LECTURE 1

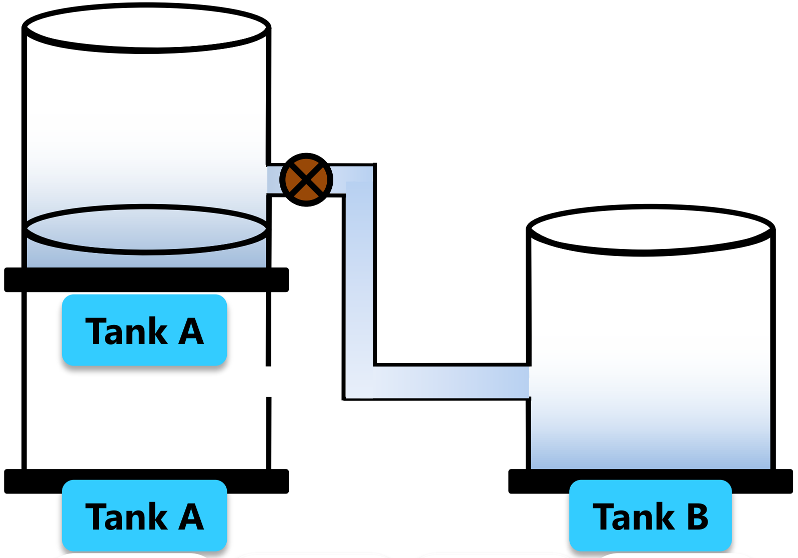
ELECTRIC CURRENT

cross sectional area

Conductor

When wind flows from one place to another it is called

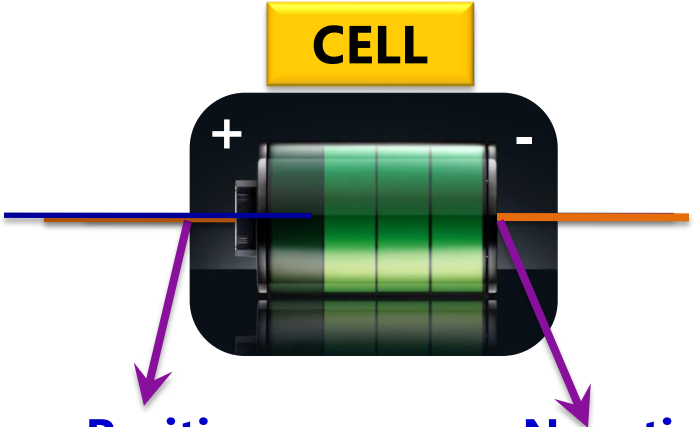
What makes the charge flow?



60° C | 40° C | 20° C | 20° C

A | A → B | B

Higher Temperature | **Lower Temperature**



Positive terminal → **Higher electric potential**

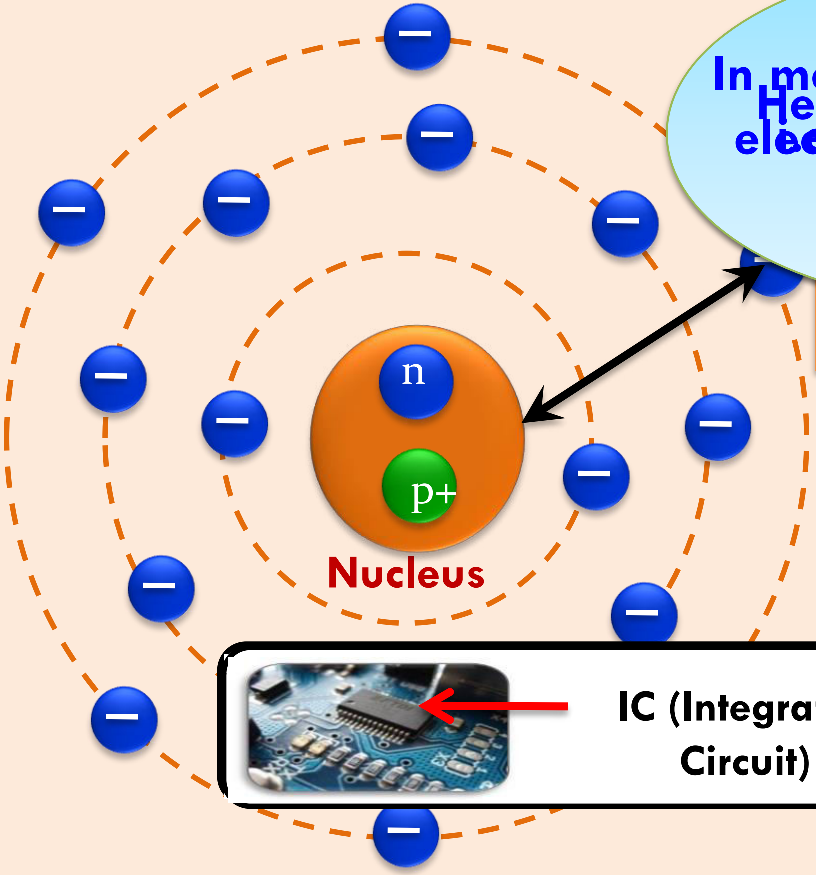
Negative terminal → **Lower electric potential**

Potential Difference

potential and lower potential

The function of the cell is to create potential difference

Now what is a free electron ?



In metals the number of electrons in outermost orbit is less

1, 2, 3 electrons

Hence, electrons are lightly bound

Depending on the number of free electrons, substances are classified into :z

...EUS AND ELECTRON ...FORCE OF ATTRACTION CALLED

CONDUCTORS

Have large number of free electrons, which are charge carriers.

Have less or practically no free electrons

IC (Integrated Circuit)

hey do not have free electrons at room temperature, but can develop under specific condition

A substance which harges to pass through it, easily is called as ....

(a) metal onductor

(c) insulator emiconductor

Insulators do not have free

As they have concentration of negative charge

Negative term ..... .

(a) higher elec (b) lower electric potential

(c) pole (d) None of these

Substances which do not but can develop under specific condition are cal

(a) metals n - metals

(c) semi conductors nductors

Free electrons are generated on imparting heat

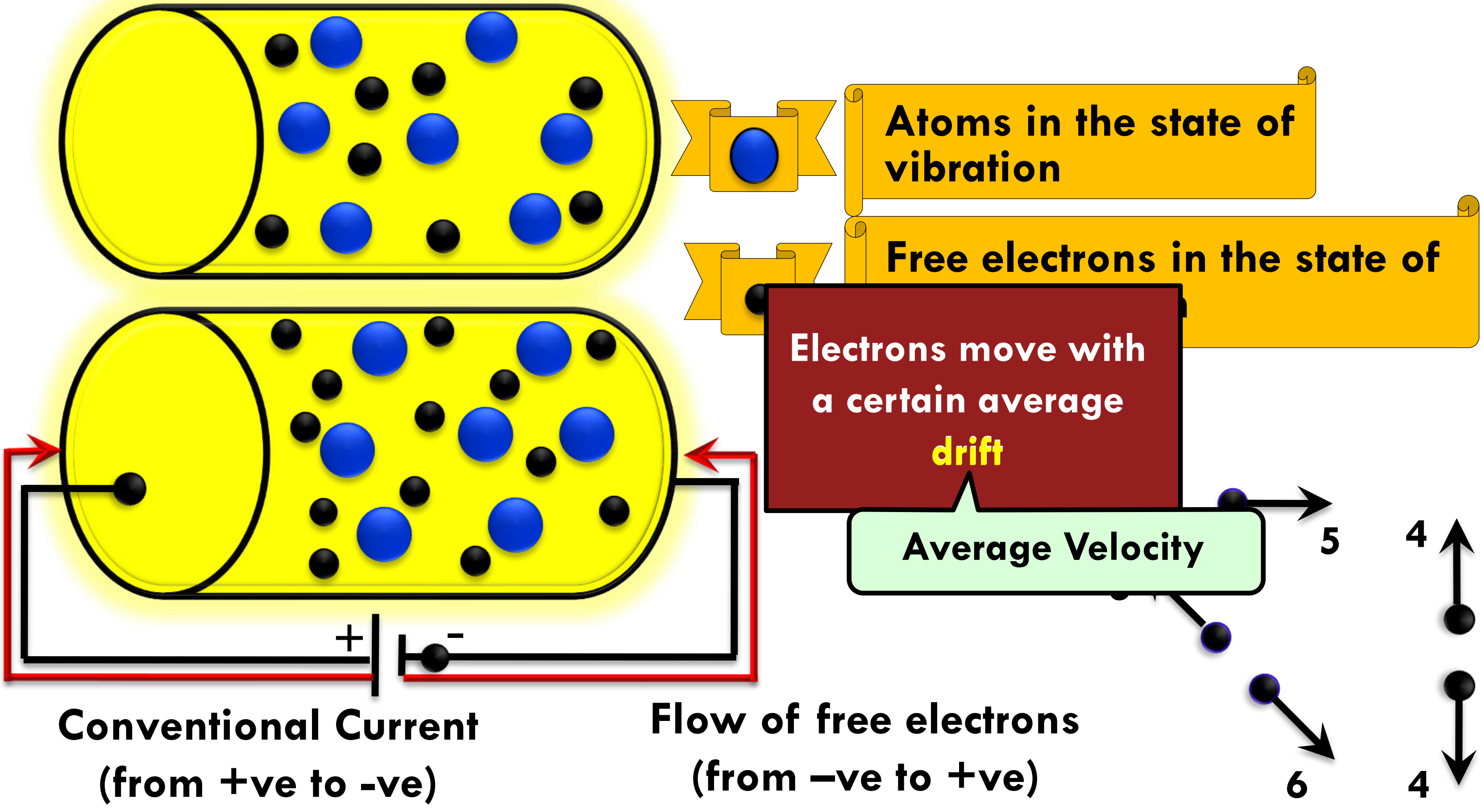
The function of the cell is ______

(a) To create difference te drop

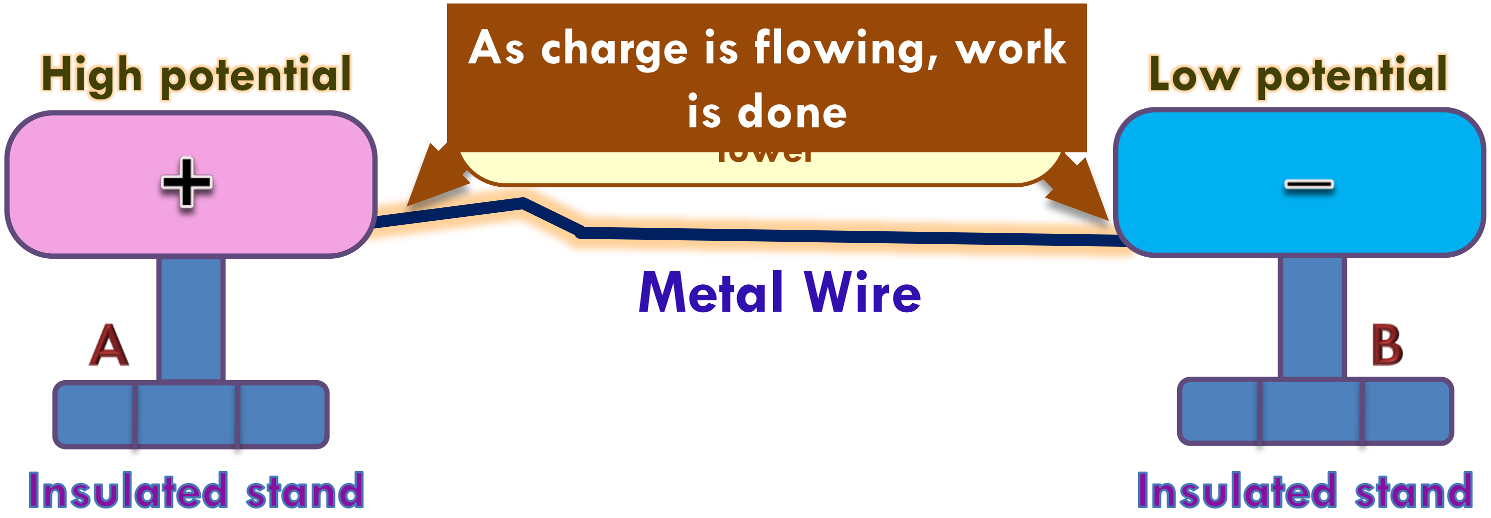
(c) To create potential difference (d) develop free electrons

Cell creates potential difference

Flow of current in a Wire



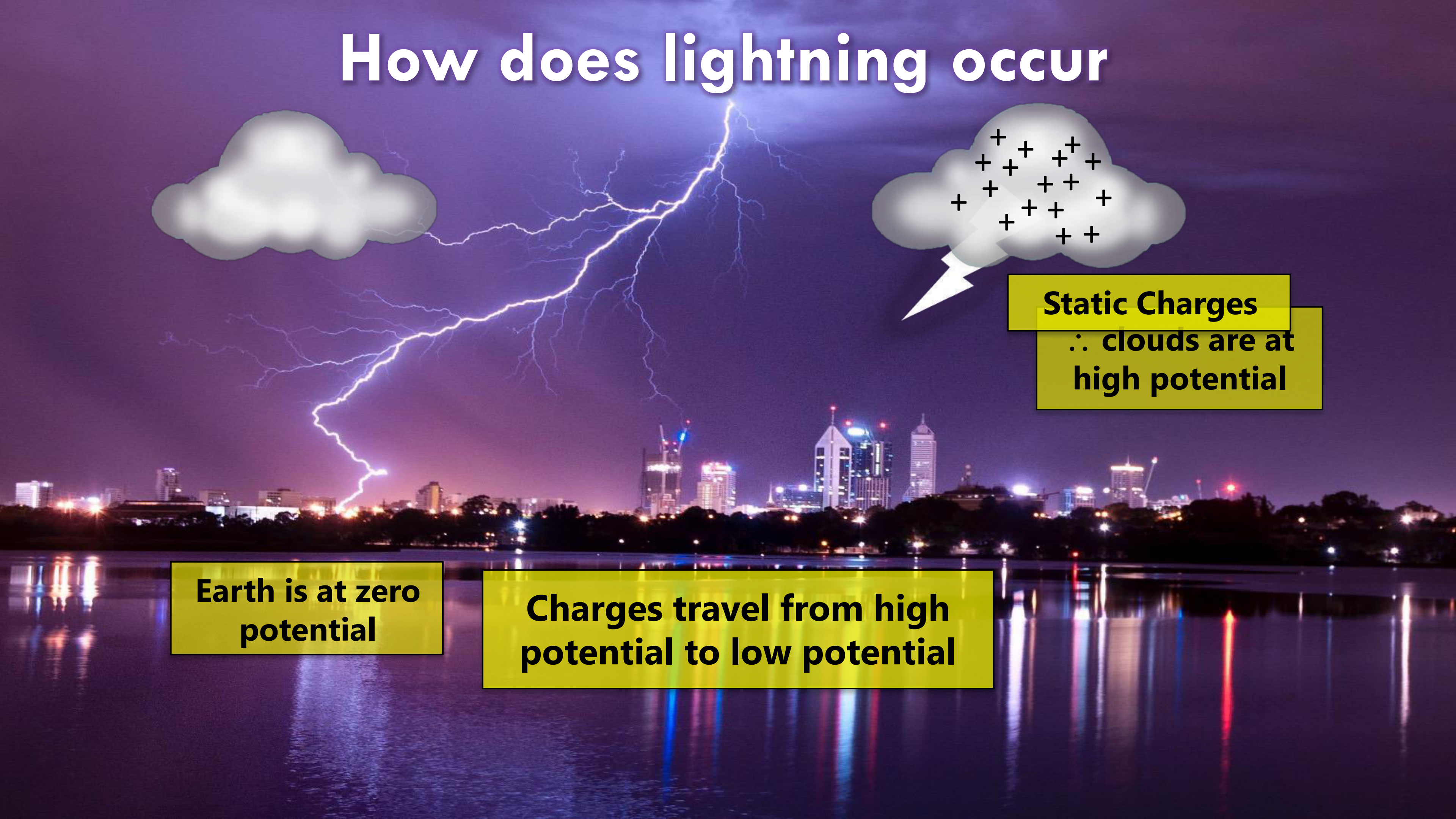
POTENTIAL DIFFERENCE



Potential Difference

The electric potential difference between two points in an electric Circuit is defined as the amount of the work done in moving a unit positive charge from one point to another point.

How does lightning occur



Static Charges

∴ clouds are at high potential

Earth is at zero potential

Charges travel from high potential to low potential

The electrons flow from negative terminal to positive terminal of the cell but the .... of current is from positive terminal to negative terminal of the cell.

(a) **conventional direction**

(c) **real current**

Conventional direction of current is opposite to the direction of flow of electrons

The function of the cell

As cell c
higher p
and l
poten

(a) **potential difference**

charges

(b) **random motion of electrons**

(d) **none of these**

The potential of earth is ....

As earth is a infinite body

(a) **positive potential**

(b) **zero potential**

(c) **high potential**

(d) **changes as per condition**

Thank You

LECTURE 2

Physical Quantities

that can be
red is a
QUANTITY.

TIME IS A PHYSICAL QUANTITY

LOVE IS NOT A PHYSICAL QUANTITY

UNITS

Units are a system of measurement.

M.K.S. System

meter–kilogram–second

S.I. System

System International units

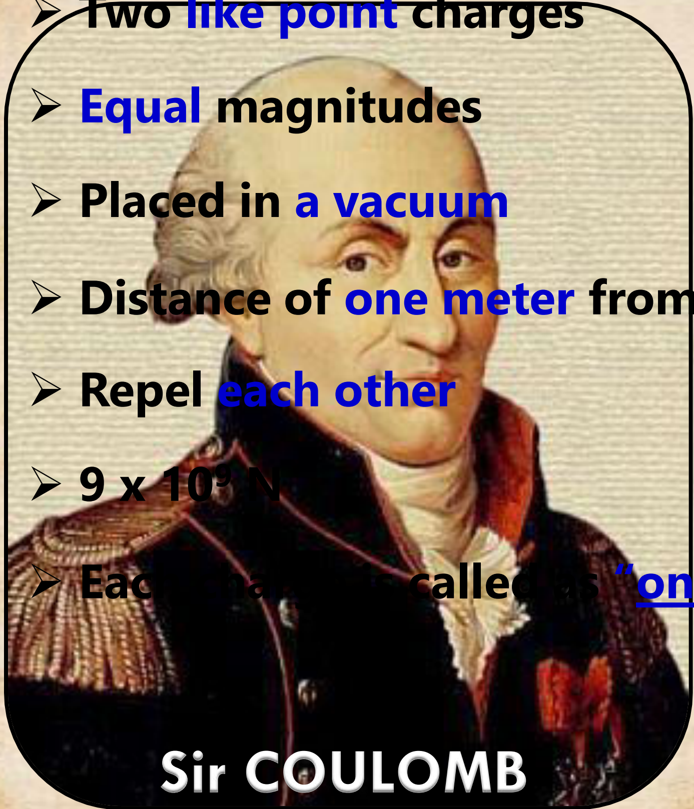
OR

Standard International units

C.G.S. System

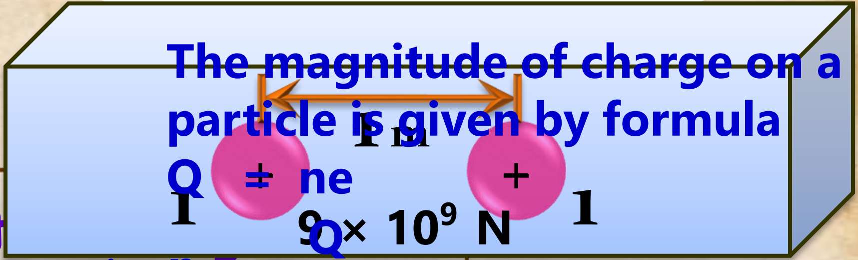
centimeter–gram–second

coulomb (C) : S.I. unit of ELECTRIC CHARGE (Q)



- Two **like point** charges
- **Equal** magnitudes
- Placed in **a vacuum**
- Distance of **one meter** from each other
- Repel **each other**
- 9×10^9 N
- Eac[illegible] called as "one coulomb".

The charge of an electron is 1.6×10^{-19}C



The magnitude of charge on a particle is given by formula

$Q = ne$

Elect[illegible] measured by coulomb

$$\therefore\ n = \frac{Q}{e}$$

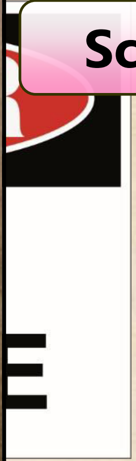
$$\therefore\ n = \frac{1}{1.6 \times 10^{-19}}$$

$$\therefore\ n = 0.625 \times 10^{19}$$

$$\therefore\ n = 6.25 \times 10^{18}$$

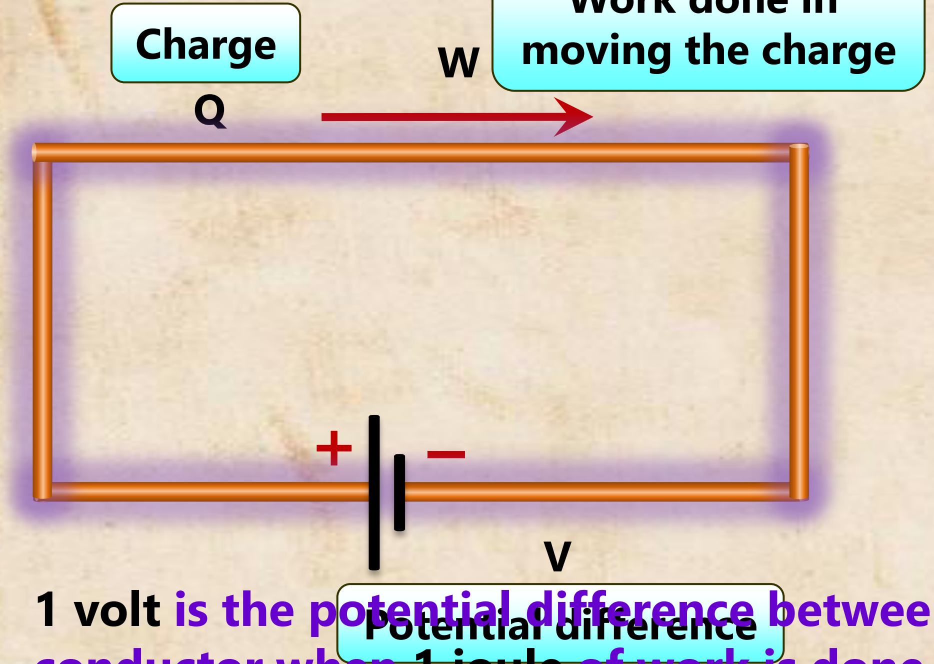
volt (V) : S.I. unit of potential difference (V)

Scientist who discovered voltaic cell



r measuring potential difference

volt (V) : S.I. unit of potential difference (V)



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

$$1\ \text{volt} = \frac{1\ \text{joule}}{1\ \text{coulomb}}$$

$$1\ V = 1\ J\ C^{-1}$$

1 volt is the potential difference between two points in a current carrying conductor when **1 joule** of work is done to move a charge of **1 coulomb** from one point to another.

$$1mV = \frac{1}{1000\ V} = \frac{1}{10^3\ V} = 10^{-3}\ V$$

$$1kV = 10^3 V$$

$$1MV = 10^6 V$$

ampere (A) : S.I. unit of ELECTRIC current (I)

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

Sir Andre Marie Ampere

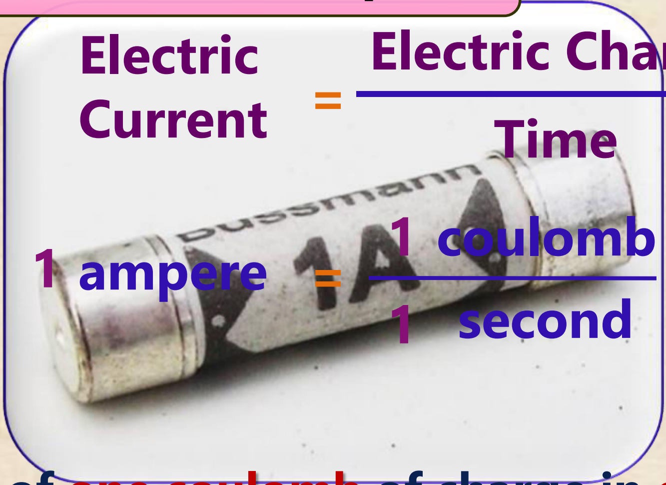
t

Time

+ −

Q

Electric charge



$$\text{Electric Current} = \frac{\text{Electric Charge}}{\text{Time}}$$

$$1 \text{ ampere} = \frac{1 \text{ coulomb}}{1 \text{ second}}$$

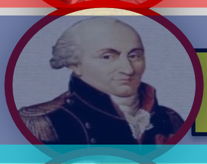
...onstituted by the flow of **one coulomb** of charge in **one second.**

...unit for measuring electric current

Ampere

$$1\text{mA} = \frac{1}{1000 \text{ A}} = \frac{1}{10^3 \text{ A}} = 10^{-3} \text{ A}$$

Match the following :

I	Answers	II
(i) Electric current (I)	ampere	 (a) joule (J)
(ii) Electric charge (Q)	coulomb	 (b) ampere (A)
(iii) Potential difference (V)	volt	 (c) coulomb (C)
		 (d) volt (V)

Type - A

$$Q = It$$

NUMERICAL

$$W = VQ$$

$$Q = ne$$

Q.1. A current of 0.5 A is drawn by a filament of an electric bulb for 10 minutes. Find the amount of electric charge that flows through the circuit.

Given : Current (I) = 0.5 A

Time (t) = 10 min

= 10×60 sec.

= 600 sec.

To find : Charge (Q) = ?

Formula : $Q = It$

Solution :

$Q = It$

$\therefore Q = 0.5 \times 600$

$\therefore Q = 300$ C

The charge flowing through circuit is 300 C

Q.2. How much work is done in moving a charge of magnitude 2 C from a point at 118 volts to a point at 128 volts ?

Given : Charge (Q) = 2 C

Potential difference (V) = 128 V – 118 V = 10 V

To find : Work (W) = ?

Formula : $W = VQ$

Solution :

$W = VQ$

$\therefore W = 10 \times 2$

$\therefore W = 20\ J$

The work done is 20 J

Q.3. Calculate the number of electrons constituting one coulomb of charge. OR
Show that 1 ampere is equivalent to flow of 6.25×10^{18} elementary charges

Given : Charge on an electron (e) $= 1.6 \times 10^{-19}$ C

Charge(Q) $=$ 1C

To find : No of electrons (n) $=$?

Formula : $Q = ne$

Solution : $Q = ne$

$$\therefore\ n = \frac{1}{1.6 \times 10^{-19}}$$

$$\therefore\ n = 6.25 \times 10^{18}$$

Number of electrons constituting one coulomb of charge is 6.25×10^{18}

Q.4. How much work is done in moving a charge of magnitude 2 C across two point having a potential difference of 12 V ?

Given :

Charge (Q) = 2 C

Potential difference(V) = 12 V

To find :

Work (W) = ?

Formula :

$$W = VQ$$

Solution :

$$\therefore W = 12 \times 2$$

$$\therefore W = 24 \text{ J}$$

The work done is 24 J

Q.5. How much energy is given to each coulomb of charge passing through 6 V battery ?

Given : Charge (Q) = 1C

Potential difference (V) = 6V

To find : Energy given by battery (W) = ?

Formula : $W = VQ$

Solution :

$W = VQ$

$\therefore W = 6 \times 1$

$\therefore W = 6\ J$

The energy given by battery is 6 J

Q.6. How many electrons are flowing per second past a point in a circuit in which there is a current of 5 amp ?

Given : Current (I) = 5 A

Time (t) = 1sec

Charge on electron (e) = 1.6×10^{-19} C

To find : No of electrons (n) = ?

Formula :

$$Q = It$$

$$Q = ne$$

Solution :

$$Q = It \quad \dots\dots\dots \text{(i)}$$

$$Q = ne \quad \dots\dots\dots \text{(ii)}$$

From equation (i) and (ii)

$$It = ne$$

$$\therefore n = \frac{It}{e}$$

$$\therefore n = \frac{5 \times 1}{1.6 \times 10^{-19}}$$

$$\therefore n = 31.25 \times 10^{18}$$

Electrons flowing per second is 31.25×10^{18}

Q.7. An electric heater is connected to the 230 V mains supply. A current of 8 A flows through the heater.

(a) How much charge flows around the circuit in each second ?

(b) How much energy is transferred to the heater in each second ?

Given :

Potential difference (V) = 230 V

Current (I) = 8 A

Time (t) = 1 sec

To find :

Charge (Q) = ?

Energy (W) = ?

Formula :

$$Q = It$$

$$W = VQ$$

Solution :

(a) $Q = It$

$\therefore Q = 8 \times 1$

$\therefore Q = 8\ C$

(b) $W = VQ$

$\therefore W = 230 \times 8$

$\therefore W = 1840\ J$

(a) Charge flowing around the circuit is 8 C.

(b) Energy transferred to the heater is 1840 J.

Thank You

LECTURE 3

OHM'S LAW

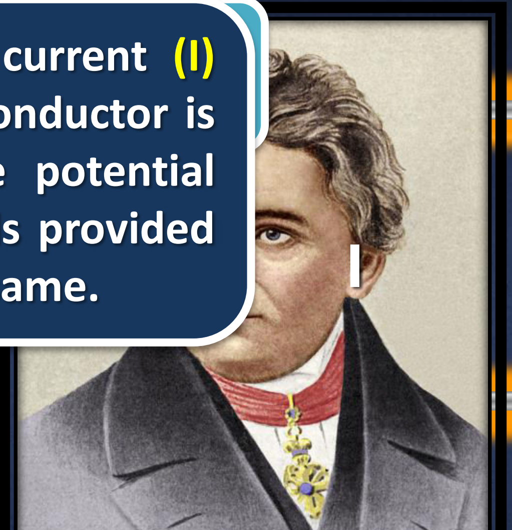
Ohms law states that, the current **(I)** flowing through a metallic conductor is directly proportional to the potential difference **(V)**, across its ends provided its temperature remains the same.

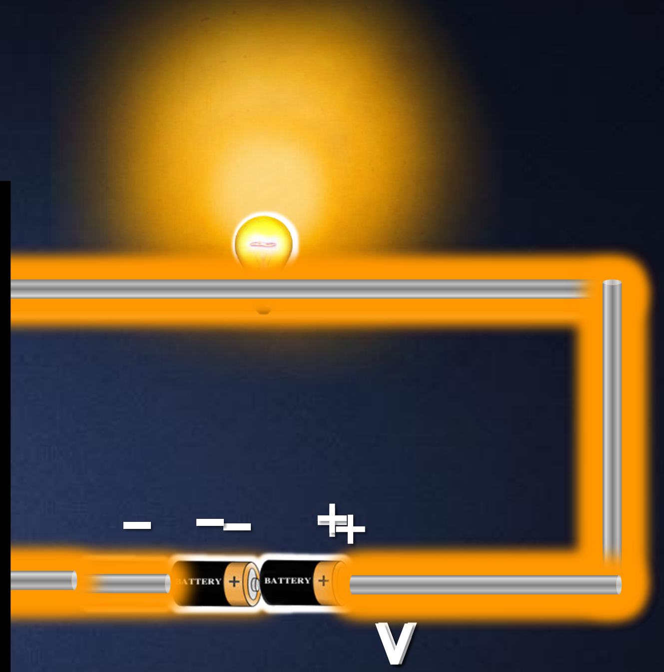
Length,
Area of cross section,
Temperature and
Material remain constant.

$V \; \alpha \; I$

$$\frac{V}{I} = \text{Constant}$$

$= R$ (Resistance)



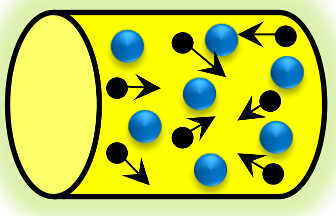


$V = I \times R$ **Hence,** $V = IR$

This is known as Ohm's law.

RESISTANCE

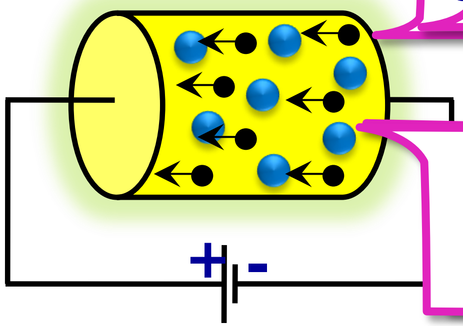
The S.I. unit of RESISTANCE (R) is ohm (Ω)



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

$$1\ \text{ohm} = \frac{1\ \text{volt}}{1\ \text{ampere}}$$

Current is more



conduc

...property of the conductor due to which it opposes flow of current is ...NCE

s

When atoms are less, Resistance is less

...ore,

FACTORS AFFECTING RESISTANCE

If the door is wider, more people can pass as resistance is less

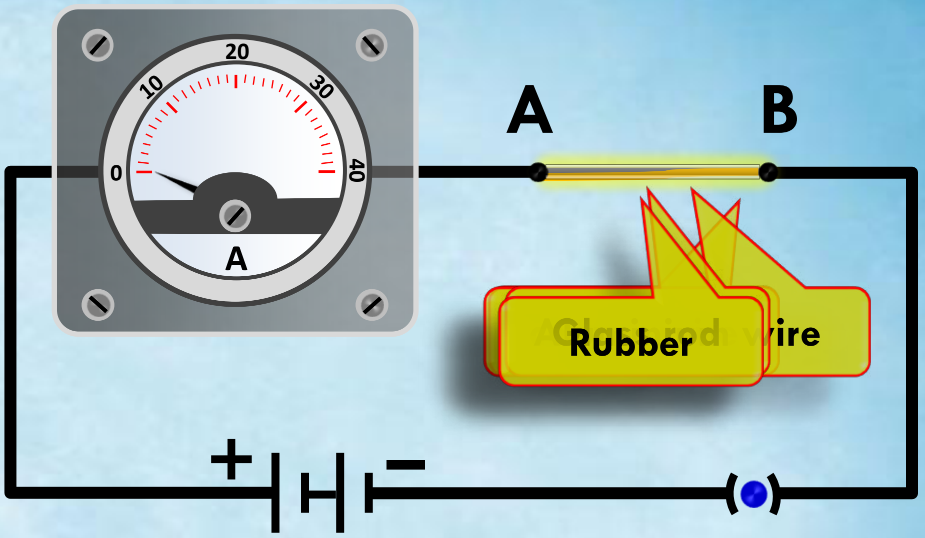
If wire is thicker, more current can flow as resistance is less

Hence $R \alpha \frac{1}{A}$

Practical understanding of resistivity

1. **Resistivity** is a specific property of a material.

2. Different materials have different resistivity



Electric Circuit

Q.1. On what factors does the resistance of a conductor depend?

Ans. : The resistance of a conductor depends on its

i. Length

ii. Area of cross – section (thickness)

iii. Material

iv. Temperature

Q.2. How does the resistance of a wire change when:

(a) Its length is tripled?

(b) Its diameter is tripled?

(c) Its material is changed to one whose resistivity is three time?

Ans. : $R = \rho \frac{l}{A}$

(a) $R \propto l$

$\therefore$ If l is tripled, resistance is also tripled.

(b) $R \propto \frac{1}{A}$ or

$$R \propto \frac{1}{d^2} \quad \left(\therefore \; A = \pi r^2 = \frac{\pi d^2}{4} \right)$$

$\therefore$ If the diameter is tripled Resistance becomes 1/9 times

(c) $R \propto \rho$

$\therefore$ If resistivity is tripled, resistance is also tripled

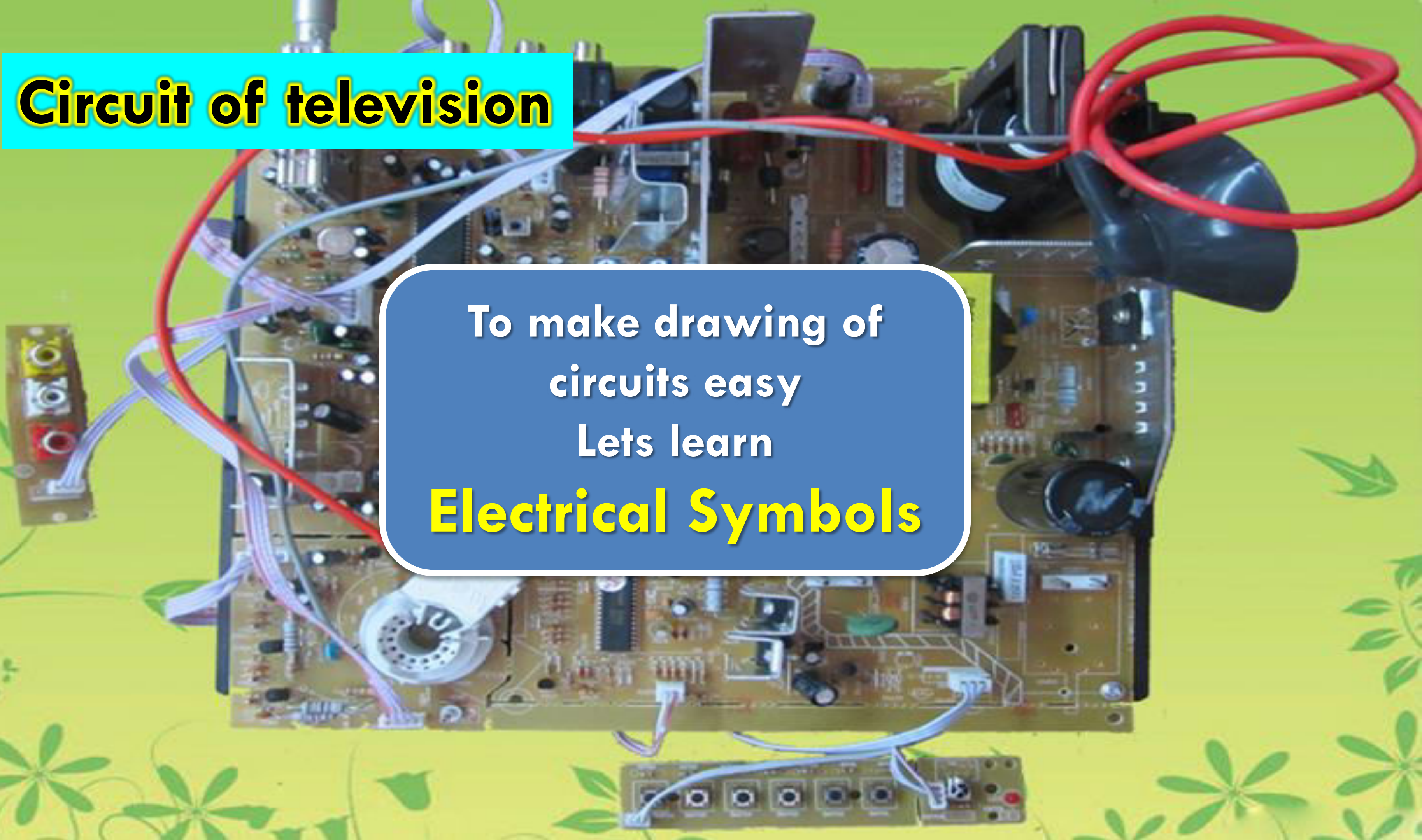
Q.3. Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

Ans. : (i) When connected to a same source, current will flow more easily through the thick wire than the thin wire.

(ii) Resistance $R \propto \frac{1}{A}$

Thank You

LECTURE 4



Circuit of television

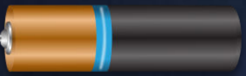
To make drawing of circuits easy

Lets learn

Electrical Symbols

ELECTRICAL SYMBOLS

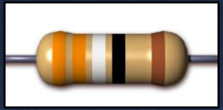
+ -



Cell

+ -

Battery



Resistance

Variable

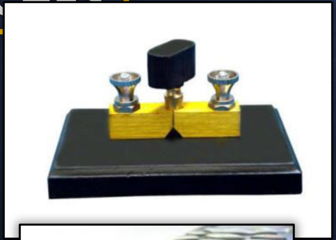
On

Resistance

KEYS / SWITCHES

Plug key

—(·)—



Closed (On)

—( )—

Open (Off)

Measuring Instruments

Variable known Resistance

A

Ammeter

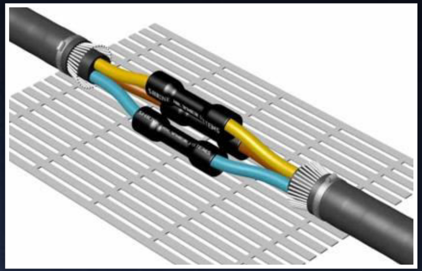
- V

Voltmeter

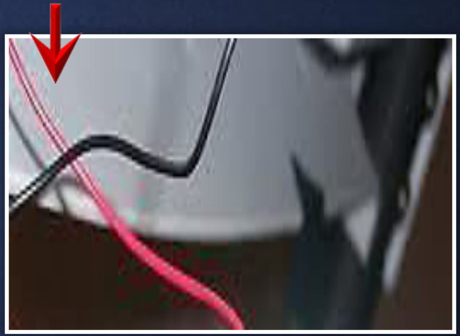
+ G -

Galvanometer

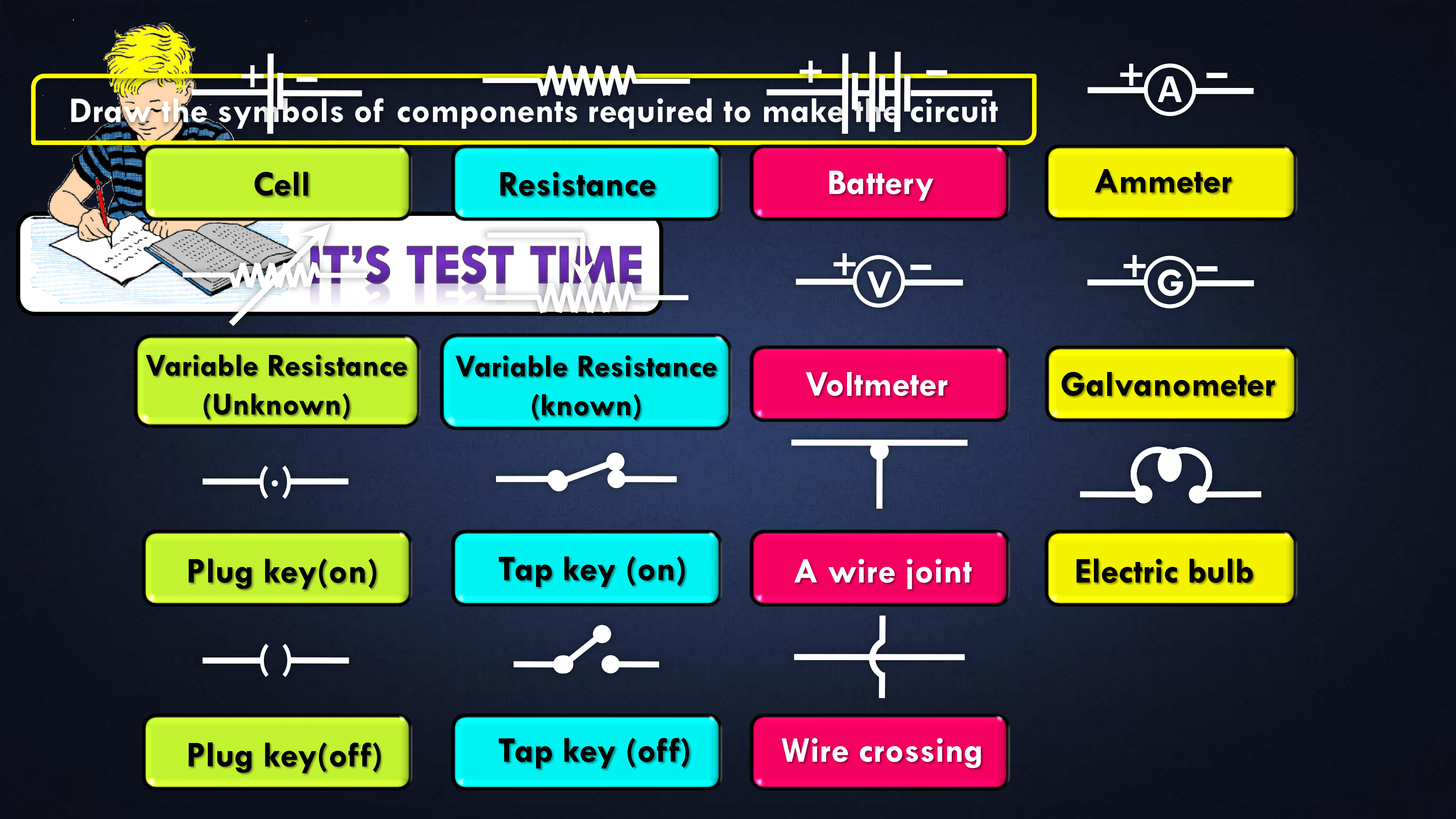
A wire joint



Wire crossing



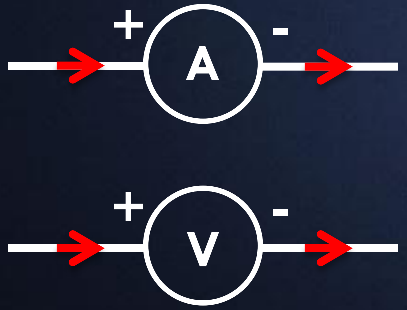
Electric bulb



Draw the symbols of components required to make the circuit
IT'S TEST TIME
Cell
Resistance
Battery
Ammeter
A
V
G
Variable Resistance (Unknown)
Variable Resistance (known)
Voltmeter
Galvanometer
Plug key(on)
Tap key (on)
A wire joint
Electric bulb
Plug key(off)
Tap key (off)
Wire crossing

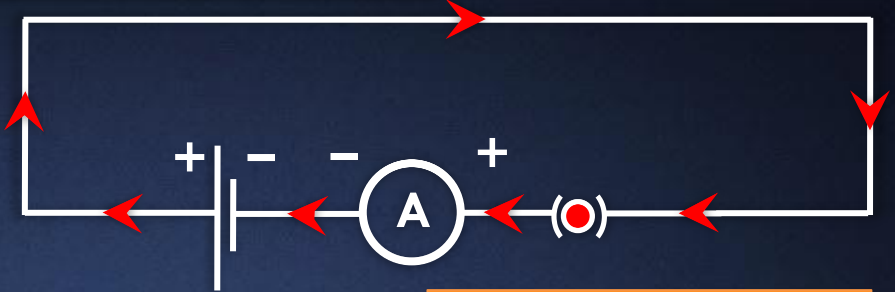
SOME IMPORTANT POINTS TO REMEMBER

While connecting cells to each other always connect unlike terminals.



For devices like ammeter or voltmeter, the side from which current enters is positive (+) and the side from current exits is negative (-).

SOME IMPORTANT POINTS TO REMEMBER

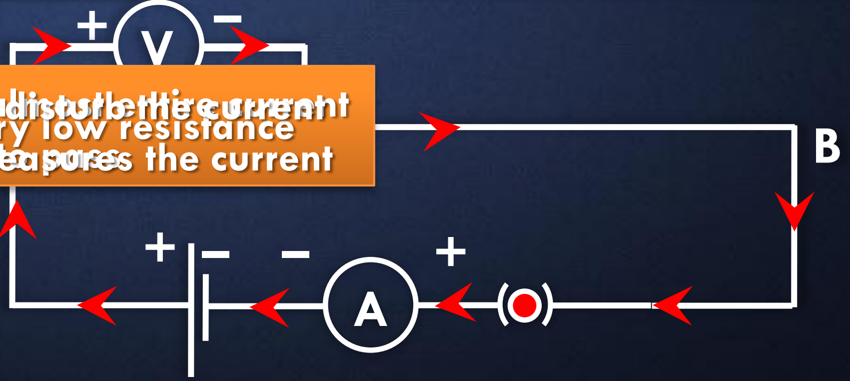


...er is connecte... l.

As the current in the circuit is not divided

It has very low resistance

as well as measures the current



...urrent in the circuit is divided

Voltmeter

Voltmeter is connected in parallel with the cell.

Q.1. How is a voltmeter connected in the circuit to measure the potential difference between two points?

Ans. : To measure the potential difference between two points, voltmeter must always be connected in parallel to the points.

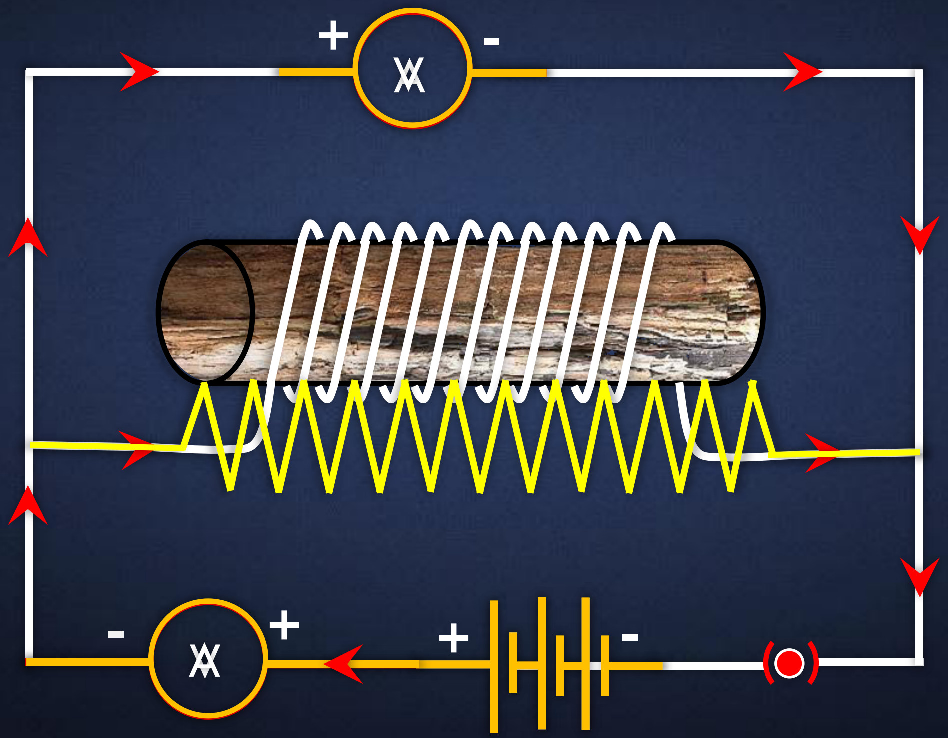
Q.2. What happens if an ammeter is connected in parallel?

Ans. : If an ammeter is connected in parallel, the resultant resistance of the circuit decreases and more current passes through the ammeter. Hence, the ammeter is likely to be burnt.

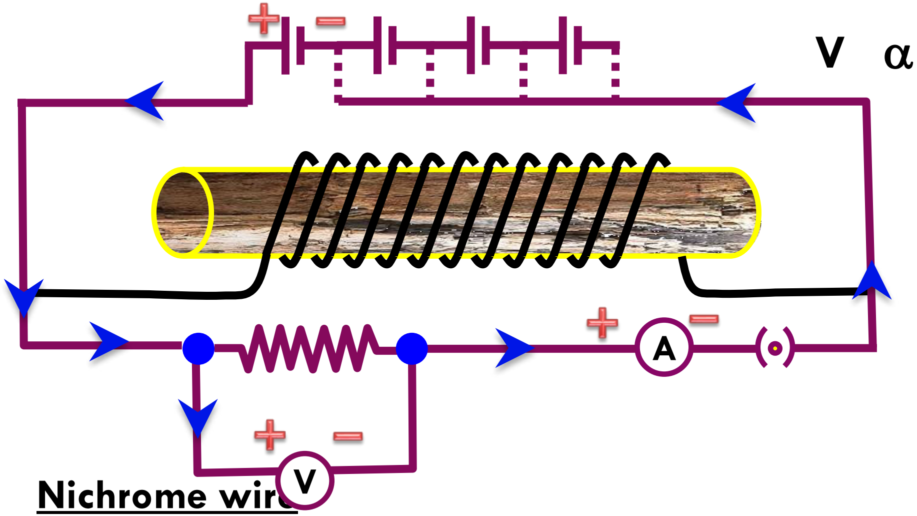
Q.3. What happens if a voltmeter is connected in series?

Ans. : When the voltmeter is connected is series, the resistance of the circuit becomes high and there is considerable fall in current through the circuit. Thus, the voltmeter will not give the correct reading of the potential difference.

How many mistakes can you find in this diagram

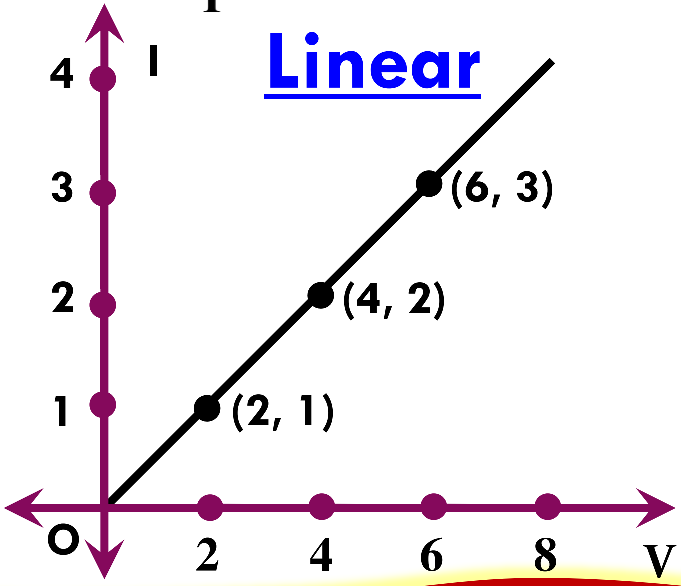


Experimental verification of Ohm's law



Nichrome wire

$V \propto I$ and $\frac{V}{I} = R$ (Constant)



No of Cells	I (A)	P.D (V)	$\frac{V}{I} = R\ (\Omega)$
1	1	2	2
2	2	4	2
3	3	6	2

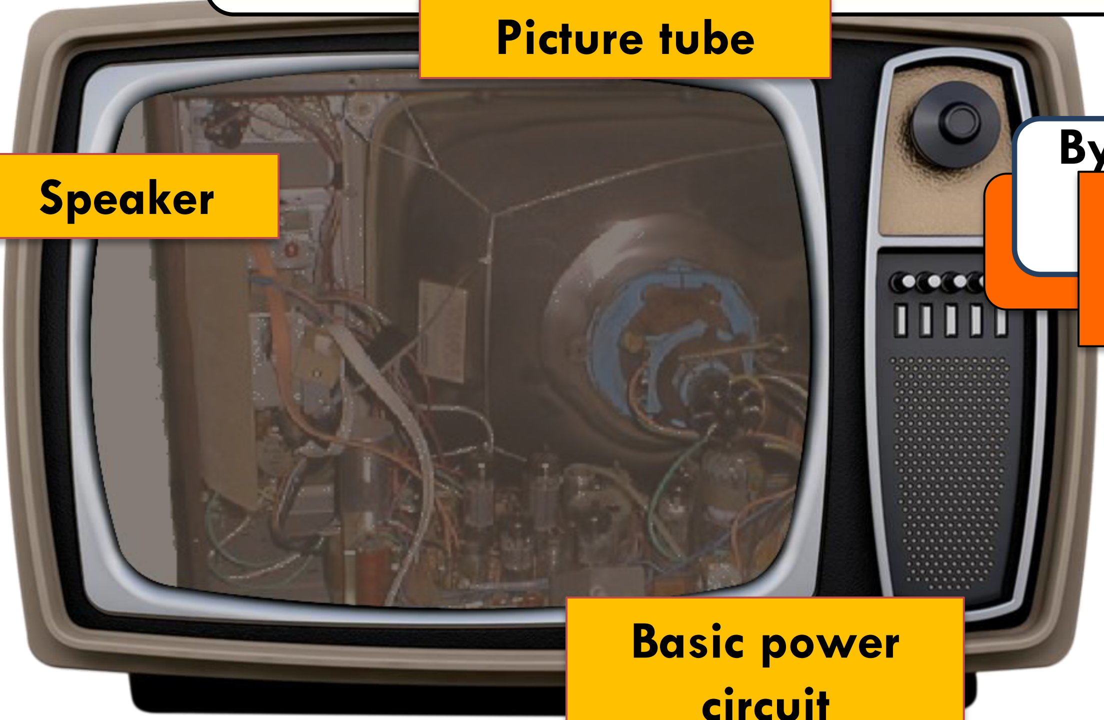
Thank You

LECTURE 5

Old CRT television

elevision which is

a combination of many components.



Picture tube

Speaker

Basic power circuit

By using resistors

How can different current be provided to different components ?

a

t

Resistances can be connected in two ways

SERIES

PARALLEL

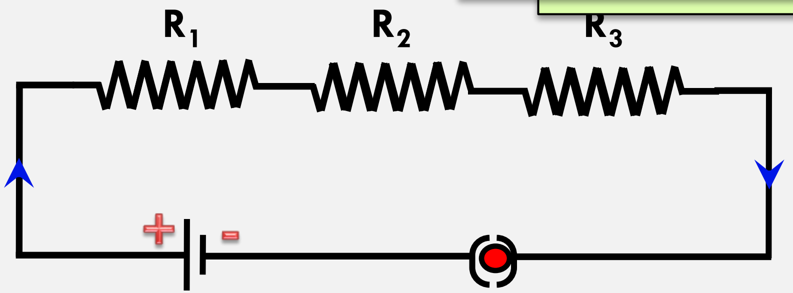
Voltage drop

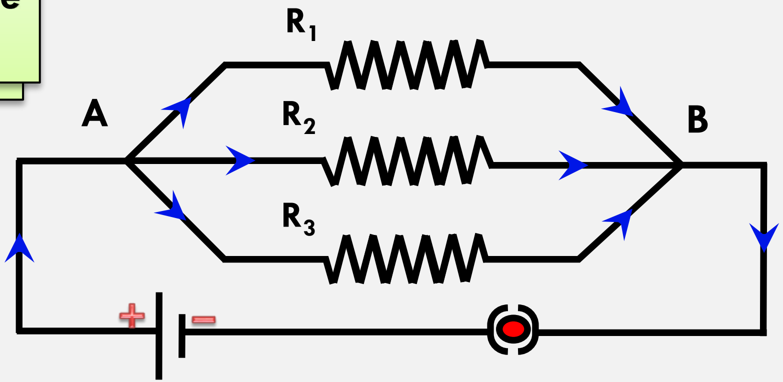
Potential difference

One after the other

Current gets divided but potential difference remains the same

ween two common points





$V = V_1 + V_2 + V_3 \ldots\ldots\text{(i)}$

According to OHM'S LAW,

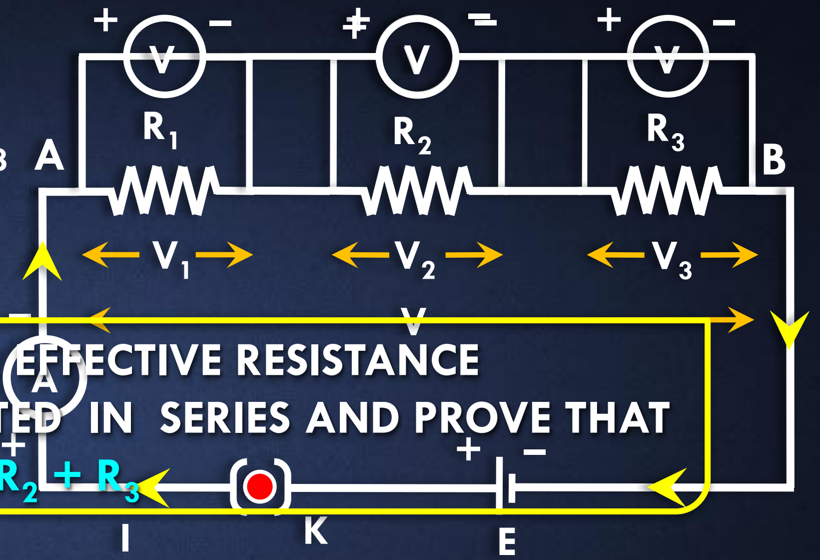
$V = IR_s$, $V_1 = IR_1$, $V_2 = IR_2$ & $V_3 = IR_3$

Substituting the values of V, V_1, V_2 and V_3 in equation (i), we get

$IR_S = IR_1 + IR_2 + IR_3$

$\therefore \cancel{I}R_S = \cancel{I}(R_1 + R_2 + R_3)$

$\therefore R_S = R_1 + R_2 + R_3$ Where R_S is the "Effective Resistance in Series".



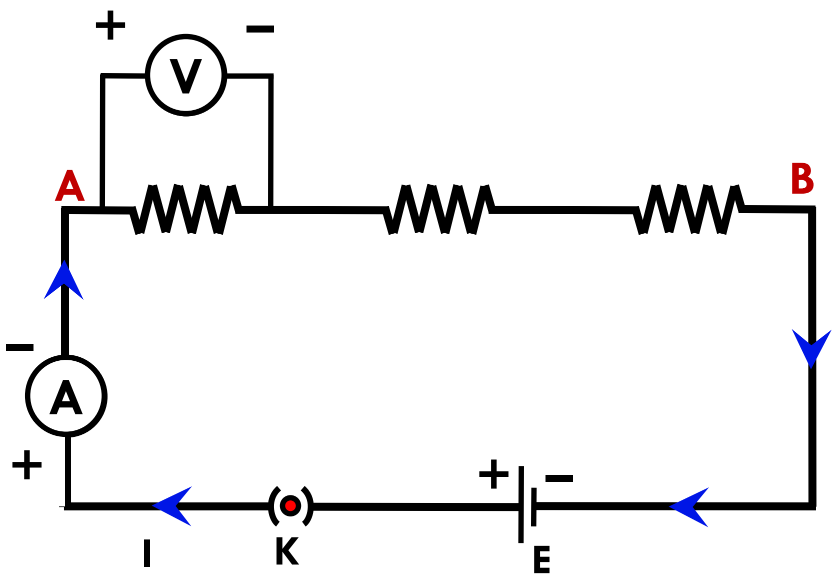
DERIVE A FORMULA FOR EFFECTIVE RESISTANCE FOR THREE RESISTANCES CONNECTED IN SERIES AND PROVE THAT $R_S = R_1 + R_2 + R_3$

For 'n' number of resistances, we have

$R_S = R_1 + R_2 + R_3 + \ldots\ldots\ldots + R_n$

Effective Resistance in series (R_S) is the sum of the individual resistances.

Draw this diagram and make the required corrections



Write the derivation of resistance in series

00: 00

$V = V_1 + V_2 + V_3 \ldots\ldots (i)$

According to OHM'S LAW,

$V = IR_s$, $V_1 = IR_1$, $V_2 = IR_2$ & $V_3 = IR_3$

Substituting the values of V, V_1, V_2 and V_3 in equation (i), we get

$IR_S = IR_1 + IR_2 + IR_3$

$\therefore \cancel{I}R_S = \cancel{I}(R_1 + R_2 + R_3)$

$\therefore R_S = R_1 + R_2 + R_3$ Where R_S is the "<u>Effective Resistance in Series</u>".

For 'n' number of resistances, we have

$R_S = R_1 + R_2 + R_3 + \ldots\ldots\ldots + R_n$

Effective Resistance in series (R_S) is the sum of the individual resistances.

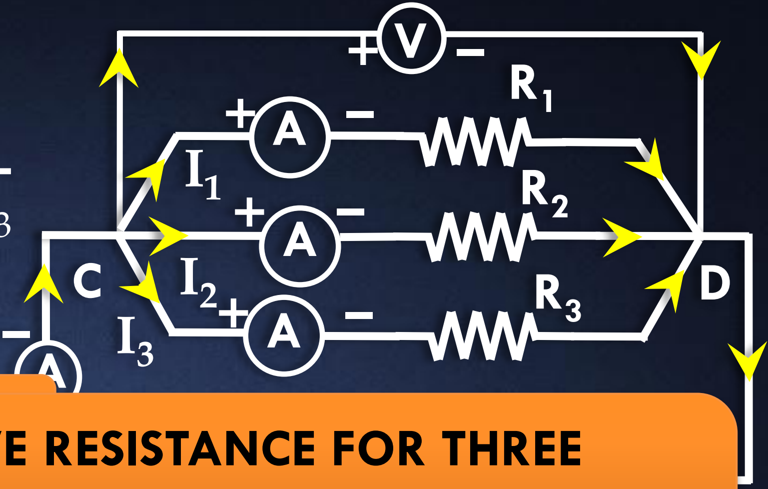
$I = I_1 + I_2 + I_3$ --------- (i)

According to OHM'S LAW,

$$V = IR,\ I = \frac{V}{R_p},\ I_1 = \frac{V}{R_1},\ I_2 = \frac{V}{R_2},\ I_3 = \frac{V}{R_3}$$

Substituting the values of I, I_1, I_2 and I_3 in equation (i), we get

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



DERIVE A FORMULA FOR EFFECTIVE RESISTANCE FOR THREE RESISTANCES CONNECTED IN PARALLEL AND PROVE THAT

$$1/R_P = 1/R_1 + 1/R_2 + 1/R_3$$

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

...ctive Resistance in Parallel”.

For n number of resistances, we have

$$1/R_P = 1/R_1 + 1/R_2 + 1/R_3 + \ldots\ldots\ldots\ldots\ldots + 1/R_n$$

The reciprocal of Effective Resistance in Parallel (R_p) is the sum of the reciprocals of the individual resistances.

Write the derivation of resistance in parallel

$I = \underline{I_1} + \underline{I_2} + I_3$ ---------------------- (i)

00: 00

According to OHM'S LAW,

$I = \underline{V}/R_p$, $I_1 = V/R_1$, $I_2 = V/\underline{R_2}$ & $I_3 = \underline{V}/\underline{R_3}$

Substituting the values of I, I_1, I_2 and I_3 in equation (i), we get

$$V/R_p = \underline{V}/R_1 + V/\underline{R_2} + \underline{V}/\underline{R_3}$$

$$\therefore \cancel{V}/R_p = \cancel{V}(\underline{1/R_1} + \underline{1/R_2} + \underline{1/R_3})$$

$\therefore 1/R_p = 1/R_1 + \underline{1/R_2} + \underline{1/R_3}$ **Where R_p is the "Effective Resistance in Parallel".**

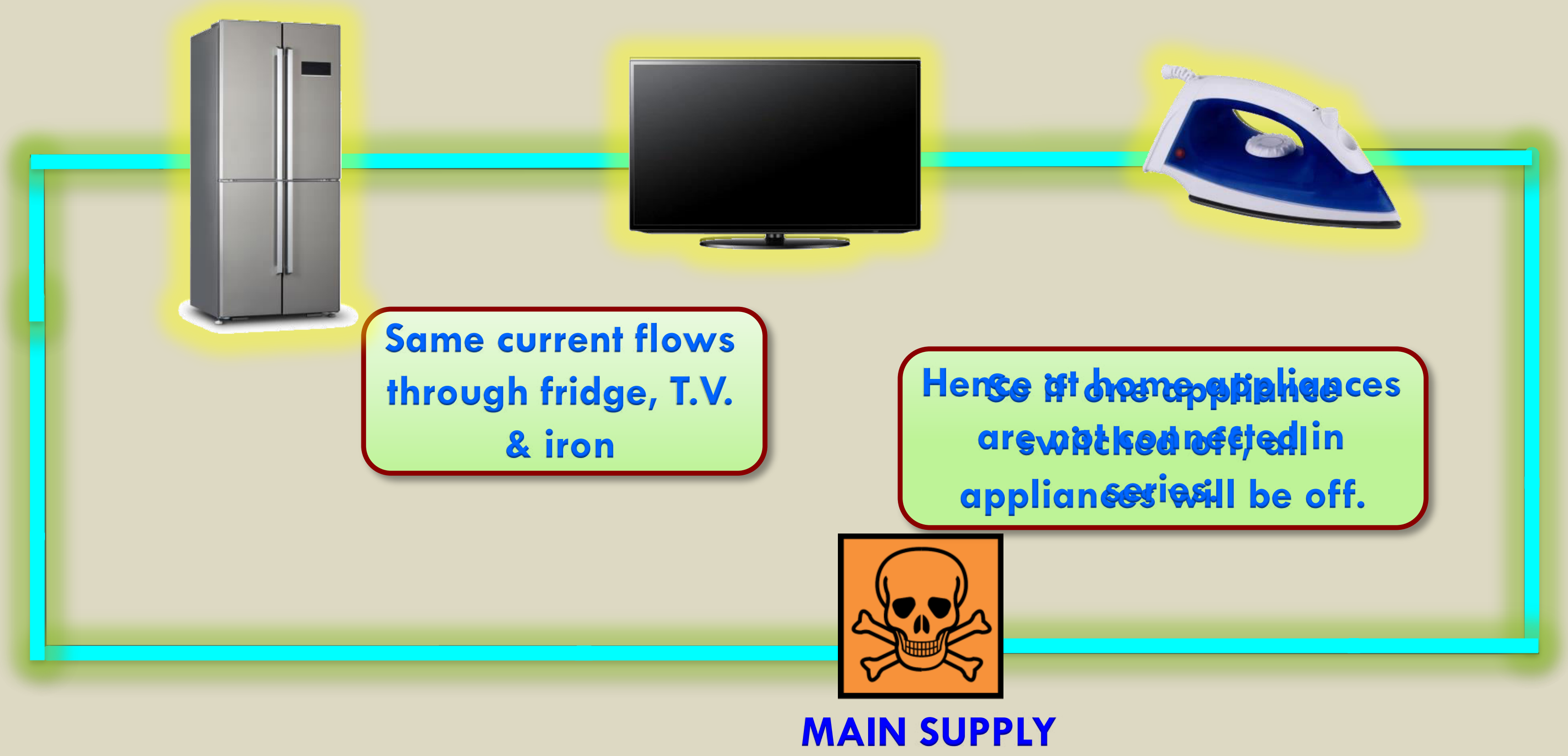
For 'n' number of resistances, we have

$$1/R_p = 1/R_1 + 1/R_2 + 1/R_3 + \dots\dots\dots + 1/R_n$$

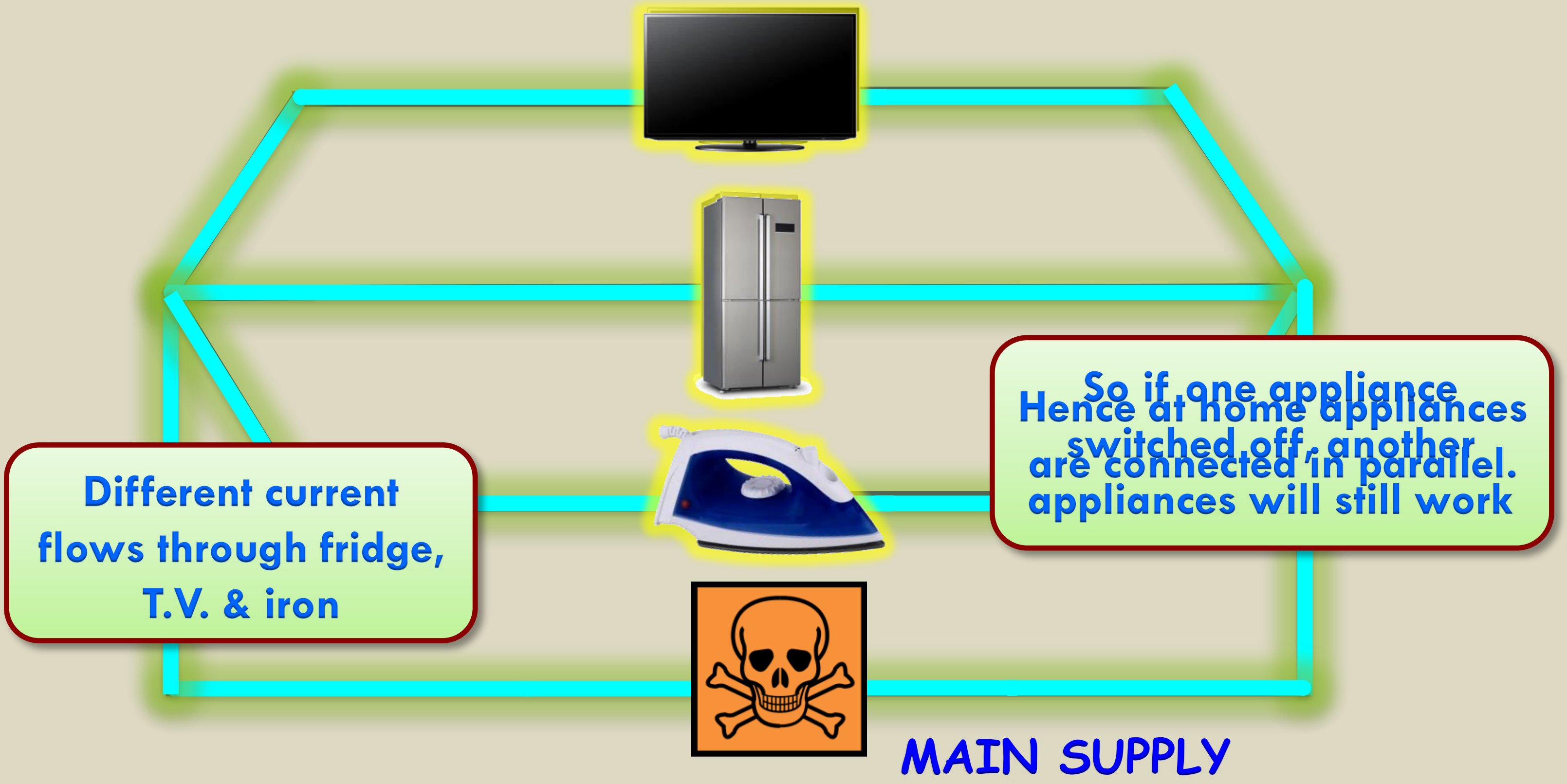
The reciprocal of Effective Resistance in parallel (R_p) is the sum of reciprocal of individual resistances.

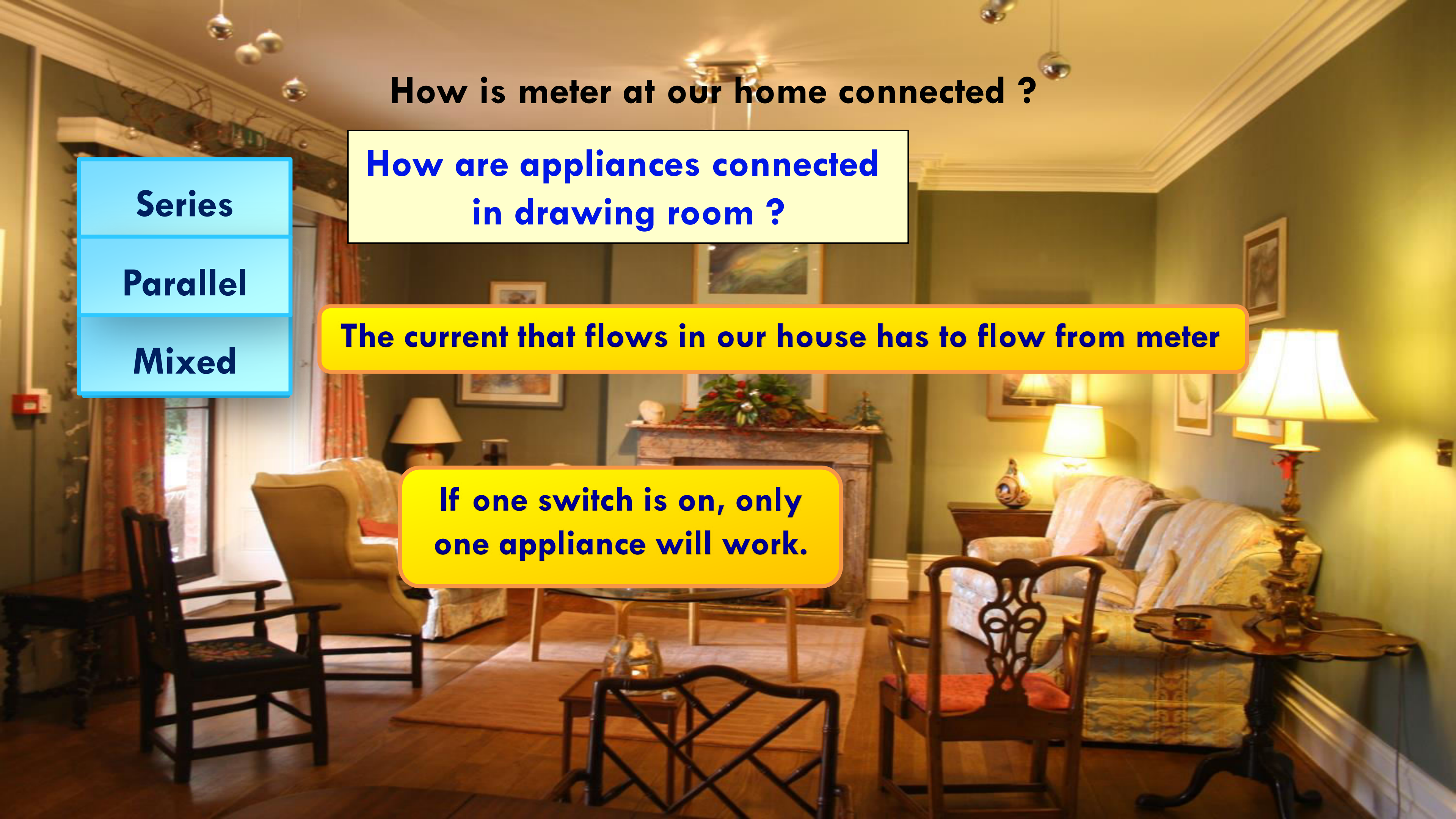
How are the appliances connected at home, series or parallel

What will happen, if appliances (resistors) are connected in series ?



What will happen, if appliances (resistors) are connected in parallel ?




How is meter at our home connected ?
How are appliances connected in drawing room ?
Series
Parallel
Mixed
The current that flows in our house has to flow from meter
If one switch is on, only one appliance will work.

Q.1. What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

Ans. :

i. When a number of electrical devices are connected in parallel, each device gets the same potential as the supplied voltage. Due to this, other devices are not affected if one device fails. In series connection, if one device fails, the circuit breaks and others stop working.

ii. The parallel circuit divides the current through the electrical devices. Thus each device gets proper current depending on its resistance. Whereas, in series circuit, same current flows through all the devices, irrespective of their resistance.

iii. The total circuit resistance can be reduced by connecting the devices in parallel.

Thank You

LECTURE 6

Type - C

$$R_S = R_1 + R_2 + R_3$$

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

Q.1. A battery of 9V is connected in series with resistance of 0.2Ω, 0.3Ω, 0.4Ω, 0.5Ω and 12Ω respectively. How much current would flow through the 12Ω resistor ?

Given : Total resistance, $R = 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4\Omega$

$V = 9V$

To find : Current (I) = ?

Formula : $V = IR$

Solution :

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

$$= \frac{9}{13.4}$$

$$= 0.67\ A$$

Current through 12 Ω resistor = 0.67A.

Q2. Judge the equivalent resistance when the following are connected in parallel :

(a) 1Ω and $10^6\Omega$

(b) 1Ω and $10^3\Omega$ and $10^6\Omega$

Ans. : (a) 1Ω and $10^6\Omega$ are connected in parallel.

$$\therefore \frac{1}{R} = \frac{1}{1} + \frac{1}{10^6} = \frac{10^6 + 1}{10^6}$$

$$\therefore R = \frac{10^6}{10^6 + 1} \approx \frac{10^6}{10^6}$$

$$\approx 1\Omega$$

$\therefore$ Equivalent Resistance $\approx 1\Omega$ (but less than 1Ω)

(b) 1Ω, $10^3\Omega$ and $10^6\Omega$ are in parallel.

$$\therefore \frac{1}{R} = \frac{1}{1} + \frac{1}{10^3} + \frac{1}{10^6}$$

$$\therefore \frac{1}{R} = \frac{10^6 + 10^3 + 1}{10^6}$$

$$\therefore R = \frac{1000000}{1001001}$$

$$\therefore R = 0.999\ \Omega$$

$\therefore$ Equivalent Resistance $= 0.999\Omega$

Q.3. An electric lamp of 100Ω, a toaster of resistance 50Ω, and a water filter of resistance 500Ω are connected in parallel to a 220V source. What is the resistance of an electric iron connected to the same source that takes as much current as all three appliances, and what is the current through it?

Given :

Resistance of lamps = R_1 = 100Ω

Resistance of toaster = R_2 = 50 Ω

Resistance of filter = R_3 = 500 Ω

V = 220V

To find : **Resistance of iron, Current through iron**

Formula : $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$, $V = IR$

Solution : Let R be the equivalent resistance,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{100} + \frac{1}{50} + \frac{1}{500}$$

$$= \frac{5 + 10 + 1}{500} = \frac{16}{500}$$

$$\therefore R = \frac{500}{16}$$

According to Ohm's law, V = IR

$$\therefore I = \frac{V}{R} = \frac{220}{\frac{500}{16}} = \frac{220 \times 16}{500} = 7.04A$$

7.04 A current is drawn by all three appliances.

∴ Current drawn by an electric iron connected to the same source of P.D. 220V = 7.04A

∴ It's Resistance,

$$R = \frac{V}{I} = \frac{220}{7.04} = 31.25\Omega$$

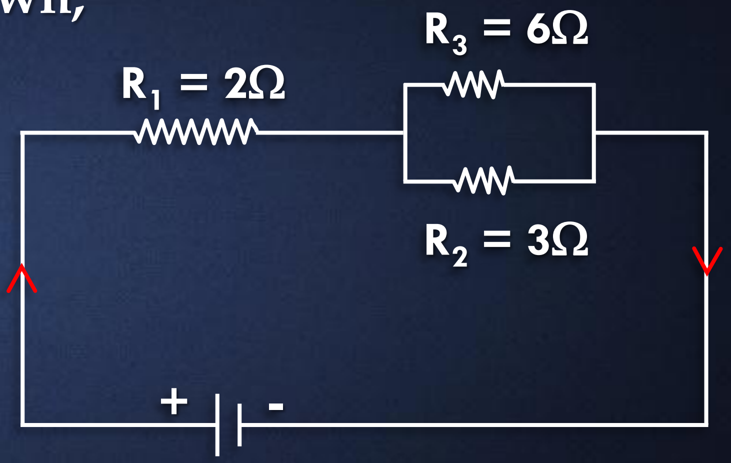
∴ Current flowing through iron = 7.04A
Resistance of iron = 31.25 Ω

Q.4. How can three resistors of resistance 2Ω, 3Ω and 6Ω be connected to give a total resistance of (a) 4Ω, (b) 1Ω?

Ans. : $R_1 = 2\Omega,\ R_2 = 3\Omega,\ R_3 = 6\Omega$

(a) To get $R_e = 4\Omega$, the circuit is as shown,

R_2 and R_3 are in parallel



$$\therefore\ \frac{1}{R_p} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_p} = \frac{2+1}{6} = \frac{3}{6} = \frac{1}{2}$$

$$\therefore\ R_p = 2\Omega$$

R_p and R_1 are in series

$$\therefore\ R_e = R_p + R_1$$

$$= 2 + 2$$

$$R_e = 4\Omega$$

Q.4. How can three resistors of resistance 2Ω, 3Ω and 6Ω be connected to give a total resistance of (a) 4Ω, (b) 1Ω?

Ans. : (b) To get $R_e = 1\Omega$, the circuit is as shown,

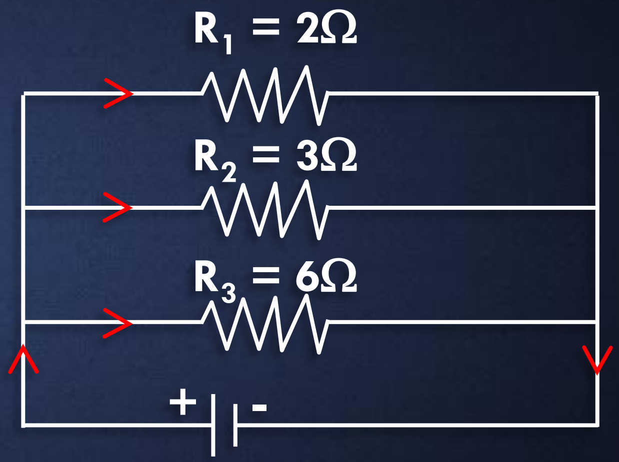
$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$= \frac{2+3+1}{6}$$

$$= \frac{6}{6} = 1\Omega$$

$\therefore\ R_e = 1\Omega$



5

An electric lamp, whose resistance is 20 Ω, and a conductor of 4 Ω resistance are connected to a 6 V battery. Calculate

(a) the total resistance of the circuit,

(b) the current through the circuit, and

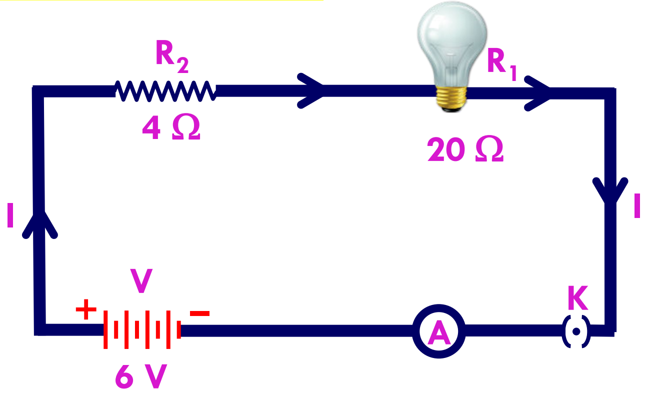
(c) the potential difference across the electric conductor and lamp

Given :

Resistance of electric lamp, $(R_1) = 20\ \Omega$

Resistance of conductor, $(R_2) = 4\ \Omega$

Potential difference $(V) = 6\ V$



To find :

(a) total resistance $(R) = ?$

(b) Current $(I) = ?$

(c) potential difference across lamp $(V_1) = ?$

potential difference across conductor $(V_2) = ?$

Formulae :

$$R_S = R_1 + R_2$$

$$V = IR$$

5 An electric lamp, whose resistance is 20 Ω, and a conductor of 4 Ω resistance are connected to a 6 V battery. Calculate
(a) the total resistance of the circuit,
(b) the current through the circuit, and
(c) the potential difference across the electric conductor and lamp

Solution :

(a) Total resistance (R_S)

$$R_S = R_1 + R_2$$
$$\therefore R_S = 20 + 4$$
$$\therefore R_S = 24\ \Omega$$

(b) Total current (I)

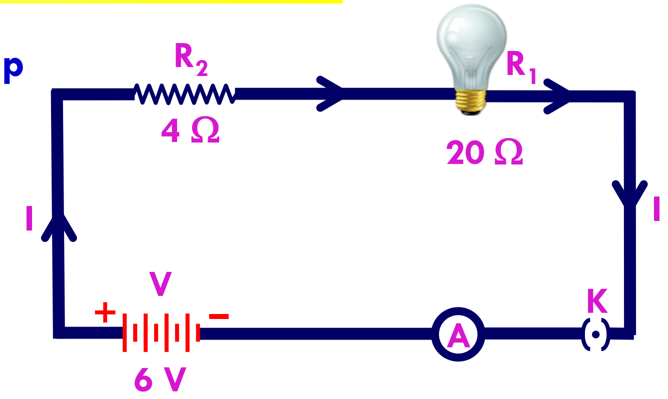
$$\therefore I = \frac{V}{R_S}$$
$$\therefore I = \frac{6}{24}$$
$$\therefore I = 0.25\ A$$

(c) (i) P.D. across the electric lamp

$$V_1 = I \times R_1$$
$$\therefore V_1 = 0.25 \times 20$$
$$\therefore V_1 = 5\ V$$

(ii) P.D. across the electric conductor

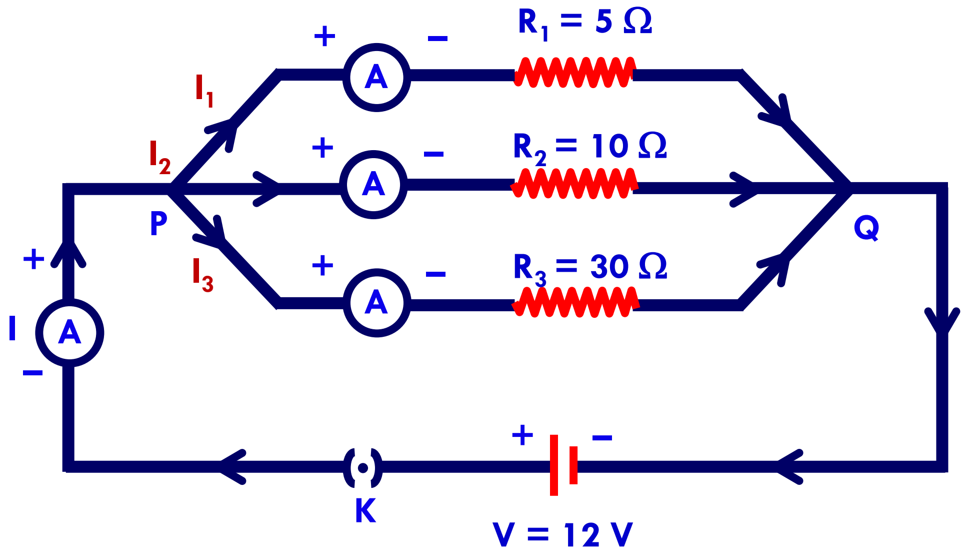
$$V_2 = I \times R_2$$
$$\therefore V_2 = 0.25 \times 4$$
$$\therefore V_2 = 1\ V$$



Ans : Total resistance is 24 Ω, Total current is 0.25 A, P.D across lamp is 5 V, P.D across conductor is 1 V.

6

In the circuit diagram given suppose the resistors R_1, R_2 and R_3 have the values 5 Ω, 10 Ω and 30 Ω, respectively, which have been connected to a battery of 12 V. Calculate (a) the current through each resistor, (b) the total current, (c) the total resistance.



6

In the circuit diagram given suppose the resistors R_1, R_2 and R_3 have the values 5 Ω, 10 Ω and 30 Ω, respectively, which have been connected to a battery of 12 V. Calculate (a) the current through each resistor, (b) the total current, (c) the total resistance.

Given :

$R_1 = 5\ \Omega$

$R_2 = 10\ \Omega$

$R_3 = 30\ \Omega$

$V = 12\ V$

To find :

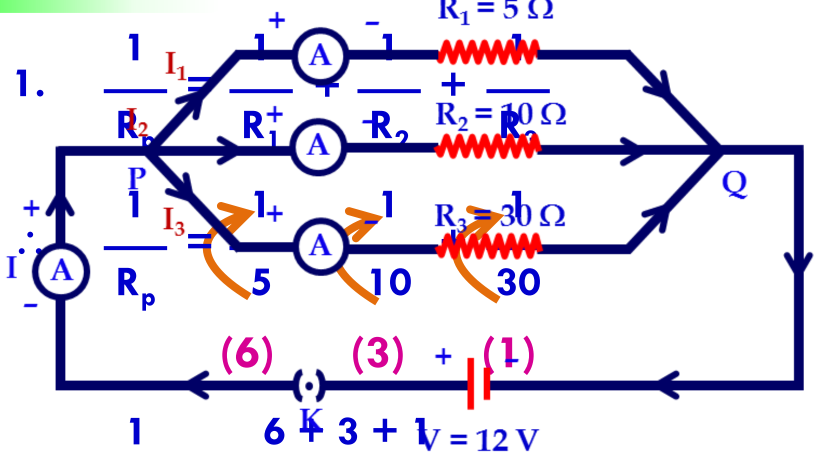
1. Effective resistance (R_p) = ?
2. Total current (I) = ?
3. Current in each resistor i.e. I_1, I_2 and I_3.

Formulae :

1. $$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

2. $V = IR$

Solution :



1. $$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{5} + \frac{1}{10} + \frac{1}{30}$$

(6) (3) (1)

$$\therefore \frac{1}{R_p} = \frac{6 + 3 + 1}{30}$$

$$\therefore \frac{1}{R_p} = \frac{10}{30}$$

$$\therefore R_p = \frac{30}{10}$$

$$\therefore R_p = 3\ \Omega$$

6

In the circuit diagram given suppose the resistors R_1, R_2 and R_3 have the values 5 Ω, 10 Ω and 30 Ω, respectively, which have been connected to a battery of 12 V. Calculate (a) the current through each resistor, (b) the total current, (c) the total resistance.

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

$\therefore I_1 = \frac{12}{5}$

$\therefore I_1 = 2.4 \text{ A}$

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

$\therefore I_2 = \frac{12}{10}$

$\therefore I_2 = 1.2 \text{ A}$

Ans :

Effective resistance in parallel is 3 Ω.
Total current is 4 A.
Current is each resistor is 2.4 A, 1.2 A, 0.4 A.

4. $I_3 = \frac{V}{R_3}$

$\therefore I_3 = \frac{12}{30}$

$\therefore I_3 = 0.4 \text{ A}$

5. $I = I_1 + I_2 + I_3$

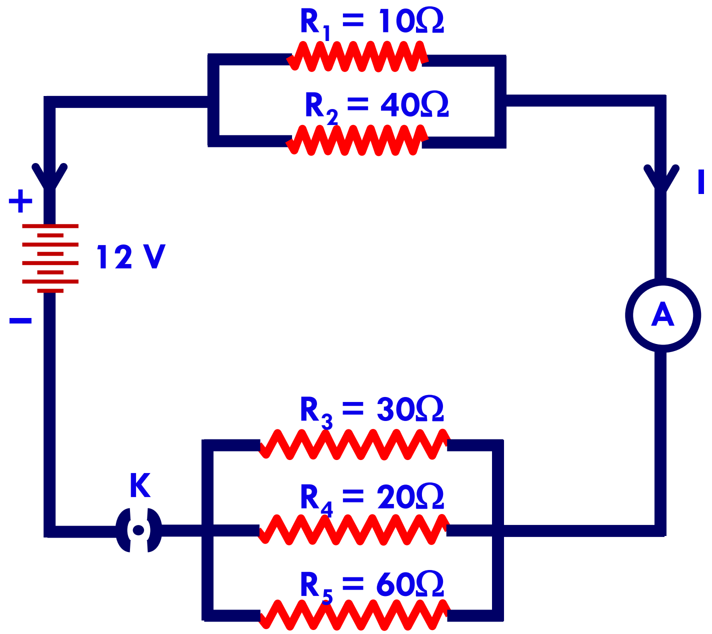
$\therefore I = 2.4 + 1.2 + 0.4$

$\therefore I = 4 \text{ A}$

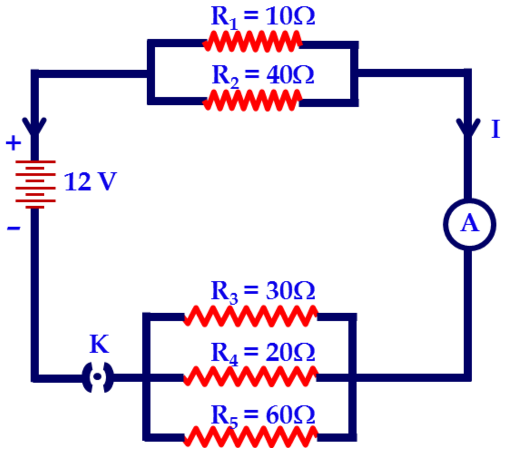
7

If in circuit diagram, $R_1 = 10\Omega$, $R_2 = 40\Omega$, $R_3 = 30\Omega$, $R_4 = 20\ \Omega$, $R_5 = 60\Omega$, a 12 V battery is connected to the arrangement.

Calculate (a) the total resistance (b) the total current flowing



7 If in circuit diagram, $R_1 = 10\Omega$, $R_2 = 40\Omega$, $R_3 = 30\Omega$, $R_4 = 20\ \Omega$, $R_5 = 60\Omega$, a 12 V battery is connected to the arrangement.
Calculate (a) the total resistance (b) the total current flowing



Given :

$R_1 = 10\ \Omega$

$R_2 = 40\ \Omega$

$R_3 = 30\ \Omega$

$R_4 = 20\ \Omega$

$R_5 = 60\ \Omega$

$V = 12\ V$

To find : Total resistance (R) = ?

Total current (I) = ?

Formulae :

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

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

Solution :

Let R_{P1} be the equivalent resistance of R_1 and R_2

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

$$\frac{1}{R_{P1}} = \frac{1}{10} + \frac{1}{40}$$

$$\therefore \frac{1}{R_{P1}} = \frac{4+1}{40} = \frac{\cancel{5}^{\,1}}{\cancel{40}_{\,8}}$$

$$\therefore \boxed{R_{P1} = 8\Omega}$$

7 If in circuit diagram, $R_1 = 10\Omega$, $R_2 = 40\Omega$, $R_3 = 30\Omega$, $R_4 = 20\ \Omega$, $R_5 = 60\Omega$, a 12 V battery is connected to the arrangement.
Calculate (a) the total resistance (b) the total current flowing

Let R_{P2} be the equivalent resistance of R_3, R_4 and R_5 then,

$$\frac{1}{R_{P2}} = \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$$

$$\therefore \frac{1}{R_{P2}} = \frac{1}{30} + \frac{1}{20} + \frac{1}{60}$$

$$\therefore \frac{1}{R_{P2}} = \frac{2 + 3 + 1}{60} = \frac{\cancel{6}^{\,1}}{\cancel{60}_{\,10}}$$

$$\therefore \boxed{R_{P2} = 10\ \Omega}$$

Total resistance (R)

$$R = R_{P1} + R_{P2}$$

$$\therefore R = 8 + 10$$

$$\boxed{R = 18\ \Omega}$$

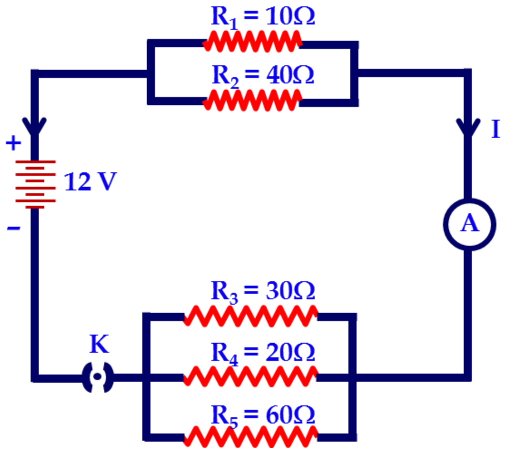
Total Current (I)

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

$$\therefore I = \frac{\cancel{12}^{\,2}}{\cancel{18}_{\,3}}$$

$$\therefore I = \frac{2}{3}$$

$$\boxed{I = 0.67\,A}$$



Ans : The total resistance of the circuit is 18Ω and the total current is 0.67 A

8 Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of
(i) 9 Ω (ii) 4 Ω

Given :
$R_1 = 6\ \Omega$
$R_2 = 6\ \Omega$
$R_3 = 6\ \Omega$

To find : How to connect to get:
(i) 9 Ω (ii) 4 Ω

Formulae :
$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$
$$R_S = R_1 + R_2 + R_3$$

Solution : (i) To get 9 Ω:

(i) R_1 and R_2 are connected in parallel

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{6} + \frac{1}{6}$$
$$\frac{1}{R_P} = \frac{2}{6} \qquad \therefore R_P = \frac{6}{2}$$
$$\therefore R_P = 3\ \Omega$$

Now R_P and R_3 are connected in series.

$$\therefore R = R_P + R_3$$
$$= 3 + 6 \quad = 9\ \Omega$$

To get combination of 9 Ω R_1 and R_2 are connected in parallel and R_3 is connected in series with them

8 Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of (i) 9 Ω (ii) 4 Ω

Given : $R_1 = 6\ \Omega$

$R_2 = 6\ \Omega$

$R_3 = 6\ \Omega$

To find : How to connect to get: (i) 9 Ω (ii) 4 Ω

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

$$R_S = R_1 + R_2 + R_3$$

Solution : (ii) To get 4 Ω :

(ii) R_1 and R_2 are connected in series.

$$R_S = R_1 + R_2$$

$$R_S = 6 + 6 = 12\ \Omega$$

Now R_s and R_3 are connected in parallel.

$$\frac{1}{R_P} = \frac{1}{R_S} + \frac{1}{R_3}$$

$$= \frac{1}{12} + \frac{1}{6}$$

$$= \frac{1+2}{12}$$

$$\frac{1}{R_P} = \frac{3}{12} \qquad \therefore R_P = 4\ \Omega$$

To get combination of 4 Ω R_1 and R_2 are connected in series and R_3 is connected in parallel with them.

Q.9. What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4Ω, 8Ω, 12Ω, 24Ω?

Given :

$R_1 = 4\Omega$

$R_2 = 8\Omega$

$R_3 = 12\Omega$

$R_4 = 24\Omega$

To find :

(a) Highest equivalent resistance

(b) Lowest equivalent resistance

Solution :

(a) To get highest equivalent resistance, these resistances should be connected in series.

$$R = R_1 + R_2 + R_3 + R_4$$

$$= 4 + 8 + 12 + 24$$

$$= 48\ \Omega$$

(b) To get lowest equivalent resistance, these resistance should be connected in parallel.

$$\therefore \frac{1}{R} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24}$$

$$= \frac{6+3+2+1}{24}$$

$$= \frac{12}{24} = \frac{1}{2}$$

$$\therefore R = 2\ \Omega$$

10 How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?

Given :

Voltage (V) = 220 V

Current (I) = 5 A

Resistance of single resistor

Formula for Equivalent resistance of *n* resistors connected in parallel

To find : No. of resistors (*n*) = ?

Formulae : $V = IR$, $R_{eq} = \dfrac{R}{n}$

Solution :

$$V = IR$$

$$R_{eq} = \frac{V}{I} \quad \ldots\ldots \text{(i)}$$

$$= \frac{220}{5}$$

$$= 44\ \Omega$$

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

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

$$n = \frac{176}{44}$$

$$n = 4$$

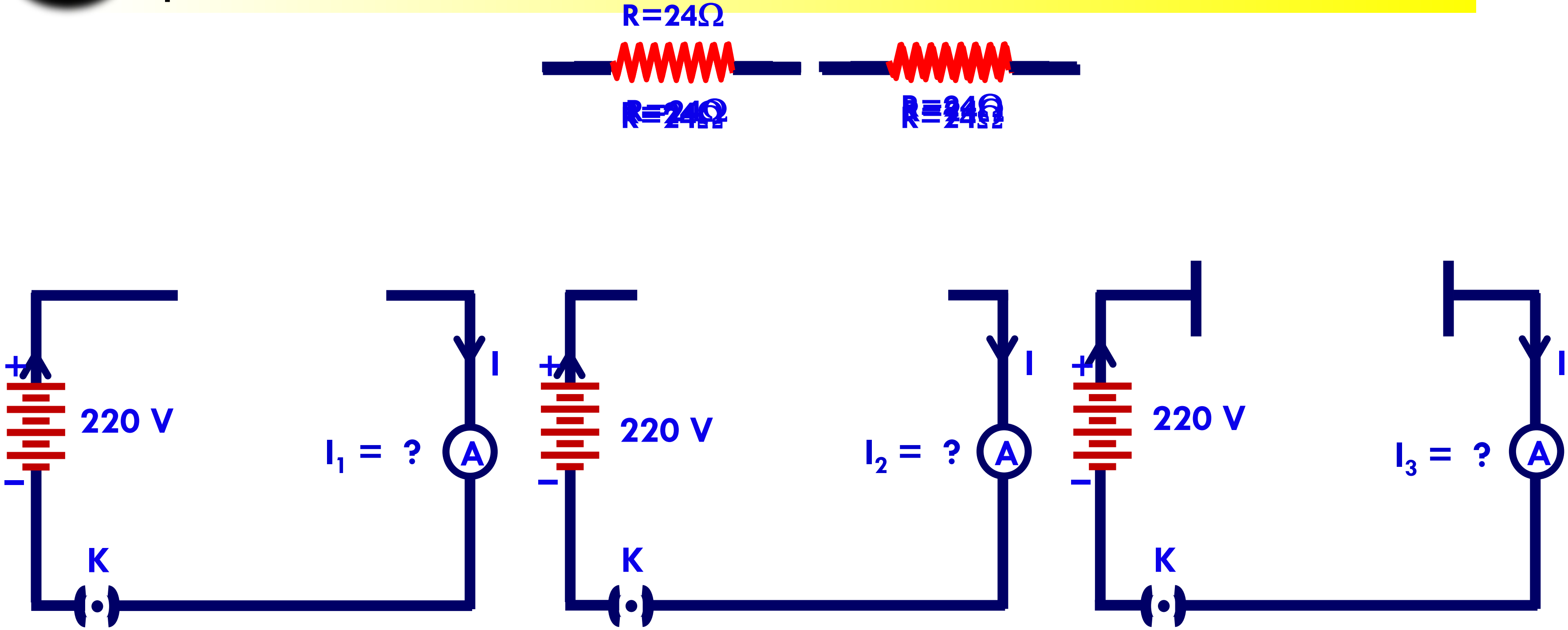
Ans : 4 resistors of 176 Ω are required to draw the given amount of current.

Thank You

LECTURE 7

11

A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ω resistances, which may be used separately, in series, or in parallel. What are the currents in the three cases ?



11

A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ω resistances, which may be used separately, in series, or in parallel. What are the currents in the three cases ?

Given :

Voltage (V) = 220 V

Resistance (R) = 24 Ω

To find :

Current when coils are used separately (I_1) = ?

Current of series combination (I_2) = ?

Current of parallel combination (I_3) = ?

Formulae :

$$V = IR$$

$$R_S = R_1 + R_2$$

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

Solution : Case I : Coils used separately

$$\therefore \quad I_1 = \frac{V}{R} = \frac{220}{24}$$

$$\therefore \quad I_1 = 9.166 \text{ A}$$

Case II : Coils in series

Total resistance in series

$$R_S = R + R$$

$$\therefore \quad R_S = 24 + 24$$

$$\therefore \quad R_S = 48 \ \Omega$$

According to ohm's law

$$V = I_2 R_S$$

$$\therefore \quad I \; = \; V \; = \; 220$$

Case III : Coils in parallel

Total resistance in parallel

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R}$$

$$\therefore \quad \frac{1}{R_P} = \frac{1}{24} + \frac{1}{24} = \frac{2}{24}$$

$$\therefore \quad R_P = \frac{24}{2}$$

$$\therefore \quad R_P = 12 \ \Omega$$

According to ohm's law

$$V = I_3 R_P$$

$$\therefore \quad I = V = \frac{220}{12}$$

3 A

Ans : The currents flowing through the coils when they are used separately, in series and in parallel are 9.166 A, 4.58 A and 18.33 A respectively

Type - B

$$V = IR$$

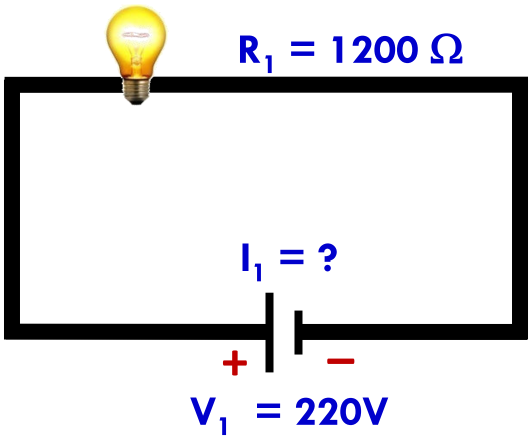
NUMERICAL

$$R = \frac{\rho l}{A} \qquad (A = \pi r^2)$$

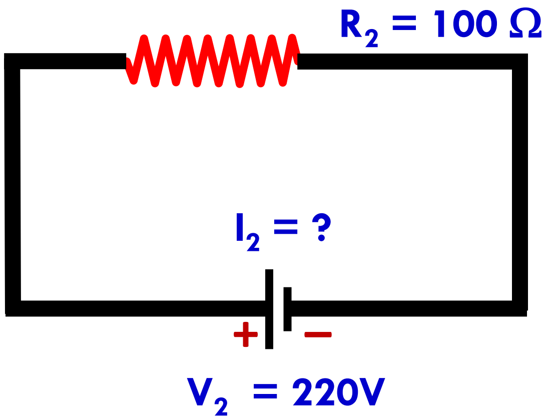
1

(a) How much current will an electric bulb draw from a 220 V source, if the resistance of the bulb filament is 1200 Ω ?

(b) How much current will an electric heater coil draw from a 220 V source, if the resistance of the heater coil is 100 Ω ?



1st circuit



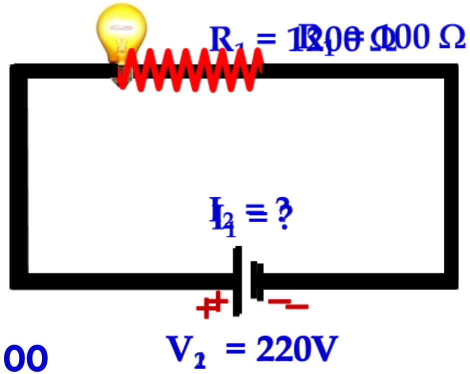
2nd circuit

1

(a) How much current will an electric bulb draw from a 220 V source, if the resistance of the bulb filament is 1200 Ω ?

(b) How much current will an electric heater coil draw from a 220 V source, if the resistance of the heater coil is 100 Ω ?

Given : $V_1 = 220\ V;\ R_1 = 1200\ \Omega,\ V_2 = 220\ V;\ R_2 = 100\ \Omega.$



2nd circuit

To find : $I_1 = ?\ I_2 = ?$

Formula: $V = IR$

Solution :

$$V_1 = I_1R_1$$

$$\therefore\ 220 = I_1 \times 1200$$

$$\therefore\ I_1 = \frac{22\cancel{0}}{120\cancel{0}} = \frac{\cancel{22}^{11}}{\cancel{120}_{60}}$$

$$\boxed{I_1 = 0.18\ A}$$

$$V_2 = I_2R_2$$

$$\therefore\ 220 = I_2 \times 100$$

$$\therefore\ I_2 = \frac{22\cancel{0}}{10\cancel{0}} = \frac{22}{10}$$

$$\boxed{I_2 = 2.2\ A}$$

Ans : Current through bulb is 0.18 A

Current through heater is 2.2 A

2 The potential difference between the terminals of an electric heater is 60 V when it draws a current of 4 A from the source. What current will the heater draw if the potential difference is increased to 120 V ?

Given :

Potential difference (V) = 60 V

Current (I) = 4 A

Increased Potential difference (V_i) = 120 V

To find : Current (I) = ?

Formula : $V = IR$

Solution :

$$V = IR$$

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

$$\therefore \quad R = \frac{\cancel{60}^{15}}{\cancel{4}_{1}}$$

$$\therefore \quad R = 15\ \Omega$$

'V' is increased but 'R' remains constant

When V is increased to 120V then,

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

$$= \frac{\cancel{120}^{8}}{\cancel{15}_{1}}$$

$$\therefore \quad I = 8\ A$$

Ans : The current in the heater is 8 A

3 Resistance of a metal wire of length 1 m is 26 Ω at 20°C. If the diameter of the wire is 0.3 mm, what will be the resistivity of the metal at that temperature?

Ans :

$(R) = 26\ \Omega$

$(l) = 1\text{m}$

$(d) = 0.3\text{ mm}$

$\therefore\ r = 0.15\text{ mm}$

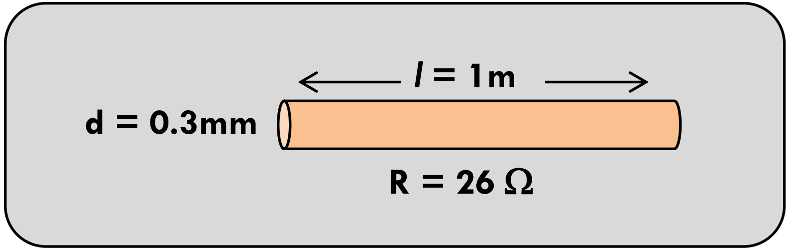
$= 15 \times 10^{-5}\text{m}$

$R = \rho \dfrac{l}{A}$

$\therefore\ \rho = \dfrac{R \times A}{l} = \dfrac{R \times \pi r^2}{l}$

$= \dfrac{26 \times 3.14 \times (15 \times 10^{-5})^2}{1}$

$= 26 \times 3.14 \times 225 \times 10^{-6}$



$\rho = 1.84 \times 10^{-6}\ \Omega\text{m}$

$\therefore$ Resistivity of metal $= 1.84 \times 10^{-6}\ \Omega\text{m}$

4 A wire of given material having length l and area of cross section A has a resistance of 4 Ω. What would be the resistance of another wire of the same material having length $l/2$ and area of cross section 2A?

Ans : (i) For 1st wire :

$$R_1 = \rho \frac{l}{A} = 4\ \Omega \quad \ldots\ \ldots\ \ldots\ \ldots(i)$$

(ii) For 2nd wire :

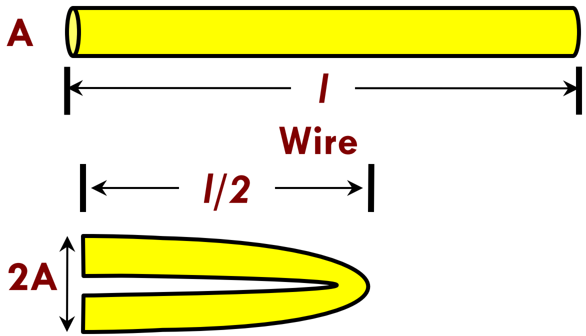
$$R_2 = \rho \frac{l/2}{2A}$$

$$= \frac{1}{4}\ \rho \frac{l}{A}$$

$$= \frac{1}{4} \times R_1 \quad \ldots\ \ldots\ \ldots\ [\text{from (i)}]$$

$$= \frac{1}{4} \times 4$$

$$\therefore\ R_2 = 1\ \Omega$$



∴ The resistance of new wire is 1 Ω

Q.5. When a 12V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.

Given :

$V = 12\ V$

$I = 2.5\ mA$

$= 2.5 \times 10^{-3}\ A$

To find : $R = ?$

Formula : $R = \dfrac{V}{I}$

Solution : $R = \dfrac{12V}{2.5 \times 10^{-3}}$

$= 4800\ \Omega$

The value of the resistance of the resistor is 4800 Ω

Q.6. Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decrease to half of its former value. What change will occur in the current through it?

Ans : According to Ohm's law,

$$V = IR$$

$$\therefore \quad I = \frac{V}{R} \quad \dots\dots\dots \text{(i)}$$

Now, the potential difference is reduced to half.

New potential difference $V' = \frac{V}{2} \quad \dots\dots\dots \text{(ii)}$

$\therefore$ Resistance remains constant,

New current $I' = \frac{V'}{R}$

New current $I' = \frac{V}{2R}$ [from(ii)]

$$= \frac{1}{2} \times \frac{V}{R}$$

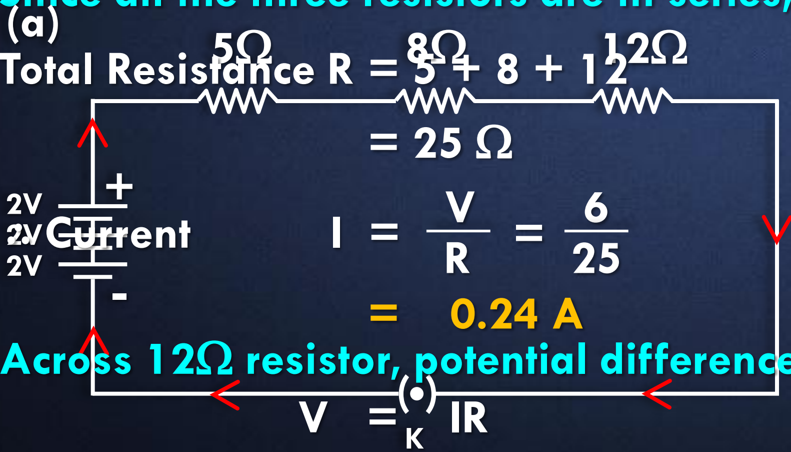
$$I' = \frac{1}{2} I$$

$\therefore$ The current through the component will also become half.

Q.7. **(a)** Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor and a plug key, all connected in series.

(b) Redraw the above circuit putting an ammeter to measure current through the resistors and a voltmeter to measure potential difference across 12 Ω resistor. What would be the readings in ammeter and voltmeter.

Ans. : Since all the three resistors are in series,



Total Resistance R = 5 + 8 + 12

= 25 Ω

Current $I = \frac{V}{R} = \frac{6}{25}$

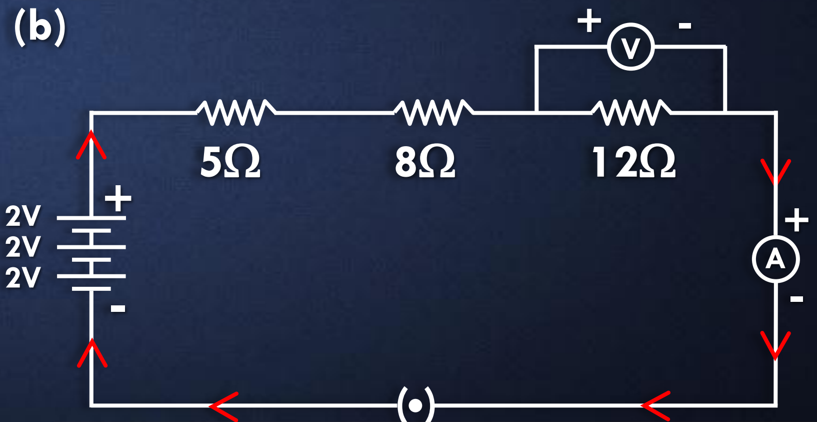
= **0.24 A**

Across 12Ω resistor, potential difference

V = IR

= 0.24 x 12

= **2.88 V**



∴ Ammeter Reading = 0.24 A

Voltmeter Reading = 2.88 V

Thank You

LECTURE 8

Effects Of Electric Current

1st Effect

Heating

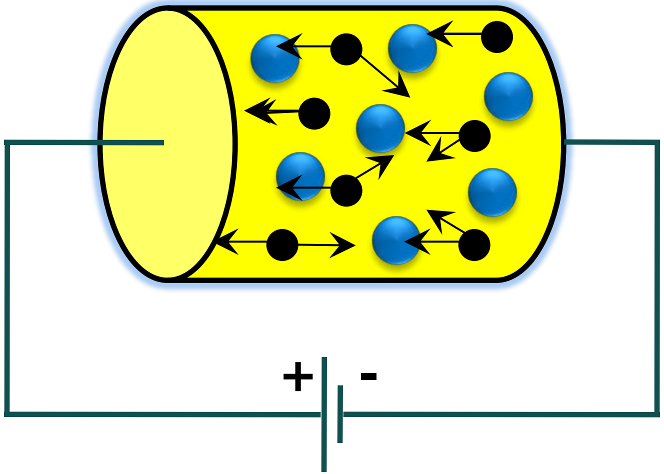
2nd Effect

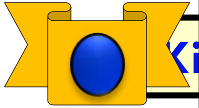
Magnetic

3rd Effect

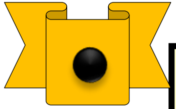
Chemical

Heating Effect of Electric Current





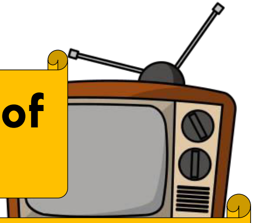
Atoms in the state of vibration

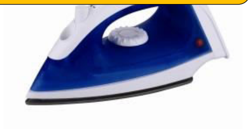


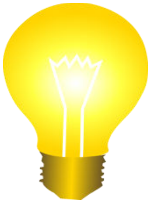
Free electrons in the state of random motion

Loss in kinetic energy

Heat energy







But, according to law of conservation of energy, energy cannot be destroyed hence, this loss in kinetic energy is converted into heat energy

JOULE'S LAW

Heat produced in a resistor is directly proportional to

- Square of the current (I^2)
- Resistance of the conductor (R) and
- Time for which the current flows (t)

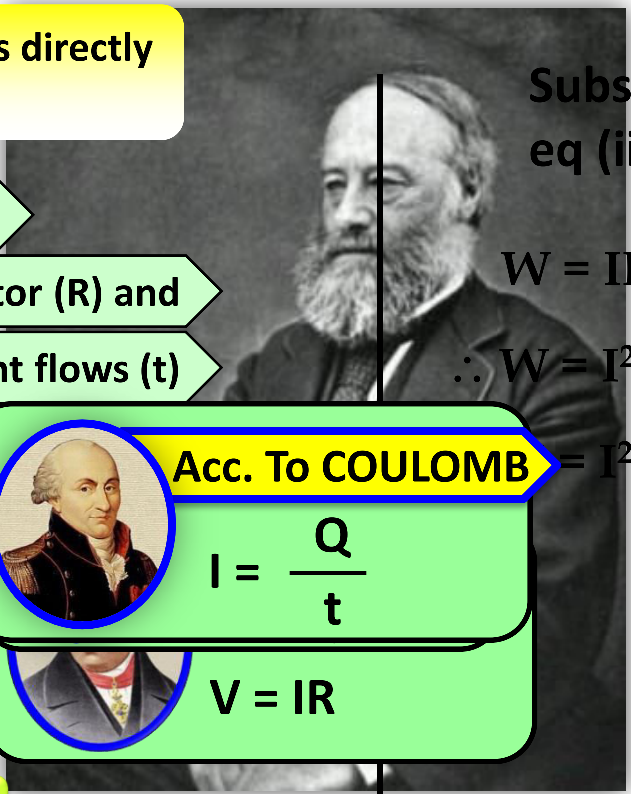
$$I = \frac{Q}{t}$$

$$\therefore Q = It \quad \text{.............. (i)}$$

$$\therefore V = IR \quad \text{.............. (ii)}$$

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

$$\therefore W = VQ \quad \text{.............. (iii)}$$



JOULE

Acc. To COULOMB

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

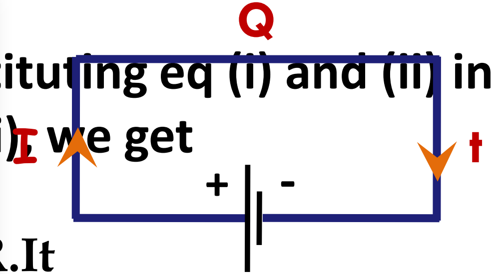
$$V = IR$$

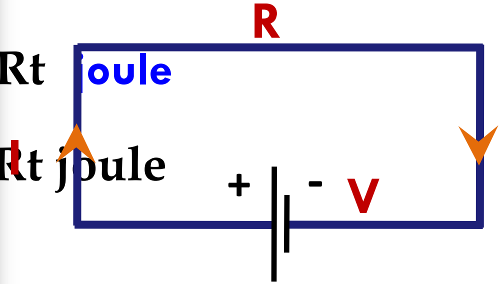
Substituting eq (i) and (ii) in eq (iii), we get

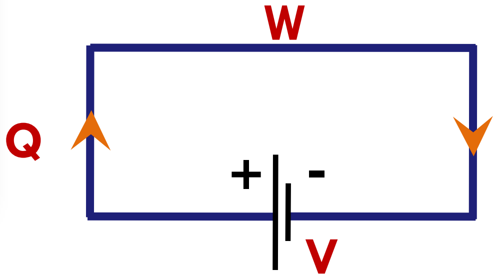
$$W = IR.It$$

$$\therefore W = I^2Rt \text{ joule}$$

$$= I^2Rt \text{ joule}$$







BRAIN TEASER

1. Which out of these is the right answer for Joule's law ?

(a) $H = VIt \ J$

(b) $H = \dfrac{Vt}{R} \ J$

$\because V = IR$

$\therefore H = IR \times It \ J$

$\therefore H = I^2Rt \ J$

(c) $H = I^2Rt \ J$

(d) $H = \dfrac{V^2t}{R} \ J$

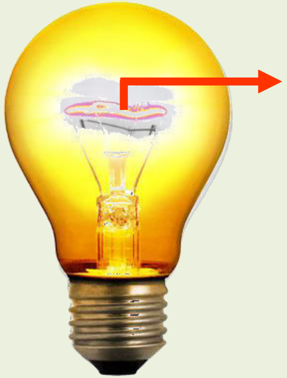
$\because V = IR$

$\therefore H = \dfrac{I^2R^2 \times t}{R} \ J$

$\therefore H = I^2Rt \ J$

APPLICATIONS OF HEATING EFFECT OF ELECTRIC CURRENT

ELECTRIC BULB

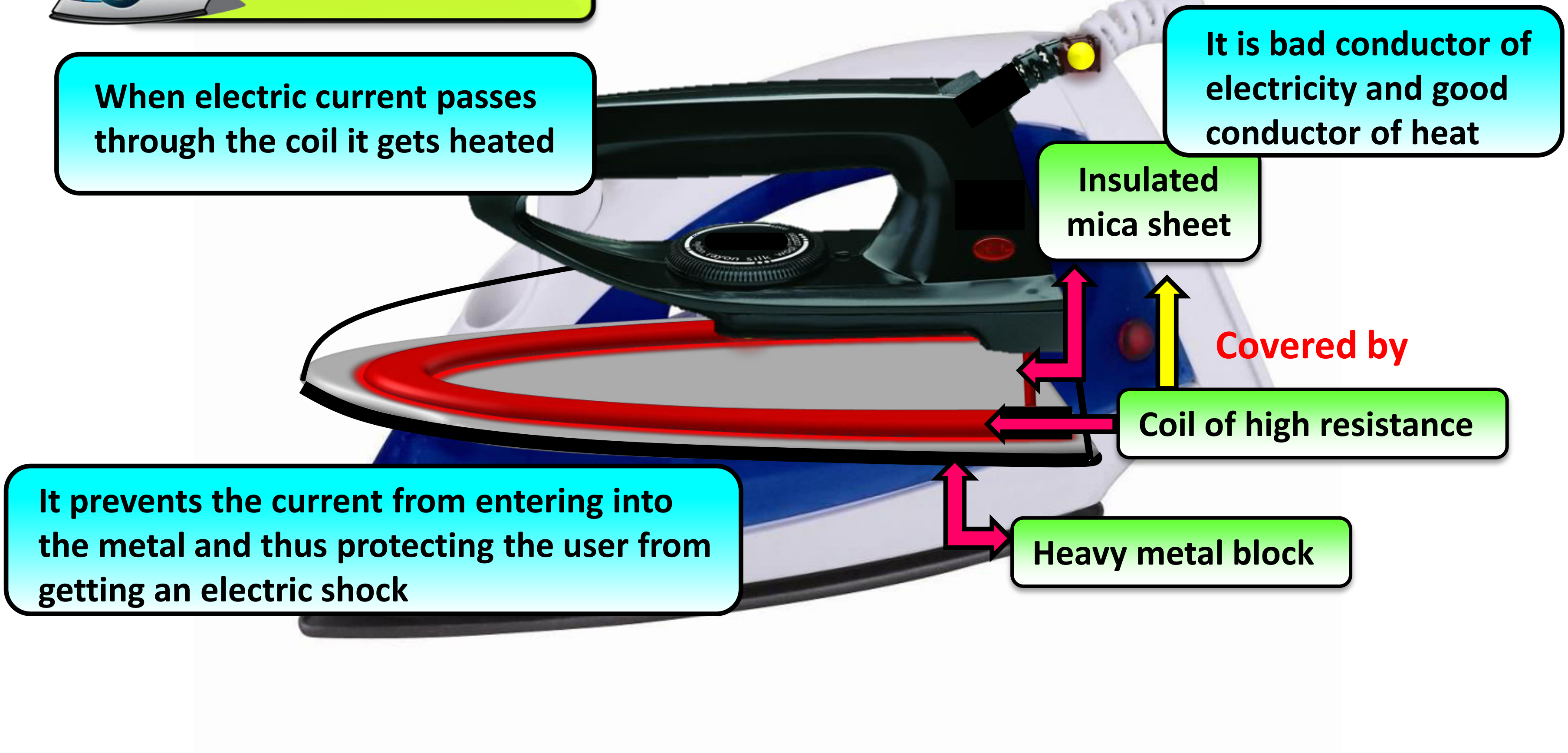


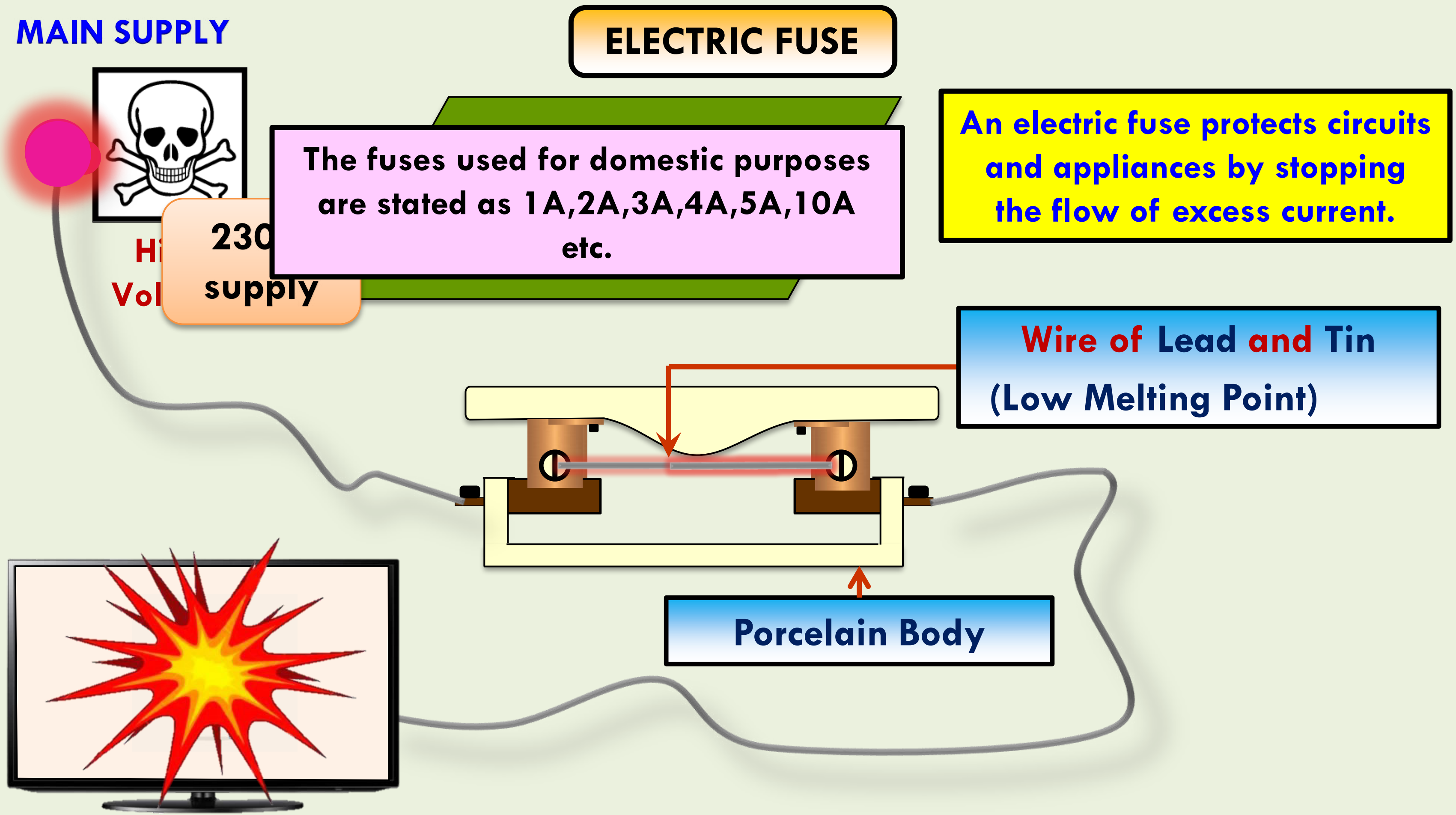
Filament made of tungsten

1. **High Resistance**
2. **High Melting Point** 3380^0C

Chemically inactive nitrogen & argon → **To Prevent oxidation**

ELECTRIC IRON





ELECTRIC FUSE
MAIN SUPPLY
Hi
Vol
230
supply
The fuses used for domestic purposes are stated as 1A,2A,3A,4A,5A,10A etc.
An electric fuse protects circuits and appliances by stopping the flow of excess current.
Wire of Lead and Tin
(Low Melting Point)
Porcelain Body

Q.1. Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

OR

Nichrome wire is used for making the heating elements of electrical appliances like iron, geyser, etc. Give reasons.

Ans. : Coils of electric toasters and irons are made of alloys rather than pure metals because :

i. Resistivity of alloy is higher than pure metals.
ii. Alloys have higher melting point, and so they don't melt easily.
iii. Alloys do not oxidize at high temperature and thus can be kept red-hot.

Q.2. **Why does the cord of an electric heater not glow while the heating element does?**

Ans. :

i. The heating element is made of alloy which has very high resistance. So when current flows through the element, it becomes very hot and glows.

ii. The cord is usually made of materials like copper and so has low resistance. Thus, for the same current, the cord does not becomes so hot and hence, does not glows.

Thank You

LECTURE 9

TYPE - D

Formulae based on work done in joules

$$\text{Power} = \frac{\text{Work done}}{\text{Time}}$$

$$W = I^2Rt \text{ joule} \qquad P = \frac{I^2R\cancel{t}}{\cancel{t}} = I^2R \text{ watt}$$

$$W = \frac{V^2t}{R} \text{ joule} \qquad P = \frac{V^2}{R} \text{ watt}$$

$$W = VIt \text{ joule} \qquad P = VI \text{ watt}$$

1

100 J of heat is produced each second in a 4 Ω resistance. Find the potential difference across the resistor.

Given : Heat (H) = 100 J

Resistance (R) = 4 Ω

Time (t) = 1 sec

To find : P.D. (V) = ?

Formula : $H = \frac{V^2 t}{R}$ J

$H = I^2Rt$ J

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

$H = VIt$ J

Solution : $H = \frac{V^2 t}{R}$ J

$\therefore \quad V = \sqrt{\frac{H \times R}{t}}$

$\therefore \quad V = \sqrt{\frac{100 \times 4}{1}}$

$\therefore \quad V = \sqrt{400}$

$\therefore \quad V = 20$ V

Ans : Potential difference across the resistor is 20 V.

2 Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

Given :

P.D. (V) = 50 V

Time (t) = 1 hr = $1 \times 60 \times 60$ s

Charge (Q) = 96000 C

To find : Heat (H) = ?

Formulae :

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

$$H = VIt$$

Solution :

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

$$\therefore \quad I = \frac{\overset{\overset{80}{\cancel{160}}}{\cancel{96000}}}{\underset{1}{\cancel{60}} \times \underset{3}{\cancel{60}}}$$

$$\therefore \quad I = \frac{80}{3}\ \text{A}$$

$$H = VIt$$

$$\therefore \quad H = 50 \times \frac{80}{\underset{1}{\cancel{3}}} \times \overset{20}{\cancel{60}} \times 60$$

$$\therefore \quad H = 4800000$$

$$\therefore \quad H = 4.8 \times 10^6\ \text{J}$$

Ans : Heat generated is 4.8×10^6 J

$$H = I^2Rt \text{ joule}$$

$$H = \frac{V^2t}{R} \text{ joule}$$

$$H = VIt \text{ joule}$$

3 An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the potential difference and heat developed in 30 s.

Given :

Current (I) = 5 A

Time (t) = 30 s

Resistance (R) = 20 Ω

To find :

Heat (H) = ?

P.D (V) = ?

Formulae :

$V = IR$

$H = VIt$

Solution :

$V = IR$

$\therefore V = 5 \times 20$

$\therefore V = 100\ V$

$H = VIt$

$\therefore H = 100 \times 5$

$\therefore H = 15000$

$\therefore H = 1.5 \times 10^4\ J$

$H = I^2Rt$ joule

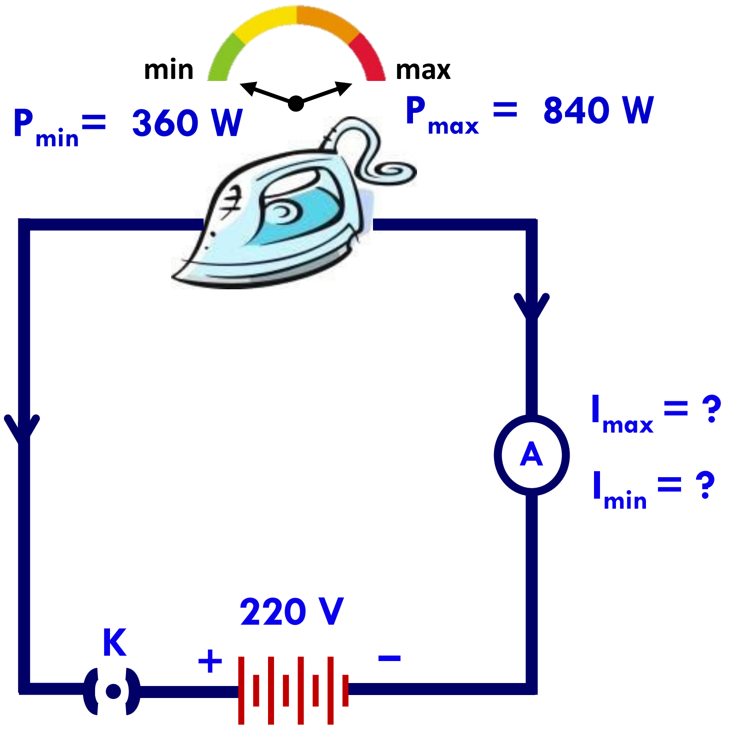
$H = \frac{V^2t}{R}$ joule

$H = VIt$ joule

Ans : The amount of heat developed in the electric iron is 1.5×10^4 J

4

An electric iron consumes energy at a rate of 840 W when heating is at the maximum rate and 360 W when the heating is at the minimum. The voltage is 220 V. What is the current in each case?



4 An electric iron consumes energy at a rate of 840 W when heating is at the maximum rate and 360 W when the heating is at the minimum. The voltage is 220 V. What is the current in each case?

Given :

Power at maximum rate (P_{max}) $=$ 840 W

Power at minimum rate (P_{min}) $=$ 360 W

Potential Difference (V) $=$ 220 V

To find :

$I_{max} = ?$

$I_{min} = ?$

Formula : $P = VI$

Solution : When heating is at the maximum rate: P_{max} = 840 W, V = 220 V

$$P_{max} = VI_{max}$$

$$\therefore \quad I_{max} = \frac{P_{max}}{V}$$

$\therefore$

$\therefore$

Wh... nimum rate:

$P_{mi...}$

$\therefore \quad I_{min} = \frac{\quad}{\cancel{220}_{11}}$

$\therefore \quad I_{min} = 1.64\ A$

$P = I^2R$ watt

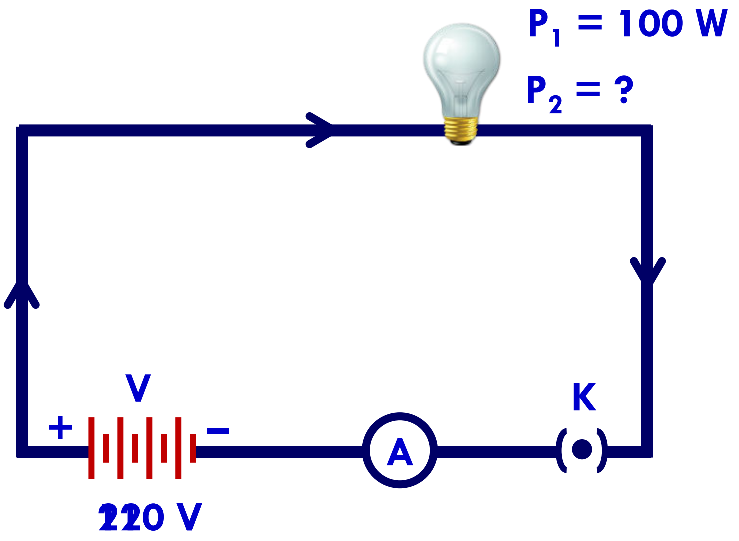
$P = \frac{V^2}{R}$ watt

$P = VI$ watt

Ans : I_{max} = 3.82 A , I_{min} = 1.64 A.

5

An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be ?



5

An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be ?

Given : Power (P_1) = 100 W

P.D. (V_1) = 220 V

P.D. (V_2) = 110 V

To find : Power (P_2) = ?

Formula :

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

Solution :

$$P_1 = \frac{V_1^2}{R}$$

$$\therefore \quad 100 = \frac{(220)^2}{R}$$

$$\therefore \quad R = \frac{22\cancel{0} \times 22\cancel{0}}{1\cancel{0}\cancel{0}}$$

$$\therefore \quad R = 484\ \Omega$$

Resistance remains constant even at 110 V

$$\therefore \quad P_2 = \frac{V_2^2}{R}$$

$$\therefore \quad P_2 = \frac{(110)^2}{484}$$

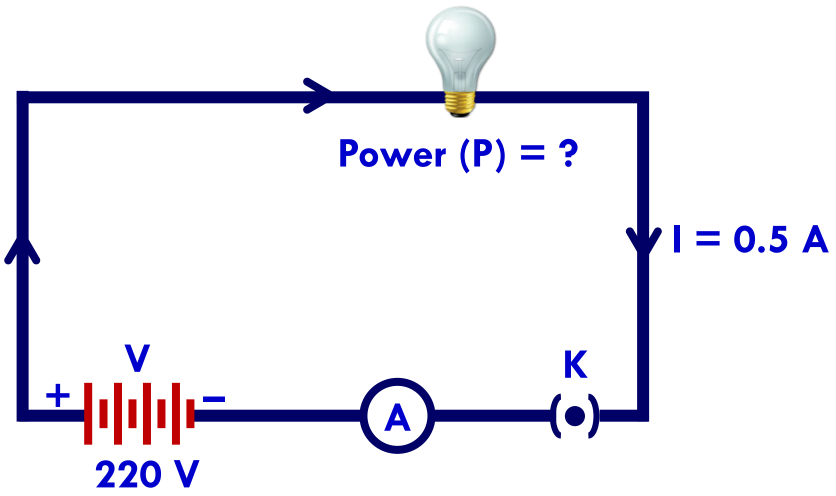
$$\therefore \quad P_2 = \frac{\overset{\overset{5}{\cancel{55}}}{\cancel{110}} \times \overset{\overset{5}{\cancel{55}}}{\cancel{110}}}{\underset{\underset{\underset{\underset{1}{\cancel{11}}}{\cancel{121}}}{\cancel{242}}}{\cancel{484}}}$$

$$\therefore \quad P_2 = 25\ \text{W}$$

Ans : The power consumed at 110 V is 25 W.

6

An electric bulb is connected to a 220 V generator. The current is 0.50 A. What is the power of the bulb?



6

An electric bulb is connected to a 220 V generator. The current is 0.50 A. What is the power of the bulb?

Given : Current (I) $=$ 0.50 A

P.D. (V) $=$ 220 V

To find : Power (P) $=$?

Formula : $P = VI$

Solution : $P = VI$

$\therefore P = 220 \times 0.50$

$\therefore P = 110$ W

Ans : Power of the bulb is 110 W.

$P = I^2R$ watt

$P = VI$ watt

$P = \dfrac{V^2}{R}$ watt

7 An electric heater of resistance 8 Ω draws 15 A from the service mains for 2 hours. Calculate the rate at which heat is developed in the heater.

Given : Resistance (R) = 8 Ω

Current (I) = 15 A

To find : Power (P) = ?

Formula : $P = I^2R$

Solution :

$P = I^2R$

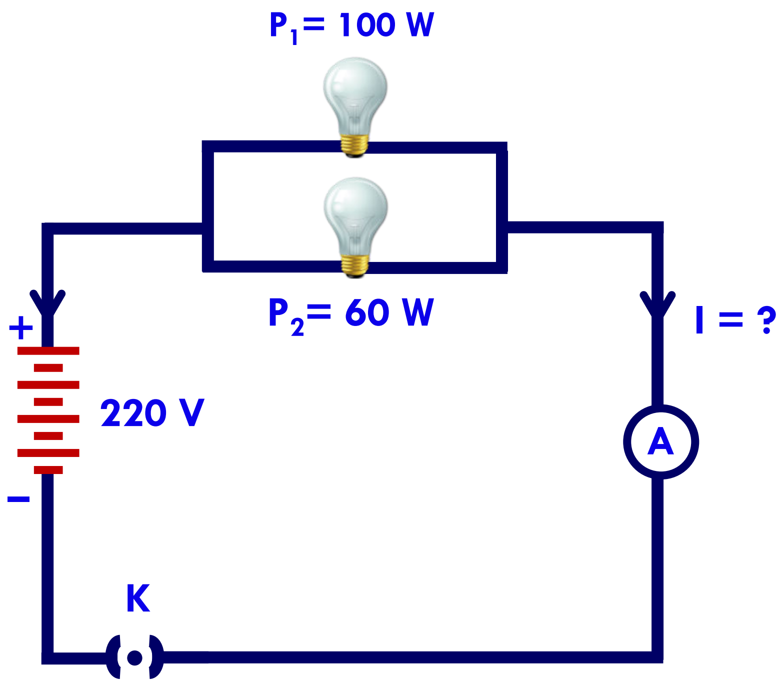
$\therefore \quad P = (15)^2 \times 8$

$\therefore \quad P = 1800$ J/s

Ans : Heat is produced by the heater at the rate of 1800 J/s

8

Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V ?



8 Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V ?

Given :

Power $(P_1) = 100$ W

Power $(P_2) = 60$ W

P. D. $(V) = 220$ V

To find : Current (I) = ?

Formula : $P = VI$

Solution : Current drawn by the bulb of rating 100 W is

$$P_1 = VI_1$$

$$\therefore \quad I_1 = \frac{P_1}{V}$$

$$\therefore \quad I_1 = \frac{100}{220} \text{ A}$$

Similarly, Current drawn by the bulb of rating 60 W is

$$P_2 = VI_2$$

$$\therefore \quad I_2 = \frac{P_2}{V}$$

$$\therefore \quad I_2 = \frac{60}{220} \text{ A}$$

Current drawn from the line $= I_1 + I_2$

$$= \frac{100}{220} + \frac{60}{220}$$

$$= 0.727 \text{ A}$$

Ans : Current drawn from the line is 0.727 A

Q.5. Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combination would be : (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1

Ans. : (c) 1:4

Let R_s be the equivalent resistances of the wire when connected in series and R_p be the equivalent resistance, when connected in parallel.

$$\therefore \quad R_s = R + R = 2R$$

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}$$

$$\frac{1}{R_p} = \frac{R}{2}$$

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

$$\therefore \quad \frac{H_s}{H_p} = \frac{\frac{V^2t}{R_s}}{\frac{V^2t}{R_p}}$$

$$= \frac{R_p}{R_s}$$

$$\therefore \quad \frac{H_s}{H_p} = \frac{1}{4}$$

Thank You

LECTURE 10

Electric power is the rate at which electric energy is dissipated or consumed in an electric circuit

❖ Relation between Commercial & S.I. unit of work

$1\,kW\,h = 1000\ W \times 3600\ s$

$1\,kW\,h = 36 \times 10^5\ W - S$

$1\,kW\,h = 36 \times 10^5$ joule

$\boxed{1\,kW\,h = 3.6 \times 10^6\ J}$

Power = $\dfrac{\text{work}}{\text{time}}$

Electric power = $\dfrac{\text{Energy consumed}}{\text{time}}$

What is kWh

Energy consumed =

Unit of electric energy = watt × second

Energy consumed in bigger units = 1 kW × 1 h

1 Unit

TYPE - E

$$\text{Electric Power} = \frac{\text{Energy Consumed}}{\text{time in hours}}$$

Note : Electric power should be in kilowatts & time should be in hours

1 An electric refrigerator rated 400 W operates 8 hour/day. What is the cost of the energy to operate it for 30 days at Rs 3.00 per kWh?

Given :

Power (P) = 400 W $= \frac{400}{1000}$ kW = 0.4 kW

Time (t) = 30 × 8h = 240 h

Cost per kWh = Rs 3

To find :

Energy consumed = ?

Formulae :

Energy consumed = P × t

Solution :

Energy consumed = P × t

Energy consumed = 0.4 kW × 240 h

$\boxed{\text{Energy consumed} = 96 \text{ kWh}}$

Cost of energy = 96 × 3

$\boxed{\text{Cost of energy} = \text{Rs. } 288}$

Ans :

The cost of energy to operate the refrigerator for 30 days is Rs. 288

2 An electric heater rated 1000W / 220V operates 2 hours daily. Calculate the cost of energy to operates for 30 days at Rs. 3 per kWh.

Given : Power (P) $= 1000W = 1\ kW$

Time (t) $= 2\ h/day$

To find : Cost of energy to operate for 30 days = ?

Formula : Energy consumed $= P \times t$

Solution : Energy consumed by electric heater $= P \times t$

$= 1\ kW \times 2h$

$= 2\ kWh$

Cost of energy to operate $= 2 \times 3 =$ Rs. 6 per day

Cost of energy to operate for 30 days $= 30 \times 6 =$ Rs. 180

Ans : Cost of energy to operate electric heater for 30 days is Rs. 180

3 A 100 watt electric bulb is lighted for 2 hours daily and four 40 watt bulbs are lighted for 4 hours everyday. Calculate the energy consumed.

Given :

Power (P_1) = 100 Watt $= \frac{100}{1000}$ kW = ~~0.1 kW~~

time (t_1) = 2 hours

Power (P_2) = 40 Watt $= \frac{40}{1000}$ kW = ~~0.04 kW~~

time (t_2) = 4 hours

To find : Energy consumed in each case?

Formula : Energy consumed = Power × time

Solution : Energy consumed $= P_1 \times t_1$

$= 0.1\ \text{kW} \times 2\ \text{h}$

$= 0.2\text{kWh}$

Energy consumed by 100 watt bulb in one day is 0.2kWh

Energy consumed $= 4 \times P_2 \times t_2$

$= 4 \times 0.04\ \text{kW} \times 4\ \text{h}$

$= 0.64\ \text{kWh}$

Energy consumed by four 40 watt bulbs in one day is 0.64kWh

Total Energy consumed $= 0.2 + 0.64$

$= 0.84\text{kWh}$

Ans : Total Energy consumed is 0.84kWh

4 Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes ?

Given :

Power (P_1) = 250 W = $\frac{250}{1000}$ kW = 0.25 kW

Power (P_2) = 1200 W = $\frac{1200}{1000}$ kW = 1.2 kW

Time (t_1) = 1 h

Time (t_2) = 10 min = $\frac{10}{60}$ h

= 0.167 h

To find : Energy consumed = ?

Formula : Energy consumed = Pt

Solution :

Energy consumed by a 250 W TV set in 1 h $= P_1 \times t_1$

$= 0.25\ \text{kW} \times 1\text{h}$

$= 0.25\ \text{kWh}$

Energy consumed by 1200 W toaster in 10 min $= P_2 \times t_2$

$= 1.2\ \text{kW} \times 0.167\ \text{h}$

$= 0.2\ \text{kWh}$

Ans :

Energy consumed by a 250 W TV set in 1 hr is more than the energy consumed by a 1200 W toaster in 10 minutes

5 A household uses the following electric appliances :

(i) Refrigerator of rating 400W for ten hours each day

(ii) Two electric fans of rating 80W for 12 hours each day

(iii) Six electric tubes of rating 18 W each for 6 hours each days

Calculate the electricity bill of the household for the month of June.

If the cost per unit of electric energy is Rs. 5.00 per kwh

Given :

Power $(P_1) = 0.4\ kW$; $t_1 = 10\ h/day$

Power $(P_2) = 0.08\ kW$; $t_2 = 12\ h/day$

Power $(P_3) = 0.018\ kW$; $t_3 = 6\ h/day$

Cost per unit of electric energy $=$ Rs. 5.00

To find : Electricity bill of household = ?

Formula : Energy consumed $= P \times t$

Solution :

Energy consumed by refrigerator $= P_1 \times t_1$

$= 0.4 \times 10$

$= 4\ kWh$

Energy consumed by two electric fans $= 2 \times P_2 \times t_2$

$= 2 \times 0.08 \times 12 = 1.92\ kWh$

Energy consumed by six electric tubes $= 6 \times P_3 \times t_3$

$= 6 \times 0.018 \times 6 = 0.648\ kWh$

Total electrical energy consumed $= 4 + 1.92 + 0.648$

$= 6.568\ kWh$

Total electrical energy consumed in month of June (30 days) $E = 6.568\ kWh \times 30$

$\therefore$ **Ans :** Electricity bill of household for month of June is Rs. 985.20

Thank You

LECTURE 11

1 Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10 W. How many lamps can be connected in parallel with each other across the two wires of 220 V line if the maximum allowable current is 5 A?

Given : P.D. (V) = 220 V

Maximum current, (I_{max}) = 5 A

Power of one bulb (P_1) = 10 W

To find : No. of bulbs to be connected in parallel(x)

Formulae : $P = \dfrac{V^2}{R}$, $V = IR$, $\dfrac{1}{R} = \dfrac{1}{R_1} \times x$

Solution : Resistance R_1, of the bulb is given by the expression,

$$P_1 = \frac{V^2}{R_1} \qquad R_1 = \frac{V^2}{P_1}$$

$$R_1 = \frac{(220)^2}{10} = 4840\ \Omega \quad ..... \text{(i)}$$

According to Ohm's law,

$$V = IR$$

R is the total resistance of the circuit for x number of electric bulbs

$$R = \frac{V}{I} = \frac{220}{5} = 44\ \Omega \quad ..... \text{(ii)}$$

$$\frac{1}{R} = \frac{1}{R_1} \times x$$

From eq. (i) and (ii),

$$x = \frac{R_1}{R} = \frac{4840}{44} = 110$$

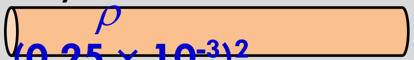
Ans : 110 electric bulbs are connected in parallel.

2

A copper wire has a diameter of 0.5 mm and resistivity of $1.6 \times 10^{-8}\ \Omega$ m.

(a) What will be the length of this wire to make its resistance 10Ω ?

(b) How much does the resistance change if the diameter is doubled?



(b) $R \propto \dfrac{1}{d^2}$

So, when the diameter of the wire is doubled, then its resistance will become $(1/2)^2$ or $1/4$

To find : (a)Length (l) = ?

(b)How much does the resistance change if the diameter is doubled?

Formula : $R = \dfrac{\rho l}{A}$, $A = \pi r^2$

Solution : $R = \dfrac{\rho l}{A}$

$$\rho = \frac{R \times A}{l} \qquad \therefore l = \frac{R \times \pi r^2}{\rho}$$

$$l = \frac{10 \times 3.14 \times (0.25 \times 10^{-3})^2}{1.6 \times 10^{-8}}$$

$$= \frac{10 \times \cancel{3.14}^{\,1.57} \times 0.0625 \times 10^{-6}}{\cancel{1.6}_{\,0.8} \times 10^{-8}}$$

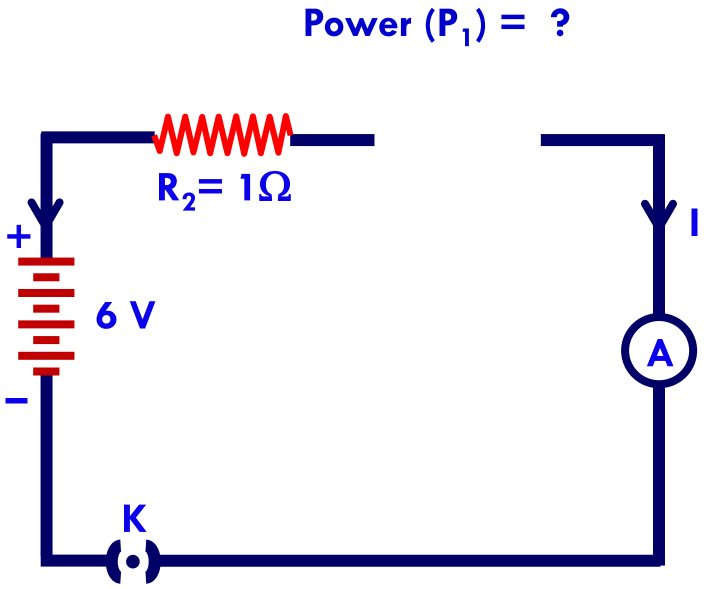
$$= \frac{10 \times 1.57 \times 0.0625 \times 10^{-6} \times 10^{8}}{0.8}$$

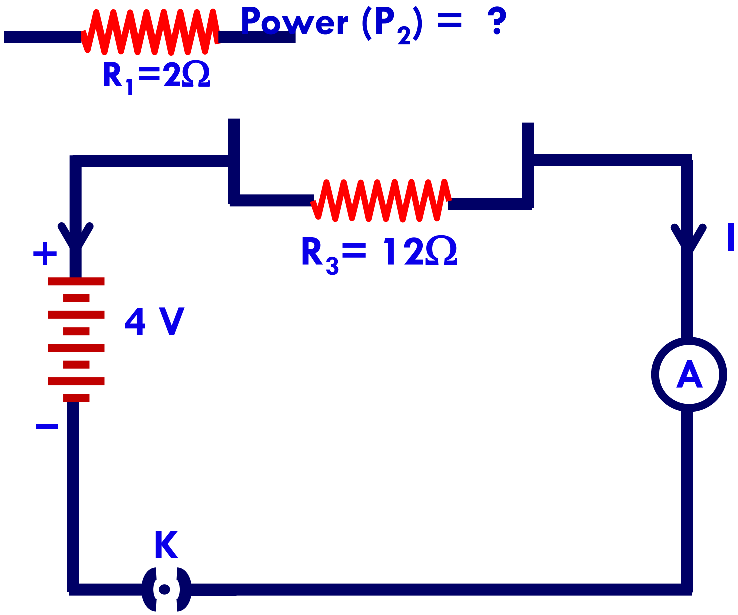
$$= \frac{10 \times 1.57 \times 0.0625 \times 10^{2}}{0.8}$$

$$l = \frac{1.57 \times 62.5}{0.8} \qquad \therefore l = 122.65 \text{ m}$$

3

Compare the power used in the 2 Ω resistor in each of the following circuits : (i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and (ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.





Current in both the circuit is I, resistance is 2Ω hence by using the formula $P=I^2R$, Power used in both cases will be the same.

3 Compare the power used in the 2 Ω resistor in each of the following circuits : (i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and (ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.

Given :

Resistance $(R_1) = 2\ \Omega$

Resistance $(R_2) = 1\ \Omega$

Resistance $(R_3) = 12\ \Omega$

P.D. $(V_1) = 6$ V

P.D. $(V_2) = 4$ V

To find :

Power $(P_1) = ?$

Power $(P_2) = ?$

Formulae :

$$R_S = R_1 + R_2$$
$$V_1 = IR_S$$
$$P_1 = I^2R_1$$

Solution :

Case I : 1 Ω and 2 Ω resistors are connected in series

$$R_S = R_1 + R_2$$
$$\therefore R_S = 1 + 2$$
$$\therefore R_S = 3\ \Omega$$
$$V_1 = IR_S$$
$$\therefore 6 = I \times 3$$
$$\therefore I = 2\text{ A}$$
$$P_1 = I^2R_1$$
$$P_1 = (2)^2 \times 2$$
$$P_1 = 8\text{ watt}$$

Case II : 12 Ω and 2 Ω resistors are connected in parallel

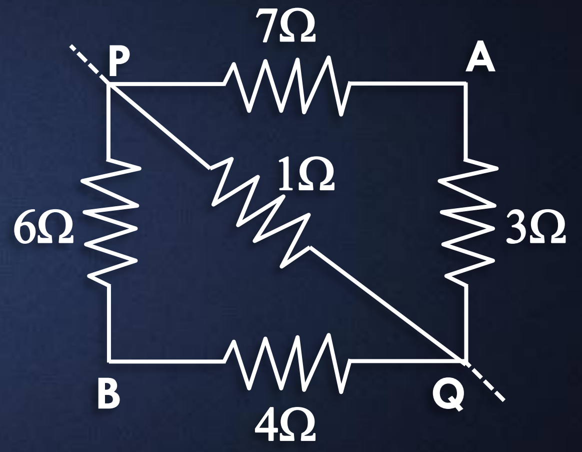
In parallel combination potential difference remains same.

$\therefore$ potential difference across 2 Ω resistor will be 2 V

$$P_2 = \frac{V_2^2}{R_1}$$
$$\therefore P_2 = \frac{(4)^2}{2}$$
$$\therefore P_2 = 8\text{ watt}$$

Ans : The power used by 2 Ω resistor in both the cases is 8 watt

Q.4. Calculate the effective resistance between P and Q.



Ans. : $R_{PAQ} = 7 + 3 = 10\,\Omega$

$R_{PBQ} = 6 + 4 = 10\,\Omega$

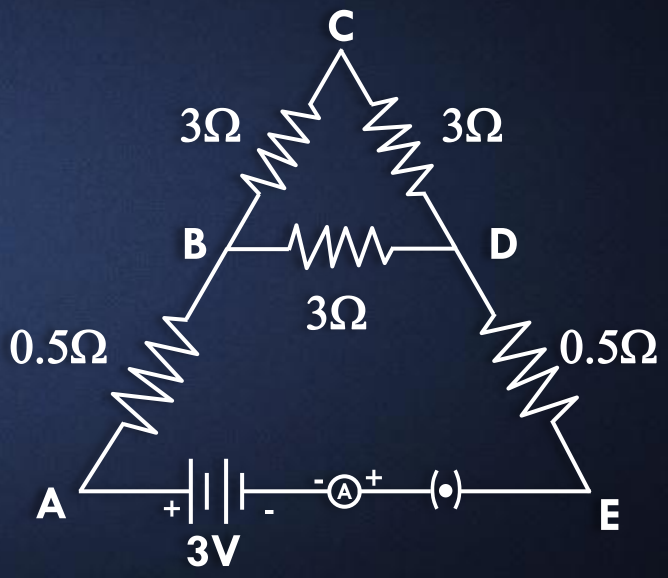
Now, $10\,\Omega$, $1\,\Omega$ and $10\,\Omega$ resistances are in parallel between P and Q.

$$\therefore \frac{1}{R} = \frac{1}{10} + \frac{1}{1} + \frac{1}{10}$$

$$= \frac{1 + 10 + 1}{10} = \frac{12}{10}$$

or $R = \frac{5}{6}\,\Omega$

Q.5 Five resistors are connected as shown in the figure. Find the ammeter reading when the circuit is closed.



Ans. : i. Between B and D

$R_s = 3 + 3 = 6\ \Omega$

$$\frac{1}{R_p} = \frac{1}{R_s} + \frac{1}{3} = \frac{1}{6} + \frac{1}{3} = \frac{3}{6} = \frac{1}{2}$$

$R_p = 2\ \Omega$

ii. Between A and E

$R_s = 0.5 + 2 + 0.5 = 3\ \Omega$

$$\therefore I = \frac{V}{R} = \frac{3}{3}$$

Ammeter reading = 1 A

Thank You