Basic concepts of Current Electricity

Electricity :-

It is a fundamental form of energy resulting from the presence & motion of electric charges, typically electrons, which creates an electric current. It is a form of energy that can be stored, transmitted through conductors like copper wires and converted into other form of energy, such as heat, light and motion.

Modern Electron Theory:-

In the past, to define electricity, several theories about electricity were developed through experiments & by observing its behaviour. However, the only theory, that has survived is

Modern Electron Theory of Matter.

Important Notes

This theory says that every matter (wheather solid, liquid or gas) consists of very small divisible particles called Molecules.

A molecule is further made up of very minute particles called **Atoms**.

Atom has two main parts:-

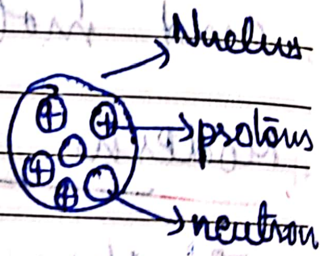
→ Nucleus

→ Extra Nucleus.

→ **Nucleus**: The central part of an atom which contains protons and neutrons is called nucleus.

Proton has positive charge

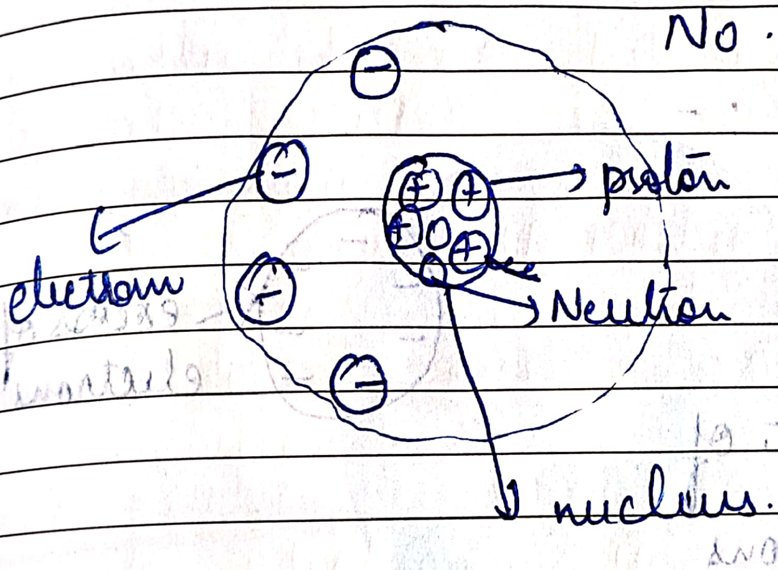
Neutron has no charge.



The mass of proton is equal to the mass of neutron & this total mass constitutes the entire mass of an atom.

→ **Extra Nucleus**:- The outer part which contains only electrons is called extra-nucleus. An e^- has negative charge (1.602×10^{-19} columbs) equal to that of a proton. The mass of e^- is nearly 1/840 times that of a proton & is usually neglected. Thus, the entire mass of an atom is constituted by the nucleus of an atom.

Atomic weight = No. of proton + No. of neutrons.



Nature of Electricity :-

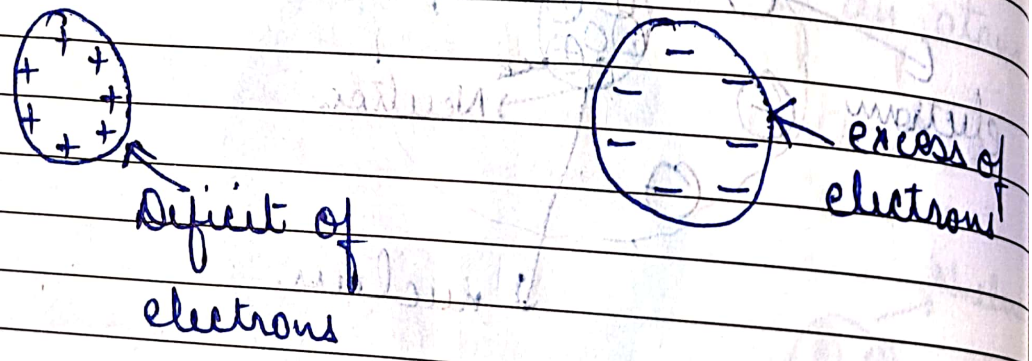
(1) A body is neutral as it has same number of protons as that of electrons.

(2) If some of the electrons are "removed from the body, there occurs a deficit

of electrons and the body attains a +ve charge.

(3) If some of the electrons are supplied to the body, there occurs excess of electrons and the body attains a –ve charge.

Charged Body :-



Thus a body is said to be charged positively or negatively if it has deficit or excess of electrons from its normal due to sharing respectively.

Important Notes

UNIT OF CHARGE :-

The charge of an e^- is very small & it is not convenient to take it as the unit of charge.

Therefore, "Coloumb" is used as unit of charge.

Hence,

1 Coloumb = charge ~~of~~ on $628 \times 10^{16} e^-$.

If a body is said to have a $-$ve charge of one coloumb, it means that the body has an excess of 628×10^{16} electrons from its normal due share.

Free electrons :- The valence e^- which are very loosely attached to the nucleus of an atom & can be easily detached are called **free electrons**.

FIELDS OF CHARGES :-

Important Notes

1) **Electric Field** :- It is force field created by electric charges, influencing other charges with a force that depends on the charge & the distance from the source.

M	T	W	T	F	S
3	4	5	6	7	1
10	11	12	13	14	8
17	18	19	20	21	15
24	25	26	27	28	22

Electric field :-

Source :- stationary or moving electric charges.

Effect :- Exerts a force on other electric charges.

Field lines :- Originate from positive charges and terminate on negative charges, forming open-ended lines.

Unit :- Volts per meter

Nature :- Can be attractive or repulsive.

2) Magnetic field :-

A magnetic field is created by moving charges (like electric current) or magnets, exerting a force on other moving charges or magnetic objects.

Source :- Moving electric charges & magnetic sources.

Effect :- Exerts a force on moving charges and other magnetic objects.

Field lines :- Emerge from the north pole & enter the south pole, forming closed loops, as there are no magnetic monopoles.

Unit :- Tesla (T)

Nature :- Can be attractive or repulsive.

The key difference between two fields are **source** (electric charges for electric field and moving charges for magnetic field), **nature** of the field lines (open-ended for electric field & closed loops for magnetic).

25 FEBRUARY TUESDAY

FEBRUARY 2014

M	T	W	T	F	S
					1
3	4	5	6	7	8
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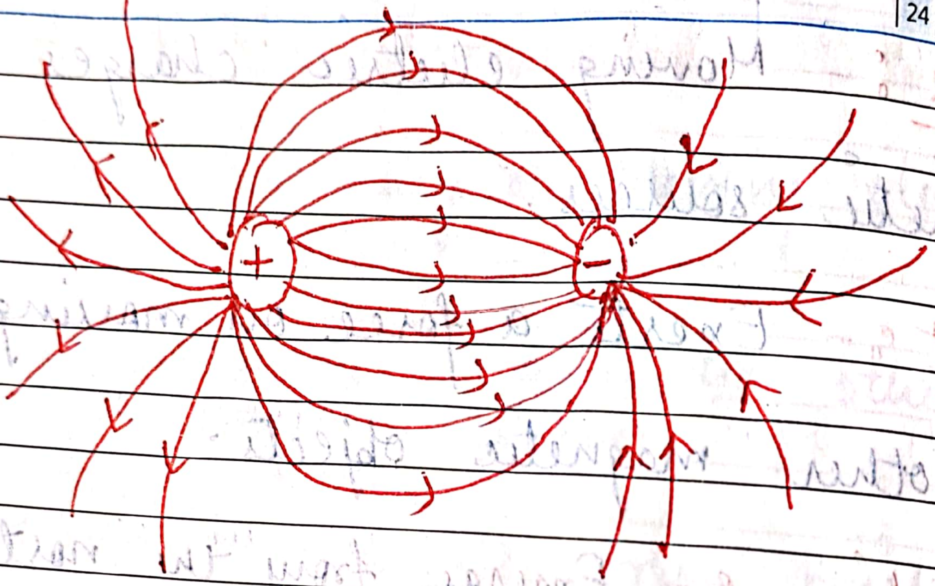
17	18	19	20	21	22
24	25	26	27	28	



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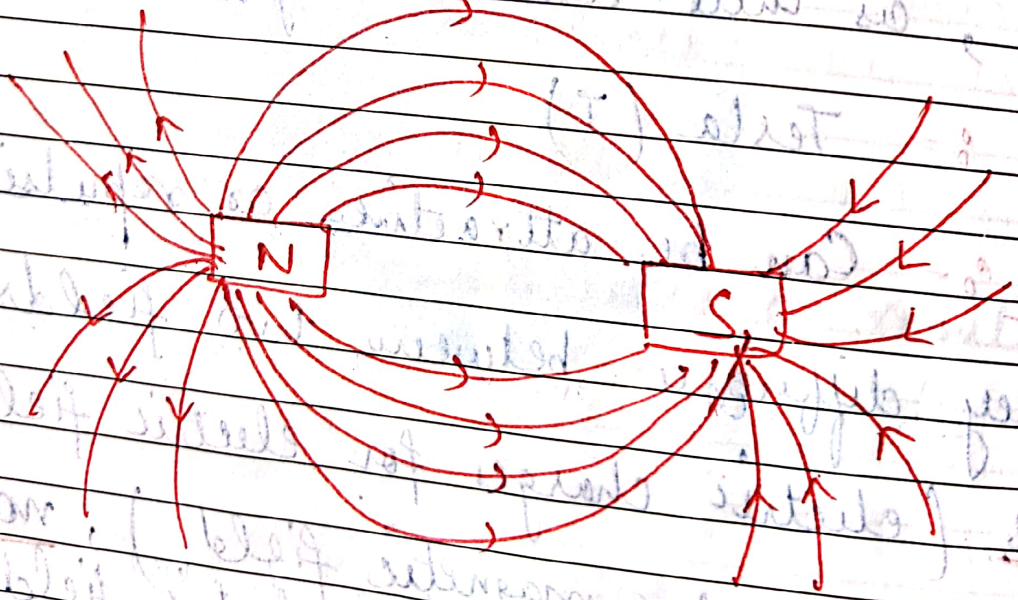
Electric fields

1

2



3

4

5

6

Magnetic field

Important Notes

(9)

electric Potential :-

When a body is charged, either electrons are supplied to it or they are removed from it. In, both the cases work is done. This work done is stored in the form of electric potential.

The capacity of a charged body to do work is called ELECTRIC POTENTIAL.

The measure of electric potential is the work done ~~to~~ to charge a body to one coloumb i.e.

$$\text{electric potential} = \frac{\text{work done}}{\text{charge}}$$

Important Notes

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

If W = 1 joules ; Q = 1 coloumb

$$\boxed{V = \frac{1}{1} = 1 \text{ volt}}$$

Hence, a body is said to have an electric potential of 1 volt if one joule of work is done to charge the body to one coloumb.

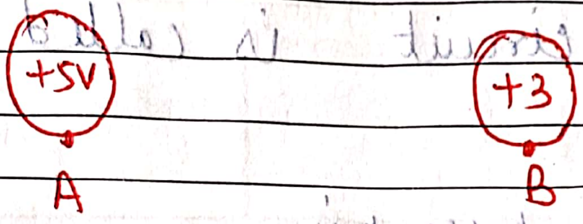
Potential Difference :-

When a body is charged to a different electric potential as compared to the other charged body, the two bodies are said to have a potential difference.

Thus, the difference in the electric potential of the two charged bodies is called potential difference.

Important Notes

Unit :- Volt.

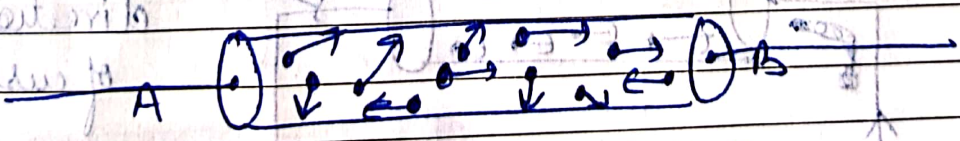


Potential difference = +5v — +3v

Difference between two potential (A & B) = +2v

CURRENT :-

In metals, a large number of free electrons are available which move from one atom to the other at random.



When a electric potential difference is applied across the conductor, the loosely attached free e^- starts moving towards the +ve terminal of the battery.

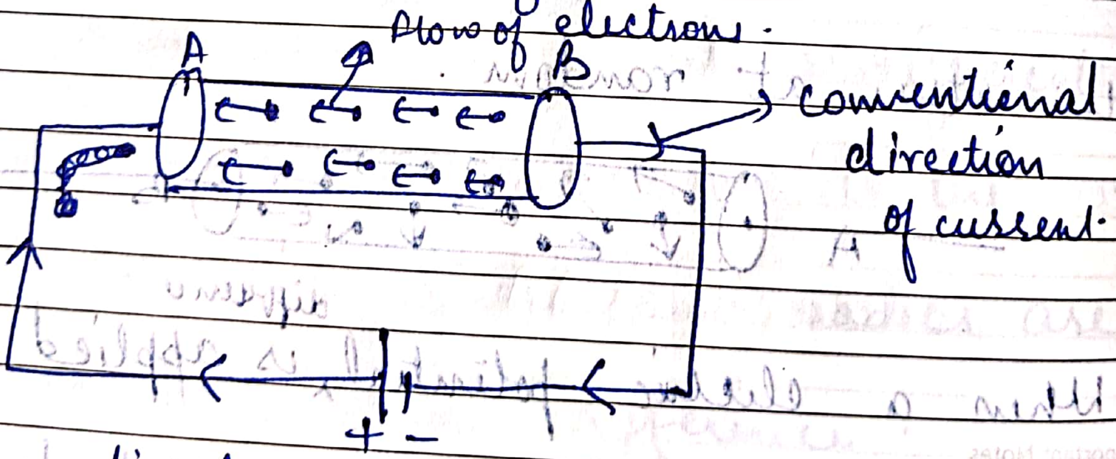
Important Notes

Thus, a continuous flow of electrons in an electric circuit is called electric current.

In other words, current is the flow of electrically charged particles, usually electrons, through a conductor. This flow is driven by a voltage.

Unit :- Amperes (A)

Conventional direction of Current :-



Mathematically, $\boxed{I = \frac{Q}{t}}$.

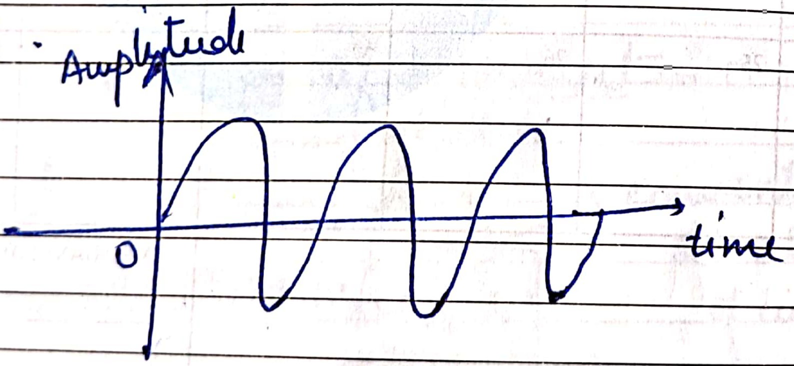
If Q = 1 coloumb
t = 1 sec
then, $\boxed{I = 1A}$

Or $$\boxed{I = \frac{dQ}{dt}}$$

AC current :-

The flow of electric charge in a periodically reverse direction is called alternating current (AC). It is also referred as (AC current).

The type of alternating current may be sinusoidal.

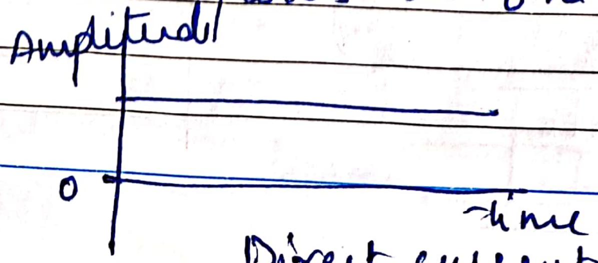


AC.

Important Notes

DC current :-

Direct current flows in one direction.



Direct current (DC)

Resistance :-

9 Resistance is the oppose to the flow of
10 current (electrons).

11 or

12 The opposition offered to the flow of
current is called resistance.

1 **Unit :-** It is denoted by Ω or $K\Omega$.

2 A wire is said to have a resistance of one
3 ohm, if one ampere of current passing
4 through it produces a heat of 0.24 calories
5

6 **Resistivity :-** (Law of Resistance)

(1) It is directly proportional to its length.
i.e $R \propto l$.

Important Notes

(2) It is inversely proportional to its area of cross-section.
i.e $R \propto \frac{1}{a}$

(15)

(3) It depends upon the nature of the material of which the wire is made of.

(4) It also depends upon the temperature of the wire.

Therefore $\boxed{R \propto \frac{l}{a}}$

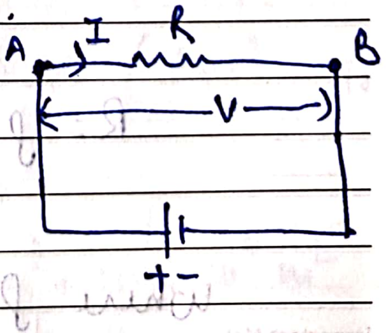
or $\boxed{R = \rho \frac{l}{a}}$

where ρ is a constant of proportionality called Resistivity.

OHM's LAW :-

Whenever a potential difference (V) is applied across a conductor (or circuit) some current (I) flows through it. The flow of current is opposed by the resistance (R) of the conductor. A relationship exists between the three quantities i.e applied voltage, current and resistance. This relationship was expressed first by "George Simon ohm". a German scientist & it is called "OHM's LAW".

Ohm's law states that the current flowing between any two points of conductor is directly proportional to the potential difference across them provided physical conditions i.e temperature etc do not change.



Mathematically

$$I \propto V$$

Important Notes

or $\frac{V}{I}$ = constant

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

or $\boxed{V = IR}$; $\boxed{I = \frac{V}{R}}$

Numericals

Q what should be the cross-sectional area of conductor of 1km length to transmit 200 A, so that the total voltage drop in the conductor may not exceed 12V. The resistivity of conductor material is $3 \mu\Omega/cm^3$.

Solution:- Acc. to ohm's law:

$$\text{Resistance}, R = \frac{V}{I} = \frac{12}{200} = 0.06\Omega$$

$$R = \rho\frac{l}{a} \quad \text{or} \quad a = \rho\frac{l}{R}$$

Important Notes

where $\rho = 3\times10^{-6}\,\Omega\,cm = 3\times10^{-8}\,\Omega\,m$

$l = 1\,km = 1000m$

$$a = \frac{3\times10^{-8}\times1000}{0.06} = 5\times10^{-4}\,m^2$$

$$= 5\,cm^2 \text{ (Ans)}$$

Q A piece of 10cm^3 of copper having specific resistance of 1.7×10^{-6} Ω cm is

(1) drawn into wire of 200m length.

(2) rolled into a square plate of 10cm side.

Determine the resistance of the wire & resistance between the opposite faces of the plates.

Solution:- $R = \rho \frac{l}{a}$ where $\rho = 1.7\times10^{-6}\times10^{-2}$ (Ωm)

(1) Since, volume = 10 cm^3 = 10×10^{-6} m^3

Area $a = \frac{\text{Volume}}{\text{length}} = \frac{10\times10^{-6}}{200} = 5\times10^{-8}$ m^2

$\therefore R = \frac{1.7\times10^{-8}\times200}{5\times10^{-8}} = 68$ Ω (Ans)

(2) Area of plate = $10\times10 = 100$ cm^2 = 100×10^{-4} m^2

Important Notes

length or thickness of plate = $\frac{\text{Volume}}{\text{Area}} = \frac{10\times10^{-6}}{100\times10^{-4}}$

$= 10\times10^{-4}$ m

$$R = \frac{1.7\times10^{-8} \times 10\times10^{-4}}{100\times10^{-4}} = 0.17\times10^{-8}$$

$$= 0.0017\,\mu\Omega$$

Energy :-

The total amount of work done in an electrical circuit is called electrical energy.

Or.

A work is said to be done by the moving stream of electrons or charge is called Electrical energy.

So,

$$V = \frac{\text{work done}}{Q}$$

Therefore work done or electrical energy is

$$W = VQ = VIt \quad \left(\text{since } I = \frac{Q}{t}\right)$$

$$\boxed{W = I^2Rt}$$ In terms of current

Or $\boxed{W = \frac{V^2}{R} t}$ in terms of voltage.

Unit :- Joule.

If 1 volt, I = 1 ampere and t = 1 sec

Then electrical energy = 1 joule.

Electrical Power :-

The rate at which work is being done in an electrical circuit is called electrical Power.

$$\text{Electrical Power} = \frac{\text{Work done in an electrical circuit}}{\text{time}}$$

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

Important Notes

Unit :- Watt.

If V = 1 volts & I = 1 ampere then,

P = 1 watt.

Mechanical Power :-

The rate of doing work or the amount of work done per unit time is called power.

$$\text{i.e. Power} = \frac{\text{Work done}}{\text{Time}}$$

Unit :- Newton meters per second or joule/sec.

Important Notes

$= \frac{Nm}{s}$ or (J/s)

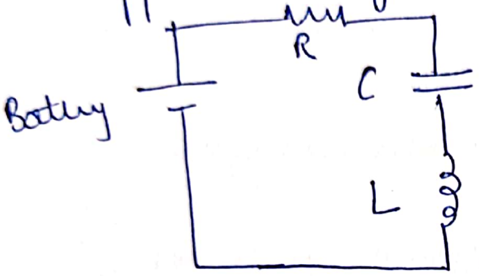
* Heat ~~energy~~ :-

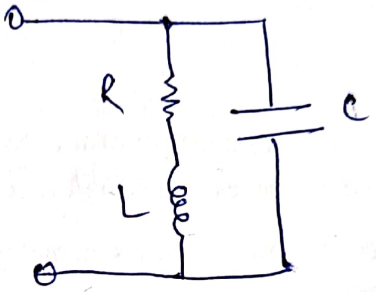
~~The form of energy~~

Electrical circuits elements (R, L & C).

In electrical circuits R, L & C represents resistor, inductors & capacitors. resp.

- Resistor opposes current flow (measured in (Ω) convert electrical energy into heat)
- Inductor store energy in a magnetic field (measured in henry(H)) opposes changes in current flow
- Capacitors store energy in an electric field, opposes changes in voltage (measured in faraday(F))





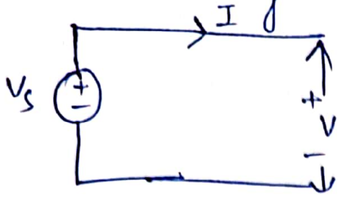
Voltage & current source :-

Voltage source — e.g. (batteries)

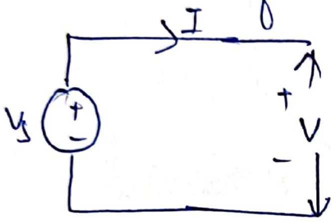
A voltage source is a device which provides a Constt voltage to load at any instance of time & is independent of the current drawn from it. This type of source is known as ideal voltage source. It is denoted by.

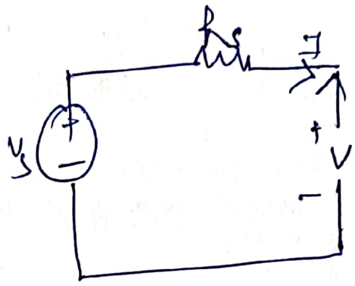
voltage source symbol

Ideal voltage source. Not possible.



practical voltage source have some amount of internal resistance are known as practical voltage source. A practical voltage source is thus denoted by a resistance in series which represents the internal resistance of source.

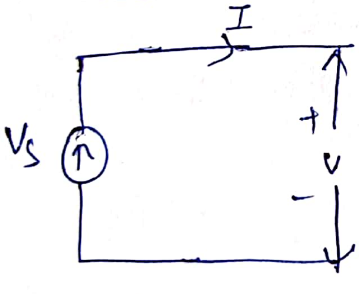




Current source :- e;g) (solar cells, transistors)

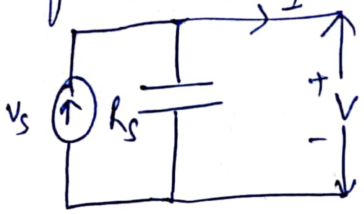
Ideal current source.

A current source is a device which provides the constant current to load at any time & is independent of the voltage supplied to the circuit.



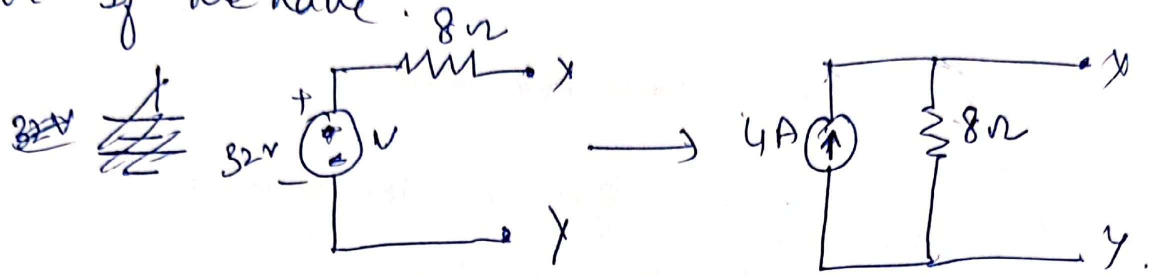
Practical ~~so~~ current source :-

A practical current source is represented as an Ideal current source connected with resistance in parallel.



Source Conversion:-

for If we have.



By using ohm's law.

$V = IR$

$\frac{32}{8} = I = 4A.$

✱ A technique used in circuit analysis to simplify complex circuits by converting a voltage source in series with a resistor into an equivalent current source in parallel with the same resistor & vice-versa.

→ This conversion helps in simplifying circuit analysis

Voltage source to current source:-

A voltage source (V) in series with a resistor (R) can be transformed into a current source (I) in parallel with same resistor where $I = \frac{V}{R}$

Current source to voltage source:-

A current source (I) in parallel with a resistor (R) can be transformed into a voltage source (V) in series with same resistor where $V = I^{*} R$

DC circuits:-

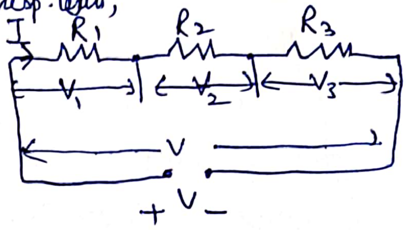
Series & parallel circuits:-

Series Circuits:-

The circuit in which no. of resistors are connected end to end so that same current flows through them is called series circuit.

In the circuit, three resistors R_1, R_2, R_3 are connected in series across a supply voltage V volts. The same current (I) is flowing through all 3 resistors. If V_1, V_2 & V_3 are the voltage drops across the 3 resistors R_1, R_2 & R_3 resp. then,

$$V = V_1 + V_2 + V_3 = IR_1 + IR_2 + IR_3$$ (As per Ohm's law)



Let R be the total resistance of the circuit, then

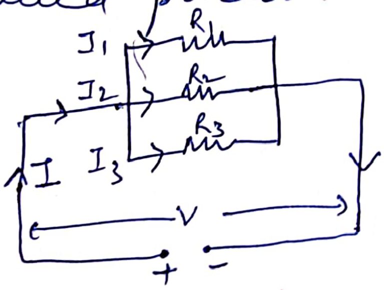
$$IR = IR_1 + IR_2 + IR_3 \text{ or } R = R_1 + R_2 + R_3$$

i.e. Total Resistance = sum of individual resistance.

Application:- In the circuit, all the lamps are connected by a single switch, they can't be controlled individually.

Parallel circuit:-

The circuit in which one end of all the resistors is joined to a common point & the other ends are also joined to another common point so that different current flows through them is called parallel circuit.



Three resistors R_1, R_2 & R_3 are connected in parallel across voltage V. Current flowing through them is I_1, I_2 & I_3

Total current is

$$I = I_1 + I_2 + I_3 = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$ (ohm's law)

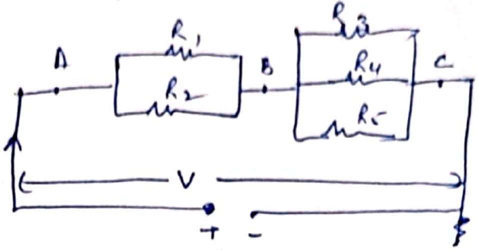
Let R is the total resistance or effective, then

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

Reciprocal of total resistance = sum of reciprocal of individual resistances.

* Series - parallel circuit:-

Circuit in which series & parallel circuits are connected in series is called S-P circuits.



(1) Across terminal AB → R_1 & R_2 are connected in parallel.

(2) Across BC → R_3, R_4 & R_5 are connected in parallel

(3) R_{AB} & R_{BC} are connected in series with each other.

Total or effective resistance of the circuit is :-

$$\frac{1}{R_{AB}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_1+R_2}{R_1R_2} \quad \text{or} \quad R_{AB} = \frac{R_1R_2}{R_1+R_2}$$

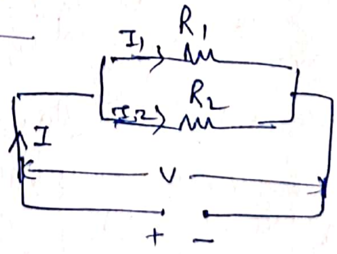
Similarly

$$\frac{1}{R_{BC}} = \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} = \frac{R_3R_4+R_4R_5+R_5R_3}{R_3R_4R_5}$$

$$\text{or} \quad R_{BC} = \frac{R_3R_4R_5}{R_3R_4+R_4R_5+R_5R_3}$$

Total resistance of the circuit is $R = R_{AB}+R_{BC}$

* Division of current in parallel circuit.



when two resistors are connected in ||el.

Acc. to ohm's law.

$$I_1R_1 = I_2R_2 = \cancel{IR}\,V \quad \text{or} \quad \frac{I_1}{I_2} = \frac{R_2}{R_1}$$

The value of branch current can also be expressed in terms of total circuit current.

$$I_1R_1 = I_2R_2 = IR = V$$ where I & R are the total resistance & current

$$R = \frac{R_1R_2}{R_1+R_2}$$

Now $I_1R_1 = IR = I\frac{R_1R_2}{R_1+R_2}$ or $I_1 = I\frac{\cancel{R_1}R_2}{\cancel{R_1}(R_1+R_2)} = \frac{IR_2}{R_1+R_2}$

Similarly $I_2R_2 = IR = I\frac{R_1R_2}{R_1+R_2}$ or $I_2 = I\frac{R_1\cancel{R_2}}{\cancel{R_2}(R_1+R_2)} = \frac{IR_1}{}$

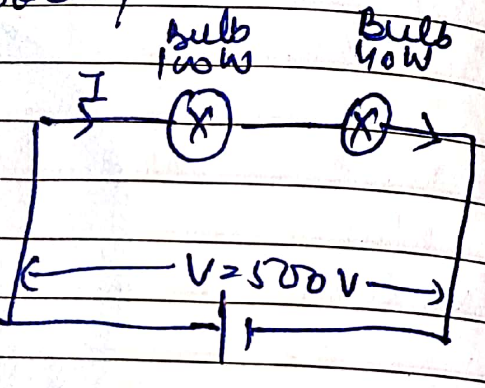
Series & Parallel Circuits

9

10 Q A 100W, 250V bulb is put in series with a 40W, 250V bulb across 500V

11 supply. What will be the current

12 ~~drawn~~ consumed by each bulb & will such a combination work?



1 Solution:-

2 Resistance of 100W bulb

3 $R_1 = \frac{V^2}{W_1} = \frac{(250)^2}{100} = 625\Omega$

4

5 Resistance of 40W bulb

6 $R_2 = \frac{V^2}{W_2} = \frac{(250)^2}{40} = 1562.5\Omega$

These resistances are connected in series

Important Notes

Total $R = R_1 + R_2 = 625 + 1562.5\Omega$

$= 2187.5\Omega$

Current drawn from 500V supply $I = \frac{V}{R}$

$= \frac{500}{2187.5} = 0.2286A$

Power consumed by 100W $P_1 = I^2R_1 = (0.2286)^2 \times 625$

$= 32.65W$

Power consumed by 40W. $P_2 = I^2R_2 = (0.2286)^2 \times 1562.5$

$= 81.63W$

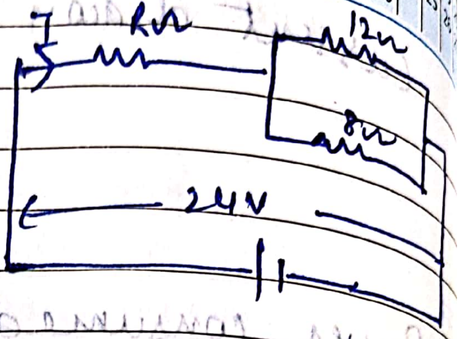
This combination will not work. The reason is that when 40W bulb will draw a power of 81.63 W its filament will be overheated & will burn.

Q A resistor R is connected in series with a parallel circuit comprising of two resistances 12 & 8 ohm resp.

Important Notes

The total power dissipated in the circuit is 96 watts when applied voltage is 24V. Calculate the value of R.

Sol:- Total dissipated power $P = 96\,W$



Applied voltage = 24V

Equivalent resistance of the two resistances connected in parallel say R_p.

$$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{8}$$

$$= \frac{2+3}{24} = \frac{5}{24}$$

$$R_p = \frac{24}{5} = 4.8\,\Omega$$

Current supplied to the circuit,

$$I = \frac{P}{V} = \frac{96}{24} = 4A$$

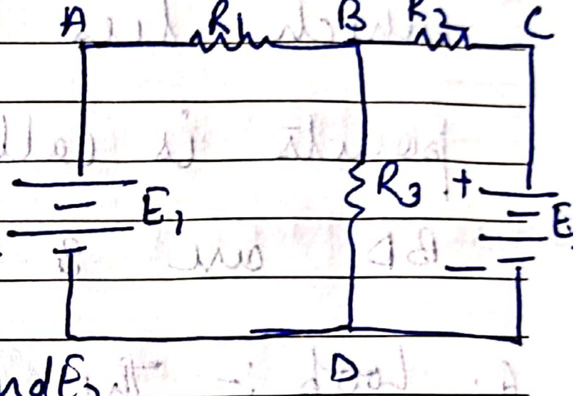
Effective resistance of the circuit, $R_{eff} = \frac{V}{I} = \frac{24}{4} = 6\,\Omega$

Important Notes

$R_{eff} = R + R_p$

$R = R_{eff} - R_p = 6 - 4.8 = 1.2\,\Omega$

Network Terminology



1. **Active Element** :- The element which supplies energy to the circuit is called active element. E_1 and E_2 are active elements.

2. **Passive Element** :- The element which receives energy is called passive element (such as resistor, inductor and capacitor). R_1, R_2 & R_3 are passive elements.

3. **Node** :- It is point in the network where ~~three~~ two or more circuit elements are joined. A, B, C and D are nodes

4. **Junction** :- It is a point in the network where three or more circuit elements are joined. It is point where current is

23

divided. B & D are the junction.

5. Branch :- The part of network which lies between two junction points is called branch. DAB, BCD & BD are 3 branches.

6. Loop :- The closed path of a network is called loop. ABDA, BCDB & ABCDA are 3 loops.

7. Mesh :- The most elementary form of a loop which cannot be further divided is called Mesh. ABDA & BCDB are 2 Mesh

Important Notes

180
60
240

KIRCHHOFF's LAWS

KVL — Kirchhoff voltage law

KCL — Kirchhoff Current Law.

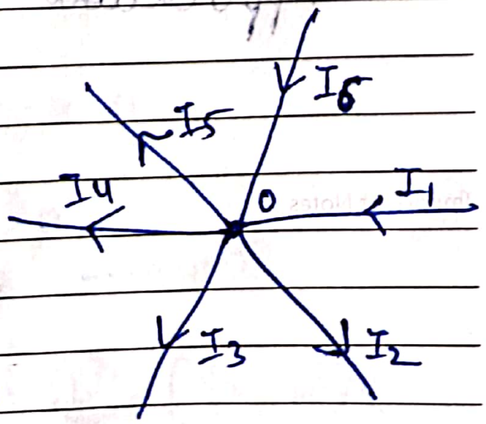
Kirchhoff Ist law :-

Its is also known as kirchhoff's Current law (KCL).

It states that :-

The algebric sum of all the currents meeting at a point or junction is zero.

Mathematically, $\boxed{\Sigma I = 0}$



Algebric sum is to be taken,

Important Notes

Consider.

Incoming currents as +ve.

Outgoing currents as −ve

Applying KCL to junction O.

$$\boxed{I_1 - I_2 - I_3 - I_4 - I_5 + I_6 = 0}$$

$$\boxed{I_1 + I_6 = I_2 + I_3 + I_4 + I_5}$$

Application - Nodal Analysis.

Kirchhoff's Second law :-

In a closed circuit or Mesh, the algebric sum of all the emf's plus the algebric sum of all the voltagedrops (product of current & resistance) is zero.

i.e $\Sigma E + \Sigma V = 0$

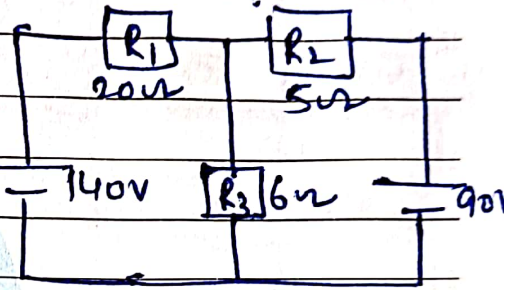
Application → Loop Analysis

→ Mesh Analysis.

Important Notes

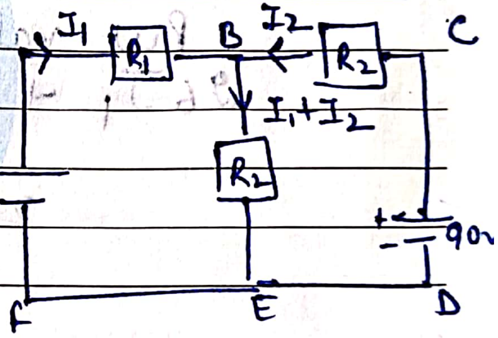
Numericals of KVL
(loop Analysis).

Q1 In the circuit, calculate current and power in the 6Ω resistor?



Sol:- ~~Apply Rule to loop~~

Define directions of current.



Apply KVL to loop ABEFA we get.

$20I_1 + 6(I_1+I_2) - 140$

$20I_1 + 6I_1 + 6I_2 = 140$

$26I_1 + 6I_2 = 140$ —— ①

Apply KVL to loop BCDEBC

$5I_2 + 6(I_1+I_2) - 90 = 0$

$5I_2 + 6I_1 + 6I_2 = 90$

$6I_1 + 11I_2 = 90$ ~~——~~ ②

Solving eq ① & ②. (for like terms)

$6(26I_1 + 6I_2 = 140)$ Multiply eq ① by 6

$26(6I_1 + 11I_2 = 90)$ Multiply eq ② by 26

M	T	W	T	F	S	S
31						
3	4	5	6	7	8	
10	11	12	13	14	15	
17	18	19	20	21	22	
24	25	26	27	28	29	

$156 I_1 + 36 I_2 = 840$

9

$156 I_1 + 286 I_2 = 2340$

10

$- \quad - \quad -$

11

$+250 I_2 = +1500$

12

$I_2 = \frac{1500}{250}$

1

$\boxed{I_2 = 6}$

2

Put value of I_n eq ①.

3

$26 I_1 + 6(6) = 140$

4

$26 I_1 \Rightarrow 140 - 36$

5

$I_1 = \frac{104}{26}$

6

$\boxed{I_1 = 4}$

Important Notes

Current across $6\Omega = I_1 + I_2 = 4 + 6 = 10$ A

Now power across 6Ω is :-

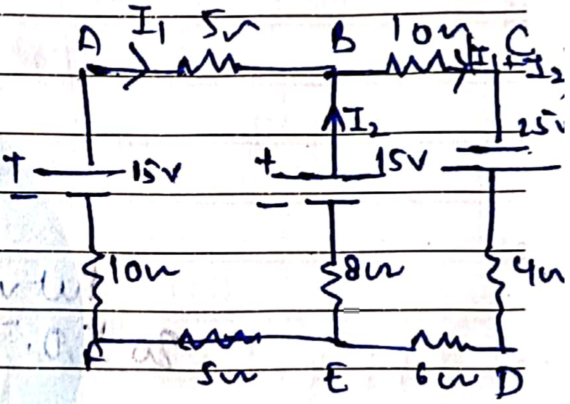
power in 6Ω resistor $= I^2 R_3$

$= (10)^2 \times 6$

$$\boxed{P = 600\ kW}$$

Q Using kirchhoff's law, solve the n/w shown & find the current in each branch.

Sol:- First make current direction



Apply KVL to loop ABEFA.

$$5I_1 + \cancel{15} + 8I_2 + 5I_1 + 10I_1 - \cancel{15} = 0.$$

$$20I_1 + 8I_2 = 0 \text{ ——— ①}.$$

$$\boxed{I_1 = 0.4I_2} \text{ ——— ②}$$

$8I_2 = 0$
40
$28I_2 =$
$= -40$
-20
$= \frac{40}{2}$

$$10(I_1+I_2) - 25 + 4(I_1+I_2) + 6I_2 + 8I_2 + 6I_1 - 15 = 0.$$

$$10I_1 + 10I_2 + 4I_1 + 4I_2 + 6I_2 + 8I_2 + 6I_1 = 40$$

Important Notes

$$20I_1 + 28I_2 = 40 \text{ ——— ③}.$$

Again solve eq.① & eq② by like terms.

$$(20I_1 + 8I_2 = 0)$$
$$(20I_1 + 28I_2 = 40)$$

By putting the value of I_1 from eq ② to eq ③

we get:

$$20(0.4I_2) + 28I_2 = 40$$

$$8I_2 + 28I_2 = 40$$

$$36I_2 = 40$$

$$I_2 = \frac{40}{36}$$

$$\boxed{I_2 = 1.11 A}$$

Now put value of I_2 in eq ② so, $\boxed{I_1 = 0.4 \times 1.11 = 0.44A}$

put I_1 & I_2 values $I_1 + I_2 = 0$

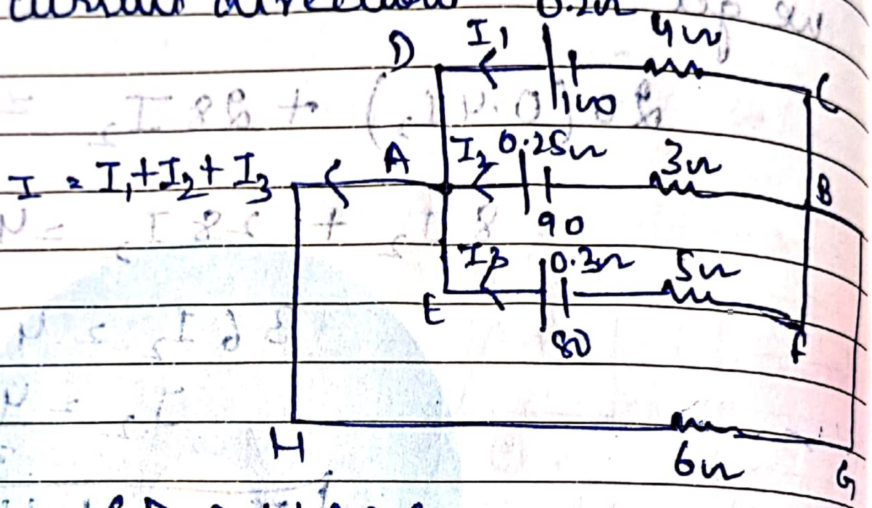
$$0.44 + 1.11 = 1.55 A$$

$$\boxed{I_1 + I_2 = 1.55 A}$$

Important Notes

Q. Solve the n/w, for the current through 6Ω resistor.

Sol:- First make current directions



Apply KVL loop CDAHGBC

$$6(I_1+I_2+I_3)+4I_1+0.2I_1-100=0$$

$$6I_1+6I_2+6I_3+4I_1+0.2I_1=100$$

$$\boxed{10.2I_1+6I_2+6I_3=100} \text{ — ①}$$

Apply KVL loop BAHGB.

$$6(I_1+I_2+I_3)+3I_2+0.25I_2-90=0$$

$$6I_1+6I_2+6I_3+3I_2+0.25I_2=90$$

$$6I_1+9.25I_2+6I_3=90 \text{ — ②}$$

Apply KVL to loop fEAHGBf

$6(I_1+I_2+I_3)+5I_3+0.3I_3-80=0$

$6I_1+6I_2+6I_3+5I_3+0.3I_3=80$

$6I_1+6I_2+11.3I_3=80$ —— ③

Subtract eq ② from ① .

$4.2I_1-3.25I_2=10$ —— ④

Solve ② & ③

$31.8I_1+68.525I_2=537$ —— ⑤

From eq ④ & ⑤, we get

$391.51I_2=1937.4$

$$\boxed{I_2=\frac{1937.4}{391.15}=4.953\text{ A}}$$

Solving eq ⑤ we get (put value of I_2)

$$\boxed{I_1=6.21\text{ A}}$$

Important Notes

solving eq ③ we get (putting value of I_1 & I_2)

$$\boxed{I_3=1.15\text{ A}}$$

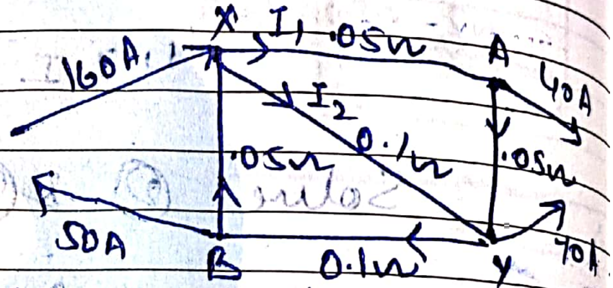
Current in 6Ω resistor = $I_1 + I_2 + I_3$

$= 6.21 + 4.95 + 1.15$

$$\boxed{I = 12.313A}$$

Q By using KVL, find the current in XY in the circuit.

Sol:- First make direction of current



Apply KVL, loop XYAX.

$0.05 I_1 + 0.5(I_1 - 40) - 0.1 I_2 = 0$

$.05 I_1 + 0.5 I_1 - 2 - 0.1 I_2 = 0$

$I_1 - I_2 = 20$ — ①.

Apply KVL, loop XYBX.

$0.1 I_2 + 0.1(I_1 + I_2 - 110)$

$+ .05(I_1 + I_2 - 160) = 0$.

$0.1 I_2 + 0.1 I_1 + 0.1 I_2 - 11 + .05 I_1 + 0.5 I_2$

$- 8 = 0$

At point X current is I_1

At node A. current is. $I_1 - 40$.

At point Y current is
$I_1 - 40 + I_2 - 70$
$I_1 + I_2 - 110$.

At point B.
$I_1 + I_2 - 160$

Important Notes

$0.15 I_1 + 0.25 I_2 - 19 = 0$

$3I_1 + 5I_2 = 380$ — ②

Multiply eq ① by 3 & subtract from eq ② we get.

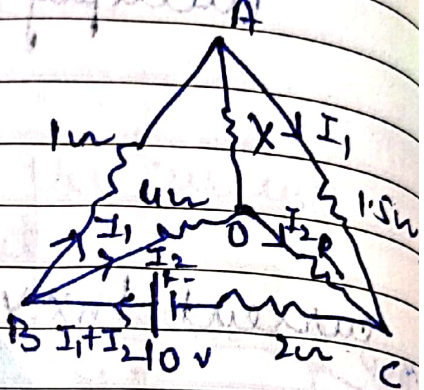
$8I_2 = 320$

current in xy $\boxed{I_2 = \frac{320}{8} = 40\text{ A}}$

~~Q2 For the n/w, calculate the current in 10Ω resistor &~~

Important Notes

Q Find the value of R & the current through it in the circuit shown, when the current is zero in branch OA.



Sol:- First make current direction.

Apply KVL loop BAOB.

$$I_1 - 4I_2 = 0$$

$$I_1 = 4I_2 \quad — ①$$

Apply KVL loop BACB

$$I_1 + 1.5I_1 + 2(I_1+I_2) - 10 = 0$$

$$4.5I_1 + 2I_2 = 10 \quad — ②$$

Put value of I_1 from eq ① to eq ②.

$$4.5(4I_2) + 2I_2 = 10$$

Important Notes

$$\boxed{I_2 = 0.5A}$$

$$\boxed{I_1 = 4 \times 0.5 = 2A}$$

Apply KVL to loop BOCB

APRIL 2014

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MARCH 28
FRIDAY

$$4I_1 + RI_2 + 2(I_1 + I_2) - 10 = 0$$

9 $$4 \times \overset{2}{\cancel{0.25}} + R \times 0.5 + 2(0.5 + 2) = 10$$

10 $$\boxed{R = 6\Omega}$$

11

12

1

2

3

4

5

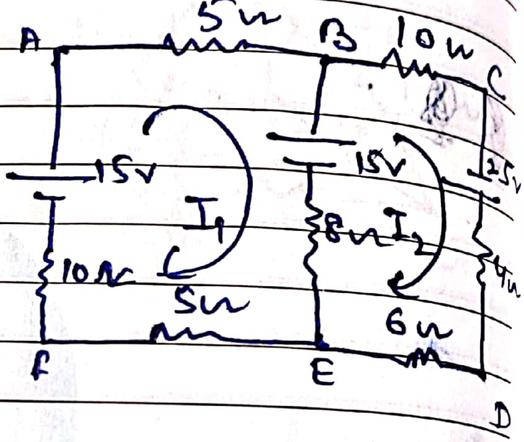
6

Important Notes

KVL

Mesh Analysis

Q Solve the n/w shown, & find the current in each branch.



Solve :- First make direction of current in two Mesh.

Apply KVL to ~~loop~~ Mesh ABEFA.

$$5I_1 + \cancel{15} + 8(I_1 - I_2) + 5I_1 + 10I_1 - \cancel{15} = 0$$

$$5I_1 + 8I_1 - 8I_2 + 5I_1 + 10I_1 = 0$$

$$28I_1 - 8I_2 = 0$$

$$I_2 = 3.5 I_1 \text{ — } ①$$

Apply KVL to Mesh BCDEB

$$10I_2 - 25 + 4I_2 + 6I_2 + 8(I_2 - I_1) - 15 = 0$$

$$10I_2 - 40 + 4I_2 + 6I_2 + 8I_2 - 8I_1 = 0$$

$$28I_2 - 8I_1 = 40 \text{ — } ②$$

Put value of I_2 from eq ① to eq ②.

$28(3.5I_1) - 8I_1 = 40$

$98I_1 - 8I_1 = 40$

$90I_1 = 40$

$I_1 = \frac{4\cancel{0}}{9\cancel{0}}$

$\boxed{I_1 = 0.444A}$

Put value of I_1 in eq ①. $I_2 = 3.5 \times 0.44$

$\boxed{I_2 = 1.54\,A}$

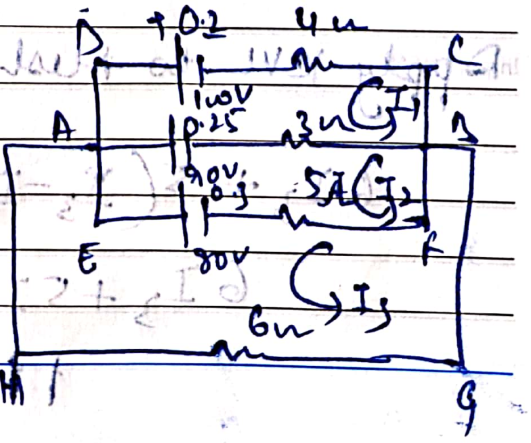
Current in branch EB = $I_1 - I_2 = -1.1A$

$I_2 - I_1 = 1.1A$

Q2 Solve the n/w shown for the current through 6Ω resistor

Important Notes

Sol:- First make directions of current.



Take Mesh CDAB.

$$90 + 0.25(I_1 - I_2) + 3(I_1 - I_2)$$
$$+4(I_1) - 100 + 0.2(I_1) = 0$$

$$0.25 I_1 - 0.25 I_2 + 3I_1 - 3I_2 + 4I_1$$
$$+0.2 I_1 = 10$$

$$7.45 I_1 - 3.25 I_2 = 10 \quad — ①$$

Apply KVL to Mesh BAEFB.

$$80 + 0.3(I_2 - I_3) + 5(I_2 - I_3) + 3(I_2 - I_1)$$
$$+0.25(I_2 - I_1) - 90 = 0$$

$$0.3 I_2 - 0.3 I_3 + 5I_2 - 5I_3 + 3I_2 - 3I_1$$
$$+0.25 I_2 - 0.25 I_1 = 10$$
$$3.25 I_1 + 8.55 I_2 - 5.3 I_3 = 10 \quad ②$$

Apply KVL to Mesh FEAHGBF

$$6I_3 + 5(I_3 - I_2) + 0.3(I_3 - I_2) - 80 = 0$$
$$6I_3 + 5I_3 - 5I_2 + 0.3I_3 - 0.3I_2 = 80$$
$$11.3 I_3 - 5.3 I_2 = 80 - ③$$

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Eliminating I_1 from eq ① & ② we get

$$16.31 I_2 - 12.15 I_3 = -32.92$$

Eliminating I_2 from eq ③ & ④ we get

$$-22.62 I_3 = 279.11$$

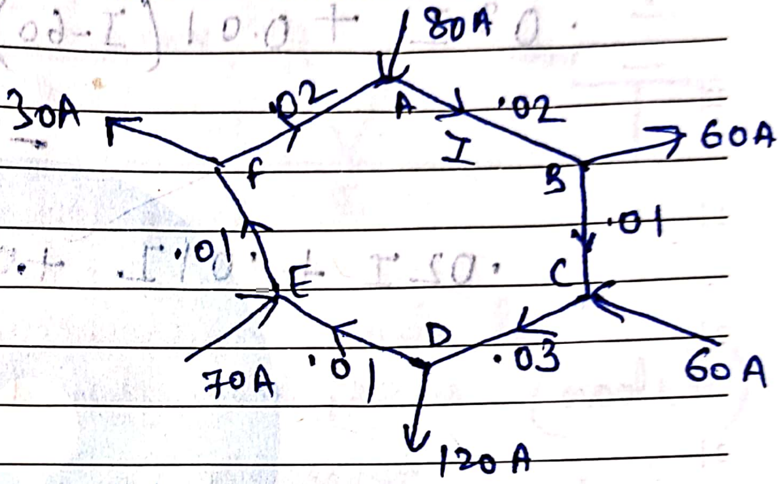
or $I_3 = -12.339$ A.

Negative sign shown that the actual flow of current in 6Ω is opposite

Important Notes

NODAL ANALYSIS

Q) Find the magnitude & direction of the currents in all branches of the circuit using Kichoff's laws. All resistances are in ohms.



Sol:- First make directions of current.

At point A assume current to be I.

At point B current is (take incoming & outgoing current both)
So, I - 60.

At point C, current is
$I - \cancel{60} + \cancel{60} = I$

At point D current is
I - 120.

Important Notes

At point E current is
I - 120 + 70 = I - 50

At point F current is
I - 50 - 30 = I - 80

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

So equation will be after appling KVL
Multiply corresponding current with the resistance.

$$.02I + 0.01(I-60) + .03I + .01(I-20)$$
$$- .01(I-50) + 0.2(I-80) = 0$$

$$.02I + .01I + .03I + .01I + .01I$$
$$+ .02I = 0.6 + 1.2 + 0.5 + 1.6$$

$$0.1I = 3.9$$
$$\boxed{I = 39\,A}$$

$I_{AB} = 39A$ (A to B)

$I_{BC} = I - 60 = -21A$ (C to B)

$I_{CD} = I = 39A$ (C to D)

Important Notes

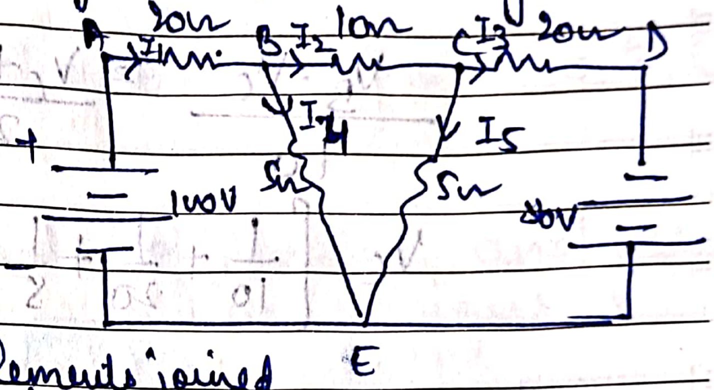
$I_{DE} = I - 120 = -81A$ (E to D)

$I_{EF} = I - 50 = -11A$ (F to E)

$I_{FA} = I - 80 = -41A$ (A to F)

Q For the circuit, find the current in various branches by nodal analysis.

Sol!- For nodal cases.



1) First find independent nodes
(nodes which have 3 or more than 3 elements joined
(A, B & C))

2) Take one node as reference node & that node is considered zero. (node E)

3) Then first make direction of current across each branch (conventional direction of current).

Solve!-
At nodeB
incoming current = outgoing current.

$$I_1 = I_2 + I_4$$

Source-destination
(S-D)

$$\frac{100 - V_B}{20} = \frac{V_B - V_C}{10} + \frac{V_B}{5}$$

$$V_B\left(\frac{1}{20} + \frac{1}{10} + \frac{1}{5}\right) - \frac{100}{20} - \frac{V_C}{10} = 0$$

$$7V_B - 2V_C - 100\ 20 \text{ ——— } ①$$

At node C

$$I_2 = I_3 + I_5$$

$$\frac{V_B - V_C}{10} = \frac{V_C + 50}{20} + \frac{V_C}{5} \quad —— ①$$

$$V_C\left[\frac{1}{10} + \frac{1}{20} + \frac{1}{5}\right] - \frac{V_B}{10} + \frac{50}{20} \quad 20$$

$$7V_C - 2V_B + 50 = 0 \quad —— ②$$

from eq ① & ②

$$V_B = \frac{40}{3} = 13.33V$$

$$V_C = -\frac{10}{3} V = -3.33V$$

Current in various branches

$I_1 = \frac{100 - V_B}{20} = 4.33A$ from A to B

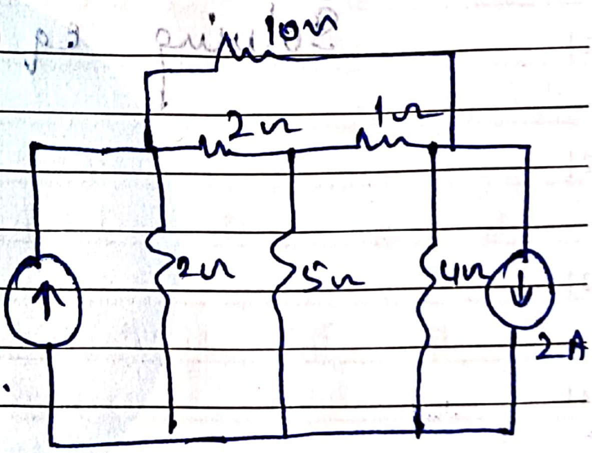
$I_2 = \frac{V_B - V_C}{10} = 1.67A$ from B to C

$I_3 = \frac{V_C + 50}{20} = 2.33A$ from C to D

$I_4 = \frac{V_B}{5} = 2.67A$ from D to E

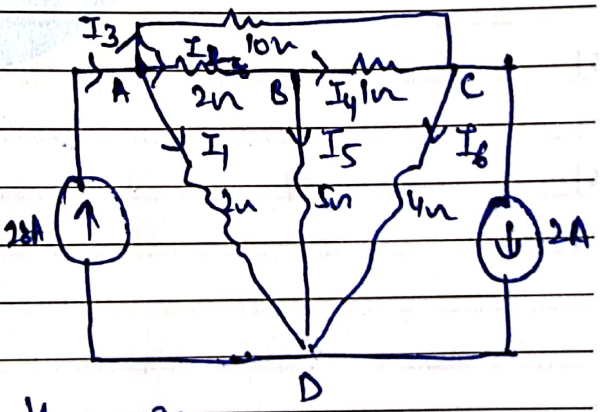
$I_5 = \frac{V_C}{5} = -0.67A$ from E to C

Q. Using method of nodal analysis determine the current in various branches of the n/w.



Sol:- First simplify the n/w for finding independent nodes & refering nodes. (node D).

Now make directions of current across each resistance.



Independent nodes – A, B, C

At node A.

Important Notes

$$V_A\left(\frac{1}{2}+\frac{1}{2}+\frac{1}{10}\right) - \frac{V_B}{2} - \frac{V_C}{10} = 28$$

$$11V_A - 5V_B - V_C = 280 \quad —— ①$$

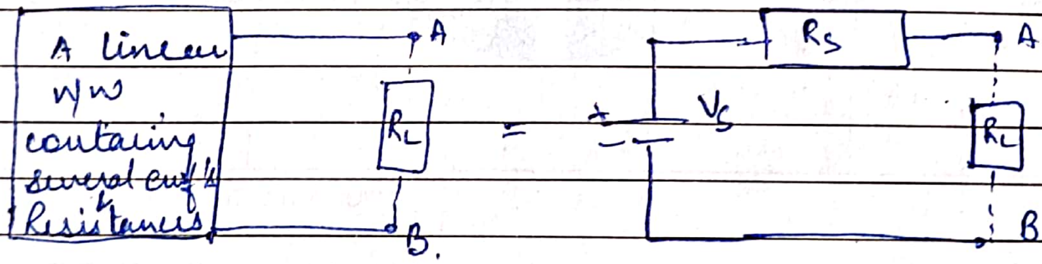
At node B

$$V_B\left(\frac{1}{2}+\frac{1}{5}+1\right) - \frac{V_A}{2} - \frac{V_C}{1} = 0$$

Thevenin Theorem :-

Thevenin theorem states that "any linear circuit containing several voltages & resistances can be replaced by just one single voltage in series with a single resistance connected across the load.

It is useful in the circuit analysis of power or battery systems & other inter-connected resistive circuits where it will have an effect on the adjoining part of the circuit.



Steps to solve Thevenin Theorem :-

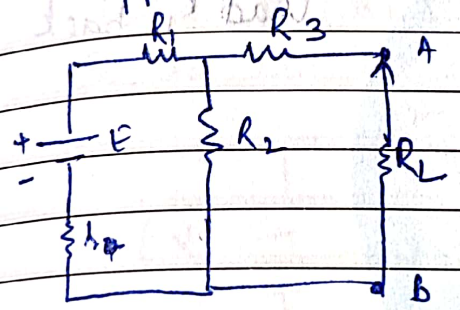
Important Notes

- Step 1:- Identify the load (R_L).
- Step 2:- Remove the load & calculate the open-circuit voltage (V_{TH})

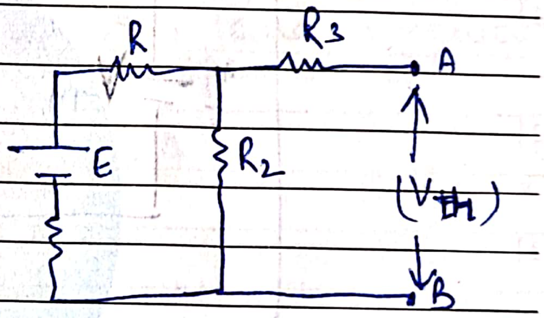
• Step3 :- To calculate Thevenin Impedance (R_{TH}) replace the sources with their internal impedance.

• Step 4:- Construct the thevenin equivalent circuit by connecting (V_{TH}) in series with (R_{TH}).

After step 1:- The circuit will be
let suppose the circuit is.



After step1:-



After Step 2:-

To determine open circuit voltage V_{th} b/w terminals A & B. (which is same as voltage across R_2)

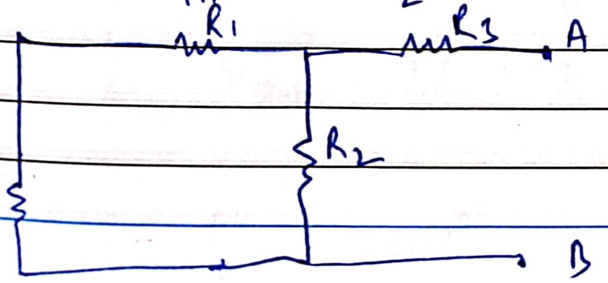
First calculate current.

$$I = \frac{E}{R+R_2}$$

Important Notes

The thevenin voltage is.

$$V_{TH} = R_2 \times I = R_2 I (V)$$



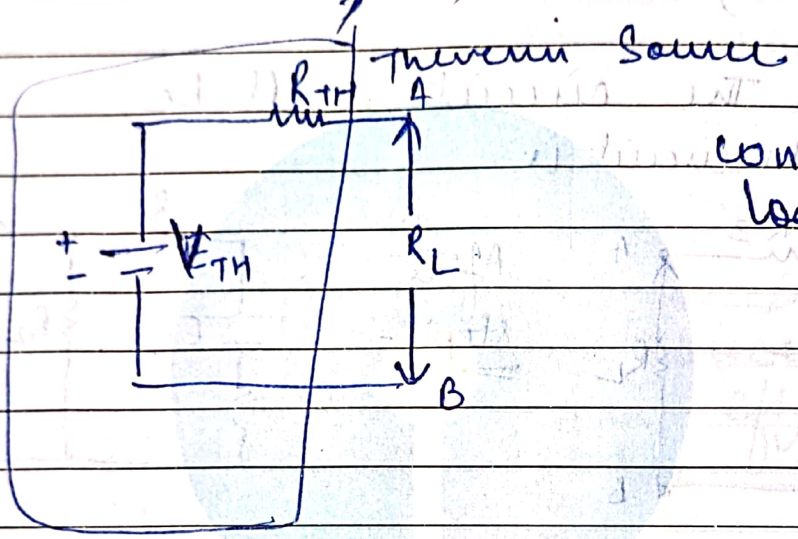
(If voltage source is the ~~calculate~~ the circuit is short circuite

(If current source is there it is open circuit)

After step 3:-

The circuit will be.

$$R_{TH} = \frac{(r+R_1)R_2}{(r+R_1)+R_2} + R_3$$

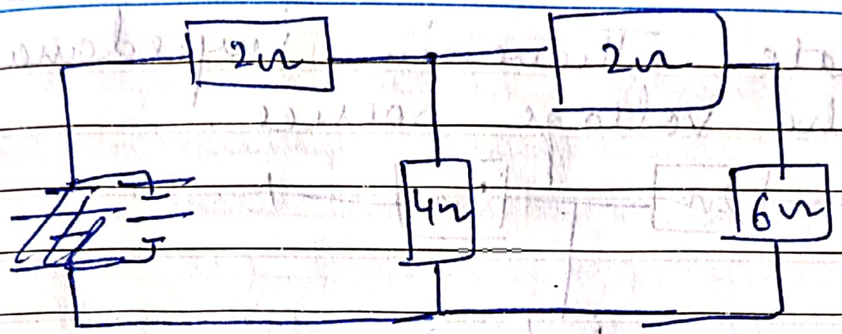


connect the load R_L back

Now, determine the current flowing through load Resistor R_L by applying ohm's law.

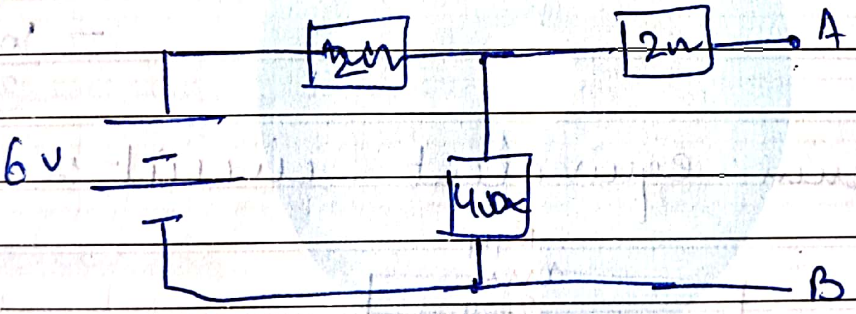
$$I = \frac{V_{TH}}{R_{TH}+R_L}$$

Q1)



Calculate the current through 6Ω resistor.

Sol:- 1) First remove the load. Here the load ~~is~~ (R_L) = 6Ω. When the load is removed it is open circuit.
So, the circuit will be.



2) Now the open circuit voltage is the same as that of the voltage across the resistor of resistance (4Ω).

So, the current in the circuit is

$$I = \frac{6}{2+4} = 1 \text{ Amp}$$

The thevenin voltage is

$$V_{TH} = 1 \times 4 = 4V.$$

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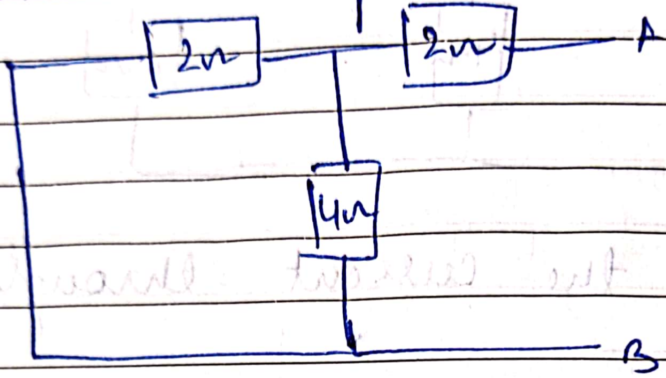
M	T	W	T	F	S
		1	2	3	4
6	7	8	9	10	11
13	14	15	16	17	18
20	21	22	23	24	25
27	28	29	30	31	

3) To calculate Thevenin impedance. (R_{TH})
Shorted the voltage source.

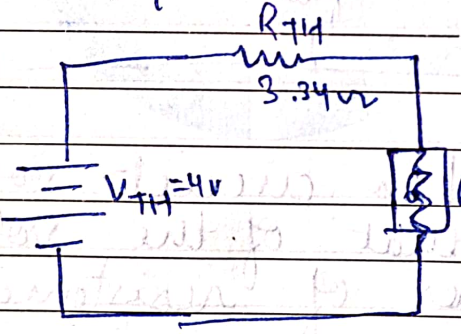


$$R_{TH} = [2+2] \,||\, [4] = \left[\frac{2\times 4}{2+4} + 2\right] = \left[\frac{4}{3} + 2\right]$$

4 $\frac{8}{3}$

$$= \frac{10}{3}\,\Omega = 3.34$$

4) Thevenin equivalent circuit :-



Now, to calculate the current across load 6Ω.

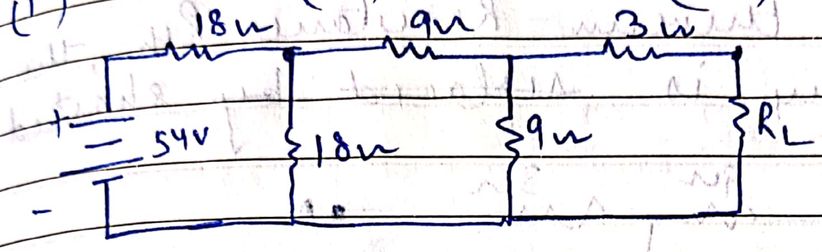
Important Notes

Apply ohm's law.

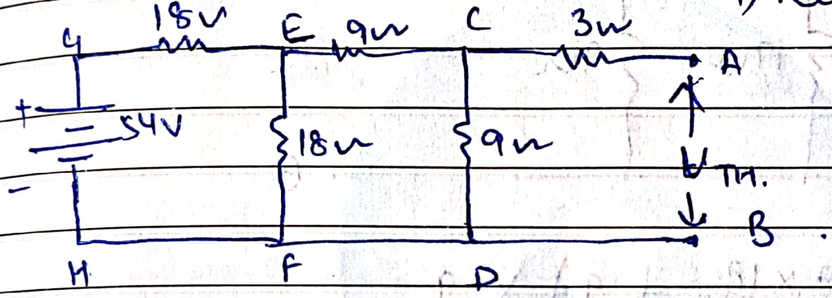
$$I = \frac{V_{TH}}{R_{TH}+R_L} = \frac{4}{3.34+6} = \frac{4}{9.34}$$

$$= 0.43 \text{ Amp.}$$

Q For a n/w shown determine the current flowing through R_L when the value of load resistance is
(i) 3 Ω (ii) 6 Ω (iii) 9 Ω



1) Remove load.



2) Calculate V_{TH}.

$$R = 18 + \frac{(9+9)\times 18}{(9+9)\times 18} = 27\Omega$$

Current supplied by battery 54V

$I = \frac{V_{TH}}{27}$ ~~for~~ V_{TH} ~~= I×27~~

$= \frac{54}{27} = 2A$

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

Important Notes

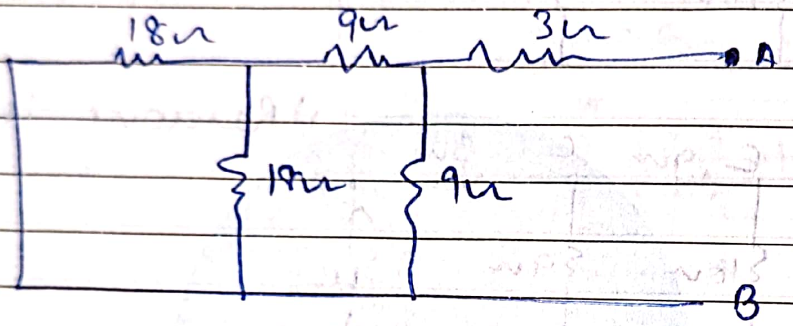
Current ~~[illegible]~~ flowing through circuit ECDF or CD.

$$= 2 \times \frac{(9+9)}{(9+9)\times 18} = 1A.$$

V_{TH} across AB or CD.

$$V_{TH} = 1 \times 9 = 9v.$$

b) To determine thevenin Resistance R_{th}, the source battery is ~~replaced by~~ shorted.

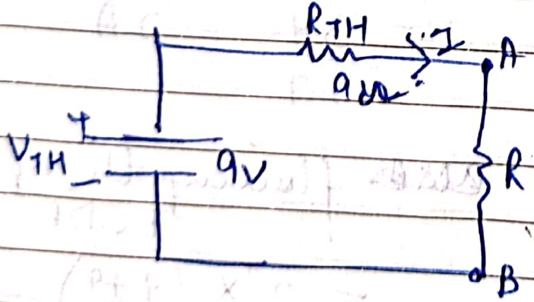


$$R_{th} = \frac{\left(\frac{18\times18}{18+18}+9\right)\times 9}{\left(\frac{18\times18}{18+18}+9\right)+9} + 3$$

$$= \frac{(9+9)\times9}{(9+9)+9} + 3 = \frac{18\times9}{27} + 3 = 9\Omega$$

Now circuit is reduced to

Important Notes



(i) when $R_L = 3\,\Omega$

$$I_1 = \frac{V_{TH}}{9\Omega+3} = \frac{\cancel{9}^{3}}{\cancel{12}_{4}} = 0.75\,A$$

(ii) when $R_L = 6\,\Omega$

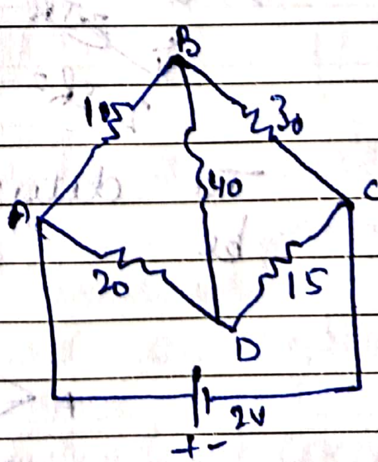
$$I_2 = \frac{9}{9+6} = \frac{\cancel{9}^{3}}{\cancel{15}_{5}} = 0.6A$$

(iii) when $R_L = 9\,\Omega$

$$I_3 = \frac{9}{9+9} = \frac{\cancel{9}^{1}}{\cancel{18}_{2}} = 0.5\,A.$$

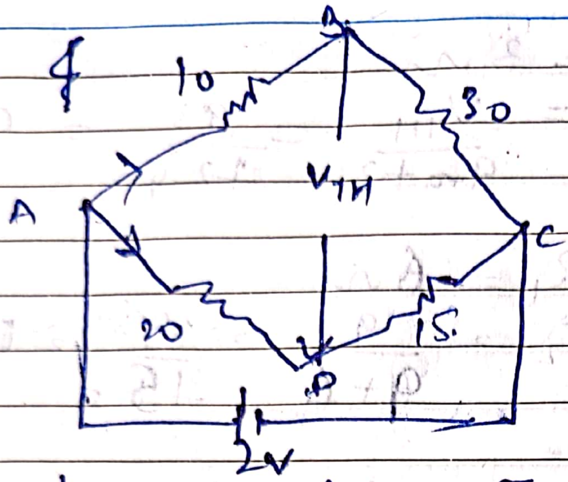
Q. A bridge n/w ABCD is arranged as follows resistance b/w terminals A-B; B-C; C-D; D-A and B-D are 10, 30, 15, 20 and 40 Ω resp. A 2 volt battery of negligible internal resistance is connected b/w terminals A & C. Determine the value and direction of the current in 40 Ω resistor by applying Thevenin theorem.

Sol:- Step 1:- Remove 40 Ω & calculate E_{TH} or V_{TH}.



Important Notes

So the circuit will be :



Current in branch ABC $I_1 = \frac{2}{10+30} = .05A$

" " " ADC $I_2 = \frac{2}{20+15} = 0.057 A.$

Voltage at point B, $V_B = 2 - 0.05 \times 10 = 1.5V$

" " " D $V_D =$ $V_A - V_D = I_2 R$

$= 2 - .05 \times 20 = V_D$

$= 0.85$

$\boxed{V_A - V_B = I_1 R}$

$= IR$

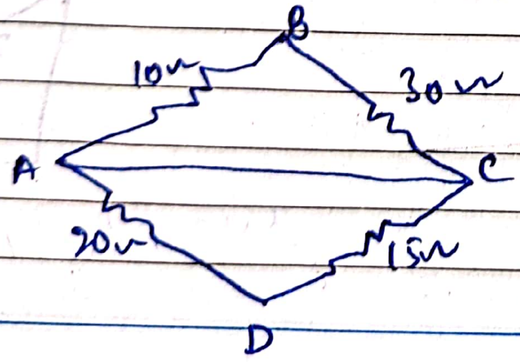
$2 - IR =$

V_{TH} across terminal B & D

$V_{TH} = 1.5 - 0.85 = 0.64$

Important Notes

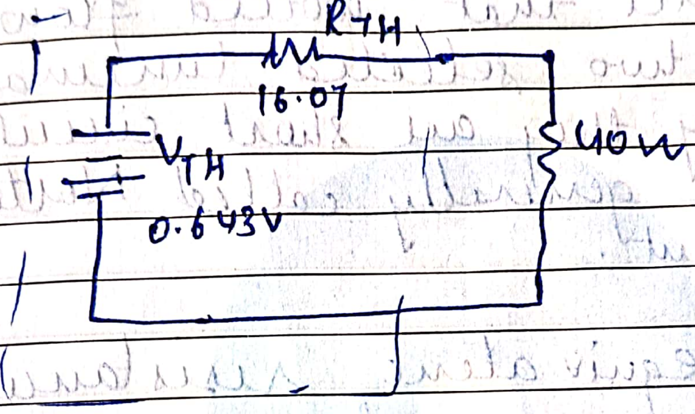
To determine R_{TH}, the circuit will be



$$R_{th} = \frac{10\times30}{10+30} + \frac{20\times15}{20+15}$$

$$= 7.5 + 8.57 = 16.07\Omega$$

- final circuit will be



$$I = \frac{0.643}{16.07+40} = 11.467 \text{ mA}$$

NORTON's Theorem :-

This theorem states that :-

The current flowing through a resistance connected across any two terminals of a n/w can be determined by replacing the whole n/w by an equivalent circuit of a current source having a current o/p of I_N in ~~ff~~ parallel with a resistance R_N.

where I_N = The short circuited current supplied by the source that would flow b/w the two selected terminals when they are short circuited. It is generally called Norton's current.

R_N = The equivalent resistance of the n/w as seen from the two terminals with all other emf sources replaced by their internal resistances & current sources replace by open circuit. It is generally called Norton's resistance.

Steps to determine Norton's equivalent circuit

Important Notes

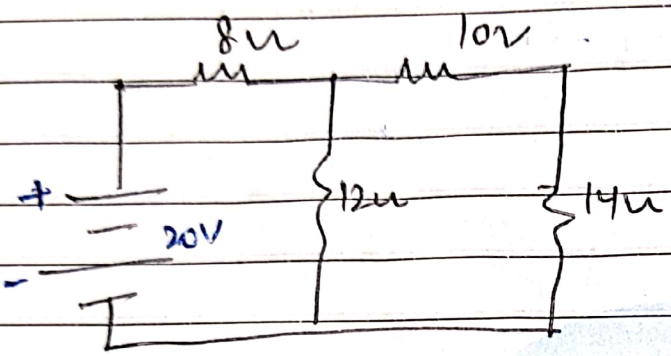
Step 1:- Short circuit the terminals across which the load resistor is connected & calculate the current which would flow b/w. them. This is the current I_N.

Step 2:- Redraw the n/w each voltage source by a short circuit in series with its internal resistance, if any & each current source by an open ~~sou~~ circuit in parallel with its internal resistance.

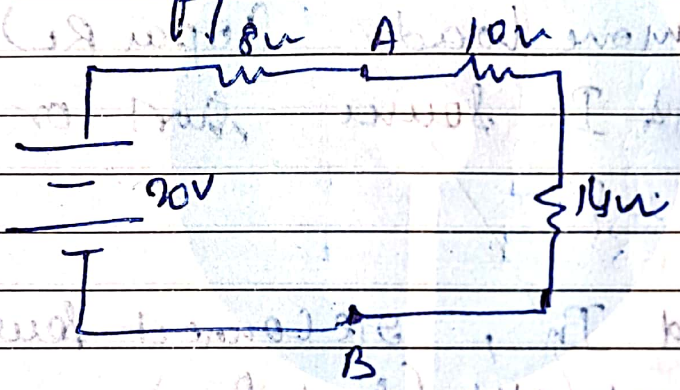
Step 3:- Determine the resistance R_N of the n/w as seen from the n/w terminals.

Important Notes

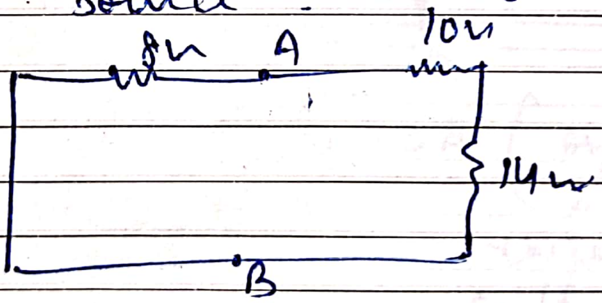
Q Using Norton's Theorem determine the current in 12Ω resistor in the n/w shown.



Step 1- Identify load & Remove it



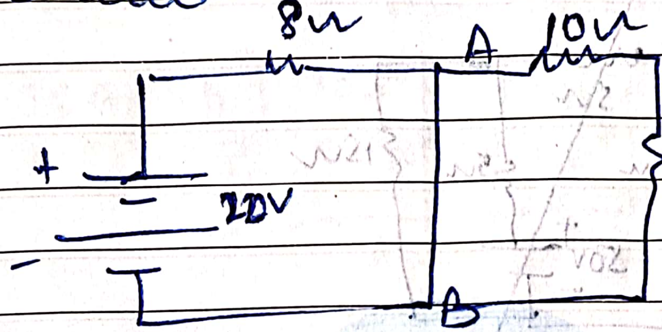
Step 2- Calculate R_N, by short circuiting voltage source.



Important Notes

$$R_N = \frac{8 \times (10+14)}{8 + (10+14)} = 6\Omega$$

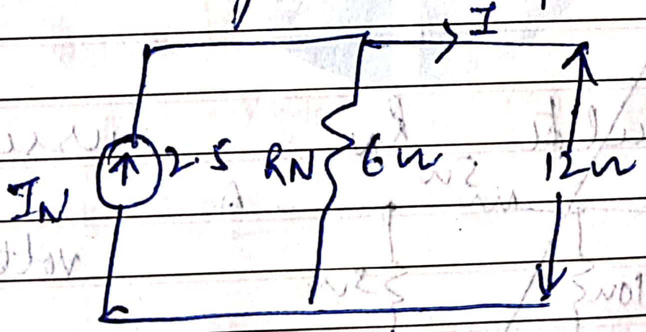
Step 3:- Bring back the voltage source & terminals A & B be short circuited to calculate current I_N.



current flow the shortest path.

$$I_N = \frac{V}{R} = \frac{20}{8} = 2.5A$$

Step 4:- Draw the equivalent Norton circuit by drawing I_N & R_N & load R_L be back



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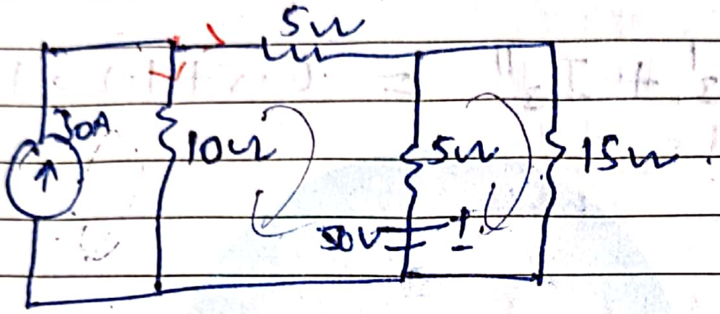
$$I = \frac{I_N \times R_N}{R_N+R_L} = 2.5 \times \frac{6}{6+12}$$

Important Notes

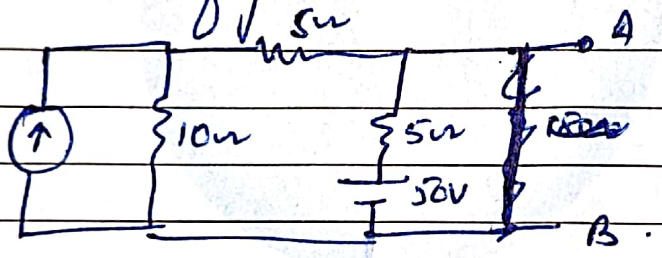
$$= 0.833 A$$

Q Norton's Numerical

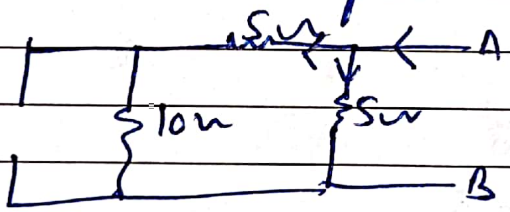
For the n/w, draw a Norton's equivalent circuit & determine the current flowing through 15 Ω resistor.



Step 1:- Identify load



Step 2:- Calculate R_N by shorting the voltage source & open the current source



Important Notes

$15 \times 5 = 75$

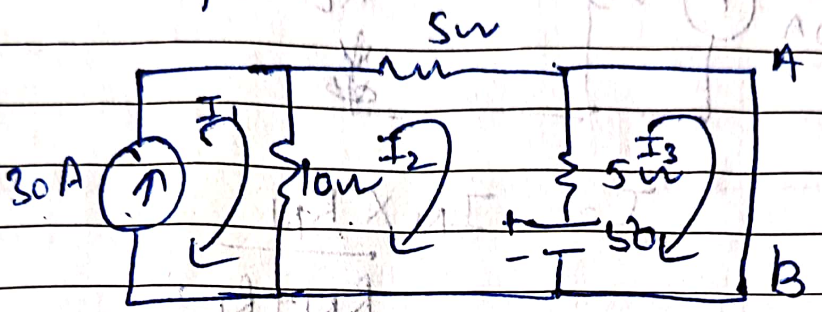
$$R_N = \frac{(5+10)\times 5}{(5+10)+5}$$

~~$= 15 \parallel 5 = \frac{1}{15} + \frac{1}{5}$~~

$$= \frac{(5+10)\times 5}{(5+10)+5} = \frac{75}{20}$$

$= 3.75\ \Omega$

Step 2:- Calculate I_N by bring back the original sources & short circuit the A & B pt.



$10(I_1-I_2)$
$10(30-I_2)$
$10I_2 = 300$
$I_2 = \frac{36}{10}$

$\cancel{30(I_1 - I_2) = 0}$ $I_1 = 30A$.

$\cancel{30I_1 - 30I_2 = 0}$ —① .

$5I_2 + 5(I_2 - I_3) + 50 + 10(I_2 - I_1) = 0$.

$5I_2 + 5I_2 - 5I_3 + 50 + 10I_2 - 10I_1 = 0$

$20I_2 - 10I_1 - 5I_3 = -50$ —②.

$-50 + 5(I_3 - I_2) = 0$.

$\cancel{80} + 5I_3 - 5I_2 = 50$ —③

Solving ②

Important Notes

$20I_2 - 10 \times 30 - 5I_3 = -50$

$20I_2 - 300 - 5I_3 = -50$

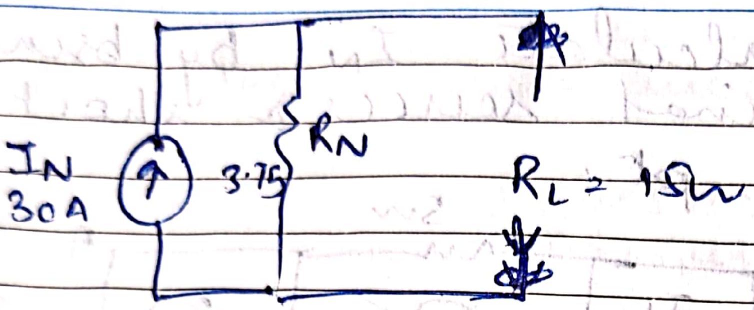
$20I_2 - 5I_3 = 250$ —②

Solving ② & ③

$I_2 = 20A$

$I_3 = 30A$

Step 4:-



$$I = \frac{I_N \times R_N}{R_N + R_L}$$

$$= 30 \times \frac{3.75}{3.75 + 15}$$

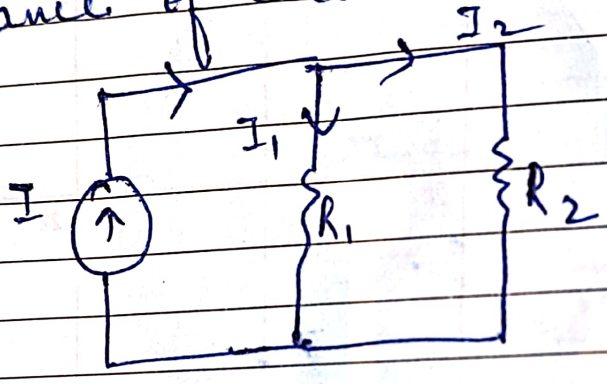
$$I = 30 \times \frac{3.75}{18.75}$$

$$= \frac{112.5}{18.75} = 6A$$

tant Notes

Current division ~~Method~~ Rule CDR

The current divider Rule states that in a parallel circuit, the total current entering the junction divides among the parallel branches in an amount inversely or proportional to the resistance Impedance of each branch.



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

opposite resis current resistance.

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

Important Notes

→ You can apply current divider Rule when you are sure of the total current entering a parallel n/w & wish to easily calculate the current in one branch.

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

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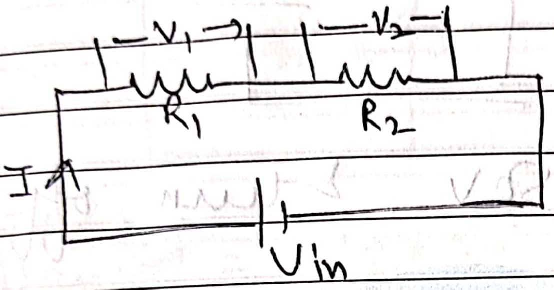
T	W	T	F	S	S
				1	2
4	5	6	7	8	9
11	12	13	14	15	16
18	19	20	21	22	23
25	26	27	28	29	30

Voltage Divider Rule :- (VDR)

Find out voltage across resistor :-
Resistors connected in series.



$I = I_1 + I_2$ (same current)

Voltage is divided

$V = V_1 + V_2$

~~V~~

$V_{in} = V_1 + V_2$

$V_1 = IR_1$ —— ①

$V_2 = IR_2$ —— ②.

$V_{in} = I(R_1 + R_2)$

$$\boxed{I = \frac{V_{in}}{R_1+R_2}}$$

putting the value of I.

Voltage across R_1

$$\boxed{V_1 = IR_1 = \frac{\cancel{V_{in}} R_1}{R_1+R_2} V_{in}}$$

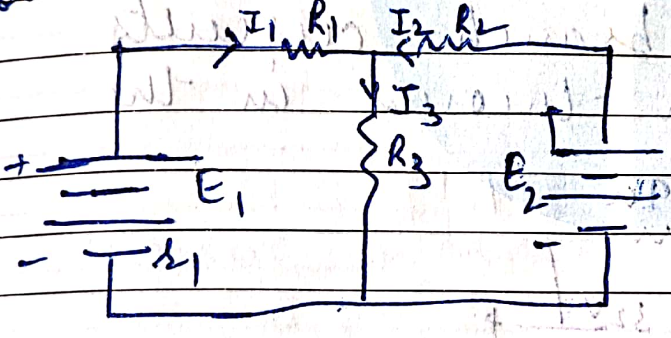
$$\boxed{V_2 = IR_2 = \frac{R_2}{R_1+R_2} V_{in}}$$

Important Notes

Super Position Theory

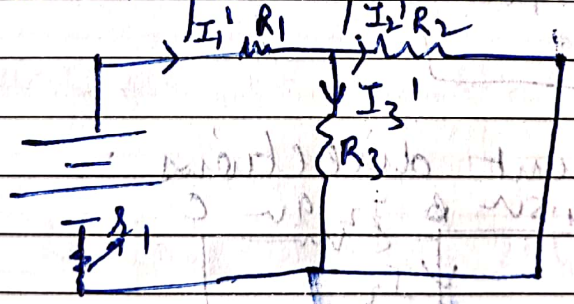
1) If there are two or more than two sources of emf acting simultaneously in a linear bilateral n/w, the current flowing through any section is the algebric sum of all the currents which should flow in that section if each sources of emf were considerd separately. All other sources are replaced for the time being by their internal resistance.

Consider the circuit.



Acc to super position theorm.

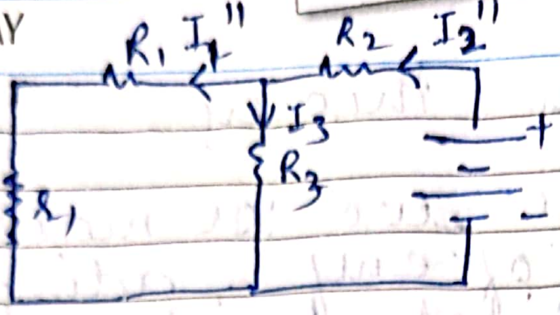
First :-



1) First one source is considerd i.e E_1

Important Notes

2) Then source 2 is considerd i.e E_2.



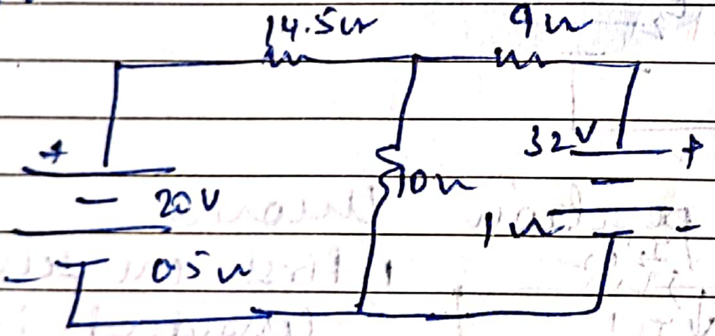
Now Actual flow of current in various sections :-

$$I_1 = I_1' - I_1''$$

$$I_2 = I_2' - I_2''$$

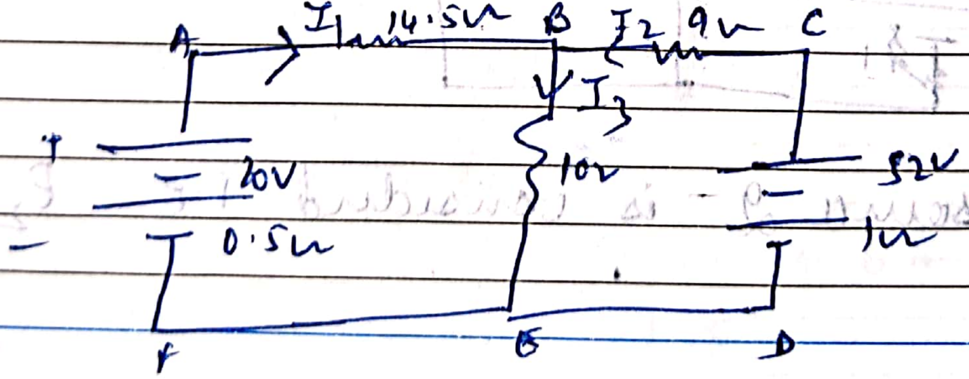
$$I_3 = I_3' + I_3''$$

Q Determine the branch currents by super position theorem in the N/w .



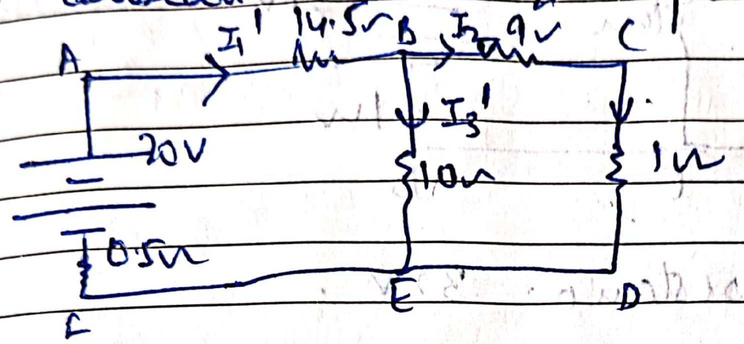
First draw current directions :

Important Notes



Acc. to super position theorem

First consider 20 V & replace 32V .



Total resistance across 20V

$$R_{total} = 14.5 + 0.5 + \frac{10\times(9+1)}{10+(9+1)} = 20\Omega$$

Current supplied by the source = $I_1' = \frac{V}{R_{total}}$

$$I_1' = \frac{20}{20} = \boxed{1A}.$$

Current in branch BCDE = $I_2' = 1\times\frac{10}{10+10}$

$$= \boxed{0.5A}.$$

I=VR

$= \frac{I}{R}$

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

Current in branch BE = $I_3' = 1\times\frac{10}{10+10} = \boxed{0.5A}$

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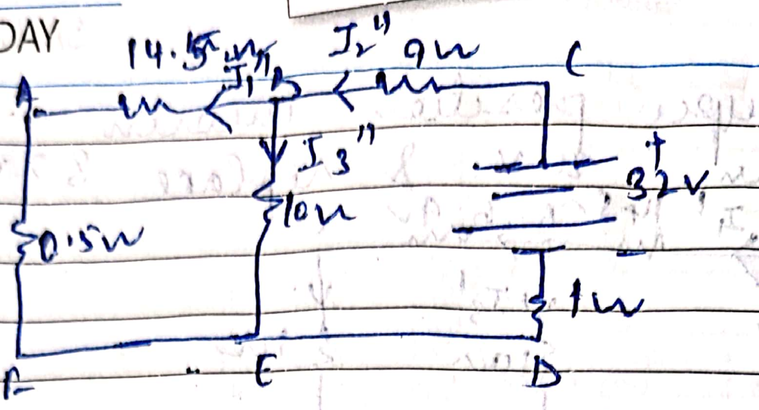
Important Notes

Now replace battery 20V & put 32 V.



9

10

11

Total resistance. 32V.

12

$$R_{total} = 9+1+\frac{15\times 10}{15+10} = 16Ω$$

1

2

Current supplied by source.

3 [illegible]

$$I_2'' = \frac{32}{16} = 2A.$$

4

Current in branch BAFE

5

$$I_1'' = 2\times\frac{10}{10+15} = 0.8\,A.$$

6

Current in branch BE

$$I_3'' = 2\times\frac{15}{10+15} = 1.2A$$

Important Notes

Acc to Super position, the actual currents will be :

$I_1 = I_1' - I_1'' = 1 - 0.8 = 0.2A$ A-B

$I_2 = I_2' - I_2'' = 0.5 - 2.0 = -1.5A$ C-B

$I_3 = I_3' + I_3'' = 0.5 + 1.2 = 1.7A.$ B-E

1

2

3

4

5

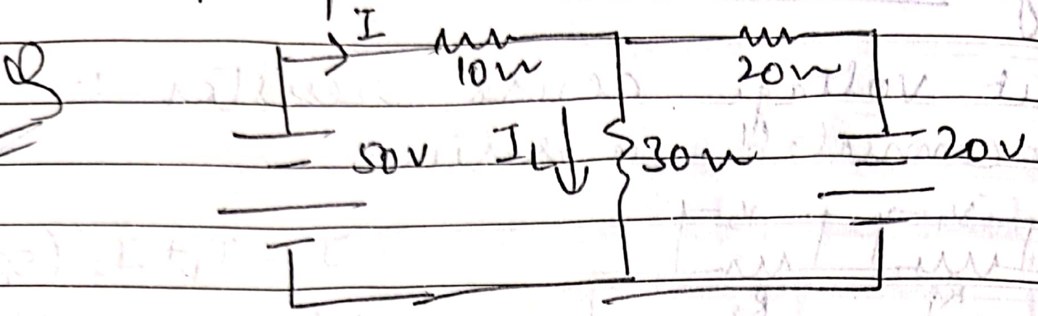
6

Important Notes

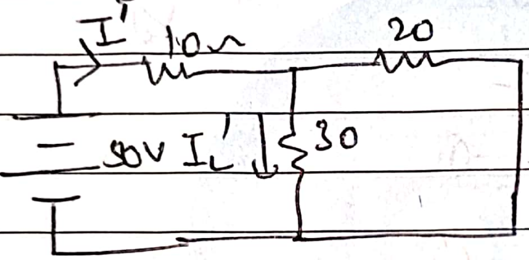
M	T	W	T	F
3	4	5	6	7
10	11	12	13	14
17	18	19	20	21
24	25	26	27	28

Super position Problems.

Q

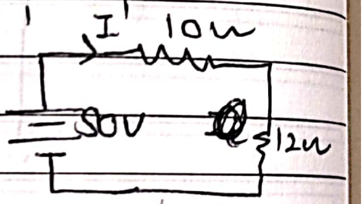


Step 1:- Consider 50V & turn off all other source



$$30\Omega \parallel 20\Omega = \frac{30 \times 20}{30+20} = \frac{\overset{12}{\cancel{600}}}{\cancel{50}} = 12\Omega$$

Redraw circuit.



$$I' = \frac{V}{R} = \frac{50}{10+12} = 2.27A.$$

By using current division Rule.

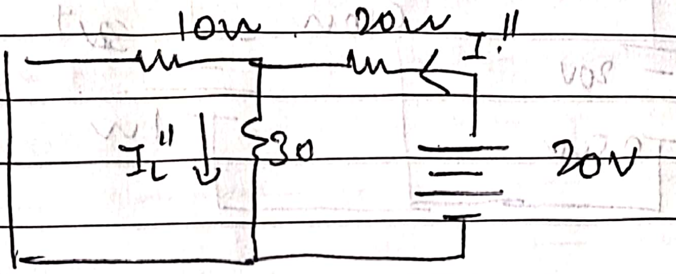
$$I_L' = I' \times \frac{20}{20+30}$$

$$= 2.27 \times \frac{20}{20+30}$$

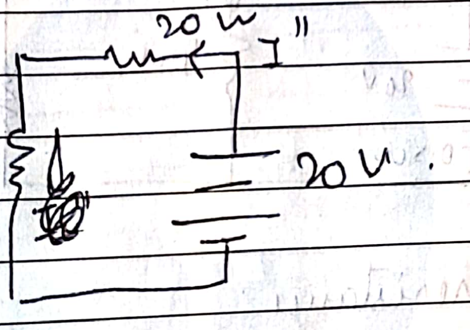
$$I_L' = 0.908.$$

Important Notes

Consider 20V voltage source & turn off all other sources.



$10||30 = \frac{10 \times 30}{10+30} = 7.5\Omega$.



$I'' = \frac{20}{20+7.5} = 0.72A$.

To find I_L'' apply C.D.R

$I_L'' = I'' \times \frac{10}{10+30}$ (opposite resistor which is in parallel)

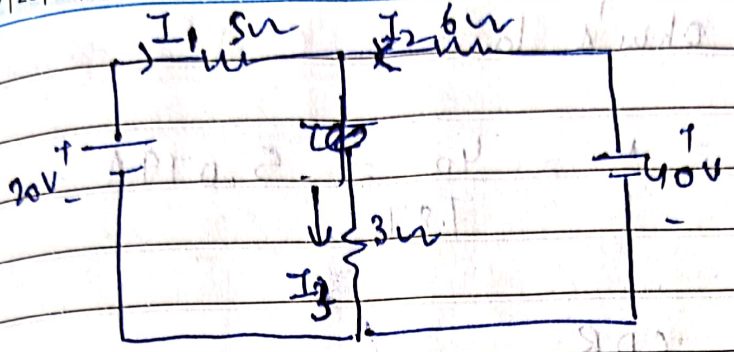
$= 0.72 \times \frac{10}{10+30}$

$I_L'' = 0.18A$

$I_L = I_L' + I_L''$

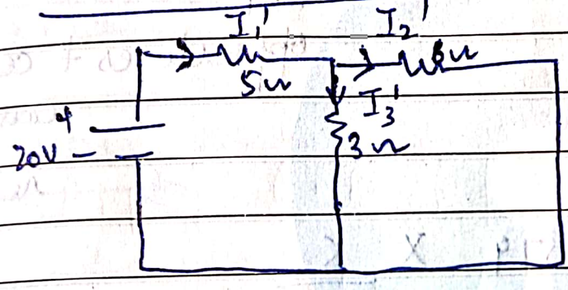
$\boxed{I_L = 0.908 + 0.18} = 1.088A$

Q



Find the current through 3Ω resistor using super position theorem.

Consider Ist source :-



Total resistance $= \frac{6\times3}{6+3}+5$

$= \frac{\cancel{18}\,2}{\cancel{9}}+5 = 7\Omega$

$= 7\Omega$

Apply ohm's law

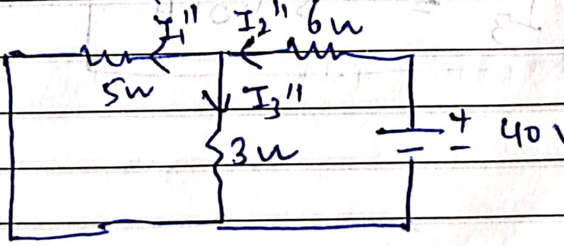
$I_1' = \frac{V}{R} = \frac{20}{7} = 2.8\,A.$

Apply CDR

$I_3' = 2.8 \times \frac{6}{3+6}$

$= 2.8 \times \frac{\cancel{6}\,2}{\cancel{9}\,3} = 1866\,A$

Now consider source 2.



Total resistance $= \frac{5\times3}{5+3}+6 = \frac{15}{8}+6 = 7.8\,7\Omega$

Apply Ohm's law.

9

$I_2'' = \frac{V}{R} = \frac{40}{7.87} = 5.079A$.

10

11 Apply CDR.

12 ~~$I_3'' = I_2'' \times$~~

1 $I_3'' = I_{Total} \times \frac{\text{opposite resistance}}{\text{opposite res + current carrying res.}}$

2

3

$I_3'' = 5.079 \times \frac{5}{5+3}$

4

$= 5.079 \times \frac{5}{8} = 3.17 A.$

5

6 $I_3 = I_3' + I_3''$

$= 1.866 + 3.17$

$$\boxed{I_3 = 5.036A}$$

Important Notes