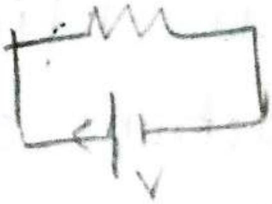
UNIT-1 Electric Circuit

Voltage: Potential difference b/w 2 points. (or) work done for moving a unit charge from one point to other point.

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



It is defined as the potential difference b/w any two points known as voltage.

Voltage is denoted by 'V' and the unit of voltage is volts.

(or)

Voltage is defined as work done in moving unit charge from one point to other point.

$$\boxed{V = \frac{W}{q} = \frac{\text{Joules}}{\text{Colomb}} \Rightarrow \text{Volts.}}$$

Units of voltage is volts & Voltage is denoted by V.

$$\boxed{V = \frac{dW}{dq}}$$

Current: Rate of flow of charge or
Rate of flow of electrons.
'i' or 'I' is the denotion.
Unit: Ampere
It is defined as rate of flow of electrons or charge known as current and current is represented by 'I' or 'i' and the unit of current is amperes.

$$\boxed{\begin{aligned} I &= \frac{q}{t} = \frac{\text{columbs}}{\text{sec}} = \text{Amp.} \\ &= \frac{dq}{dt} \end{aligned}}$$

Energy (W): Capacity to do the work.
Energy is nothing but capacity to do work it is represented by 'W' & unit of energy is joules.

$$\boxed{W = \int P\,dt}$$

$W = \int P\,dt$

<u>Power</u>: Power is nothing but energy with respect to time (or) product of voltage and current. $P = \frac{W}{t}$

Power is denoted by <u>'P'</u>

Units of power is <u>watts.</u>

$$\boxed{\text{Power} = \frac{\text{Workdone}}{\text{Time}} = \frac{\text{Energy}}{\text{Time}} = \frac{W}{t}}$$

$$\text{Power} = \frac{\text{Energy}}{\text{time}} = \text{watts}. \quad P = \frac{dW}{dt}$$

$$\boxed{P = V \times I}$$

$$P = \frac{dW}{\cancel{dq}} \times \frac{\cancel{dq}}{dt}$$

$$\boxed{P = \frac{dW}{dt}}$$

$W = P \times t$

<u>Ohm's law</u>: It states that at constant temperature current is directly proportional to voltage and inversely

proportional to resistance known as ohm's law

Current is directly $\propto$ V

$I \propto V$

$I \propto \frac{1}{R}$

$\boxed{V = IR}$ A

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

$\boxed{R = \frac{V}{I}}$ Ω

Power formulas: $\cancel{P = V \times R}$

$P = V \times I$

$= V \times I = IR \times I$

$\boxed{V = I^2 R}$

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

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

Energy:

$W = \int P.dt = \int V \times I dt$

$W = \int I^2 R dt$

$\boxed{W = I^2 R t}$

limitations: Nature of the material

1) Ohm's law is not applicable to non linear circuits like SCR, diodes, transistors, Ohm's law also depends on the nature of the material.

2) Ohm's law is also not applicable to metals.

Temperature also effects ohm's law.

Problems:

1) A 12 Ω resistor is connected across 6 volts battery find how much current flows through the resistor.

$$V = I R.$$

$$6 = I \times 12$$

$$I = \frac{6}{12}$$

$$I = 0.5 \text{ Amp.}$$

$V = IR$

$6 = I \times 12$

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

0.1Ω

2Q) If 0.6 A current flows through a resistor voltage of 2 points of a resistor is 12 volts. what is the resistance of resistor. $I = 0.6A$

$$R = \frac{V}{I} = \frac{12}{0.6} = 20\Omega \quad V = 12V.$$

3Q) If charge of a material is 30 coulomb we take the time 5 sec. I = ?

$$I = \frac{q}{t} = \frac{30}{5} = 6 \text{ Amp.}$$

Resistor: Resistor is nothing but

Resistor opposes the very ~~of~~ flow of current through it

It is denoted by R.

Units = Ohm (Ω)

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

ρ = Specific resistance (or) resistivity.

factors effecting resistors:

1) Resistance depends upon length of the material

$$R \propto l.$$

2) Area of Cross section

Resistance depends upon area of

cross section $\boxed{R \propto \frac{1}{a}}$

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

ρ = specific resistance or resistivity.

l = length

a = cross sectional area.

Conductance(G): It is the reciprocal of resistance. Denoted by G.

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

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

$$= \Omega^{-1} \text{ (or) } \text{Mho} (\mho)$$

Unit of conductance is ~~mho~~ mho

Resistivity: It is defined as resistance of unit area and unit length it is denoted by 'ρ' & the units are 'ohm-m' (Ω-m)

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

$$\boxed{\rho = \frac{Ra}{l}}$$ = resistance per unit area by unit length

$$\rho = \frac{\text{ohm-m}^2}{m} = \text{ohm-m}.$$

<u>conductivity!</u>

It is defined as reciprocal of resistivity it is represented by 'σ'. unit of conductivity is $\boxed{\sigma = \frac{1}{\rho}}$.

Q. Determine the resistance of 564m length of aluminium conductor whose rectangular cross section ~~is~~ is 4cm x 2cm assume resistivity is equal to 2.826×10^{-8} ohm-m

$$2.826 \times 10^{-8} = \frac{R \times 8 \times 10^{-4}}{564}$$

$$\frac{2.826 \times 10^{-8} \times 564}{8 \times 10^{-4}} = R.$$

$= 1.413 \times 141 \times 10^{-4}$

$R = 1.99233 \times 10^{-2}\ \Omega$

$$\begin{array}{r} 1413 \\ \times\ 141 \\ \hline 1413 \\ 5652 \\ 1413 \\ \hline 199233 \end{array}$$

Q) Calculate the length of copper wire 1.5mm in diameter to have a resistance of 0.3 ohm the resistivity of copper is 0.017 ~~μ Ohm~~ $\mu\Omega$-m.

$r = \frac{1.5}{2} \times 10^{-3}$. $\quad a = \frac{\pi d^2}{4}$.

$R = 0.3\ \Omega$.

$\rho = 0.017 \times 10^{-6}$.

$$a = \frac{\pi d^2}{4}$$

$$= \frac{\cancel{3.14}^{1.} \times \cancel{1.5}^{0.75} \times 1.5 \times 10^{-6}}{\cancel{4}\,\cancel{2}\,1}$$

2)

$2)\,3.14(1.57$
$\quad 2\downarrow$
$\quad 11$
$\quad 10$
$\quad 14$

$$= 1.57 \times 0.75 \times 1.5 \times 10^{-6}$$

$$= 1.76625 \times 10^{-6}$$

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

2

$\mu = 10^{-6}$ m.

1 meter = 100 cms

1 cm = 10 mm

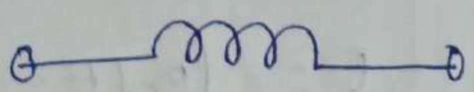
$$0.3 = \frac{0.017 \times 10^{-6} \times l}{1.76625 \times 10^{-6}}$$

$$l = \frac{0.3 \times 1.76625 \times 10^{-6}}{0.017 \times 10^{-6}}$$

$$l = 31.19\text{ m}$$ //

Inductor (L): It doesnot allow any sudden change of current through it. It stores energy in the form of electromagnetic field. It is denoted by 'L'. It is a storage element. When a wire is wound forms L.

Unit of Inductor is Henry (H)

Symbol : .

$V \propto I$ (from Ohm's law)

voltage across inductor

$$V \propto \frac{di}{dt}$$

$$\boxed{V = L\frac{di}{dt}}$$

L

Henry (H)

$V \propto I$

$V \propto \frac{di}{dt}$

$V = L\frac{di}{dt}$

current across the inductor:

$$\frac{di}{dt} = \frac{V}{L}$$

$$\int di = \int \frac{V}{L}\, dt$$

$$\boxed{i = \frac{1}{L}\int V dt}$$

$\frac{V}{L} = \frac{di}{dt}$

$\int di = \int \frac{V}{L} dt$

$i = \frac{1}{L}\int V dt$

Power across the inductor

$$P = V \times I$$

$$= L \frac{di}{dt} \times I$$

$$\boxed{P = IL \frac{di}{dt}}$$

$P = VI$

$= L\frac{di}{dt} \cdot I$

$= IL\frac{di}{dt}$

Energy stored in inductor.

$$E = \int P dt$$

$$= \int I L \frac{di}{\cancel{dt}} \cdot \cancel{dt}$$

$$= L \int I \, di$$

$$\boxed{E = \frac{LI^2}{2}}$$

$W = \int P dt$

$= \frac{LI^2}{2}$

When the inductor is connected to the battery it stores its energy in the form of electromagnetic field & when the battery is removed it provides its energy to the circuit or to the capacitor.

Capacitor (C) :

It is a basic electric element

It is works on the principle of capacitance

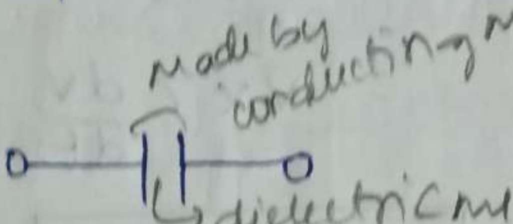
capacitor is a storage element which stores energy in the form of electro static field.

It is denoted by 'c'

unit of capacitor is Faraday (F)

μF

mF

symbol: 

__Current stored in the capacitor:__

__Note__: It stores energy in the form of electrostatic field

It doesnot allow the sudden change of voltage in the circuit.

$q = CV$

$$\frac{dq}{dt} = c\frac{dv}{dt}$$

$$i = c\frac{dv}{dt}$$

$$q = \frac{CV}{\cancel{SEt}}$$

$v = \frac{1}{c}\int i dt$

$$\frac{dq}{dt} = \frac{d}{dt}(CV).$$

$$\boxed{i = C\frac{dv}{dt}}$$

voltage across the capacitor :

$$\frac{dv}{dt} = \frac{1}{C} i$$

$$\int dv = \int \frac{i}{C} dt$$

$$\boxed{v = \frac{1}{C}\int i\,dt}$$

Power across the capacitor :

$$P = V \times I$$

$$= V \times C\frac{dv}{dt}$$

$$\boxed{P = CV\frac{dv}{dt}}$$

Energy across the capacitor :

$$E = \int P\,dt$$

$$= \int CV\frac{dv}{\cancel{dt}}\cancel{dt}$$

$$\boxed{E = \frac{1}{2}CV^2}$$

Types of Elements:

(i) Active & passive
capable to deliver energy / not capable to provide energy but store energy

(ii) linear & non linear.

(iii) lumped & Distributed.

(iv) Unilatural & Bilateral.

Active & Passive elements:

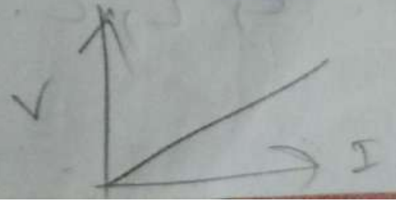
Active elements: capable to provide energy for a very long time

These are nothing but energy sources like voltage and current source & the passive elements includes ~~Indu~~ Resistor, Inductor, capacitor. they are not capable of providing energy for a very long period of time

linear & Non linear

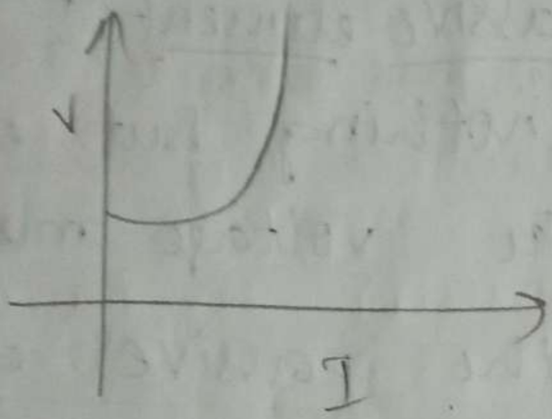
I & V characteristics of these types of elements which passes through the origin and satisfies superposition theorem, ~~principle~~ & ohm's law. principle known as linear elements:

Ex: R, L, C.



Non linear:
In current & voltage characteristics of these types of elements does not pass through origin & Doesnot satisfy superposition theorm, Principle called Non linear elements.

Ex: semiconductors like diodes.



(iii) lumped & Distributed: elements / parameters:

lumped → physically separable small size devices.

Distributed → non physically separable.

lumped elements: which are very small in size and we can separate it easily.

Ex: R, L, C.

Distributed elements:

size is very high which cannot be separated physically

Ex: Transmission lines.

(iv) Unilateral & Bilateral elements:

current passes from anode to cathode

Elements which can conduct current in only one direction known as Unilateral elements

Ex: Diode, SCR (Silicon control Rectifier)

anode, cathode are terminals

Elements which are having two directions or which can conduct current in both the directions known as Bilateral elements.

Ex: R, L, C.

Types of Sources:

(i) Independent

Independent

V

I

Ideal 'V'

Practical 'V'

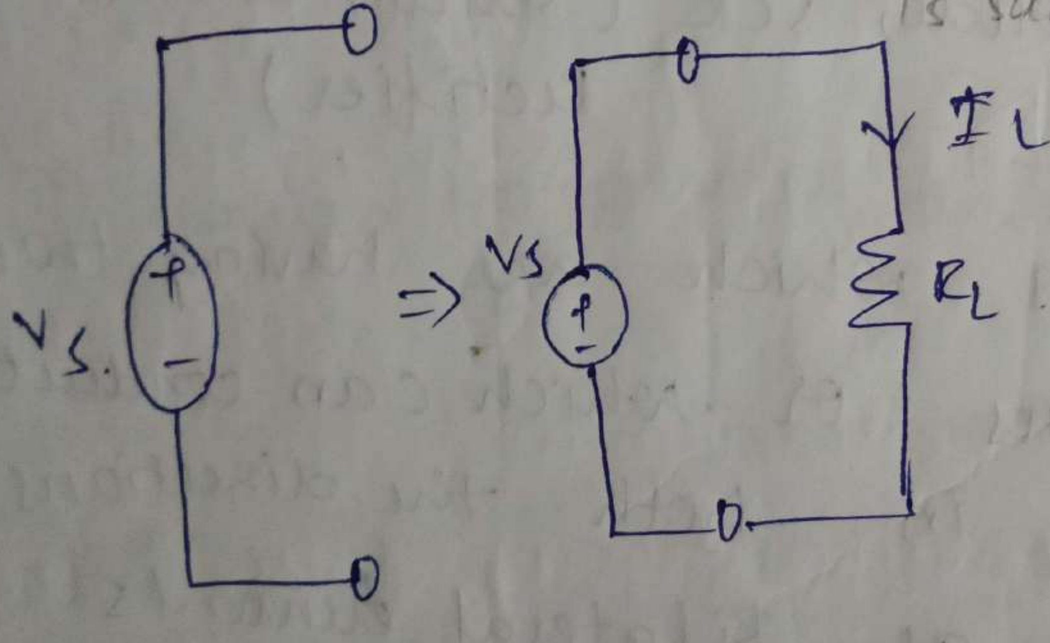
Ideal I

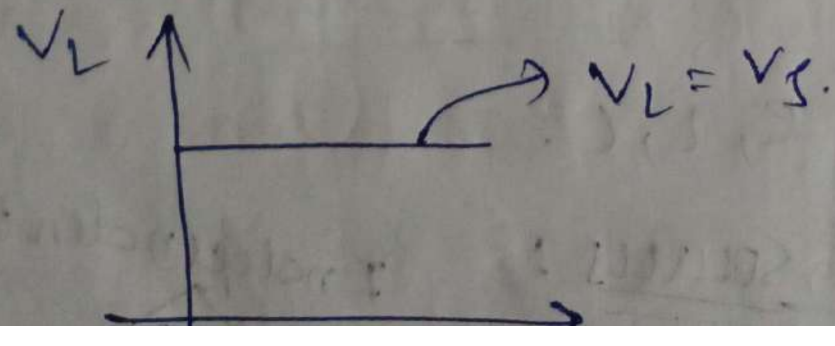
Practical I

(ii) Dependent

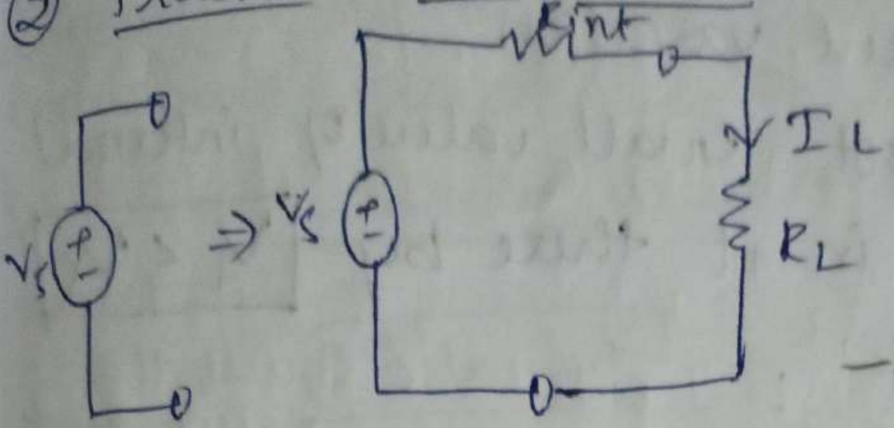
VDVS	VDCS	CDCS	CDVS.
voltage dependent voltage source	voltage dependent current source	current dependent current source.	current dependent voltage source

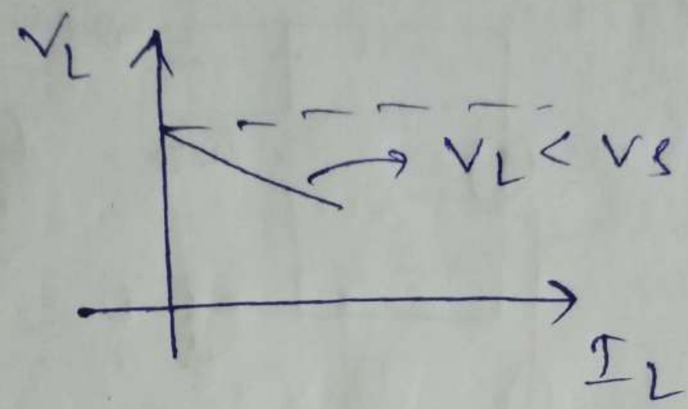
① <u>Ideal</u> <u>(V)</u> <u>source</u>: voltage across the load & source is same irrespective of difference in current





② Practical 'V' source!





① Ideal voltage source!

It is a voltage source which gives constant to the load terminals irrespective of load current variation $\boxed{V_L = V_s}$

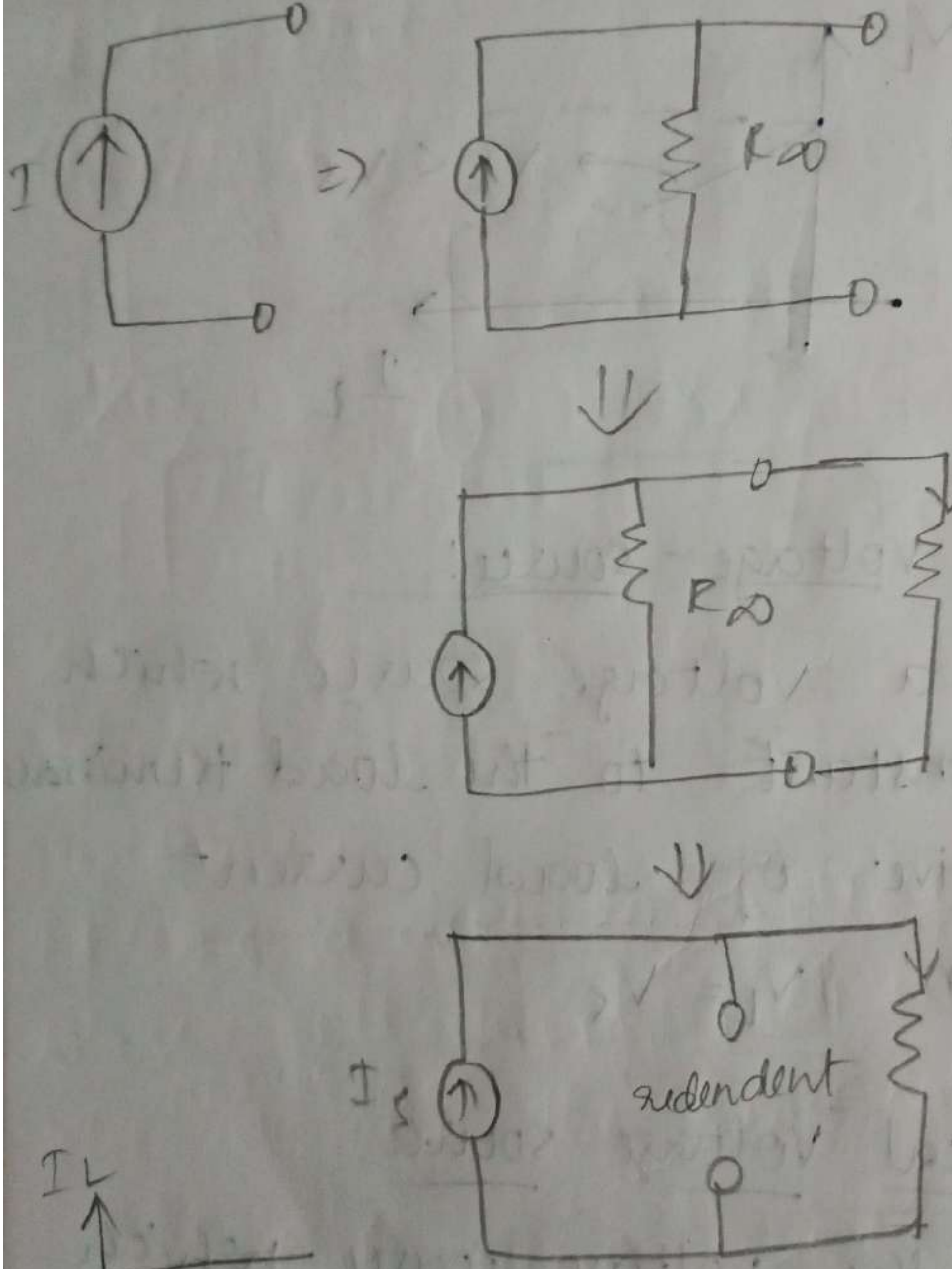
② Practical voltage source!

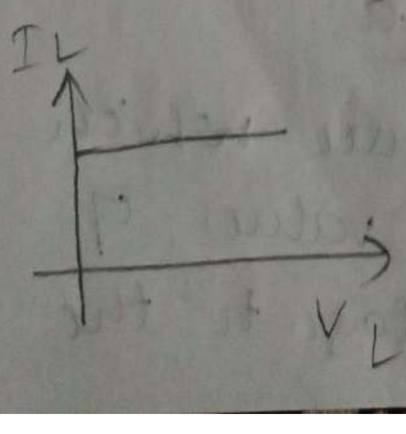
It is the voltage source which delivers the specified value of the voltage or reduced voltage to the

the load terminals with respect to load current variation.

It has got small value of internal resistance in it there by $\boxed{V_L < V_S}$

(iii) Ideal 'I' : In Ideal 'i' source the value of R is ∞ (very high) so 'i' doesn't flow through it. & we remove R_∞ this is called redundant



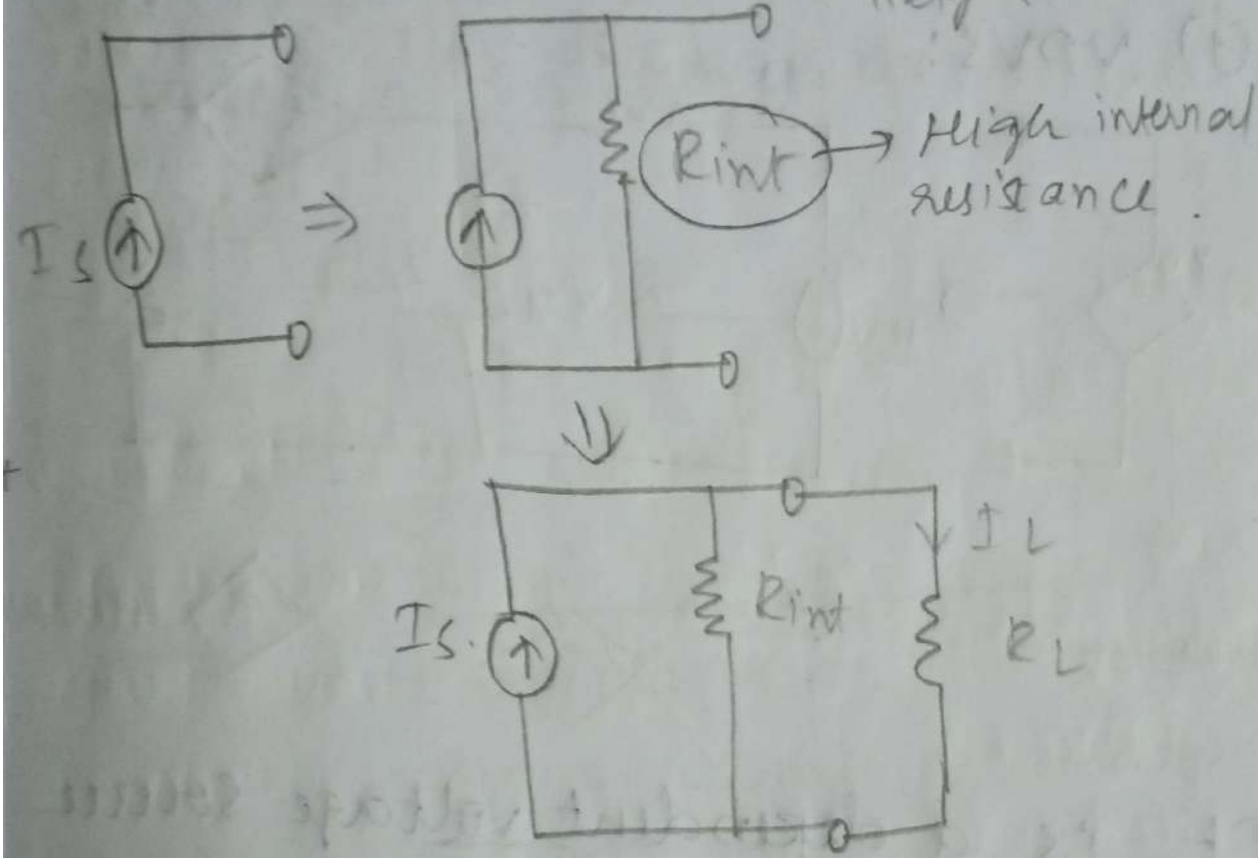


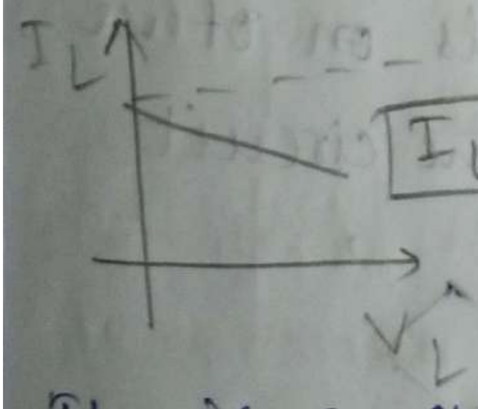
It is a current source which delivers constant value of load current to load terminals irrespective of load variations.

It has infinite value of internal resistance.

$$\boxed{I_L = I_S}$$

(iv) Practical I : In current source int resistor is connected ||ely.





$$\boxed{I_L < I_S}$$

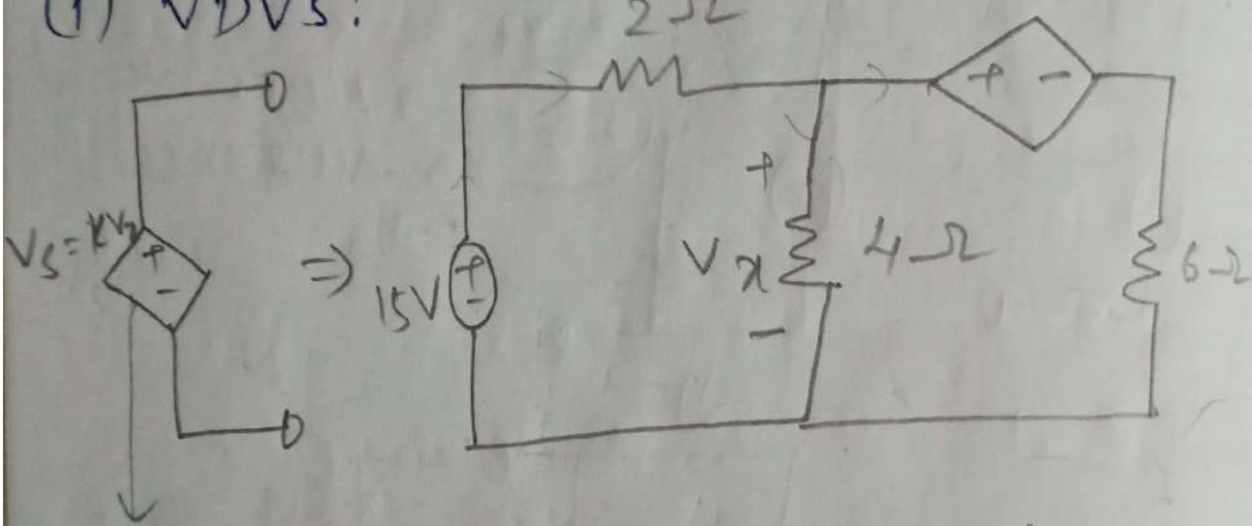
It is a current source which delivers specified value of current or reduced value of current to load terminals wrt load voltage variation

→ It has got high internal resistance

$\boxed{I_L < I_S}$

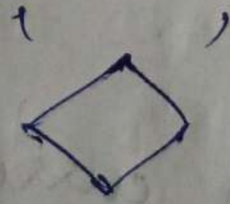
(2) Dependent :

(i) VDVS:

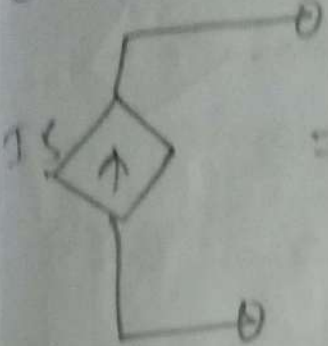


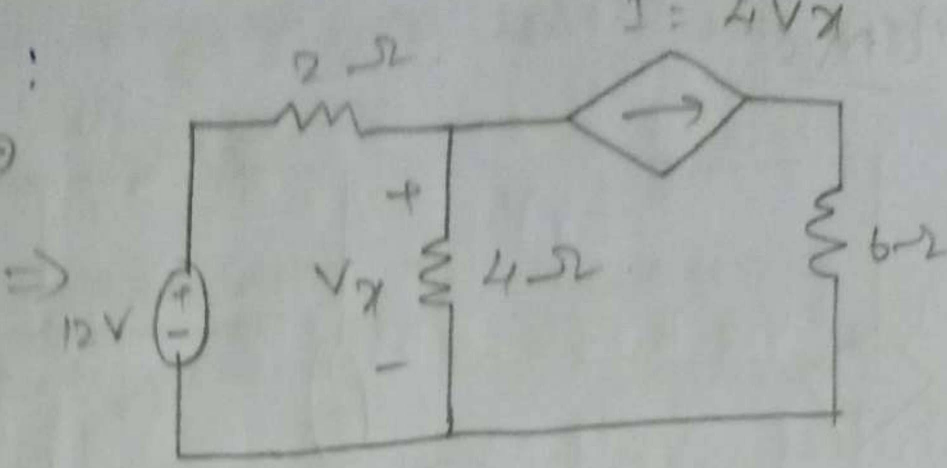
It is a dependent voltage source whose voltage depends on other element voltage in the same circuit

Dependent source



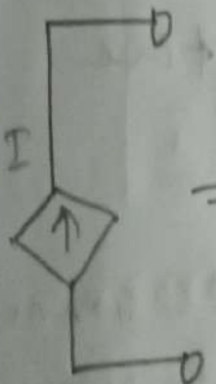
(ii) VDIS:

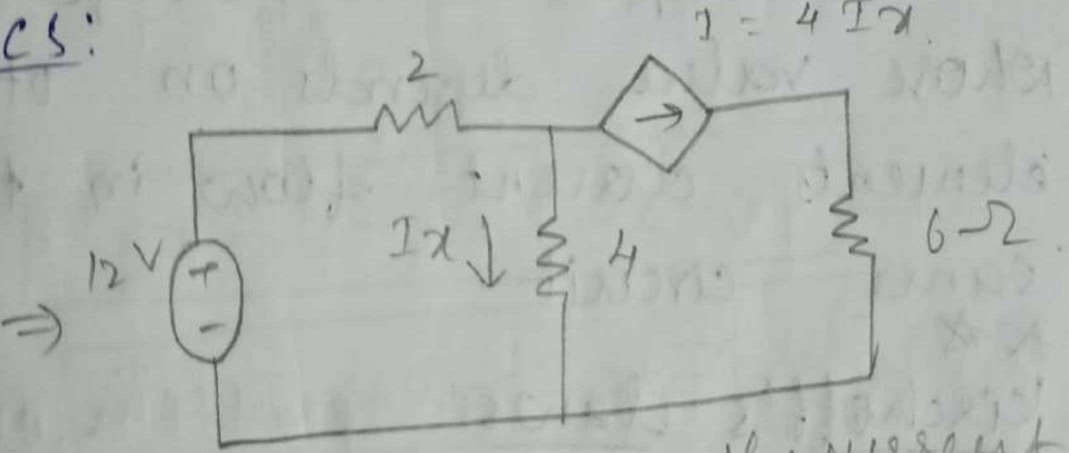




It is a dependent current source which depends on other element voltage in the same circuit.

(iii) CDCS:



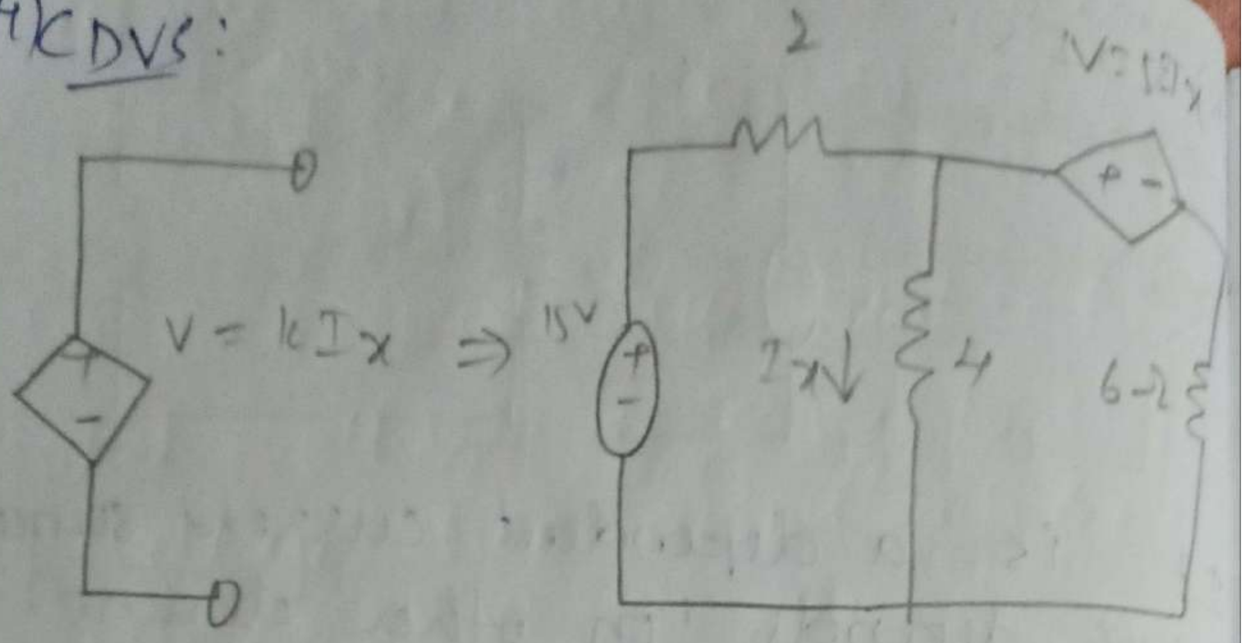


depending on the current from some element in the same circuit.

current dependent current source

It is dependent current source whose value depends on other elements in the same circuit.

4) CDVS:



current dependent voltage source
It is dependent voltage source whose value depends on other elements current flow in the same circuit.

★★
Kirchoff's laws! problem in exam

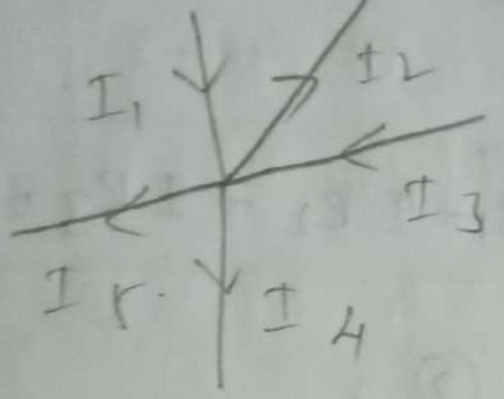
① KCL
② KVL.

1) Kirchoff's current law:

It states that algebraic sum of all the currents meeting at a common point or junction or node is equal to zero

(or)

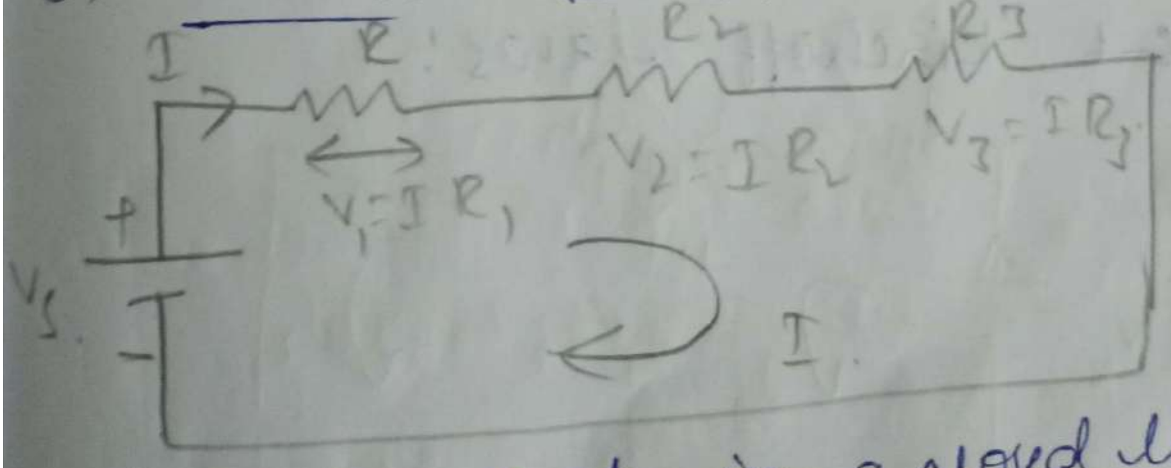
The algebraic sum of incoming currents is equal to algebraic sum of out going current.



$$\boxed{I_1 + I_3 = I_2 + I_4 + I_5} \quad \text{—} (1)$$

$$\boxed{I_1 + I_3 - I_2 - I_4 - I_5 = 0} \quad - (2)$$

(ii) Kirchoff's Voltage law:



It states that in a closed loop algebraic sum of voltage drop across the each and every element is equal to zero

(or)

In a closed loop total voltage total voltage is equal to sum of voltage drop across each & every element.

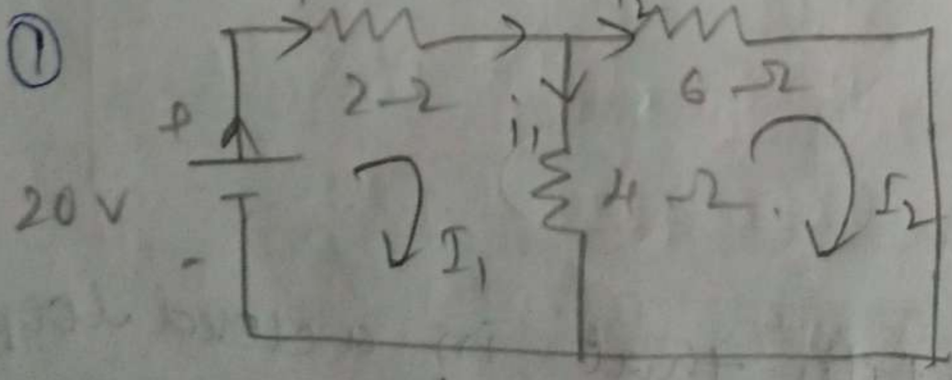
$$\boxed{-V_s + IR_1 + IR_2 + IR_3 = 0.} \quad -①$$

②

$$\boxed{V_s = IR_1 + IR_2 + IR_3}$$

Q) Determine current through each and every element using ~~KCL~~ kirchoff laws:

①



$-20V + 2i + i_1 4 + i_2 6$

Applying KVL to loop 1

$$-20 + 2I_1 + 4(I_1 - I_2) = 0$$

$$2I_1 + 4I_1 - 4I_2 = 20$$

$$6I_1 - 4I_2 = 20 \quad -(1)$$

Applying KVL to loop 2.

$$6I_2 + 4(I_2 - I_1) = 0$$

$$6I_2 + 4I_2 - 4I_1 = 0$$

$$-4I_1 + 10I_2 = 0$$

$$2(3I_1 - 2I_2 = 10)$$

$$3(-2I_1 + 5I_2 = 0)$$

$$\cancel{6I_1} - 4I_2 = 20$$

$$-\cancel{6I_1} + 15I_2 = 0$$

$$11I_2 = 20$$

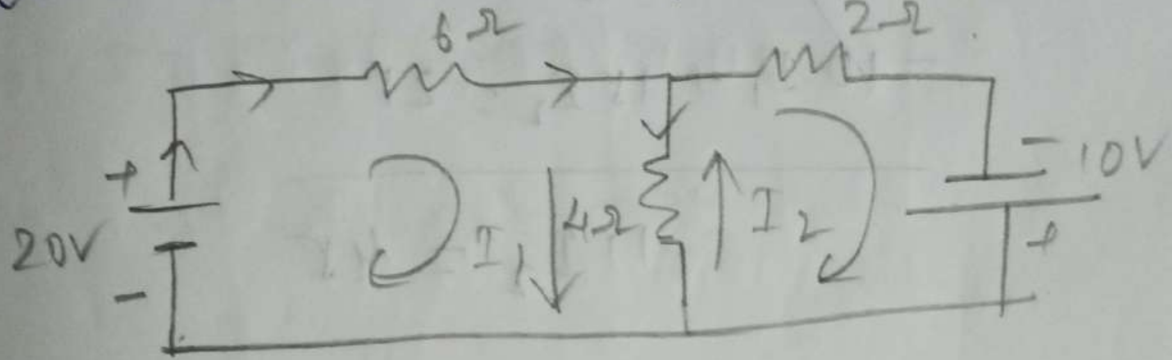
$$I_2 = \frac{20}{11}$$

$-4I_1 + 10\left(\frac{20}{11}\right) = 0$

$-44I_1 + 200 = 0$

$I_1 = \frac{50}{11}$ $-10V + 4(I_2 - I_1) + 2I_2$

1) Determine I value from the circuit.



loop 1

$-20 + 6I_1 + 4(I_1 - I_2) = 0.$

$6I_1 + 4I_1 - 4I_2 = 20.$

$10I_1 - 4I_2 = 20.$

$3(5I_1 - 2I_1 = 10.)$

loop 2

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

$6I_2 - 4I_1 - 10 = 0.$

$5(3I_2 - 2I_1 = 5)$

$2(5I_1 - 2I_2 = 10)$

$5(-2I_1 + 3I_2 = 5)$

$$\cancel{10 I_1} - 4I_2 = 20$$

$$\cancel{-10 I_1} + 15 I_2 = 25$$

$$11 I_2 = 45$$

$$I_2 = \frac{45}{11}$$

$$5I_1 - 2\left(\frac{45}{11}\right) = 10$$

$$55 I_1 - 90 = 110$$

$$55 I_1 = 200$$

$$I_1 = \frac{\cancel{200}\ 40}{\cancel{55}\ 11}$$

$$I_1 = \frac{40}{11}$$

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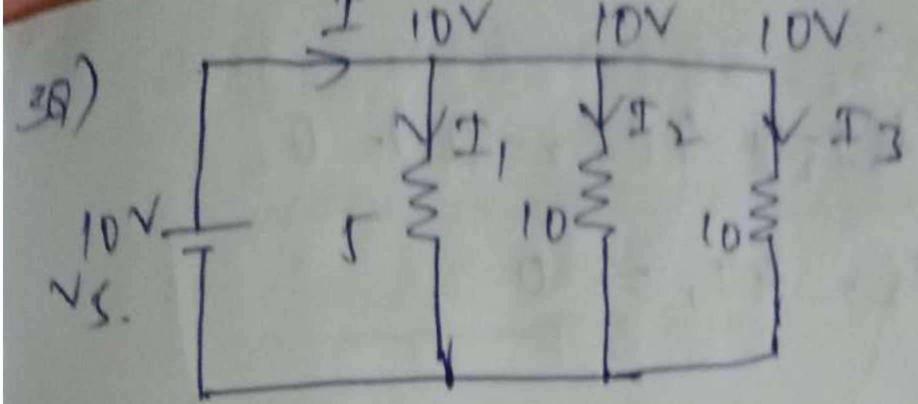
3a)



find out the value of i

→ KCL

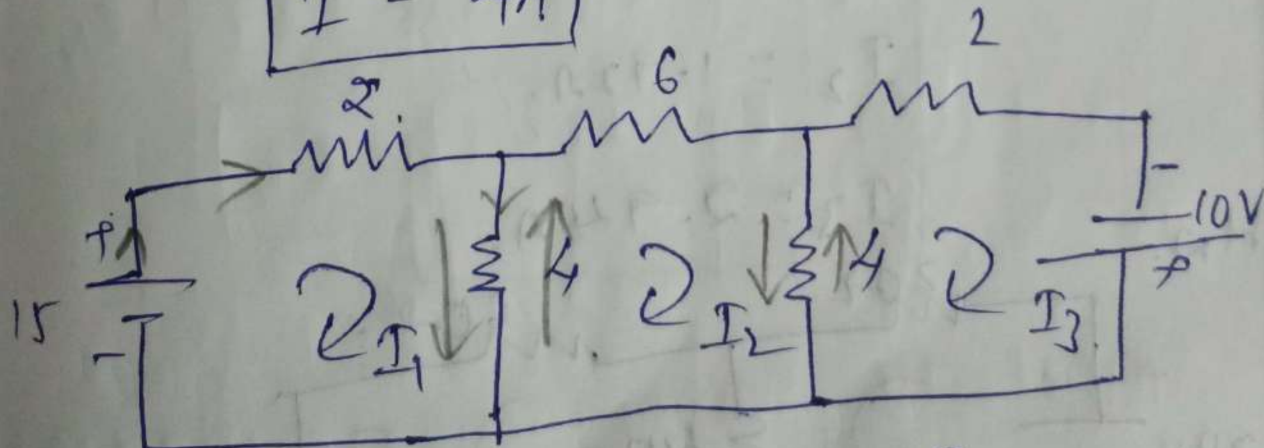
→ $I = I_1 + I_2 + I_3$.

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

$I = \frac{10}{5} + \frac{10}{10} + \frac{10}{10}$.

$= 2 + 1 + 1$

$\boxed{I = 4A}$



$-15 + 2i_1 + 4(I_1 - I_2) = 0$.

$6I_1 - 4I_2 = 15$

loop 2:

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

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

$$14I_2 - 4I_1 = 0.$$

$$14I_2 - 4I_1 + 4I_3 = 0. \quad — (2)$$

loop 3:

$$2I_3 - 20 + 4(I_3 - I_2) = 0.$$

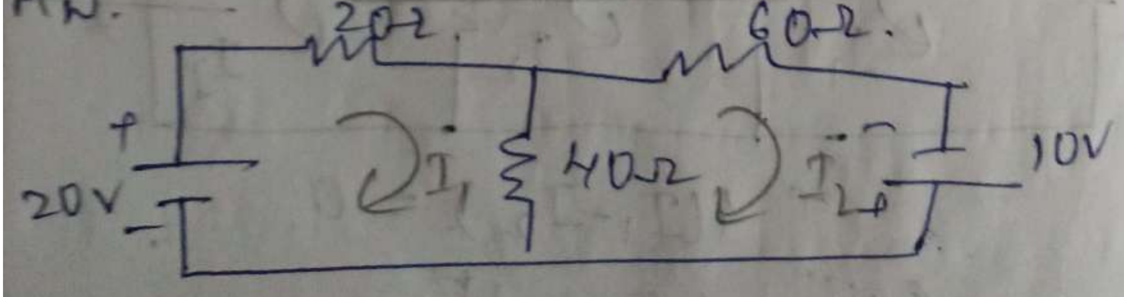
$$2I_3 - 10 + 4I_3 - 4I_2 = 0.$$

$$6I_3 - 4I_2 = 10.$$

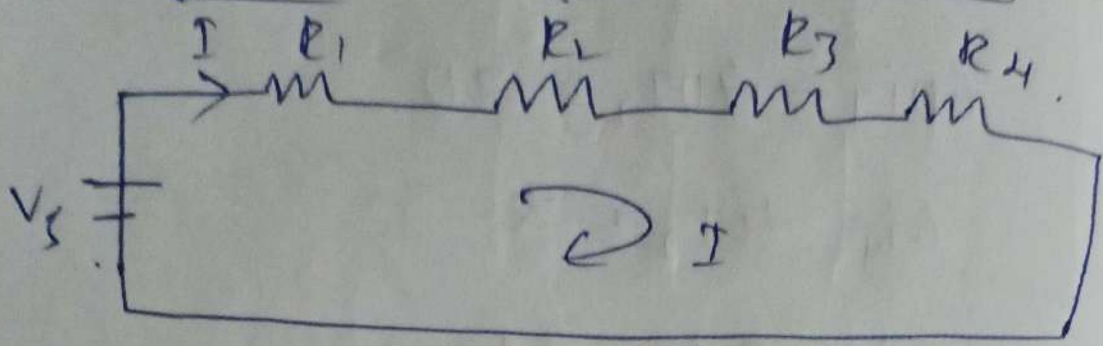
$$3I_3 - 2I_2 = 5. \quad — (3)$$

$$\boxed{\begin{aligned} I_1 &= 3.78A. \\ I_2 &= 1.92A. \\ I_3 &= 2.94A. \end{aligned}}$$

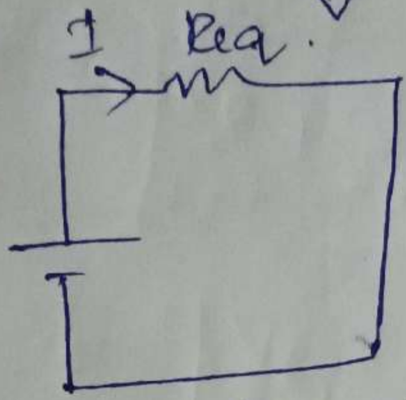
H.W.



→ Resistors- Series Connection:



⇓



Equivalence circuit

$$-V_s + V_1 + V_2 + V_3 + V_4 = 0.$$

$$V_1 + V_2 + V_3 + V_4 = V_s.$$

$$I R_{eq} = I R_1 + I R_2 + I R_3 + I R_4.$$

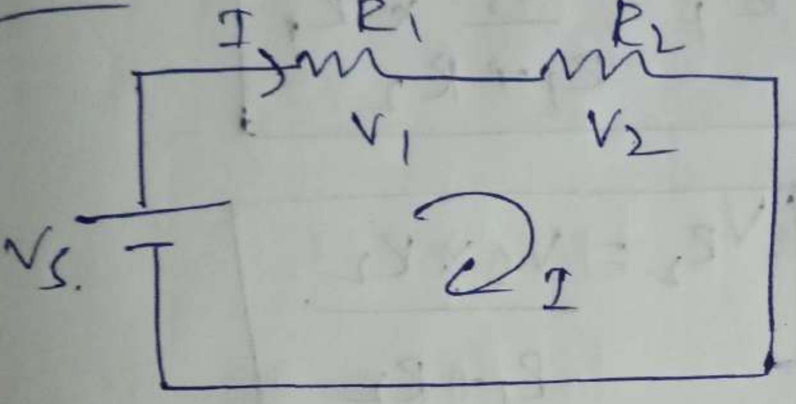
$$\boxed{R_{eq} = R_1 + R_2 + R_3 + R_4}$$

In series connection Req is equal to summation of all resistors.

Q) Consider a series, resistive circuit in which two resistors r_1 & r_2

are connected in series across one voltage source in these series circuits current is constant voltage drop across ~~ress~~ resistor is given by IR

Voltage division principle:



consider a series resistive circuit in which R_1 & R_2 are connected in series across a single voltage source. Here, since the circuit is series current is constant

$$-V_S + V_1 + V_2 = 0$$

$$V_S = V_1 + V_2$$

$$V_S = IR_1 + IR_2$$

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

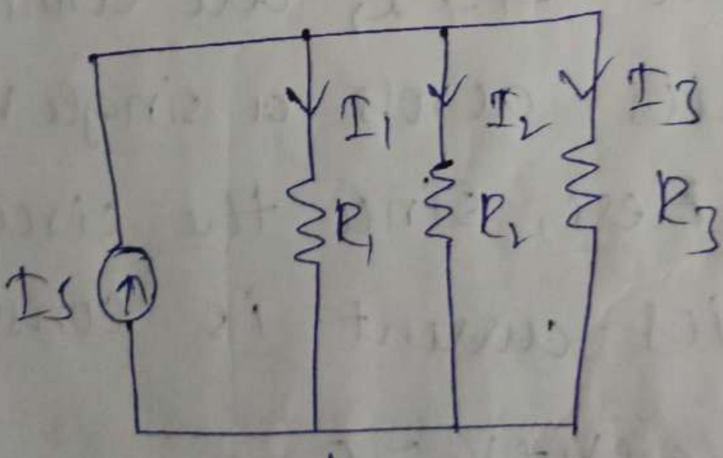
$$I = \frac{V_s}{R_1+R_2}$$

$$V_1 = I R_1$$

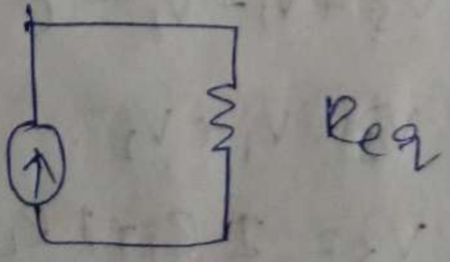
$$\boxed{V_{R_1} = \frac{V_s}{R_1+R_2} \times R_1}$$

$$\boxed{V_{R_2} = \frac{V_s \times R_2}{R_1+R_2}}$$

Resistor- Parallel combination:



$\Rightarrow$



$KCL = I_1 + I_2 + I_3$.

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\boxed{I_s = \frac{V}{R_{eq}}}$$

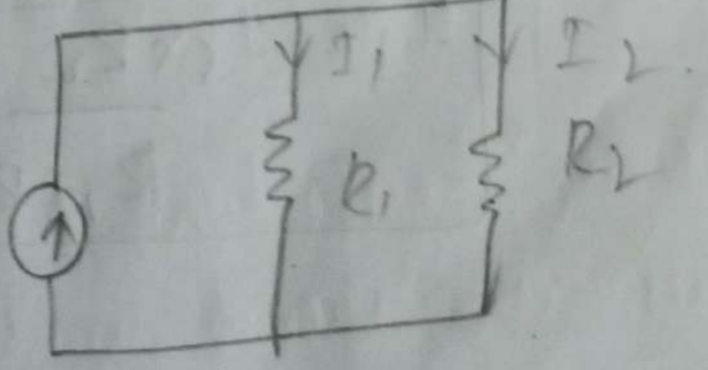
$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

If n resistors are connected in parallel

$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_n}}$$

<u>Current division principle</u>:

current across single element in the circuit



KCL

$I_S = I_1 + I_2$

$V_S = V_1 = V_2$

$V_1 = V_2$

$I_1 R_1 = I_2 R_2$

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

$I_S = I_1 + I_2$

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

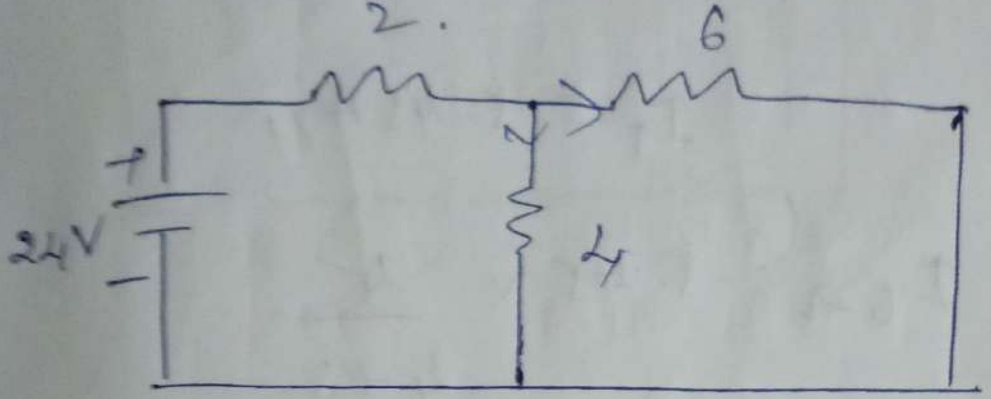
$$I_S = I_2 \left(\frac{R_2 + R_1}{R_1} \right)$$

$$\boxed{I_2 = I_S \cdot \frac{R_1}{R_1 + R_2}}$$

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

Problem !

1) Determine power dissipated by 6 Ohms resistor using required technique.



$$P = VI.$$

264 $\quad P_{6\Omega} = I_6^2 R.$

$$I_6 = I_T \times \frac{4}{4+6}.$$

$$I_T = \frac{V}{Req}$$

$$R_T \text{ (or) } R_{eq} = \frac{6 \times 4}{6+4} + 2$$

$$= \frac{24}{10} + 2$$

$$Req. = 4.4 \Omega$$

$\frac{60}{240}$
44
I_1

$\frac{60}{11}$

11)60(5.4
55
50

$$I_T = \frac{V}{R_{eq}}$$

$$= \frac{24}{4.4}$$

$$I_T = 5.45A$$

$$I_{6\Omega} = 5.45 \times \frac{4}{4+6}.$$

$$= \frac{5.45 \times 4}{10}$$

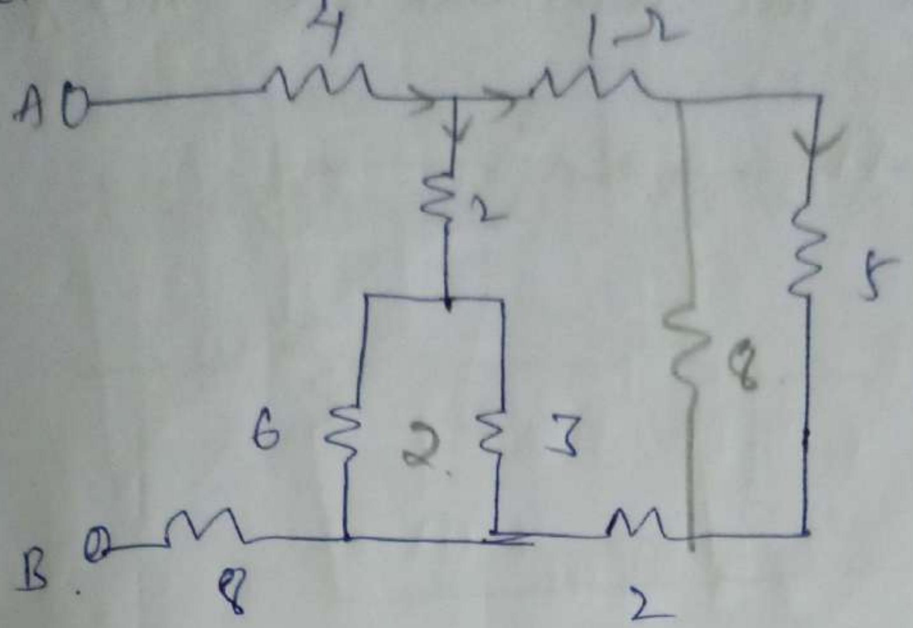
$$\boxed{I_{6\Omega} = 2.18A}$$

$$P_{6\Omega} = I_6^2 R_6$$

$$= (2.18)^2 \times 6$$

$$\boxed{P_{6\Omega} = 28.5144W}$$

Q) Determine Req b/w A & B terminals as shown in the below circuit : came in final exams



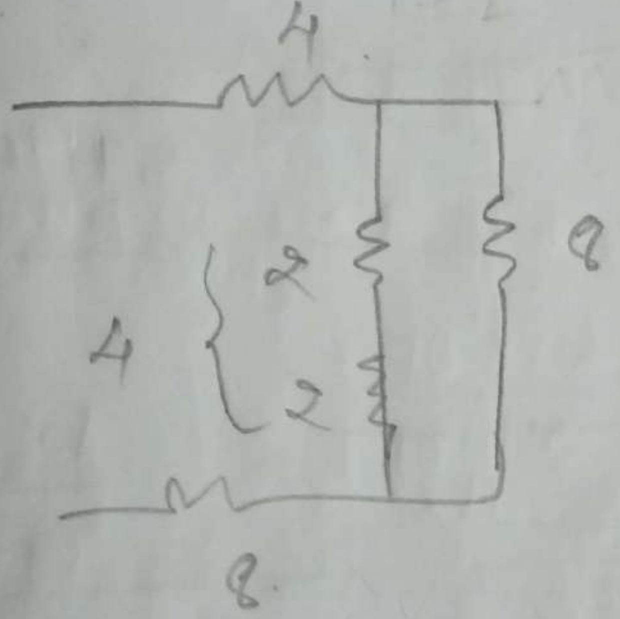
1+5+2

= 8

2

$\frac{\cancel{6}\times\cancel{3}}{\cancel{9}}$

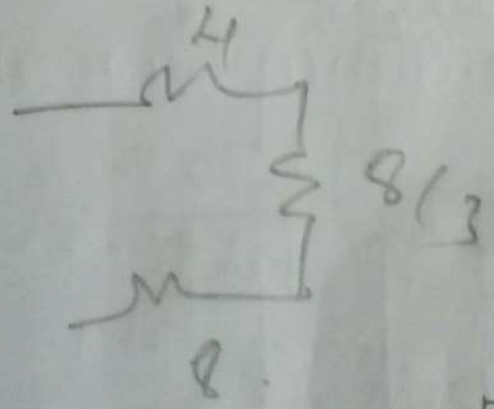
4+



$\frac{32}{4+8}$

$\frac{\cancel{32}}{\cancel{12}}$ 8

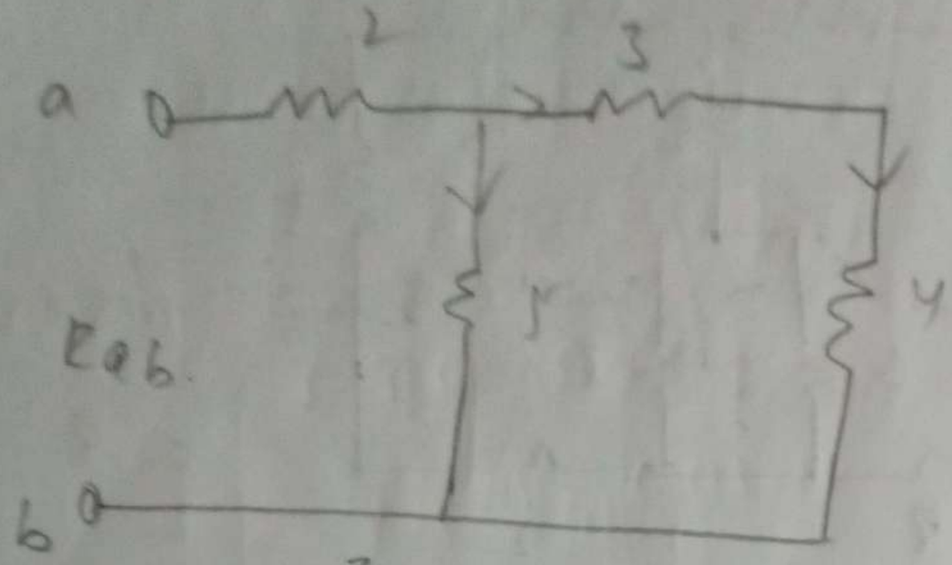
3



$4+8/3+8$

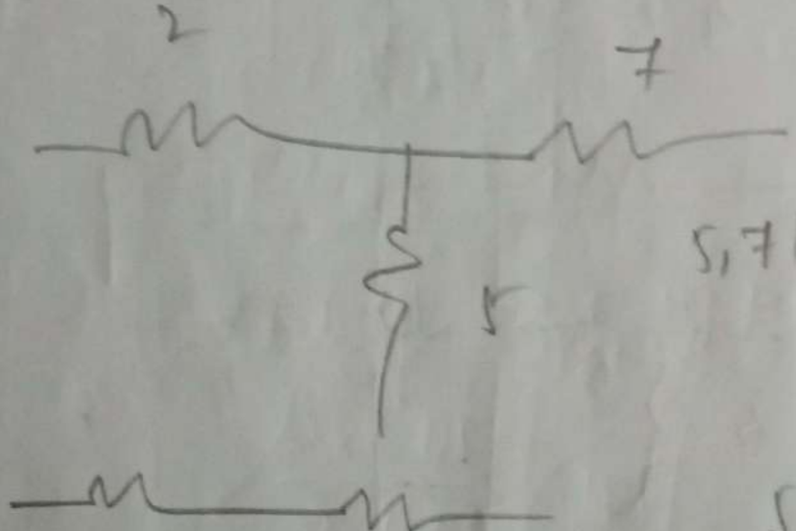
$R_{AB} = 14.6\Omega$

8) Evaluate the resistance b/w A & B



3, 4 series

$3+4=7$



5, 7 || el.

35/

$\frac{5\times 7}{5+7}$

$2+35/12$

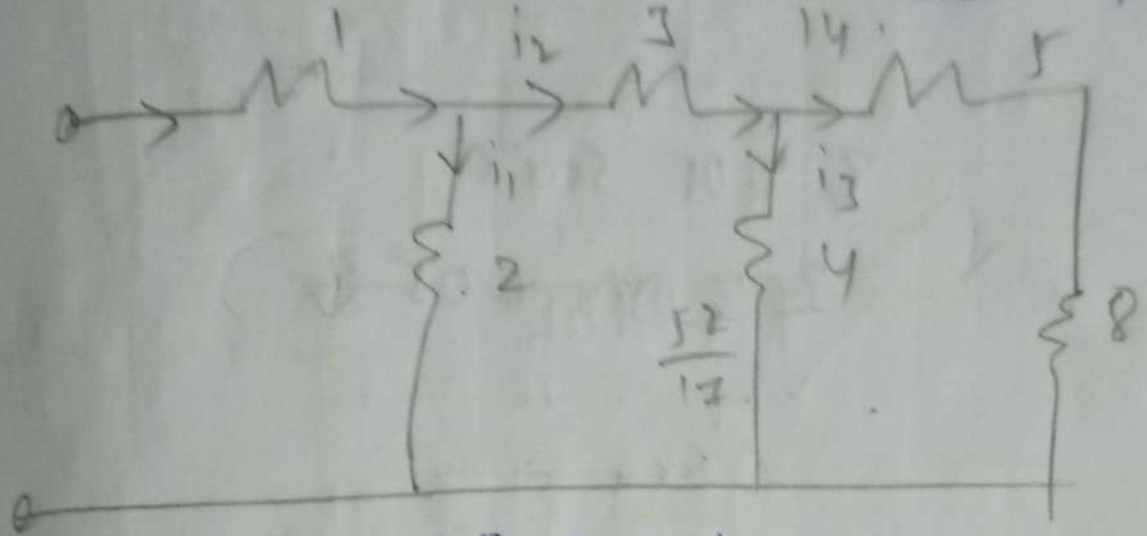
$\frac{35}{12}$

$\frac{24+35}{12} = \frac{59}{12}$

$R_{ab} = 4.91$

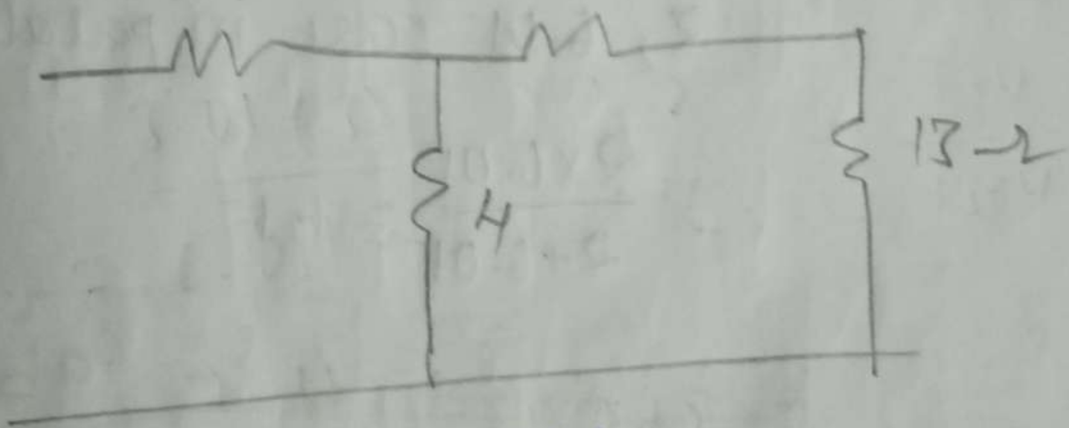
Always sort out series from right

Q) calculate the resistance b/w AB terminals of the circuit shown below.



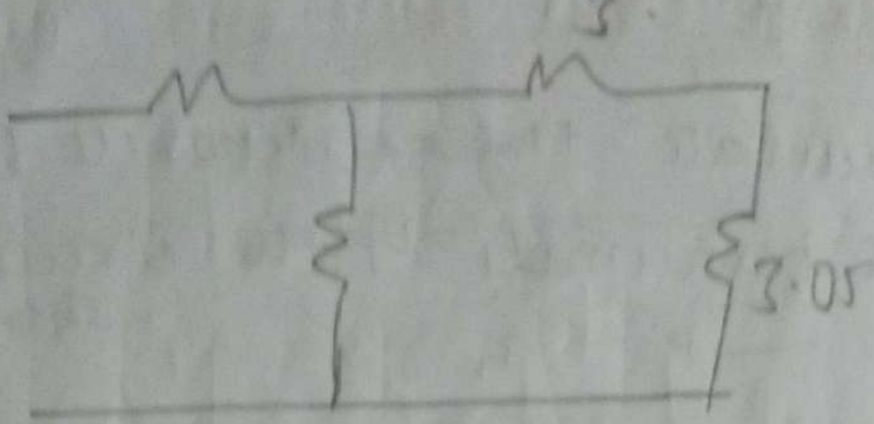
5, 8 series

5 + 8 = 13.



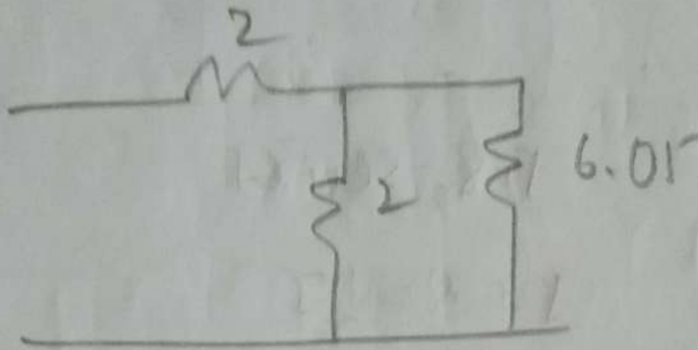
4, 13 ∥el.

$$\frac{4 \times 13}{4 + 13} = 3.05\ \Omega.$$



3, 3.05 series.

$3+3.05 = 6.05\,\Omega$.



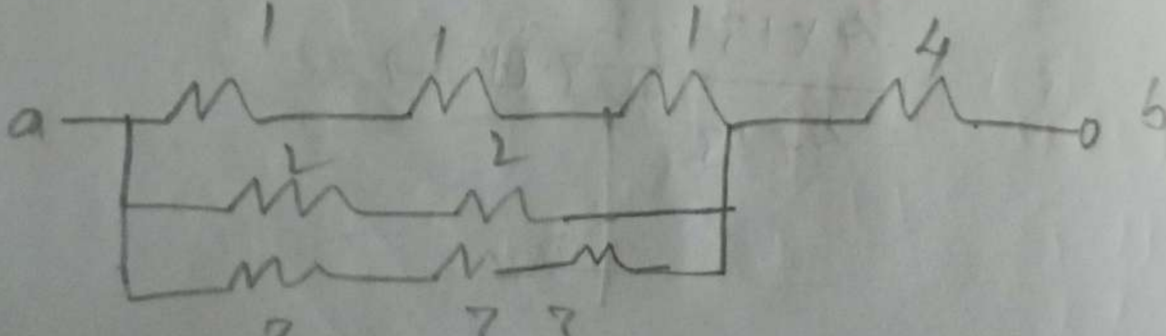
2, 6.05 are in parallel

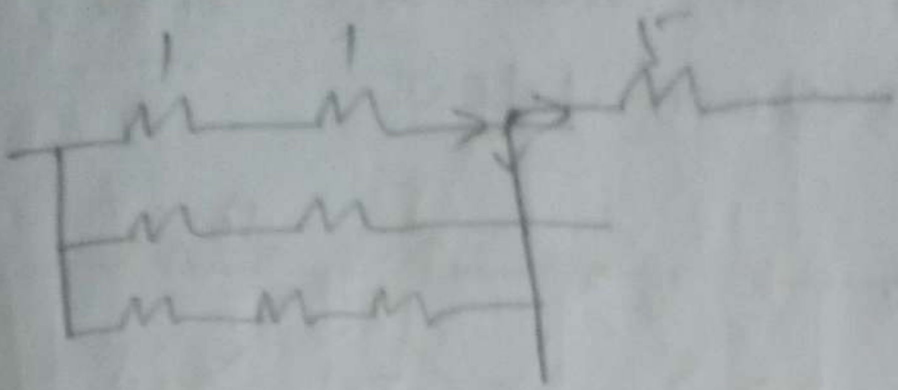
$$\frac{2\times 6.05}{2+6.05} = 1.5$$

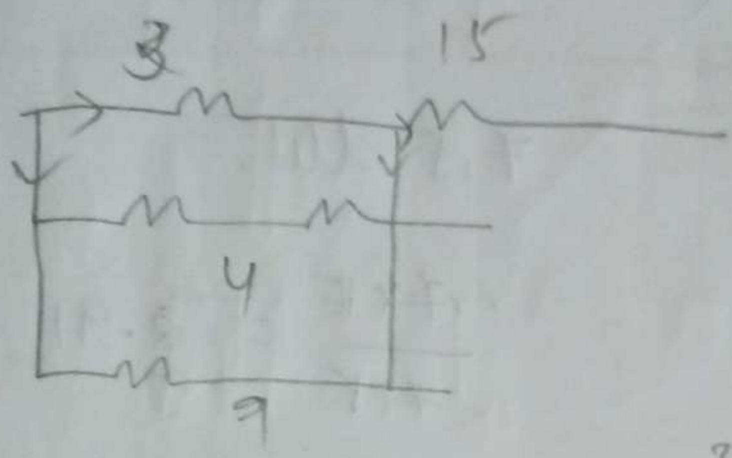
$1+1.5 = \boxed{2.5 = R_{ab}}$

6marks.

Q) Evaluate resistance b/w ab terminals







$$\frac{\frac{12}{7} \times 9}{\frac{12}{7} + 9} + 15 \qquad \frac{3 \times 4}{7} \qquad \frac{12}{7}$$

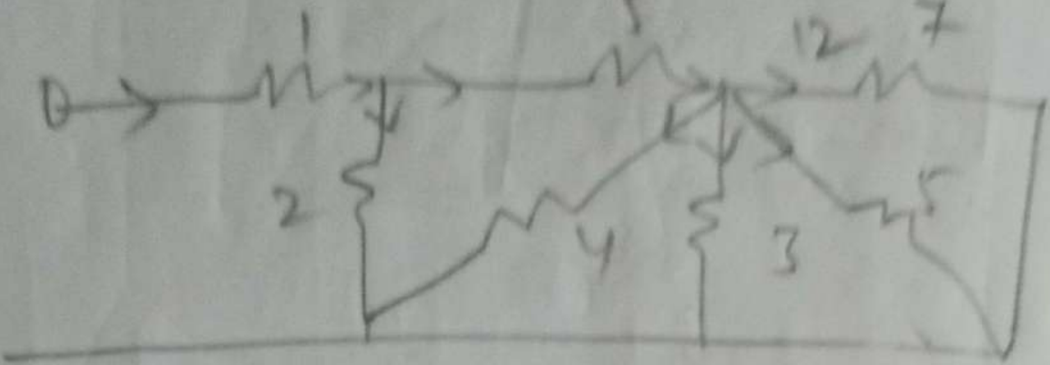
$$= \frac{1.7 \times 9}{1.7 + 9} + 15$$

$$\frac{15.3}{10.7} + 15$$

$$1.42 + 4.$$

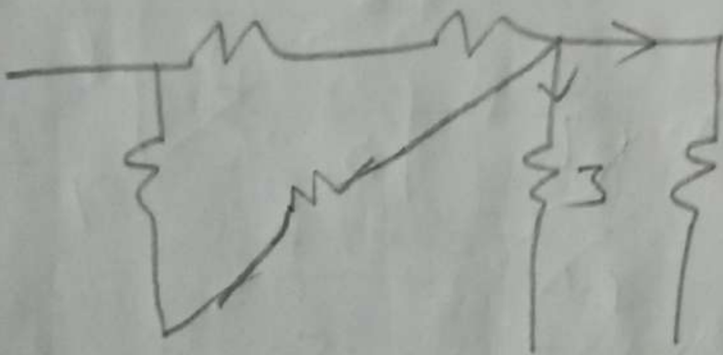
$$\boxed{R_{ab.} = 5.42\Omega}$$

Q. Calculate the total resistance of the circuit shown below:

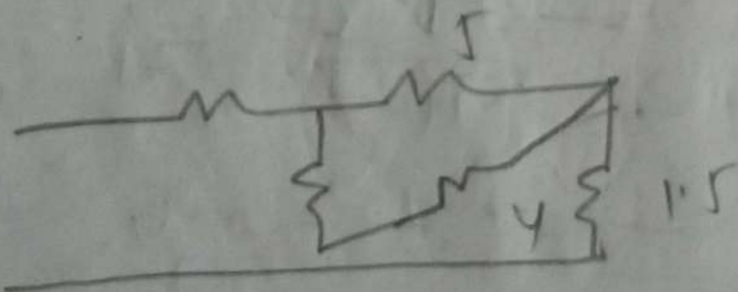


7,5 ll.

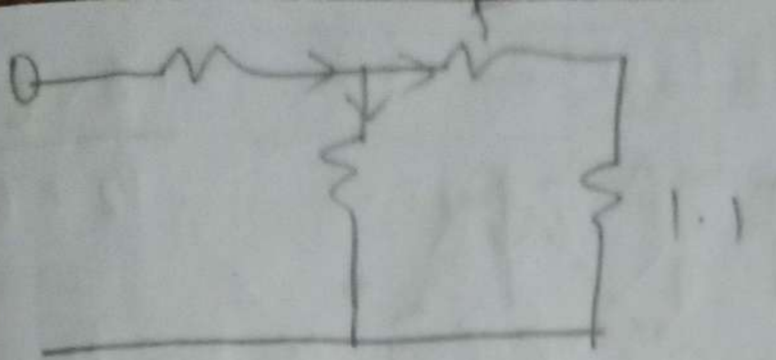
$$\frac{7\times 5}{7+5} = 2.91$$



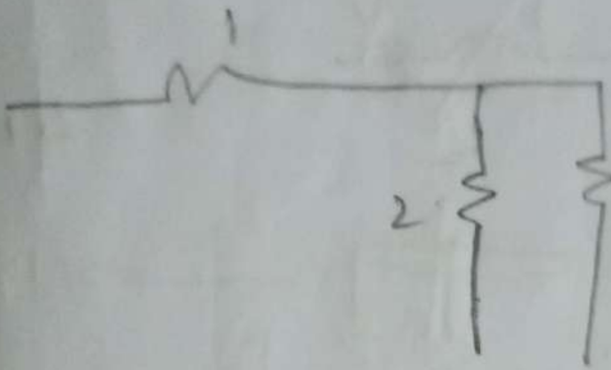
$$\frac{3\times 2.91}{3+2.91} = 1.5$$



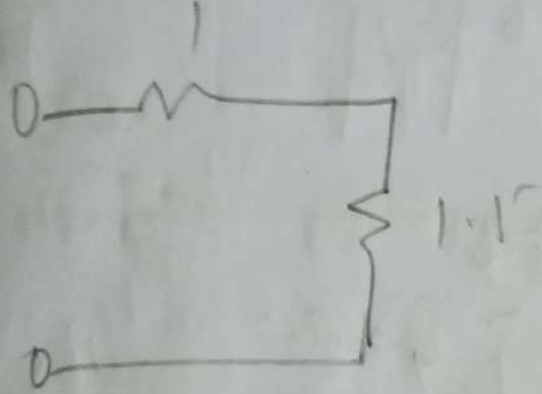
$$\frac{4\times 1.5}{5.15} = 1.1\Omega$$



$5+1.1=6.1$

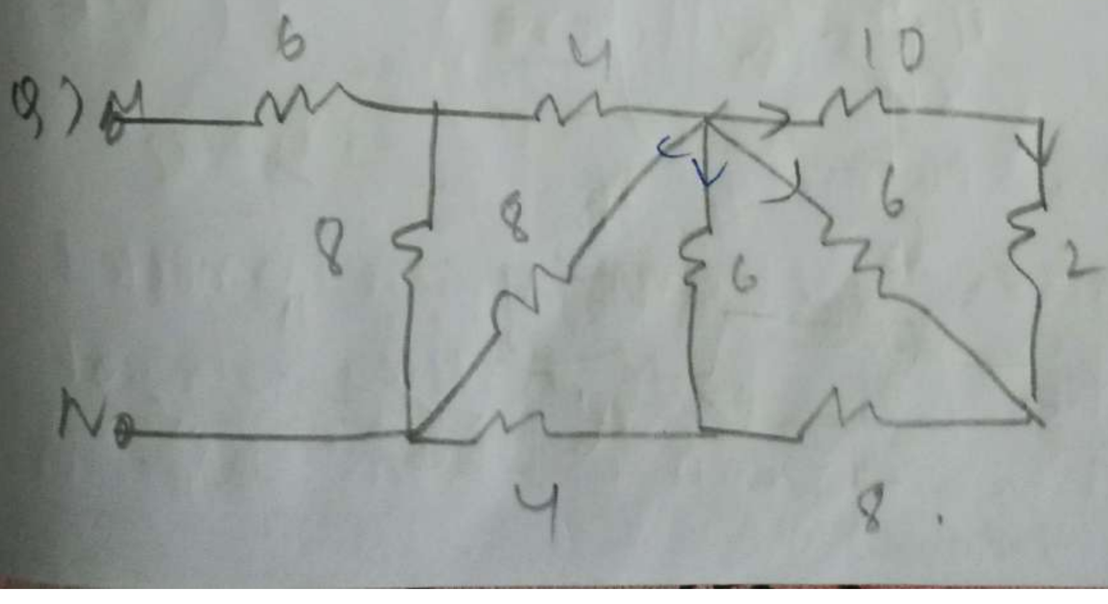


$6.1 = \frac{2\times6.1}{2+6.1} = 1.5$

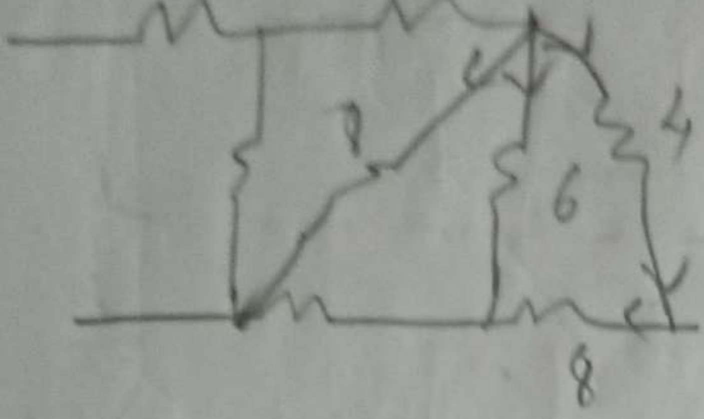


$1+1.5=2.5$

$\boxed{2.5 = R_{ab}}$

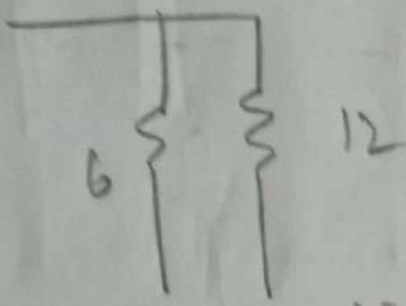


$$\frac{12\times 6}{12+6}$$



$4+8$

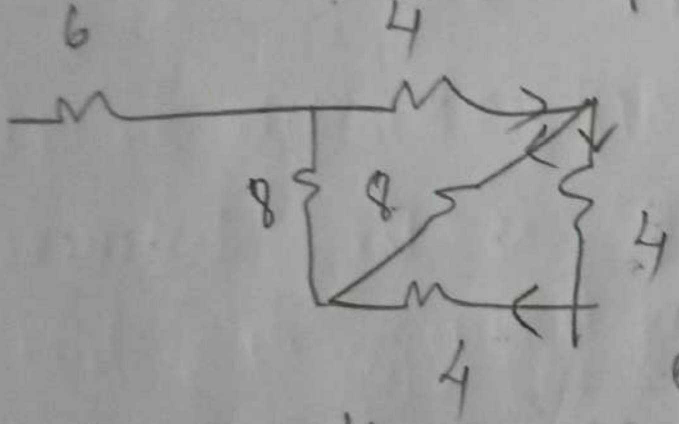
12



3

$$\frac{12\times 4}{12+4} = \frac{12\times 4}{16}$$

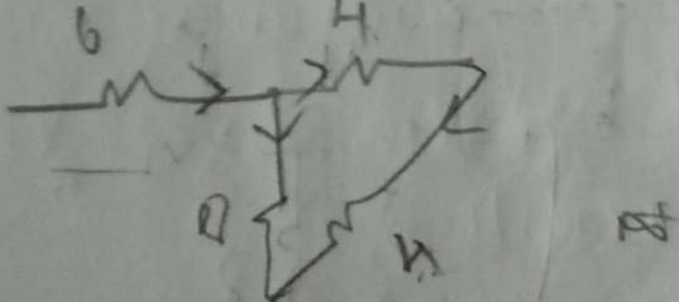
4

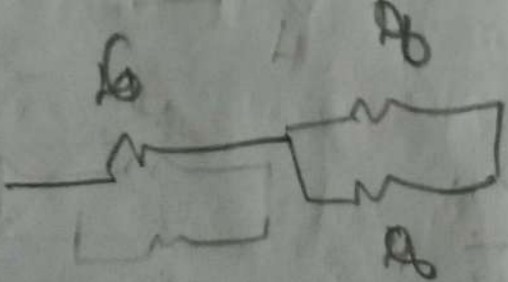


$$\frac{4\times 8}{4+8}$$

$$\frac{8\times 8}{8+8} = 4$$

$$\frac{32}{12}$$

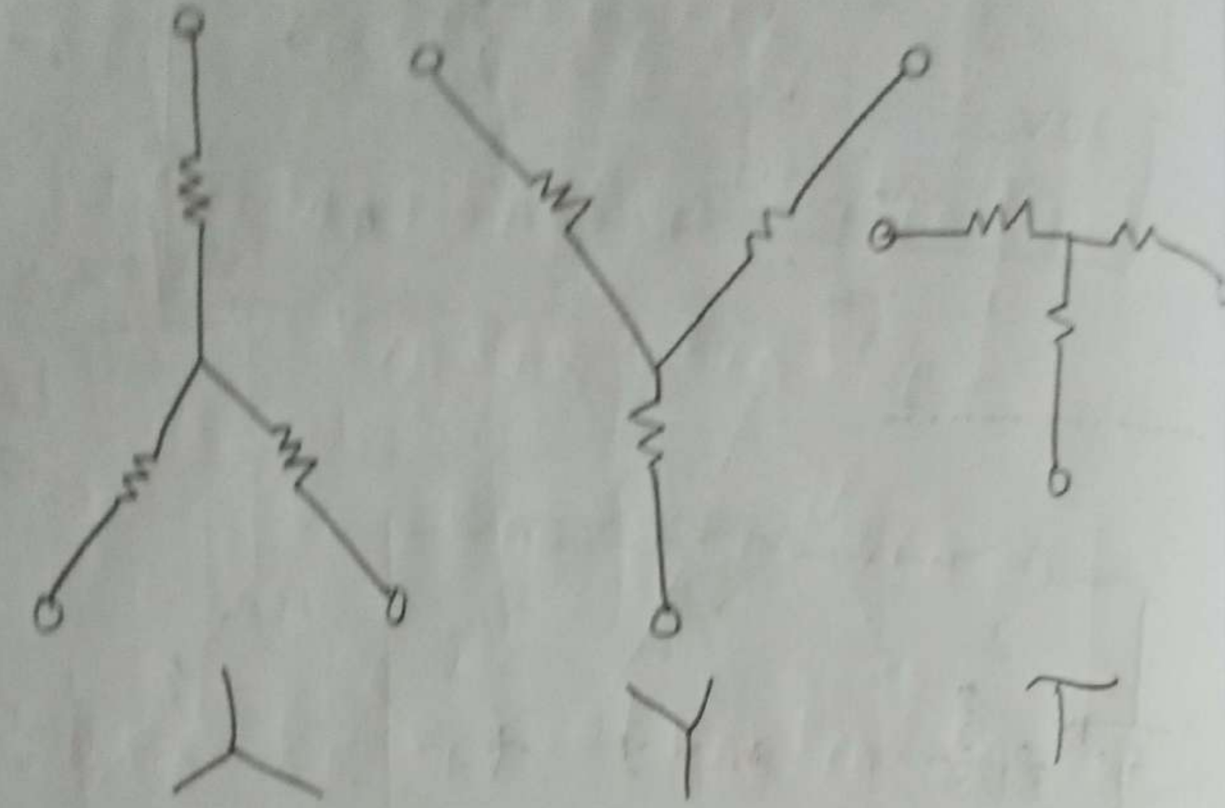




4

$6+4=10$

Star Connection!



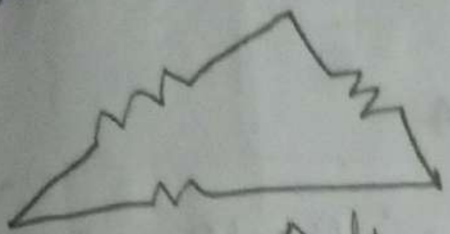
It is defined as the three elements connected at a single node, node point or neutral point known as star connection.

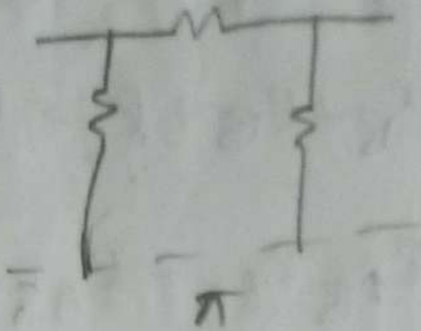
It is Represented by ⅄ (star)
(Y-network) Y (T-Shape)
T

Delta Connection:

Whenever 3 elements are connected together it forms a delta network either it will be Δlar shape or π shape.

Delta Connection: 3 elements are taken

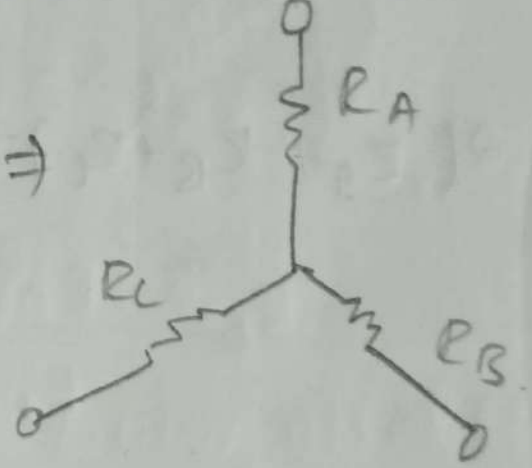


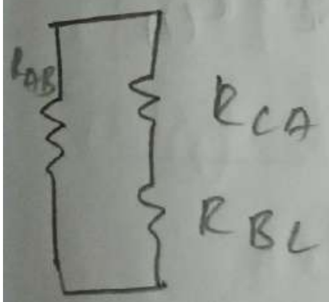


and connected together as a closed loop.

Delta to star Connection:

RAB ⇒





$$R_{A\cancel{B}} + R_B = \frac{R_{AB} \parallel (R_{CA} + R_{BC})}{R_{AB} + R_{BC} + R_{CA}} \quad -(1)$$

$$R_B + R_C = \frac{R_{BC} \parallel (R_{CA} + R_{AB})}{R_{AB} + R_{BC} + R_{CA}} \quad -(2)$$

$$R_C + R_A = \frac{R_{CA} \parallel (R_{AB} + R_{BC})}{R_{AB} + R_{BC} + R_{CA}} \quad -(3)$$

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Adding ① + ② + ③

$$R_A + R_B + R_B + R_C + R_C + R_A = \frac{R_{AB}R_{CA} + R_{AB}R_{BC} + R_{BC}R_{CA} + R_{BC}R_{AB} + R_{CA}R_{AB} + R_{CA}R_{BC}}{R_{AB} + R_{BC} + R_{CA}}$$

$$2(R_A + R_B + R_C) = \frac{2(R_{AB}R_{CA} + R_{AB}R_{BC} + R_{CA}R_{BC})}{R_{AB} + R_{BC} + R_{CA}} \quad -④$$

④ − ①

$$\cancel{R_A} + \cancel{R_B} + R_C - \cancel{R_A} - \cancel{R_B} = \frac{R_{AB}\cancel{R_{CA}} + R_{AB}\cancel{R_{BC}} + R_{CA}R_{BC}}{R_{AB} + R_{BC} + R_{CA}} - \frac{R_{AB}\cancel{R_{CA}} + R_{\cancel{AB}}R_B}{R_{AB} + R_{BC} + R_{CA}}$$

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$$\boxed{R_C = \frac{R_{CA} R_{BC}}{R_{AB} + R_{BC} + R_{CA}}}$$

④ − ②

$$R_A + \cancel{R_B} + \cancel{R_C} - \cancel{R_B} - \cancel{R_C}$$

$$= \frac{R_{AB} R_{CA} + \cancel{R_{AB} R_{BC}} + \cancel{R_{CA} R_{BC}} - \cancel{R_{BC} R_{CA}} - \cancel{R_{BC} R_{AB}}}{R_{AB} + R_{BC} + R_{CA}}$$

$$\boxed{R_A = \frac{R_{AB} R_{CA}}{R_{AB} + R_{BC} + R_{CA}}}$$

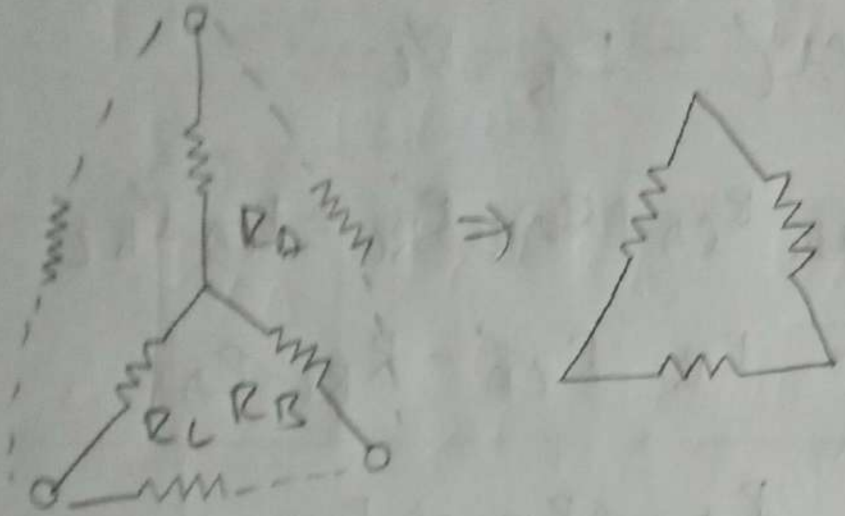
④ − ①.

$$\cancel{R_A} + R_B + \cancel{R_C} - \cancel{R_A} - \cancel{R_C}$$

$$= \frac{\cancel{R_{AB} R_{CA}} + R_{AB} R_{BC} + \cancel{R_{CA} R_{BC}} - \cancel{R_{AB} R_{CA}} + \cancel{R_{CA} R_{BL}}}{R_{AB} + R_{BC} + R_{CA}}$$

$$\boxed{R_B = \frac{R_{AB} R_{BC}}{R_{AB}+R_{BC}+R_{CA}}}$$

Star to Δ transformation:



$$R_A = \frac{R_{AB} R_{CA}}{R_{AB}+R_{BC}+R_{CA}} \quad - (1)$$

$$R_B = \frac{R_{BC} R_{AB}}{R_{AB}+R_{BC}+R_{CA}} \quad - (2)$$

$$R_C = \frac{R_{CA} R_{BC}}{R_{AB}+R_{BC}+R_{CA}} \quad - (3)$$

(1)(2) + (2)(3) + (3)(1)

$R_A R_B + R_B R_C + R_C R_A$

$$= \frac{R_{AB}R_{CA} \cdot R_{BC}R_{AB}}{(R_{AB}+R_{BC}+R_{CA})^2} + \frac{R_{BC}R_{AB}\,R_{CA}R_{BC}}{(R_{AB}+R_{BC}+R_{CA})^2}$$

$$+ \frac{R_{CA}R_{BC}R_{AB}R_{CA}}{(R_{AB}+R_{BC}+R_{CA})^2}$$

$$= \frac{R_{AB}^2 R_{CA}R_{BC} + R_{BC}^2 R_{AB}R_{CA} + R_{CA}^2 R_{AB}R_{BC}}{(R_{AB}+R_{BC}+R_{CA})^2}$$

$R_A R_C + R_A R_B + R_B R_C$

$$= \frac{R_{AB}R_{BC}R_{CA}(R_{AB}+\cancel{R_{BC}+R_{CA}})}{(R_{AB}+R_{BC}+R_{CA})^4} \quad -④$$

4/1

$$\frac{R_C \cancel{R_A} + \cancel{R_A} R_B + R_B R_C}{\cancel{R_A}} = \frac{\dfrac{R_{BC}\cancel{R_{AB}}R_{\cancel{CA}}}{R_{AB}+\cancel{R_{BC}}+R_{CA}}}{\dfrac{\cancel{R_{AB}}\,\cancel{R_{CA}}}{R_{AB}+\cancel{R_{BC}}+R_{CA}}}$$

$$\boxed{R_C + R_B + \frac{R_B R_C}{R_A} = R_{BC}}$$

$$\boxed{R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C}}$$

$$\boxed{R_{CA} = R_C + R_A + \frac{R_C R_A}{R_B}}$$

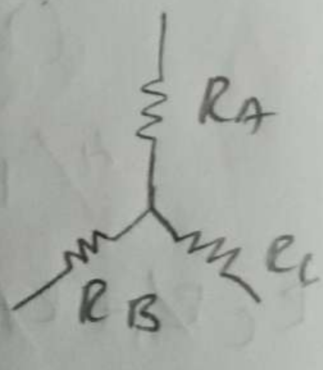
Problem:

Q) Delta values are given by 2Ω, 3Ω, and 4Ω resistances find star values

$R_{AB} = 2\Omega$

$R_{BC} = 3\Omega$

$R_{CA} = 4\Omega$



$$R_A = \frac{(2)(4)}{2+3+4}$$

$$= \frac{8}{9}\,\Omega = 0.88\,\Omega$$

$$R_B = \frac{(2)(3)}{2+3+4}$$

$$= \frac{6}{9}$$

$$= 0.66\,\Omega.$$

$$R_C = \frac{(4)(3)}{2+3+4}$$

$$= \frac{12}{9}$$

$$= 1.33\,\Omega.$$

8) Star values are given by 4Ω, 5Ω, 6Ω find delta values.

$R_A = 4\Omega$, $R_B = 5\Omega$, $R_C = 6\Omega$.

$$R_{AB} = 4 + 5 + \frac{20}{6}$$

$$= 9 + 3.3$$

$$= 12.33\,\Omega$$

$$R_{CA} = (4) + 6 + \frac{24}{5}$$

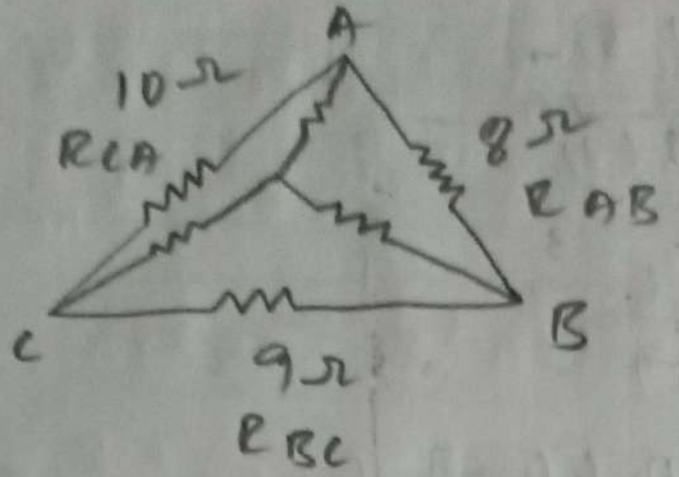
$$= 10 + 4.8$$

$$= 14.8\,\Omega$$

$$R_{BC} = 5 + 6 + \frac{30}{4}^{5} = \cancel{18.5\Omega}$$

$$= 18.5\,\Omega$$

Q)



star from delta.

$$R_A = \frac{(8)(10)}{8+9+10}$$

$$= \frac{80}{27} = 2.96\ \Omega.$$

$$R_B = \frac{(8)(9)}{10+9+8}$$

$$= \frac{72}{27}$$

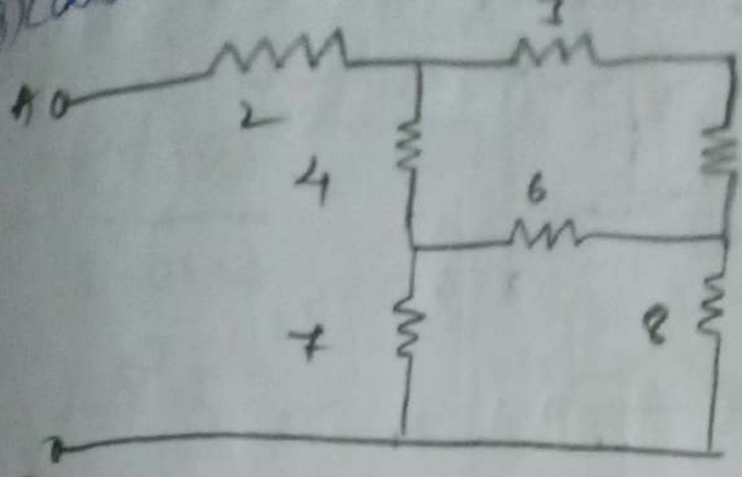
$$= 2.66\ \Omega.$$

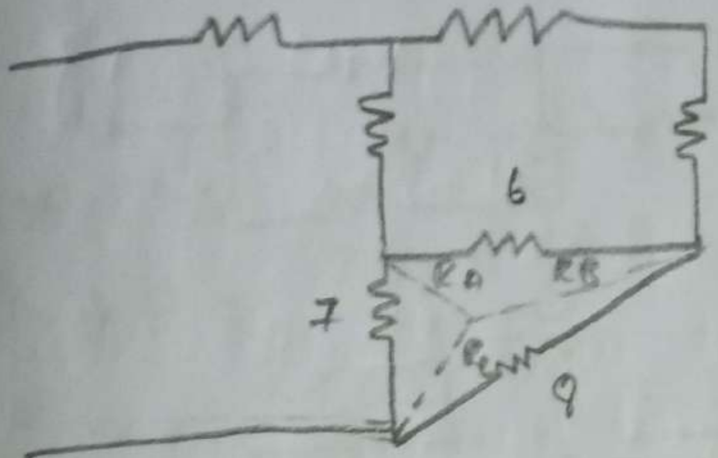
$$R_C = \frac{(10)(9)}{27}$$

$$= \frac{90}{27}$$

$$= 3.33\ \Omega$$

Q) calculate the resistance b/w AB terminals by using star delta transformation





4Ω

$\frac{7+8}{21}$

$$R_A = \frac{7\times 6}{7+6+8} = 2\Omega$$

$$R_B = \frac{6\times 8}{7+6+8} = 2.3\Omega$$

$$R_C = \frac{7\times 8}{6+7+8} = 2.6\Omega$$

$\frac{1}{10.3} + \frac{1}{6}$

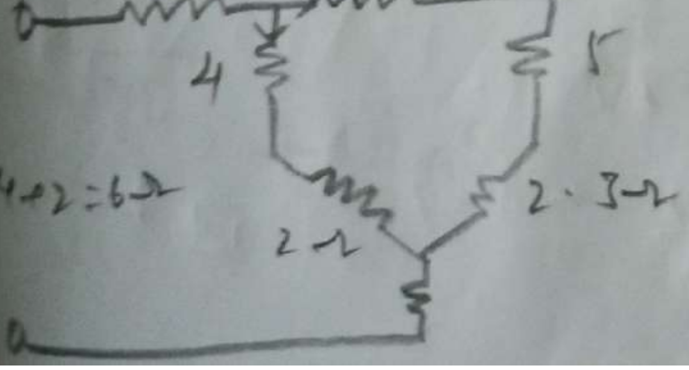
$\frac{10}{103} + \frac{1}{6}$

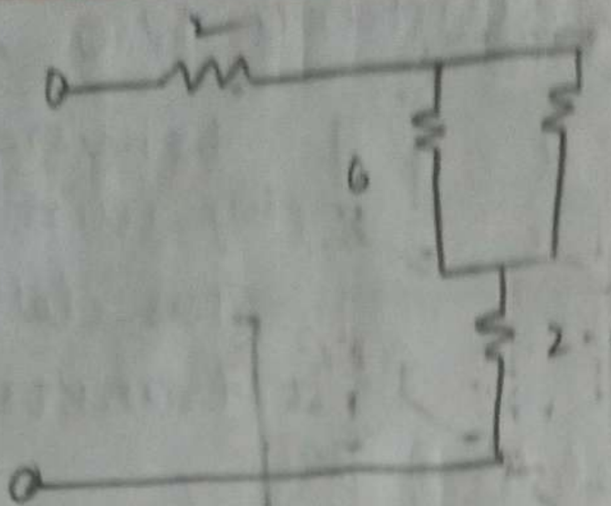
$0.097 +$

0.166

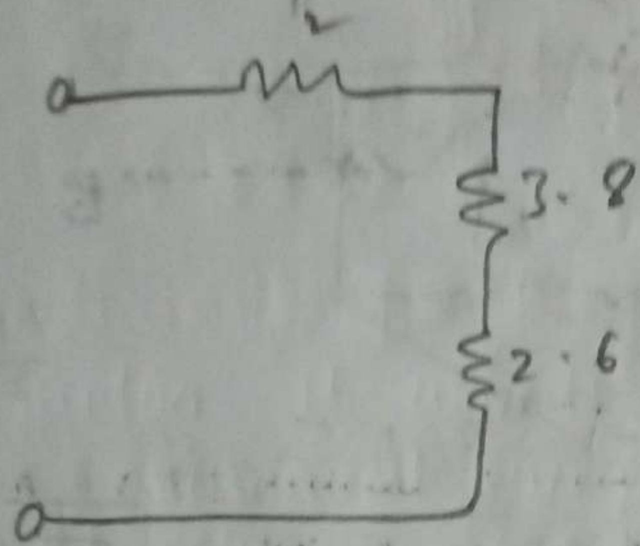
$\frac{1}{} = 0.263$

$3+5+2.3 = 10.3$



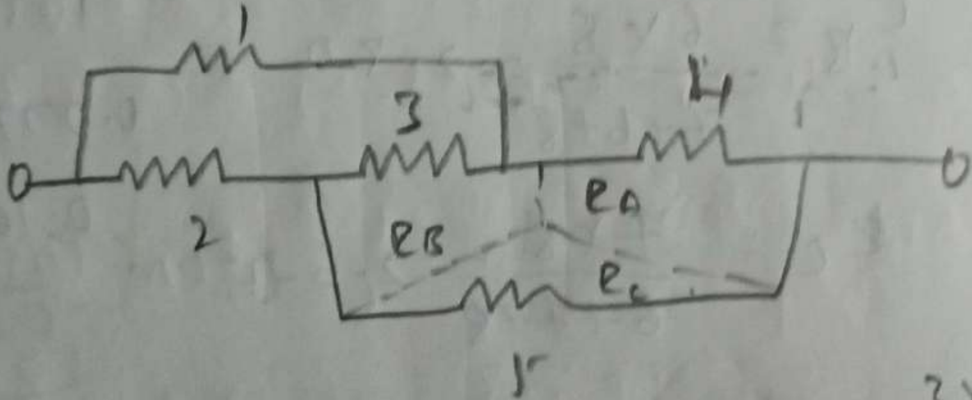


$$\frac{6 \times 10.3}{6 + 10.3} = 3.8\,\Omega$$



$$2 + 3.8 + 2.6 = 8.4\,\Omega$$

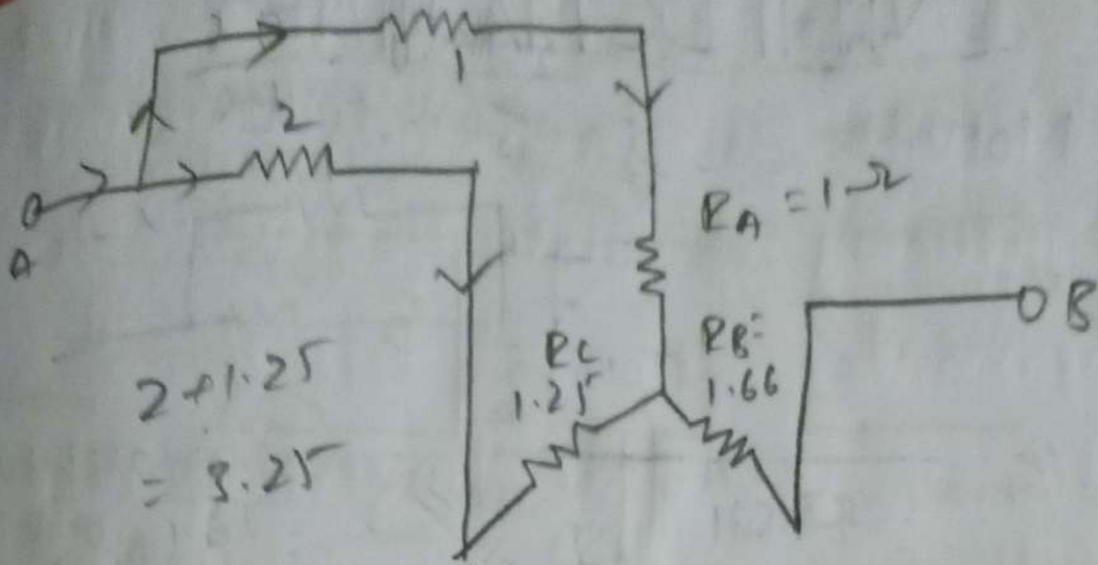
Q) calculate resistance b/w AB terminals.



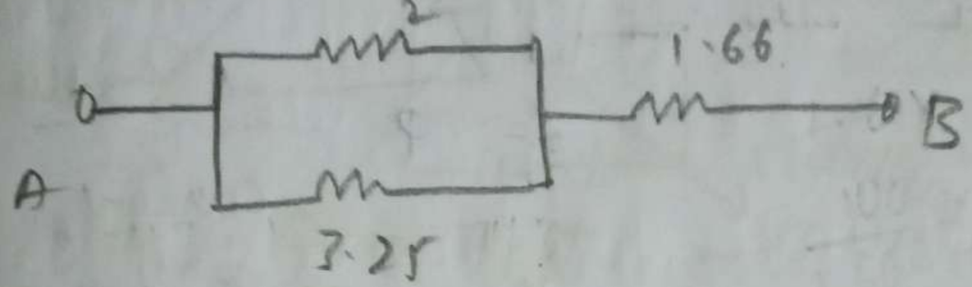
$$\frac{3 \times 5}{12} = \frac{15}{12} = 1.25$$

$$\frac{3 \times 4}{3+4+5} = \frac{12}{12}$$

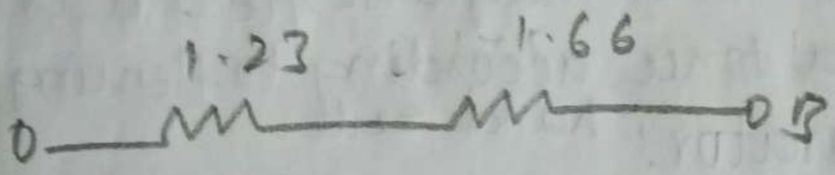
$R_A = 1\,\Omega$



$2+1.25 = 3.25$



$$\frac{2\times 3.25}{5.25} = \frac{6.5}{5.25} = 1.23\,\Omega$$



$R_{eq} = 2.89\,\Omega$.

DC Machines

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