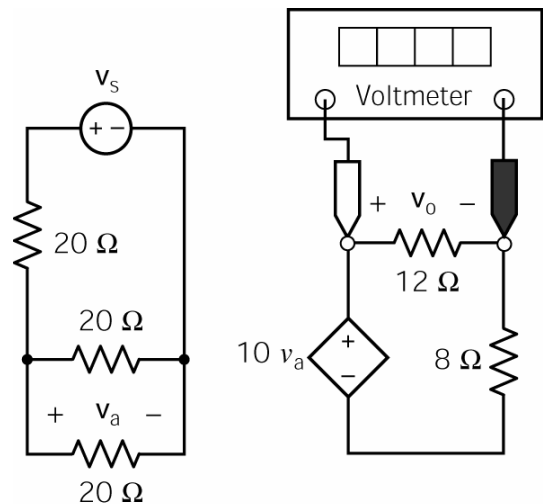


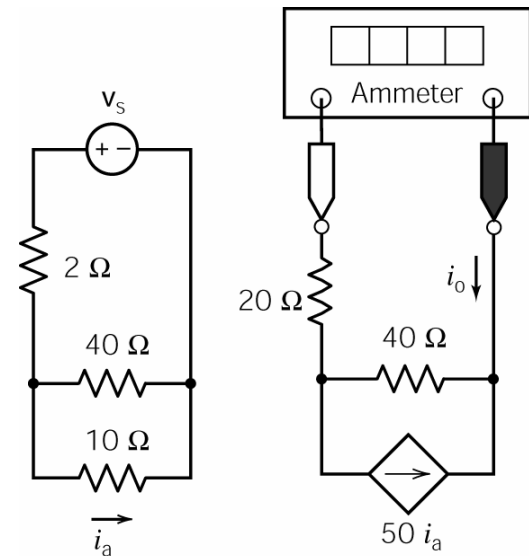
Problem 1.

The input to this circuit is the voltage of the independent voltage source. The output is the voltage measured by the meter. Show that the output is proportional to the input. Determine the value of the constant of proportionality.



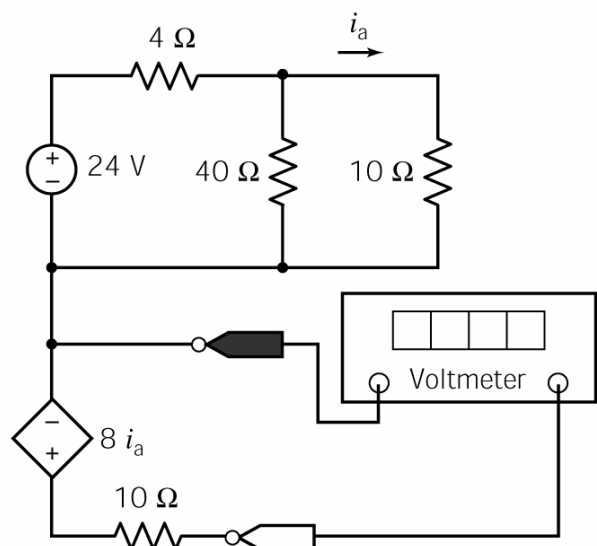
Problem 2.

The input to this circuit is the voltage of the independent voltage source. The output is the current measured by the meter. Show that the output is proportional to the input. Determine the value of the constant of proportionality.



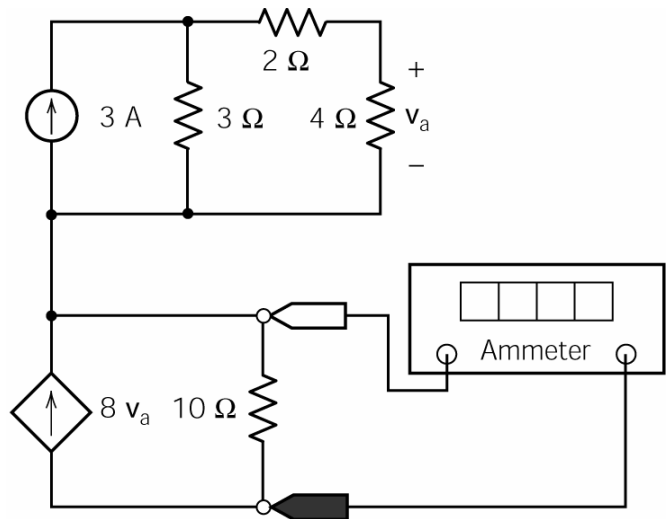
Problem 3

Determine the value of the voltage measured by the meter.



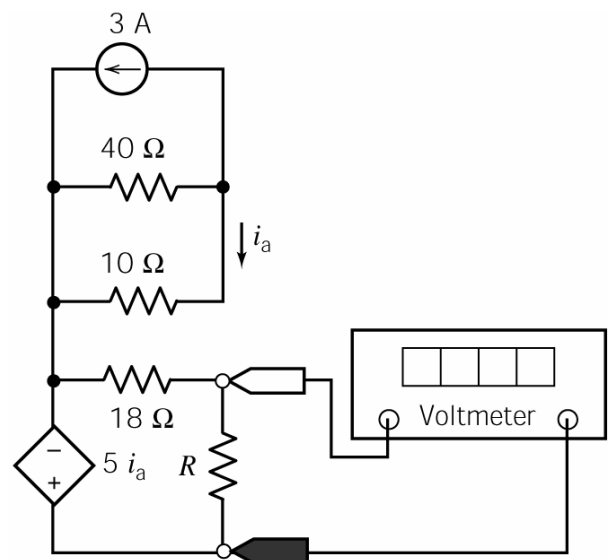
Problem 4

Determine the value of the current measured by the meter.



Problem 5

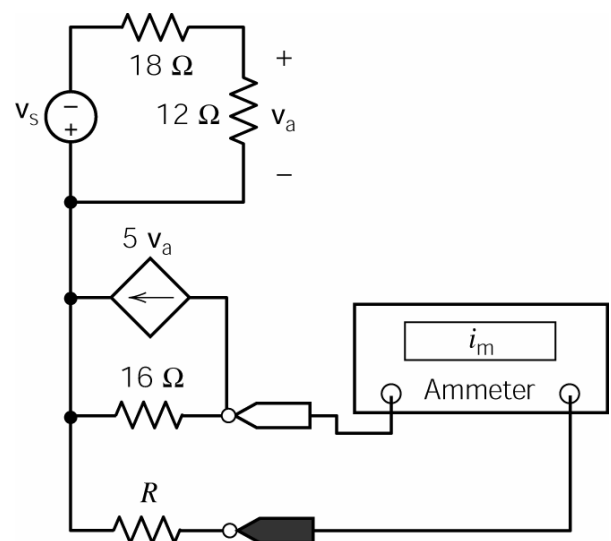
Determine the value of the resistance R required to cause the value of the voltage measured by the voltmeter to be 4 V.



Problem 6

The input to this circuit is the voltage of the independent voltage source, v_s . The output is the current measured by the meter, i_m .

- (a) Suppose $v_s = 15 \text{ V}$. Determine the value of the resistance R that causes the value of the current measured by the ammeter to be $i_m = 5 \text{ A}$.
- (b) Suppose $v_s = 15 \text{ V}$ and $R = 24 \text{ Ω}$. Determine the value of the current measured by the ammeter.
- (c) Suppose $R = 24 \text{ Ω}$. Determine the value of the input voltage, v_s , that causes the value of the current measured by the ammeter to be $i_m = 3 \text{ A}$.

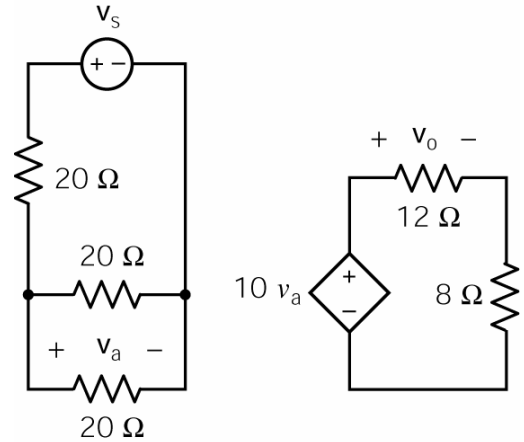


Solution 1

$$v_a = \frac{20 \parallel 20}{20 + (20 \parallel 20)} v_s = \frac{1}{3} v_s$$

$$v_o = \left(\frac{12}{12+8} \right) (10v_a) = \frac{3}{5} \times 10 \times \frac{1}{3} v_s = 2v_s$$

So v_o is proportional to v_s and the constant of proportionality is $2 \frac{V}{V}$.



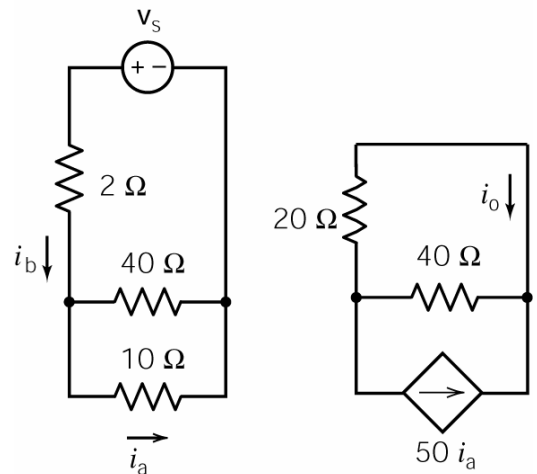
Solution 2

$$i_b = \frac{v_s}{2 + (40 \parallel 10)} = \frac{v_s}{10}$$

$$i_a = \left(\frac{40}{40+10} \right) i_b = \left(\frac{4}{5} \right) \left(\frac{v_s}{10} \right) = \frac{4}{50} v_s$$

$$i_o = - \left(\frac{40}{20+40} \right) (50i_a) = - \frac{100}{3} \left(\frac{4}{50} \right) v_s = - \frac{8}{3} v_s$$

The output is proportional to the input and the constant of proportionality is $-\frac{8}{3} \frac{A}{V}$.



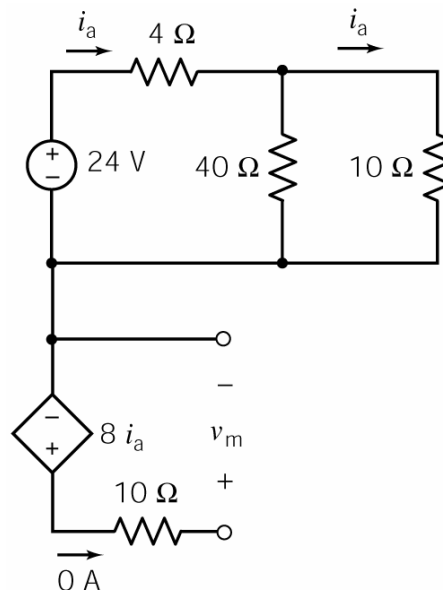
Solution 3

Replace the voltmeter with the equivalent open circuit and label the voltage measured by the voltmeter as v_m . Then

$$i_b = \frac{24}{4 + (40 \parallel 10)} = \frac{24}{4+8} = 2 \text{ A}$$

$$i_a = \left(\frac{40}{40+10} \right) i_b = \left(\frac{4}{5} \right) 2 = 1.6 \text{ A}$$

$$v_m = 8i_a = 8(1.6) = 12.8 \text{ V}$$



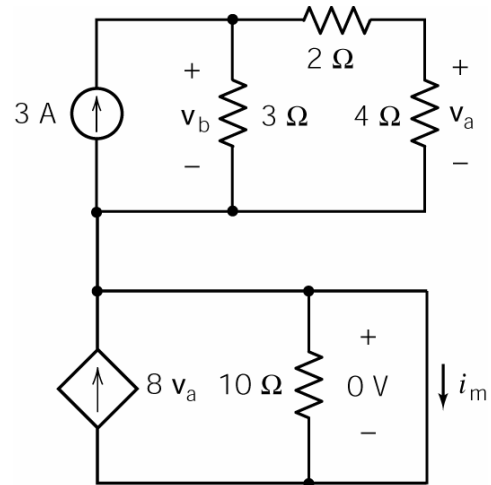
Solution 4

Replace the ammeter with the equivalent short circuit and label the current measured by the ammeter as i_m . Then

$$v_b = [3 \parallel (2 + 4)]3 = (2)3 = 6 \text{ V}$$

$$v_a = \left(\frac{4}{4+2}\right)v_b = \left(\frac{2}{3}\right)6 = 4 \text{ V}$$

$$i_m = 8v_a = 8(4) = 32 \text{ A}$$

**Solution 5**

Replace the voltmeter with the equivalent open circuit and label the voltage measured by the voltmeter as v_m . Then use current division in the top part of the circuit to get

$$i_a = -\left(\frac{40}{40+10}\right)(3) = -2.4 \text{ A}$$

Next, use voltage division in the bottom part of the circuit to get

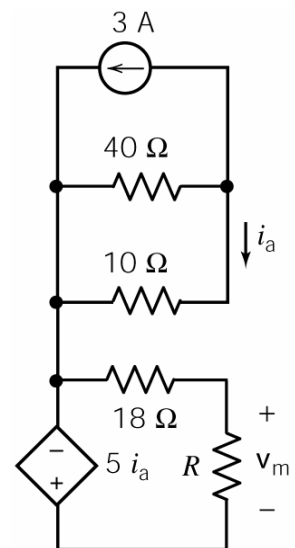
$$v_m = -\left(\frac{R}{18+R}\right)(5i_a) = \left(\frac{-5R}{18+R}\right)i_a$$

Combining these equations gives:

$$v_m = \left(\frac{-5R}{18+R}\right)(-2.4) = \frac{12R}{18+R}$$

When $v_m = 4 \text{ V}$,

$$4 = \frac{12R}{18+R} \Rightarrow R = \frac{4 \times 18}{12-4} = 9 \text{ } \Omega$$



Solution 6

Replace the ammeter with the equivalent short circuit and label the current measured by the ammeter as i_m . Then use voltage division in the top part of the circuit to get

$$v_a = -\left(\frac{12}{12+18}\right)(v_s) = -\frac{2}{5}v_s$$

Next, use current division in the bottom part of the circuit to get

$$i_m = -\left(\frac{16}{16+R}\right)(5v_a) = \left(-\frac{80}{16+R}\right)v_a$$

Combining these equations gives:

$$i_m = \left(-\frac{80}{16+R}\right)\left(-\frac{2}{5}v_s\right) = \left(\frac{32}{16+R}\right)v_s$$

- a. When $v_s = 15$ V and $i_m = 5$ A

$$5 = \left(\frac{32}{16+R}\right)15 \Rightarrow 80 + 5R = 480 \Rightarrow R = \frac{400}{5} = 80 \Omega$$

- b. When $v_s = 15$ V and $R = 24 \Omega$

$$i_m = \left(\frac{32}{16+24}\right)15 = 12 \text{ A}$$

- c. When $i_m = 3$ A and $R = 24 \Omega$

$$3 = \left(\frac{32}{16+24}\right)v_s = \frac{4}{5}v_s \Rightarrow v_s = \frac{15}{4} = 3.75 \text{ V}$$

