Matter :

The matter is anything around us that has both mass and volume which occupies space.
For example: A car would be said to be made of matter as it occupies space & has mass. → Matter commonly exists in three stages, solid, liquid & Gas.

Molecules :

A molecule is an electrical neutral group of two or more atoms held together by covalent chemical bond.
or, A molecule is formed when two or more atoms join together chemically.
A compound is a molecule that contains at least two different element.

Atom :

The atom is a basic unit of matter that consists of a dense central nucleus surrounded by cloud of negatively charged electron.
The atomic nucleus contain a wire of tvely charged proton & electrically neutral neutrons.

* ## Electrical charge:

Electrical charge is the physical property of matter that causes it to experience a force which is close to other electrically charge matter.
There are two types of electric charges called +ve and -ve.
+vely charged substances are repelled from other +vely charged substances but -vely charged substances are repelled from -ve charge & attracted to +ve charge.
An object will be -vely charged, if it has an excess of electron & will be otherwise positively charged or, uncharged.
The unit of electric charge is Coulomb (C) & it is denoted by symbol (Q).

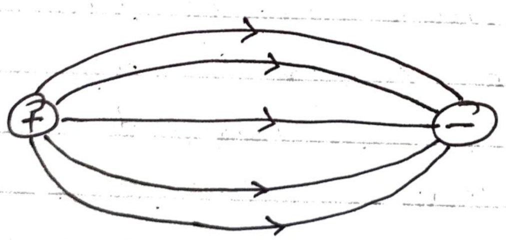


Fig: Electric field of +ve & -ve point charge.

* Electric Current:

The drift (flow or, movement) of electrons in any Conductor is Called electric current.

i.e. the rate of moment of charge (electron)

$$I = \frac{Q}{T} = \frac{dq}{dt} = \frac{\text{Coulomb}}{\text{Second}} = \text{Ampere}$$

where,

Q or dq be the quantity of charge electricity passed during a given time(t).

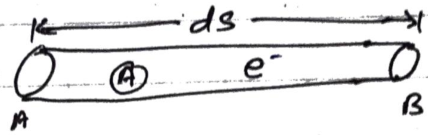


fig: conductor

let, in any conductor

n = no. of electrons available per meter cube

v = Final drift velocity in ~~obly~~

ds = distance travelled in dt second by the electron.

i.e. $ds = v.dt$

A = Area of cross-section of the conductor

$\therefore V = A \times ds = A \times v.dt$ (volume)

Total number of electrons Contained in this volume $= A.v.dt.n$

All these electrons will cross the Conductor of cross-section in time dt. dq will be the charge of electrons then total quantity of ~~at~~ charge, which cross the section in the time dt is

$$dq = A.v.dt.n.e \quad \text{coulomb.}$$

then, by defination; we have

electric current = rate of flow of charge

$$= \frac{A \times v \times dt \times n \times e}{dt}$$

$$= nevA$$

$$\therefore \boxed{I = nevA}$$

I N

The current per unit of area of cross-section of the conductor is called current density and is denoted by J.

i.e. $J = \frac{I}{A} = \frac{nevA}{A}$

$$= nev$$

It's Unit is (Ampere/m^2)

V/Q volts potential

Conventional Current versus Electron Flow:

⇒ Due to dil. H_2SO_4 contained in a vessel; Electron travels from Cu-plate to Zinc plate. So, the Zn-plate becomes -ve and Cu-plate becomes +ve. The large number of electrons collected on Zn plate and being attracted by anode

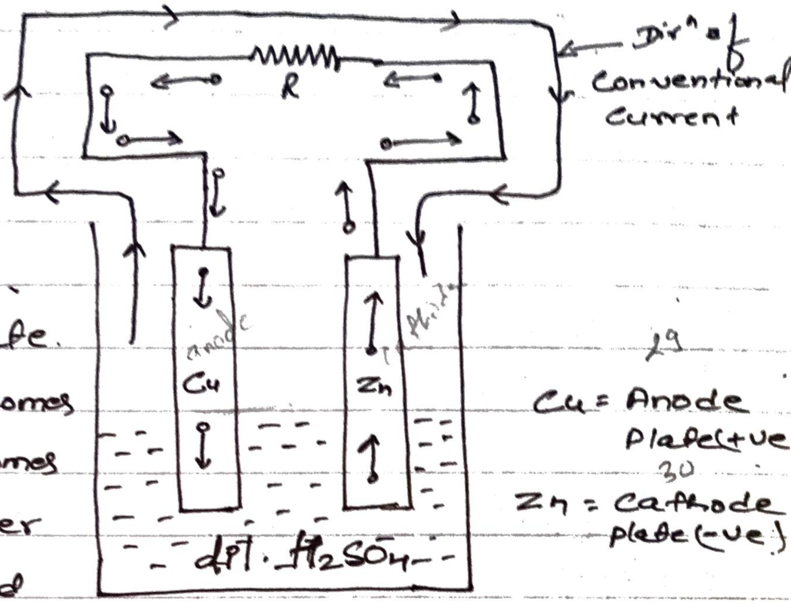


Fig: Voltage Cell or Voltaic cell.

but is prevented from returning to it by the action of dil. H_2SO_4. When these two electrodes are joined by a wire externally, then electrons rush (try to go fast) to the anode(Cu) These by equalizing the charges.

At the same time chemical action in the vessel transfers electrons ~~electrons~~ from Cu-plate to Zn-plate internally, this process continues as long as there is chemical energy. The flow of electrons through the external wire from ~~Zn~~ Zn-plate to Cu-plate is the electric current (electronic current e^-) (cathode to anode). & Conventional current flow from Cu to Zn i.e Anode to Cathode.

* Measurement of Current and Voltage:

→ Ammeter is used for the measurement of current and is connected in Series.

→ Voltmeter is used for measurement of voltage and is connected in parallel.

Potential difference (P.d) or, Voltage (V) & Electromotive force

* Potential difference: Potential difference between two points can also be defined as the work done in moving unit potive test charge from one point to another point against electrical force.

OR

The difference of electric pressure between any two points of conductor is called P.d.

So, it is that which causes the current to flow in a close circuit.

It's unit is 'Volt'.

Electromotive force (E.m.f)

It is the force which tends to move the electron in any closed circuit.

OR

The force which ~~tends~~ compels the electron to move in a complete path.

It cannot be measured accurately.

E.m.f = P.d + Voltage drop inside the source of supply.

Q) Why E.m.f cannot be measured?

⇒ E.m.f cannot be measured because the instrument which we use to measure, that instrument consume some energy/ voltage and doesnot give accurate Voltage.

Conductor, Insulator and Electron flow:

Conductor: The materials that have one or, two valence electron which are free to move is called Conductor.

$\boxed{OR}$

Those substance which offers such a small resistance that rapidly allow electricity to flow through them. Such as Ag, Cu, Al, Au, electrolytes etc.

Insulator / Badconductor: Those materials having no free electron or more valence electron which are away to be freed.

$\boxed{OR}$

The insulators are those substance which offers

Such a resistance that they allow no flow of electricity through them.

Such as rubber, asbestor, bakelite, all-non metals etc.

Resistance and its Variation with temperature

Resistance: It is defined as that property of a substance which opposes the flow of electricity (e°) through it.

It is represented by 'R' and measured in ohm (Ω) and its ckt. symbol is denoted by

V.V.I

* **Law of Resistance** or,
Factor affecting the value of resistance.

The value of the resistance depends upon the following factors:

a) The resistance of the conductor varies directly for its length. i.e. as length increases the resistance also increases.

i.e. $R \propto l$

+ve Temp. coefficient of resistance : Conductor

-ve " " " : Insulator

b) Resistance of the conductor varies inversely for its cross-section area. i.e. as c.s-area of the conductor increases then resistance decreases

i.e. $R \propto \frac{1}{A}$

c) Resistance of the conductor depends on the nature of material (ρ) directly.

i.e $R \propto \rho$

d) Resistance also depends upon the temperature of the conductor negatively, that factors we can write

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

or, $R = \rho \frac{l}{A}$ or, $\rho = \frac{RA}{l}$ $\left[\because A = \frac{\pi d^2}{4}\right]$

Where,

l = length of conductor in m

A = Area of conductor in m^2

ρ = Constant for material. It's value depends on the nature of material of the conductor in Ω-m called its specific resistance or, resistivity.

(#) The increase in temperature ~~decrease~~ increases resistance of conductor (Pure metal) and decrease in temperature decreases resistance of conductor.

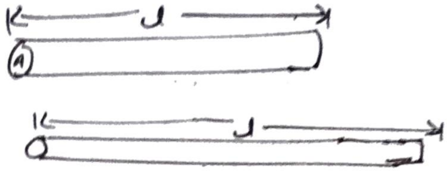
& opposite for insulator.

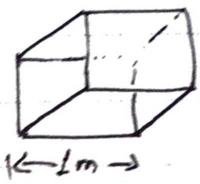
* Specific resistance or, resistivity (ρ):

It is defined as the resistance of the pieces of unit length & unit cross-section.

i.e. it is a resistance between the opposite faces of unit ~~of~~ cube of material.

It is measured in Ω-m.





where,

$l = 1\,m$

$A = 1\,m^2$

$\therefore R = \rho \frac{l}{A} = \rho \frac{1}{1}$

$\therefore \boxed{R = \rho}$

α = the change in resistance per ohm per degree rise ~~of ter~~ at some specified temperature usually 0°c.

* Variation of resistance with temperature /

or Temperature coefficient of resistance (α)

It is defined as the increase in resistance per ohm of original resistance for a rise in temperature of 1°c from 0°c & vice versa.

i.e.

$$\alpha = \frac{\text{Increase in resistance for } 1°c \text{ rise in temperature}}{\text{Original resistance at } 0°c}$$

Consider a piece of copper of resistance $R_0\ \Omega$ at 0°c. After heating let R_t be the resistance at t°c & t be the rise in temperature

In order to estimate the resistance of a conductor at one temperature, having known its resistance at another, the temperature coefficient of material is used.

α alpha

$\therefore$ Rise in resistance $\Delta R = R_t - R_0$

→ It directly depends upon its original initial resistance,
→ directly on the rise of temperature $(t_2 - t_1 = t)$
→ on the nature of the material of conductor.

Hence,

$$R_t - R_0 \propto R_0 \times t$$

or $$R_t - R_0 = \alpha \cdot R_0 t$$

or $$R_t = R_0 + \alpha R_0 t$$

or $$R_t = R_0 (1 + \alpha t) \quad \text{--- (1)}$$
$$= R_0 (1 + \alpha t)$$

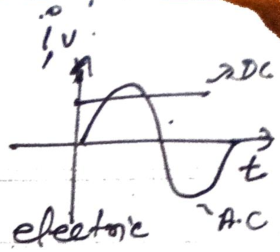
3M

Where, α be the temperature coefficient of resistance at 0°C

$$\boxed{\alpha = \frac{R_t - R_0}{R_0 t}} \qquad \boxed{R_0 = \frac{R_t}{1 + \alpha t}}$$

Note: The resistivity like resistance also increase with temperature and increase is given by $\boxed{\rho_t = \rho_0 (1 + \alpha t)}$

~~# If a conducto.~~



Direct and Alternating Current:

In alternating current (AC), the flow of electric charge periodically reverses direction, whereas in direct current (DC) the flow of electric charge is only in one direction.

9 C.

* Difference between DC and AC.

D.C	A.C
1) The value of D.C is steady Constant at any time.	1) The value of A.C changes Continuously.
2) The value of D.C is generated by chemical reaction i.e. Batteries, solar energy	2) A.C is generated by the relative motion of magnetic field & the conductor.
3) Effect of D.C on resistance, Capacitance & inductance is not different	3) Effect of AC in all these elements are different
4) DC current flow in only one direction.	4) A.C current first flows in one direction & then in opposite direction.

Electrical power and Energy

Electric power: It is the rate of doing work

i.e. $P = \frac{W}{t} = \frac{Joules}{sec} = watt$

where,

P = power in watts

W = Work done in joule

t = time in second.

$\boxed{1 \text{ kW} = 1000 \text{ Watt}}$

1 unit = 1 kWh

= $1000 \times 60 \times 60$ ...

* Power in Electric Circuit:

$P = VI$

$\because V = IR$ [According to Ohm's law]

$\therefore P = IR.I$

or, $P = I^2R$

or, $P = VI = V.\frac{V}{R} = \frac{V^2}{R}$

$\therefore \boxed{P = VI = I^2R = \frac{V^2}{R}}$

The power is also measured in h.P

$\therefore$ 1hp = 746 watt.

* Electrical Energy:

Energy is the capacity of doing work. Energy may exists in severals forms & may be changed from one form to another form.

For example: A generator changes mechanical energy into electrical energy & electrical radiator converts electrical energy to heat energy.

The m.k.s unit of energy is joule.
It is the workdone when the point of application of force of one newton is moved 1 m in the direction of force.

i.e. $W = F \times S$

or $J = 1\,N \times 1\,m$

$\therefore 1\,J = 0.7375$

Numerical Q.(1)

A coil consists of 2,000 turns of copper wire having a cross-sectional area of $0.8\,mm^2$. The mean length per turn is 80 cm and the resistivity of copper is ~~0.02~~ $0.024\,\Omega m$. Find the resistance of the coil and power absorbed by the coil when connected across 110 V d.c supply.

Solution:

Length of the coil, $l = 0.8 \times 2000$ [$\because$ 80cm = 0.8m]

$= 1600\,m$

$A = 0.8\,mm^2 = 0.8 \times 10^{-6}\,m^2$

given,
$\rho = 0.024\,\Omega m$
$A = 0.8\,mm^2$

We know, $R = \rho \frac{l}{A} = 0.02 \times \frac{1600}{0.8 \times 10^{-6}}$

$= \frac{0.02 \times 10^{-6} \times 1600}{0.8 \times 10^{-6}}$

Also on
$\rho = 0.02\,\Omega m$
Ans $R = 40000000$
$= 4 \times 10^4\,k\Omega$

$= 40\,\Omega$ //

Power absorbed $= V^2/R = 110^2/40$

$= 302.5\,W$ //

(2). A conductor of copper at $20°C$ with its resistance 8Ω is heated to $25°C$, find the resistance of conductor at $25°C$, Temp. coefficient of copper at $20°C$ is 39.3×10^{-4}.

$\Rightarrow$

given,
Resistance at $20°C$, $R_{20} = 8\Omega$, $\alpha = 39.3 \times 10^{-4}$

$R_{25} = ?$

$\therefore R_t = R_0(1 + \alpha t)$

raise in temp, $t = 25°C - 20°C$

$= 5°C$

ρ Aluminium at $20^\circ c$ $= 28 \times 10^{-8} \Omega m$ $= 0.0284 \Omega\text{-}m$

$\therefore R_{25} = R_{20}(1+\alpha t)$

or, $R_{25} = 8(1 + 39.3 \times 10^{-4} \times 5)$

$= 8(1 + 5 \times 39.3 \times 10^{-4})$

$= 8.1572 \Omega$.

③. Length of the Copper Conductor is (l) 300 m, with cross-sectional area(A) $0.6\ mm^2$. Find the resistance of Conductor if the resistivity of Copper wire is $0.017\ \mu\Omega\text{-}m$.

⇒ given,

Length (l) = 300 m

C-area $(A) = 0.6 mm^2 = 0.6 \times 10^{-6} m^2$

$\rho = 0.017\ \mu\Omega\text{-}m = 0.017 \times \frac{1}{10^6} \Omega\text{-}m$.

$= 0.017 \times 10^{-6} \Omega\text{-}m$

$= 1.7 \times 10^{-8} \Omega\text{-}m$

$R = ?$

$A = 0.6 mm^2$
$= 0.6 \times \frac{1}{1000} \times \frac{1}{1000} m^2$
$= 0.6 \times 10^{-6} m^2$

$\because R = \rho \frac{l}{A}$

$= 1.7 \times 10^{-8} \times \frac{300}{0.6 \times 10^{-6}}$

$= 1.7 \times 10^{-2} \times \frac{300}{0.6}$

$= \frac{1.7 \times 300}{100 \times 0.6}$

$= 8.5 \Omega$ Answer

Unit:2

Electric Circuit fundamentals

2.1) Electric Current and Voltage

2.2) Circuit elements: Resistor, Capacitor, Inductor

* **Resistor:** A resistor is a passive two terminal components that implements electrical resistance as a circuit element.

The current through the resistance is directly proportional to the voltage across the resistor's terminal. This relation is represented by ohm's law:

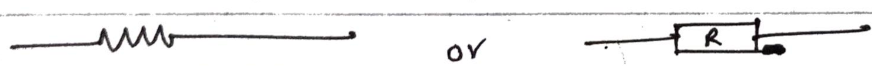
$$I = \frac{V}{R}$$

where,

I = ckt. current in Ampere

V = P.d measured across the conductor in Volt

R = Resistance of the conductor in ohm.



Symbol of resistor.

* **Inductor:**

An inductor is also called a coil or, reactor is a passive two terminal electrical component which resists changes in electric current.

passing through it.

Symbol of Inductor / coil.

It consists of a Conductor such as wire, usually wounded into a coil. When a current flow through it, energy is stored in a magnetic field in the coil. When the current flowing through an inductor changes, the time varying magnetic field induces a voltage in the conductor according to Faraday's law of electromagnetic induction.

* Capacitor:

A capacitor is also known as Condensor. Condensor/Capacitor is a passive two terminal Component used to store energy electrostatically in a electric field. There are various forms of Capacitor but all Contains at least two electrical Conductor Seperated by a dielectric.

Symbol of Capacitor.

2.3) Voltage and Current Source

Voltage Source : Any device that produce voltage output (O/P) Continuously is known as Voltage Sources. Example: Cells and d.c generators

Current Source : Any device that produce current o/p continuously is known as Current Sources.

Resistance in Series:

when some Conductor having resistances R_1, R_2, R_3 etc are joined end to end as shown in fig: ① they are said to be Connected in Series

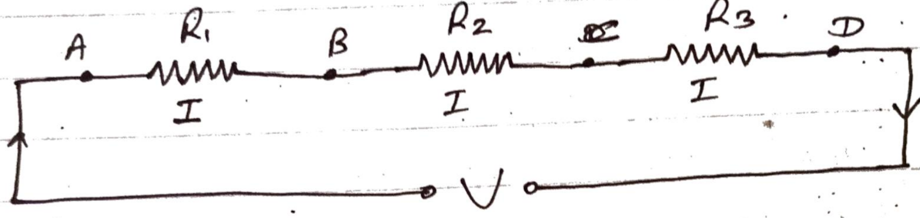
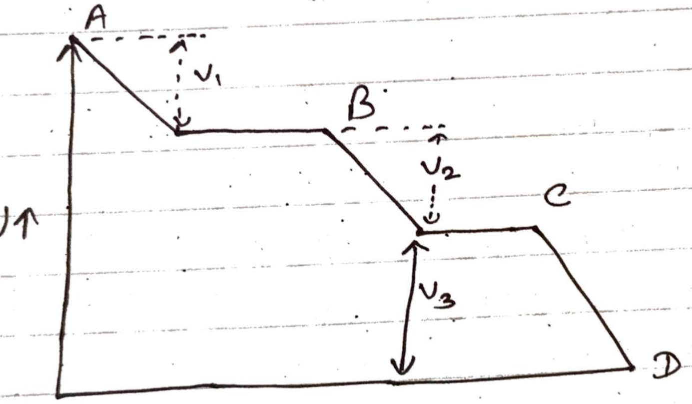


Fig: 1



It can be proved that the equivalent resistance or, total resistance (R_T or R_{eq}) between points A and D is equal to the sum of the three individual resistance.

In series connection of resistance, it should be noted that:

1) Current is same through all the resistance
i.e. $I = I_1 = I_2 = I_3 = I_n$

2) Voltage drop across each resistance is different
or, voltage is different in all resistance.
i.e. drop in $R_1 = V_1$
" " $R_2 = V_2$
$R_3 = V_3$

3) Sum of the voltage drop is equal to the applied voltage across the resistances.
i.e. $V = V_1 + V_2 + V_3$

Applying Ohm's law

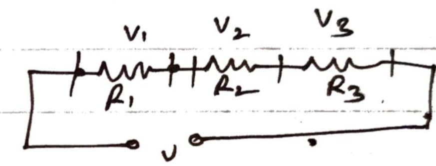
$$V = IR$$

or, $IR = I_1R_1 + I_2R_2 + I_3R_3$ $[\because V = V_1 + V_2 + V_3]$
or, $IR = IR_1 + IR_2 + IR_3$ $[\because I_1 = I_2 = I_3 = I]$
or, $IR = I(R_1 + R_2 + R_3)$
$\therefore \boxed{R = R_1 + R_2 + R_3}$
or, $\boxed{\Sigma R = R_1 + R_2 + R_3}$

where, R = equivalent or, total resistance or ckt.

⊛ The main characteristics of a Series ckt. are:

1) Same current flow through all parts of the ckt.
2) Different resistor have their individual voltage drops.
3) Voltage drops are additive (added)
4) Applied voltage is equal to the sum of different voltage drops.
5) Resistance are additive (added)
6) Power are additive (added)



$$P = P_1 + P_2 + P_3$$

or $VI = V_1 I_1 + V_2 I_2 + V_3 I_3$

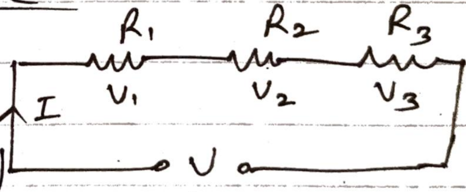
or $VI = V_1 I + V_2 I + V_3 I$

$P_1 = V_1 I_1$

$P_2 = V_2 I_2$

$P_3 = V_3 I_3$

* Voltage divider Rule



$$\text{Voltage drop} = \frac{\text{total Voltage} \times \text{Same resistor}}{\text{total resistance} (\Sigma R)}$$

i.e. $V_1 = \dfrac{V \times R_1}{R_1 + R_2 + R_3} = \dfrac{V \times R_1}{\Sigma R}$

$$V_2 = \frac{V \times R_2}{\Sigma R}$$

$\Sigma R = R_1 + R_2 + R_3$

$= R_{equivalent}$

$$V_3 = \frac{V \times R_3}{\Sigma R}$$

Resistance in Parallel

Three resistances are joined as shown in fig:1. are said to be connected in parallel. In this case,

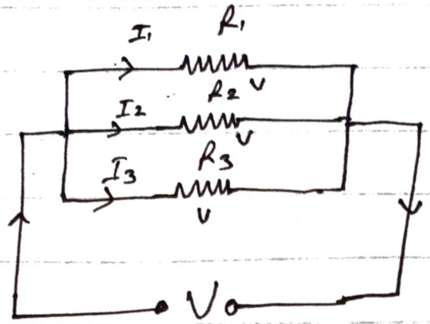


fig: 1

1) P.d (V) across all resistor is same.

2) Current in each resistor is different & is given by ohm's law.

3) Total current is the sum of the three seperate currents.

$$\therefore I = I_1 + I_2 + I_3$$

But, by ohm's law $V = IR$ or $I = \frac{V}{R}$

where,

V = total or, applied voltage

R = equivalent resistance in the parallel combination

$$\therefore \frac{V}{R} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \quad [\because I = I_1 + I_2 + I_3]$$

$$\text{or, } \frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \quad [\because V = V_1 = V_2 = V_3]$$

$$\text{or, } \frac{\cancel{V}}{R} = \cancel{V}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

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

OR

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

$$\therefore \boxed{R = \frac{R_1 R_2 R_3}{R_2 R_3 + R_1 R_3 + R_1 R_2}}$$

* <u>The main characteristics of Parallel ckt is:</u>

1. The same voltage acts across all parts of resistances.
2. Different resistance have their individual (own) current
3. Branch currents are additive (added)

   $(I = I_1 + I_2 + I_3)$
4. Powers are additive
5). Conductance are additive.

* <u>Conductance:</u>

The reciprocal of resistance (R) is called Conductance (G).

$\therefore G = \frac{1}{R}$ 'R' ohm

Unit of 'G' = 'Mho' or 'Simens'

$\boxed{\text{In Series}}$

$R = R_1 + R_2$

or, $\frac{1}{G} = \frac{1}{G_1} + \frac{1}{G_2}$

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

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

$\boxed{\text{In Parallel}}$

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

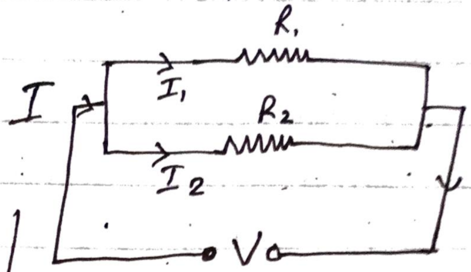
or, $G = G_1 + G_2$

Resistance in Parallel

$R_1 \parallel R_2 = \dfrac{R_1 . R_2}{R_1 + R_2}$

* Current divider rule:

$\because \boxed{V = IR}$ $\qquad R = R_1 \parallel R_2$



Here, $V = I_1 R_1$

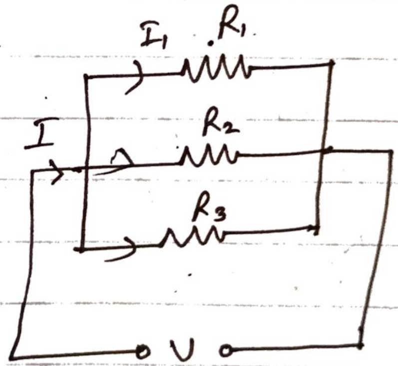
$\therefore IR = I_1 R_1$

$$\boxed{I_1 = \frac{IR}{R_1} = \frac{I}{\cancel{R_1}} \cdot \frac{\cancel{R_1} R_2}{R_1 + R_2} = \frac{I R_2}{R_1 + R_2}}$$

$\therefore$ Current divide $= \dfrac{\text{Total current} \times \text{Opposite resistance}}{\Sigma R}$

$$\therefore I_1 = \frac{I \times R_2}{R_1 + R_2}$$

$$I_2 = \frac{I \times R_1}{R_1 + R_2}$$



$$I_1 = I\left(\frac{R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}\right)$$

$$I_2 = I \frac{R_1 R_3}{(R_1 R_2 + R_2 R_3 + R_3 R_1)}$$

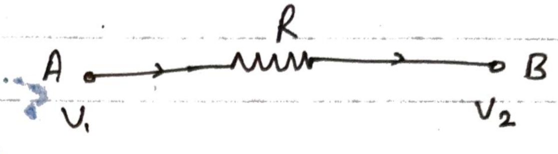
$$I_3 = \frac{I\,(R_1 R_2)}{(\qquad)}$$

V.V.I

Ohm's Law:

It states that, "the ratio of potential difference (V) between any two points of a ckt. or Conductor to the current (I) flowing between them is constant, provided the temperature remains constant".

i.e.



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

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

where, V = Voltage between two points
I = Current flowing in the conductor.
R = Resistance of the Conductor.

$\therefore$ $\boxed{V = IR}$

V.V.I

Kirchhoff's point law or, Current law (KCL):

It states that, "In any electrical network, the algebraic sum of the current meeting at a point (or, Junction) is zero"

It means simply that total leaving current from a junction is equal to the total entering current to the junction.

[i.e. incoming current = outgoing current]

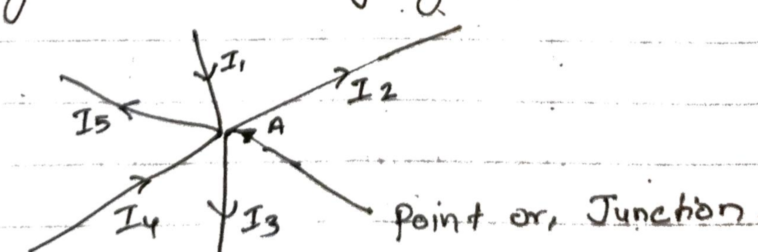


Fig: 9

Consider a few conductors meeting at a point 'A' as shown in fig: a. Some conductors have currents incoming, while some currents are outgoing. Assuming the incoming currents to be +ve and the outgoing currents to be -ve, we have

$$I_1 + (-I_2) + (-I_3) + I_4 + (-I_5) = 0 \text{ or } \Sigma I = 0$$

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

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

$\therefore$ Incoming currents = outgoing currents.

V.V.I

Kirchoff's Mesh or Voltage Law (KVL):

It states that, "the algebraic sum of products of current & resistance in each of the conductor in any closed path or (mesh) in a network plus the algebraic sum of the e.m.f.s in that path is zero".

In other words:

$$\Sigma IR + \Sigma \text{e.m.f} = 0$$

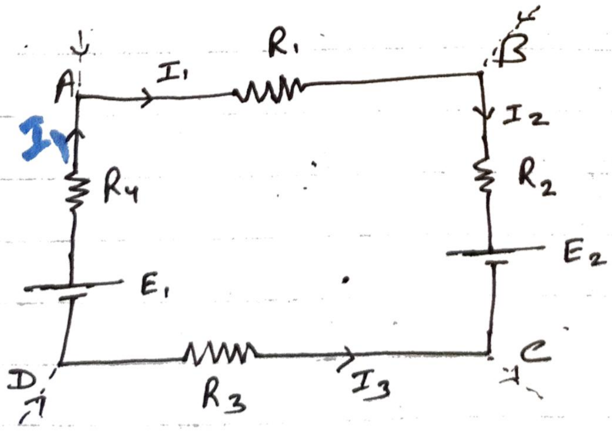


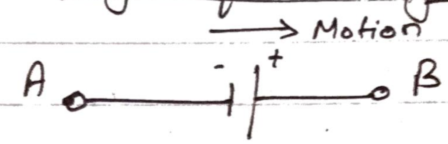
Fig: B

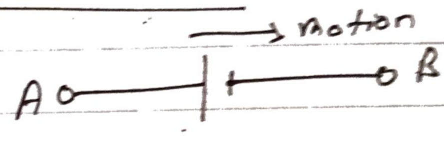
Consider the closed path ABCDA as shown in fig.b
~~as~~ using KVL, we get

$$-I_1 R_1 - I_2 R_2 + I_3 R_3 - I_4 R_4 - E_2 + E_1 = 0$$

or, $$I_1 R_1 + I_2 R_2 - I_3 R_3 + I_4 R_4 = E_1 - E_2 \quad //.$$

a) Sign of Battery, e.m.f (EMF)

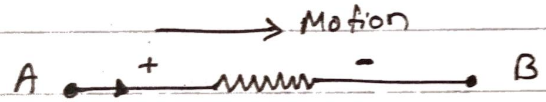


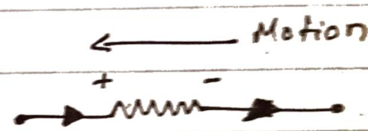


rise in Voltage (+E)

Fall in Voltage (-E)

b) Sign of IR drop



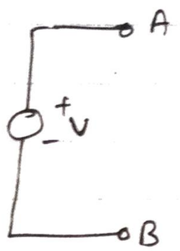


Fall in Voltage
$V = (-IR)$

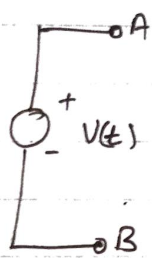
rise in Voltage
$V = (+IR)$

Independent Source

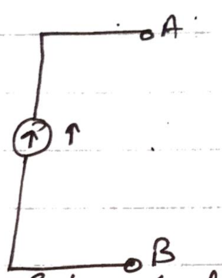
Those voltage or current sources, which do not depend on any other quantity in the ckt. are called independent source.



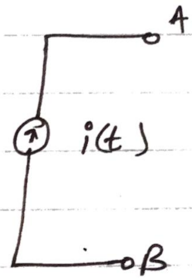
Independent D.C voltage Source



Time Varying Independent Voltage Source



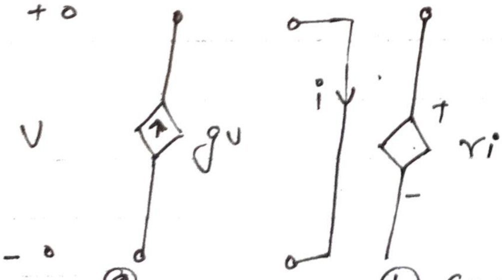
Independent Current Source



Time Varying Current Source.

Dependent Source:

A dependent voltage source or current source is one which depends on some quantity (current/voltage) in the circuit, which may be either voltage or current. Such a source is represented by a diamond shaped symbol as shown in figure below:



ⓐ Voltage dependent Current Source

ⓑ Current dependent Voltage Source

Nemerical: chapter 7

1) If 10 metres of manganin-wire, 0.13cm in diameter has a resistance of 3.4 ohms, Find the specific resistance of the material.

Solⁿ:

diameter of wire $(d) = 0.13 cm$

Length of wire, $l = 10$ metre $= 1000$ cm

area of wire, $a = \frac{\pi}{4} d^2 = \frac{\pi}{4}(0.13)^2 = 0.01327\ cm^2$

$\boxed{1.327 \times 10^{-6} m^2}$

Resistance of wire, $R = 3.4\,\Omega$

Resistivity of wire, $\rho = ?$

We know, $R = \rho \frac{l}{a}$

or, $\rho = \frac{Ra}{l} = \frac{3.4 \times 0.01327}{1000}$

$= 4.51 \times 10^{-5}\ \Omega\ cm$

$\boxed{4.51 \times 10^{-7}\ \Omega m}$

Tutorial:

2) Calculate the resistance of 915 metres length of wire having a uniform cross-sectional area of $0.77\ cm^2$ if the wire is made of copper having a resistivity of $1.7 \times 10^{-6}\ \Omega cm$.

Solⁿ:

length $(l) = 915$ m $= 915 \times 100$ cm

area of cross-section $(a) = 0.77\ cm^2$

resistivity of wire $(\rho) = 1.7 \times 10^{-6}\ \Omega cm$

$R = ?$

$R = \rho \frac{l}{a} = 1.7 \times 10^{-6} \times \frac{91500}{0.77} = 0.2020\ \Omega$

note:

If a conductor has a resistance R_0, R_1 and R_2 at 0°c, t_1°c and t_2°c respectively, then

$$R_1 = R_0(1+\alpha_0 t_1) \quad \& \quad R_2 = R_0(1+\alpha_0 t_2)$$

$$\therefore \frac{R_2}{R_1} = \frac{1+\alpha_0 t_2}{1+\alpha_0 t_1}$$

$$\left[\begin{array}{l} \alpha_0 = \dfrac{R_t - R_0}{R_0 t} \\ R_0 = \dfrac{R_t}{1+\alpha_0 t} \\ R_t = R_0(1+\alpha_0 t) \end{array}\right]$$

(2067) (new course)

③. The shunt winding of a motor has a resistance of 35.1Ω at 20°c. Find the resistance at 32.6°c. The temperature coefficient of copper is 0.00427/°c at 0°c

Soln:

Given,

$\alpha_0 = 0.00427/°c$

Resistance at 20°c, $R_{20} = 35.1\Omega$

finding resistance at 0°c,

$$R_0 = \frac{R_t}{1+\alpha t} \qquad \left[\alpha = \frac{R_t - R_0}{R_0 t}\right]$$

$$\therefore R_0 = \frac{R_{20}}{1+\alpha \cdot 20}$$

$$= \frac{35.1}{1+0.00427\times 20}$$

$$= \frac{35.1}{1+0.0854} = 32.33\Omega$$

Now,

$$R_{32.6°c} = R_0(1+\alpha_0 \times t)$$

$$= \cancel{R_0 t} \; 32.33(1+0.00427\times 32.6)$$

$$= 36.83\Omega$$

w

(4) The resistance of a Copper coil at 30°c is $0.18\,\Omega$. What is the resistance at 91.6°c ? for Copper, $\alpha_0 = 0.00427$

$\Rightarrow$

Given,

$\alpha_0 = 0.00427/°C$ at 0°c

$R_{30} = 0.18\,\Omega$

$R_{91.6} = ?$

Now, finding resistance at 0°c

$$R_0 = \frac{R_t}{1+\alpha_0 t} = \frac{R_{30}}{1+\alpha_0 \cdot 30} = \frac{0.18\,\Omega}{1+0.00427\times 30}$$

$$= \frac{0.18}{1.1281}$$

$$= 0.159\,\Omega$$

Therefore, $\because R_t = R_0(1+\alpha_0 t)$

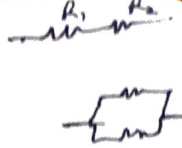
$$R_{91.6} = 0.159(1+0.00427\times 91.6)$$

$$= 0.222\,\Omega$$ Answer

direct. $0.227\,\Omega$

$0.221\,\Omega$

$R = R_1 + R_2$ $V_1 = \frac{V \times R_1}{R_{tot}}$



$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ $I_1 = \frac{I \times R_2}{R_{tot}}$

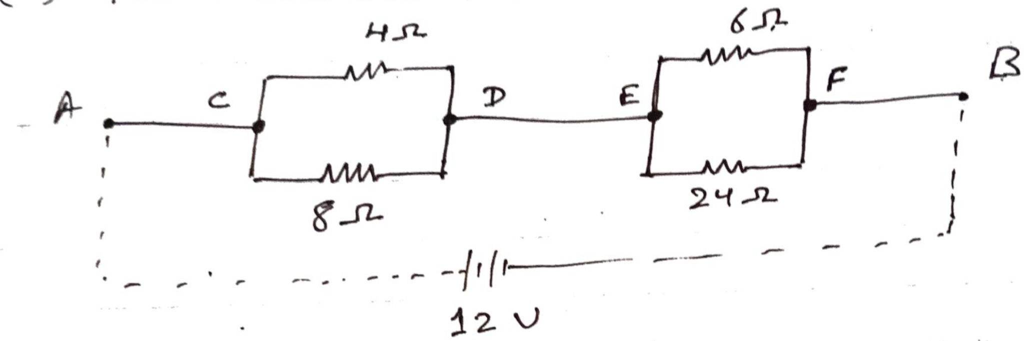
$R = \frac{R_1 \cdot R_2}{R_1 + R_2}$

$V = IR$

Chapter-2 (Numerical)

1)

A battery having an e.m.f of 12V is conneted across terminal AB of the circuit.
F (i) Current flowing in each resistance and
(ii) total power absorbed by the ckt.
(iii) Power absorbed in 24Ω resistor.



Sol^n:

Resistance between C and D is calculated as $\frac{1}{R_{CD}} = \frac{1}{4} + \frac{1}{8} = \frac{3}{8}\ \Omega \approx 0.378$

$\therefore R_{CD} = \frac{8}{3} = 2.67\ \Omega$

And $R_{EF} = \frac{24 \times 6}{24 + 6} = \frac{144}{30} = 4.8\ \Omega$

$\therefore$ Resistance between A and B is $R_{CD} + R_{EF}$

$R_{AB} = R_{CD} + R_{EF}$

$= 2.67 + 4.8 = 7.47\ \Omega$

Total circuit current, $I = \frac{V}{R_{AB}} = \frac{12}{7.47} = 1.606A$

Voltage between C & D, $V_{CD} = I \times R_{CD}$

$\therefore V_{CD} = 1.606 \times 2.67$

$= 4.289\ V$

Voltage between E & F, $V_{EF} = I \times R_{EF}$

$\therefore V_{EF} = 1.606 \times 4.8$

$= 7.708\ V$

(i) Current through 4Ω resistor,

$\because V = IR$, $I = \frac{V_{CD}}{R}$ $\boxed{V = V_{CD} = 4.289V}$

$I_{4\Omega} = \frac{4.289}{4} = 1.072\ A$

$I_{8\Omega} = \frac{4.289}{8} = 0.5361\ A$

$I_{6\Omega} = \frac{V_{EF}}{6} = \frac{7.708}{6} = 1.284\ A$

$I_{24\Omega} = \frac{V_{EF}}{24} = \frac{7.708}{24} = 0.3211\ A$

(ii) Power absorbed by circuit (P) = $I^2R = (1.606)^2 \times 7.47$

$= 19.27$ Watts

or, $P = VI$

$= 12 \times 1.606$

$\boxed{= 19.27 \text{ watts.}}$

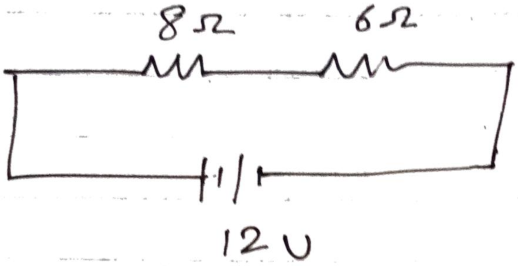
(iii) Power absorbed by 24Ω resistor,

$P_{24\Omega} = (0.3211)^2 \times 24 = \boxed{2.47 \text{ Watts}}$

or, $P_{24\Omega} = V_{EF} \times I_{24\Omega} = 7.708 \times 0.3211$

$= \boxed{2.47 \text{ watts}}$

② Find (i) Circuit current and (ii) Voltage drop on Resistors 8Ω and 6Ω, across 12 V emf.



Sol^n:

$R_{equivalent} = 8 + 6 = 14\,\Omega$

$V = 12\text{ V}$

(i) Total current through circuit :

$$I = \frac{V}{R_{eq.}} = \frac{12}{14} = 0.857\text{ A}$$

(ii) Voltage across 8Ω resistor.

$V_8 = I \times 8$
$= 0.857 \times 8$
$= 6.856\text{ V}$

or, $V_8 = \frac{V \times 8}{R_{eq}}$
$= \frac{12 \times 8}{14}$
$= 6.85\text{ V}$

Voltage across 6Ω resistor

$V_6 = I \times 6$
$= 0.857 \times 6$
$= 5.142\text{ V}$

or, $V_6 = \frac{V \times 6}{R_{eq}}$
$= \frac{12 \times 6}{14}$
$= 5.14\text{ V}$.

(iii) Power absorbed

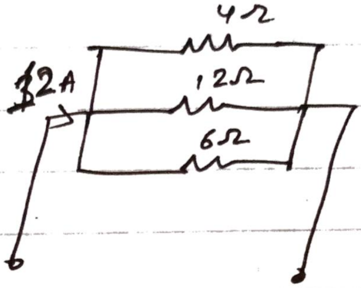
$P = VI = 12 \times 0.857$
$= 10.28$ Watts

or $I^2R = 10.28$ watts

③. Three resistors $4\Omega, 12\Omega, 6\Omega$ are connected in parallel. If the total current taken is 12A, find the current through each resistor.

Sol:

Total equivalent resistance.



$$\frac{1}{R_T} = \frac{1}{4} + \frac{1}{12} + \frac{1}{6} = \frac{6}{12}$$

$$R_t = \frac{12}{6} = 2\Omega$$

(P.) Voltage across the circuit $= I R_T$

$= 12 \times 2$

$= 24V$

Current through $4\Omega = \frac{24}{4}$ $\quad [\because I = \frac{V}{R}$

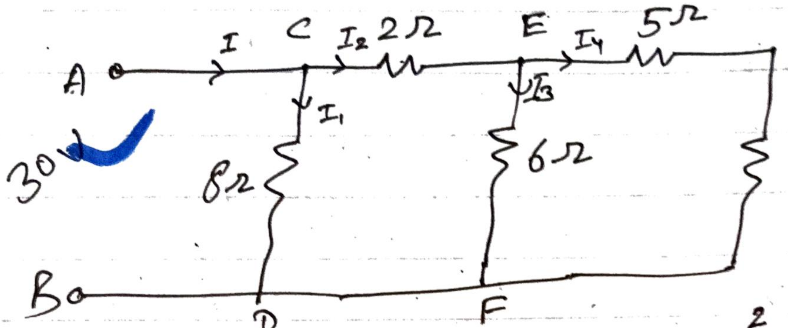
$= 6A$

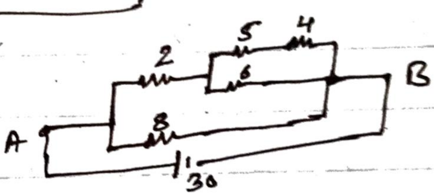
" " $12\Omega = \frac{24}{12} = 2A$

$6\Omega = \frac{24}{6} = 4A$.

2068

4) A battery of 30 V is applied across terminal AB of the circuit in figure. The current in 5 Ω resistor will be what?





Sol^n:

Resistance between E and F,

$$R_{EF} = \frac{(5+4) \times 6}{(5+4)+6} = \frac{54}{15} = 3.6\ \Omega$$

Total Resistance between C and D, i.e. bet^n A & B

$$\text{total Resist}^n\ R_{AB} = R_{CD} = \frac{(2+3.6) \times 8}{(2+3.6)+8} = \frac{44.8}{13.6} = 3.29\ \Omega$$

Now,

(i) Total Circuit current $(I) = \frac{V}{R_{AB}} = \frac{30}{3.29}$
Current from battery,

$$= 9.107\ A.$$

(ii) Current through 8 Ω resistor,

$$I_1 = \frac{V}{R} = \frac{30}{8} = 3.75\ A$$

(iii) Current through 2 Ω resistor,

$$I_2 = I - I_1 = 9.107 - 3.75 = 5.357\ A$$

Potent P.D across EF $= 30-(5.357 \times 2)$

$V_{EF} = 19.286\ V$

(iv) Current through $6\,\Omega$ resistor $= \dfrac{V_{EF}}{R}$

$= \dfrac{19.286}{6}$

$I_3 = 3.214\ A$

(v) $\therefore$ current through $5\,\Omega$ resistor is

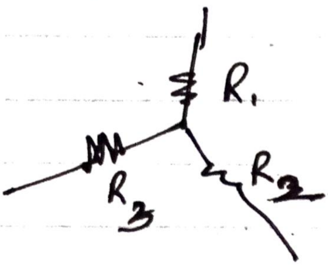
$I_4 = I_2 - I_3 \qquad [\because I_2 = I_4 + I_3]$

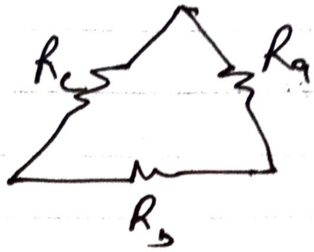
$= 5.357 - 3.214$

$= 2.142\ A$

Equivalent Resistance

Star to Delta.



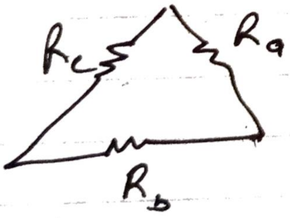


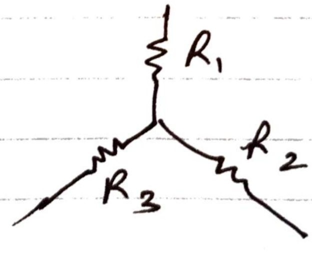
$$R_a = \frac{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}{R_3}$$

$$R_b = \frac{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}{R_1}$$

$$R_c = \frac{''}{R_2}$$

Delta to Star





$$R_1 = \frac{R_a \cdot R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_a \cdot R_b}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_b \cdot R_c}{R_a + R_b + R_c}$$