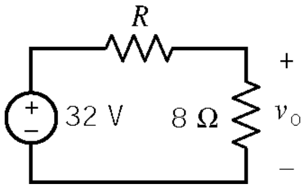
ES 250 First Midterm Practice Exam 1

1.



a. To cause v_o = 17.07 V choose R = ____7______Ω.

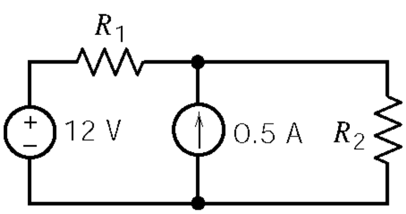
b. To cause v_o = 9.143 V choose R = ____20_____Ω.

c. If R = 14 Ω then v_o =____11.6____ V

d. If v_o = 14.22 V the voltage source supplies ___56.9____W of power.

$v_o = \left(\frac{8}{8+R}\right)32$. When v_o = 17.07 V, then $17.07 = \left(\frac{8}{8+R}\right)32 \Rightarrow R = \frac{(8)32}{17.07} - 8 = 6.997 \simeq 7\ \Omega$. When v_o = 9.143 V then $9.143 = \left(\frac{8}{8+R}\right)32 \Rightarrow R = \frac{(8)32}{9.143} - 8 = 19.999 \simeq 20\ \Omega$. When R = 14 Ω then $v_o = \left(\frac{8}{8+14}\right)32 = 11.6363\ \text{V}$. The power supplied by the voltage source is given by $32\frac{v_o}{8} = 4v_o$ since $\frac{v_o}{8}$ is the current in each of the series elements. When v_o = 14.22 V the voltage source supplies 56.88 W.

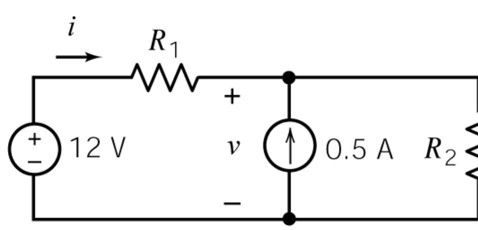
2.



The voltage source supplies 4.8 W of power and the current source supplies 3.6 W of power.

R_1 = ____12______Ω and R_2 = ____8______Ω

Use the given power values to determine that $i = \frac{4.8}{12} = 0.4\ \text{A}$ and $v = \frac{3.6}{0.5} = 7.2\ \text{V}$. Then $R_1 = \frac{12 - 7.2}{0.4} = 12\ \Omega$ and $R_2 = \frac{7.2}{0.4 + 0.5} = 8\ \Omega$.



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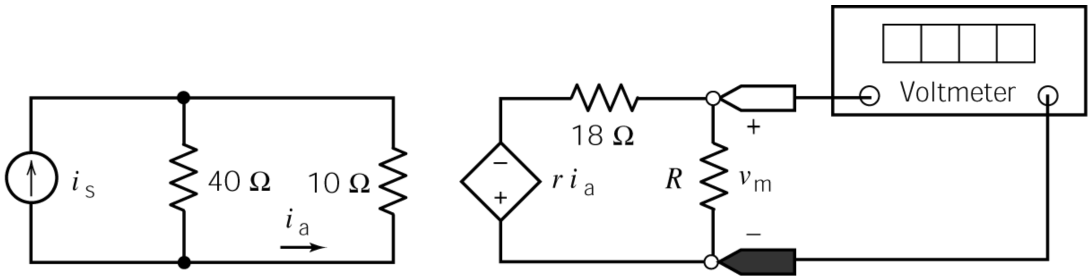
3. The input this circuit is the current of the current source, i_s. The output is the voltage measured by the meter, v_m. The output is proportional to the input, that is $v_m = k\, i_s$, where k is the constant of proportionality.



a. When $i_s = 3$ A, $R = 12\ \Omega$ and $r = 10$ V/A, then i_a = ____2.4___ A and v_m = ____9.6___ V.

b. When $R = 12\ \Omega$, then r = __6.25___ V/A is required to cause $v_m = 2\ i_s$.

c. When $r = 10$ V/A then R = _____6_____ Ω is required to cause $v_m = 2\ i_s$.

d. When $R = 12\ \Omega$ and $i_s = 5$ A, then r = ___7.5___ V/A is required to cause $v_m = 12$ V.

From current division $i_a = -\left(\dfrac{40}{40+10}\right) i_s = -\left(\dfrac{4}{5}\right) i_s$. From voltage division $v_m = -\left(\dfrac{R}{R+18}\right)\left(r\,i_a\right)$. Combining these equations gives $v_m = -\left(\dfrac{R}{R+18}\right)(r)\left(-\dfrac{4}{5}\right) i_s$.

When $i_s = 3$ A, $R = 12\ \Omega$ and $r = 10$ V/A, $i_a = -\left(\dfrac{4}{5}\right)(3) = -2.4\text{ A}$ and $v_m = -\left(\dfrac{R}{R+18}\right)(10)(-2.4) = 9.6\text{ V}$.

When $R = 12\ \Omega$ and $v_m = 2\ i_s$ then $2 = -\left(\dfrac{12}{12+18}\right)(r)\left(-\dfrac{4}{5}\right) \Rightarrow r = 2\left(\dfrac{30}{12}\right)\left(\dfrac{5}{4}\right) = 6.25\text{ V/A}$.

When $r = 10$ V/A and $v_m = 2\ i_s$ then $2 = -\left(\dfrac{R}{R+18}\right)(10)\left(-\dfrac{4}{5}\right) \Rightarrow R+18 = \left(\dfrac{R}{2}\right)(10)\left(\dfrac{4}{5}\right) \Rightarrow R = 6\ \Omega$.

When $R = 12\ \Omega$, $i_s = 5$ A and $v_m = 12$ V then $12 = -\left(\dfrac{12}{12+18}\right)(r)\left(-\dfrac{4}{5}\right)5 \Rightarrow r = \left(\dfrac{12}{4}\right)\left(\dfrac{30}{12}\right) = 7.5\text{ V/A}$.

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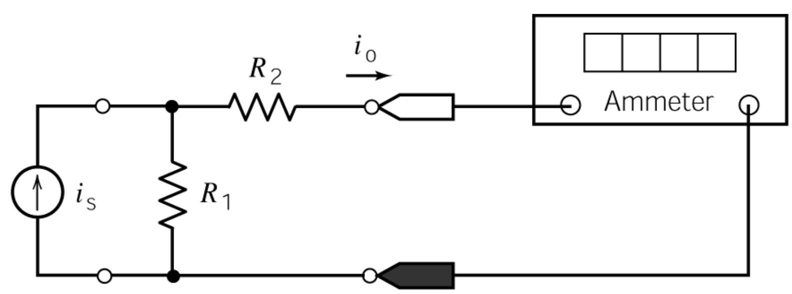
4. The input to this circuit is the source current, i_s. The output is the current measured by the meter, i_o. A current divider connects the source to the meter.



Given these observations:

A. The input $i_s = 5$ A causes the output to be $i_o = 2$ A.

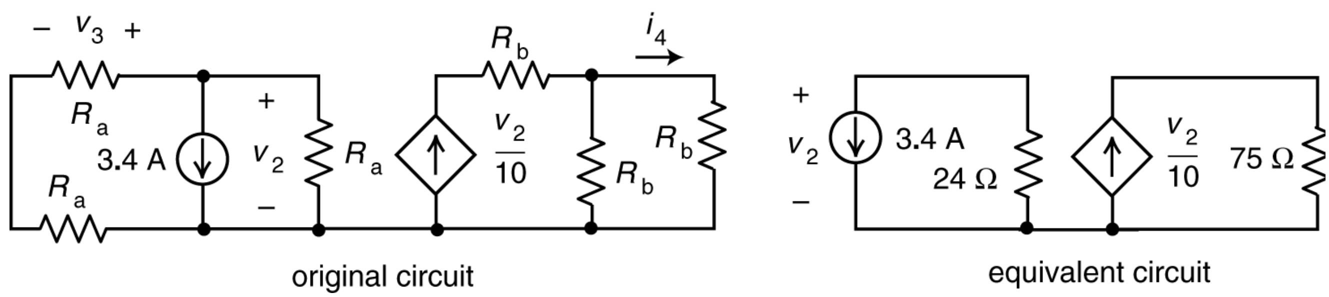
B. When $i_s = 2$ A the source supplies 48 W.

The values of the resistances are R_1 = _________ Ω and R_2 = _________ Ω.

From current division, $i_o = \left(\dfrac{R_1}{R_1+R_2}\right) i_s$. When $i_s = 5$ A and $i_o = 2$ A then $\dfrac{2}{5} = \dfrac{R_1}{R_1+R_2}$ so $2(R_1+R_2) = 5R_1$ or $2R_2 = 3R_1$. The power supplied by the source is given by $i_s\left[\left(\dfrac{R_1 R_2}{R_1+R_2}\right)i_s\right]$. When $i_s = 2$ A the source supplies 48 W, so $48 = 2\left[\left(\dfrac{R_1 R_2}{R_1+R_2}\right)2\right] \Rightarrow 12 = \dfrac{R_1 R_2}{R_1+R_2}$.

Then
$$12 = \frac{R_1\left(\frac{3}{2}R_1\right)}{R_1+\left(\frac{3}{2}R_1\right)} = \frac{\frac{3}{2}R_1}{\frac{5}{2}} = \frac{3}{5}R_1 \Rightarrow R_1 = \frac{5}{3}(12) = 20\ \Omega \text{ and } \frac{3R_1}{2} = 30\ \Omega.$$

5.



The equivalent circuit on the right is obtained from the original circuit on the left by replacing series and parallel combinations of resistors by equivalent resistors. The original circuit contains 3 equal resistances labeled R_a and another 3 equal resistances labeled R_b. Determine the values of R_a and R_b. Given that

v_2 = -81.6 V, determine the values of v_3 and i_4.

R_a = ____36____ Ω, R_b .= ____50____Ω, v_3 = ___–40.8___V and i_4 = ___–4.08____A.

$$R_a \parallel 2R_a = \frac{2}{3}R_a = 24 \Rightarrow R_a = 24\left(\frac{3}{2}\right) = 36\ \Omega$$

and
$$R_b + \frac{R_b}{2} = \frac{3}{2}R_b = 75 \Rightarrow R_b = 50\ \Omega$$

$$v_2 = -24(3.4) = -81.6 \text{ V},\ v_3 = \frac{1}{2}v_2 = \frac{1}{2}(-81.6) = -40.8 \text{ V and } i_4 = \frac{1}{2}\left(\frac{v_2}{10}\right) = \frac{-81.6}{20} = -4.08 \text{ A}$$

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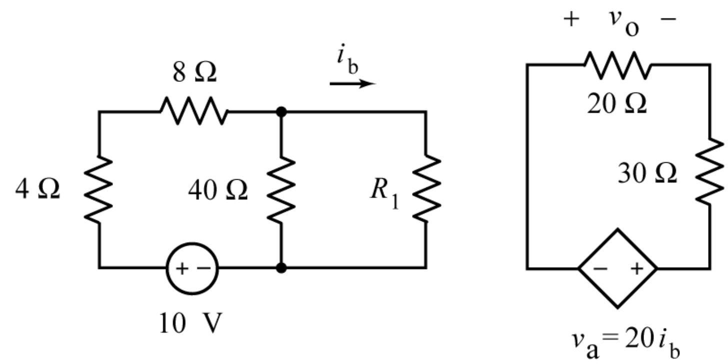
6. Given that

$$v_a = 8 \text{ V},$$

Determine the values of R_1 and v_o:



$R_1 =$ ____10____ Ω,

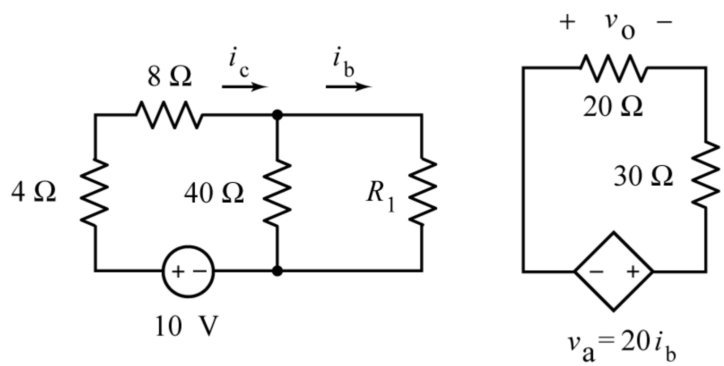
and

$v_o =$ ___−3.2___ V

First,

$$v_o = -\frac{20}{20+30} 8 = -3.2 \text{ V}$$

Next,

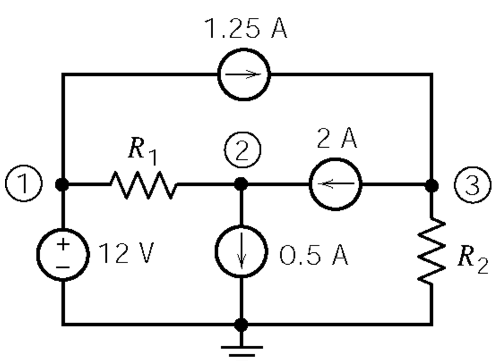


$$\frac{8}{20} = i_b = \frac{40}{40+R_1} i_c = \frac{40}{40+R_1}\left(\frac{10}{12+40 \| R_1}\right) = \frac{40}{40+R_1}\left(\frac{10}{12+\frac{40 R_1}{40+R_1}}\right) = \frac{400}{12(40+R_1)+40 R_1} = \frac{400}{480+52 R_1}$$

then

$$\frac{8}{20} = \frac{400}{480+52 R_1} \quad \Rightarrow \quad 480 + 52 R_1 = \frac{400(20)}{8} = 1000 \quad \Rightarrow \quad \frac{1000-480}{52} = 10 \ \Omega$$

7.



The encircled numbers are node numbers. The corresponding node voltages are

$$v_1 = 12 \text{ V}, \ v_2 = 21 \text{ V and } v_3 = -3 \text{ V},$$

a. The 0.5 A current source **supplies** ____−10.5___ W of power.

b. The 2 A current source **supplies** _____48____ W of power.

c. $R_1 =$ _____6____Ω and $R_2 =$ ____4_____Ω

d. The voltage source **supplies** ____−3_____ W of power.

The power **received** by the 0.5 A current source is $v_2(0.5) = 21(0.5) = 10.5$ W W of power.

The 2 A current source **supplies** $(v_2 - v_3)(2) = [21-(-3)](2) = 48 \text{ W}$ of power.

$$R_1 = \frac{v_2 - v_1}{2-0.5} = \frac{21-12}{2-0.5} = 6\ \Omega \text{ and } R_2 = \frac{v_3}{1.25-2} = \frac{-3}{-0.75} = 4\ \Omega$$

The voltage source **supplies** $12[1.25+0.5-2] = 12(-0.25) = -3 \text{ W}$ of power.