* D.C circuits *

Electric current:

⇒ It is defined as the rate of flow of charge through a conductor that is called electric current (I).

i.e $I = \frac{Q}{t} = \frac{dQ}{dt}$. IS SI unit is Ampere (A).

It is a scalar quantity.

Types of Electric current.

⇒ Generally, their are two types of Electric current.

① Direct current
② Alternating current (A.C).

* Direct current (D.C)

⇒ The electric current whose magnitude and direction is constant throughout in an electric circuit. It is denoted by '⟶'

* Alternating current (A.C)

⇒ It is the electric current whose magnitude changes continously with time but direction reverse perodically. It is denoted by ∿

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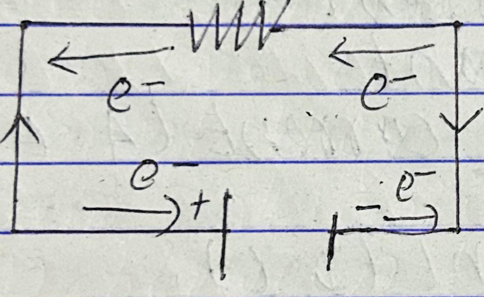
* Electric current (I)
=) It is defined as the

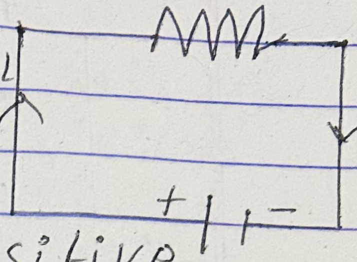
* one ampere :- It is defined as the amount of electric current when 1 coulomb charge is passed through a conductor in one second.

* Direction of current:
(i) Direction of conventional current:



* current density ($\vec{J}$).
i.e $\vec{J} = \frac{I}{A}$.
=) It is defined as the current a passing through until cross-section area held perpendicular to the direction of the current. It is vector quantity. It SI unit is ampere/m^2.

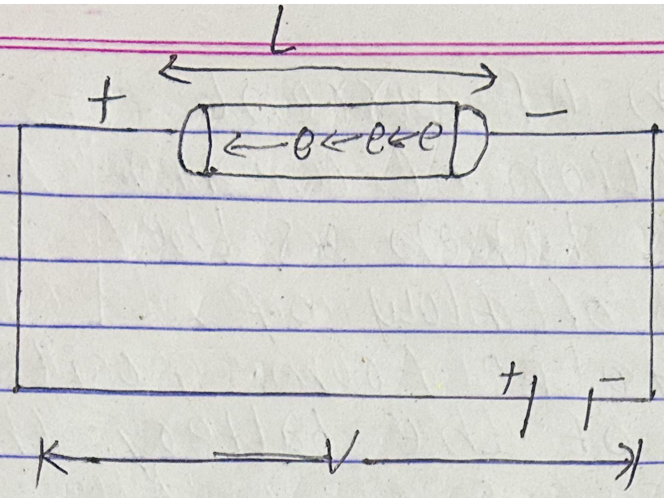
* Direction of current.



⇒ The direction of conventional current is taken as the direction of flow of −ve charge i.e from positive terminal of the battery through the circuit.

(ii) Direction of electric current.
⇒ The direction of electric current as the direction of flow of electron i.e from −ve terminal to +ve terminal of a battery through the circuit.

* Mechanism of metallic conduction:
÷ Drift velocity.
⇒ A metal contains a large no. of free electrons. Due to the motion of these free electrons, metallic conduction is developed. In the absence of an electric field, the free electron moves randomly in all posible directions so that their resultant velocity comes out be zero. Thus, the net flow of electron will be zero. Hence, no current will flow through the conductor.



when an electric field is applied across a metallic conductor, the free electrons moves frove -ve terminal to +ve positive terminal of the battery through the conductor. on their movement they collide with the +ve ions at which they are retarded. Again between two sucessive collisions. ~~Again between~~ they are accolerated by the applied electric field.

In this way the electron moves with an average velocity from '-ve' terminal to '+ve' terminal of the battry through the conductor. This average velocity is called drift velocity.

Therefore, drift velocity of an electron is its avarage velocity with which

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the electron moves from -ve terminal to -ve terminal of the battary when electric field is applied.

Expression for drift velocity.

consider a metallic conductor of length 'l' and cross section area, A.
volume of the conduct = A*l
If n be the no. of electrons per unit volume of the conductor,

The total no. of electrons containing in the conductor = n·A·l

Let e be be the charge of an electron.
total charge in the conductor = q = n·A·l·e

when a p.d (V) is applied across the conductor, the charge, q flows through the conductor in a given time, t
Then

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

$$or, I = \frac{q}{t}$$

$$or, I = \frac{n \cdot A \cdot l \cdot e}{t}$$

$= n \cdot A \cdot e \left(\frac{L}{t}\right)$.

$I = V_d \cdot enA$ · where, $V_d = \frac{L}{t}$ = drift velocity of electron.

$\therefore V_d = \frac{I}{enA}$

If J be the current density.

$J = \frac{I}{A}$

or, $J = \frac{V_d e n A}{A}$

$\therefore J = V_d e n$

* **Ohm's Law** ÷

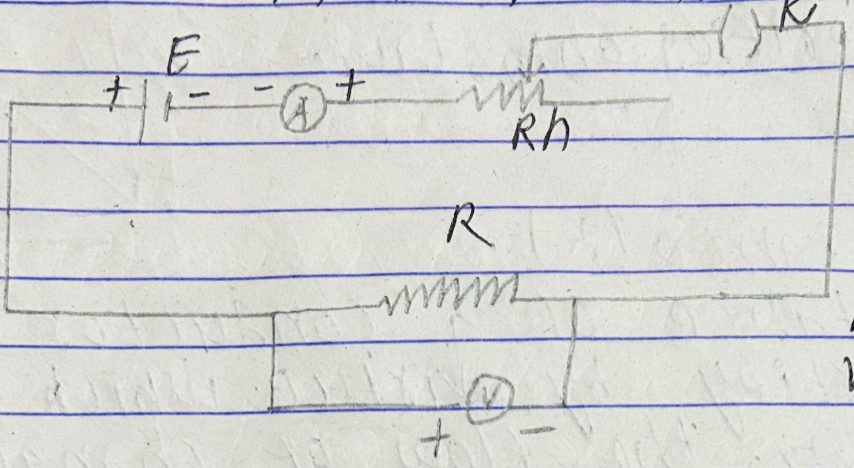
=) It state that, "The current flowing through a conductor is directly proportional to the potential difference applied between two ends of conductor provided all physical condition and temperature remains ~~current~~ constant.

i.e $I \propto V$

$V \propto I$

$V = RI$ (where R = Resistance of the conductor).

verification of ohm's law

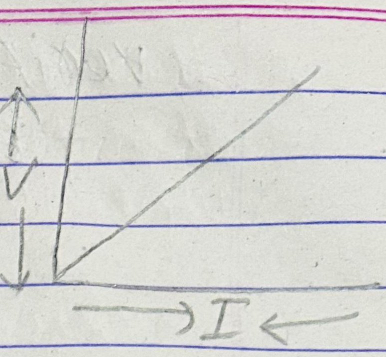


E = battery
A = Ammeter
Rh = Rheostat
K = key
R = Resistor
V = voltmeter

To verify ohm's law the required circuit diagram shown as the figure. In the diagram, A battery (E), an Ammeter (A), Rheostat (Rh), key (K), Resistor (R) are connected in series, but a voltmeter (V) connected in parallel across two ends of the resistors.

By adjusting the Rheostat a particular value of electric current (I) is obtained in the ammeter and the corresponding value of potential difference (V) is noted from voltmeter. The experiment is repeated for different values of 'I' if a graph is plotted between 'V' and 'I', a straight line passing through the origin is obtained.

i.e $V \propto I$
This verifies ohm's law.



* Resistance (R).
⇒ Resistance of a conductor is its propertiey by virtue which its opposing the flow of change through it and is define as the ratio of potential difference between two ends of the conductor to the current flowing through it

i.e. $R = \frac{V}{I}$

It's SI unit is ohm (Ω).

* Conductor (C) =
⇒ It is the reciprocal of resistance

i.e. $C = \frac{1}{R} = \frac{I}{V}$

It' SI unit 'mho' or Ω^{-1} or siemen.

* Resistivity or specific resistance (ρ).
⇒ It is found that the resistance of a conductor is.
(i) directly proportional to the length of the conductor.

i.e $R \propto L$

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(ii) Inversely proportional to the cross-section area of the conductor.

i.e $R \propto \frac{1}{A}$ —— (ii)

on combining, we get

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

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

where ρ = resistivity of the material of a conductor.

If $L = 1m$

$A = 1m^2$

$\rho = R$.

* Therefore resistivity of the material of a conductor is defined as the resistance offered by its unit length and unit cross section area. Its value depend upon nature of the material of the conductor, but not on its length and cross section area. It SI unit is Ω-m.

* A copper wire of length 'L' is halved to its length, what will be its resistance and resistivity?

For resistivity, there is no change because it depends upon the nature of the material of the conductor.

For resistance $l' = \frac{l}{2}$

since

$R \propto l$

it's resistance will be halved.

A A wire is stretched ~~two~~ to double its length. What will be its resistance and resistance?

For resistivity, there is no change because it depends upon the nature of the ~~resistance~~ material of the conductor.

For resistance, we have.

$V = V'$

or, $A \times L = A' \times L'$

$A \times L = A' \times 2L$

or, $A' = \frac{A}{2}$

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

$= \frac{\rho \cdot 2L \times 2}{A}$

$= 4 \cdot \frac{\rho L}{A}$

$R' = 4 \cdot R$

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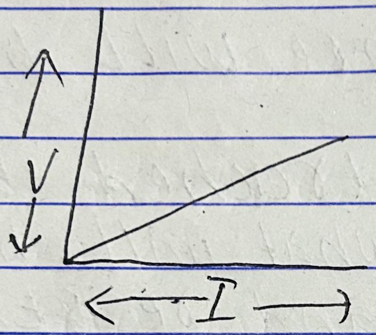
① ohmic conductor

⇒ ohmic conductor are those conductors which follow ohm's law.

⇒ For ohmic conductor the graph between 'V' and 'I' is a straight line passing through origin

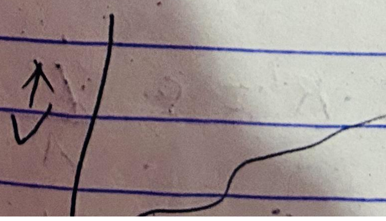


⇒ For ohmic conductor the value of 'R' is unique and independent of direction and magnitude of V and I. For example: metals.

② non-ohmic conductor.

⇒ Non-ohmic conductor are those conductor which do not follow the ~~law~~ ohm's law.

⇒ For non-ohmic conductor, the graph between 'V' and 'I' is rather than staight line



⇒ For non-ohmic conductor the value of R is difference and depond of direction and magnitude of V and I. For example ÷ semi-conductor, diode, transistor, etc.

* Variation of resistance with temp.

⇒ The resistance of a conductor also changes with temperature and is given by:

$$R_2 = R_1 [1 + (\alpha \cdot \Delta\theta)]$$

$$\alpha = \frac{(R_2 - R_1)}{R_1 \times \Delta\theta} \quad (\alpha = \text{temp of coeff of resistance})$$

* Temperature coeff of resistance.

⇒ Therefore, temp coeff of resistance is defined as the change in resistance per unit original resistance, per degree change in temp. It value depond upon nature of material of the conductor and its SI unit is K^{-1} or $°C^{-1}$.

For metals, the value of 'α' is '+ve' i.e resistance increases '↑' on increasing (↓) the temp and vice-versa.

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* For nom-metals and semiconductor. the value of α is '-ve' i'e Resistance decrease '↓' on increasing '↑' temp and vice-versa.

For alloys, the value of α is +ve and small. i.e the effect of temperature on resistance is negligible. so, alloys are used as standary resistance.

* Why is alloys used as standary resistance?

⇒ Alloys are use as standary resistor due to the following regions:-

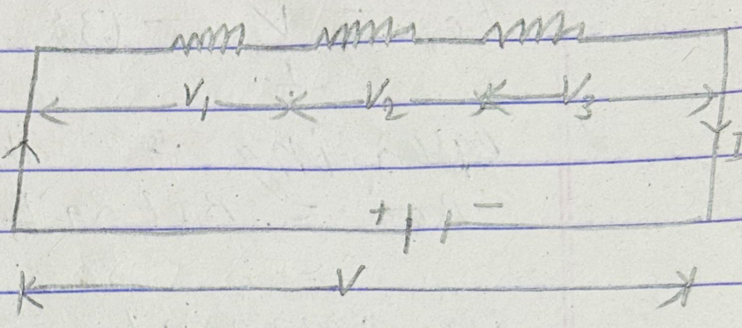
① They have high resistivity.
② They have small temp coeff of restance.

* Why are conneting wires made up of copper?

⇒ connecting wires made up of copper because they have low resistivity. or high conductivity.

* combination of resistances.

① series combination.



Two or more resistors are said to be connected in series if they are joined ~~in two~~ end to end show that same current will flow through them.

consider 3' resistors of resistance R_1, R_2, R_3 are connected in series. when a p.d (v) is applied across them, the total current 'I' flows through the circuit. If V_1, V_2 and V_3 be the p.d across R_1, R_2 and R_3 respectively, them. From ohm's law,

$$\left.\begin{aligned} V_1 &= I \cdot R_1 \\ V_2 &= I R_2 \\ V_3 &= I \cdot R_3 \end{aligned}\right\} \quad \text{—— (1)}$$

From figure, we have

$$V = V_1 + V_2 + V_3$$

or, $V = I \cdot R_1 + I R_2 + I R_3$

or, $V = I(R_1 + R_2 + R_3)$.

or, $\frac{V}{I} = (R_1 + R_2 + R_3)$ —— (2)

If R_{eq} be the equivalent resistance of the combination.

$R_{eq} = \frac{V}{I}$ — (3)

equating '2' and '3' we get.

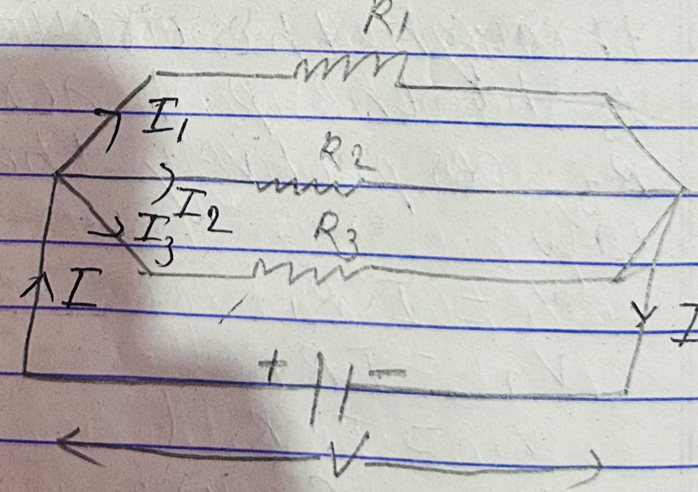
$R_{eq} = R_1 + R_2 + R_3$

in general,

$R_{eq} = R_1 + R_2 + R_3 + \cdots$

In series combination of resistances, the equivalent resistance is equal to the sum of individual resistances and is always greater than individual.

(ii) parallel combination:-



Two or more resistors are said to be connected in parallel if they are joined side by side so that same potential difference appers across them

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consider '3' resistors of resistances R_1, R_2 & R_3 are connected in parallel. when a potential difference (V) is applied across them, the total current (I) flows through them.

If 'I_1', 'I_2' and 'I_3' be the the current flowing through R_1, R_2 and R_3 respectively, from ohm's law, we have.

$$\left.\begin{aligned} I_1 &= \frac{V}{R_1} \\ I_2 &= \frac{V}{R_2} \\ I_3 &= \frac{V}{R_3} \end{aligned}\right\} \text{———} (i)$$

from figure, we have.

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \text{ ——— } (2)$$

If I_{eq} be the equivalent resistance of the combination.

$$\frac{1}{R_{eq}} = \frac{I}{V} \text{ —— } (3)$$

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equating '2' and '3' we have

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

In general,

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \text{-----}$$

Therfore, in parallel combination of resistances is the reciprocal of the resistance is equal to the sum of the reciprocal of the individual resistance and equivalent resistance is always less than individuals.

* To increase equivalent resistances which combination do you perfer and why?

$\frac{}{n}$

* To decrease equivalent resistance which combination do you perfer and why?

* If you are given 'n' wires, each of restance 'R' what is the ratio of maximum to minimum equivalent restance

soln.

in series has maximum 'Req'

$R_{eq} = R + R + R + \ldots + nR$

$= nR$

In parallel has minimum Req so,

$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} \ldots$

$\frac{1}{R_{eq}} = \frac{n}{R}$ $\therefore R_{eq} = \frac{R}{n}$

by the question,

$\frac{R_{max}}{R_{min}} = \frac{nR}{\frac{R}{n}} = n \times n = n^2$.

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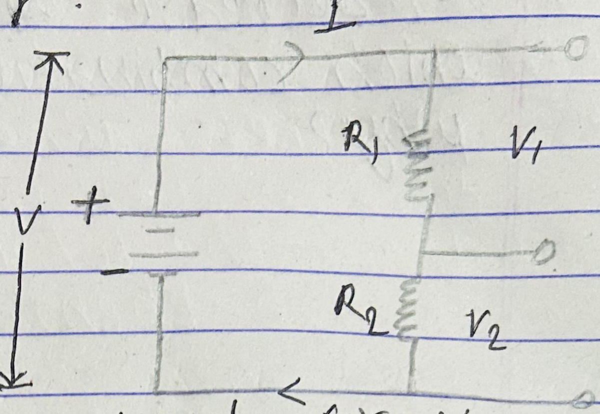
* potential divider.

⇒ It is an arragement of two or more resistors in series in order to obtain a required fraction of potential difference from the source of potential difference (p.d).



suppose two resistors of resistance R_1 and R_2 are connected in series through a source of p.d, 'V'. Then current flowing through the circuit is given by.

$$I = \frac{V}{R} = \frac{V}{R_1+R_2}$$

Now,

potential difference (p.d) across R_1

$= V_1 = IR_1$

$$V_1 = \frac{V}{R_1+R_2} \cdot R_1$$

$$\therefore V_1 = \frac{R_1}{(R_1+R_2)} V \text{ --- (1)}$$

similary,

p.d across $R_2 = V_2 = IR_2 = \frac{R_2}{(R_1+R_2)} V$ --- (2)

Here V_1 and V_2 are required fraction of V.

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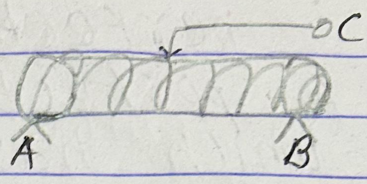
* Rheostat:

⇒ A Rheostat is an electric device which is used as a variable resistor and potential divider. It works on the principal that resistance varies with length of the wire.



construction.

⇒ It consists of uniform insulated copper wound on a porcelin cylinder. In the rheostat their are 3 terminal. Two fixed terminal and 1 variable terminal.

To use the rheostat in a circuit it is connected between one fixed terminal and other variable terminal.

working:

⇒ when point of contract of variable terminal is slided, the length of wire used is also changed so that its resistance is also changed.

perfect conductor

* A perfect conductor is one which has zero resistance and resistivity.

* super conductor

⇒ A super conductor is a material having zero resistance below zero temp.

In super conductor the magnetic field inside the conductor will be zero.

The behivour of the super conductor is called super conductivity. It is widely in super computer.

* Thermistor *

⇒ A Thermistor is a temperature sensior consisting of semi-conducting material, which docteds and measure heat energy and converts its into signal

⇒ It work on the principel that resistance varies with temperature

uses
- fire allam.
- Refrigerator
- washing machine.
- Digital thermeter.
- In automotive.
- LDR (light dependent resistor) or photosesistor.

* LDR (light dependent resistor) or photosesistor.

⇒ LDR is a light sensior made up of photo sensativity semi-conducting materials which detects and measures light energy and converts it into a signal

⇒ It works on principle that resistance varies with light energy.

Uses
- street lamp
- Automatic transpotation
- Mobile screen.

* strain guaze÷

⇒ It is a pressure sensior which detects and measures the strain produce in the materials and converts it into a signal.

⇒ It works on the principle that resistance varies with pressure or force applied.

Uses:-
- In tunale and dame.
- In automotive.
- In nuclear plant.
- In railway traffic

E.m.f (Electromotive force) of a cell (E)
⇒ E.m.f of a cell is define as the work done or energy supplied by a cell to drive unit charge through the circuit. It is not the force.

⇒ It is the potential difference between '2' terminal of a cell in an open circuit. It is denoted by (E). It's unit is volt (V).

Terminal p.d of a cell (V):-
⇒ It is the potential difference between two terminal of a cell in a closed cicuit. It is denoted by 'V'. It unit is volt.

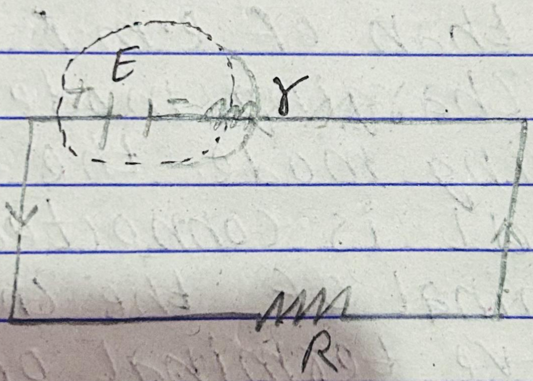
Internal resistance of a cell (r).

⇒ Internal resistance of a cell is a resistance offered by electrods and electrolyte of a cell. It value depond upon ÷

- Nature of electrodes.
- Nature of electrolyte.
- distance between two electrodes.
- cross-section of the electrodes.

⇒ It is denoted by (r).

Relation between E, V, and r.



consider a cell of e.m.f, E and internal resistance, r is connected to be external resistance, R. Then, the current flowing through the circuit is given by.

$$I = \frac{E}{(R+r)}$$

$$E = I(R+r)$$

$$E = IR + Ir.$$

$$E = V + IR$$

$$E - V = IR$$

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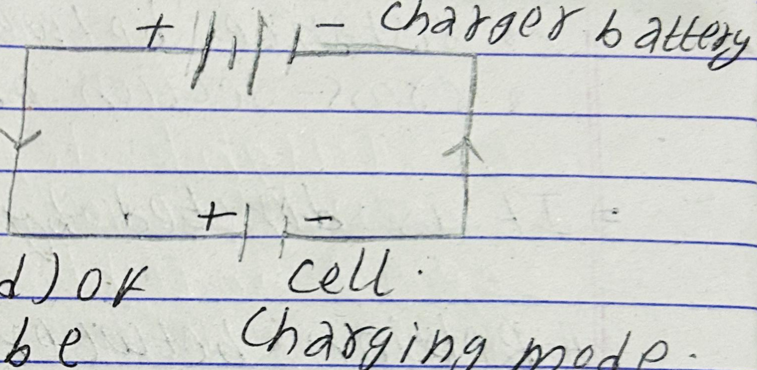
Being $I \cdot r$ a positive quantity,
$E > V$

In an open circuit, $I = 0$.
$E = V$

* Is the terminal p.d of a cell greater than e.m.f of the cell?



⇒ yes, the terminal potential difference (p.d) of a cell will be greater than of e.m.f of the cell in charging mode.

⇒ In charging mode, the +ve terminal of the cell is connected to the +ve terminal of the charger battery and −ve terminal of the cell is connected −ve of the charger battery, so that current is driven by the charger battery through the circuit.

$V = E - (-Ir)$

or, $V = E + Ir$

that is.