VOLTAGE (or) POTENTIAL :-

→ The Amount of workdone to bring a unit positive charge from ∞ to a point is known as Absolute potential of that point. we are interested in potential difference (Voltage) between two points.

→ If the Energy required to move a charge of Q coulombs from point A to point B is W Joules, the Voltage V between A and B is given as

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

→ The unit of voltage is Volt. 1 Volt = 1 Joule/coulomb

Energy :-

→ Capacity to do work is called as Energy. The unit of Energy is joule(J)

→ If current is entering at +ve terminal of an element, Then The element is absorbing the energy. Vice - Versa.

POWER :-

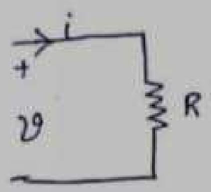
→ Consider an element having a voltage v across it. A small change in charge Δq is moved through element from the positive terminal to the negative terminal in time Δt. The Energy ΔW absorbed by the element in this process is given as $\Delta W = v \Delta q$.

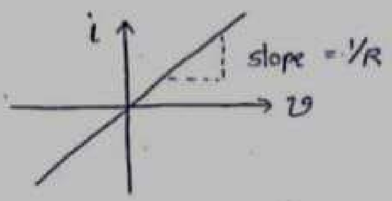
i.e $$\frac{\Delta W}{\Delta t} = v \cdot \frac{\Delta q}{\Delta t}$$

$$\Rightarrow \frac{dW}{dt} = \frac{dq}{dt} \cdot v = vi = P$$

→ The Rate of doing work is known as power.

$$\boxed{P = VI}$$





OHM's LAW in graphical form.

Applications of OHM's LAW :-

i) $V = IR$, $P = VI = I^2R = V^2/R$. when two quantities are known, we can Easily Calculate the third quantity by using ohm's law.

Limitation of OHM's LAW :-

1. This law can't be applied unilateral network. Eg: Network having Diodes etc..
2. ohm's law also not applicable ~~to~~ for Non-linear elements. Eg. Diode, Transistor etc..

POWER AND ENERGY IN RESISTOR :-

→ From ohm's law, $V = IR$.

$$\text{Power} = P = \frac{dw}{dt} = \frac{dw}{dq} \cdot \frac{dq}{dt} = V \cdot I \text{ watt}$$

$$\Rightarrow \boxed{\begin{aligned} P &= VI \text{ watt} \\ &= I^2R \text{ watt} \\ &= V^2/R \text{ watt.} \end{aligned}}$$

→ Energy (I will denote with E or W). is given by

$P = \frac{dW}{dt}$ where W is workdone (Energy).

$$\Rightarrow P \cdot dt = dW$$

$$\Rightarrow \int P \cdot dt = \int dW.$$

$$\Rightarrow W \text{ or } E = \int P \cdot dt \quad J \text{ (or) joule.}$$

$$\therefore \boxed{E = \int VI \cdot dt = \int I^2R \cdot dt = \int \frac{V^2}{R} \cdot dt.}$$

POWER AND ENERGY IN CAPACITOR :-

→ The property of material which stores energy in an electric field is known as Capacitence. (C). units are Farad (F)

→ A Capacitence (C) Satisfies a Relation.

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

→ power in a Capacitor $= p = V.i$

$$\Rightarrow p = \frac{dv}{dt}.C.v.$$

$$\Rightarrow \boxed{p = C.V.\frac{dv}{dt}} \text{ Watt.}$$

→ Energy in a Capacitor $= E = \int P.dt.$

$$= \int C.v.\frac{dv}{dt}.dt$$

$$\Rightarrow \boxed{E = \frac{1}{2}Cv^2} \text{ Joule}$$

POWER AND ENERGY IN INDUCTOR :-

→ The property of Material which stores Energy in Magnetic field is known as Inductance. (L). Units are Henry (H)

→ An Inductor satisfies a Relation,

$$v = L.\frac{di}{dt}$$

→ power in an Inductor $= p = vi$

$$= L.\frac{di}{dt}.i$$

$$\Rightarrow \boxed{p = Li\frac{di}{dt}} \text{ Watt}$$

→ Energy in an Inductor $= E = \int P.dt = \int Li\frac{di}{dt}.dt$

$$\Rightarrow \boxed{E = \frac{1}{2}Li^2} \text{ Joule.}$$

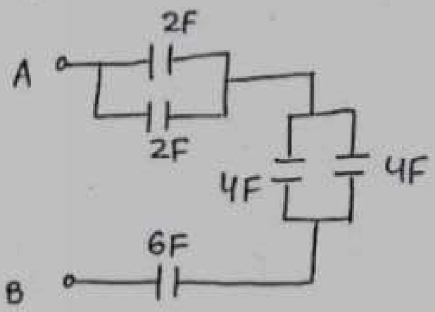
→ when Three Capacitors are in parallel. The Equivalent Capacitence C_{eq} is given by $C_{Eq} = C_1 + C_2 + C_3$ where C_1, C_2 and C_3 are given capacitence.

→ when C_1, C_2, and C_3 are in Series. Then

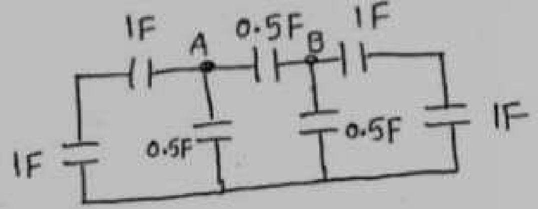
$$\frac{1}{C_{Eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}.$$

Q. Calculate Equivalent Capacitence between A and B terminals in the following Circuits.

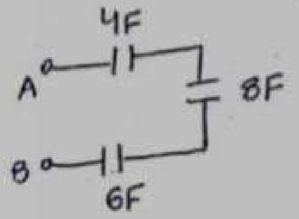
i)



ii)

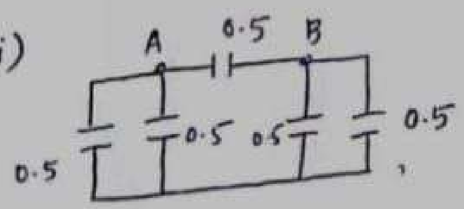


Sol:- i)

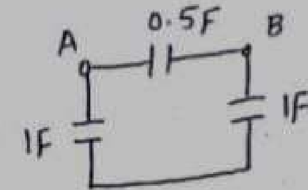


$$\Rightarrow C_{AB} = \frac{(4F)\left[\frac{8\times6}{8+6}\right]}{4+\left[\frac{8\times6}{8+6}\right]} = \frac{4\times\frac{48}{14}}{4+\frac{48}{14}} = 1.84F.$$

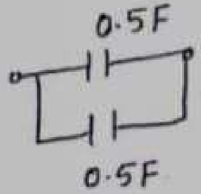
ii)



$\Rightarrow$



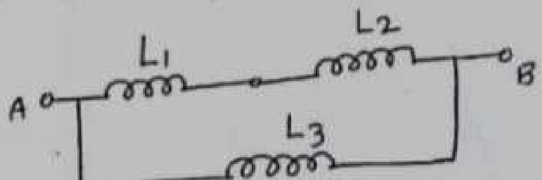
$\Rightarrow$



$\Rightarrow \underline{C_{AB} = 1F}$

Q. Calculate Equivalent inductance b/w A and B terminals.

i)

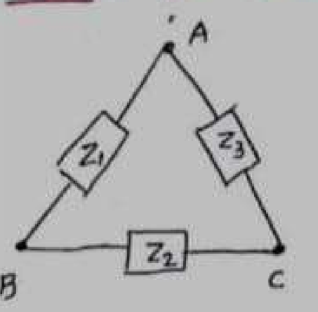


ii) If $L_1 = 2H$ $L_2 = 4H$. $L_3 = 6H$.
$L_{AB} = ?$

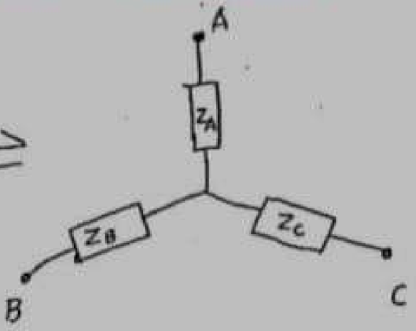
Sol:- i) $$L_{AB} = \frac{L_3(L_1+L_2)}{L_3 + L_1 + L_2}$$

ii) $$L_{AB} = \frac{6(4+2)}{6+4+2} = \underline{3H}$$

STAR TO DELTA & DELTA TO STAR CONVERSION :-



Delta connection



Star connection.

→ Delta to Star conversion :- (Assume above values of impedences)

$$Z_A = \frac{Z_1 Z_3}{Z_1 + Z_2 + Z_3} \qquad Z_B = \frac{Z_1 Z_2}{Z_1 + Z_2 + Z_3} \qquad Z_C = \frac{Z_3 Z_2}{Z_1 + Z_2 + Z_3}$$

→ STAR TO DELTA CONVERSION :-

$$Z_1 = Z_A + Z_B + \frac{Z_A Z_B}{Z_C}$$

$$Z_2 = Z_B + Z_C + \frac{Z_B Z_C}{Z_A}$$

$$Z_3 = Z_A + Z_C + \frac{Z_A Z_C}{Z_B}.$$

→ In Case Resistor,

i) STAR TO DELTA :

$$R_1 = R_A + R_B + \frac{R_A R_B}{R_C}$$

$$R_2 = R_B + Z_C + \frac{R_B R_C}{R_A}$$

$$R_3 = R_A + R_C + \frac{R_A R_C}{R_B}$$

ii) DELTA TO STAR :-

$$R_A = \frac{R_1 R_3}{R_1 + R_2 + R_3}$$

$$R_B = \frac{R_1 R_2}{R_1 + R_2 + R_3}$$

$$R_C = \frac{R_2 R_3}{R_1 + R_2 + R_3}$$

→ In Case of Capacitor,

i) STAR TO DELTA :-

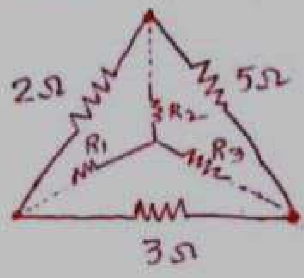
$$\frac{1}{j\omega C_1} = \frac{1}{j\omega}\left[\frac{1}{C_A} + \frac{1}{C_B} + \frac{C_C}{C_A C_B}\right]$$

$$\Rightarrow \frac{1}{C_1} = \frac{1}{C_A} + \frac{1}{C_B} + \frac{C_C}{C_A C_B}$$

DELTA TO STAR

$$\frac{1}{C_A} = \frac{1/C_1 \cdot 1/C_3}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

(7). If Delta connection is converted into star equivalent. Then Calculate R_1, R_2, R_3 values in the following network.



Sol:-

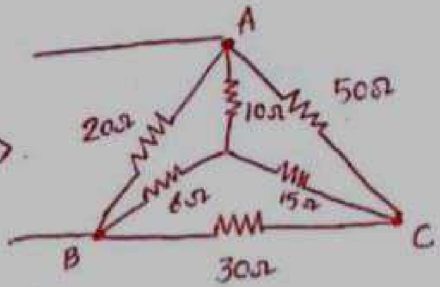
$$R_1 = \frac{2(3)}{2+3+5} = \frac{6}{10} = 0\cdot 6\,\Omega$$

$$R_2 = \frac{2(5)}{2+3+5} = \frac{10}{10} = 1\,\Omega$$

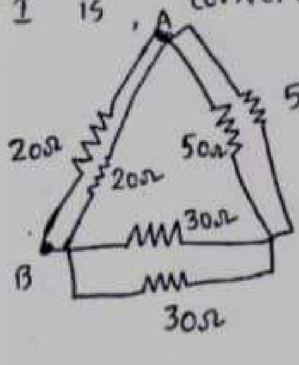
$$R_3 = \frac{3(5)}{2+3+5} = \frac{15}{10} = 1\cdot 5\,\Omega$$

(8). Find Equivalent Resistance between A and B terminals in the following Network.

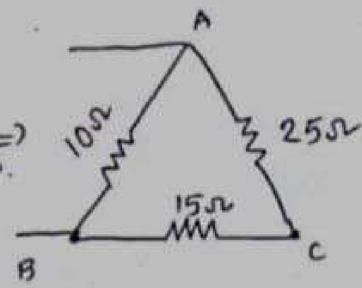
R_{AB} =>



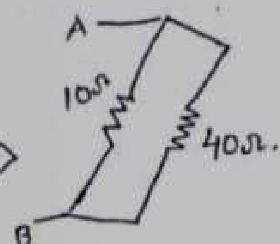
Sol:- Step 1 is, convert internal Star into Delta network.



=> R_{AB} =>

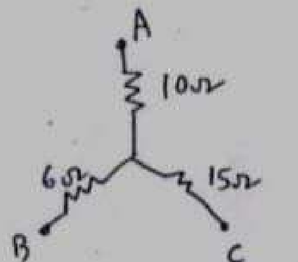


=>

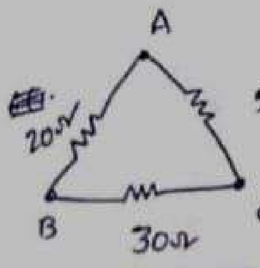


$$\therefore \quad R_{AB} = \frac{10(40)}{10+40} = \frac{40\cancel{0}}{5\cancel{0}} = \underline{\underline{8\,\Omega}}$$

Hint:- convert



=>



$50\Omega = 10+15+\frac{10(15)}{6}$

$30\Omega = 6+15+\frac{15(6)}{10}$