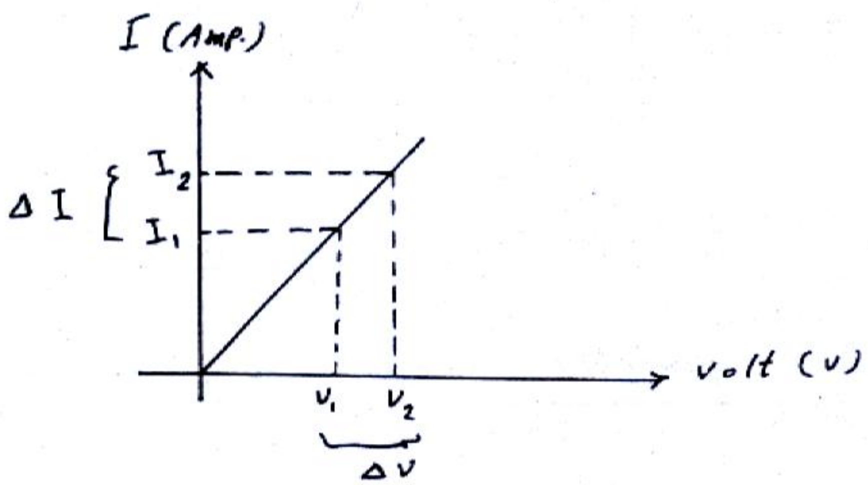
Ohm's Law :- Ohm's law states that the voltages (V) across a resistor (R) is directly proportional to the current (I) flowing through the resistor .

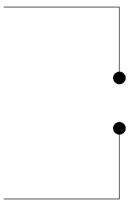


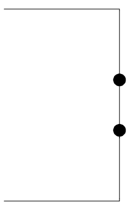
Slop = $\dfrac{\Delta I}{\Delta V} = \dfrac{1}{R}$

$\dfrac{V}{I}$ = constant = R

$$R = \frac{V}{I} \quad \Omega \; ; \quad \Rightarrow \quad V = I \,.\, R \quad ; \quad I = \frac{V}{R}$$

- ❖ The resistance of short circuit element is approaching to zero.
- ❖ The resistance of open circuit is approaching to infinity.


O.C. $R = \infty$, $G = \dfrac{1}{R} = 0$


S.C. $R = 0$, $G = \dfrac{1}{R} = \infty$

Hence $G = \dfrac{1}{R} = \dfrac{I}{V}$ Siemens (S) or mhos (℧) .

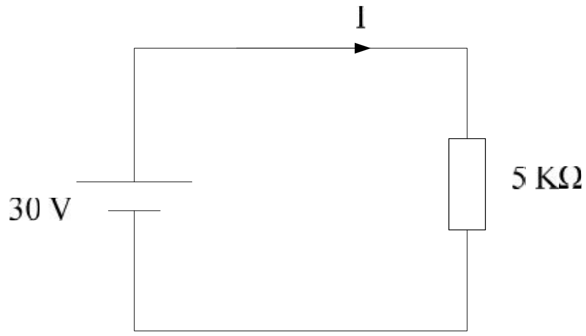
Electrical Energy (W) :-

$$\because \quad P = \frac{W}{t} \Rightarrow W = P.t \qquad \text{KWh}$$

$$W = P.t$$
$$= (V.I).t$$
$$= (I^2.R).t$$
$$= \left(\frac{V^2}{R}\right).t$$

Energy in KWh (W) = $\frac{\text{Power}(\text{P}) \times \text{time}(\text{t})}{1000}$

Example : For the following circuit diagram , calculate the conductance and the power ?



Solution :

$$I = \frac{V}{R} = \frac{30}{5 \times 10^3} = 6mA$$

$$G = \frac{1}{R} = \frac{1}{5 \times 10^3} = 0.2m^{3}$$

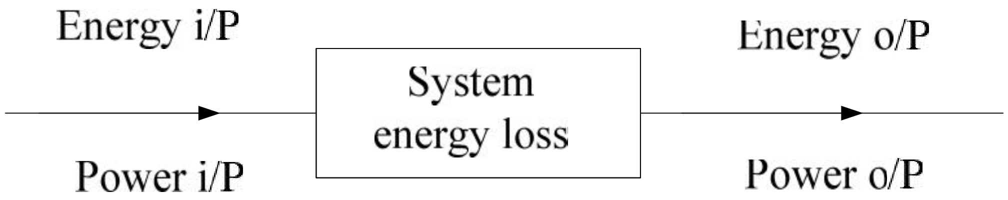
$$P = I.V = (6 \times 10^{-3}) \times 30 = 180mW$$

or $P = I^2.R = (6 \times 10^{-3}) \times (5 \times 10^3) = 180mW$

or $P = V^2.G = (30)^2 \times (0.2 \times 10^{-3}) = 180mW$

or $P = \frac{V^2}{R} = \frac{(30)^2}{(0.2 \times 10^{-3})} = 180mW$

<u>Efficiency (η) :-</u>



$W_{i/p} = W_{o/p} + W_{loss}$

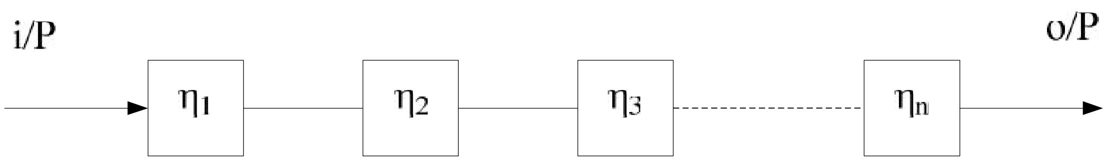
$$\frac{W_{i/p}}{t} = \frac{W_{o/p}}{t} + \frac{W_{loss}}{t}$$

$P_{i/p} = P_{o/p} + P_{loss}$

$$\text{Efficiency } (\eta) = \frac{\text{Output power}}{\text{Input power}} \times 100\%$$

$$\eta = \frac{P_o}{P_i} \times 100\%$$

$$\eta = \frac{W_o}{W_i} \times 100\%$$



$$\eta_T = \eta_1 \times \eta_2 \times \eta_3 \times \ldots\ldots \times \eta_n$$

Example: A 2 hp motor operates at an efficiency of 75 %, what is the power input in Watt, if the input current is (9.05) A, calculate also the input voltage?

Solution:

1 hours power (hp) = 746 Watt

$$\eta = \frac{P_o}{P_i} \times 100\%$$

$$0.75 = \frac{2 \times 746}{P_i} \Rightarrow P_i = \frac{1492}{0.75} = 1989.33W$$

$$P = E.I \Rightarrow E = \frac{P}{I} = \frac{1989.33}{9.05} = 219.82 \cong 220V$$

Example: What is the energy in KWh of using the following loads:-

a) 1200 W toaster for 30 min.

b) Six 50 W bulbs for 4 h.

c) 400 W washing machines for 45 min.

d) 4800 W electric clothes dryer for 20 min.

Solution :

$$W = \frac{P(W) \times t(h)}{1000}$$

$$W = \frac{1200 \times \left(\frac{30}{60}\right) + 6 \times 50 \times 4 + 400 \times \left(\frac{45}{60}\right) + 4800 \times \left(\frac{20}{60}\right)}{1000}$$

$$= \frac{600 + 1200 + 300 + 1600}{1000} = \frac{3700}{1000} = 3.7KWh$$

<u>D.C. Sources:-</u>

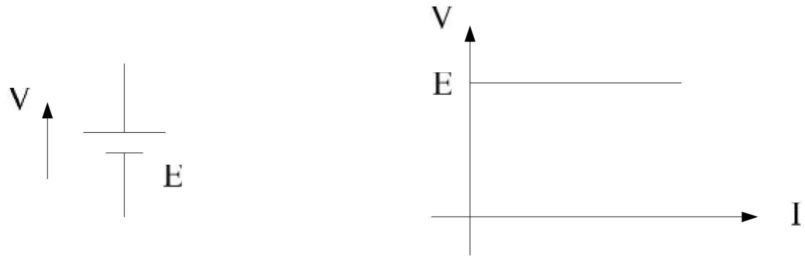
The d.c. sources can be classified to:-

1- Batteries . → Voltage
→ Amper - hours

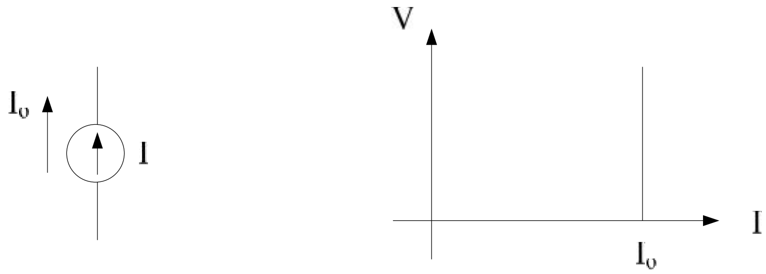
2- generators .

3- Photo cells .

4- Rectifiers .



V = E = constant voltage element

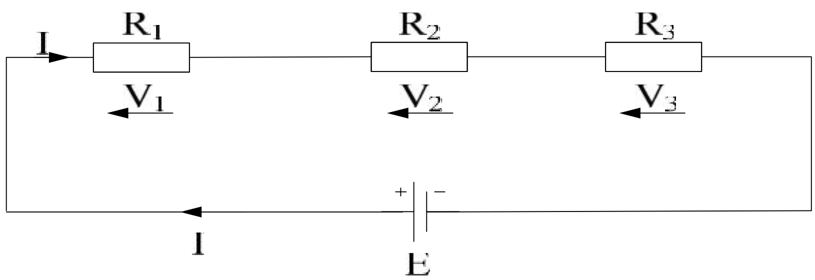


$I = I_o$ = constant current element

مصدر الفولتية يولد تيار و فولتية و لكن الفولتية تكون ثابتة .

مصدر التيار يولد تيار و فولتية و لكن التيار يكون ثابت .

<u>Series Circuit :-</u>



$V_1 = I.R_1$

$V_2 = I.R_2$

$V_3 = I.R_3$

$E - V_1 - V_2 - V_3 = 0 \Rightarrow E = V_1 + V_2 + V_3$

$\therefore E = I.R_1 + I.R_2 + I.R_3$

$E = I.[R_1 + R_2 + R_3] = I.R_T$

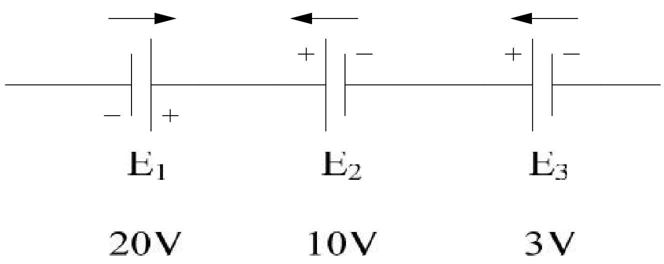
The current in the series circuit is the same through each series element &

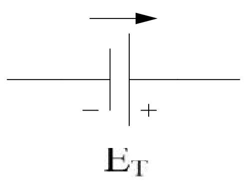
$R_T = R_1 + R_2 + R_3 + \text{--------} + R_N$

$$I = \frac{E}{R_T} = \frac{V_1}{R_1} = \frac{V_2}{R_2} = \frac{V_3}{R_3}$$

$P_t = P_1 + P_2 + P_3 = E.I$

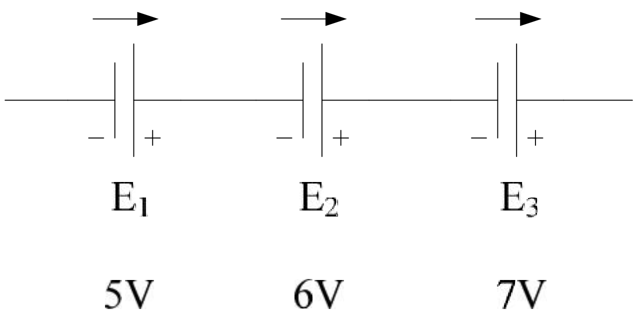
<u>Voltage Source in Series:-</u>

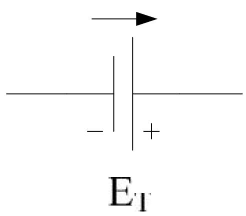




$E_T = E_1 - E_2 - E_3$

$E_T = 20 - 10 - 3 = 7$

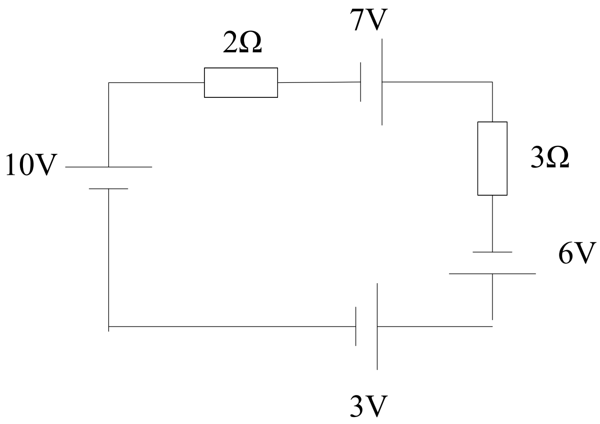




$E_T = E_1 + E_2 + E_3$

$E_T = 5 + 6 + 7 = 18$

Example: Find the current for the following circuit diagram?



Solution:

$E_T = 10 + 7 + 6 - 3 = 20$ V

$R_T = 2 + 3 = 5\ \Omega$

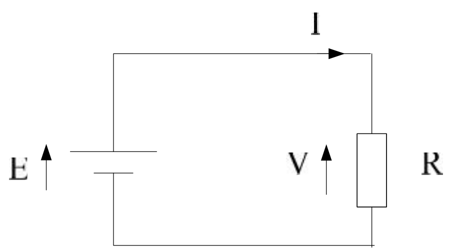
$$I = I_T = \frac{E_T}{R_T} = \frac{20}{5} = 4A$$

<u>Kirchoff's voltage law (K.V.L.):-</u>

The algebraic sum of all voltages around any closed path is zero.

$$\sum_{m=1}^{m} V_m = 0$$

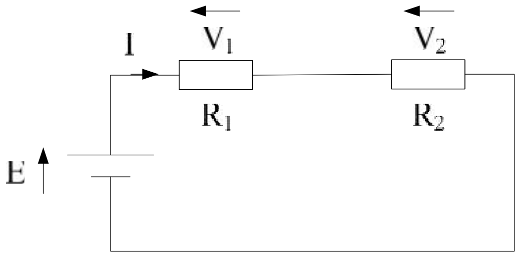
Where m is the number of voltages in the path (loop) , and V_m is the m^{th} voltage .



$E - V = 0$

$E = V$

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

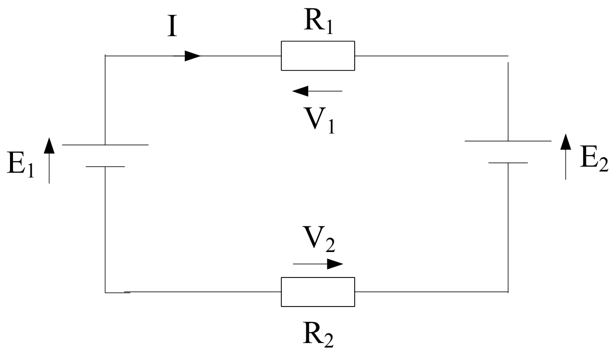


$E - V_1 - V_2 = 0$

$E = V_1 + V_2$; $R_T = R_1 + R_2$

$$I = \frac{E}{R_T} = \frac{V_1 + V_2}{R_T}$$

Example: Use K.V.L. to find the current in the following circuit diagram?



Solution: From K.V.L. $\sum V = 0$

$\therefore$ $E_1 - V_1 - E_2 - V_2 = 0$

$E_1 - E_2 = V_1 + V_2$

$E_1 - E_2 = IR_1 + IR_2$

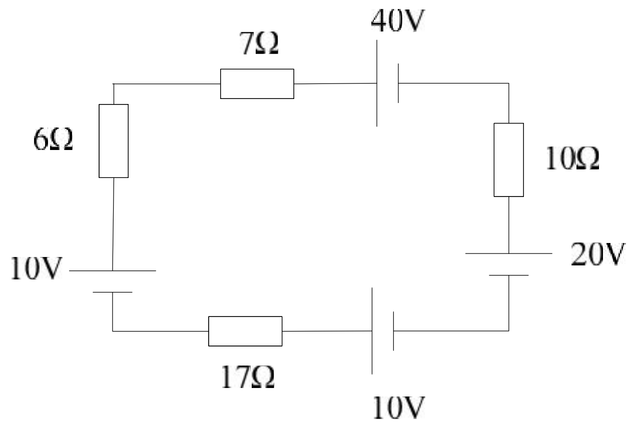
$E_1 - E_2 = I (R_1 + R_2)$

$$\therefore I = \frac{E_1 - E_2}{R_1 + R_2}$$

Example: For the following circuit diagram, Find I using:-

a) Ohm's law.

b) K.V.L.



Solution:

a) By applying ohm's law :-

$$I = \frac{E_T}{R} = \frac{20+40-10-10}{10+7+6+17} = \frac{40}{40} = 1A$$

b) By applying K.V.L. :-

10 + 6I + 7I - 40 + 10I – 20 + 10 + 17I = 0

10 – 40 – 20 + 10 + I (6 + 7 + 10 + 17) = 0

-40 = -I (40) $\Rightarrow I = \frac{40}{40} = 1A$