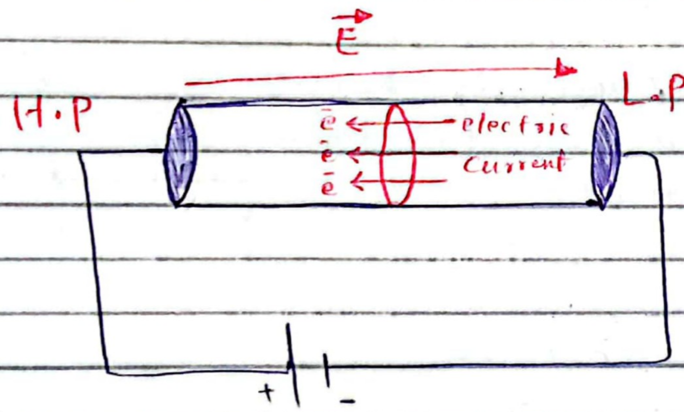
Potential difference of one Cell = 1.5V

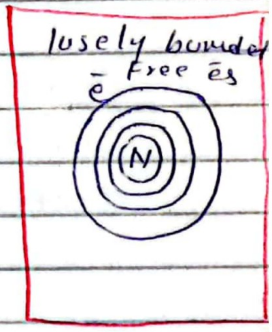
Electrodynamics
⇑

CH # 12 "Current Electricity"

Dated:- 11 OCT, 2017

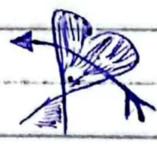
Electric Current:- The rate of flow of charges passing through any cross-sectional area of a conductor is called electric current.





* Because of random motion of $\bar{e}$s, electric field inside the conductor is zero..

$$I = \frac{\Delta Q}{\Delta t}$$



UNIT:-

$$1A = \frac{1C}{1\,Sec}$$

$$\frac{1C}{1.6\times10^{-19}} = \frac{1.6\times10^{-19}C}{1.6\times10^{-19}}$$

$$1C = \frac{1}{1.6\times10^{-19}}\bar{e}s \Rightarrow \boxed{1C = 6.25\times10^{18}\,\bar{e}s}$$

* In Metals Current is due to flow of ēs.

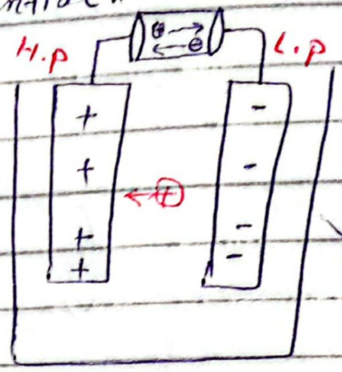
* Semi-conductors → ēs and holes.

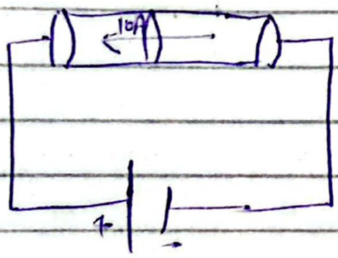
* Solutions → opposite Ions

(i) Conventional Current:- A Current which flows from high potential to low potential..

(ii) Electronic Current:-

A Current which is due to the flow of negatively charged electrons is called electronic Current.





Basically ⊖ moves from one plate to another and neutrilize ⊕.

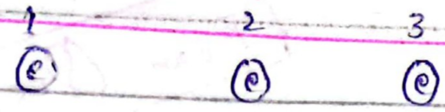
* Positive charges do not move at all. but it is a convention..

A Current which is equall to electronic current in magnitude but is in opposite direction is called conventional Current.

Drift of ēs in Metalic conductor:

push on ēs by external electri field.

Thermal velocity: without external ēs field



Drift velocity:-
The average velocity gained by ēs with which they get drifted under the influence of external electric field.

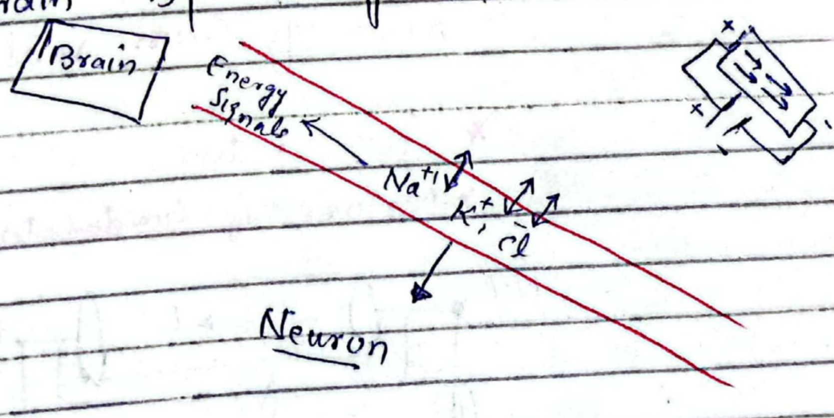
V_d: Drift velocity..

$V_{effective} \approx C$ $V_d \approx 10^{-6}\, m/s$

12 OCT, 2017

Electroencephalography (E.E.G).

A nervological activity test by which we measure electricalical activity of brain by using a monitor.



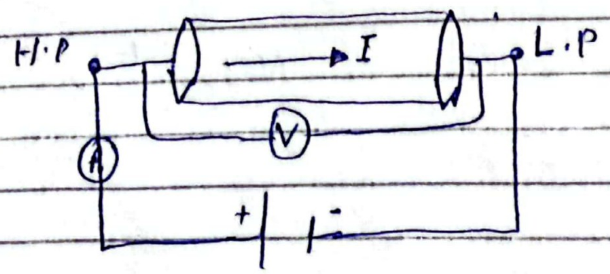
Exam Que

Ohm's Law:-

This Law States that "The magnitude of Current (I) passing through a Conductor is dirrectly proportional to the magnitude of potential difference (V) across its two ends, provided the physical Resistance State of the Conductor remains Constant."

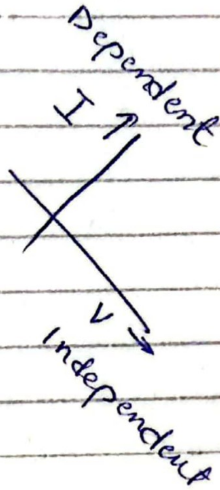
Physical State

* Length
* Area of Cross Section
* Temperature.
* Nature of Conductor



$I \propto V$

V = is Independent
I = is dependent.



$I = KV$

$$\boxed{K = \frac{1}{R}}$$

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

$$\boxed{V = IR}$$

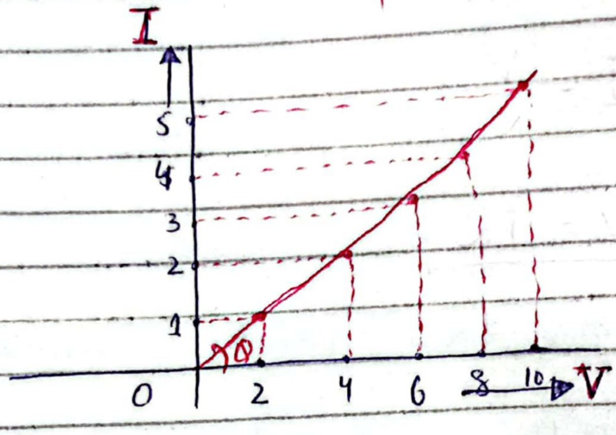
Ohm's law relate Current and Voltage through resistor...

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

$$1\Omega = \frac{1V}{1A}$$

Resistance:- The opposisson offered by a conductor to the flow of ~~charge~~ ~~Current~~ Current is called Resistance.

V	I	$R = \frac{V}{I}$
2	1	2
4	2	2
6	3	2
8	4	2
~~9~~10	5	2
12	6	2



* Any conductor which satisfy ohm law called ohmic conductor.

* For same straight line slope remains constant. $\boxed{\theta = y/x}$

Slope = $\tan\theta$

$$K = \frac{I}{V}$$

$$\therefore V = IR$$

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

$$\boxed{\frac{I}{V} = \frac{1}{R}}$$

$$\boxed{K = \frac{1}{R}}$$

* The Slope = Shows reseprocal of resistance.
$\left(K = \frac{1}{R}\right)$

* I

* The reseprocal of Slope gives us Resistance of the conductor.

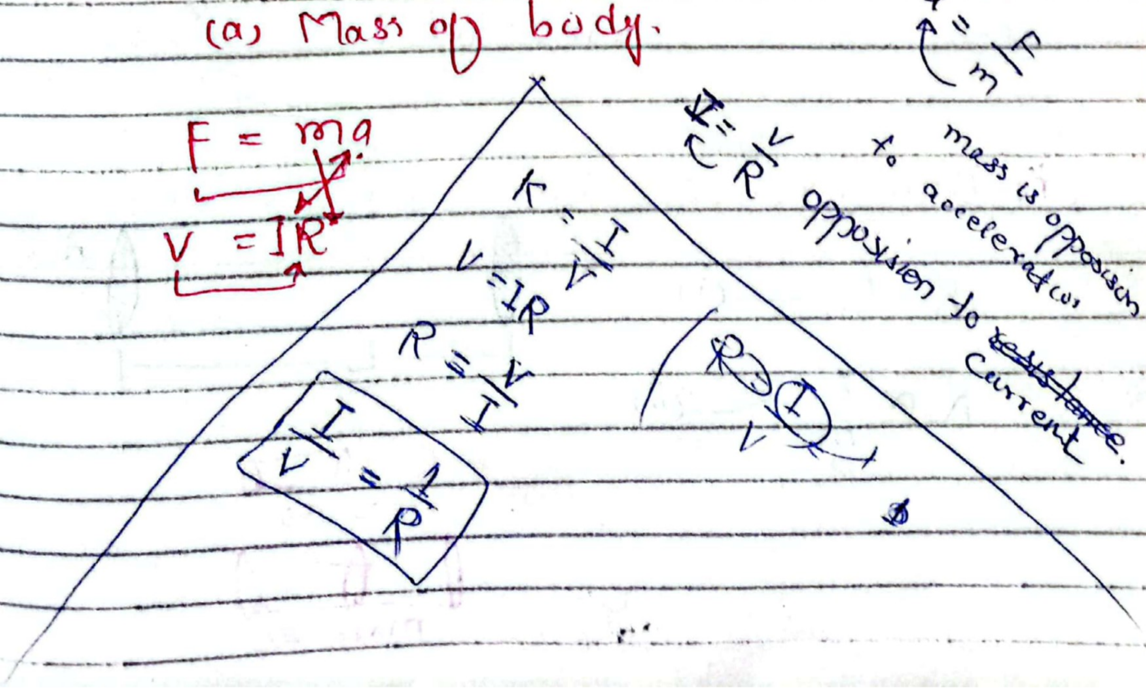
$$\boxed{\text{i.e } \frac{1}{\text{Slope}} = R}$$

MCQ:- The resistance of conductor resemble to the

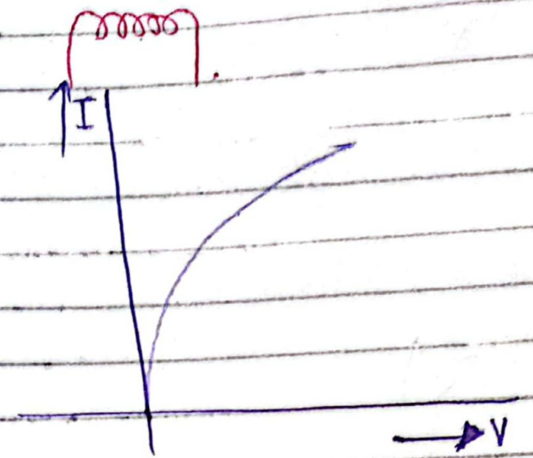
(a) Mass of body. ✓

$F = ma$

$V = IR$



Filament of a bulb:-



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

when R increases in filament,

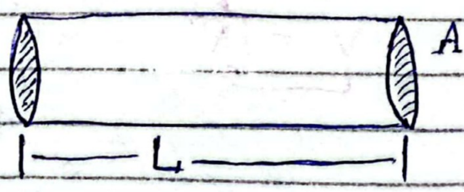
then ~~I~~ do not increases, ~~~~ is on begaining.

* So, Filament of a bulb is non-ohmic conductor.

13 OCT, ~~~~ 2017

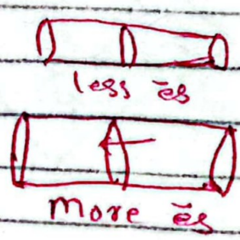
Factors Upon which Resistance depends:-

(i) Dimensions:-



$R \propto L$ —— (I)

$R \propto \frac{1}{A}$ —— (ii)



Combining the relations:

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

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

ρ = Specific Resistance, or

Resistivity of the Conductor

Specific Resistivity.

$$\boxed{\rho = \frac{RA}{L}}$$

Resistance	Resistivity
opposion offered by conductor.	The Resistance of a unit area of Cross Section of a wire per unit length.
$R = \frac{V}{I}$	$\rho = \frac{RA}{L}$
* Unit is Ω (ohm)	

$$\rho = \frac{\Omega . m^2}{m} = \Omega . m$$

$\rho = \Omega . m$

ρ depends upon:

* Temprature

* Nature of the Conductor

Resistor:-

A conductor use for Resistance conductor.

③ → Nessesary

 variable Resistor

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

A → more
R – less
L – Same
ρ – constant

Conductance:- (G).

The Reseprocal of Resistance of a conductor is called Conductance.

Unit:-

$$G = \frac{1}{R}$$

$$= \frac{1}{\Omega}$$

$$= \Omega^{-1}$$

= Semen → Name of Scientist...

$$\boxed{G = S}$$

(Segma)

Conductivity:- (σ)

The Reseprocal of Resistivity of a conductor is called conductivity.

$$\sigma = \frac{1}{\rho}$$

$$\sigma = \frac{1}{\Omega \cdot m}$$

$$\sigma = (\Omega \cdot m)^{-1}$$

$$\sigma = \Omega^{-1} \cdot m^{-1}$$

ohm = mho

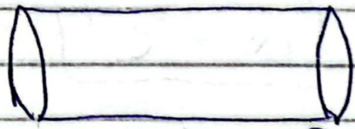
$$\sigma = mho \cdot m^{-1}$$

$$\sigma = \frac{mho}{m}$$

Conductivity

$$\boxed{\sigma = \frac{S}{m}} \rightarrow \text{Semen} = \Omega^{-1}$$

2. ~~Temp~~ Variation of Resistance with temprature :-



$R_1 \rightarrow T_1 \longrightarrow R_2 \longrightarrow T_2$

$$R_2 - R_1 \propto R_1 \quad \text{---(i)}$$

$$R_2 - R_1 \propto \Delta T \quad \text{---(ii)}$$

$$R_2 - R_1 \propto R_1 \Delta T$$

$$R_2 - R_1 = \alpha R_1 \Delta T \quad \text{---(iii)}$$

$$R_2 = R_1 + \alpha R_1 \Delta T$$

$$R_2 = R_1(1 + \alpha \Delta T)$$

$$3 \Rightarrow \Delta R = \alpha R_1 \Delta T$$

$$\boxed{\alpha = \frac{\Delta R}{R_1 \Delta T}}$$

Temprature coefficient of Resistance.

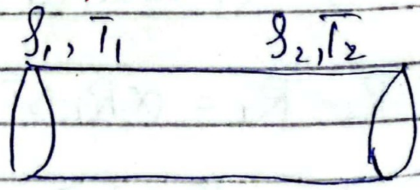
α = change in Resistance per degree rise in temprature to the Initial resistance.

$$\alpha = \frac{\cancel{\Omega}}{\cancel{\Omega} \cdot K}$$

$$\boxed{\alpha = K^{-1}}$$

$$\boxed{\alpha = {}^{\circ}C^{-1}}$$

Variation of Resisitivity with temprature:-



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

$$\rho_2 - \rho_1 \propto \rho_1 \quad \text{--- (i)}$$

$$\rho_2 - \rho_1 \propto \Delta T \quad \text{--- (ii)}$$

$$\rho_2 - \rho_1 \propto \rho_1 \Delta T$$

$$\rho_2 - \rho_1 = \alpha \rho_1 \Delta T \quad \text{--- (iii)}$$

$$\rho_2 = \rho_1 + \alpha \rho_1 \Delta T$$

$$\rho_2 = \rho_1 (1 + \alpha \Delta T) \quad \text{--- (iv)}$$

3 $\Rightarrow \Delta \rho = \alpha \rho_1 \Delta T$

$$\boxed{\alpha = \frac{\Delta \rho}{\rho_1 \Delta T}}$$

Temp coefficient of Resistivity...

Unit is same as:

$$\boxed{\begin{array}{l} \alpha = K^{-1} \\ \alpha = {}^{\circ}C^{-1} \end{array}}$$

: 14 OCT, 2017 :

Wire Wound Resistors :-

We use alloys in Resistors.

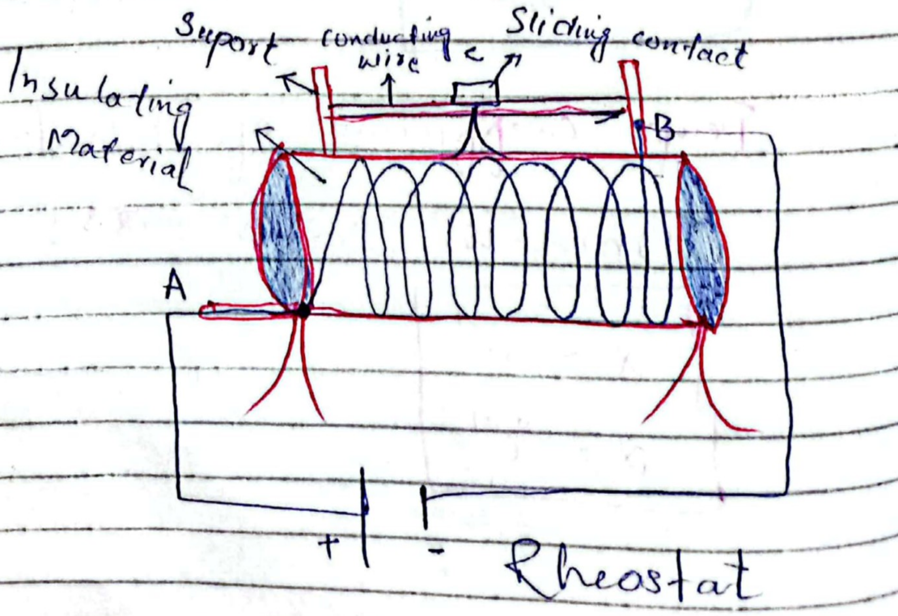
1. Manganin (Mangenize, Copper, Nickel)
2. Constantan (Copper, Nickel)
   50%, 50%
3. Eureka (Copper, Nickel)

Diffrent proportions

Wires are made from these alloys, which are then used as Resistor.

① Rheostat :- "Variable Resistor"

A device by which we can Varry the resistance in a Circut is called Rheostat.

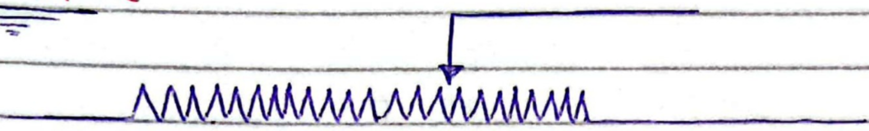


Rheostat

Resistance is must for a circuit.

* Rheostat is a Current Controling Device.

* Rheostat :-



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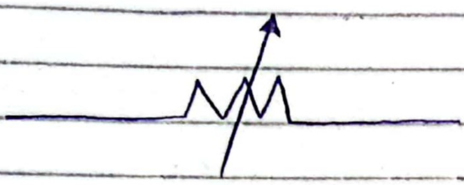
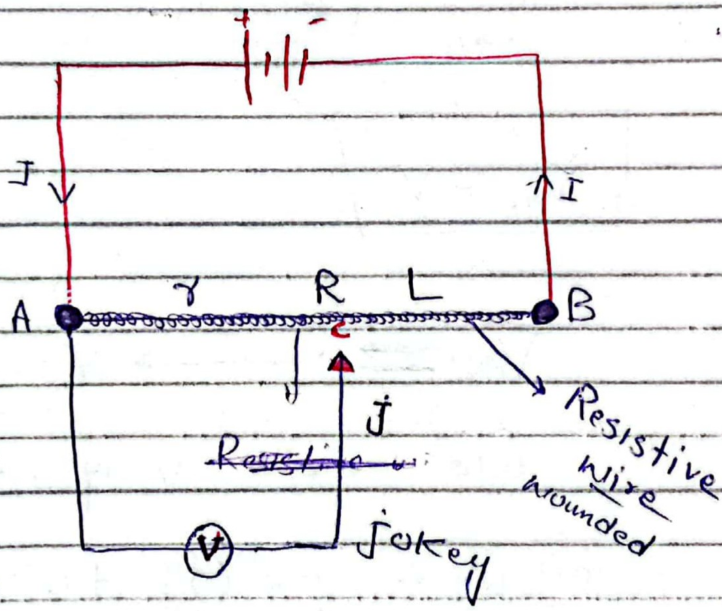


(II) potential divider:-

A Special type of Circuit from which We Can take any potential Diffrence from a Known P.D or Voltage.



$V_{AC} = I\gamma$ ———— (i)

$V_{AB} = IR$

$I = \frac{V}{R}$ ———— (ii)

$V = IR$

$I =$ constant

$V \propto R \propto L$

$V \propto L$

$V = IR$

$I = \frac{V}{R}$ $\quad V_{BC} = \left(\frac{V}{R}\right)R$

$V_{AC} = \frac{R}{R}(V)$

$$V_{AC} = \left(\frac{V}{R}\right) r$$

$$V_{AC} = V\left(\frac{r}{R}\right) \text{ --- (iii)}$$

When $r = 0$ at A..

$$\boxed{V_{A} = 0}$$

When $r = R$ at B.

$$\underset{\hookrightarrow B}{V_{AC}} = V\left(\frac{R}{R}\right)$$

$$\boxed{V_{AC} = V}$$

$$V_{AC} \Rightarrow 0 \longrightarrow V$$

We can vary (V) from minimum i.e (0) to maximum i.e (V) by potential divider.

2. Thermistors :- (Thermal Resistors)

Resistors whose Resistance is markably changing with temprature are Called Thermastors.

* Thermastors are temprature dependent Resistors.

* Thermastors → Temprature Sensitive Resistors

→ Temprature Sensors.

* There are two types of thermestors :-

(I) PTCs (Positive temprature coefficient thermistors). $\alpha = +ive$

(II) NTCs (Negative temprature Coefficient thermesitors. ($\alpha = -ive$)

$$\alpha = \frac{\Delta R}{R_1 \Delta T}$$

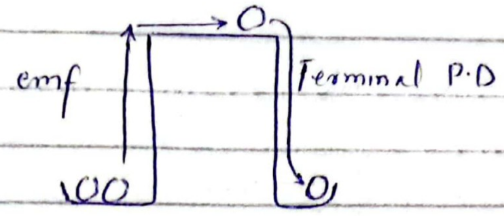
$$\alpha = \frac{R_2 - R_1}{R_1 \Delta T}$$

When $R_2 > R_1$ (Resistance Increases)

$$\boxed{\alpha = +ive}$$

When $R_2 < R_1$ $\boxed{\alpha = -ive}$

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



* The phenomena will occure when a Source convert non-electrical energy to electrical energy.

Source of emf :-

Non E. energ $\longrightarrow$ E. Energy.

Example :-

(i) Battery
C.E $\longrightarrow$ E.E

(ii) Genrator
M.E $\longrightarrow$ E.E

(iii) Thermocopule
H.E $\longrightarrow$ E.E

(iv) Solar Cell
L.E $\longrightarrow$ E.E

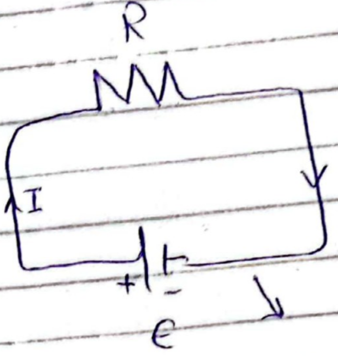
Source → non. E $\longrightarrow$ Electrical.

Circut → Electrical → Non - electrical ......

Internal Resistance of a Source:-

$\mathcal{E} = IR$

$I = \frac{\mathcal{E}}{R}$ —(i)



Not consider Internal R.

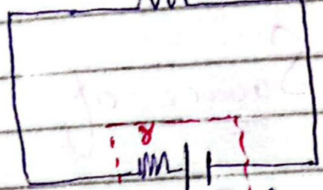
Example:-

$\mathcal{E} = 12V$

$R = 4\Omega$

$I = \frac{12}{4}$

$\boxed{I = 3A}$



practically Current is not 3A

bcz Source also has Internal resistance. The net Current will be less then theoratically.

* We Can write eq(I):

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

So I will decreases.

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

$\mathcal{E} = Ir + IR$

$\mathcal{E} = V_{in} + V_{ext}$ ——(iii)

Emf = Internal P.D + External P.D

The total Strength (voltage) of a Source is called emf.

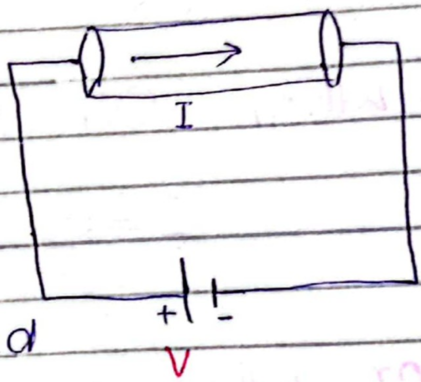
~~When Basing~~

emf Increases as we charge the battery and at last it became equall to terminal potential differen When the battery is fully charged...

: 17 OCT, 2017 :

Electric power and power dissipated in Resistors:-

"The power Supplied by Source."



Electric power:-

The Electric energy per unit ~~charge~~ time Supplied by a Source to a Circut is Called electric power.

$$E.P = \frac{E.E}{t}$$

The Conversion of electrical energy Into non-electrical energy in a circut is called energy dissipated.

~~Electric~~ ~~power~~ : Power Dissipated:

The Conversion of electric energy per unit time into non-electrical energy is in a circuit is called power dissipated.

$$P = \frac{W}{t} \quad \text{—(i)}$$

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

$$W = qV \quad \text{—(ii)}$$

$v = \frac{w}{q}$, $w = qv$

put (ii) in (i).

$$P = \frac{Q}{t}(V)$$

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

$$\boxed{P = IV} \quad \text{~~~~ (iii)}$$

Electric power ~~dissipated~~

As, $V = IR$

$$P = I^2R \quad \text{—(iv)}$$

↳ Power disipated in Resistor.

The conversion of electrical energy → Heat energy → per unit time → power disipated in Resistor

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

$$P = \frac{V^2}{R^{\cancel{2}}}(\cancel{R})$$

$$\boxed{P = \frac{V^2}{R}} \quad \text{--- (V)}$$

x —— x — x —— x —— x ——

$\because W = Pt$

Energy dissipated :-

$\boxed{P = IV}$

$$\boxed{W = IVt} \quad \text{--- (VI)}$$

$$\boxed{W = I^2Rt} \quad \text{--- (VII)} \qquad \boxed{V = IR}$$

$$\boxed{W = \frac{V^2}{R}t} \quad \text{--- (VIII)}$$

energy dissipated in Resistor

$W = I^2Rt \Rightarrow$ Also Called joule's heating Law..

Unit :- $P = \frac{W}{t}$

$W = J/s$

$\rightarrow$ 1 Watt = 1 J/1 s

$1KW = 10^3 W$

$1MW = 10^6 W$

$1H.P = 746W$

Commercial Unit of Power $\rightarrow$ Basically energy.

$1KWh = (10^3 W)(3600 sec)$

$= 36 \times 10^5 W.s$

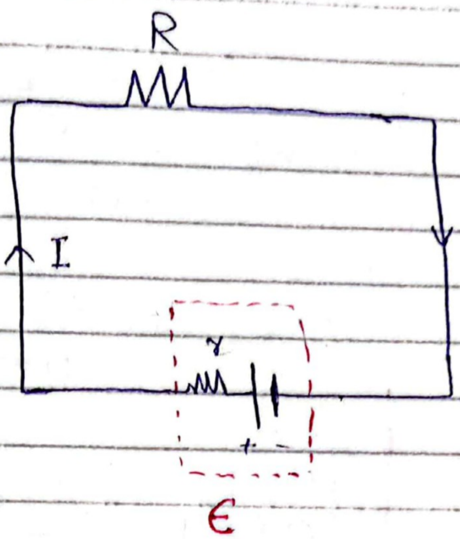
$\boxed{\text{1 KWh, Energ} = 3.6 \times 10^6 J}$

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

$W = F.S$

Maximum power out:-

"Maximum out put power".



$$P_{out} = I^2 R \quad \text{--- (1)}$$

Net emf $\longrightarrow$

$$\epsilon = Ir + IR$$

$$\epsilon = I(r+R)$$

$$I = \frac{\epsilon}{r+R} \quad \text{--- (II)}$$

put in (1),

$$P_{out} = \left(\frac{\epsilon}{r+R}\right)^2 R$$

$$P_{out} = \frac{\epsilon^2}{(r+R)^2} R \quad \text{--- (III)}$$

$\rightarrow$ "If it is minimum $\rightarrow$ power out will be maximum.

$$(r+R)^2 = r^2 + R^2 + 2rR$$

$$(r+R)^2 = r^2 + R^2 - 2rR + 2rR + 2rR \quad \text{(Ad } 2rR \text{ and } -2rR\text{)}$$

$$(r+R)^2 = (r-R)^2 + 4rR \quad \text{--- (IV)}$$

eq (III) $\Rightarrow$

$$P_{out} = \frac{\epsilon^2}{(r-R)^2 + 4rR} R \quad \text{--- (V)}$$

is Clear that:
It Shows that:
when Internal Resistance = External Resistance
$r = R \quad P_{out} = (P_{out})_{max}$

$$(P_{out})_{max} = \frac{\epsilon^2}{(\cancel{R}-\cancel{R})^2 + 4R\cancel{R}}(\cancel{R})$$

$$\boxed{(P_{out})_{max} = \frac{\epsilon^2}{4R}}$$

$$\boxed{(P_{out})_{max} = \frac{\epsilon^2}{4r}}$$

This is a theoratical approach, practically it is not possible

i.e $r = R$....

P.b # 1 Given data:

$V = 12.8$

$I = 3.2A$

$\Delta t = 5m$

$\Delta t = 300s$

(i) $R = ?$ $\quad V = IR$

(ii) $\Delta Q = ?$ $\quad I = \frac{\Delta Q}{\Delta t}$

P.b # 2: Data:-

$R_1 = 0.125$

$t_1 = 20°c$

$t_2 = 85°c$

~~Req~~ $\Delta t = t_2 - t_1 = 85 - 20 = 65°c$

~~Req~~ $\alpha = -0.0005$

Calculate: $R_2 = ?$

$$R_2 = R_1(1 + \alpha \Delta t)$$

P.b #3:-

$L = 10m$

$D = 2mm$

$r = 1 mm$

$\rho = 2.63 \times 10^{-2} \Omega.m.$

Req:-

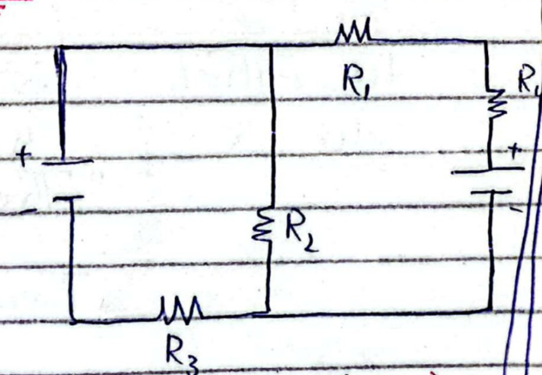
$R = ?$

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

$$R = \frac{2.63 \times 10^{-2} \times 10}{\pi r^2}$$

19 OCT, 2017

Kirchoff's Law:-



We can't decide that resistors are in parallel or Series.

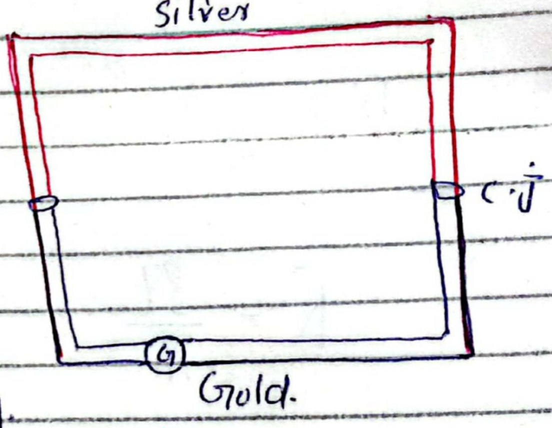
Complex Circuits

Dated :- 18 OCT, 2017

Thermocouple :-

Any arrangment of two ~~or~~ different metals in which thermoelectric current flows due to the temprature gradient (difference) between its hot and cold junctions is called thermocouple.

Hot ⟶ Cold



* In 1821, (Seebeck) Discovered that Heat energy can be converted into electrical energy.

* This conversion is called Seebeck effect.

Heat Energy ⟶
Gain by ēs ⟶ ēs also move from H-j ⟶ cold junction ⟶ thermoelectric current.

* The potential difference (emf) due to which ēs move from H-j to C-j is called "Thermoelectric emf"
↓
Thermoelectric Current.

El.

Electronic Density = $\frac{\text{No of free } \bar{e}s}{\text{volume}}$

In thermoelectric Current ↓

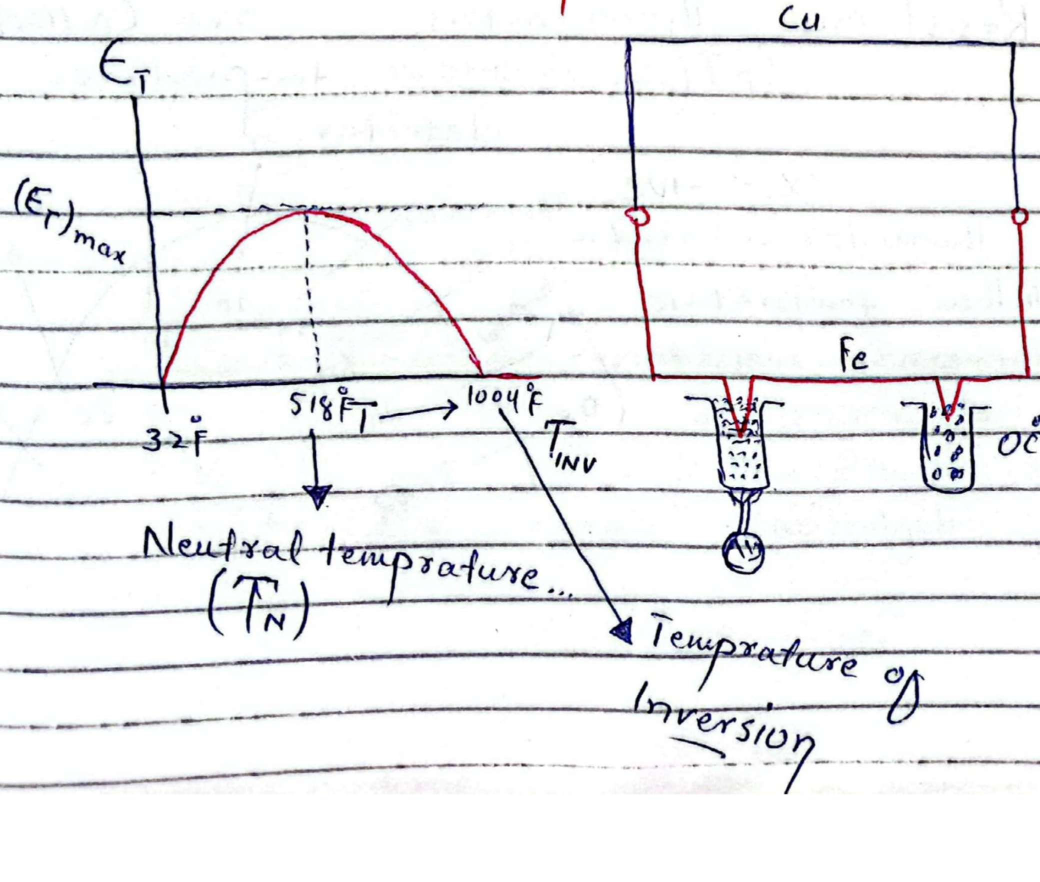
* Es move from High electron density metal to Low electron density.

$$\boxed{E_T = \alpha T + \frac{1}{2}\beta T^2}$$

$\alpha, \beta \Rightarrow$ Thermoelectric co-efficient

The change in Thermoelectric emf with rise in temprature is Called Thermoelectric co-efficient. (α, β)

Variation in thermoelectric emf with temprature:-



At "T_{INV}" → Electrons gain enough heat which are randomized → which Increases resistance → So the emf become Zero at T_{INV} and the State of Thermocouple is Inversed...

"Thermoelectric effect is reversible when the order of junction is Changed....

Resistance Thermometers:-

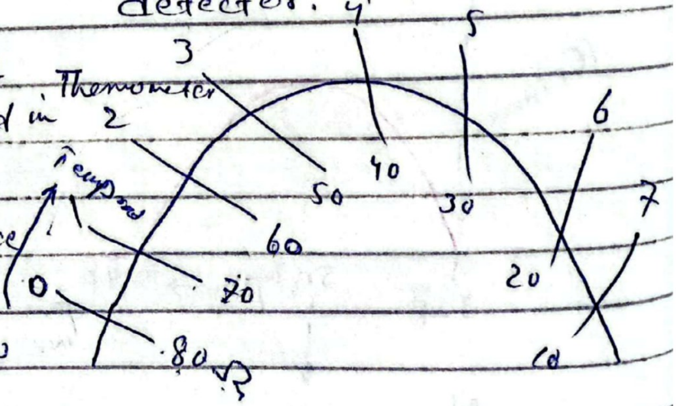
They utilize the resistance property of matter to measure the temprature.

* Resistance Thermometers are Called (RTDs). → Resistance temprature detecter.

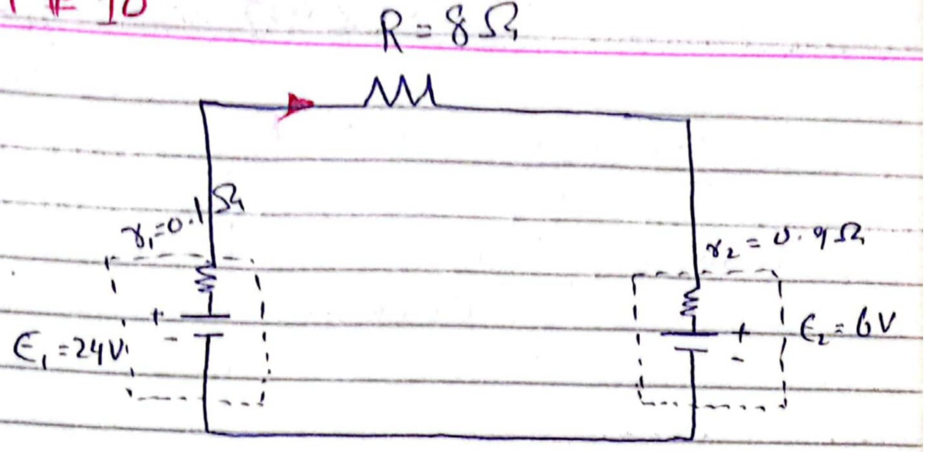
α = -ive

Thermistor is used in Thermometer

When temprature Increases, resistance decreases. So the needle will Show deflection...



Numerical # 10:



$R = 8\Omega$

$r_1 = 0.1\Omega$

$r_2 = 0.9\Omega$

$E_1 = 24V$

$E_2 = 6V$

$V_1 = ?$

$V_2 = ?$

Now $E_1 = Ir_1 + IR$

$E_1 = Ir_1 + V_{t_1}$ —— (1)

$V_{t_1} = E_1 - Ir_1$

$V = E_1 - E_2$

$\boxed{V = 18V}$

$R_e = r_1 + R + r_2$

$R_e = 0.1\Omega + 8\Omega + 0.9\Omega$

$\boxed{R_e = 9\Omega}$

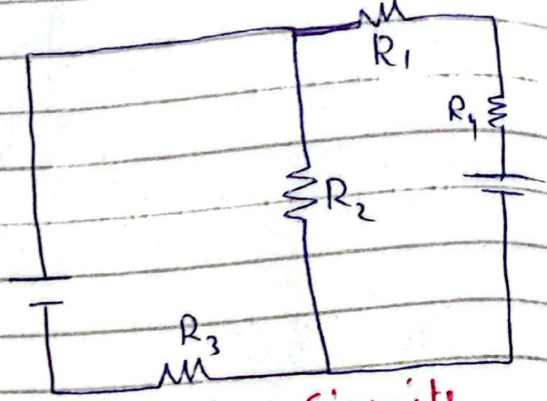
$\boxed{V = IR}$

$V_{t_2} = E_2 - (-Ir_2)$ For Second Cell

18 OCT 2017

Kirchoff's Law:-

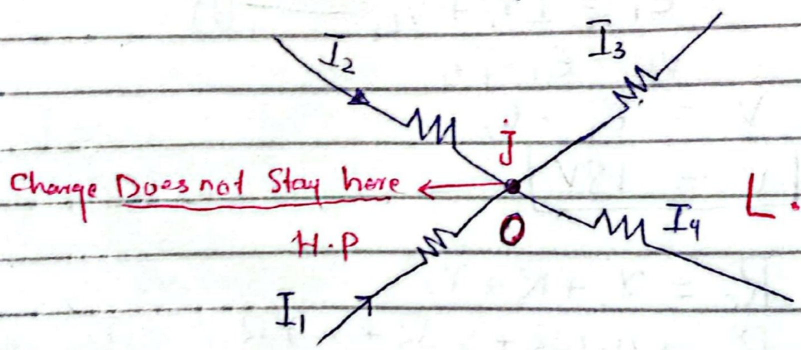
There are two law's of kirchoff:



① Kirchoff's Current Law (KCL) :-

This Law States that " The algebric Sum of all the Current at a junction in a circuit is equall to zero".
complex circuits.

* Algebric Sum:- In which +ive and -ive are not neglected...



junction:- Current enter and leave the G. Resistor

Conventions :-

① Current entering the junction are considers to be positive.

ⅱ) Current leaving the junction is -ive.

$$\sum i = 0$$

$$I_1 + I_2 + (-I_3) + (\cancel{I_3}) + (-I_4) = 0$$

$$I_1 + I_2 - I_3 - I_4 = 0$$ (Algebric Sum)...

$$I_1 + I_2 = I_3 + I_4$$

$$\boxed{\sum_E I = \sum_L I}$$

Sum of Current entering the junction = Sum of current leaving the junction...

This law means that:

$$\frac{\Delta Q_E}{\cancel{\Delta t}} = \frac{\Delta Q_L}{\cancel{\Delta t}}$$

$$\boxed{\Delta Q_E = \Delta Q_L}$$

Shows that:

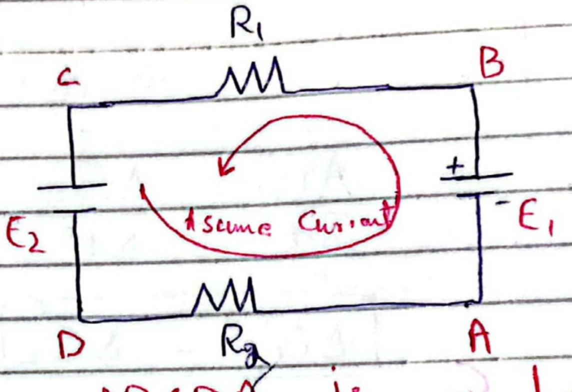
(I) charge does not Stay on the junction.

(II) KCL is ~~manifestation~~ Representation of the law of conservation of charge.

(ii) Kirchoff's Voltage Law :- (KVL)

This Law States that "The algebric Sum of all the Voltage changes in a around a Loop in a Curcuit is equall to zero.

$$\sum V = 0$$



ABCDA is a Loop

Conventions :-

(i) Inside the Source when we go from -ive to positive terminal E is taken to be positive, E = +ive

(ii) When we go In the Source we from +ive to -ive take E negative. E = -ive.

(iii) When we go Along the

direction of assumed Current.
IR Drop = -ive

(iv) In opposite dirrection of assumed ~~Circuit~~ Current,
IR Drop = +ive

Applying KVL to loop ABCDA:

$$\sum V = 0$$

$$\epsilon_1 - IR_1 - \epsilon_2 - IR_2 = 0$$

$$\epsilon_1 - \epsilon_2 = IR_1 + IR_2$$

$$\sum \epsilon = \sum IR$$

Algebric Sum of all emf's
= Algebric Sum of all IR drops..

$$\frac{W_s}{\cancel{q}} = \frac{W_r}{\cancel{q}}$$

$$W_s = W_r$$

| Energy Supplied = Energy dissipate

KVL is a manifestation of the Law of conservation of Energy...

Numerical #9:-

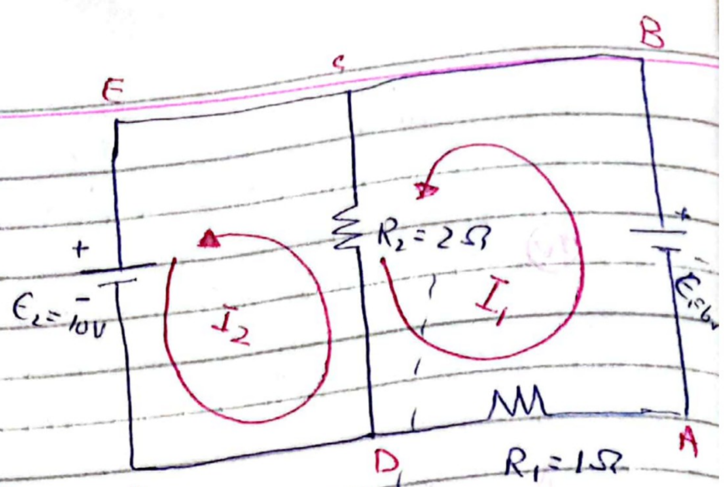
Data:-

$\epsilon_1 = 6V$

$\epsilon_2 = 10V$

$R_1 = 1\Omega$

$R_2 = 2\Omega$



Calculate Current passing throug R_1 and R_2 = ?

(I) Applying KVL to loop ABCDA:

$$\epsilon_1 - I_1R_2 + I_2R_2 - I_1R_1 = 0$$

$$6V - 2I_1 + 2I_2 - I_1 = 0$$

$$6 - 3I_1 + 2I_2 = 0 \quad \text{---} (I)$$

(II) Applying KVL to loop EFDCE:

Note.

$$-\epsilon_2 - I_2R_2 + I_1R_2 = 0$$

$$-10 - 2I_2 + 2I_1 = 0 \quad \text{---} (II)$$

Adding (I) and (II).

$$-10 + 2I_1 - 2I_1 = 0$$

$$6 - 3I_1 + 2I_2 = 0$$

$$-4 - I_1 = 0$$

$$\boxed{I_1 = -4A}$$

put $I_1 = -4A$ in eq (I)

$$6 - 3(-4) + 2(I_2) = 0$$

$\boxed{I_2 = -9A}$

Current passing through $R_1 = I_1 = -4A$

Current passing through $R_2 = I_2 = I_2 - I_1$

$= -9A + 4A$

$= -5A$

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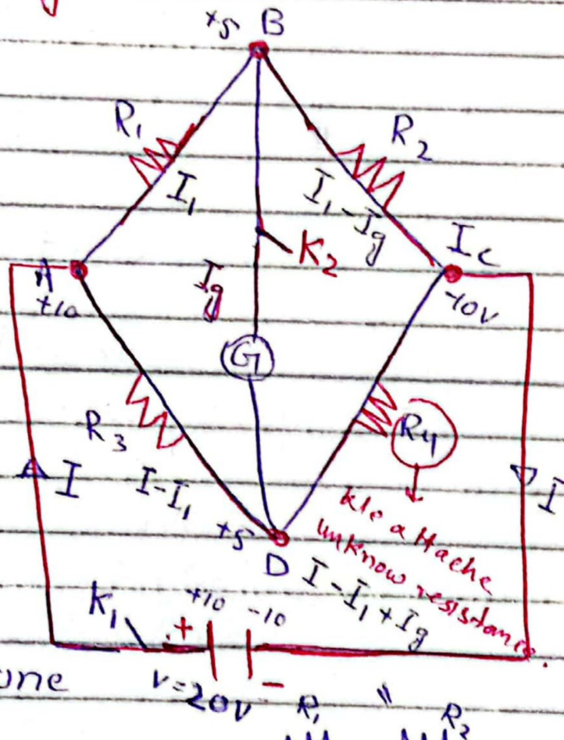
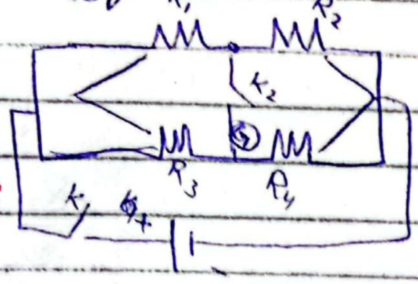
Wheatstone Bridge ~~Current~~ Circuit :-

Scientist



It is a special type of electric circuit by which we determine the Resistance of an unknown Resistor is called Wheatstone bridge circuit.



Potential Differences across R_1, R_2, R_3 and R_4:

$V_1 = I_1 R_1$ —— (i)

$V_2 = (I_1 - I_g) R_2$ —— (ii)

$V_3 = (I - I_1) R_3$ —— (iii)

$$V_4 = (I - I_1 + I_g) R_4 \quad \text{—— (IV)}$$

When point B and D become at the same potential: Then potential difference across the galvanometre will be zero.

$\because I_g = 0$ NO Current passing...

$$\text{eq (II)} \Rightarrow V_2 = I_1 R_2 \quad \text{—— (5)} \qquad I_g = 0$$

$$\text{eq (IV)} \Rightarrow V_4 = (I - I_1) R_4 \quad \text{—— (6)}$$

$$V_1 = V_3 \quad \text{—— (7)}$$

$$V_2 = V_4 \quad \text{—— (8)}$$

put values in (7) and (8) ,

$$I_1 R_1 = (I - I_1) R_3 \quad \text{—— (9)}$$

$$I_1 R_2 = (I - I_1) R_4 \quad \text{—— (10)}$$

Dividing (9) by (10) ,

$$\frac{\cancel{I_1} R_1}{\cancel{I_1} R_2} = \frac{\cancel{(I - I_1)} R_3}{\cancel{(I - I_1)} R_4}$$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

$R_1 R_4 = R_2 R_3$

$$\boxed{R_4 = \frac{R_2 R_3}{R_1}}$$

$$\boxed{X = \frac{QR}{P}}$$

$Q = R_2, \quad P = R_1$

$R = R_3$ 50% → Potential divider

potentiometer:- A device by which ~~by which~~ we measure the emf of an unknown Cell.

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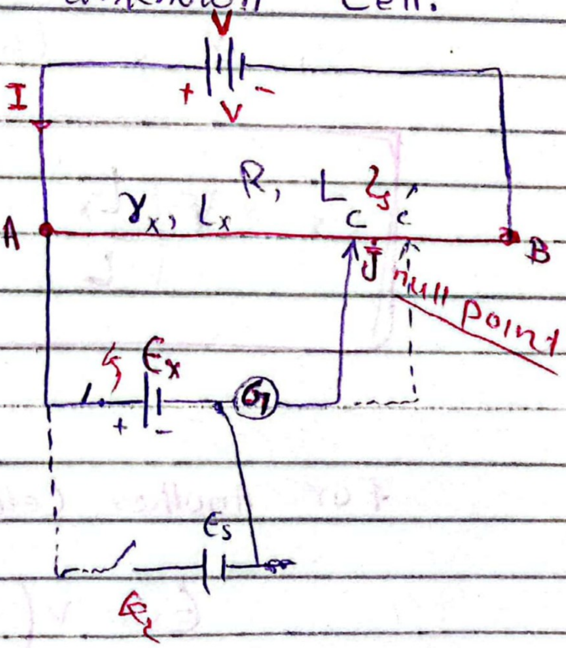

$V_{AC} = I r_x$ —— (i)

$V = IR$

$I = \frac{V}{R}$ —— (ii)

put in (i) :

$V_{AC} = \left(\frac{V}{R}\right) r_x$

$V_{AC} = \left(\frac{r_x}{R}\right) V$ —— (iii) :

As,

$$R \propto L$$

$$R = KL \text{ —— (IV)}$$

$$r_x \propto L_x$$

$$r_x = KL_x \text{ —— (V)}$$

Dividing (5) by (4) :

$$\frac{r_x}{R} = \frac{\cancel{K}L_x}{\cancel{K}L} \text{ —— (VI)}$$

$$\frac{r_x}{R} = \frac{L_x}{L}$$

put eq (VI) in (III) :

$$V_{AC} = V\left(\frac{L_x}{L}\right)$$

$V_{AC} = E_x$ (when voltage across AC is equall to emf no P.D).

$$\boxed{E_x = V\left(\frac{L_x}{L}\right) \text{ —— (VII)}}$$

For Another Cell:-

$$E_s = V\left(\frac{L_s}{L}\right) \text{ —— (VIII)}$$

Dividing eq (VIII) by (VII) :

$$v = \pi r^2 L$$
$$v = \pi\left(\frac{d^2}{4}\right)(L)$$
$$v = \pi r^2$$

$$\frac{\epsilon_s}{\epsilon_x} = V\left(\frac{L_s}{L}\right) \div V\left(\frac{L_x}{L}\right)$$

$$\frac{\epsilon_s}{\epsilon_x} = \cancel{V}\left(\frac{L_s}{\cancel{L}}\right) \times \frac{1}{\cancel{V}}\left(\frac{\cancel{L}}{L_x}\right)$$

$$\boxed{\frac{\epsilon_s}{\epsilon_x} = \frac{L_s}{L_x}}$$

comparision of emf of two cells by potentiometere...

$\boxed{\text{emf of Source} \propto \text{Length}}$

Example:

① $\frac{\epsilon_s}{\epsilon_x} = 2$

ϵ_s is double of ϵ_x.

$\frac{\epsilon_s}{\epsilon_x} = \frac{1}{2}$. ϵ_s is half of ϵ_x...