Chapter 3

Voltage and current laws

NODES, PATHS, LOOPS, AND BRANCHES

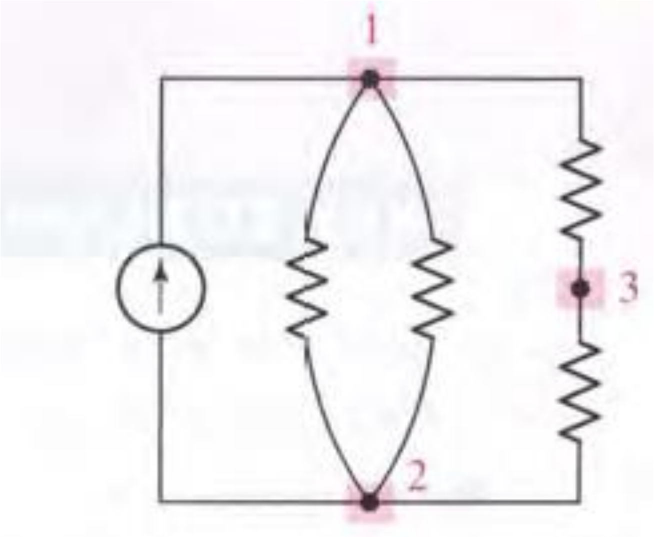
A node is a place where two or more element connect

Path: a route from one node to another

Loop : closed path

Branch: a path that contain an element

No of nodes =3
No of branches=5
No of loops =6



KIRCHHOFF'S CURRENT LAW

KCL

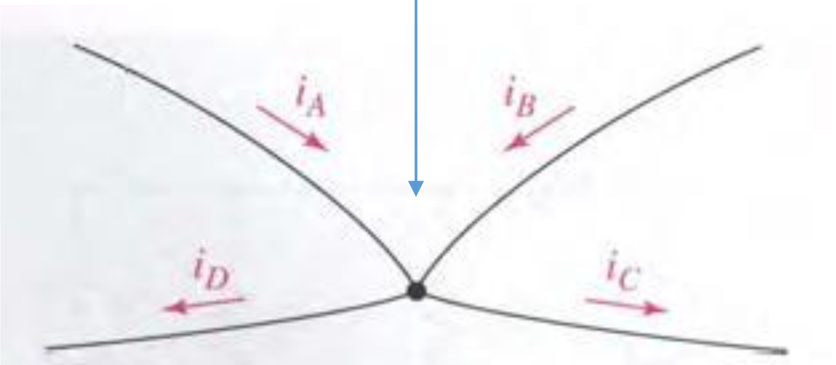
The algebraic sum of currents entering a node is equal to algebraic sum of currents leaving the same node

For any node

$$\sum i_{in} = \sum i_{out}$$

Node

$$i_A + i_B = i_C + i_D$$

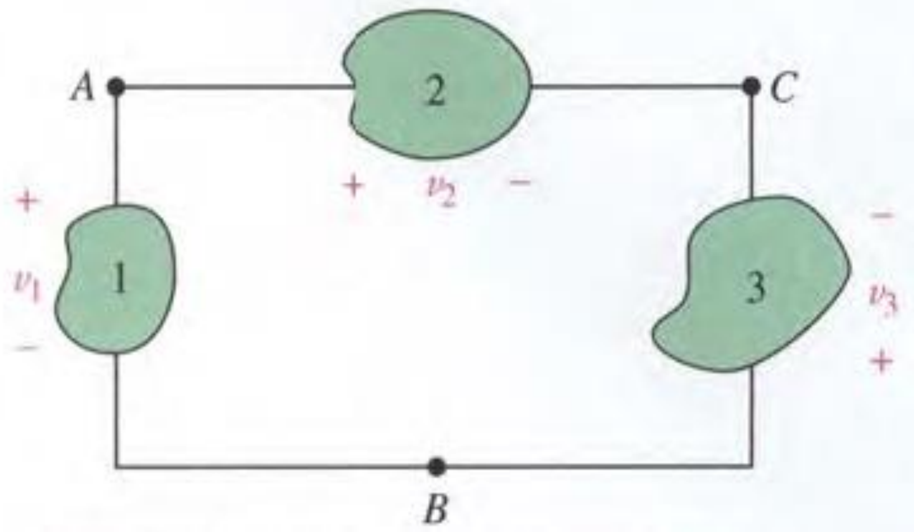


KIRCHHOFF'S VOLTAGE LAW KVL

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

$$\sum_{n=1}^{N} v_n = 0$$

$$-v_1 + v_2 - v_3 = 0$$



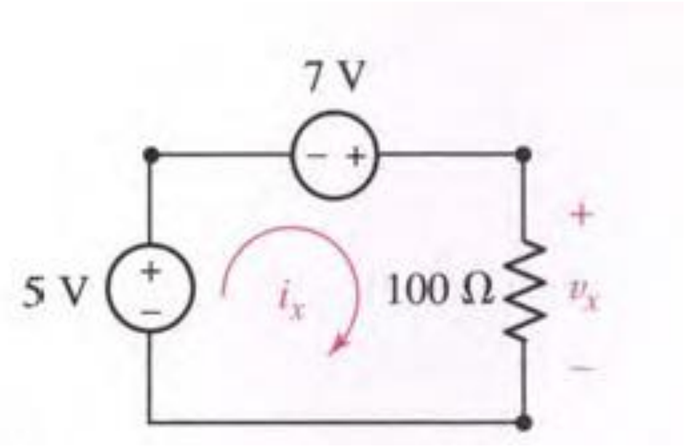
Example : Find V_x and I_x

KVL

$$-5 - 7 + v_x = 0$$

Ohms Law

$$i_x = \frac{v_x}{100} = \frac{12}{100}\ \text{A} = 120\ \text{mA}$$



Example : find V_{R2}, V_x ?

KVL at loop 1

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

$$V_{R2} = 32v$$

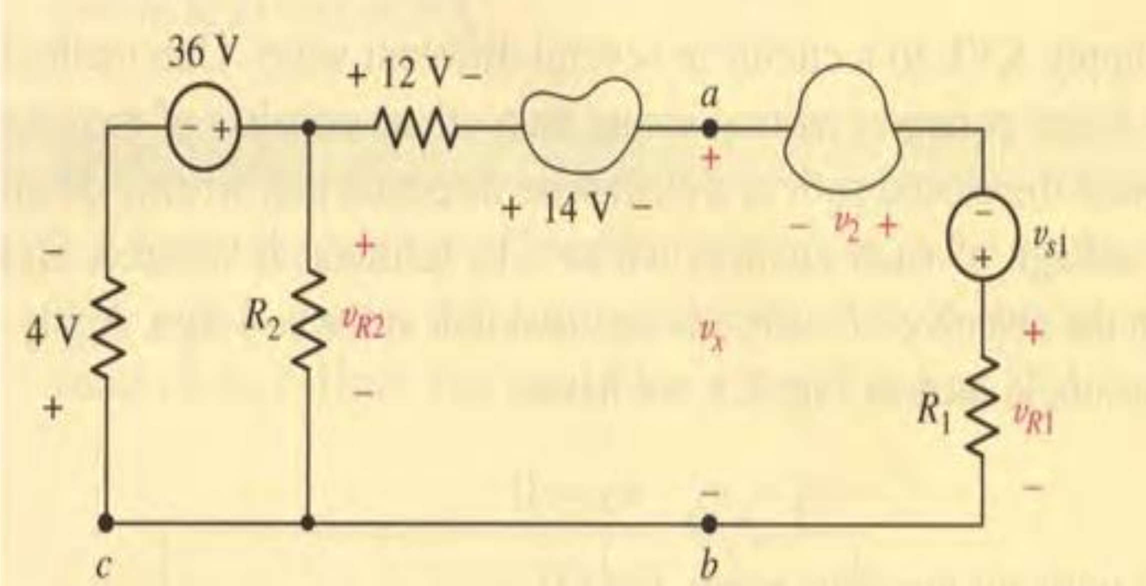
KVL at loop 2

$$-v_{R2} + 12 + 14 + v_x = 0$$

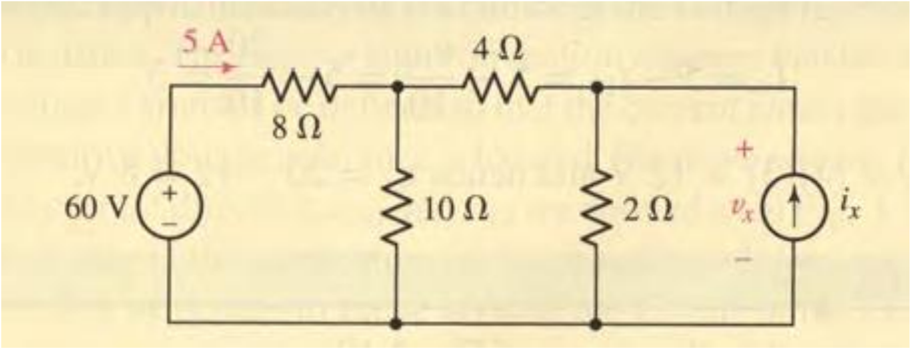
$$-32 + 12 + 14 + v_x = 0$$

$$-6 + v_x = 0$$

$$v_x = 6v$$



Find Vx in the following circuit

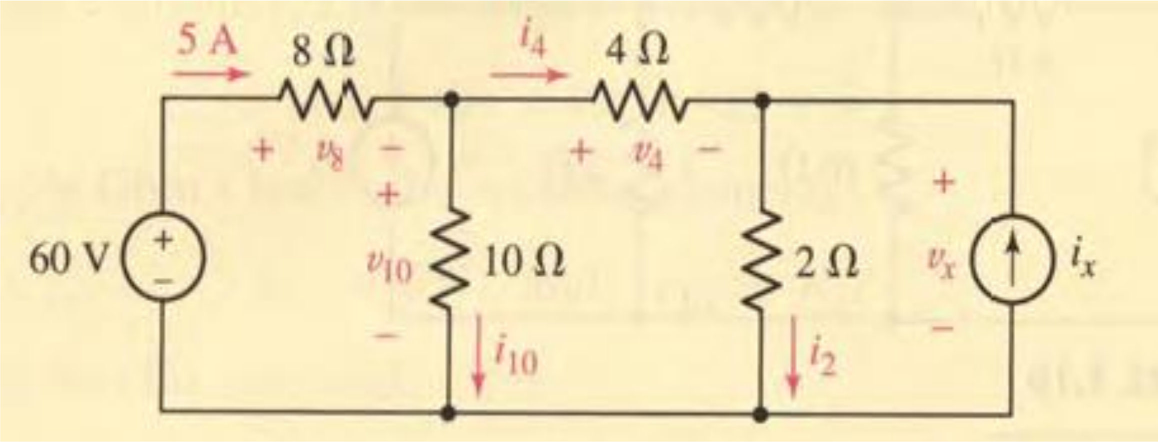


KVL at loop 1

$$-60+v_8+v_{10}=0$$
$$-60+5(8)+v_{10}=0$$
$$-60+40+v_{10}=0$$
$$v_{10}=20v$$

KcL at node 1

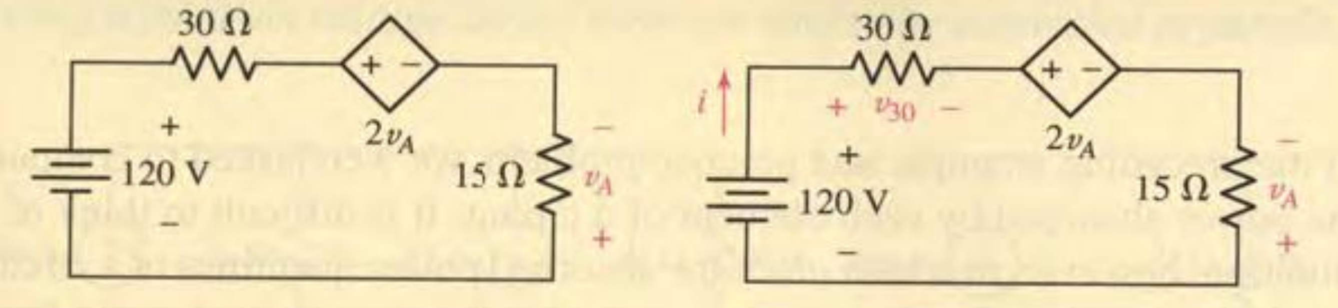
$$5=i_4+i_{10}$$
$$i_{10}=\frac{v_{10}}{10}=\frac{20}{10}=2A$$
$$5=i_4+2$$
$$i_4=3A$$



KVL at loop 2

$$-v_{10}+v_4+v_x=0$$
$$v_4=i_4(4)=3(4)=12v$$
$$-20+12+v_x=0$$
$$v_x=8v$$

Find power of each element in the following circuit



applying KVL around the loop:

$$-120 + v_{30} + 2v_A - v_A = 0$$

Using Ohm's law to introduce the known resistor values:

$$v_{30} = 30i \quad \text{and} \quad v_A = -15i$$

Note that the negative sign is required since i flows into the negative terminal of v_A.

Substituting into Eq. [7] yields

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

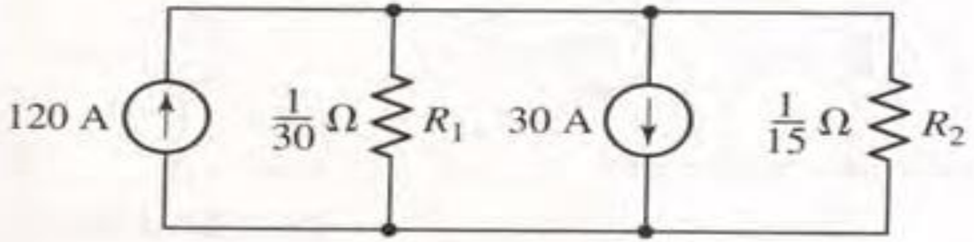
and so we find that

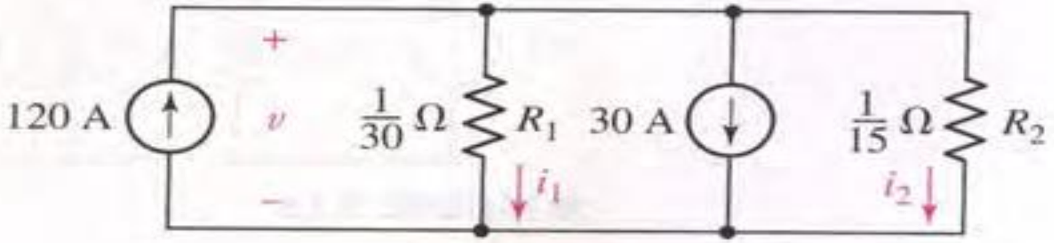
$$i = 8 \text{ A}$$

Computing the power *absorbed* by each element:

$$p_{120\text{V}} = (120)(-8) = -960 \text{ W}$$
$$p_{30\Omega} = (8)^2(30) = 1920 \text{ W}$$
$$p_{\text{dep}} = (2v_A)(8) = 2[(-15)(8)](8) = -1920 \text{ W}$$
$$p_{15\Omega} = (8)^2(15) = 960 \text{ W}$$

Find power of each element in the following circuit





$$-120 + i_1 + 30 + i_2 = 0$$

Writing both currents in terms of the voltage v using Ohm's law,

$$i_1 = 30v \quad \text{and} \quad i_2 = 15v$$

we obtain

$$-120 + 30v + 30 + 15v = 0$$

Solving this equation for v results in

$$v = 2\text{ V}$$

and invoking Ohm's law then gives

$$i_1 = 60\text{ A} \quad \text{and} \quad i_2 = 30\text{ A}$$

The absorbed power in each element can now be computed. In the two resistors,

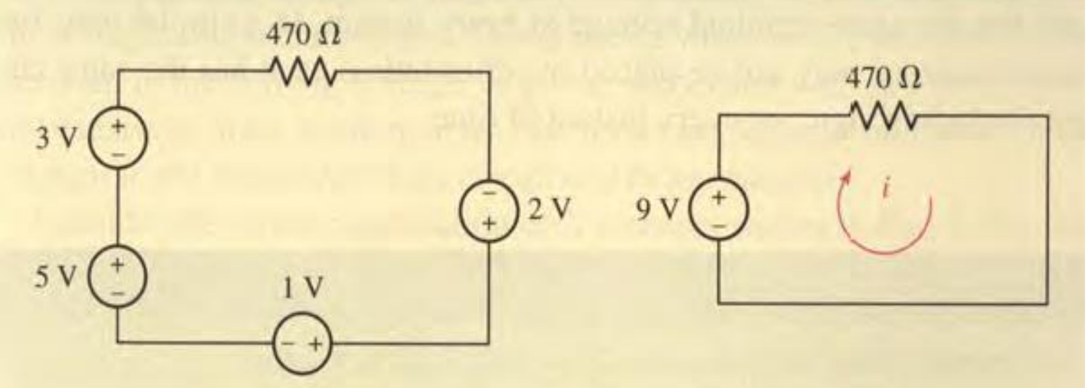
$$p_{R1} = 30(2)^2 = 120\text{ W} \quad \text{and} \quad p_{R2} = 15(2)^2 = 60\text{ W}$$

and for the two sources,

$$p_{120\text{A}} = 120(-2) = -240\text{ W} \quad \text{and} \quad p_{30\text{A}} = 30(2) = 60\text{ W}$$

Since the 120 A source absorbs negative 240 W, it is actually *supplying* power to the other elements in the circuit. In a similar fashion, we find that the 30 A source is actually *absorbing* power rather than *supplying* it.

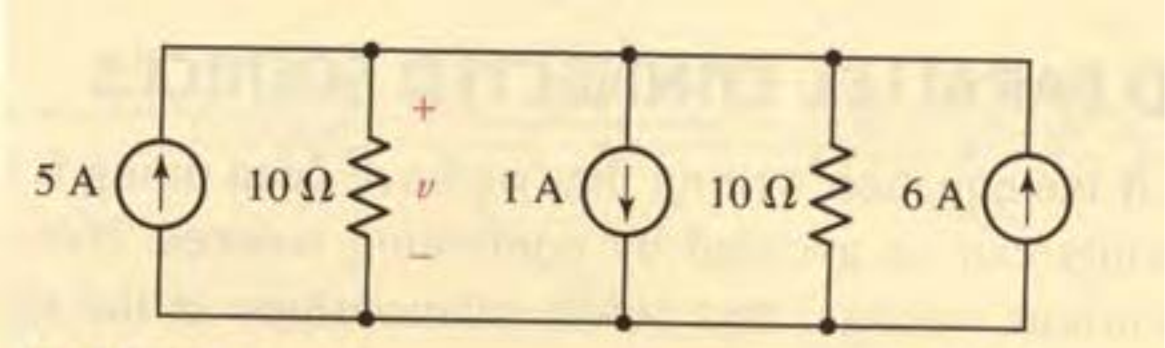
SERIES AND PARALLEL CONNECTED SOURCES



(a) (b)

$$+3+5-1+2=9\text{ V}$$

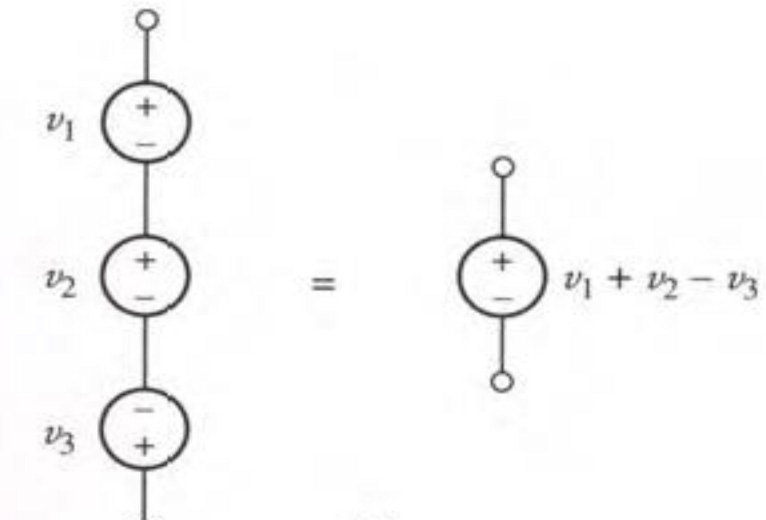
$$i=\frac{9}{470}=19.15\text{ mA}$$



$$I_T=5-1+6=10A$$

$$R_t=5\Omega$$

$$V=I_T.R_t=10*5=50v$$



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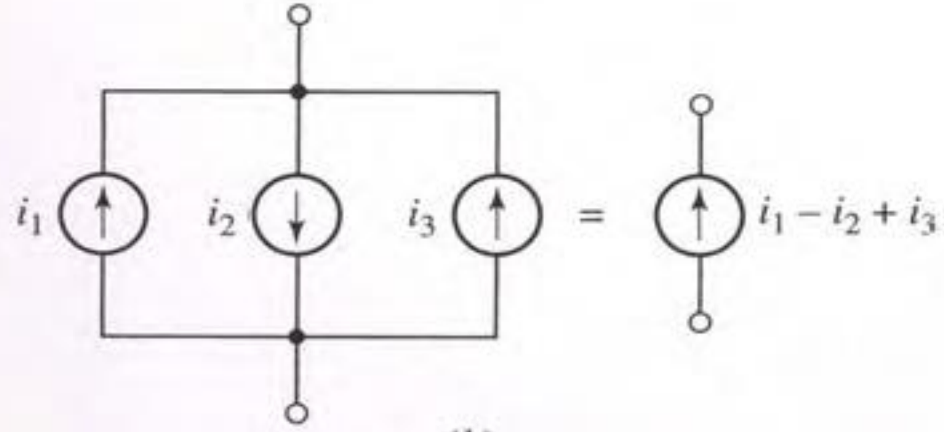

(b)