CURRENT ELECTRICITY...

Hints:

- it is a mechanism whereby charges flow from one point to another within a circuit

ELECTRIC CURRENT (I)

- Is the rate of flow of electric charges
- it is measured in Ammeter

Mathematically

$$\text{Electric current} = \frac{\text{Quantity of charges}}{\text{unit Time}}$$

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

- The SI-unit of electric current is Ampere (A)

AMPERE

- Is the current flowing through a point in a conductor when a charge of one coloumb passes through a point after every one second

Hints

$$1\ \text{Ampere} = \frac{1\ \text{coloumb}}{1\ \text{second}}$$

QUANTITY OF CHARGE

- Is the energy that is transferred from one point to another within a conductor carrying current in a circuit

The SI-unit is coloumb.

COULOMB (C)

- Is the charge that is transported by constant current of one ampere in one second

OR

Is the quantity of electricity passing at a given point in one second when a steady current of one Ampere (A) is flowing in a circuit

Hints:

1 coulomb = 1 Ampere x 1 second

1C = 1A x 1S

- Device that is used to measure electric current is AMMETER
- The other units of electric current are millampere (MA), kiloamper (KA), Microampere (UA)

EQUIVALENCE

$1A = 10^{-3} MA$

$1A = 10^{-6} UA$

$1KA = 10^{3} A$

ELECTRIC POTENTIAL DIFFERENCE (P.d)

- Is the workdone per unit charge in moving electric charge from one point to another in an electric field

OR

Is the difference in electrical potential between any two points.

Mathematically

$P.d(V) = \frac{Workdone}{Charge}$

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

- The common SI unit of P.d is VOLT (V)

HOW ELECTRIC POTENTIAL IS CREATED

Mechanism

- When electric charges move through a conductor ~~on~~ an elastic field set up in the conductor
- This electric field interact with electric charges and hence some energy is spent in moving the electric charge in the foward direction

SIMPLE ELECTRIC CIRCUIT

- Is the circuit that consist of electronic equipment Like sarce of moving charge (it may be battery/generator) connecting wire that is made of a conducting material (copper metal) and electric al device Like;

=> Bulb, switches or plug key, resistors, Ammeter, Voltmeter etc

Electric circuit

Is a continuas conducting path between the terminal of the source of electricity such as cell or battery

TYPES OF CIRCUIT

01. Open electric circuit

Is a circuit in which flow of current stops because of open switch

Reason

Due to ~~closed~~ open switch

02. Closed electric circuit

Is the circuit in which current flows continuosly

Reason.

- Due to closed switch

VOLTAGE

HOW ELECTRIC POTENTIAL IS CREATED

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Reason.

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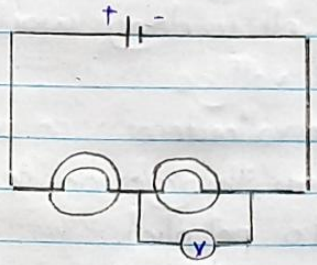
VOLTAGE

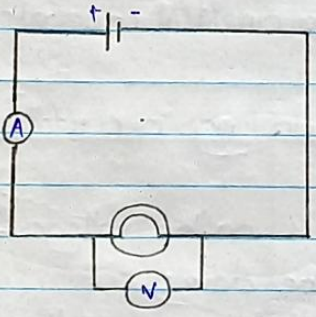
- It is measured by using a device known as VOLTIMETER
  - Its SI-unit is VOLT (V)
- It is always connected parrallel to the device when you want to measure its voltage drop across it.

CONSIDER.



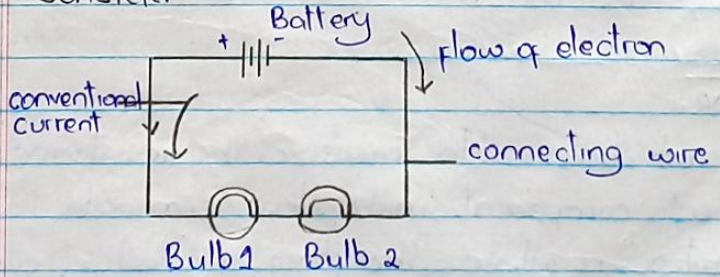
- Wrong connection of an ammeter can damage the circuit, so the red terminal of ammeter should be connected in series with the circuit

Consider



SIMPLE CIRCUIT

Consider



Hints.

- Current always flows from positive to negative

- Electron always flow from negative to positive
- The potential difference is measured in volt

ELECTROMOTIVE FORCE (EMF)

- Is the maximum potential difference between terminals of a cell when the cell is doing work
  - it is also called voltage
  - it is measured in voltmeter

It pumps current to flow through an electric circuit although its not a force is just a potential

- The difference between the electromotive force and the terminal voltage is known as LOST VOLT

RESISTANCE

Hints:

- As current flows through the circuit it encounters some opposing force.

This force determines the flowing of current in a electric device

- Flowing of current depends on the voltage (pd) across the device and the nature of the device.
- The property of conductors that opposes the flow of electric charges depends on the relationship between the current and voltage across their ends.

RESISTOR

- Is the device which is used to measure the resistance
- it is an electrical component with two terminals that is used to limit or regulate the flow of electric current in an electric circuit

RESISTANCE

- Is the measure of opposition of the flow of current in an electric circuit

Its SI-unit is ohm (Ω)

OHM (Ω)

Is the resistance of a conductor in such a way that when a potential difference of 1volt is applied to its ends with a current of 1Ampere flows through it.

TYPES OF RESISTORS

Hints

They are divided according to the material used to make them and value of resistance offered.

Types of resistors due to materials used

01 Wire wound resistor

=> It is made by winding wire made of a certain metallic alloys used to control amount of resistance

02 Carbon resistor

=> Made by mixing carbon granules with varying amount of clay and moulding them into cylinders.

03 Metal film resistor

=> Made of stable ceramic core created with metal alloys such as nickel, chromium

- it is more accurate and more expensive than carbon resistor

04 Metal oxide film resistor

=> Made up of a stable ceramic core coated with metal alloys such as tin oxide

TYPES OF RESISTORS DUE TO VALUE OFFERED

01 Fixed resistor

=> it has the value which cannot be changed e.g 2Ω, 3Ω, 4Ω etc.

- Most carbon resistors are fixed resistor

02 Variable resistor

It has a resistor value which can be changed by means of control e.g potentiometers, photo resistors and Rheostat.

RHEOSTAT

It is also called Variable resistance

- it is divided into two parts namely

01. known variable resistor

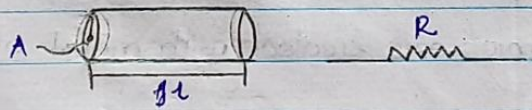
=> Involve the arrangement of number of known resistance which can be added or removed (Resistance box)

02. Unknown variable resistor

=> its magnitude can be altered but its exact magnitude is not known.

FACTORS AFFECTING RESISTANCE OF A WIRE

Consider



01 Length of a conductor

Length of a conductor varies direct proportional to the resistance of a wire

$R \propto l$ — 01

=> As the length increase it lead to an increase in resistance

02 Temperature

Resistance varies direct proportion to the temperature °C

⇒ As the temperature increases it lead to the increase in resistance.

✓ for semi-conductors the increase in temperature cause the decrease in resistance.

03 Nature of material

Resistance depends on the type of material used for making conductor. eg Nichrome wire has more resistance than copper wire of the some dimensions.

⇒ Nichrome wire is used to heat element of electric force

⇒ Copper is used mostly to connect wires

04 Cross-section area

Resistance of a wire varies inversely proportional to the cross section area

✓ As the cross section area increase it tend to decrease resistance of a wire.

GENERAL HINTS:

Combine eqn 1 and eqn 2

$R \propto l - 01$

$R \propto 1/A - 02$

$R \propto l \cdot 1/A$

$R \propto l/A$

$R = \frac{K l}{A}$

$K = \frac{A R}{l}$

K = Constant = Resistivity of material (ρ)

$K = \frac{l}{} = AR$

$\rho = \frac{AR}{l}$

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

$\rho = \Omega m.$

RESISTIVITY (ρ)

Is the ability of a material to oppose the flow of electric current

The SI-unit is ohm meter (Ωm)

CONDUCTANCE

- Is the reciprocal of resistance
- its SI-unit is per ohm (Ω^{-1}) or siemen (S)

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

RESISTIVITY OF SOME MATERIALS AT 20°C

MATERIAL	RESISTIVITY (Ωm)
Aluminium	2.7×10^{-8}
Chronium	1.3×10^{-7}
Copper	1.68×10^{-6}
Iron	9.71×10^{-8}
Lead	2.1×10^{-1}
Silver	1.6×10^{-8}
Constantan	4.9×10^{-7}
Manganin	4.8×10^{-1}
Nichrome	1.0×10^{-6}
Glass	$1 \times 10^{9} - 1 \times 10^{13}$
Rubber	$1 \times 10^{13} - 1 \times 10^{15}$
Quartz	7.5×10^{17}

OHMS LAW

state that "At constant temperature a current flowing through a wire conductor is direct proportional to the potential difference across its ends"

Hints

$V \propto I$

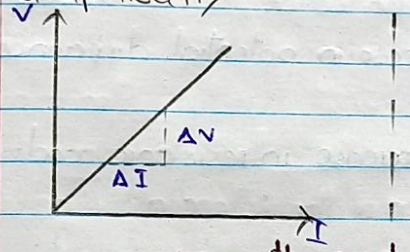
$V = kI$

k = constant = Resistance (R)

$V = RI$

$V = IR$

Graphically



From the graph

slope $= \frac{\Delta Y}{\Delta X}$, $m = \frac{\Delta V}{\Delta I}$

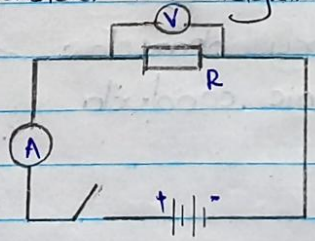
m = slope = resistance.

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

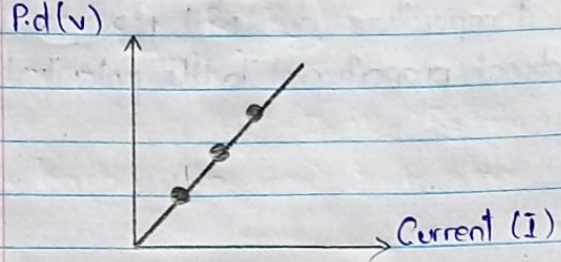
VERIFICATION OF OHMS LAW.

- it can be verified by using Voltmeter ammeter method.

Consider the diagram.



The graph is found to be straight



$V \propto I$

$V = KI$

$V = RI$

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

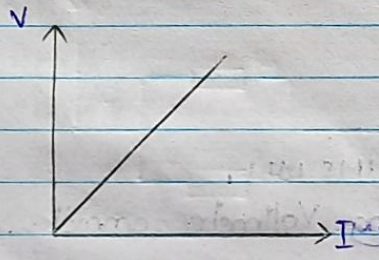
i.e Current increase with increase in potential difference and vice versa

- Current increase with the decrease in resistance and vice versa

OHMIC RESISTANCE

- The resistance that obey ohms law are said to have ohmic resistance. e.g metallic alloys

its graph

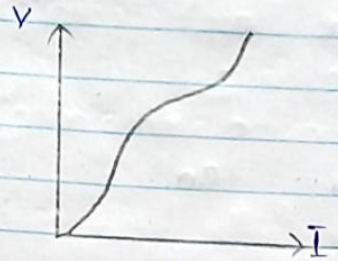


NON-OHMIC RESISTANCE

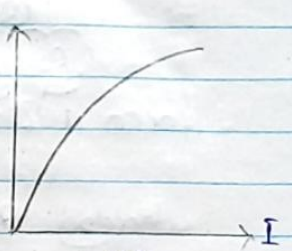
- Resistance that do not obey ohms law

e.g electric valve and ionic conductor

graph



(a)



(b)

LIMITATION OF OHMS LAW

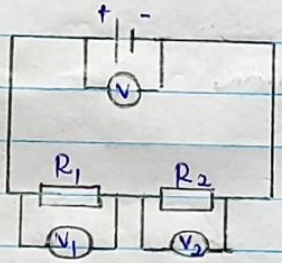
01 it does not apply to some electrolytes. eg dilute H_2SO_4
02 it does not apply for conduction of electricity charges.
03 it does not hold in semi conductor (diode and transistors)

COMBINATION OF RESISTORS

Resistors can be combined in series or in parallel form

SERIES ARRANGEMENT

Consider



Conditions

01. P.d across the battery = sum of p.d around the conducting path
02. Current is the same at all point

Hints

✓ Since p.d is not the same then

$$V_T = V_1 + V_2$$

From ohms law $V = IR$

$V_T = IR_T$, $V_1 = IR_1$, $V_2 = IR_2$

$\therefore V_T = V_1 + V_2 \Rightarrow IR_T = IR_1 + IR_2$

$$IR_T = I(R_1 + R_2)$$

$$R_T = R_1 + R_2$$

for n resistor

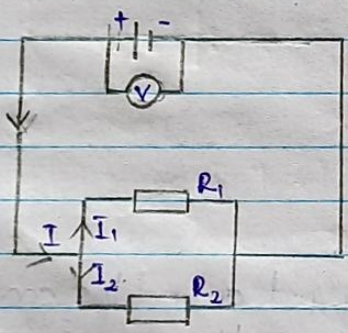
$$R_T = R_1 + R_2 + R_3 + R_4 \cdots + R_n$$

whereby R_n is a last resistor

CHARACTERISTICS OF RESISTANCE IN SERIES

01. The sum total of resistance in series increases with the increase in number of resistors.
02. The current tend to decrease as the number of resistors are increasing
    ⇒ (This explains that series connection of bulb are not brighter due to high resistance)
03. All elements (bulbs) in series circuit works simultaneously
    ⇒ This explains that if the circuit is broken anywhere between elements (bulbs) Non of the element functions.

PARALLEL CONNECTION



Conditions

In parrallel connection the current passing outside the branches is equal to the sum of the current in the individual branches.

e.g $I_T = I_1 + I_2$

Voltage in each branch is the same

Hints

- Since the current is not the same then

$$I_T = I_1 + I_2$$

from ohms law $V = IR$, $I = V/R$

$$I_T = I_1 + I_2$$

$$I_T = \frac{V}{R_T}, \quad I_1 = \frac{V}{R_1}, \quad I_2 = \frac{V}{R_2}$$

from $I_T = I_1 + I_2$

$$\frac{V}{R_T} = \frac{V}{R_1} + \frac{V}{R_2}$$

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

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\left(\frac{1}{R_T}\right) = \left(\frac{R_1 + R_2}{R_1 R_2}\right)$$

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

from (n) resistors

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}$$

Whereby R_n is the last resistance.

CHARACTERISTICS OF RESISTANCE IN PARALLEL CONNECTION

01 Sum of resistance in parallel decreases with the increase in number of resistors

02 The current flowing in any resistor in parallel connection will be inversly proportional to the resistance.

⇒ The more the resistance the less the resistance and viceversa

- This explains that arrangement at elements (bulbs) are brighter due to low effective resistance

⇒ Effective resistance (Total resistance) decreases as the number of resistors keep increasing

03 Each resistor in parallel function independently with respect to the other resistor

⇒ (This explains that if one bulb blow of the other bulbs will continue working)

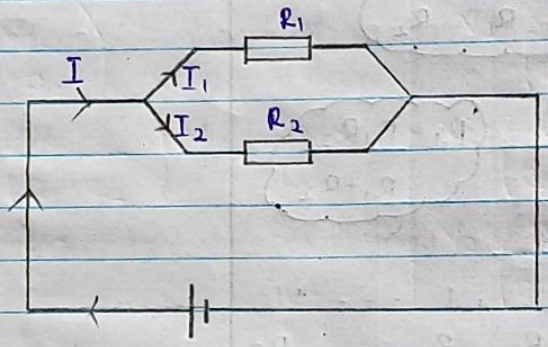
04. Used in house wiring

APPLICATION OF OHMS LAW

01. it is applied in resistor network e.g series and parallel combination of resistors.

02 it is used to divide current (current divide theorem)

Consider



Hints 01

- The total current tend to be divided

Effective resistance $R = \frac{R_1 R_2}{R_1 + R_2}$

from ohms law

$$V = IR$$

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

Case 01

Current due to branch 1

$$I_1 = \frac{V}{R_1}$$

$$I_1 = V\left(\frac{1}{R}\right) \quad \text{but}$$

$$I_1 = IR\left(\frac{1}{R_1}\right)$$

But R = Effective resistance

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

$$I_1 = I\left(\frac{R_1 R_2}{R_1 + R_2}\right) \div \left(\frac{1}{R_T}\right)$$

$$I_1 = I\left(\frac{R_2}{R_1 + R_2}\right)$$

$$\boxed{I_1 = \frac{R_2}{R_2 + R_1}}$$

CASE 02:

Current due to branch 2

$$I_2 = \frac{V}{R_2}$$

$$I_2 = V\left(\frac{1}{R_2}\right)$$

but $V = IR$

$$I_2 = IR\left(\frac{1}{R_2}\right)$$

But R = Effective resistance

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

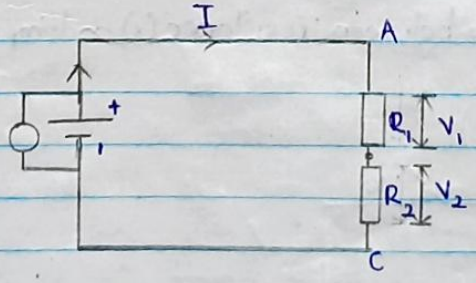
$$I_2 = I\left(\frac{R_1 R_2}{R_1 + R_2}\right) \div \left(\frac{1}{R_2}\right)$$

$$I_2 = I\left(\frac{R_1}{R_1 + R_2}\right)$$

$$\boxed{I_2 = \left(\frac{R_1}{R_1 + R_2}\right) I}$$

3 When used in dividing voltage (voltage divider theorem

Consider



Hints

From ohms law

$V = IR$

But $R = R_1 + R_2$ { effective resistance

$V = I(R_1 + R_2)$

$I = \frac{V}{(R_1 + R_2)}$

Case 01

Voltage due to R_1

$V_1 = IR_1$

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

$V_1 = \left(\frac{V}{R_1 + R_2}\right)$

$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) V$

Case 02

Voltage due to R_2

$V_2 = IR_2$

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

$V_2 = \left(\frac{V}{R_1 + R_2}\right) R_2$

$V_2 = \left(\frac{V}{R_1 + R_2}\right)$

$V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V$

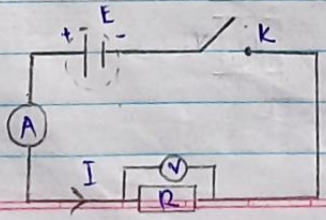
INTERNAL RESISTANCE OF A CELL

Hints 01

- Cell has an internal resistance that opposes the flow of electric current causes the potential drops across their resistance
- The relationship between resistance (r) and emf (e) of a cell is given by

$E = I(R + r)$

Consider



$E = I(R+r)$

Where E = Electromotive force

I = Eledric current

r = Internal resistance

R = External resistance (Load resistance)

p.d across R (terminal voltage), $V = IR$

p.d across (Lost voltage) $V_L = Ir$

$E = IR + Ir$

$E = V_L + V$

Hints 02

01 When the Terminal of the battery are short circuited when disconnected from their external circuit

⇒ The resistance of the circuit is the internal resistance of the cells.

✓ Recall from

$E = I(R+r)$

$E = V + V_L$

$E = V + V_L$ Where $V = 0$

$E = V_L$ $\qquad$ $E = Ir$

02 The total emf available in the cell is used up in two way

✓ Driving the current through the cell to overcome internal resistance

✓ Driving the current through the external resistance R

Recall,

✓ This eqn can be used to determine the internal resistance of a cell

✓ When the current $I = 0$ then $V = E$

RESISTOR COLOUR CODES

Hints:

- Resistors which are used in determine devices always pointed with different colour texture called BAND
- The BAND represent the exactly value of a resistance it contains four band with different meaning

RESISTOR'S COLOUR CODES

Consider Table

	Colour	Code
Better	Black	0
Be	Braun	1
Ready	Red	2
Or	Orange	3
Your	Yellow	4
Great	Green	5
Big	Blue	6
Plan	Purple	7
Goes	Grey	8
Wrong	White	9

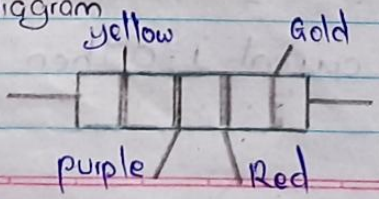
TOLERANCE COLOUR CODES

- Colours of resistors may be represented in percentage

Consider Table

Tolerance	± 1	± 2	± 5	± 10	± 20
Colour	Brown	Red	Gold	Silver	Nocolor

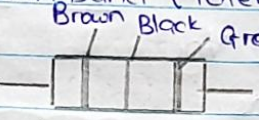
Consider the diggram



Hints:

- First band represent the first digit
- Second band represent the second digit
- Third band (multiplier) represents the number of zero
- The fourth band (Tolerance) represent the percentage accuracy

Example:



Given the resistance above find the value of the resistance

Solution

Bn	Bl	Gn
1	0	5

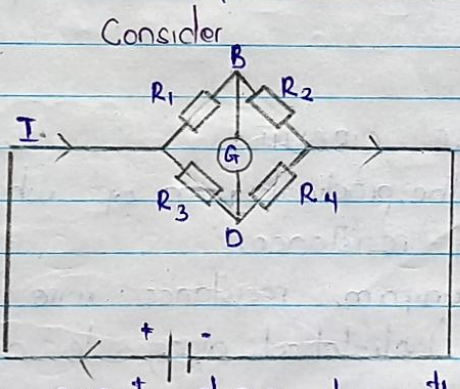
1000000Ω

∴ The value of resistance is 1000000Ω

WHEAT STONE BRIDGE METHOD

- Is an electrical bridge circuit used to measure the unknown resistance of a conductor

Consider



- The circuit above show that R_1, R_2 and R_4 are known resistance and R_3 is unknown
- The resistance R_4 is varied until the balancing point is obtained where the galvanometer show no deflection

Hints 01

- At balancing point

$V_{AB} = I_1 R_1$, $V_{BC} = I_1 R_2$

$V_{AD} = I_2 R_3$, $V_{DC} = I_2 R_4$

Hints 02

Potential at B and D are not equal

Reason

No current is flowing/passes through the galvanometer

So;

$V_{AB} = V_{AD}$ and $V_{BC} = V_{DC}$

which means

$$\frac{V_{AB}}{V_{BC}} = \frac{V_{AD}}{V_{DC}}$$

$$\frac{I_1 R_1}{I_2 R_3} = \frac{I_1 R_2}{I_2 R_4}$$

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

ADVANTAGES OF WHEATSTONE

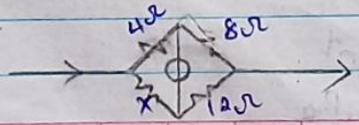
- Measurement of resistance is not affected by internal resistance of the supply battery.
- it is more sensitive when the resistance of four arms are nearly equal.

METER BRIDGE CIRCUIT

- Is the one of the practical form of wheatstone bridge used for measuring resistance.
- it consist of a uniform resistance wire let say AC (usually 100cm long) stretched along side a meter ruler

Question.

The galvanometer in the bridge network shown in figure below given no deflection what is like value of x.



Solutions

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

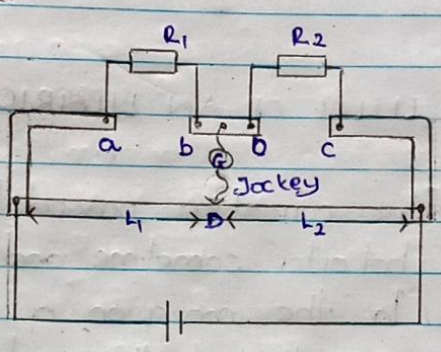
$$\frac{4\Omega}{8\Omega} \times \frac{x}{12\Omega}$$

$$\frac{8\Omega \times x}{8\Omega} = \frac{4\Omega \times 12\Omega}{8\Omega}$$

$$x = 6\Omega$$

$\therefore X = 6\Omega, \; R_3 = 6\Omega$

Consider



Hints

- Resistance R_1 is connected across the gap ab
- Another resistor R_2 is connected across the gab bc
- As the jockey is moved along the AC at one position let say D, the galvanometer will read zero
- The meter bridge is then said to be balanced
- D is the balancing point
- R_1 is the resistance to be measured

Consider from figure

$R_1 \propto L_1$ —— 01

$R_2 \propto L_2$ —— 02

$L_1 + L_2 = 100cm$ —— 03

$R_1 = KL_1$ —— 04

$R_2 = KL_2$ —— 05

Take eqn 04 and 05 then divide

$$\frac{R_1}{R_2} = \frac{KL_1}{KL_2}$$

$$\frac{R_1}{R_2} = \frac{L_1}{L_2} \quad \text{—06}$$

Recall from eqn 03

$L_1 + L_2 = 100cm$

Make L_2 the subject formula

$L_2 = (100cm - L_1)$

Recall eqn 06

$$\frac{R_1}{R_2} = \frac{L_1}{L_2}$$

$$\frac{R_1}{R_2} = \frac{L_1}{(100 - L_1)} \quad \text{—07.}$$

HEATING EFFECT OF AN ELECTRIC CURRENT

Hints.

- When an electric current is passed through a conductor become hot after sometime and produce heat
- This happens due to the conversion of some electric charges energy passing through the conductor into heat

e.g the steel wool stand will get hot as current flows through the circuit

⇒ Here electrical energy is converted to heat energy in the steel wool.

FACTORS AFFECTING HEAT QUANTITY

01 Resistance of a conductor

- The higher the heat the resistance and vice versa

02 Magnitude of the electric current

- The higher the current the more the heat produced.

03 The time for which current flow

- The heat produces by an electric current is proportional the time taken by the current to pass through a conductor

JOULE'S LAW

Hints

- it tell us the relationship between resistance current and heat generated

Joule's law state that " When an electric current is passed through a conductor the heat evolved in a given time is directly proportional to the resistance of the conductor in ohms multiplied by the square of the current in Amperes "

HINTS

$H \propto I^2 Rt$

$H = KI^2 Rt$

K = Constant

$H = I^2 Rt$ — 01

Recall from ohm's law

$V = IR$

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

$H = I^2 \left(\frac{V}{I}\right) t$

$H = IVt$

$H = ItV$ — 02

Recall from potential difference in term of workdone

$P.d(V) = \frac{w.d}{q}$

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

$w = qV$ — 03

from

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

$\therefore w = (It)V$

$w.d = ItV$ — 04

Recall eqn 03

$w = qV$

but $V = IR$

$w = qIR$

$w = IqR$ — 05

GENERAL HINTS

- The workdone become transferred to molecular energy in the conductor accompanied by rise in temp°C

✓ This energy is given out in form of heat

w.d = H = itv = I^2Rt

ELECTRIC POWER

✓ Is the rate at which electrical energy is connected to other forms of energy e.g heat, light

Hints.

Electric power = $\frac{\text{Electrical energy}}{\text{time}}$

Δ Electrical energy = workdone = Heat energy

$P = \frac{\text{Energy}}{\text{time}}$

$P = \frac{I^2Rt}{t}$

$P = I^2R$ —— 06

from ohms law

$V = IR$

Recall form eqn 06

$P = I^2R$

$P = I(IR)$

$P = IV$ —— 07

Recall again from eqn 06

$P = I^2R$

from ohms law

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

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

$P = \frac{V^2}{R^2} R$

$P = \frac{V^2}{R}$ —— 08

KILOWATT HOUR (KWH)

Is the energy supplied by the rate of working of 1000 watts for 1 hour

Hints

1 kilowatt hour = 1000 watt hour

= 1000 J/s for 1 hour

= 1000 J/s (60×60) s

$1000J \times 3600 = 3600000J$

$3.6 \times 10^6 J$

The energy given in (1kwh) is $3.6 \times 10^6 J$

Commercial unit of electrical energy is (k·wh)

EFFICIENCY OF ELECTRIC DEVICE

Is the ratio of useful output power to the input power expressed in percentage

Mathematically

$$\text{Efficiency} = \frac{\text{Useful output power}}{\text{input power}} \times 100\%$$

APPLICATION OF HEATING EFFECT

- Used in electrical heating appliance such as iron room heater water heater
- Used in electric bulb to produce light
- Used in electric fuse

NB: The wire used in the fillament of household bulb should have high resistance and high melting point (heated to a very high temp°c) inorder to emit light.

MEASUREMENT OF ELECTRICAL POWER AND BILLING OF ELECTRICAL ENERGY

- ~~Used in electrical heating appliance such as~~
- Power is the rate of doing work.

OR

Is the workdone per unit time in (second)

- Power companies like TANESCO usually measure the electrical energy in kilowatt hour (kwh)

Hints 01:

1 kwh = 1kw x 1 hour

= (1000W x 60 x 60)

1kwh = 3600000J

1kwh = 3600 kJ

Hints 02:

High voltage is used for commercial transmission of electrical energy

Reason:

- Inorder to reduce the powerless during electrical transmission.

ELECTRICAL APPLIANCES

- Is the device that uses heating element To produce heat energy
- Nichrome wire is among of the heating element due to high melting point
- The common electrical appliances include heaters, electric iron, bulbs, kettles, cookers, fridges, television and air conditioners

RATING OF THE ELECTRICAL APPLIANCES

(Is the device that uses heating element to produce heat energy.) Out of concept.

- Is the rate at which the appliance dissipate energy Each electrical appliances has its own rating which enables us To know energy despitated

e.g

- An appliance marked 3000W, 240V dissipates energy at the rate of 3000Joules per second when

connected to 240V
The resistance of fillament increases with the increase in temp°C

POWER RATINGS OF COMMON ELECTRICAL APPLIANCES.

Electrical appliance	Power rating at 240V
Immersion water	2000W (2KW)
Electrical heater	2000W (2KW)
Electrical Iron	1000W (1KW)
Electrical kettle	2500W (2.5KW)
Colour Tv	300W
Refrigirator	120W
Light bulb	25W - 150

Hints:
- Is the main supply falls below 240V, the rating of the appliances would drop
Similarly when the power supply rises, the rating would rise and it would damage the appliance due to over heating

ELECTRICAL INSTALLATION OF A HOUSE

Hints:
Domestic electricity is supplied by two cables
=> Live (L)
=> Neutral (N)
- The third cable is Earth (E) that is used to provide extra safety

LIVE CABLE (L)
- it is 240V relative to the neutral

- it is represented by BROWN and RED colour

Then potential difference the LIVE and NEUTRAL wire is 240V - 0V = 240V

NEUTRAL CABLE (N)

- It is earthed at the power station

Reason.

⇒ To ensure current at neutral remains zero potential (V=0V) so it cannot give an electric shock on touching

- it is represented by BLUE or BLACK colour

EARTH CABLE (E)

It is introduced to provide extra safety especially in electrical appliance

- it is represented by YELLOW or GREEN colour

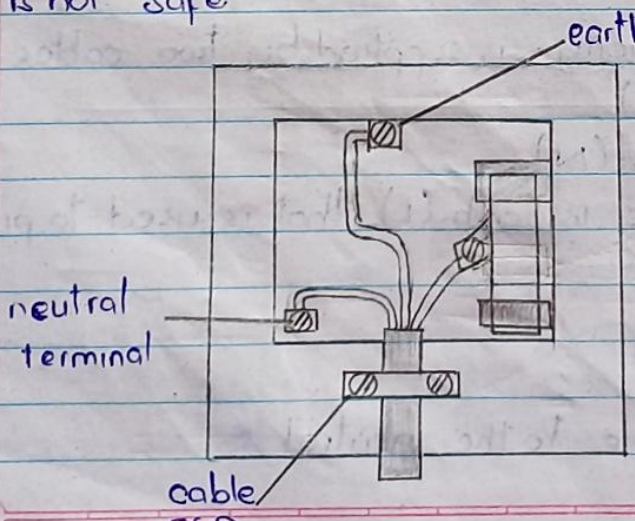
THREE PIN PLUG

- it consist of all three cables which are Live cable, neutral cable and earth cable

Hints.

- A fuse is connected to LIVE cable

Sometime a fuse can be connected to neutral which is not safe



N:B

- The earth pin/cable is longer than the other two
- Switch must be off when you push the plug into the socket

TWO PIN PLUG

- It consist of only two cables which is Live cable and neutral cable
- An appliance using two-pin plug its body is not connected to the earth

FUSE

- Is a safety device used to protect an electric circuit against excess current

OR

Is a short piece of special wire which melt when more than a rated amount of current passes through it.

- it is made of a thin copper wire covered with tinor a lead tin alloy.
- it works as a circuit breaker or stabilizer which protects the device from damage

Types of fuse

a) Rewireble fuse
b) Catridge fuse

MECHANISM OF A FUSE

- A fuse works on the principle of heating effect of an electric current.
- it is always connected in serres with the electrical circuit to protect from over current in the running cable
- When the excessive current flows in the circuit, the fuse

it opens (breaks) the circuit
- the excessive flow may lead to the break down of wire and stop the flow of current
then the fuse can be replaced with the new one with suitable rating

APPLICABLE OF FUSE

- Electrical appliances (devices)
- Auto mobiles such as car, trucks, and other vehicles
- Spanners, portable electronics, hard disc drivers
- Fuses in capacitors, transformers etc

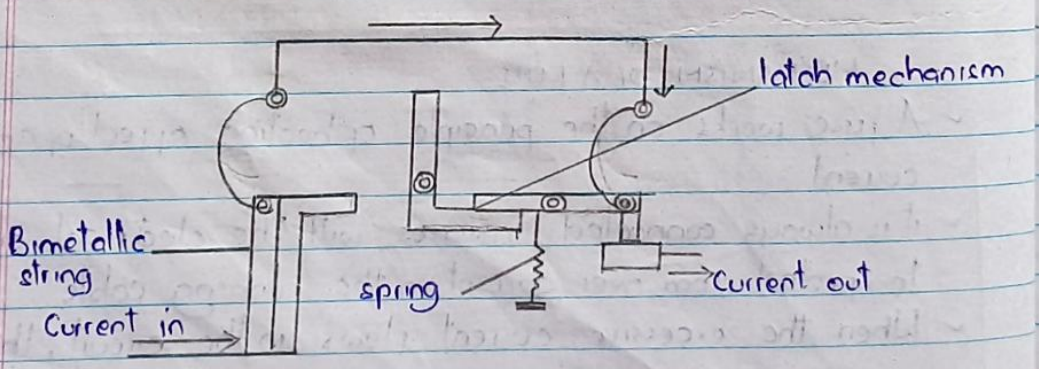
WHAT HAPPEN IF WE DONT USE FUSE

- If we don't use fuses, electrical faults occurs in the wiring and it burns the wire and electrical appliances and this may start fire at home

Also the Lives of television, computers, radios and other home appliances may put at risk.

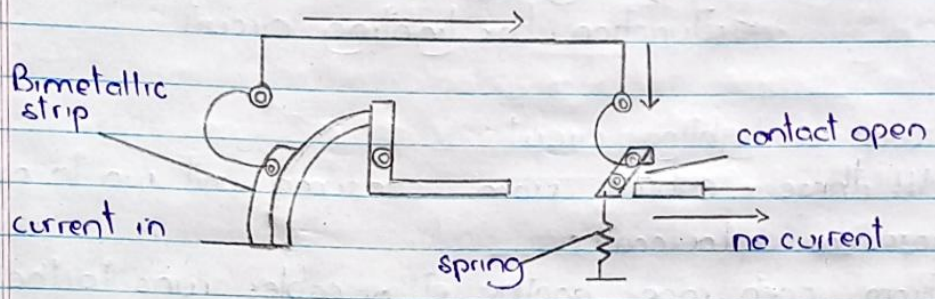
CIRCUIT BREAKER

- Is a type of switch that cut off the flow of current when the current exceeds a specific volume.



MECHANISM OF CIRCUIT BREAKER

When the current exceed tend to increase the temperature and bimetallic strip bend to push latch mechanism which enable the spring to cut off the current.



DOMESTIC WIRING CIRCUIT

- The power company connects power to the house up the consumers unit where they wiring starts.
- Consumer unit is the place where the main switch, main fuse and distribution board and placed in a single box or unit.
- From the consumer unit the cables branch into the various parts of the house

TYPES OF DOMESTIC WIRING CIRCUIT

01. Ring main circuit
02. Lightning circuit

RING MAIN CIRCUIT

⇒ It is the cable which begins and ends at the consumer unit
- its three cables are forming ring around part of the house
- its fuse is of 30A fuse.

LIGHTING CIRCUIT

In this circuit the first lamp connected from the consumer unit inturn is connected to the second lamp and so on.

TYPES OF LIGHTING CIRCUIT

- ✓ loop in lighting circuit
- ✓ Junction box lighting circuit

Loop in lighting circuit

✓ All these cables from consumer unit run to each roses one after another
From each rope another set of cables runs to the switch which operates the light.

Junction Box lighting circuit

All three cables from consumer init run to one junction box to another where one cable runs to the light and another run to the switch for that light

REPAIRING ELECTRICAL APPLIANCES FAULTS.

✓ (All three cables from consumer init run to one junction). incorrect.

✓ Multimeter and Live mains lead indicator are devices important when checking electrical appliances faults.

LIVE MAIN LEAD INDICATOR (TESTOR)

✓ Is the electronic device used for testing the flow of electric current

Multimeter

Is the single meter for measuring current both (a.c and d.c)

REPAIRING OF FAULTS PROCEDURES.

If electrical appliance fail to work, the following procedure should be done

01 check by using Live mains lead indicator if there is power or not

02 check the cable from the socket to the appliance

03 If no faults is detected open the plug and then check the fuse

04 Check each cable for continuity by using multimeter.

05 If the cable are working properly check the fault is in the element by using a multimeter.

06 If element is in fault replace element as repair

07 If the element is not in fault, look for Loose connection

SOURCES OF FAULTS IN DOMESTIC SYSTEM

01 When fuse blows/melts

02 Wire cutting

03 Wire joining

04 Socket getting dusty

05 Switches breaking

CELL

A cell is a device used to cause a flow of current electric in a conductor

Types of Electrochemical cells.

01. Primary cells.

02. Secondary cells.

PRIMARY CELLS

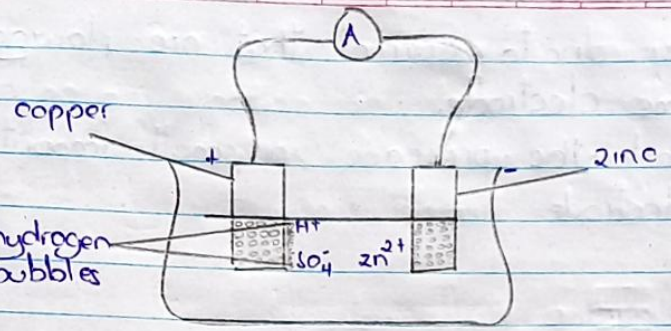
- Is a cell which produces current as a result of irreversible

chemical changes taking place within a cell
it is a cell that is designed to be used once and discarded.
it cannot be recharged after being used.
- Primary cells have high density and get discharged slowly

Examples of primary cells.
01. Simple cell
02. Leclanché cell
03. Dry cell:

CHARACTERISTICS OF PRIMARY CELL.
- Have high energy density and slow in discharge and easy to use
- There are no fluids in the cell hence it is also called dry cell
- it has high internal resistance
- it has an irreversible chemical reaction
- its design is smaller and lighter
- its initial cost is cheap

SIMPLE CELL
- Is a device that converts chemical energy into electrical energy
- It consist of two electrodes (two different metals) and an electrolyte solution.
- It is made from copper as anode, zinc as a cathode and dilute acid as electrolyte.



The processes that occur when the cell is an operation
↳ oil H_2SO_4 separates into sulphate ions (SO_4^{2-}) and hydrogen ion (H^+)

$$H_2SO_4 \longrightarrow 2H + SO_4^{2-}$$

At Anode

Zinc metal dissolved into solution to form zinc cation which reacts with sulphate anion to form zinc sulphate

$$Zn^+ + SO_4^{2-} \longrightarrow ZnSO_4$$

At cathode

Hydrogen cation discharges to liberate hydrogen gas (bubbles)

$$2H^+ + 2e^- \longrightarrow H_2$$

DEFECTS OF A SIMPLE CELL

Simple cell has two defects which causes the current to drop quickly when the cell is being used. These are

01. Local action
02. Polarization.

LOCAL ACTION

Local action of a battery is the deterioration of the battery

of the battary due to current that are flowing from and the same electrode.
- it is caused the presence of small impurities in the zinc electrode.

Exercise

1. An electric cooker has coil resistance 50Ω. If it operated on 240V main supply for 1hour how much energy does it produce?

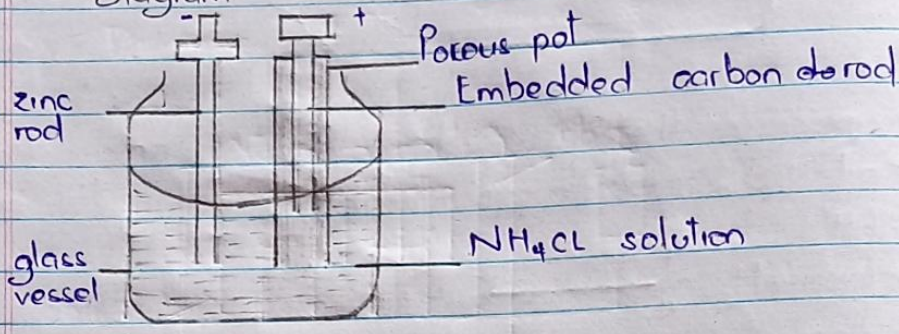
2. A house has six rooms each with a 85W, 240V bulb If the bulbs are switched on 06:50pm to 10:30pm determine the power consumed by bulbs per day

3 A bulb rated 120V, 75W burns continuosly for 3days Given that the cost of one unit (1kw) is 320Tsh determine the:
a) Total electrical energy consumed
b) Total power bill.

LECLANCHE' CELL

- It is a cell that is made of ocirbon as an anode, zinc as cathode, ammonium chloride (NH_4Cl) solution and depolazir manganese dioxide (MnO_2)

Diagram



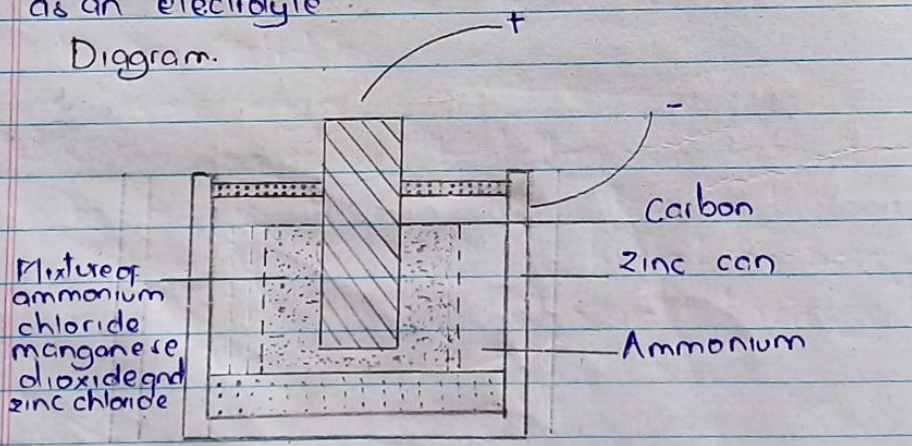
DRY CELL.

- Is a modified leclanche' cell in which ammonium chloride solution is replaced with ammonium chloride jelly.

FUNCTION OF MnO_2

- it act as a depolizer
- Ammonium chloride (NH_4CL) and zinc chloride acts as an electrolyte

Diagram.



USES OF DRY CELL

- Used to operate on radar, electronic calculator and other small electrical devices

ADVANTAGES OF DRY CELL

- it is portable
- The chemicals for its production are relatively cheap
- it has a relatively high emf.
- it is able to recover from its polarized.

DISADVANTAGES OF DRY CELL

- It cannot be recharged thus disposed after use.

SECONDARY CELLS

- Are cells which can be recharged after running down. e.g lead acid cells and Nickel ferrous cells.
- They are also called ACCUMULATORS

ADVANTAGES OF SECONDARY CELL

- Last stronger than primary cells.
- Can supply large current (low internal resistance) for a long time.
- Can be recharged.

DISADVANTAGES OF SECONDARY CELL

- Heavy and cumbersome to carry.
- The electrolyte is corosive
- it produces gases which may explode if ignited
- it cannot produce large current in cold weathers (Lowering the temperature causes chemical reactions to proceed more slowly)

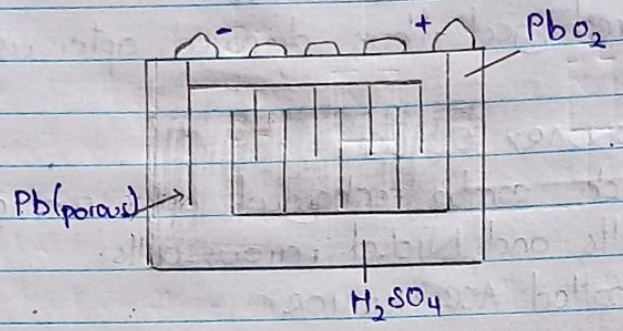
LEAD ACID BATTERY

- It consist of two plates of Lead immersed in water dilute sulphuric acid

⇒ These are anode of Lead (iv) oxide and cathode of spongy Lead.

- An electrolyte is separated by insulator called separator
- Cathode joining together to form negative terminal while anode joining together to form positive terminal

Diagram.



DISCHARGING OF LEAD-ACID BATTERY

Discharging
Means that

- A battery tend to provide electrical energy

Charging of Lead acid battery
Charging

- It is aim is to drive all the acid out of plates and return it to the electrolyte
- During charging

⇒ Negative terminal of the battery charger is connected to the negative terminal of the battery and vice versa

- When battery is full discharged, the battery is said to be sulphated (will not function until it recharged)

TAKING CARE OF ACCUMULATORS

- Cells should be charged regularly and should never left discharged

- the acid level should be maintained by adding distilled water when necessary (never add acid)
- the terminal should be kept clean and greased.
- Rough handling should be avoided
- The cell should not be short circuit e.g if you connect two terminals to eachother rate.
- The rate specified by manufacturer should not be exceeded during charging.

USES OF ACCUMULATORS.

- To provide power in motorvehicles.
- To provide energy to power domestic appliances such as radio.
- Used together with solar panels to convert solar energy to electrical energy
- They are used to store electrical energy

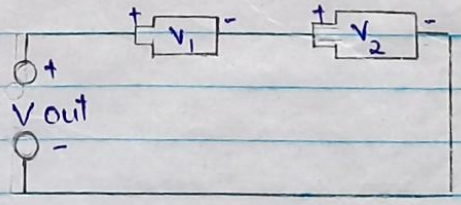
ARRANGEMENT OF CELLS

01. SERIES ARRANGEMENT

Hints.

- In this arrangement the positive terminal of one cell is connected to the negative terminal of another cell
- Electrical current is the same to each cell.
- Total voltage across the cell is equal to the sum of voltage arrangement.

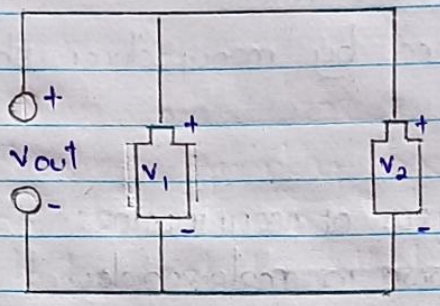
Diggram.



Parallel arrangement

- In parallel arrangement all the positive terminal of the cells are connected together and negative terminal of the cells are connected together.

Diagram.



Hints.

- Total voltage of all the cells is the same as that of single cell
- Currents is not the same

  ie. $I_T = I_1 + I_2 + I_3 + \dots + I_n$ that is why lead and accumulated uses this arrangement.