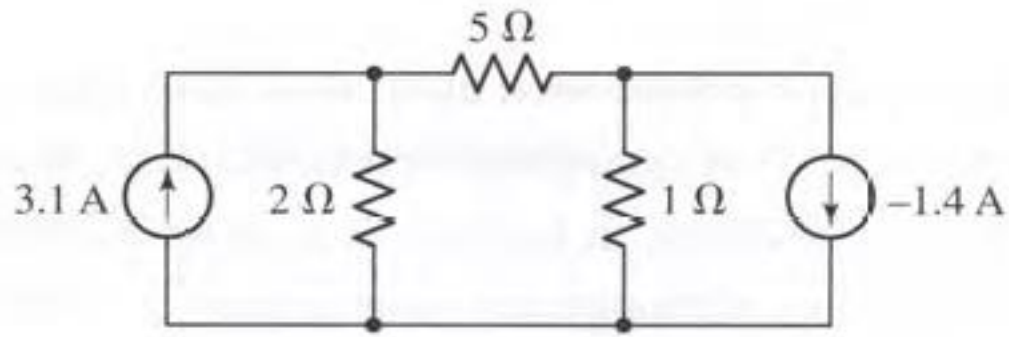
Chapter 4

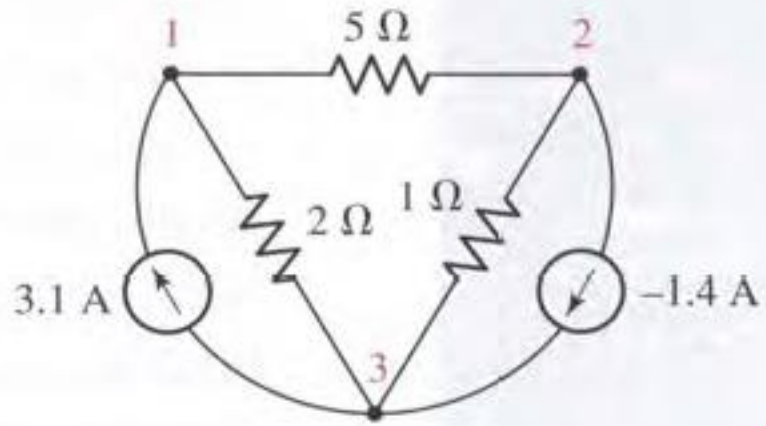
Basic Nodal and Mesh Analysis

Summary of Basic Nodal Analysis Procedure

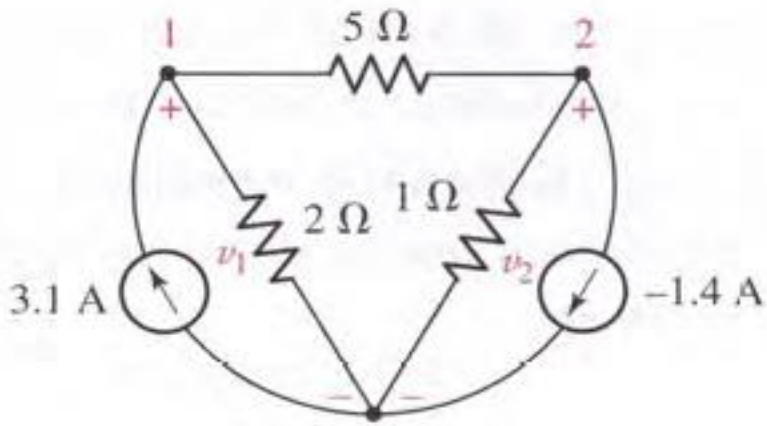
1. **Count the number of nodes** (N).
2. **Designate a reference node.** The number of terms in your nodal equations can be minimized by selecting the node with the greatest number of branches connected to it.
3. **Label the nodal voltages** (there are $N - 1$ of them).
4. **Write a KCL equation for each of the nonreference nodes.** Sum the currents flowing *into* a node from sources on one side of the equation. On the other side, sum the currents flowing *out of* the node through resistors. Pay close attention to "—" signs.
5. **Express any additional unknowns such as currents or voltages other than nodal voltages in terms of appropriate nodal voltages.** This situation can occur if voltage sources or dependent sources appear in our circuit.
6. **Organize the equations.** Group terms according to nodal voltages.
7. **Solve the system of equations for the nodal voltages** (there will be $N - 1$ of them).



(*a*)

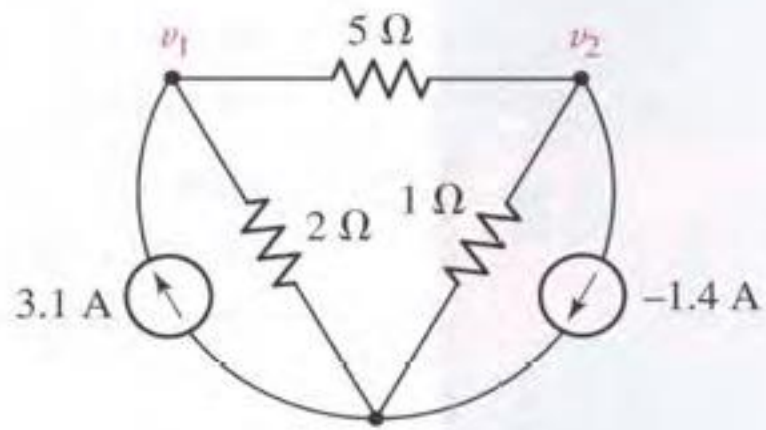


(*b*)



Reference node

(*c*)



Ref.

(*d*)

KCL at node 1

$$\frac{v_1}{2} + \frac{v_1 - v_2}{5} = 3.1$$

$$0.7v_1 - 0.2v_2 = 3.1$$

KCL at node 2

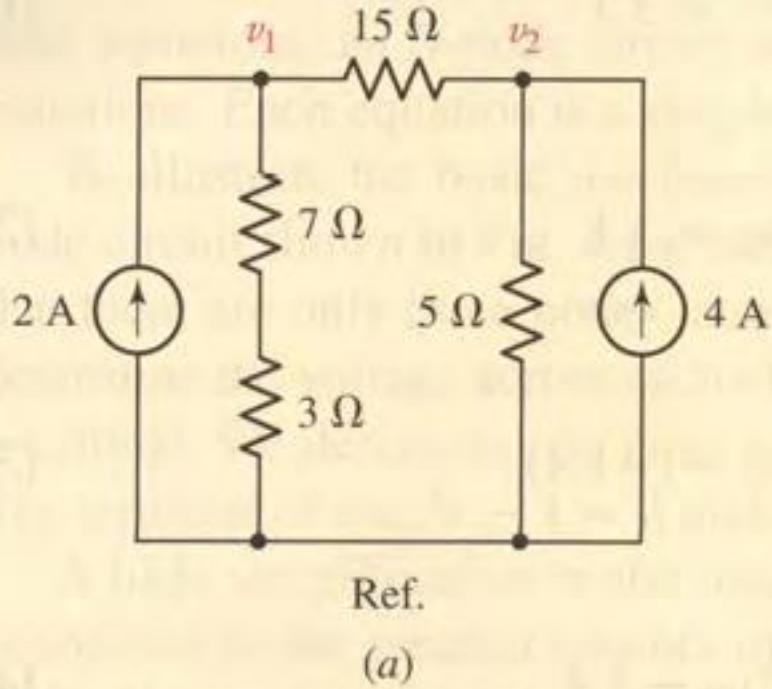
$$\frac{v_2}{1} + \frac{v_2 - v_1}{5} = -(-1.4)$$

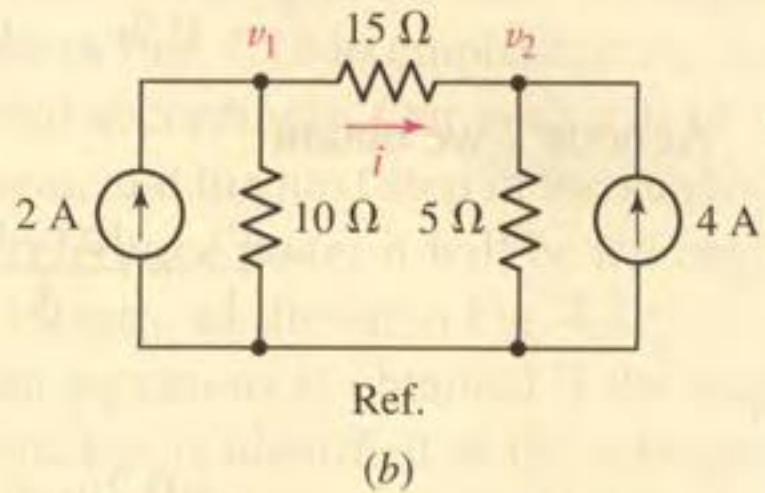
$$-0.2v_1 + 1.2v_2 = 1.4$$

The results are $v_1 = 5$ V and $v_2 = 2$ V.

$$v_{5\Omega} = v_1 - v_2 = 3 \text{ V}.$$

Determine the current flowing left to right through the 15 Ω resistor of Fig. 4.2*a*.





Writing an appropriate KCL equation for node 1,

$$2 = \frac{v_1}{10} + \frac{v_1 - v_2}{15}$$

KCL for node 2

$$4 = \frac{v_2}{5} + \frac{v_2 - v_1}{15}$$

Rearranging, we obtain

$$5v_1 - 2v_2 = 60$$

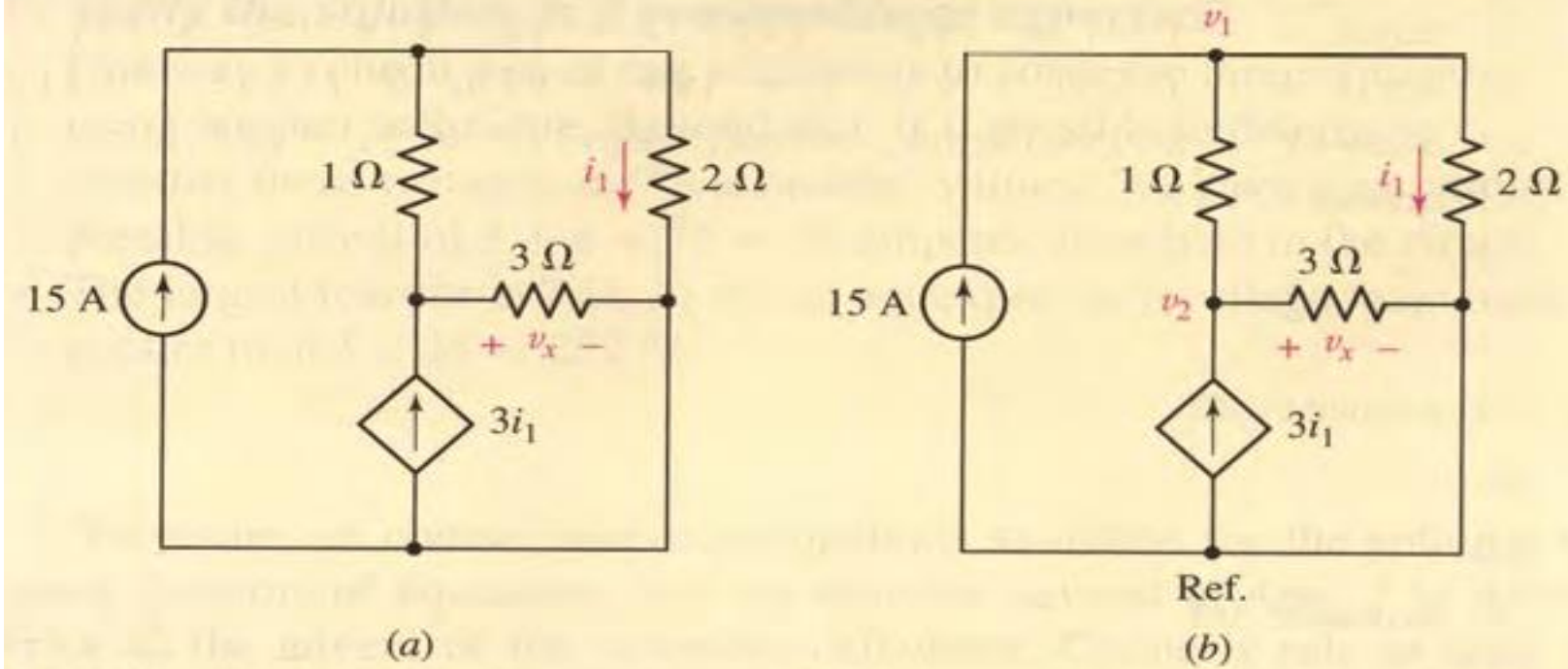
and

$$-v_1 + 4v_2 = 60$$

$v_1 = 20$ V and $v_2 = 20$ so that $v_1 - v_2 = 0$.

zero current is flowing through the 15 Ω resisto

Determine the power supplied by the dependent source of Fig. 4.6*a*.



KCL at node 1

$$15 = \frac{v_1 - v_2}{1} + \frac{v_1}{2}$$

KCL at node 2

$$3i_1 = \frac{v_2 - v_1}{1} + \frac{v_2}{3}$$

$$i_1 = \frac{v_1}{2}$$

After substituting i1

$$3v_1 - 2v_2 = 30$$

$$-15v_1 + 8v_2 = 0$$

Solving we find $v_1 = -40$ V, $v_2 = -75$ V, and $i_1 = 0.5v_1 =$ -20 A

Power of dependent source is $(3i_1)(v_2) = (-60)(-75) = 4.5$ kW.