Node voltage method with dependent sources:

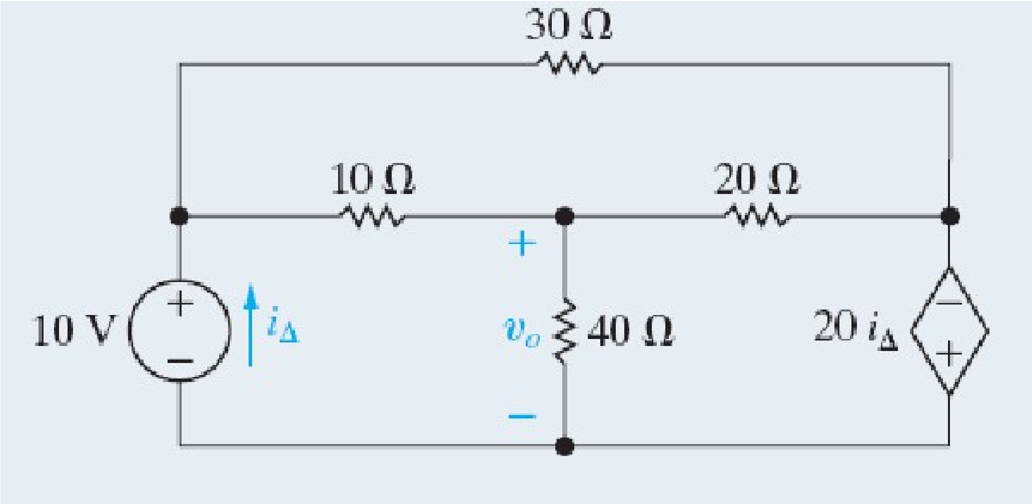
- The "modified recipe":
  1. Identify the essential nodes
  2. Pick a reference node
  3. Label remaining essential nodes with voltage values
  4. Write a KCL equation at each non-reference essential node
     a) Any dependent sources? If so, write a constraint equation for each one that defines the variable the source depends upon
  5. Put equations in standard form and solve
  6. Check your solutions by balancing power
  7. Calculate quantities of interest

In the circuit we just analyzed, all of the sources are delivering power to the circuit.

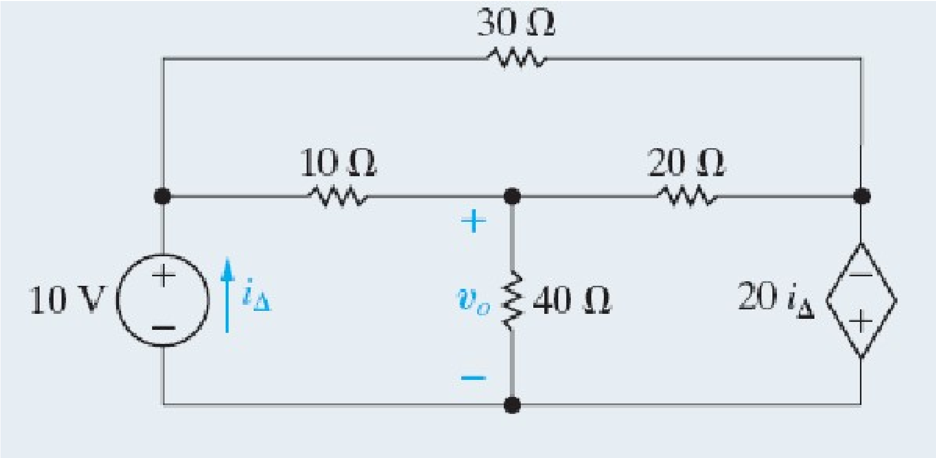
A. True
B. False

Node voltage method with a voltage source alone in a branch:

Find the voltage v_o.



How many essential nodes does this circuit contain?



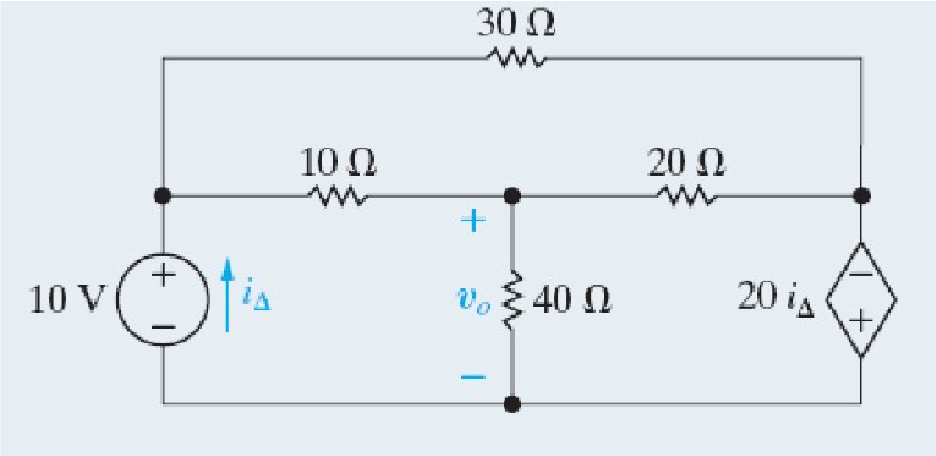
A. 2

B. 3

C. 4

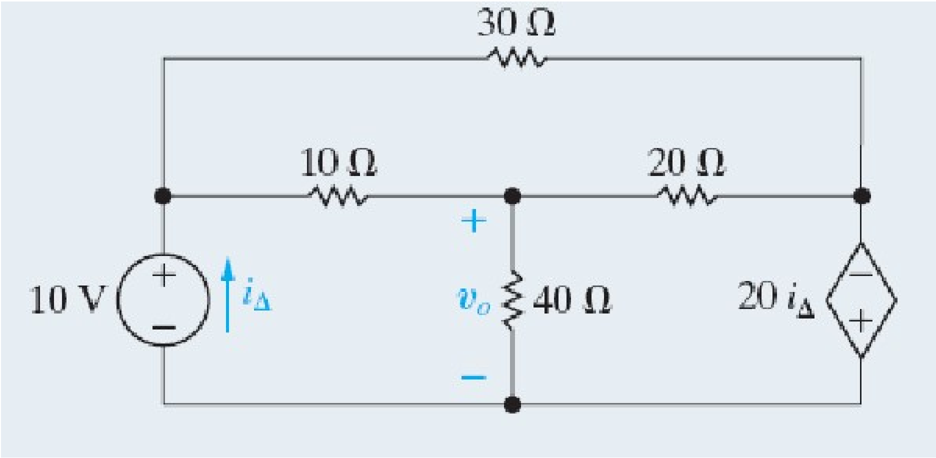
D. 5

THE DEPENDENT SOURCE CONSTRAINT EQUATION MUST DEFINE THE VALUE OF WHICH VARIABLE?



A. i_Δ
B. v_o
C. The voltage across the dependent source
D. The reference voltage

If the essential node at the bottom of the circuit is the reference node, what is the voltage at the middle left node with respect to the reference node?



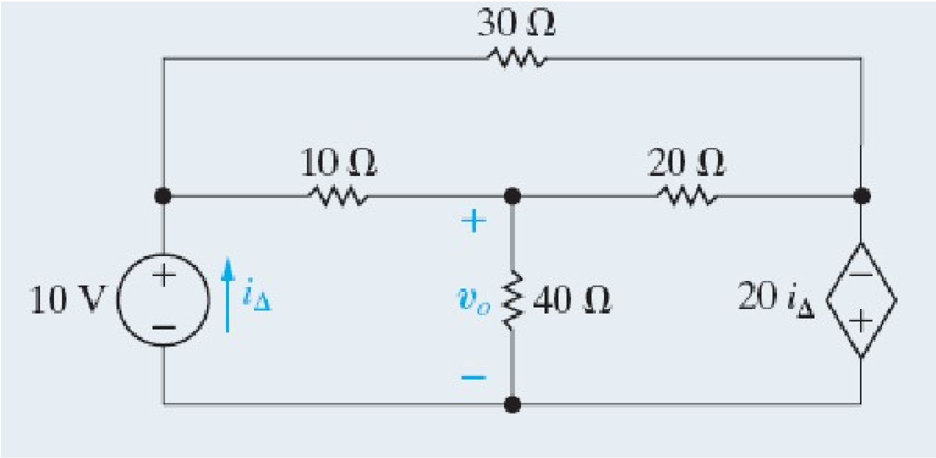
A. $20i_\Delta$

B. v_o

C. 10 V

D. It is unknown

If the essential node at the bottom of the circuit is the reference node, what is the voltage at the middle right node with respect to the reference node?



A. $20i_\Delta$

B. v_o

C. 10 V

D. $-20i_\Delta$

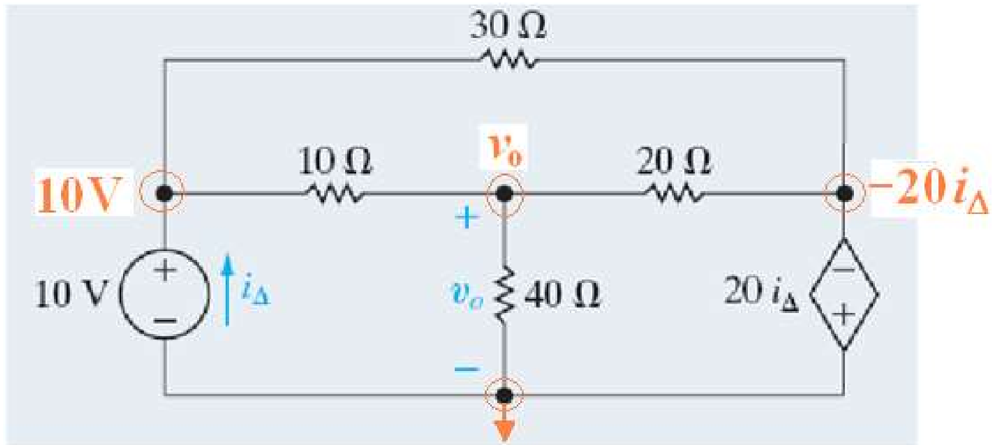
CHAPTER 4 – TECHNIQUES OF CIRCUIT ANALYSIS

The "modified recipe":

1. Identify the essential nodes
2. Pick a reference node
3. Label remaining essential nodes with voltage values
    a) Any voltage sources between the reference node and any other essential nodes? If so, label with the value of the voltage source
4. Write a KCL equation at each non-reference essential node
    a) Any dependent sources? If so, write a constraint equation for each one that defines the variable the source depends upon
5. Put equations in standard form and solve
6. Check your solutions by balancing power
7. Calculate quantities of interest

Node voltage method with a voltage source alone in a branch:

Find the voltage v_o.



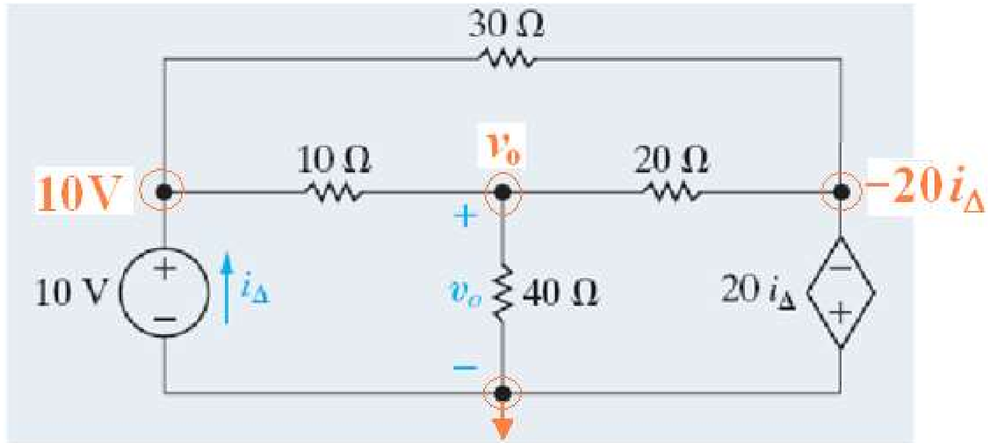
$$\text{At } v_o: \quad \frac{v_o - 10}{10} + \frac{v_o}{40} + \frac{v_o + 20i_\Delta}{20} = 0$$

$$\text{constraint}: \quad i_\Delta = \frac{10 - v_o}{10} + \frac{10 + 20i_\Delta}{30}$$

$$\text{Std. form}: \quad \begin{aligned} \mathrm{v_o}\left(\frac{1}{10} + \frac{1}{40} + \frac{1}{20}\right) &+ i_\Delta\left(\frac{20}{20}\right) &= \frac{10}{10} \\ \mathrm{v_o}\left(-\frac{1}{10}\right) &+ i_\Delta\left(1 - \frac{20}{30}\right) &= \frac{10}{10} + \frac{10}{30} \end{aligned}$$

$$\text{Solution}: \quad v_o = 24\text{ V}; \qquad i_\Delta = -3.2\text{ A}$$

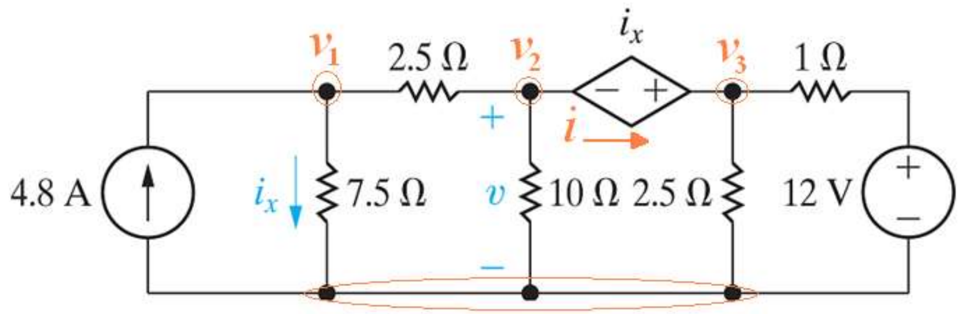
Power balance:



Component	Equation	p [W]
10 V	–(10)(–3.2)	32
Dep. Source	–[–3.2 – 24/40][20(–3.2)]	–243.2
30 Ω	$[-20(-3.2) - 10]^2/30$	97.2
10 Ω	$(24 - 10)^2/10$	19.6
20 Ω	$[24 + 20(-3.2)]^2/20$	80
40 Ω	$24^2/40$	14.4

Node voltage method with a voltage source between two non-reference essential nodes:

Find the voltage v.



$$\text{At } v_1: -4.8 + \frac{v_1}{7.5} + \frac{v_1 - v_2}{2.5} = 0$$

$$\text{At } v_2: \frac{v_2 - v_1}{2.5} + \frac{v_2}{10} + i = 0$$

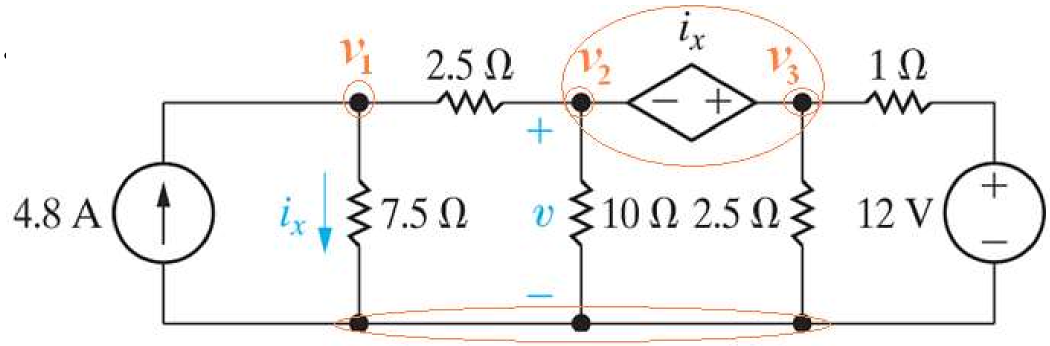
$$\text{At } v_3: -i + \frac{v_3}{2.5} + \frac{v_3 - 12}{1} = 0$$

Sum the last two equations to eliminate i:

$$\frac{v_2 - v_1}{2.5} + \frac{v_2}{10} + i - i + \frac{v_3}{2.5} + \frac{v_3 - 12}{1} = 0!$$

Node voltage method with a super node:

Find the voltage v.



$$\text{At } v_1: -4.8 + \frac{v_1}{7.5} + \frac{v_1 - v_2}{2.5} = 0$$

$$\text{At supernode}: \frac{v_2 - v_1}{2.5} + \frac{v_2}{10} + \frac{v_3}{2.5} + \frac{v_3 - 12}{1} = 0$$

$$\text{SN constraint}: \ v_3 - v_2 = 1 i_x$$

$$\text{Dep source constraint}: \ i_x = \frac{v_1}{7.5}$$

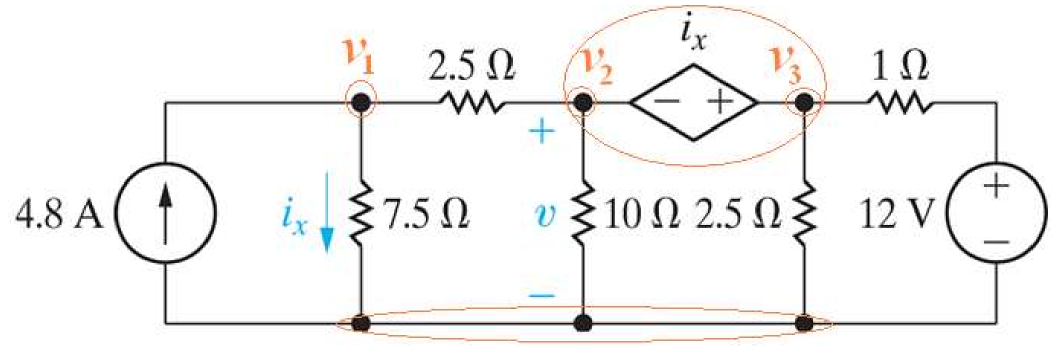
Chapter 4 – techniques of circuit analysis

The “modified recipe”:

1. Identify the essential nodes
2. Pick a reference node
3. Label remaining essential nodes with voltage values
   a) Any voltage sources between the reference node and any other essential nodes? If so, label with the value of the voltage source
   b) Any voltage sources between two non-reference essential nodes? If so, create a super node
4. Write a KCL equation at any super nodes. Then write a KCL equation at each remaining non-reference essential node where the voltage is unknown
   a) Any dependent sources? If so, write a constraint equation for each one that defines the variable the source depends upon
   b) Any super nodes? If so, write a super node constraint equation
5. Put equations in standard form and solve
6. Check your solutions by balancing power
7. Calculate quantities of interest

Node voltage method with a super node:

Find the voltage v.



Standard form and solve:

$$v_1\left(\frac{1}{7.5}+\frac{1}{2.5}\right)+v_2\left(-\frac{1}{2.5}\right)+v_3(0)+i_x(0)=4.8$$

$$v_1\left(-\frac{1}{2.5}\right)+v_2\left(\frac{1}{2.5}+\frac{1}{10}\right)+v_3\left(\frac{1}{2.5}+\frac{1}{1}\right)+i_x(0)=12$$

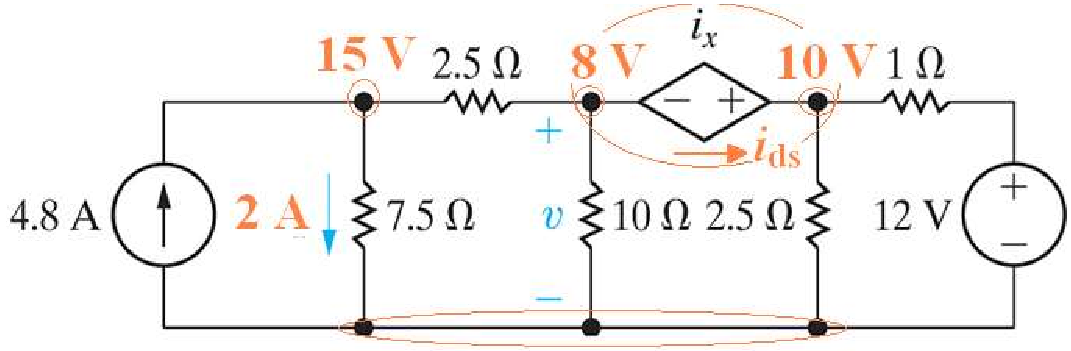
$$v_1(0)+v_2(-1)+v_3(1)+i_x(-1)=0$$

$$v_1\left(-\frac{1}{7.5}\right)+v_2(0)+v_3(0)+i_x(1)=0$$

$$v_1=15\text{ V};\qquad v_2=8\text{ V};\qquad v_3=10\text{ V};\qquad i_x=2\text{ A}$$

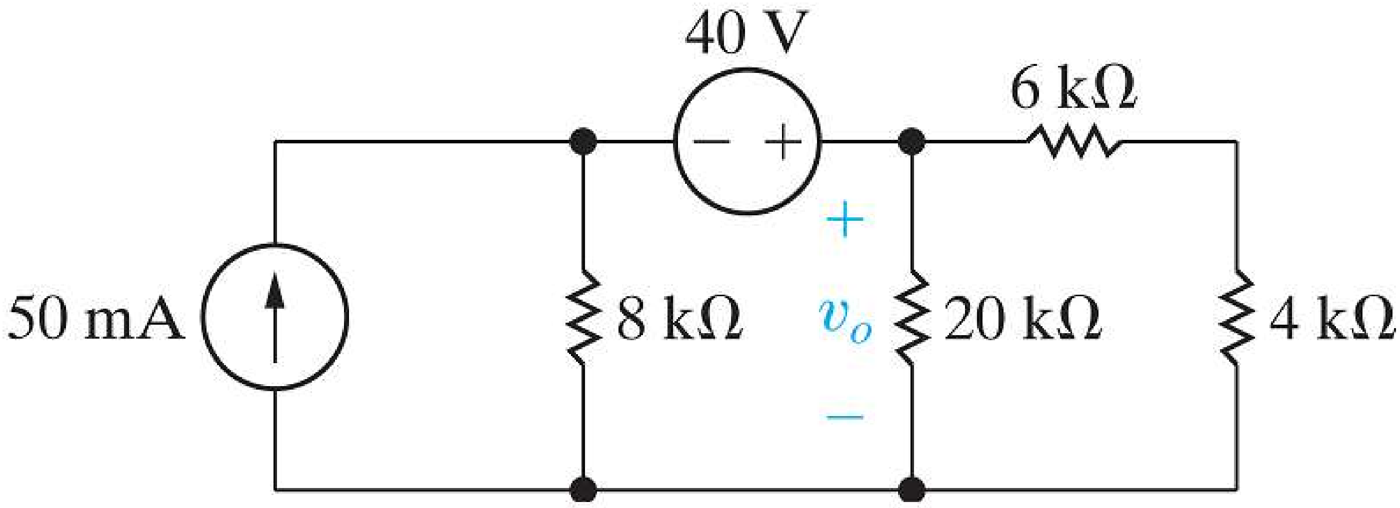
Power balance:

$$i_{ds} = \frac{10}{2.5} + \frac{10-12}{1} = 2\text{ A}$$



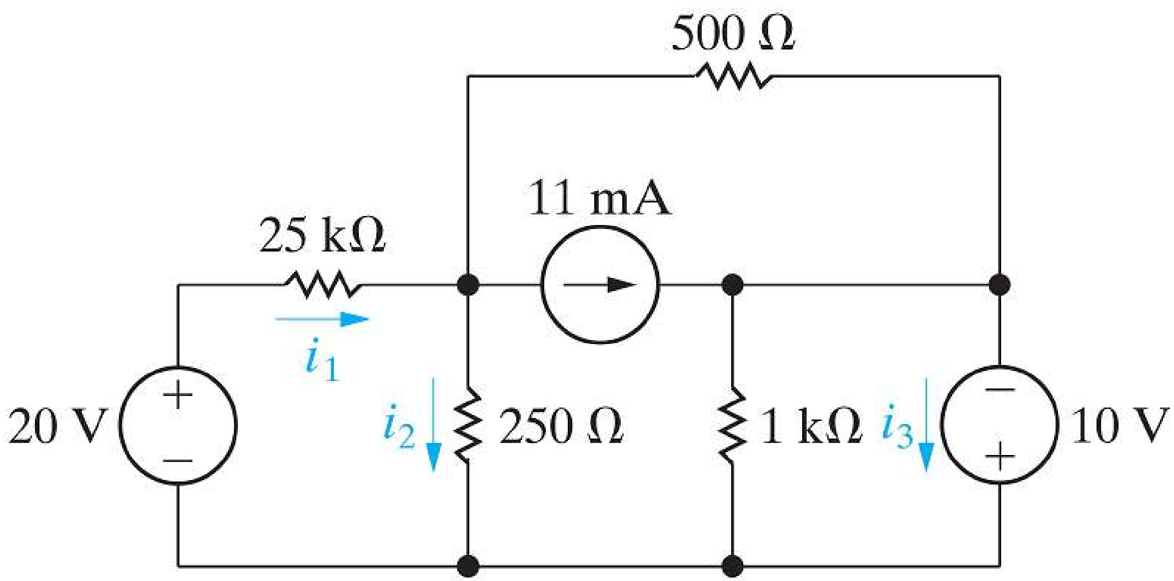
Component	Equation	p [W]
4.8 A	–(4.8)(15)	–72
Dep. Source	–(2)(2)	–4
12 V	(12)(10 – 12)/1	–24
7.5 Ω	$(2)^2(7.5)$	30
2.5 Ω (top)	$(15 - 8)^2/2.5$	19.6
10 Ω	$(8)^2/10$	6.4
2.5 Ω	$(10)^2/2.5$	40
1 Ω	$(10 - 12)^2/1$	

How many super nodes does this circuit contain?



A. 0
B. 1
C. 2

HOW MANY SUPER NODES DOES THIS CIRCUIT CONTAIN?



A. 0
B. 1
C. 2