(8)

Relation ship between power, Energy and time

$$P = \frac{E}{T}$$

what is the power in watts if energy equal to 50 J is used in 2.5 sec ?

$$P = \frac{E}{T} = \frac{50}{2.5} = 20 \text{ watts}.$$

ohm's law :- It describes the fundamental relationship between voltage, current and resistance in an electrical circuit.

defn :- It states that the current through a conductor is directly proporti -onal to the voltage across it and inversely proportional to its resistance.

mathematical Rep :-

$$V = IR$$

V = Voltage in volts (V)

I = Current in amperes (A)

R = Resistance in ohms (Ω)

Limitations of ohm's law.

→ This law is applicable only for constant temperature

→ not applicable for all non-metallic (graphite) conductors

→ not applicable for non-linear devices such as zener diode, voltage regulator etc

Pbm 1 A 100Ω resistance is directly switched on across a 10V battery. what is the current through the resistor? How much is the power loss? Also find the energy consumed in 5 sec.

Soln

given

Voltage = 10V.

Resistance = 100Ω.

time = 5 sec.

By ohms law,

$$V = IR \implies I = \frac{V}{R} = \frac{10V}{100} = 0.1A$$

$$\text{power loss} = VI = IR \times I = I^2R = (0.1)^2 100$$
$$= 0.01 \times 100$$
$$= 1W.$$

$$\text{Energy consumed} = PT = 1 \times 5 = 5Ws$$

(10)

2) A 560Ω resistor is connected to a circuit which causes a current of 42.4 mA to flow through it. Calculate the voltage across the resistor and the power it is dissipating.

Given $R = 560\ \Omega$

$I = 42.4\ mA$

To find voltage & power dissipation.

By ohms law,

$$V = IR.$$

$$= 42.4 \times 10^{-3} \times 560$$

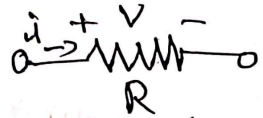
$$\boxed{V = 23.744\ V}$$

Power $P = VI$

$$= 23.744 \times 42.4 \times 10^{-3}\ W.$$

$$= 1.006\ W$$

3) For the circuit shown calculate R if $i = -2\mu A$ and $V = -44V$



$$R = \frac{V}{I} = \frac{-44}{-2 \times 10^{-6}} = 22 \times 10^{6} = 22\ M\Omega.$$

4).

4) The power absorbed by the resistor if $V = 1V$ and $R = 2k\Omega$.

Soln

Gn $V = 1V$

$R = 2k\Omega$.

$P = VI$

$P = I^2R$

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

By ohms Law $V = IR$

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

Power $= VI$

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

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

$= \frac{1^2}{2k} = 0.5 \times 10^{-3}$

$= 0.5 \times 10^{-3}$ watt.

$P = 500$ Mwatt.

5) If $i = 3nA$ and $R = 4.7M\Omega$ Calculate power absorbed.

$i = 3nA$, $R = 4.7M\Omega$.

$P = V \cdot I$

$= IR \cdot I = I^2R = (3n)^2 \times 4.7M$.

$= 9 \times 10^{-9} \times 10^{-9} \times 4.7 \times 10^{6}$

$= 42.3 \times 10^{-12}$ W $= 42.3$ PW

(12)

Relation ship b/w resistance and resistivity.

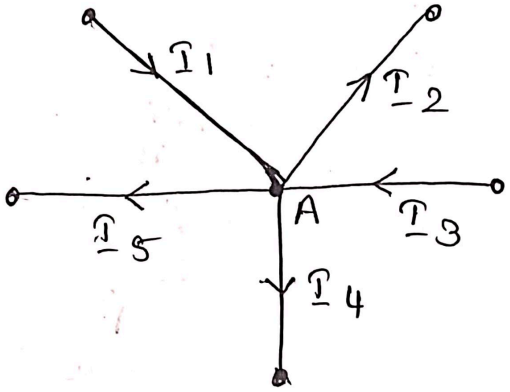
$$R = \rho \cdot \frac{l}{A}.$$

G → conductance = $\frac{1}{\text{Resistance}}$.

Kirchoff's current law:-

The algebraic sum of the current entering any node is zero.

(e) there is no accumulation of charges at nodes.



In other term current flowing towards the junction is equal to current flowing away from the junction.

$$I_1 + I_3 = I_2 + I_4 + I_5.$$

(or)

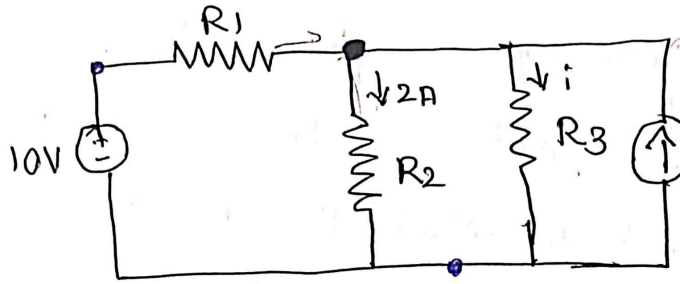
$$I_1 - I_2 + I_3 - I_4 - I_5 = 0.$$

Node: point where two (or) more circuit elements meet.

Branch: current flowing path b/w two nodes.

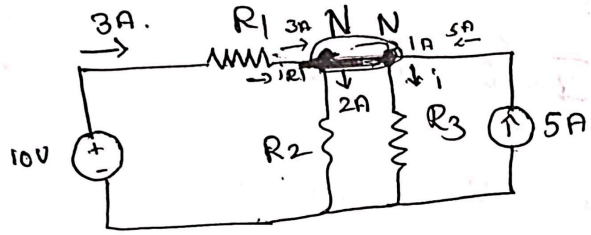
(13)

7) For the circuit shown below calculate the current through the resistor R_3 if it is known that the voltage source supplies a current of 3A.



KCL

Soln



Ans = 6A

Apply KCL at N.

$$i_{R1} + 5A = 2A + i$$

$$8 - 2 = i \Rightarrow 6A.$$

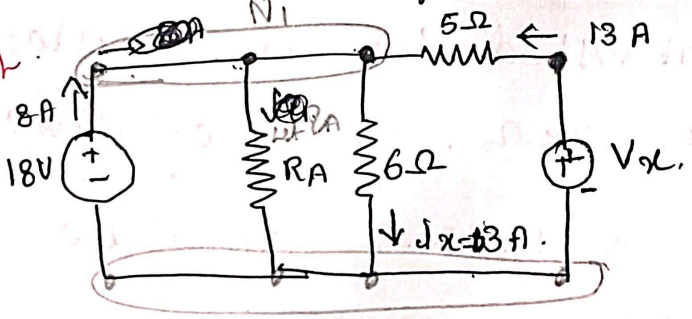
$$i = 6A$$

Total ct in the ckt is

3A + 5A.

= 8A.

8) count the number of branches and nodes in the following circuit if $i_x = 3A$ and the 18V source delivers 8A of current. what is the value of R_A?



KCL

N = 3 B = 5.

Apply KCL at N1

$$8 + 13 = 2_A + 3A$$

$$21 = 2_A + 3A$$

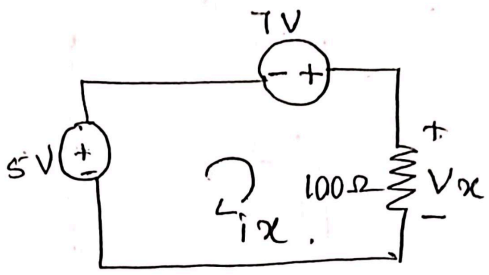
$$2_A = 18A.$$

$$\therefore R_A = \frac{V}{I} = \frac{18V}{18A} = 1\Omega.$$

Kirchoff's voltage law:- Algebraic sum of the vtg around any closed path is zero.

KVL

9) Find V_x and I_x.



KVL

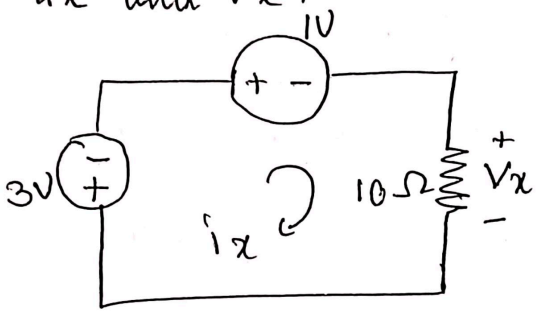
$+5V + 7V - V_x = 0$

$V_x = 12V$

$I_x = \frac{V_x}{R_x} = \frac{12V}{100} = .12A.$

$= 120mA.$

10) Find i_x and V_x.



KVL

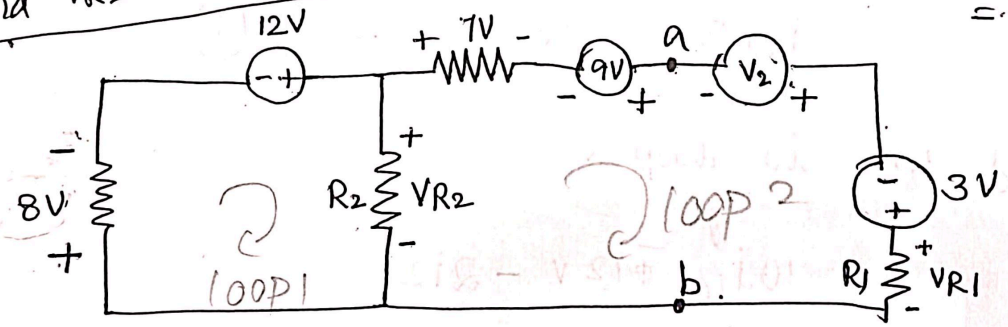
$-3V - 1V - V_x = 0$

$\boxed{V_x = -4V}$

$i_x = \frac{-4}{10} = -0.4A.$

$= -400mA.$

11. Find V_{R2} & V_2 if $V_{R1} = 1V$



Find V_{R2} and V_2 if $V_{R1} = 1V$.

Apply KVL at loop 1

$(-8V) + 12V - V_{R2} = 0.$

$\boxed{4 = V_{R2}}$

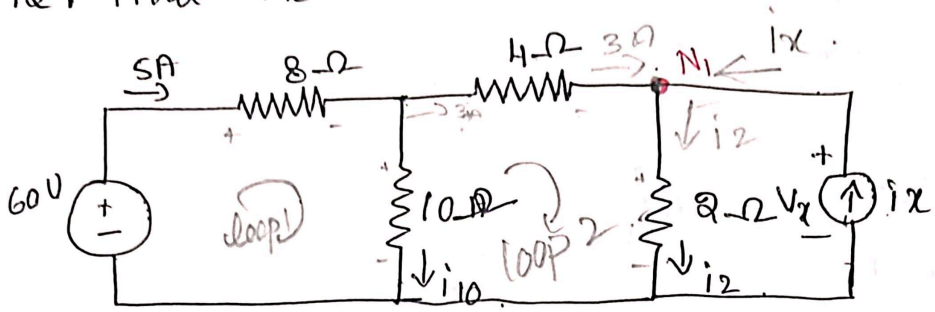
Apply KVL to loop 2

$-7 + 9 + V_2 + 3 - V_{R1} + V_{R2} = 0$

$-7 + 9 + V_2 + 3 - 1 + 4 = 0$

$8 + V_2 = 0 \Rightarrow \boxed{V_2 = -8V}$

(b) 12. Find V_x in the ckt.



Apply KVL to loop 1

$$60V - 4i_0 - 10i_{10} = 0.$$

$$20 = 10i_{10}$$

$$i_{10} = \qquad i_{10} = \frac{20}{10} = 2A. \qquad \boxed{i_{10} = 2A}$$

since $5 - i_{10} = 5 - 2 = 3A$ ct flow through 4Ω.

Apply KVL to loop 2.

$$10i_{10} + 12V - 2i_2 = 0$$

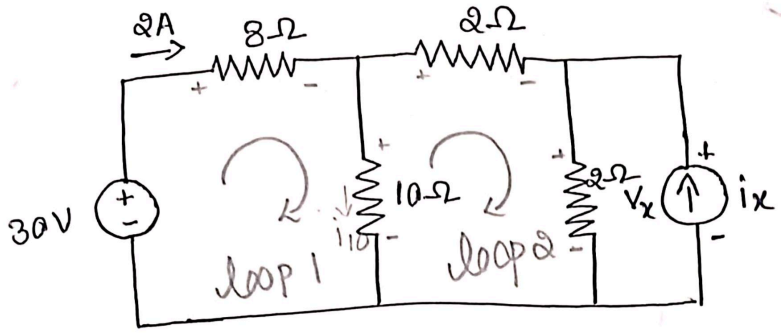
$$20 - 12 - 2i_2 = 0$$

$$8 = 2i_2 \Rightarrow \quad i_2 = \frac{8}{2} \Rightarrow \boxed{i_2 = 4A}$$

$$V_x = 2 \times i_2$$

$$= 2 \times 4 = 8V$$

13.



Determine V_x.

Soln

Apply KVL to loop 1

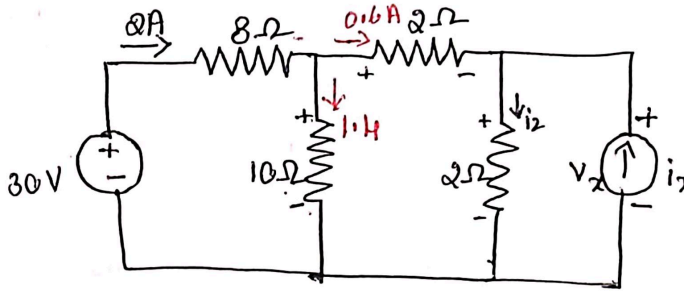
$$30V - 16V - 10 i_{10} = 0$$

$$14V - 10 i_{10} = 0$$

$$10 i_{10} = 14$$

$$i_{10} = \frac{14}{10}$$

$$\boxed{i_{10} = 1.4\ A}$$



Apply KVL to loop 2

$$14 - 1.2 - 2 i_2 = 0$$

$$12.8 = 2 i_2$$

$$i_2 = \frac{12.8}{2} = 6.4$$

$$\boxed{i_2 = 6.4\ A.}$$

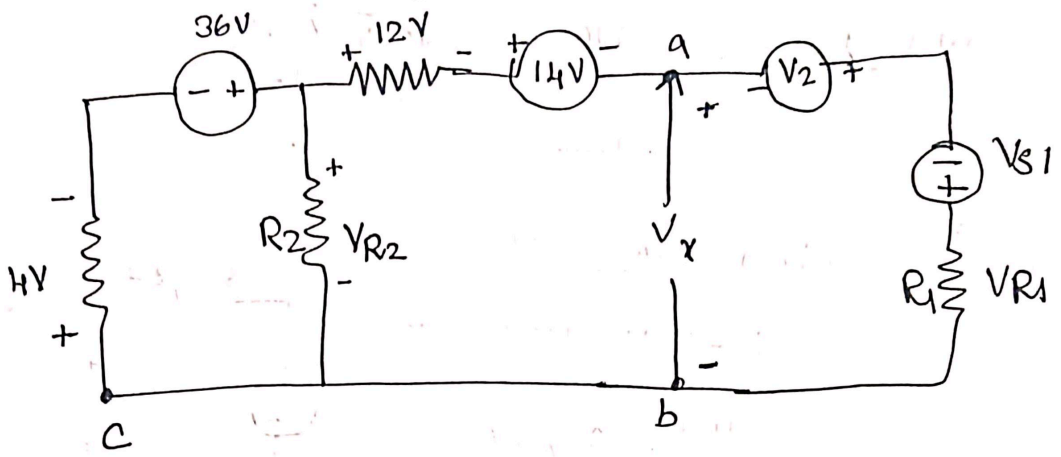
$$V_x = i_2 \times 2\Omega$$

$$= 6.4 \times 2$$

$$\boxed{V_x = 12.8\ V}$$

(17)

14) For the given circuit calculate V_{R2} & V_x



Soln

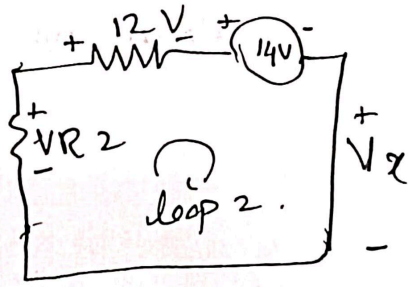
Apply KCL to loop 1

$$-4V + 36 - V_{R2} = 0$$

$$32 - V_{R2} = 0$$

$$\boxed{V_{R2} = 32}$$

Apply to loop 2.



$$V_{R2} - 12V - 14V - V_x = 0$$

$$32 - 26 - V_x = 0$$

$$6 - V_x = 0$$

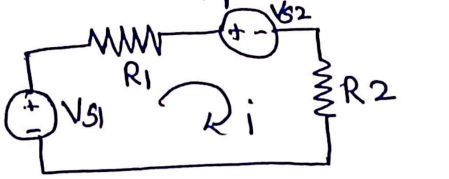
$$\boxed{V_x = 6}$$

DC circuit: A DC circuit is a closed electrical circuit where current flow in one direction typically from positive terminal to negative terminal of the power source like a battery. DC circuit → Series ckt → parallel ckt

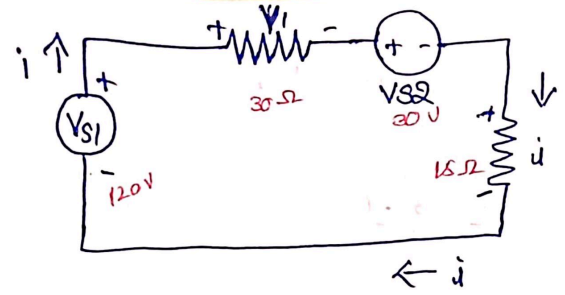
Series ckt:- In this type of ckt all the element in the circuit carry the same current

Apply KVL $V_{S1} - iR_1 - V_{S2} - iR_2 = 0$

$V_{S1} - V_{S2} = iR_1 + iR_2 \Rightarrow \boxed{i = \frac{V_{S1} - V_{S2}}{R_1 + R_2}}$



15)



DC Circuits

$V_{S1} = 120V$, $V_{S2} = 30V$ $R_1 = 30\Omega$, $R_2 = 15\Omega$ compute power absorbed by each element.

Soln

We can find ~~$i = \frac{120}{30} = 4A$~~

Apply KVL to loop.

$$120V - 30i - 30 - 15i = 0$$

$$90V - 45i = 0$$

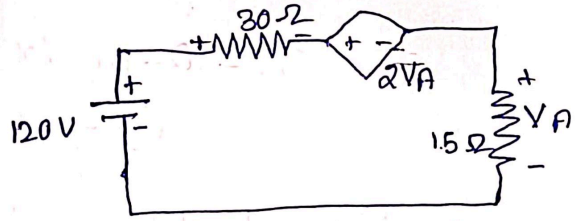
$$45i = 90$$

$$\boxed{i = 2A}$$

Power across VS1 $= P_{VS1} = VxI = 120 \times 2 = 240W$ | $P_{VS2} = 2 \times 30 = 60W$

$P_{30\Omega} = I^2R = 2^2 \times 30 = 120W$ | $P_{15\Omega} = 4 \times 15 = 60$ watt

16) Find power absorbed in each element



Apply KVL

$120V - 30i - 2VA - VA = 0.$

$120V - 30i - 3VA = 0$ ——— (1)

WKT $-VA = 15i$ ——— (2)

Sub (2) in (1),

$120V - 30i - 3(-15i) = 0$

$120V - 30i + 45i = 0$

$120V + 15i = 0$

$i = \frac{-120}{15} = -8A.$

$\boxed{i = -8A}$

$\therefore VA = -15 \times 8 = -120$

$P_{120} = 120 \times 8 = 960W$

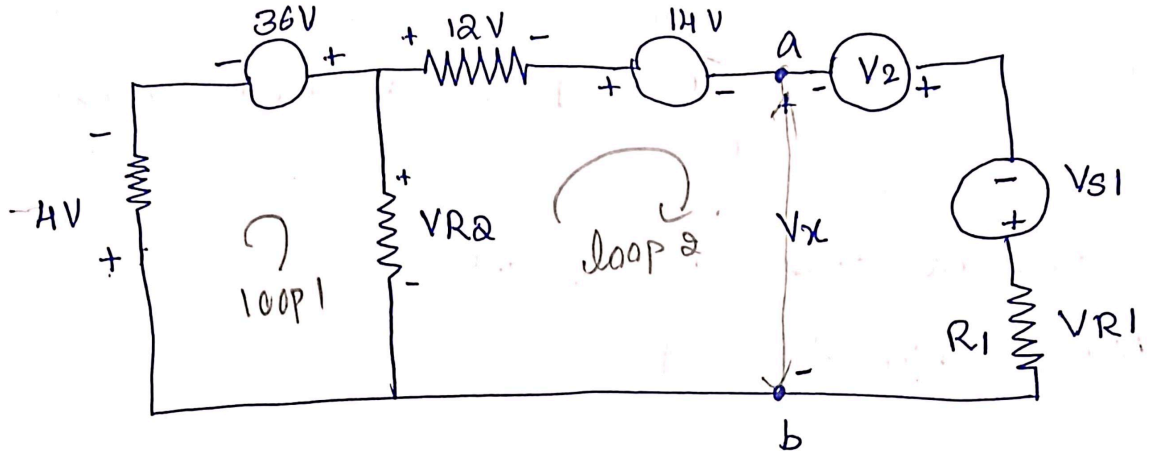
$P_{30\Omega} = 30 \times 8^2 = 64 \times 30 = 1920W.$

$P_{2VA} = 8 \times 2 \times 120 = -1920W$

$P_{15\Omega} = 8^2 \times 15 = 960W.$

(11)

1) For the given circuit calculate V_{R2} and V_x.



Apply KVL to loop 1

$$-4V + 36V - V_{R2} = 0$$

$$32 - V_{R2} = 0$$

$$\boxed{V_{R2} = 32V}$$

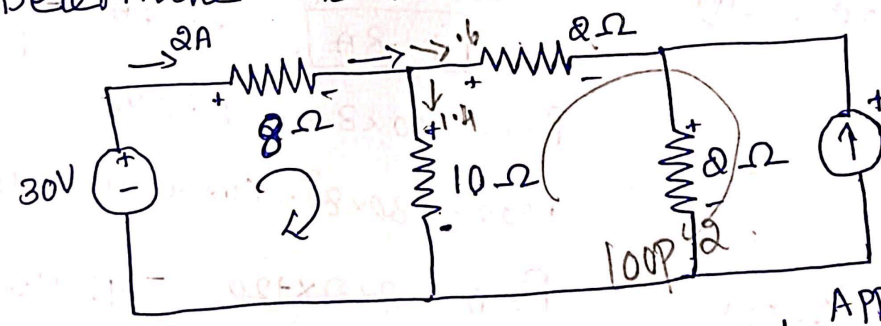
Apply KVL to loop 2.

$$\therefore V_{R2} - 12V - 14 - V_x = 0$$

$$32 - 12 - 14 - V_x = 0$$

$$6V - V_x = 0 \implies \boxed{V_x = 6V}$$

2) Determine V_x in the circuit.



Soln Apply KVL to loop 1

$$30V - 16V - V_{10} = 0$$

$$\boxed{V_{10} = 14V}$$

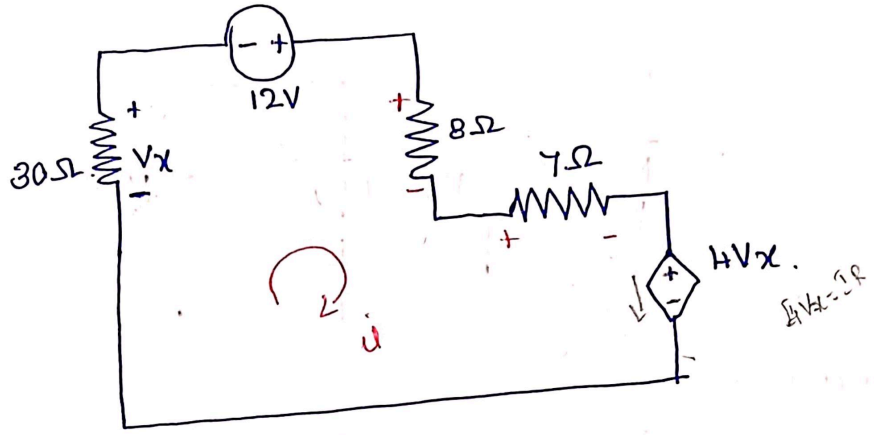
Apply KVL to loop 2

$$+V_{10} + V_2 - V_x = 0$$

$$14V + 0.6V - (0.6 \times 2) = V_x$$

$$\boxed{V_x = 12.8V}$$

17. Find the power absorbed by each of the five elements in the following circuit.



Solution

* mark polarity:
* For series DC circuit the current flowing through the entire circuit is same let it be i
* Apply KVL

$$Vx + 12V - 8i - 7i - 4Vx = 0.$$

$$-30i + 12V - 15i - (4 \times -30i) = 0 \qquad [\because Vx = -30i]$$

$$-30i + 12V - 15i + 120i = 0$$

$$-45i + 120i = -12$$

$$75i = -12$$

$$i = \frac{-12}{75} = -0.16A \Rightarrow \boxed{i = -0.16A}$$

$P_{30\Omega} = I^2R = (0.16)^2 30 = 0.768$ watts.

$P_{12V} = V(I) = 12 \times +0.16 = +1.92$ watts.

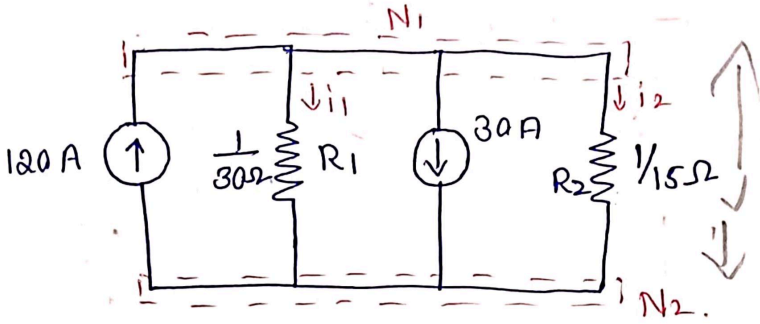
$P_{8\Omega} = I^2R = (-0.16)^2 8 = 0.2048W$

$P_{7\Omega} = I^2R = (-0.16)^2 7 = 0.1792W$

$P_{4Vx} = 4Vx\,I = 4(-30 \times -0.16)(-0.16) = -3.072$

(21)

18. Find the voltage, current and power associated with each element.



Solution :-

There are two nodes in the circuit

Apply KCL

$\sum$ current entering N_1 = $\sum$ current leaving N_1

$$120 = i_1 + 30 + i_2$$

$$i_1 + i_2 = 90$$

$$\frac{V}{1/30} + \frac{V}{1/15} = 90$$

$$30V + 15V = 90$$

$$45V = 90$$

$$V = \frac{90}{45} \Rightarrow \boxed{V = 2V}$$

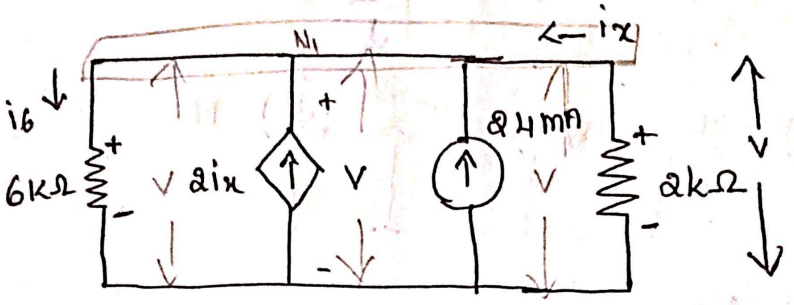
$P_{120A} = VI = 2 \times 120 = 240$ watts.

$P_{1/30\Omega} = \frac{V^2}{R} = \frac{4}{1/30} = 4 \times 30 = 120$ watts.

$P_{30A} = VI = 2 \times 30 = 60$ watts.

$P_{1/15} = V^2/R = 4 \times 15 = 60$ watts.

19. Determine the value of v and the power supplied by the independent current sources.



Solu

Apply KCL at node 1.

$$2i_x + 24mA + i_x = i_6$$

$$3i_x - i_6 + 24m = 0 \quad \text{---(1)}$$

To know i_x, i_6. from fig

For IInd circuits voltage is same

$$\therefore \boxed{i_x = \frac{V}{2k}} \quad \text{---(2)}, \qquad i_6 = \frac{V}{6k} \quad \text{---(3)}$$

Sub (2) & (3) in (1) $\Rightarrow$

$$\frac{-3 \times V}{2k} - \frac{V}{6k} + 24m = 0$$

$$V\left[\frac{-9-1}{6k}\right] = -24m$$

$$V = \frac{-10}{6k} = -24m$$

$$V = \frac{6k \times 24m}{10} = \frac{72}{5} = 14.4\,V$$

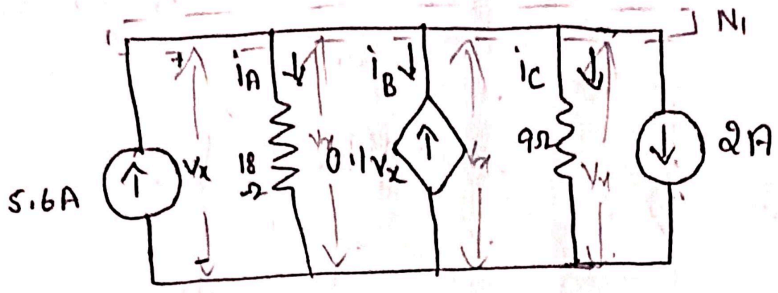
$$\boxed{V = 14.4V}$$

$$P_{24} = V \times 24m$$

$$= 14.4 \times 24mA$$

$$\boxed{P_{24} = 345.6mA.}$$

(23) For the single node pair ckt find i_A, i_B & i_C.



Apply KCL at N_1,

$5.6 = i_A + i_B + i_C + 2$

$3.6 = i_A + i_B + i_C$

$= \frac{V_x}{18} + 0.1V_x + \frac{V_x}{9}$

$= \frac{V_x + 2V_x}{18} - 0.1V_x$

$= \frac{3V_x}{6 \cdot 18} - 0.1V_x$

$3.6 = V_x\left(\frac{1}{6} - 0.1\right)$

$= V_x(0.166 - 0.1)$

$\frac{3.6}{0.066} = V_x$

$\boxed{V_x = 54.54}$

$5.6 + 0.1V_x = i_A + i_C + 2$

$5.6 + 0.1V_x = \frac{V_x}{18} + \frac{V_x}{9} + 2$

$3.6 + 0.1V_x = \frac{2V_x + V_x}{1}$

$3.6 = \frac{3V_x}{18} - 0.1V_x$

$3.6 = \frac{3V_x - 1.8V_x}{18}$

$64.8 = 1.2\ V_x \Rightarrow V_x = 54$

$\boxed{V_x = 54A}$

$i_A = \frac{V_x}{18} = \frac{54}{18} = 3A.$

$i_C = \frac{V_x}{9} = \frac{54}{9} = 6A.$

$i_B = -0.1V_x = -5.4A.$