Pot Holes**



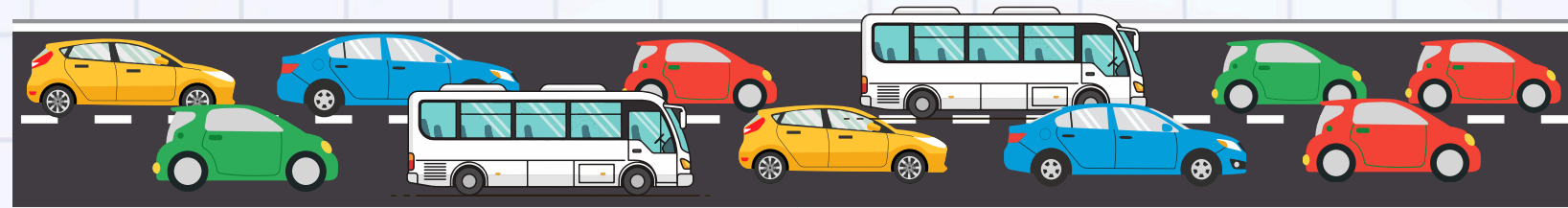
FACTORS ON WHICH RESISTANCE DEPENDS

LENGTH



(Rider)

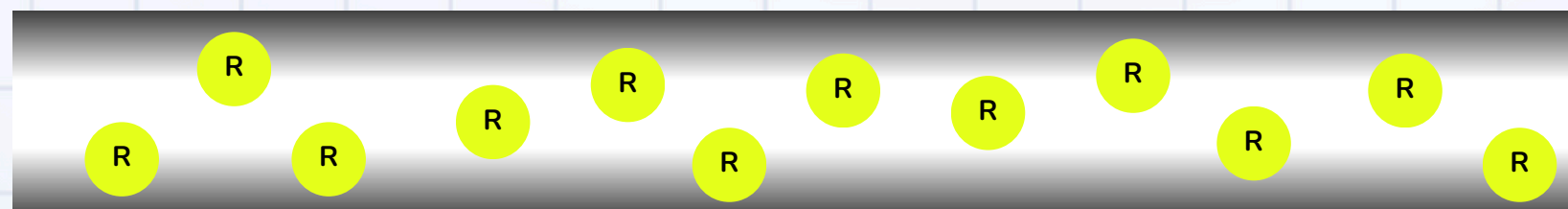
Traffic



Road

More Length = More Traffic

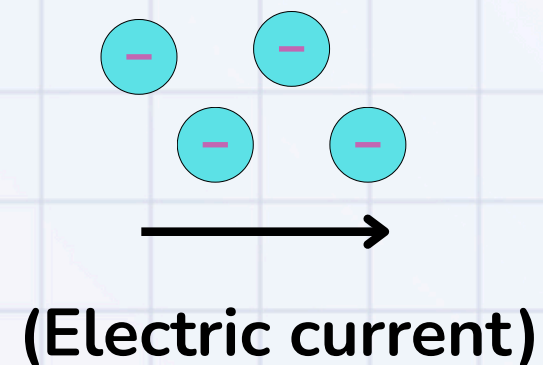
Resistance



Wire

More Length = More Resistance

$$L \propto R$$



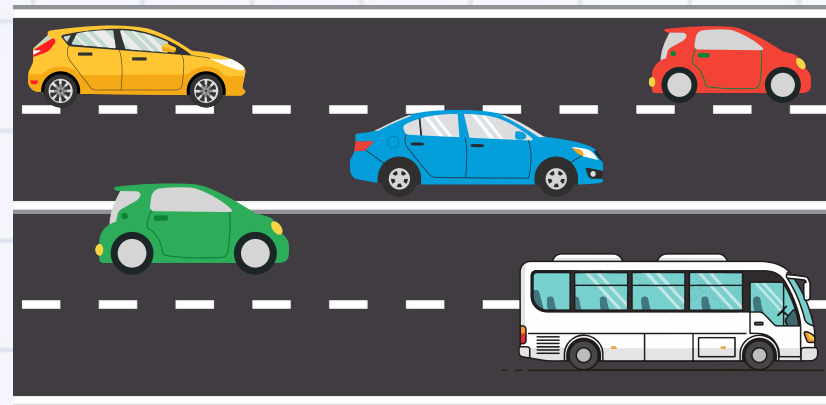
FACTORS ON WHICH RESISTANCE DEPENDS

AREA



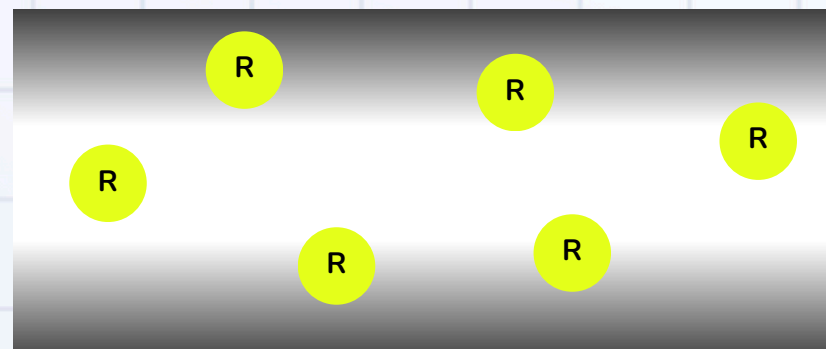
(Rider)

Traffic



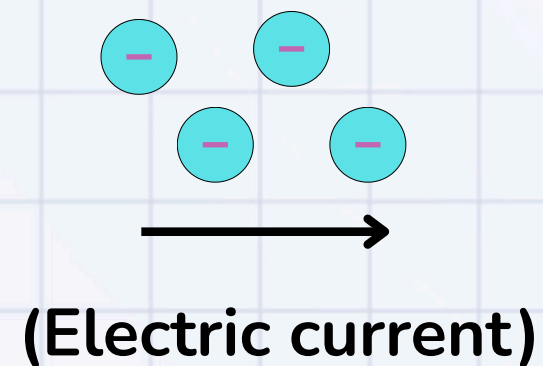
More Width = More Space = Less Traffic

Resistance



More Width = More Space = Less Resistance

$$\mathbf{A} \propto \frac{1}{\mathbf{R}}$$



(Electric current)

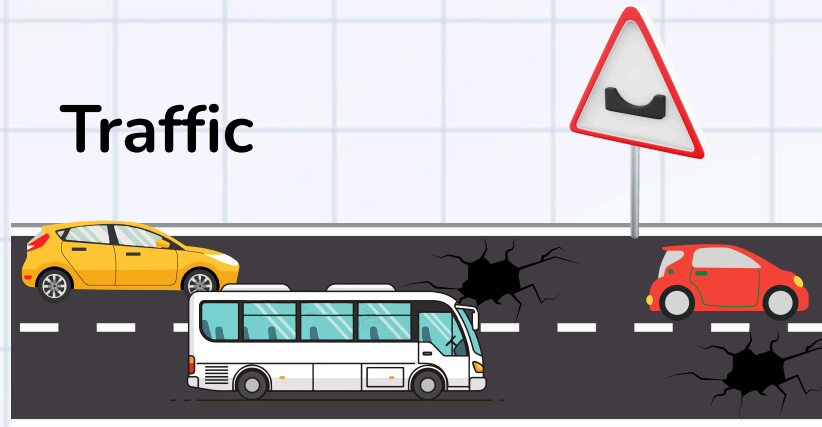
FACTORS ON WHICH RESISTANCE DEPENDS

RESISTIVITY



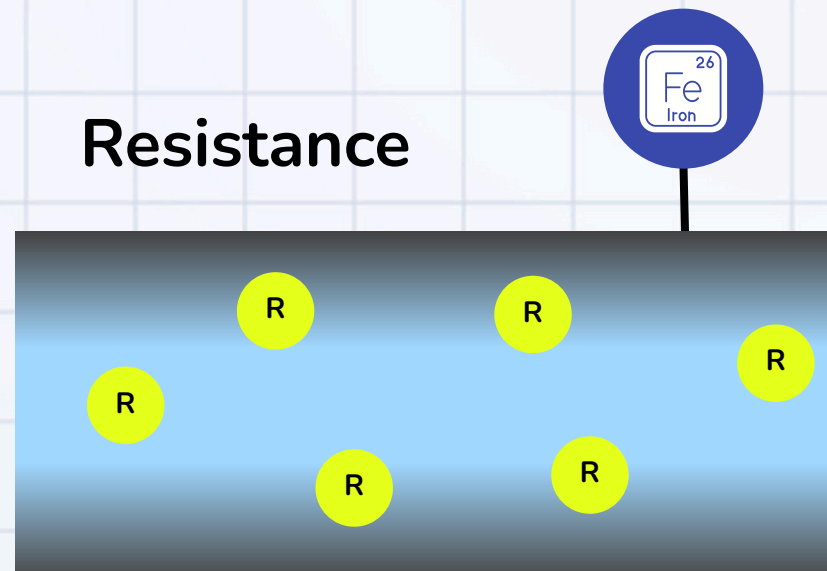
(Rider)

Traffic

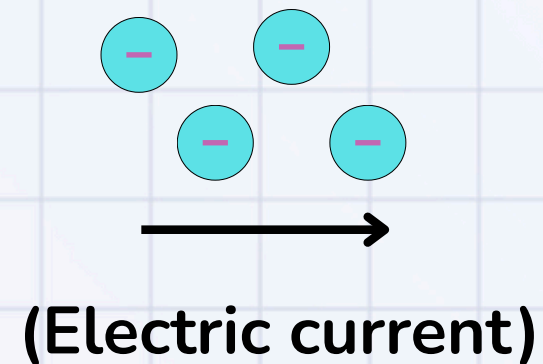


More the Pot holes = More Traffic

Resistance



More Resistivity = More Resistance



$$\rho \propto R$$

FACTORS ON WHICH RESISTANCE DEPENDS

Resistance is 'opposition to flow of electric current'.

It is given by

$$R = \rho \frac{L}{A}$$

- Resistance **depends on** these things
 - Length of wire (l)
 - Area of wire (A)
 - Resistivity of wire (ρ)
- Resistivity is **property of a material**.
- **More resistance = More Heat**

Remember this

Material	Resistivity (Ohm . meter)
Silver	1.59×10^{-8}
Copper	1.72×10^{-8}
Gold	2.44×10^{-8}
Aluminium	2.82×10^{-8}
Tungsten	5.60×10^{-8}
Nichrome	150×10^{-8}

- We **use copper wires** because it has less resistivity.
- We **use nichrome wires** in 'heating coil' because it has high resistivity.
- We **don't use silver wire** because it is expensive than copper.

RESISTANCE IN SERIES AND PARALLEL

To identify resistance in series or parallel ,
Draw 2 different dots on its both sides



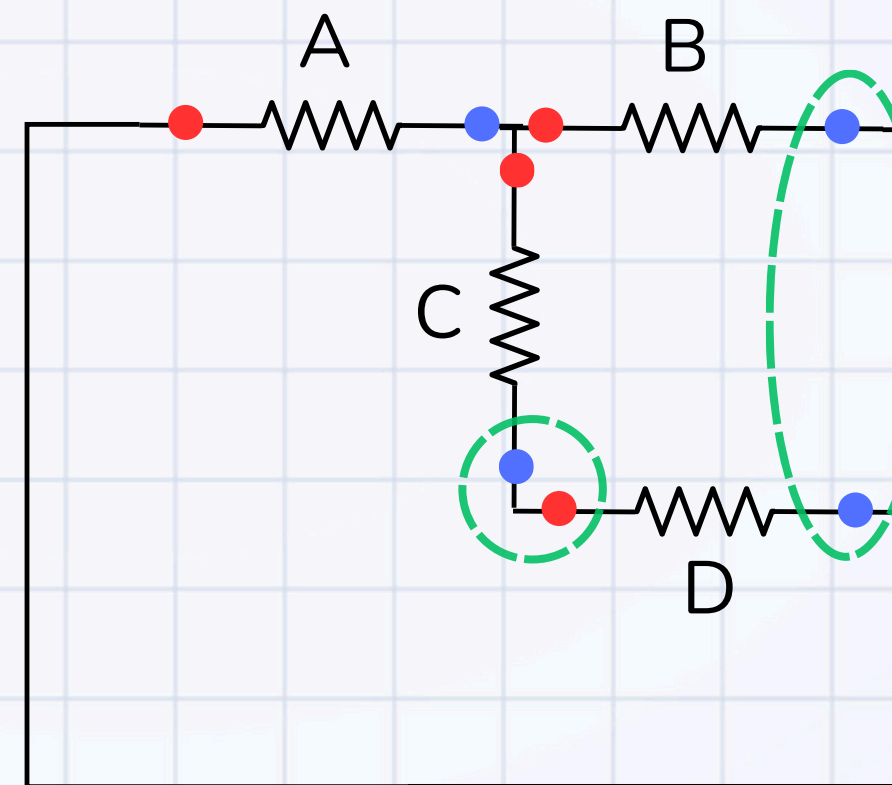
If opposite dots are together then it is

Series Combination



If same dots are together then it is

Parallel Combination



Step 1:

$$[R1] = [D \text{ series } C]$$

Step 2:

$$[R2] = [R1] \text{ parallel } [B]$$

Step 3:

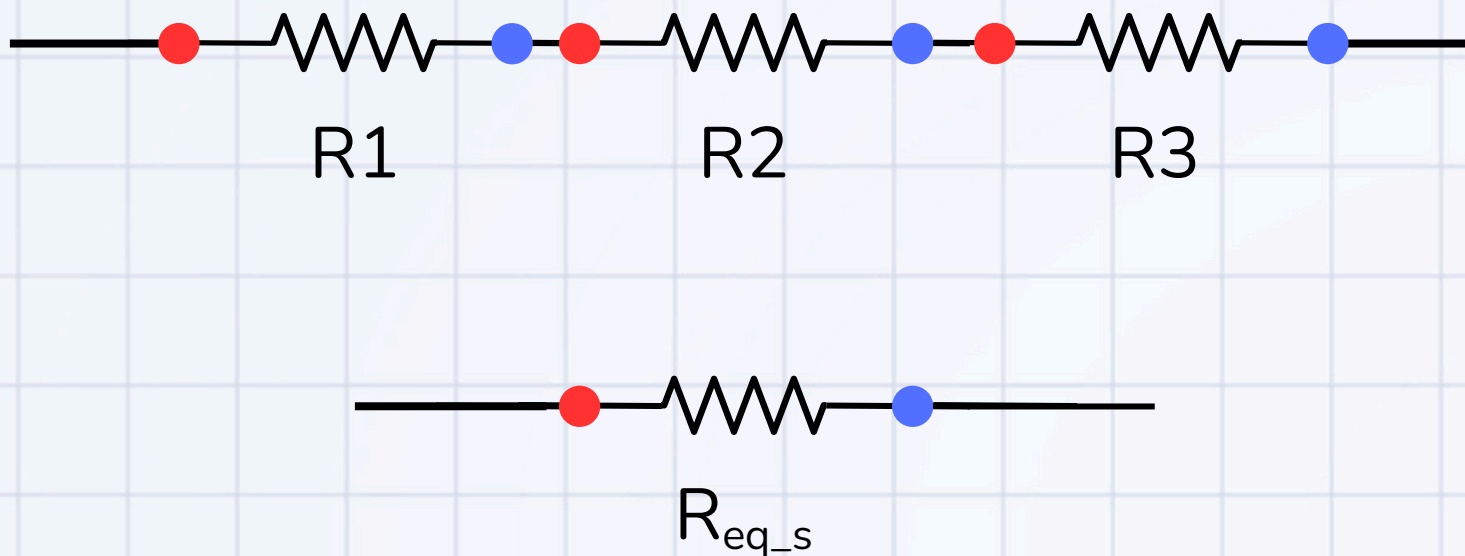
$$[R3] = [R2] \text{ series } [A]$$

In such scenarios do this -->

- Start with resistance who's **both sides have only 2 dots** (same or different)

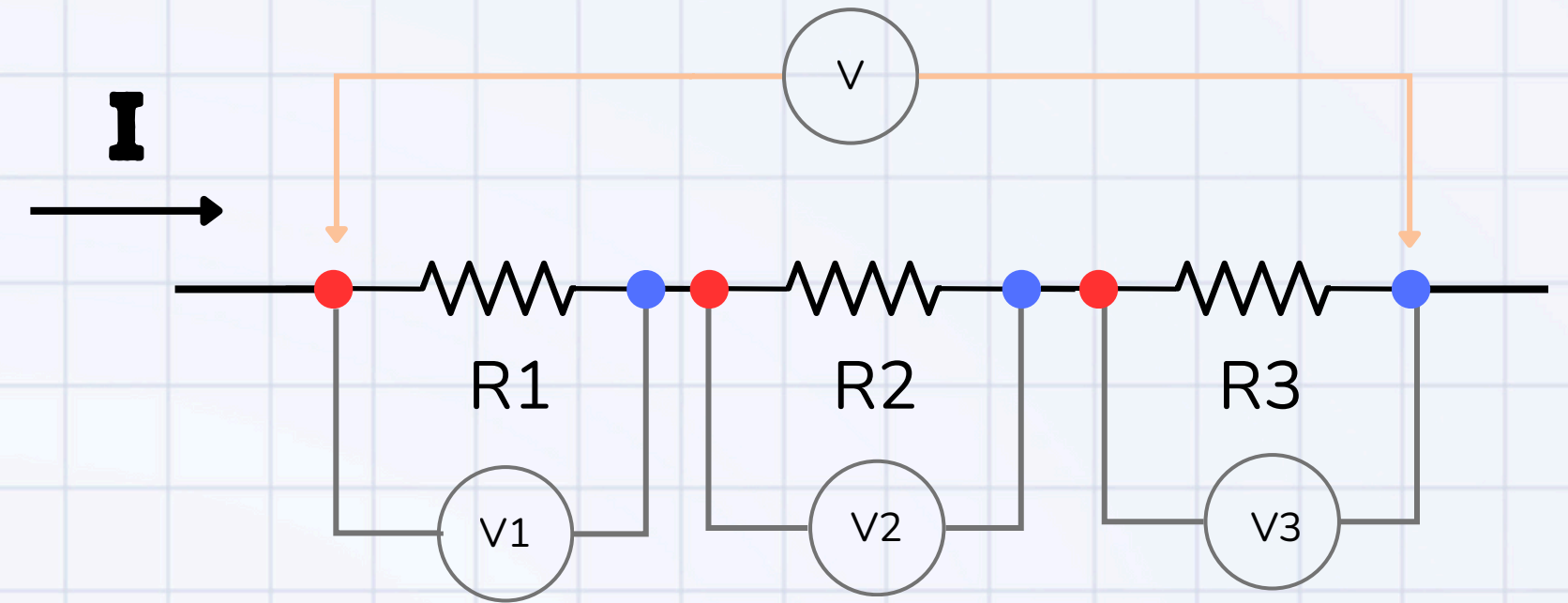
EQUIVALENT RESISTOR - SERIES

This is resistance in series combination



We are finding equivalent resistance,

- Equivalent Series resistance is the resistance which has **same effect of all resistance** connected in series.
- In series combination
 - **Current is same in all 'Resistances'**
 - Voltage is different in all 'Resistance'



Total voltage is given by

$$V = V_1 + V_2 + V_3$$

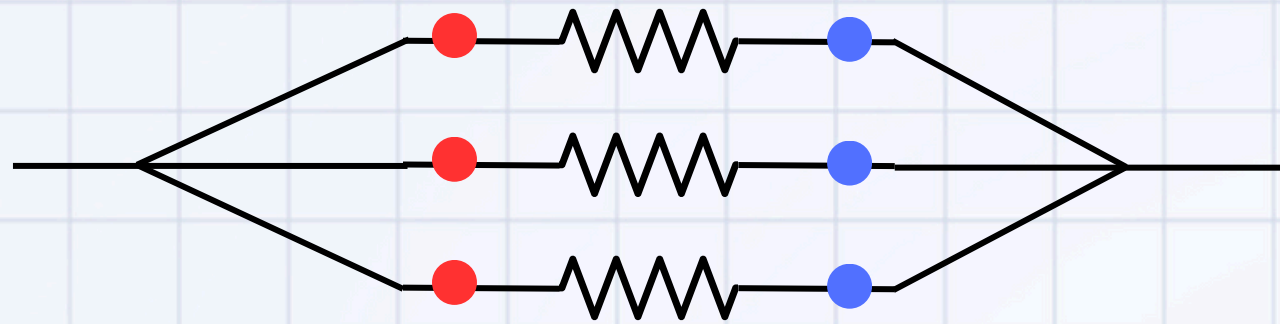
$V = I.R$, converting all voltages

$$I.R_{EQ_S} = I.R_1 + I.R_2 + I.R_3$$

Since current is common, so cancel it.

$$R_{EQ_S} = R_1 + R_2 + R_3$$

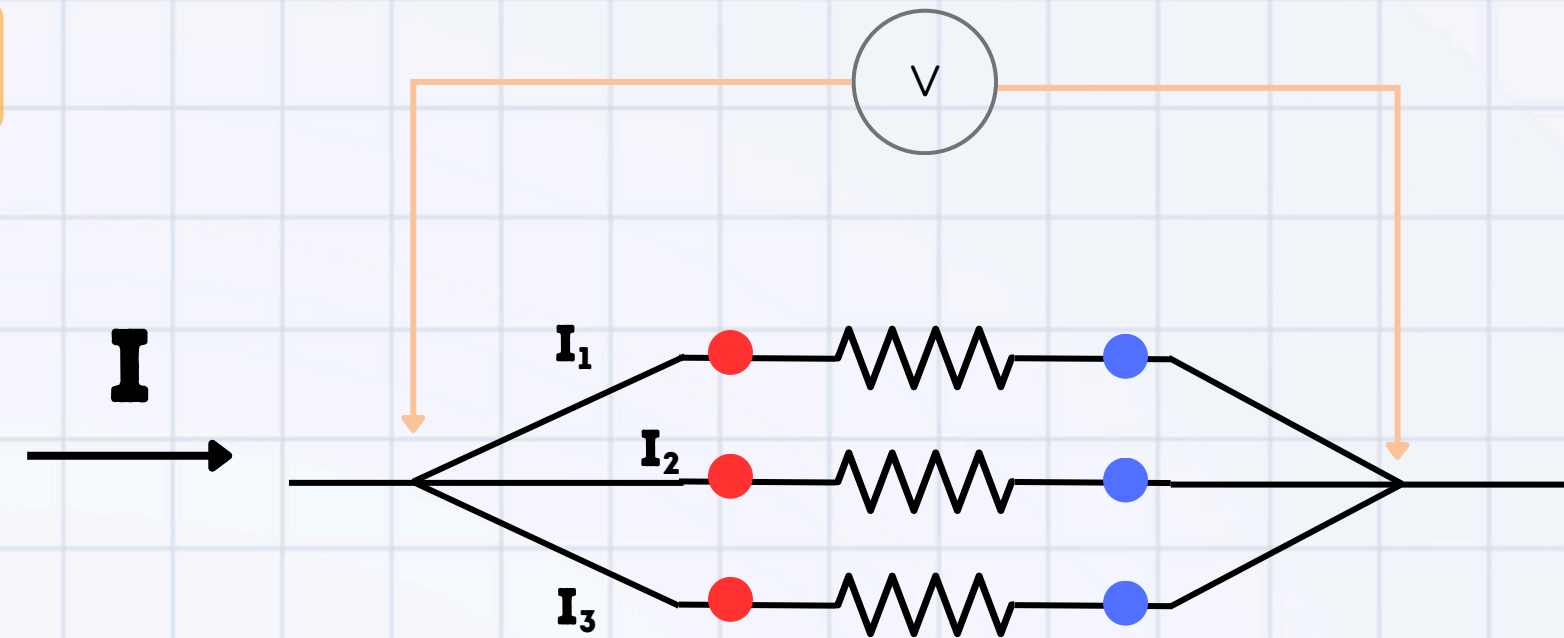
EQUIVALENT RESISTOR - PARALLEL



If same dots are together then it is
Parallel Combination

We are finding equivalent resistance,

- Equivalent Parallel resistance is the resistance which has **same effect of all resistance** connected in parallel.
- In parallel combination
 - Current is Different in all 'Resistances'
 - **Voltage is Same in all 'Resistance'**



Total Current is given by

$$I = I_1 + I_2 + I_3$$

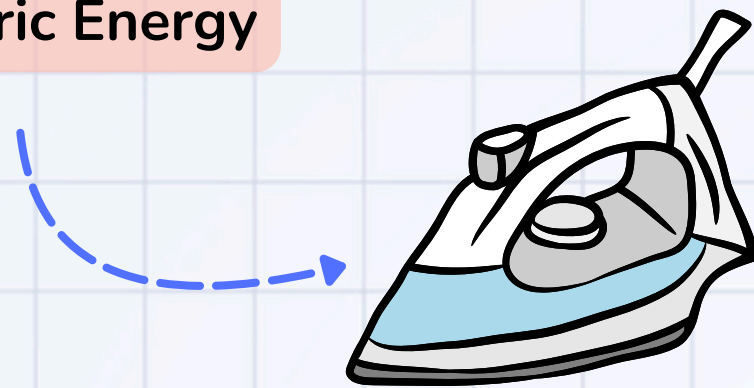
$$\frac{V}{R_{EQ_P}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{1}{R_{EQ_P}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

HEATING EFFECT OF ELECTRIC CURRENT

CONCEPT

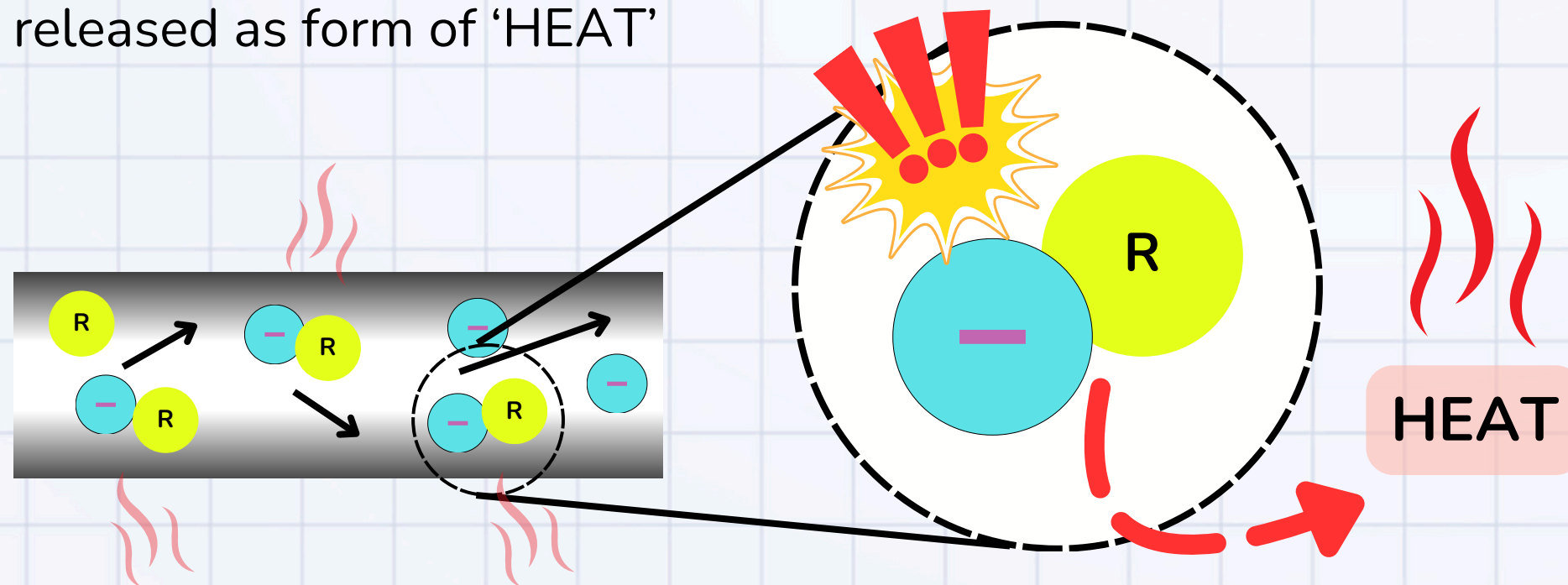
Electric Energy



Heat Energy

- When an electric current passes through a conductor, some of the **electrical energy** is **converted into heat energy**.
- This is called the **Heating Effect of Electric Current**.

Due to **Collision** of moving electrons with atoms, energy is released as form of 'HEAT'



$$H = I^2 \cdot R \cdot T$$

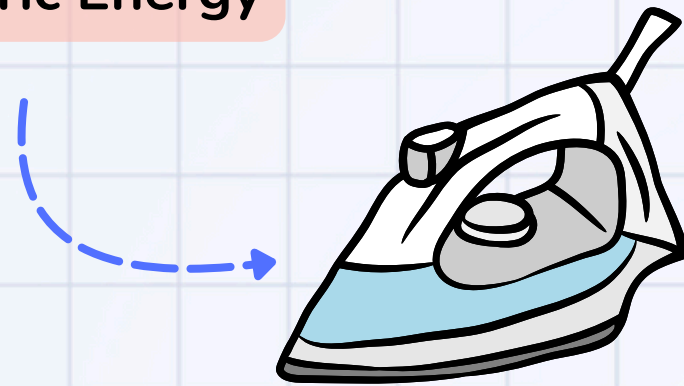
Where:

- H = Heat produced (Joules)
- I = Current (Ampere)
- R = Resistance (Ohm)
- T = Time (seconds)

HEATING EFFECT OF ELECTRIC CURRENT

APPLICATION

Electric Energy



Heat Energy

Electric Energy



Heat Energy

We humans know how to make use of everything.. Thus we created devices which seems waste but are useful

Application

- Electric heater / geyser / toaster / iron – converts electricity into heat.
- Electric bulb (filament lamp) – filament glows due to heating effect.
- Fuse wire – melts and breaks the circuit when excess current flows (safety use).

Important Points

- Greater current → more heat.
- Higher resistance → more heat.
- Longer time → more heat.
- Useful as well as harmful (too much heating can damage devices).

Dear Student,

I hope you find these notes helpful in your studies.

My motto in creating these notes is simple: to make learning more interesting, enjoyable and easy to understand for everyone.

If these notes spark your interest in studies, I would truly appreciate it if you could leave a review on my website—I'd love to hear your thoughts and feedback.

As for your marks, the credit belongs entirely to you—your dedication, hard work, and a little bit of luck.

Wishing you all the best for your future.
Keep shining, keep learning!

With warm regards,
Professor Phi
Indian YouTube Educator

