# Chapter-01:

* Units Measurement-

* System of Unit:

| | M.K.S | C.G.S | F.P.S | SI |
|---|---|---|---|---|
| L → | m | c.m | ft | m |
| T → | Sec. | Sec. | Sec | Sec |
| M → | Kg | gm | pnd | Kg |

# Power of Ten:

$10^1 = 10$

$10^2 = 100$

$10^3 = 1000 = \text{Kilo}$

$= 1K$

$10^6 = 1000000 = 1\text{ Mega}$

$= 1M$

$10^9 = 1000000000 = 1\text{ Giga} = 1G.$

$10^{12} = 1\text{ tera}$

$= 1T$

$10^{18} = 1\text{ exa}$

$= 1E$

$10^{15} = \text{peta} = 1P.$

* $10^{-3} = \frac{1}{1000}$

$= 0.001 = 1\text{mili}$
$= 1\text{m}$

$10^{-6} = 1\mu$.

$1\text{n} = 10^{-9}$.

$10^{-12} = 1\text{Pico}$

$1\text{ Femto} = 10^{-15}$

$1\text{ atto} = \cancel{10} \; 10^{-18}$.

* Conversion Between Power of Ten:

$20{,}000\text{Hz} = ?\ \text{MHz}$

$= 20 \times 10^3 \text{Hz}$

$= 20\text{KHz} = 0.02\text{MHz}$

$0.01\text{ms} = ?\ \mu\text{s}$

$= 0.01 \times 10^{-3}\text{s} = 0.01 \times 10^{-3} \times 10^{-3} \times 10^{3}\text{ s}$

$= 0.01 \times 1000 \times 10^{-6}$

$= 10^{-2} \times 10^{3} \times 10^{-6}\text{ s}$

$= 10\ \mu\text{s}$

*Atom:

① 

# * Voltage → Chapter-02

→ The simplest of all atoms is the Hydrogen atom.

→ made up two basic particles, the proton and electron.

* Atomic Structure: The atomic structure of any stable atom has an equal ~~a~~ number of electrons and protons.

## ⊞ Materials:

* Conductors: Less than 4 $e^-$ in outermost orbit
  Examples: Al, Cu, etc.

* Insulators: Greater than 4 $e^-$ in outermost Orbit.
  Examples: Ni.

* Semi Conductor: Exactly 4 $e^-$ in outermost orbit.

Examples: Carbon, Silicon etc.

Some Good Conductors: Silver, Cu, Gold, Al, Fe, Steel, Brass.

* Voltage: It is the pressure from an ~~elel~~ electrical circuits power source that pushes charged electrons (current) through a conducting loop, enabling them to do work such as illuminating a light.

* an electromotive force or potential difference expressed in volts.

Equation: $\cdot\, W = VQ;$

$$\Rightarrow V = \frac{W}{Q}; = \frac{1J}{1C} = JC^{-1} = \text{volt} = V.$$

**Current:** The current is a reaction to the applied voltage.

**Equation:** $\cdot\ Q = It.$

$$\Rightarrow I = \frac{Q}{t} \; ; = \frac{1C}{1s} = Cs^{-1} = 1Amp. = A.$$

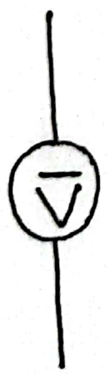
# Symbols:

Cell

→ Dry Cell

Battary

Volt



DC type

Volt m.

AC type

Current Source

AC type
Current Source

DC type
Current Source

AC
Voltage Source

# Resistance: It is a measure of the opposition to current flow in an electrical circuit.

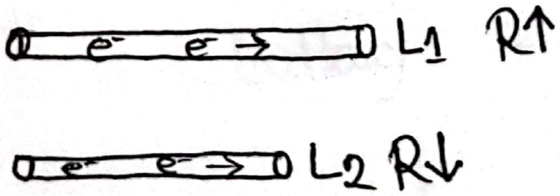
## * Dependency:

1. Material (Conductor)
2. Length.
3. Cross-sectional Area.
4. Temperature of the material.

1. Material: Conductor.

$R \propto L$;

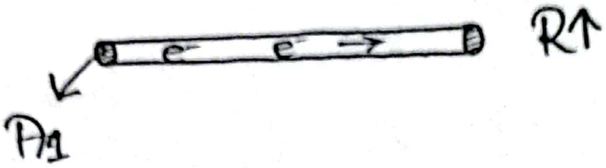
2. Length:

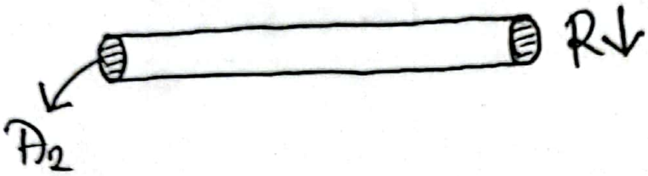



$\therefore R \propto L$.

~~2. Leng~~

3. Cross-Sectional Area:

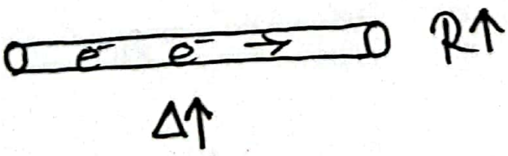


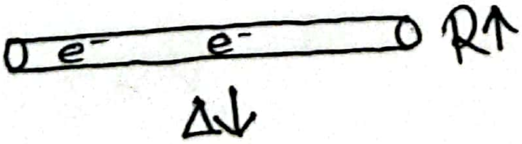




$$\therefore R \propto \frac{1}{A}.$$

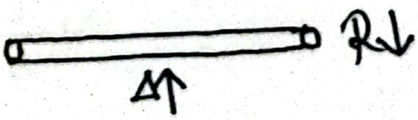
4. Temperature:

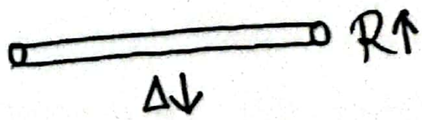
For → Conductor




Semi-Conductor:



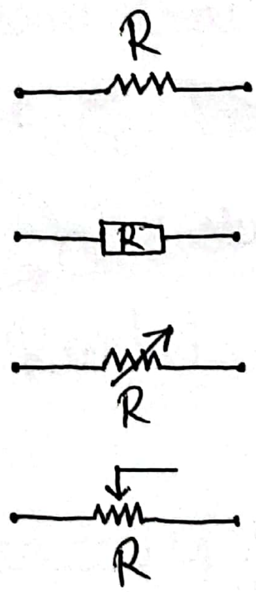



# Equation:

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

$$\Rightarrow R = \rho \frac{L}{A};$$

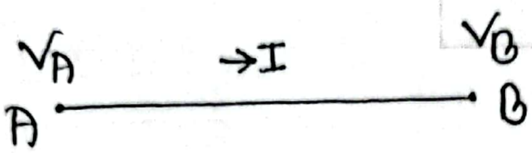
Symbols:



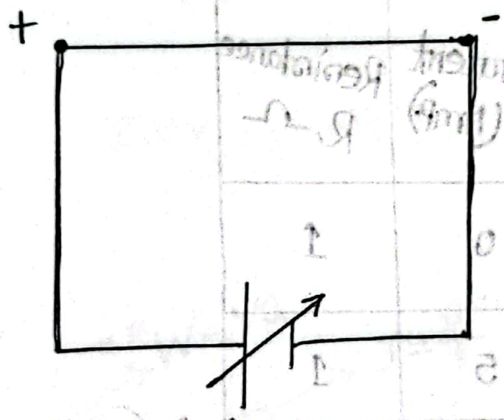
# Chapter-1

## Ohm's Law, Power and Energy

### # Ohm's Law:




$T \rightarrow$ Constant




$V \propto I$ ✗

$I \propto V$ ✓

*Voltage pushes the electron.

$V_{AB} = V_A - V_B \quad \boxed{V_A > V_B}$

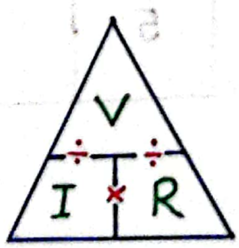
$\Rightarrow I \propto V_A - V_B$

$\Rightarrow I \propto V$

$\Rightarrow I = GV \; ; R = \frac{1}{G}$

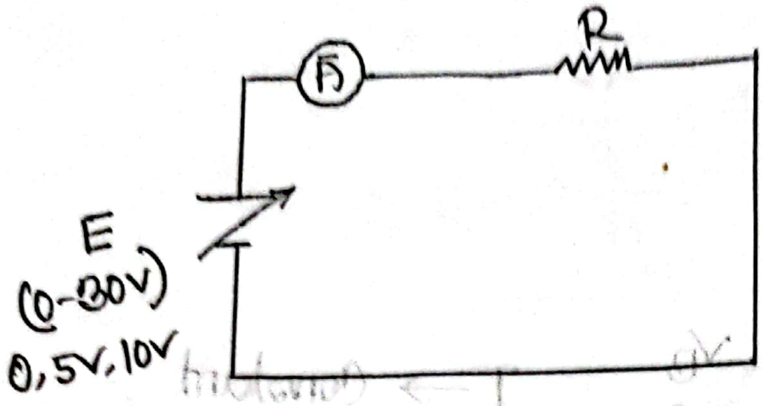
$= \frac{1}{R} V$

$\therefore V = IR$




* I = Intensity of current

# Examination of Ohm's Law:



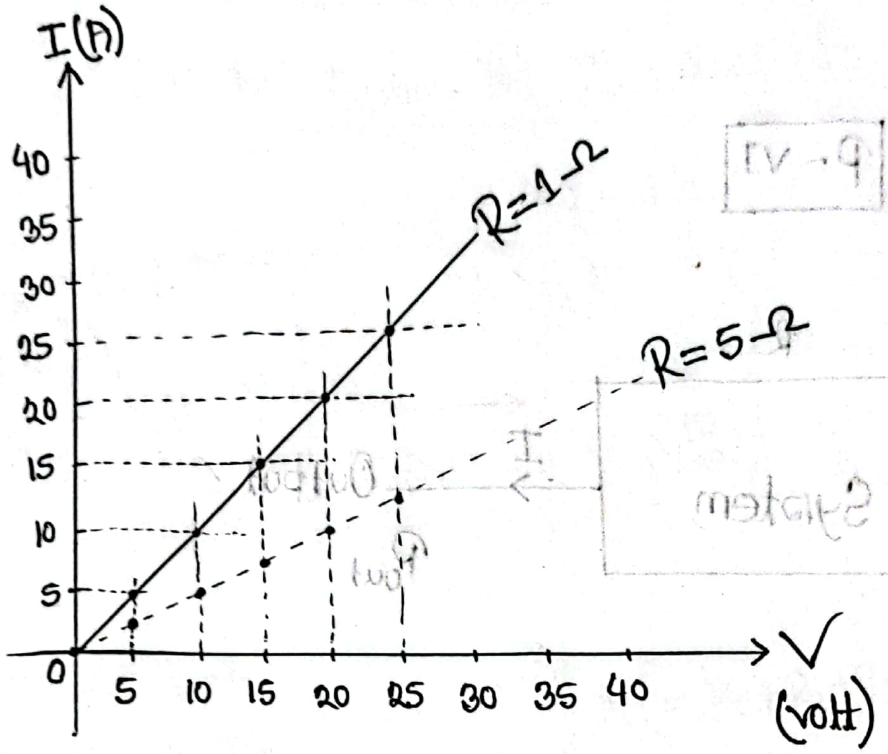

T- Constant

| Obs. No. | Supply Voltage(V) | Current I(Amp) | Resistance R, $\Omega$ |
|---|---|---|---|
| 1 | 0 | 0 | 1 |
| 2 | 5 | 5 | 1 |
| 3 | 10 | 10 | 1 |
| 4 | 15 | 15 | 1 |
| 5 | 20 | 20 | 1 |

$V = IR$

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

# Verification of $I \propto V$:




$I \propto V \rightarrow$ Verified

# Power:

** $W = Pt$

** $W = VQ$

$I = \frac{Q}{t} \therefore Q = It$

$$\boxed{P = \frac{W}{t}} = \frac{VQ}{t} = VI = IRI = I^2R = \frac{V^2}{R^2} \cdot R = \frac{V^2}{R}$$

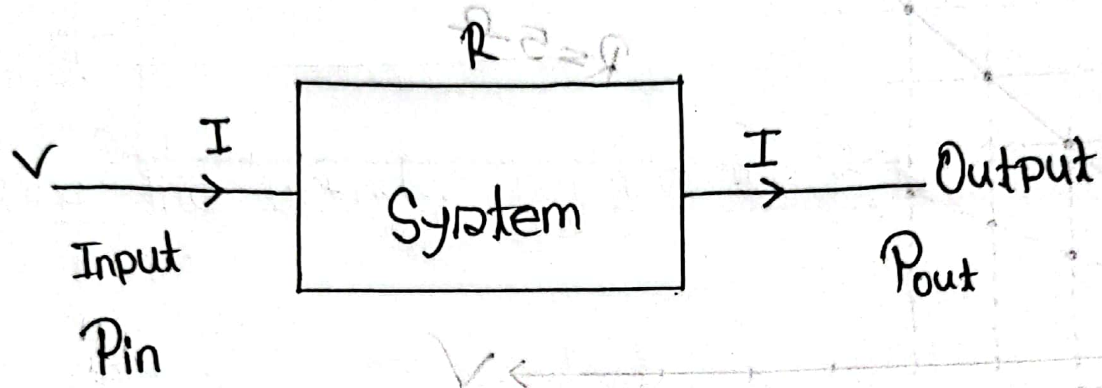
$$\boxed{P = VI}$$

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

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

# Effieiency: $\eta$

$$\boxed{P = VI}$$



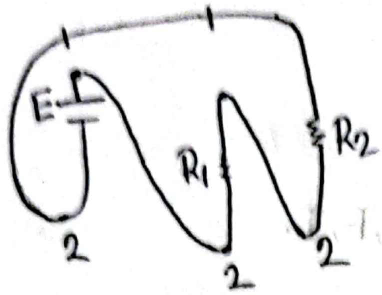

$$\eta = \frac{\text{Output}}{\text{input}}$$

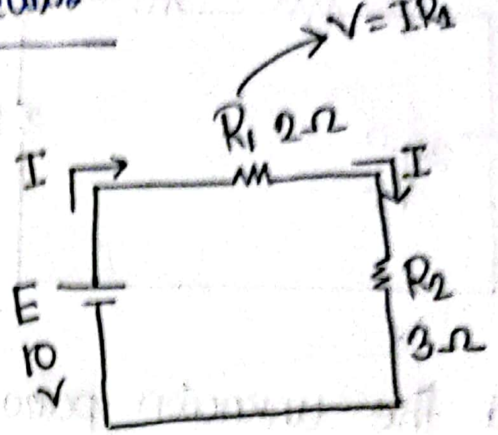
$$= \frac{P_{out}}{P_{in}}$$

$$= \frac{P_{out}}{P_{in}} \times 100\%$$

# Chapter-5

## Series DC Circuits




Series

* Series এর ক্ষেত্রে same Current flow করে হয়।

$R_S = R_1 + R_2 + R_3 \cdots\cdots R_n$

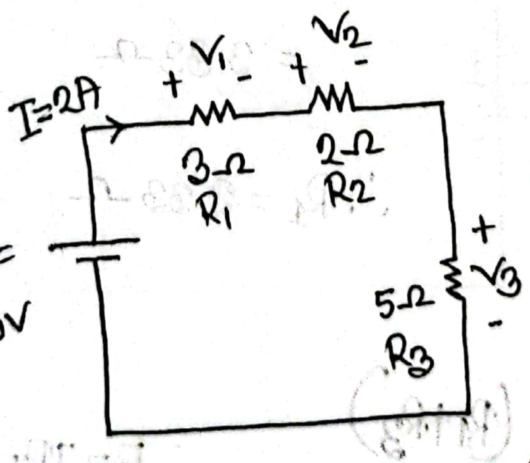
$R_S = N \cdot R \longrightarrow R_T = R_1 + R_2 + R_3$

$= 3R \; [\because R = R_1 = R_2 = R_3]$

$= N \cdot R \; [\text{No. of Resistor}]$

$\therefore R_T = N \cdot R$

$V = I R$ → Main Current




$\cdot \; I = \dfrac{E}{R_T}$

$= \dfrac{20}{10}$

$= 2A$

$\cdot \; V_1 = IR_1 = 2 \times 3 = 6V$

$\cdot \; V_2 = IR_2 = 2 \times 2 = 4V$

$\cdot \; V_3 = IR_3 = 5 \times 2 = 10V$

$\longrightarrow R_T = 3 + 2 + 5 = 10\Omega$

# $P = VI \;\therefore\; P = P_1 + P_2 + P_3 + \cdots\cdots$

$P = I^2 R$

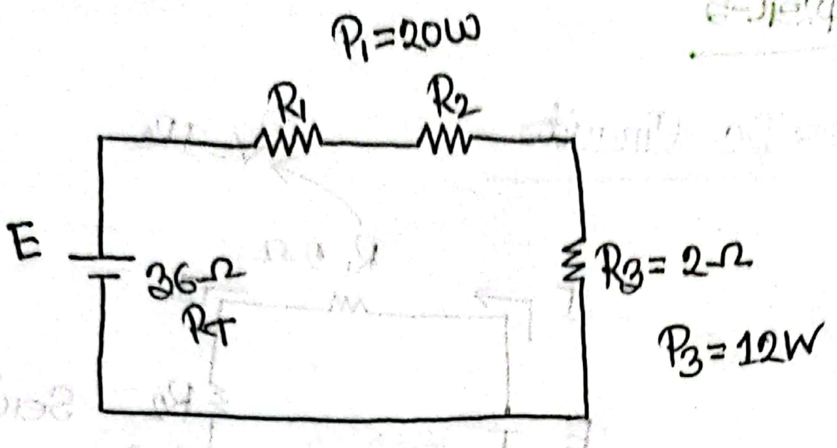
$P_1 = V_1 I = 6 \times 2 = 12W$

$P_3 = V_3 I = 10 \times 2 = 20W$

$P_2 = V_2 I = 4 \times 2 = 8W$

$P = VI = 20 \times 2 = 40W$

Example: 5.7




Find the unknown parameters $R_1, R_2, E, I$.

Sol$^n$:

$P_3 = I^2 R_3$

$\Rightarrow I^2 = \frac{P_3}{R_3}$

$= \frac{12}{2} A$

$= 6A$

$\therefore I = \sqrt{6} A = 2.45 A$

$\therefore P_1 = I^2 R_1$

$\Rightarrow R_1 = \frac{P_1}{I^2}$

$= \frac{20}{6} \Omega$

$= 3.33 \Omega$

$\therefore R_1 = 3.33 \Omega$

$\therefore R_2 = R_T - (R_1 + R_3)$

$= 36 - (3.33 + 2)$

$= 30.67 \Omega$

$\therefore E = I R_T$

$= 2.45 \times 36$

$\therefore E = 88.181 V$

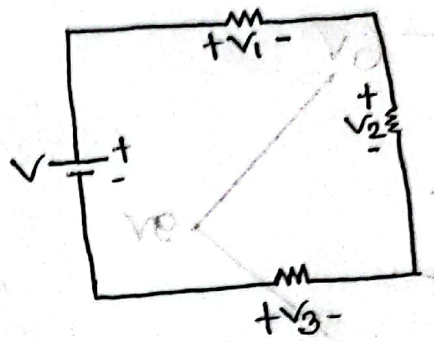
$P = EI = 88.181 \times 2.45$

$= 216.09 W$

$P = P_1 + P_2 + P_3 = 216.09 W$

# Kirchhoff's Theory

$\sum V_c = 0$

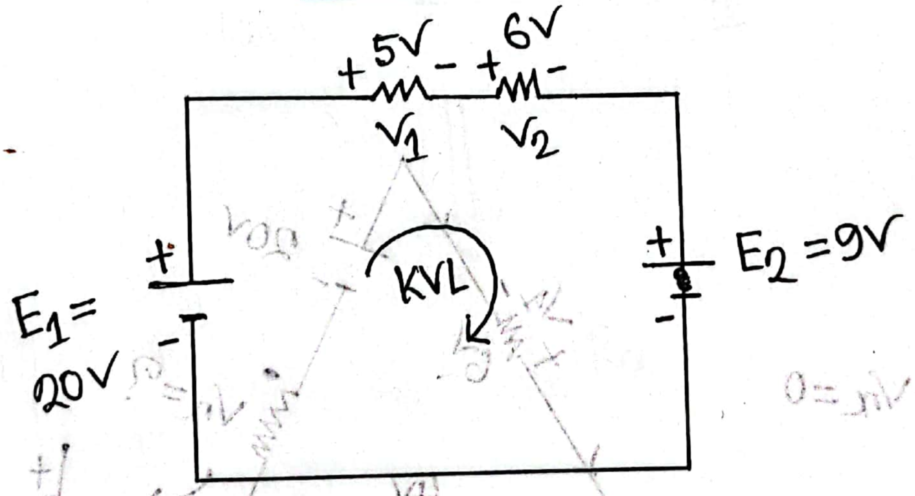



$\Rightarrow +V + (-V_1) + (-V_2) + (-V_3) = 0$

$\Rightarrow V = V_1 + V_2 + V_3$

$\Rightarrow V_{rises} = V_{drops}$ —— (i)

## KVL



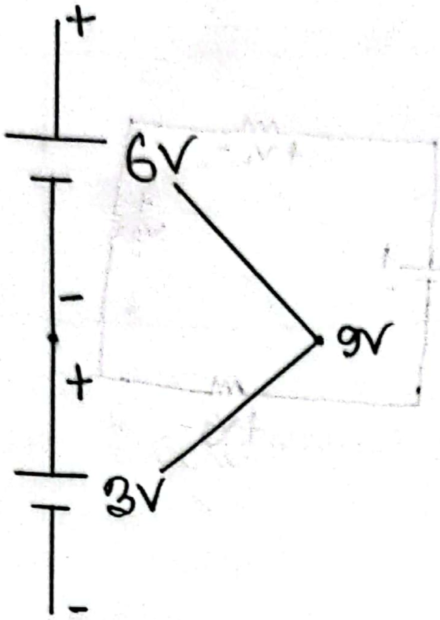

$\sum V_c = 0$

$\Rightarrow +E_1 + (-V_1) + (-V_2) + (-E_2) = 0$

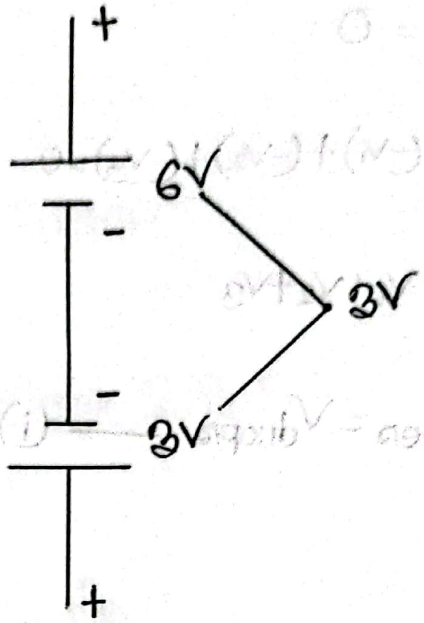
$\Rightarrow E_1 - V_1 - V_2 - E_2 = 0$

$\Rightarrow 20 - V_1 - 6 - 9 = 0$

$\Rightarrow \boxed{V_1 = 5V}$







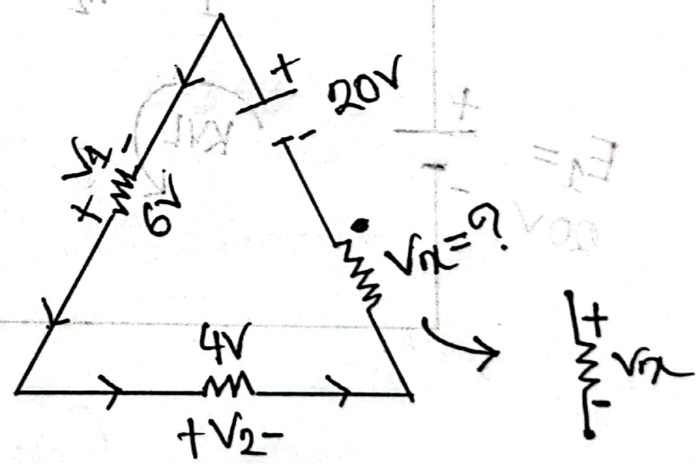


Problem-2:

F.

$\sum V = 0$

$\Rightarrow +20V + V_1 - V_2 + V_x = 0$





$\Rightarrow 20 + 6 - 4 + V_x = 0$ → ⊖

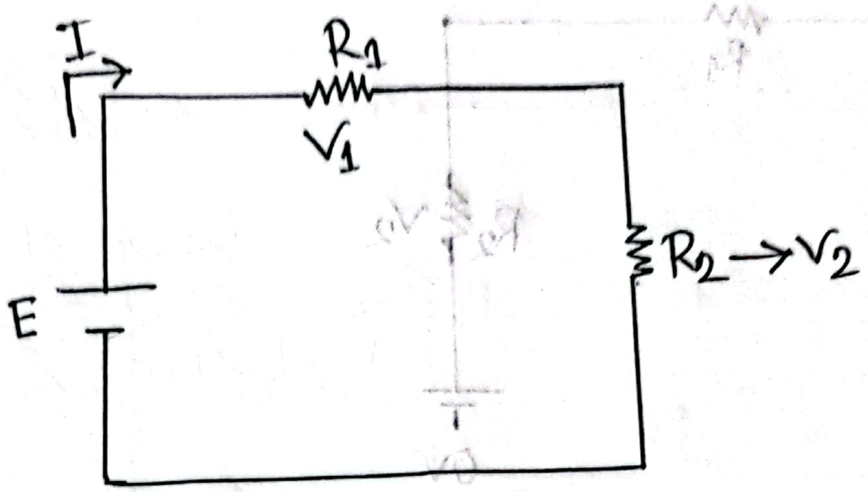
$\Rightarrow V_x = -22V$

$\rightarrow -V_x = -22V$ but $V_x$ can't be negative; So we have

$\therefore V_x = 22V$ to define it correctly $+\!\!\text{ww}\!\!-$ $V_x$

So, $V_x = 22V$

## ⊞ VDR (Voltage Divider Rule):




$\rightarrow V_1 = IR_1$

$\Rightarrow V_1 = \left(\frac{E}{R_T}\right)R_1$

$\uparrow$
I

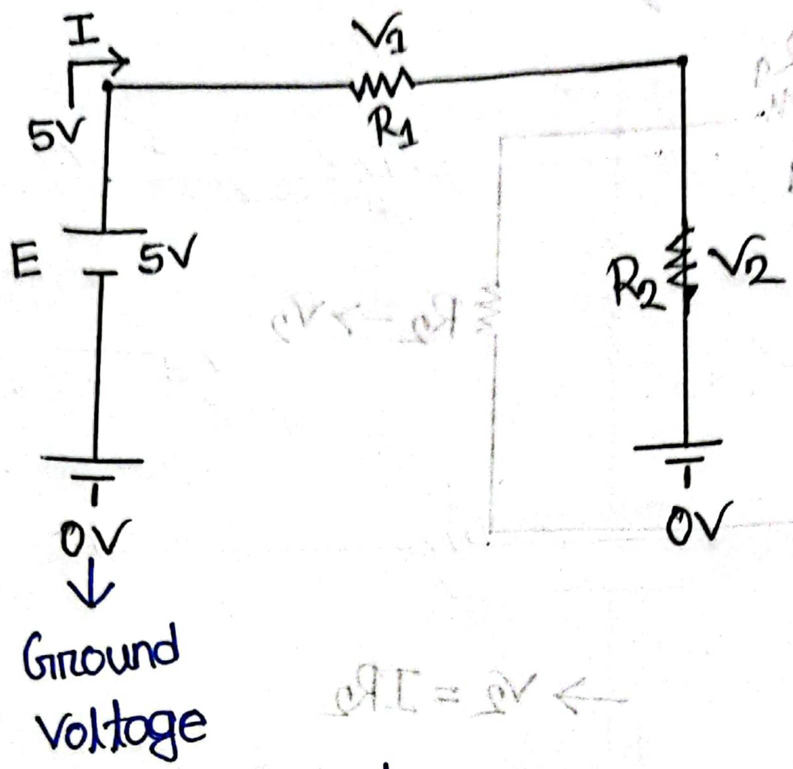
$\rightarrow V_2 = IR_2$

$\Rightarrow V_2 = \left(\frac{E}{R_T}\right)R_2$

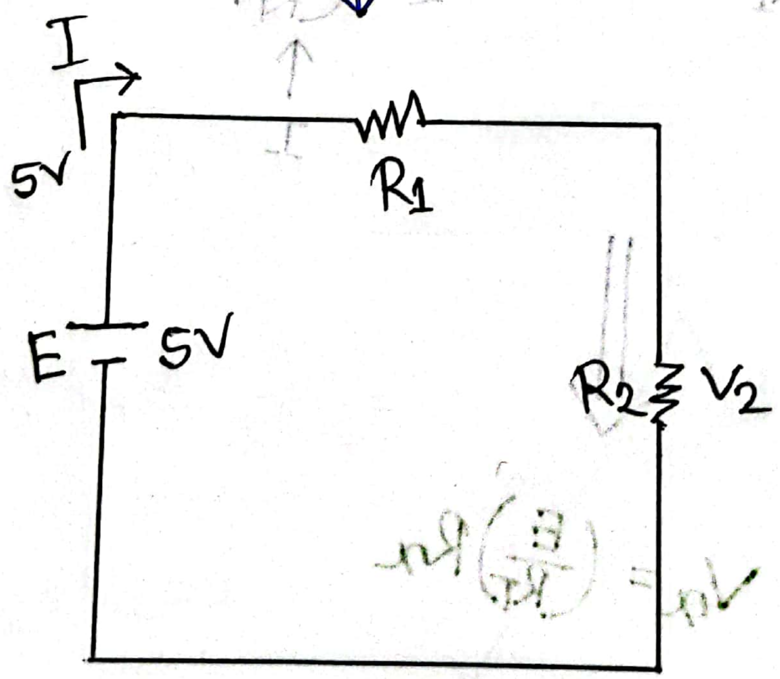
$\uparrow$
I

$\Downarrow$

⊞ $V_x = \left(\frac{E}{R_T}\right)R_x$

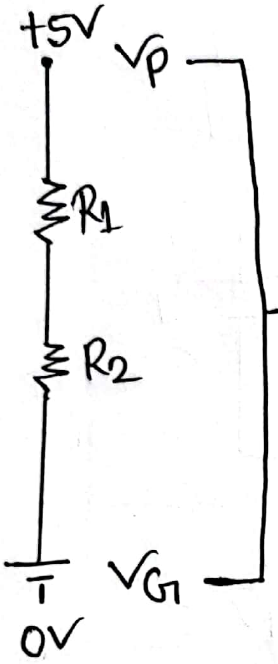


I
5V
$V_1$
$R_1$
E
5V
$R_2$
$V_2$
0V
0V
Ground Voltage

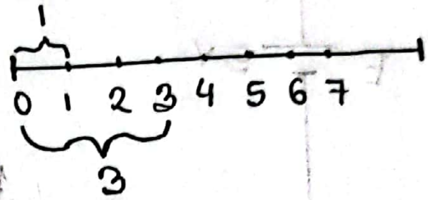



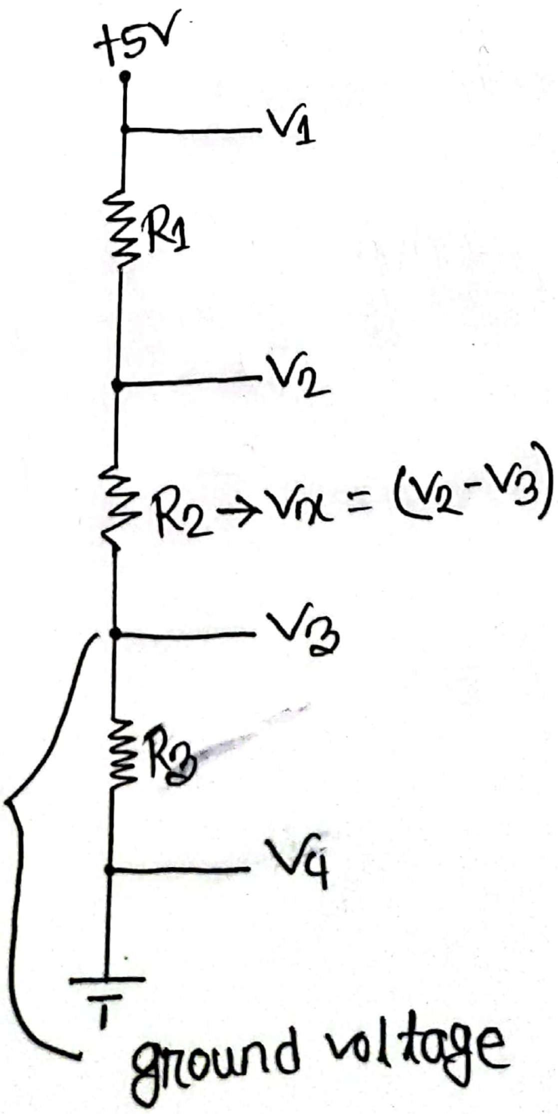
I
5V
$R_1$
E
5V
$R_2$
$V_2$

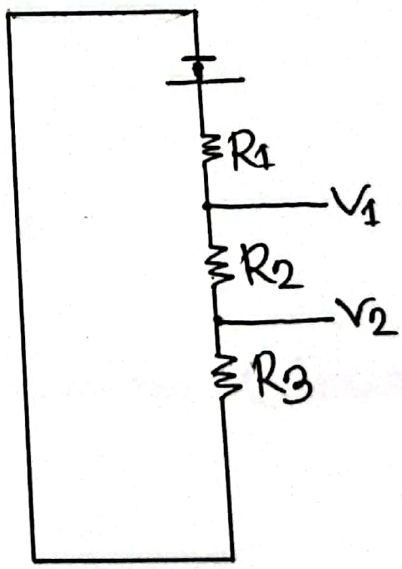
Point Voltage: From the point to ground voltage.

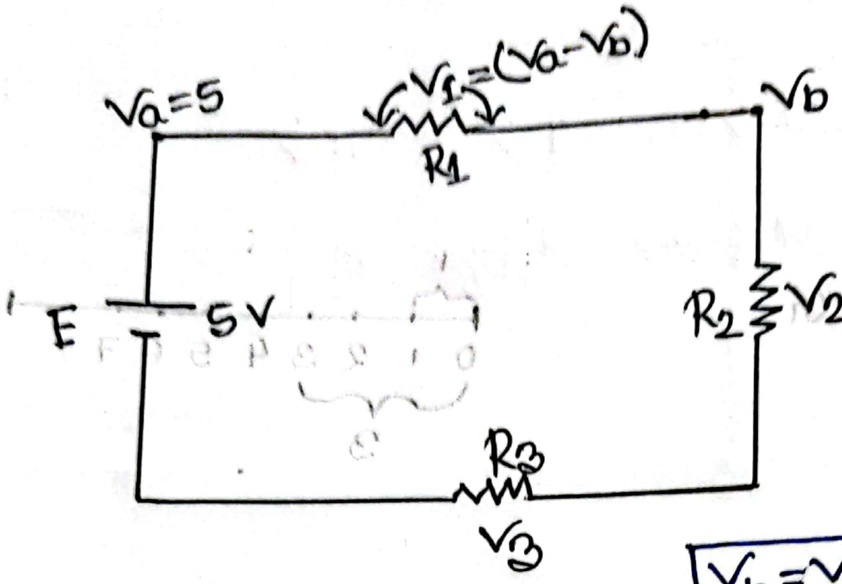



$$V = V_p - V_G = 5 - 0 = 5V$$



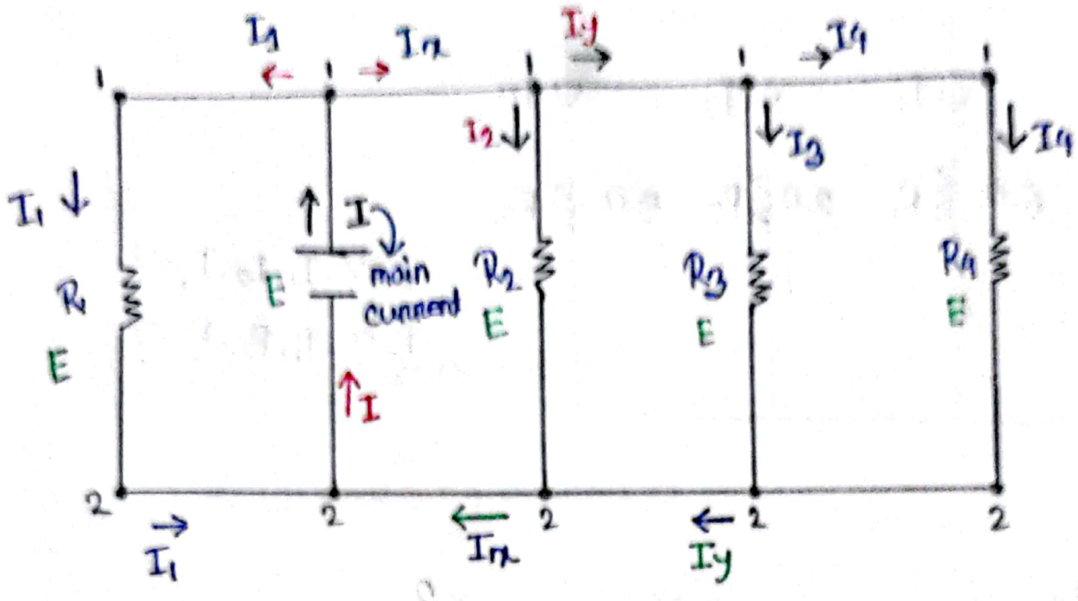






$$\boxed{V_b = V_2 + V_3}$$

# Parallel DC Circuits:




Note: * Parallel Circuit: Voltage Same.

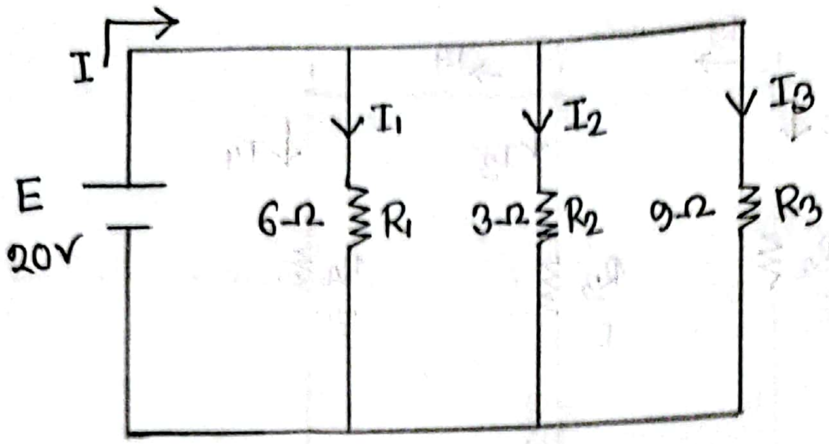
* Series Circuit: Current Same.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \dots + \frac{1}{R_n}$$

* 2টি Resistence: $R_T = \dfrac{R_1 R_2}{R_1 + R_2}$ → For 2 Resistence

$$I = \frac{E}{R_T} \; ; \; P = VI = I^2 R$$

## Problem:




- $I = ?$, $I_1, I_2, I_3 = ?$
- $P = ?$, $P_1, P_2, P_3 = ?$

**Soln:** Here,

$$R_{T_1} = \frac{R_1 R_2}{R_1 + R_2} = \frac{6 \times 3}{6+3} = \frac{18}{9} = 2\Omega$$

$$\therefore R_{T_1} = 2\Omega$$

$$\therefore R_T = \frac{R_{T_1} R_3}{R_{T_1} + R_3} = \frac{2 \times 9}{9+2} = 1.64\Omega$$

$$\therefore R_T = 1.64\Omega$$

$$\therefore I = \frac{E}{R_T} = \frac{20}{1.64} = 12.22A$$

$$I_1 = \frac{E}{R_1} = \frac{20}{6} = 3.33A$$

$$I_2 = \frac{E}{R_2} = \frac{20}{3} = 6.67A$$

$$I_3 = \frac{E}{R_3} = \frac{20}{9} = 2.22A$$

$$I = I_1 + I_2 + I_3$$

$$= 3.33 + 6.67 + 2.22$$

$$= 12.22A$$

$$P_1 = VI_1 = 20 \times 3.33 = 66.6\ W$$

$$P_2 = VI_2 = 20 \times 6.67 = 133.4\ W$$

$$P_3 = VI_3 = 20 \times 2.22 = 44.4\ W$$

$$\therefore P = VI = 20 \times 12.22$$

$$= 244.\ W$$

or

$$P = P_1 + P_2 + P_3$$

$$= 66.6 + 133.4 + 44.4$$

$$= 244.\ W$$

Note: Series and Parallel Circuit have same power