
NDA-CDS 2 2024
GS
LIVE
PHYSICS
CLASS 10
NAVJYOTI SIR
SSBCrack EXAMS

11 July 2024 Live Classes Schedule

8:00AM	11 JULY 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	11 JULY 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

SSB INTERVIEW LIVE CLASSES

9:00AM	OVERVIEW OF GPE & PRACTICE SESSION	ANURADHA MA'AM

NDA 2 2024 LIVE CLASSES

1:00PM	GS - PHYSICS - CLASS 10	NAVJYOTI SIR
4:00PM	MATHS - BINARY NUMBERS	NAVJYOTI SIR
5:30PM	ENGLISH - SENTENCE COMPLETION - CLASS 1	ANURADHA MA'AM

CDS 2 2024 LIVE CLASSES

1:00PM	GS - PHYSICS - CLASS 10	NAVJYOTI SIR
5:30PM	ENGLISH - SENTENCE COMPLETION - CLASS 1	ANURADHA MA'AM

SSBCrack EXAMS

ELECTRICITY

WHAT WILL WE STUDY ?

- Charges and Static Electricity
- Coulomb’s Law of Electrostatics
- Electric Field
- Electric Potential and Potential Difference
- Electric Current
- Ohm’s Law
- Resistance and Resistivity
- Combination of Resistors
- Internal Resistance, Series and Parallel Combination of Cells
- Kirchoff’s Law
- Electric Energy, Power and Heating Effects

CHARGE

- **Charge is that property of an object by virtue of which it apply electrostatic force of interaction on other objects.**
- **Charges are of two types (i) Positive charge (ii) Negative charge**
- **Like charges repel and unlike charges attract each other.**

BASIC PROPERTIES OF CHARGE

Additivity of Charge

If a system consists of n charges $q_1, q_2, q_3 \ldots\ldots\ldots q_n$, then the total charge of the system will be $q_1 + q_2 + q_3 + q_4 + \ldots\ldots + q_n$.

- **Quantisation of Charge : Charge on any object can be an integer multiple of a smallest charge (e).**

charge on an electron,

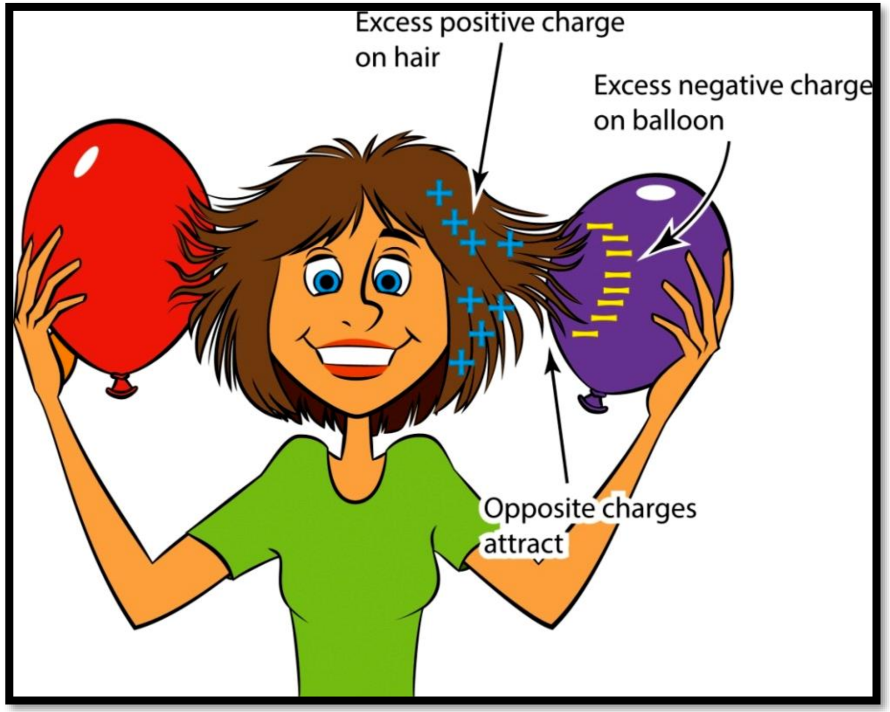
$$Q = \pm ne$$

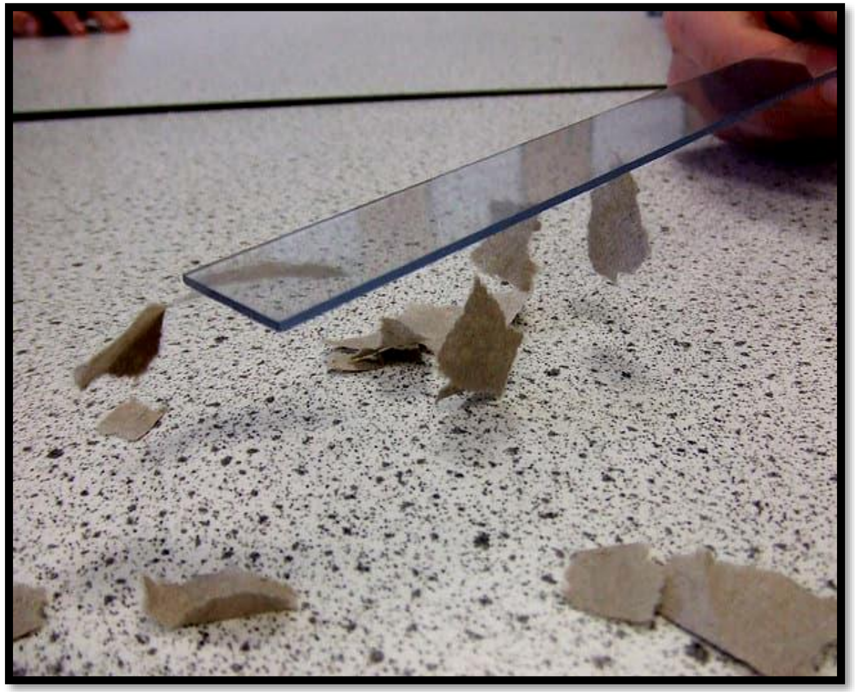
where, $n = 1, 2, 3, \ldots$ and $e = 1.6 \times 10^{-19}$ C.

SI unit of charge = Coulomb.

- **Conservation of Charge : Charge can neither be created nor be destroyed, but can be transferred from one object to another object.**

STATIC ELECTRICITY

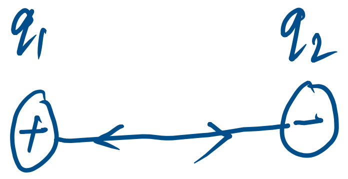




charges are not moving,

Coulomb's Law

- **The force of interaction between any two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.**



Forces of equal magnitude,

$$-\frac{kq_1q_2}{r^2}$$

Suppose two point charges q_1 and q_2 are separated in vacuum by a distance r, then force between two charges is given by

$$F_e = \frac{K|q_1q_2|}{r^2}$$

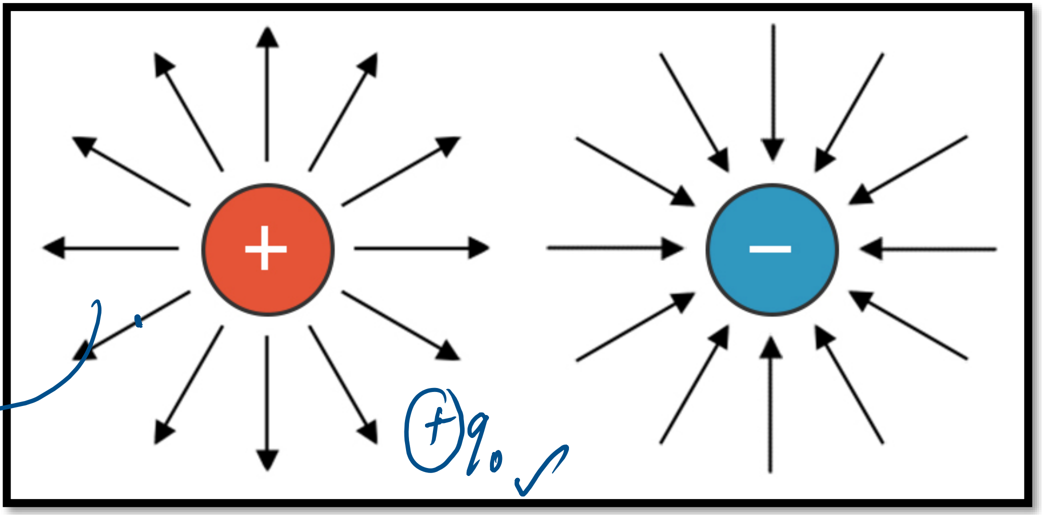
F_e can be attractive & repulsive,

$F_e < 0$ — attractive, $F_e > 0$ — repulsive,

Electric Field

- The space in the surrounding of any charge in which its influence can be experienced by other charges.

Electric field intensity $\mathbf{E} = \lim_{q_0 \to 0} \frac{\mathbf{F}}{q_0}$



Lines of electric field

- It is a vector quantity and its direction is in the direction of electrostatic force acting on positive charge.
- Its SI unit is NC^{-1} or V/m.

ELECTRIC POTENTIAL

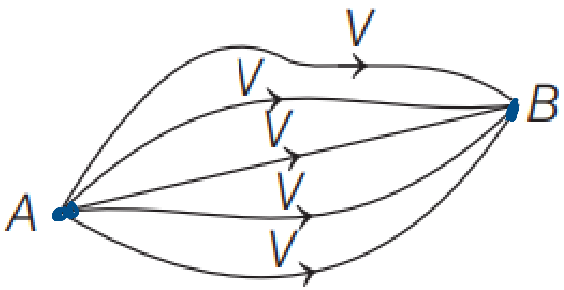
- **Electric potential at any point is equal to the work done per unit positive charge in carrying it from infinity to that point in electric field.**

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

- **It is a scalar quantity. Its SI unit is J/C or volt.**

POTENTIAL DIFFERENCE / Voltage

- **The potential difference between two points A and B is equal to the work done by the external force in moving a unit positive charge against the electrostatic force from point B to A along any path between these two points.**

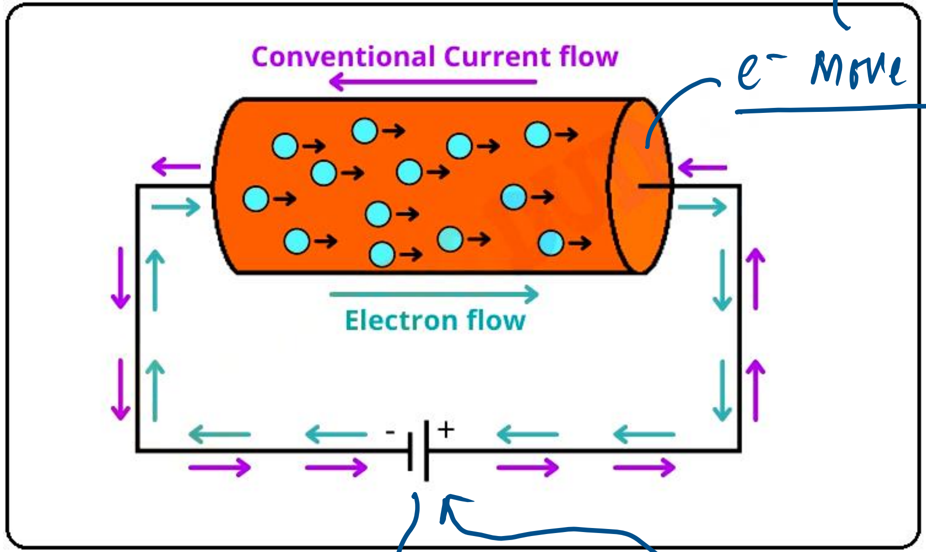


$$\Delta V = \frac{W_{AB}}{q}$$

ELECTRIC CURRENT

- Electric current $(I) = \frac{q}{t}$. Its SI unit is ampere (A).

- The conventional direction of electric current is opposite to the direction of motion of electrons.



drifting of e^- } drift velocity (v_d)

e^- move towards +ve terminal of battery (because of electric field creation)

potential difference / voltage

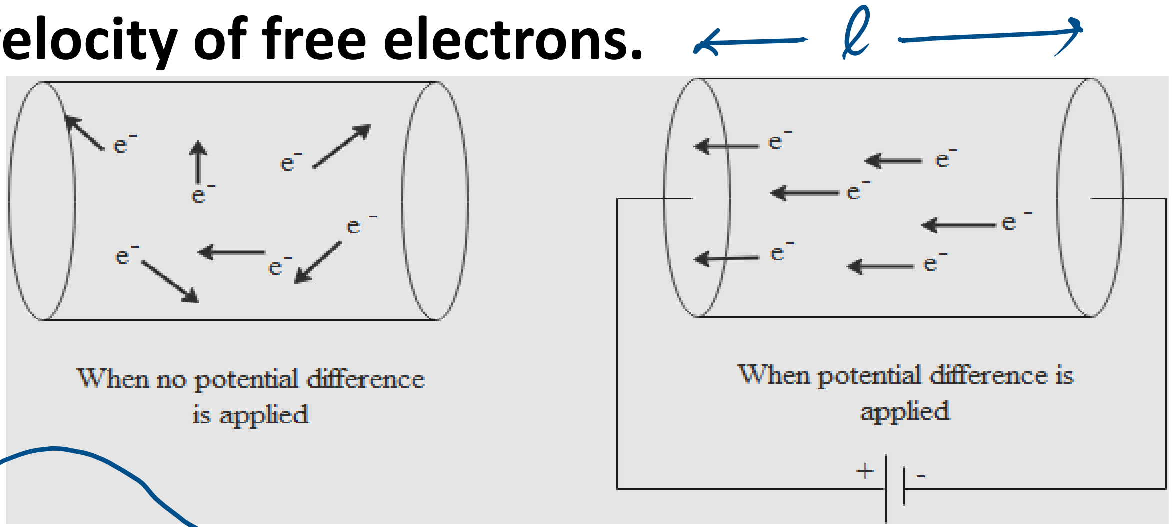
DRIFT VELOCITY

When a potential difference is applied across the ends of a conductor, the free electrons in it move with an average velocity opposite to the direction of electric field, which is called drift velocity of free electrons.

$$v_d = \frac{eE\tau}{m} = \frac{eV\tau}{ml}$$

$E = \frac{V}{l}$

τ – avg. relaxation time – avg. time of collision of e^-,



Relation between electric current and drift velocity is given by

$$v_d = \frac{I}{An\,e} \quad / \quad I = neAv_d$$

n – no. of e^- per unit vol. of conductor

A – Area of cross section of conductor

(#) OHM's LAW

- **If physical conditions of a conductor such as temperature remains unchanged, then the electric current (I) flowing through the conductor is directly proportional to the potential difference (V) applied across its ends.**

$$I \propto V \quad \text{or} \quad V = IR$$

where, R is the electrical resistance of the conductor and $R = \dfrac{ml}{Ane^2\tau}$

$I = \frac{1}{R}(V) \Rightarrow V = IR$

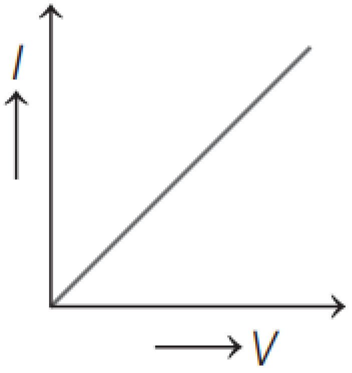
$v_d = \frac{eV\tau}{ml} \Rightarrow V = \frac{v_d\, ml}{e\tau}$, $I = neAv_d$

OHMIC AND NON-OHMIC RESISTANCES

Ohmic Conductors

Those conductors which obey Ohm's law, are called ohmic conductors, *e.g.* all metallic conductors are ohmic conductor.

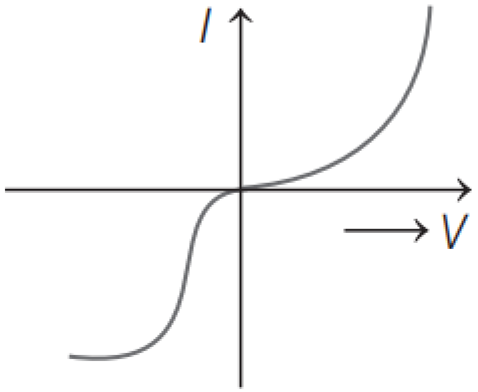
For ohmic conductors *V-I* graph is a straight line.



Non-ohmic Conductors

Those conductors which do not obey Ohm's law, are called non-ohmic conductors, *e.g.* diode valve, triode valve, transistor , vacuum tubes etc.

For non-ohmic conductors *V-I* graph is not a straight line.



RESISTANCE

- **The obstruction offered by any conductor in the path of flow of current is called its electrical resistance.**

Electrical resistance of a conductor, $R = \frac{\rho l}{A}$

where, l = length of the conductor, A = cross-section area

and ρ = resistivity of the material of the conductor.

SI unit → Volt A^{-1}

or ohms

(Ω)

$$R = \frac{ml}{ne^2 A\tau} = \rho \frac{l}{A}$$

where, ρ → resistivity of material,

$$\rho = \left(\frac{m}{ne^2\tau}\right)$$

Factors

1. $R \propto l$ – Length of conductor
2. $R \propto \frac{1}{A}$, area of cross section

RESISTIVITY

Resistivity of a material of a conductor is given by

$$\rho = \frac{m}{ne^2\tau}$$

where, n = number of free electrons per unit volume.

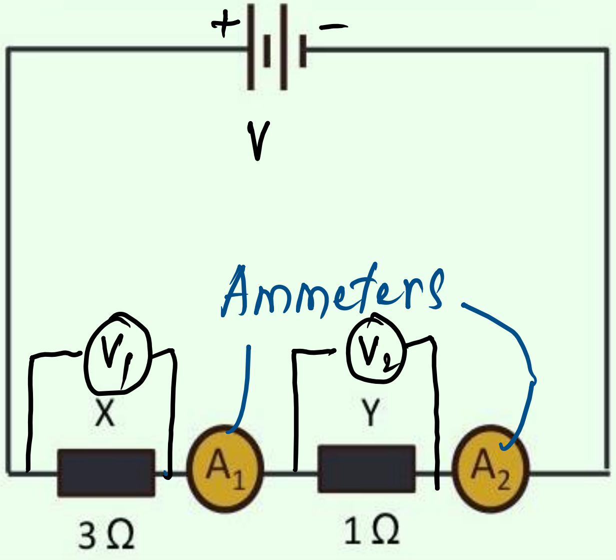
Resistivity is low for metals, more for semiconductors and very high for alloys like nichrome, constantan etc.

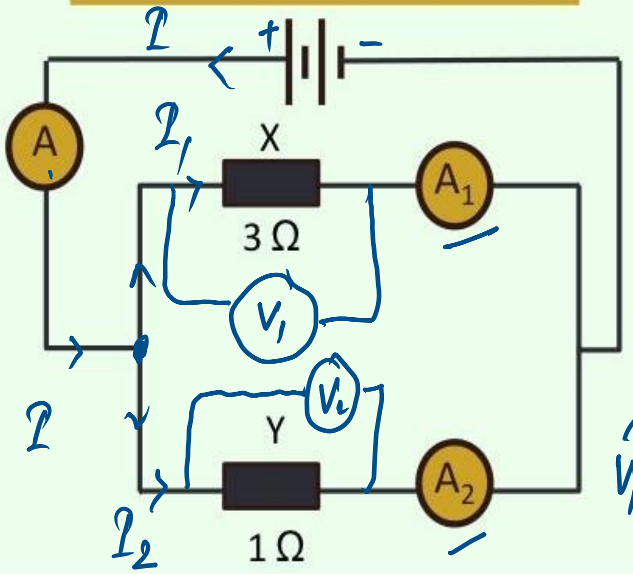
Resistivity of a material depend on temperature and nature of the material. It is independent of dimensions of the conductor, *i.e.* length, area of cross-section etc.

factors → Resistivity
- nature of material
- temperature

COMBINATION OF RESISTORS

Series Circuit	Parallel Circuit





Series Circuit	Parallel Circuit
Current has only one path to flow ✓	Current splits into different paths
Reading on A1 = Reading on A2	Reading on A = Reading on A1 + A2
Same current flows through each resistors	Main current is shared between the two resistors

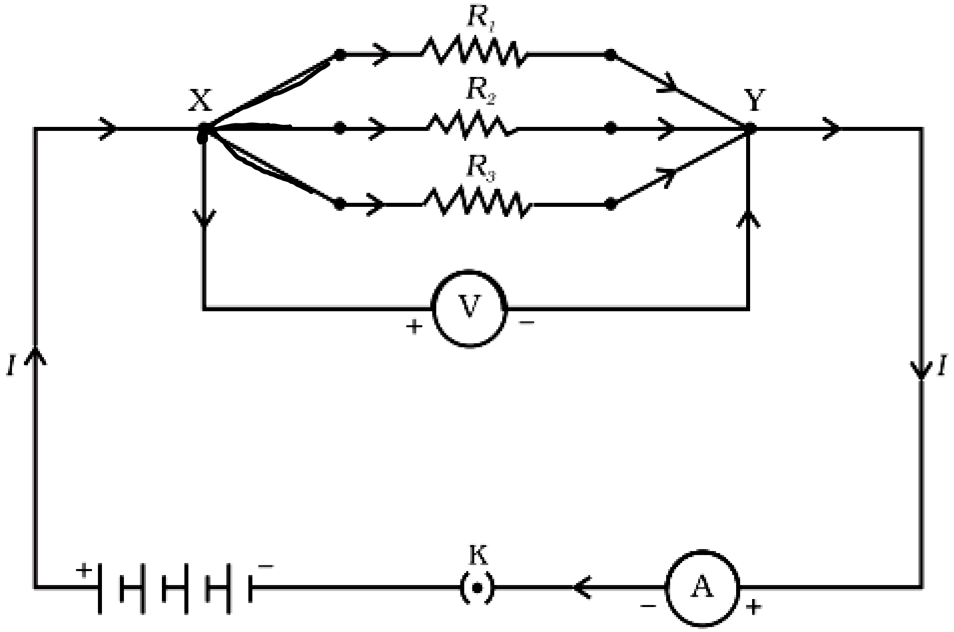
A_1, A_2 — device to measure current

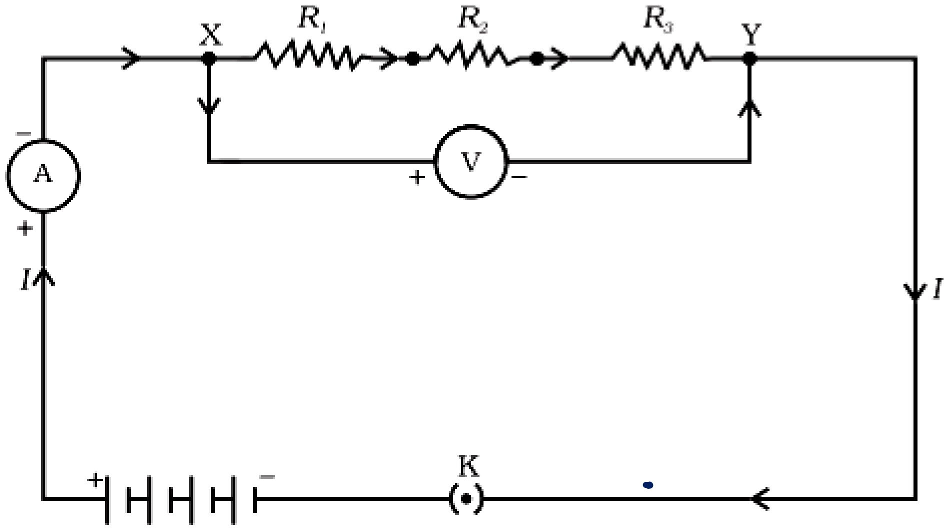
$V_1 = V_2$

$I = I_1 + I_2$

$V = V_1 + V_2$

COMBINATION OF RESISTORS





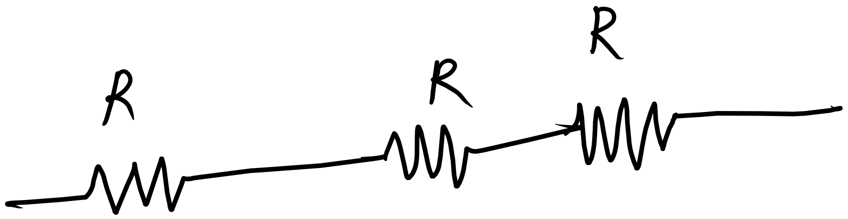
(parallel connection) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

(series) $R = R_1 + R_2 + R_3$

for 2 resistors, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_2 + R_1}{R_1 R_2} \Rightarrow R = \frac{R_1 R_2}{R_1 + R_2}$

for n equal resistances $R\,\Omega$,

Total resistance,



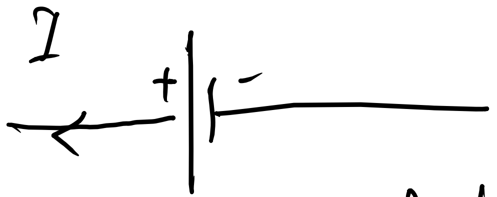
→ SERIES : Total resistance $= R + R + R \ldots$ n times

(R_t) $\boxed{R_t = nR}$

→ PARALLEL : Total resistance (R_t) $\Rightarrow \dfrac{1}{R_t} = \dfrac{1}{R} + \dfrac{1}{R} + \cdots \dfrac{1}{R}$

$$\frac{1}{R_t} = \frac{n}{R} \Rightarrow \boxed{R_t = \frac{R}{n}}$$

CELLS AND INTERNAL RESISTANCE



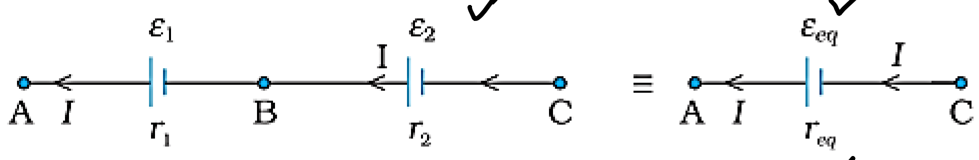
r — internal resistance (resistance from cell)

$$V = \mathcal{E} - Ir$$

$\mathcal{E}$ — emf

V — voltage

CELLS – SERIES AND PARALLEL CONNECTION



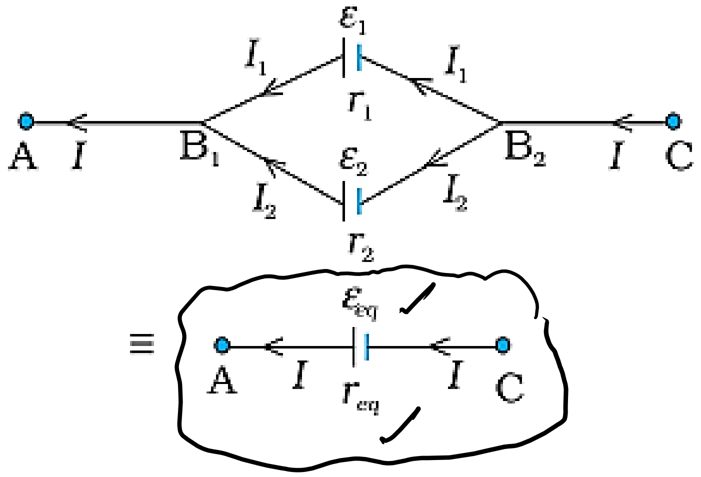
(Series)

$$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$$

$$r_{eq} = r_1 + r_2$$

$$I = \frac{\varepsilon_{eq}}{r_{eq}}$$

CELLS – SERIES AND PARALLEL CONNECTION



$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \ldots + \frac{1}{r_n}$$

$$\frac{\varepsilon_{eq}}{r_{eq}} = \frac{\varepsilon_1}{r_1} + \ldots + \frac{\varepsilon_n}{r_n} \quad — \quad \varepsilon_{eq} = \left(\frac{\varepsilon_1}{r_1} + \ldots\right) r_{eq}$$

For 2 cells,

Total emf, — $$\varepsilon = \frac{\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$$

KIRCHOFF'S LAWS

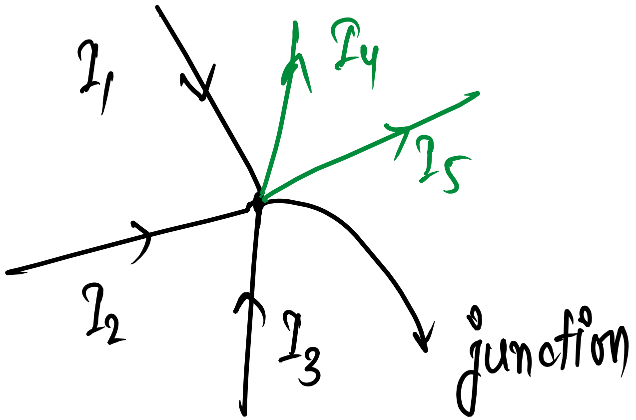
(i) **Junction Rule** The algebraic sum of all currents meeting at a junction in a closed circuit is zero, *i.e.* $\Sigma I = 0$.
This law follows law of conservation of charge.

(sum of currents)$_{in}$ = (sum of currents)$_{out}$

(ii) **Loop Rule** The algebraic sum of all the potential differences in any closed circuit is zero, *i.e.*

$$\Sigma \Delta V = 0$$

This law follows law of conservation of energy.



$$I_1 + I_2 + I_3 - I_4 - I_5 = 0$$

$$I_1 + I_2 + I_3 = I_4 + I_5$$

ELECTRIC ENERGY

The energy supplied by any source in maintaining the current in the electric circuit is called electric energy consumed by the electric circuit.

$$\text{Electric energy } (W) = Vq = VIt = I^2Rt = \frac{V^2}{R}t$$

Its SI unit is joule (J) but another unit is watt-hour. The bigger unit of electric energy is kilowatt hour (kWh). It is known as Board of Trade (BOT) unit.

$$1 \text{ kilowatt hour} = 1000 \text{ watt} \times 1 \text{ hour}$$
$$= 1000 \text{ J/s} \times 3600 \text{ s}$$
$$= 3.6 \times 10^6 \text{ J}$$

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

$W = Vq$

work done as electrical energy,

$W = V(I \times t)$

$E = VIt$

ELECTRIC POWER

The electrical energy produced or consumed per unit time is called electric power.

$$\text{Electric power, } P = VI = I^2R = \frac{V^2}{R}$$

where, V is the potential difference across the conductor, I is current flowing through the conductor and R is the resistance.

Its SI unit is watt (W).

$E = VIt$

$\text{Power} = \frac{E}{t} = VI$

VI

$V\left(\frac{V}{R}\right) = \frac{V^2}{R}$ (parallel connection)

$(IR)I = I^2R$ (series connection)

HEATING EFFECT

- When current I flows through a conductor of resistance R for a time t, then heat generated in it is given by ,

$$H = I^2Rt$$

Joule's law of heating,

$H \propto I^2$

$H \propto R$

$H \propto t$ (current flow time — appliance is switched on time)

SUMMARY

- Charges and Static Electricity
- Coulomb’s Law of Electrostatics
- Electric Field
- Electric Potential and Potential Difference
- Electric Current
- Ohm’s Law
- Resistance and Resistivity
- Combination of Resistors
- Kirchoff’s Law
- Electric Energy and Heating Effects

Which one of the following is primarily responsible for conduction of current in a metal ?

(a) Bound electrons

(b) Free electrons

(c) Both bound and free electrons

(d) Ions

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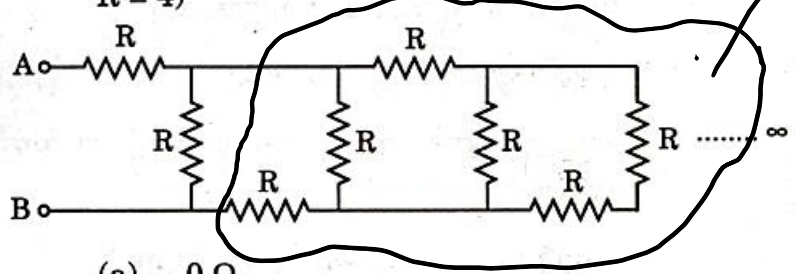
(d) Ions

ANS : B

An infinite combination of resistors, having resistance R = 4 Ω, is given below. What is the net resistance between the points A and B ? (Each resistance is of equal value, R = 4)

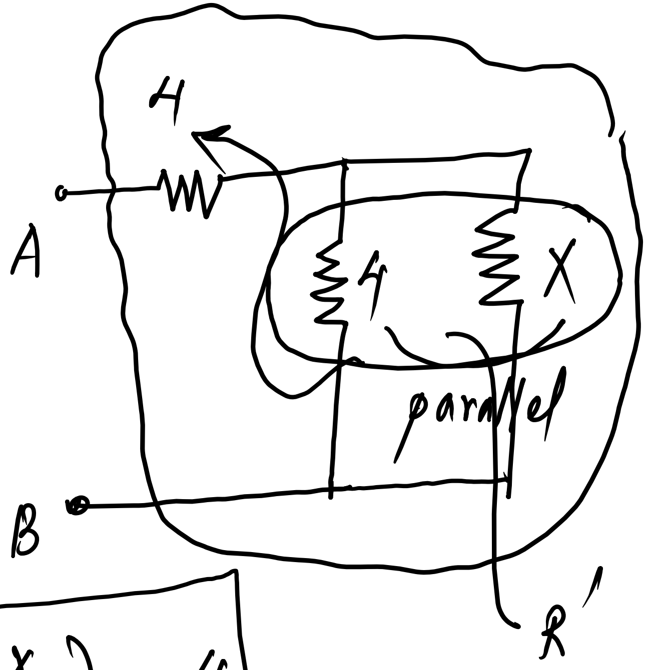


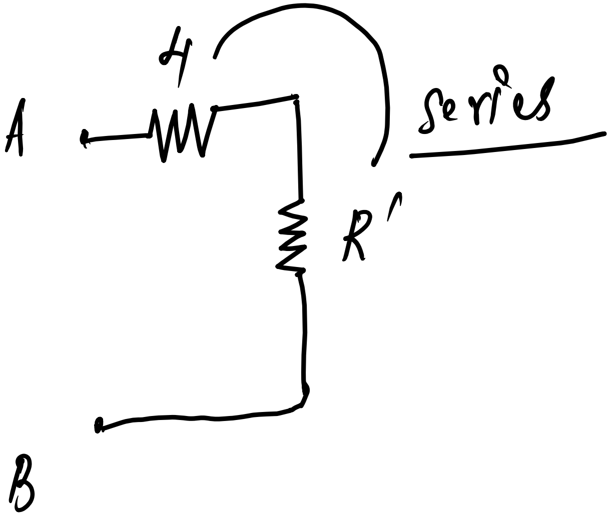
(a) 0 Ω

(b) $2+2\sqrt{5}$ Ω ✓

(c) $2+\sqrt{5}$ Ω

(d) ∞ Ω





$$X = \left(\frac{4X}{4+X}\right) + 4$$

R'

$$4X + X^2 = 4X + 16 + 4X$$

$$X^2 - 4X - 16 = 0$$

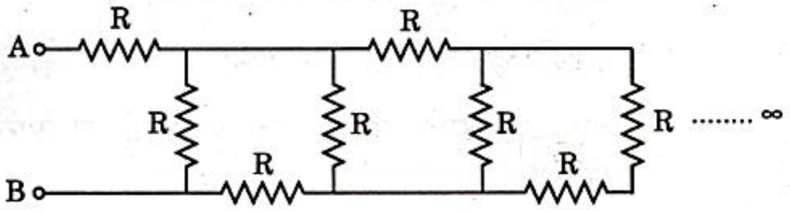
$$X = \frac{4 \pm \sqrt{16+64}}{2}$$

$$X = \frac{4 \pm \sqrt{80}}{2} = \frac{4 \pm 4\sqrt{5}}{2}$$

$2 + 2\sqrt{5}$

$2 - 2\sqrt{5}$ (-ve – not possible)

An infinite combination of resistors, having resistance R = 4 Ω, is given belo\. What is the net resistance between the points A and B ? (Each resistance is of equal value, R = 4)



(a) 0 Ω

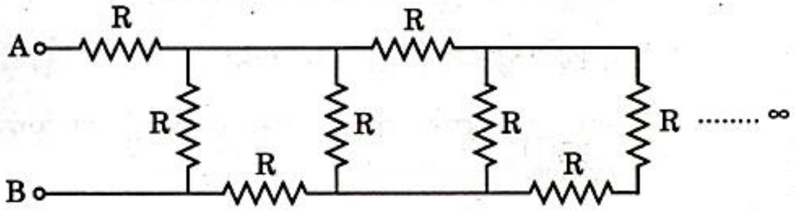
(b) $2+2\sqrt{5}\ \Omega$

(c) $2+\sqrt{5}\ \Omega$

(d) ∞ Ω

Answer: (B)

51. An infinite combination of resistors, each having resistance R = 4 Ω, is given below. What is the net resistance between the points A and B ? (Each resistance is of equal value, R = 4)



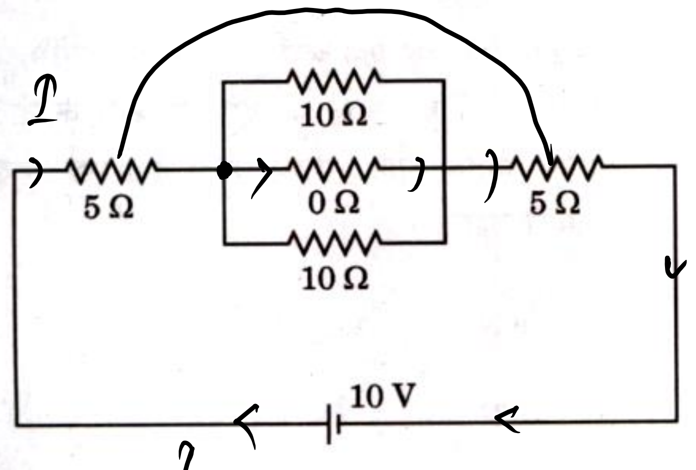
(a) 0 Ω

(b) $2 + 2\sqrt{5}$ Ω

(c) $2 + \sqrt{5}$ Ω

(d) ∞ Ω

Consider the following electric circuit :



The current in the above electric circuit is :

(a) 1 A

(b) (10/15) A

(c) 2 A

(d) 1·5 A

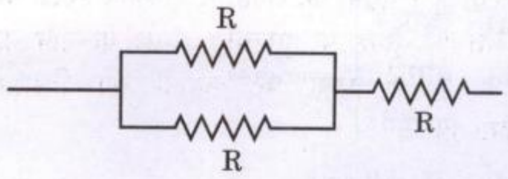
current will always go through least resistive path.

So, path is having only 5 Ω and 5 Ω in series,

$R = 5 + 5 = 10\ \Omega$

$I = \frac{V}{R} = \frac{10V}{10\ \Omega} = 1\text{ A}$

1. What is the total resistance in the following circuit element ?



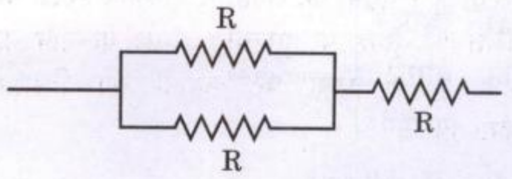
(a) R/2

(b) 3R

(c) 3R/2

(d) 2R/3

What is the total resistance in the following circuit element ?



(a) R/2

(b) 3R

(c) 3R/2

(d) 2R/3

Answer: (C)

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The cost of energy to operate an industrial refrigerator that consumes 5 kW power working 10 hours per day for 30 days will be
(Given that the charge per kW.h of energy = ₹ 4)

(a) ₹ 600

(b) ₹ 6,000

(c) ₹ 1,200

(d) ₹ 1,500

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(a) ₹ 600

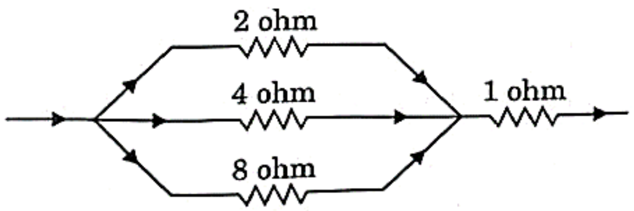
(b) ₹ 6,000

(c) ₹ 1,200

(d) ₹ 1,500

Answer: (B)

Consider the following part of an electric circuit :



The total electrical resistance in the given part of the electric circuit is

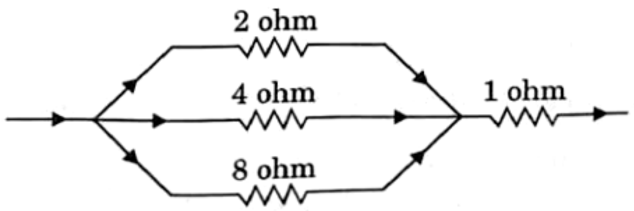
(a) $\frac{15}{8}$ ohm

(b) $\frac{15}{7}$ ohm

(c) 15 ohm

(d) $\frac{17}{3}$ ohm

Consider the following part of an electric circuit :



The total electrical resistance in the given part of the electric circuit is

(a) $\frac{15}{8}$ ohm

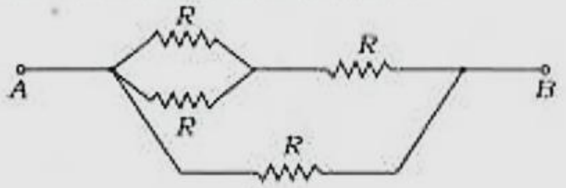
(b) $\frac{15}{7}$ ohm

(c) 15 ohm

(d) $\frac{17}{3}$ ohm

Answer: (B)

Consider the following circuit :



Which one of the following is the value of the resistance between points A and B in the circuit given above?

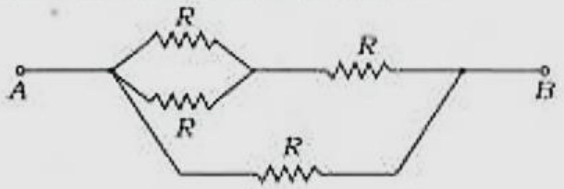
(a) $\frac{2}{5}R$

(b) $\frac{3}{5}R$

(c) $\frac{3}{2}R$

(d) $4R$

Consider the following circuit :



Which one of the following is the value of the resistance between points A and B in the circuit given above?

(a) $\frac{2}{5}R$

(b) $\frac{3}{5}R$

(c) $\frac{3}{2}R$

(d) $4R$

Answer: (B)

Which one of the following is the value of 1 kWh of energy converted into joules ?

(a) $1{\cdot}8 \times 10^6$ J

(b) $3{\cdot}6 \times 10^6$ J

(c) $6{\cdot}0 \times 10^6$ J

(d) $7{\cdot}2 \times 10^6$ J

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Which one of the following is the value of 1 kWh of energy converted into joules ?

(a) $1{\cdot}8 \times 10^6$ J

(b) $3{\cdot}6 \times 10^6$ J

(c) $6{\cdot}0 \times 10^6$ J

(d) $7{\cdot}2 \times 10^6$ J

Answer: (B)

Which one of the following devices is non-ohmic ?

(a) Conducting copper coil

(b) Electric heating coil

(c) Semi conductor diode

(d) Rheostat

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(b) Electric heating coil

(c) Semi conductor diode

(d) Rheostat

Answer: (B)

NDA & CDS 2 2024 PHYSICS - CLASS 11

Which one of the following can charge an insulator ?

(a) Current electricity

(b) Static electricity

(c) Magnetic field

(d) Gravitational field

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Answer: (B)

A current of 1·0 A is drawn by a filament of an electric bulb for 10 minutes. The amount of electric charge that flows through the circuit is

(a) 0·1 C

(b) 10 C

(c) 600 C

(d) 800 C

A current of 1·0 A is drawn by a filament of an electric bulb for 10 minutes. The amount of electric charge that flows through the circuit is

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(c) 600 C

(d) 800 C

Answer: (C)

9. Which one of the following correctly represents the SI unit of resistivity?

(a) Ω

(b) Ω / m

(c) Ω cm

(d) Ω m

9. Which one of the following correctly represents the SI unit of resistivity?

(a) Ω

(b) Ω / m

(c) $\Omega\,cm$

(d) $\Omega\,m$

Answer: (D)

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Which one of the following formulas does ***not*** represent electrical power ?

(a) $I^2 R$

(b) $I R^2$

(c) $V I$

(d) V^2 / R

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(c) $V I$

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Answer: (B)

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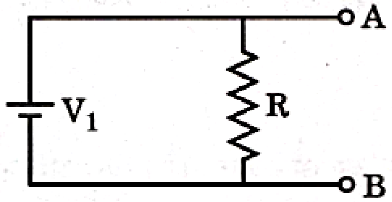
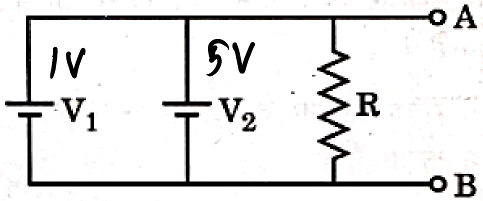
An electric circuit is given below. $V_1 = 1$ V and Resistance $R = 1000\ \Omega$.



The current through the resistance R is very close to 1 mA and the voltage across point A and B, $V_{AB} = 1$ V. Now the circuit is changed to :



where value of $V_2 = 5$ V. The internal resistances of both the batteries are $0{\cdot}1\ \Omega$. The current through the resistance R is about :

(a) 1·0 mA

(b) 1·2 mA

(c) 3·0 mA

(d) 5·0 mA

V_1, V_2 as given in question,

$$\text{Total voltage} = \frac{\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{\frac{1}{0.1} + \frac{5}{0.1}}{\frac{1}{0.1} + \frac{1}{0.1}} = \frac{6}{2} = 3\text{ V}$$

$$I = \frac{\text{Total voltage}}{R} = \frac{3}{1000} = 3.0 \times 10^{-3}\text{ A}$$

$$= 3.0\text{ mA}$$

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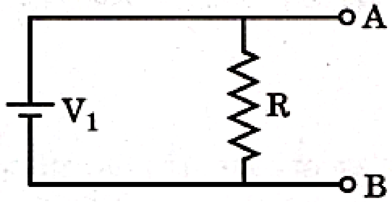
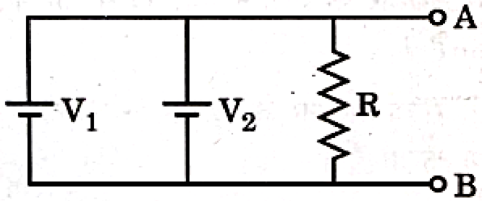
An electric circuit is given below. $V_1 = 1$ V and Resistance R = 1000 Ω.



The current through the resistance R is very close to 1 mA and the voltage across point A and B, $V_{AB} = 1$ V. Now the circuit is changed to :



where value of V_2 = 5 V. The internal resistances of both the batteries are 0·1 Ω. The current through the resistance R is about :

(a) 1·0 mA

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(d) 5·0 mA

ANS : C


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