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Chapter-11

Electricity

→ Electricity
↘ Study of Charges

- Static Electricity
  ↘ Study of charges at rest
- Current Electricity
  ↘ Study of charges in motion

→ e^- (electron) flows from ⊖ to ⊕

* Conductors
↙ ↘ Allow the current to pass through them.
E.g. - Gold, Iron etc.

* Insulators
↙ ↘ Don't allow the current to pass through them.
E.g. - Plastic bottle,

Note:- Water is both Conductor and Insulator of Electricity.
Pure water - Insulator
Impured water - Conductor

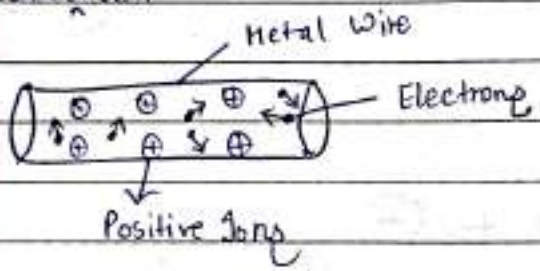
* How do Metals Conduct Electricity ?
↘

For any material to become good conductor of Electricity. They must possess free charge carriers.

- Metals ⟶ Have large nucleus
- Non-Metal ⟶ Have small nucleus

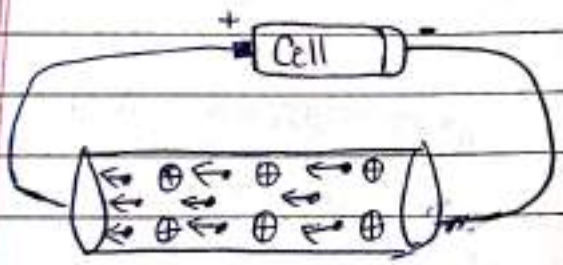
* Metal Wire :-

- With out Cell



Electrons are in random motion.

- With Cell



Electrons flow in definite motion.

* Direction of Conventional Current

+ve to -ve
(or in the opposite direction of electrons)

* Electric Charge :-

(+ve) (-ve)

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- Electrons carry a negative charge (-1.6×10^{-19}) and protons carry a positive charge ($+1.6 \times 10^{-19}$)
- (Charge) Symbol → Q —— SI unit (Coloumb) C

* Repel each other.

+ + ⟸ ⟹

+ − → ⟸

Attract each other

* Electric Current :-

→ SI unit - Ampere

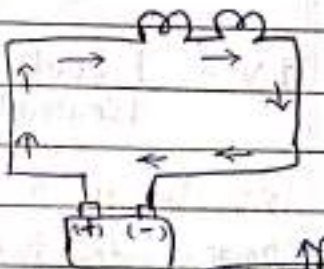
Rate of flow of electric charges. $I = \frac{Q}{t}$

Symbol I

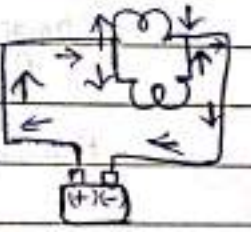
1 Ampere :- When 1 Coloumb of charge flows in circuit for 1 sec, the current is said to be of 1 ampere.

1 Coulomb :- When 1 ampere of current flows in circuit for 1 sec, the amount of charge circulated is of 1 Coulomb.

Note :- $mA = 10^{-3} A$



- Series Connection → (current) → I Same for all but V divides
- Parallel Connection → I will divide but V is same

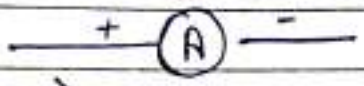


$I = I_1 + I_2 + I_3$

Resistance Low

* Ammeter → Applied in a series connection

→ used to Calculate the value of Current.



Symbol →

{Q} what is the difference of Ammeter and Galvanometer?

* Galvanometer

→ used to measure smaller currents, or Sensitive currents.

→ Show the direction of Current flowing

* Concept of Potential Difference

held

Water Tank are on the height because they create potential energy that's why the water is supplied to all taps.

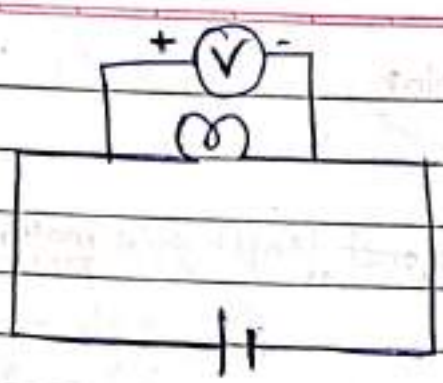
- Potential Difference → SI unit - volt

→ It is the work done per unit charge.

$V = \frac{\text{Work done}}{\text{Charge}}$

- $1\,V = \frac{1 \text{ Joule}}{1 \text{ Coulomb}}$
- 1V - When 1 Joule work is done in carrying one Coulomb charge then potential difference is called 1 volt.
- Measuring device - voltmeter → Resistance high

→ Applied in a parrallel connection



* Current depends upon Potential difference (voltage)

$I \uparrow V \uparrow$
$I = 0, V = 0$ $\Rightarrow V \propto I$
$I \downarrow V \downarrow$

→ Ohm's law

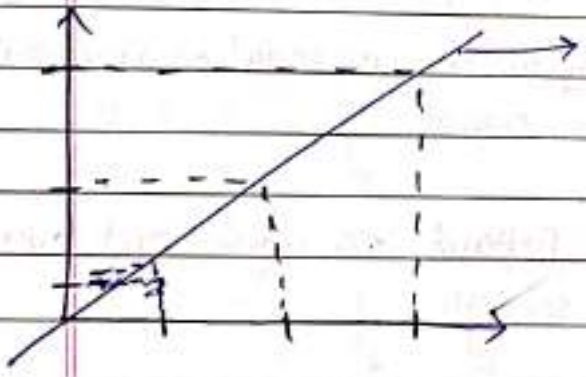
↓

So long as the circuit remains the same, the potential difference is directly proportional to the Current.

$V = IR$ → Resistance

↓

Constant



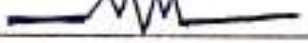
→ Slope represents Resistance

* Resistance :- → measuring device - ammeter

→ It is the property of a Conductor to resist the flow of charges through it.

↓

SI unit - Ohm (Ω)

Symbol — 

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* **Resistance of Conductor**

depends upon area, and length and material.

⇒ $R \propto \frac{1}{\text{area}}$

⇒ $R \propto \text{Length}$

$R \propto \frac{L}{a}$

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

$\rho \longrightarrow$ Rho $\rightarrow$ Resistivity

$\rho = \frac{RA}{L} \Rightarrow \frac{\Omega \times m^2}{m}$

$\rho = \Omega m$

* Resistance V/S Resistivity

	Resistance	Resistivity
i)	Ability of the conductor to oppose current.	i) Ability of the material of Conductor to oppose current.
ii)	Depends on length and area of Cross section.	ii) Not Depend on length and area of Cross section

* Combination of Resistors

• Resistance in Series

We know,

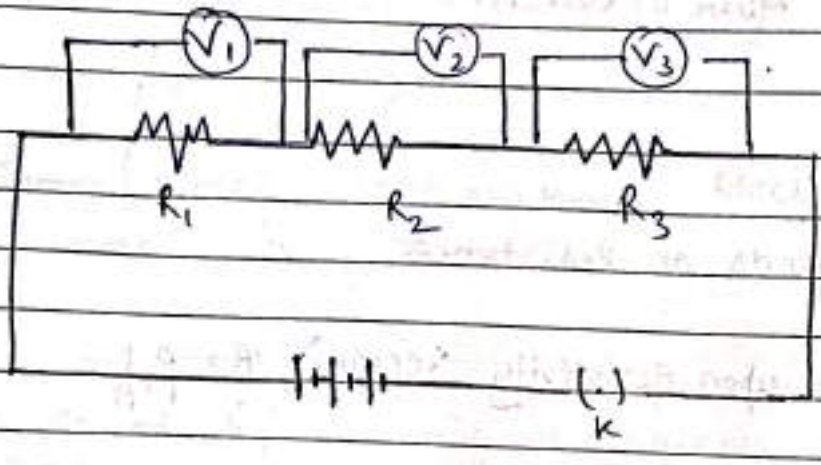
$V = V_1 + V_2 + V_3$

Now, According to Ohm's law, $V = IR$

$IR_S = IR_1 + IR_2 + IR_3$

$IR_S = I(R_1 + R_2 + R_3)$

$R_S = R_1 + R_2 + R_3$



- Resistance in Parallel

We know,

$I = I_1 + I_2 + I_3$

Now, According to ohm's law, $I = \frac{V}{R}$

$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$ {V is same in parallel connection}

$\therefore \frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

* Heat Crenerated :-

→ Heat Effect of Electric Current

• Joule's Law of Heating :-

Heat Generated in the Conductor is directly proportional to :-

- Time for which the Current is passed.
- Square of Current.
- Resistance.

$$H = I^2Rt$$

Hence, ∴ Heat depends on Resistance

Also depends upon Resistivity because, $R = \rho \frac{L}{A}$

$$H = VIt \quad \{V = IR\}$$

$$H = \frac{V^2t}{R} \quad \{I = \frac{V}{R}\}$$

* Electric Power :- → SI unit - Watt (W)

Work done per unit time

Common unit :-
1 Hp = 746 W
1 KW = 1000 W

$$P = \frac{W}{t}$$

$$P = VI$$

$$W = I^2R \quad \{V = IR\}$$

$$W = \frac{V^2}{R} \quad \{I = \frac{V}{R}\}$$

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Chapter-11 Electricity

→ Question Bank - Oswaal

1.) $W = QV$

2.) The circuit is incorrect because voltmeter ~~is~~ should be placed in parallel connection and ammeter ~~is~~ should be placed in a series connection.

3.) The function of galvanometer in a circuit is :-
i.) It is used to measure sensitive or small current.
ii.) It is used to detect the direction of flow of Current.

4.) Due to high resistivity of alloys rather than its constituting metals.

5.) The resistance will be high. In Parallel Connection, less current passes through high resistance. Hence, Current flowing in the circuit would not be disturbed and it can measure the correct value.

6.) Yes, the electrical ~~wire~~ resistance of both wires can be the same.

Justification :-
i.) If the cross-section area of the wires are different.
ii.) If the thickness of two wires is different.

7.) a.) The Ohm's law states that so long as the circuit remains the same, the potential difference is directly proportional to Electric Current.

Mathematical Representation for Ohm's law :-

$V \propto I$

or ~~$I = VR$~~ $V = IR$

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

where, R is a constant called Resistance of the given metal.

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b.) 1 Ohm = When the Potential difference is 1V and current through the circuit is 1A, then the Resistance is One Ohm, Since, $R = \frac{V}{I}$ or $1\text{ohm} = \frac{1V}{1A}$

c.) given:- Current = 0.5 A

Potential difference = 2 V

To find:- Resistance = ?

Now, Applying Ohm's law we have,

$$R = \frac{V}{I} \Rightarrow R = \frac{2}{0.5} = 4\,\Omega$$

Hence, the Resistance is 4 Ω

8.) a.) Factors on which the Resistance is dependent are:-

i.) Length of the Conductor:- Resistance is directly proportional to the length of the Conductor such that if the Length increases then Resistance increases or vice-versa.

ii.) Area of Cross Section:- Resistance is inversely proportional to the Area of Cross Section of the Conductor such that if the Area of Cross Section increases then Resistance decreases or vice-versa.

iii.) Temperature:- Resistance is directly proportional to the temperature such that the Temperature increases then Resistance also increases.

b.) 'r' of the wire = 0.01 cm = 0.0001m

Resistance of the wire is = 10 Ω

'a' of the wire = $3.14 \times (0.0001)^2\,m^2$ {Using :- πr^2}

Resistivity of the wire = 50×10^{-8}

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We know,

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

$L = \frac{Ra}{\rho}$

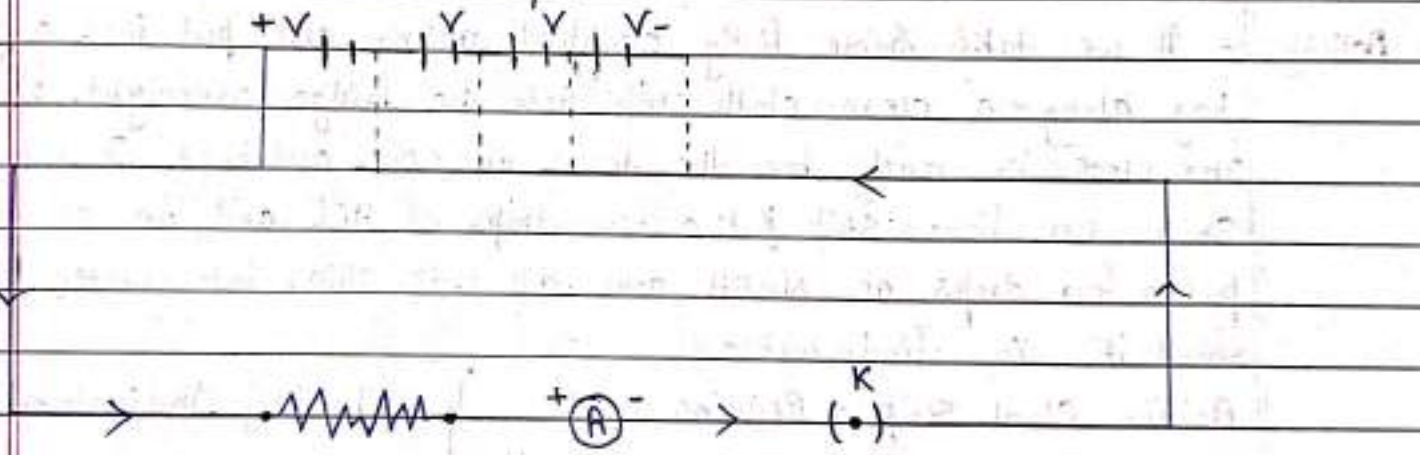
$= \frac{10 \times 3.14 \times (0.0001)^2}{50 \times 10^{-8}}$

$= 0.628\ m$

Hence, the length of the wire is 0.628 m.

9.) The graph shows that, $V \propto I$ ~~Resistance is~~ Potential difference is directly proportion to the Electric Current.

Electric Current for this Graph :-



10.) given:- $L = 1km = 1000\ m$

$a = 2 \times 10^{-2}\ cm^2 = 2 \times 10^{-2} \times 10^{-4}\ m^2$ $\{ 1\ cm^2 = 10^{-4}\ m^2 \}$

$\rho = 1.629 \times 10^{-8}\ \Omega m$

Using, $R = \rho \frac{L}{a}$

$= \frac{1.629 \times 10^{-8} \times 1000}{2 \times 10^{-2} \times 10^{-4}}$

$= 8.1\ \Omega$; Hence, the resistance of the copper wire is $8.1\ \Omega$

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All Activities - Acid, Bases & Salts

Activity 1:-

Solutions	Red litmus	Blue litmus	Phenolphthalein	Methyl orange
HCl	N.C.	Red	C.L.	Red
H_2SO_4	"	"	"	"
HNO_3	"	"	"	"
CH_3COOH	"	"	"	"
NaOH	B	N.C.	Pink	Yellow
$Ca(OH)_2$	"	"	"	"
KOH	"	"	"	"
$Mg(OH)_2$	"	"	"	"
NH_4OH	"	"	"	"

Activity 2:- If we take some finely chopped onions and put into a plastic bag along a clean cloth strip into the fridge overnight. Now, the cloth is ready for the test of acid and base. Take two cloth strip, on first strip put a few drops of HCl and on second strip put a few drops of NaOH and dip both strips into water and then smell it. You find out:-

Acidic Cloth strip - Retains Smell
Basic Cloth strip - Vanishes Smell
} olfactory Indicators

We can do same with vanilla essence & Clove oil.

Activity 3:- Take ~~##~~ Some pieces of zinc granuels into a test tube put Some dilluted H_2SO_4 into it Now you can see some bubbles on the surface of zinc granules. Connect the delivery tube to Soapy Solution now put a ~~Candle~~ Candle, you can observe a pop Sound because of the formation of hydrogen gas. If we touch the tube we feel warm — Exothermic.

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

Metal + Acid $\longrightarrow$ Salt + H_2

Activity 4:- Now, take Zinc granules into tube and put a few Solution of NaOH and warm the content. Similarly, we connect delivery tube to soapy solution now put candle and we observe the similar pop sound because of H_2 gas. But in this Reaction we give the heat to the contents — Endothermic.

$Zn + NaOH \longrightarrow Na_2ZnO_2 + H_2$

(Sodium Zincate)

Metal + Base $\longrightarrow$ Salt + H_2

Activity 5:- Take Some Na_2CO_3 or $NaHCO_3$ in a test tube and put some drop of ~~Het~~ dillute HCl. Now, the Gas which is realeased is passed through lime water and it turns milky such that we got to know that the Gas evolved is CO_2. Now, it turns milky because of Calcium Carbonate (Precipitate) which is insoluble in water.

$Na_2CO_3(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l) + Co_2(g)\uparrow$

$NaHCO_3(s)$ " " " "

Turns Milky :-

$Ca(OH)_2(aq) + Co_2(g) \longrightarrow CaCo_3(s) + H_2O(l)$

On passing excess CO_2, lime water becomes clear again :-

$CaCo_3(s) + H_2O(l) + Co_2(g) \longrightarrow Ca(HCO_3)_2(aq)$

{Calcium hydrogen Carbonate}

↓

Soluble in water

Acid + Metal Carbonate / Metal bi-carbonate $\longrightarrow$ Salt + CO_2 + H_2O

Base + Metal Carbonate / Metal bi-carbonate $\longrightarrow$ No Reaction

Basic in Nature

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Activity 6:- If we take an NaOH solution into Phenophthalein we can see the pink colour, but if we add HCl in the solution we can see that the Pink Colour of Phenophthalein ~~becomes~~ becomes Colourless because of the Reaction between Acids and Bases. And if again put NaOH solution the pink colour re-appear.

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

Activity 7:- Take small amount of Black Copper oxide and put a small amount of HCl into it and stirr it we can see that after some time the Solution became bluish green due to the formation of Copper Chloride.

$\therefore$ $HCl + CuO \longrightarrow CuCl_2(aq) + H_2O(l)$

Acid + Metal oxide $\longrightarrow$ Salt + Water

(Metal oxide: Basic in Nature)

Base + Non-Metallic oxide $\longrightarrow$ Salt + water

(Non-Metallic oxide: Acidic in Nature)

Activity 8:- If we take two nails and Connect them with a bulb through 6v battery and put some ~~drops of~~ amount of HCl then we can see that the bulb will glow. Because, Acids dissociate to Conduct electricity such that all acids have H^+ ions common. Similarly Base also dissociate to conduct electricity such that all bases have OH^- ions Common. But if we take glucose & alcohol then they will not dissociate the ions therefore the bulb doesn't glow.

Acid — $HCl \xrightarrow[\text{~~Electricity~~}]{\text{Water}} H^+ + Cl^-$

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Bases - $NaOH \xrightarrow{\text{Water}} Na^+ + OH^-$

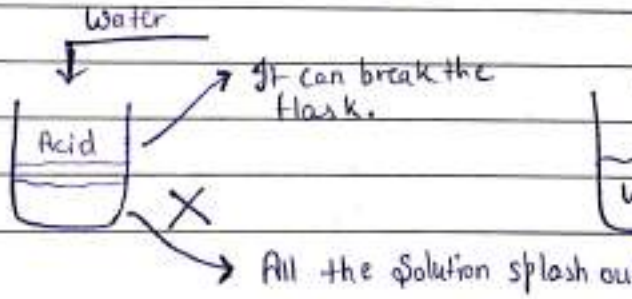
Activity 1:- Take 1 g of NaCl into a dry test tube and add some Concentrated Sulphuric Acid into it. We can see a gas coming out which is HCl (g), If we pass this gas through dry blue litmus paper then there is no change in colour because the acid shows its acidic nature in water, In water acids produce H^+ ions which are responsible for their acidic nature, if we pass this gas through wet blue litmus paper then it turned into red

$$NaCl(s) + H_2SO_4(aq) \longrightarrow HCl(g) + Na_2SO_4(aq)$$

If the place is humind then:

It absorbs the water (moisture) present inside the gas.

Activity 2:- Take 10ml water in a beaker add a few drops of HCl and Swirl the beaker slowly. If we touch the beaker we feel hot because adding acid into the water is a highly exothermic reaction in which ~~a large~~ heat is released.



This process is called Dilution.
decrease the Concentration of H^+ or OH^- ions.

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Activity 11:- How to identify Salt family

$NaCl$ and Na_2SO_4 — Both have Na which means that they both belong to Sodium Salt family

Na_2SO_4 and K_2SO_4 — Both have SO_4 which means that they both belong to Sulphate Salt family

Activity 12:- Take few crystal of Copper Sulphate which are Blue in Colour. They have fixed number of water molecules, if boil it into a dry test tube then it lost its water molecules and turns into white colour.

$$CuSO_4 . 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$$

If we put few drops of water on the Sample of Copper Sulphate then it again get its water molecules

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4 . 5H_2O$$

(Water of Crystallization)

Blue Colour Restored