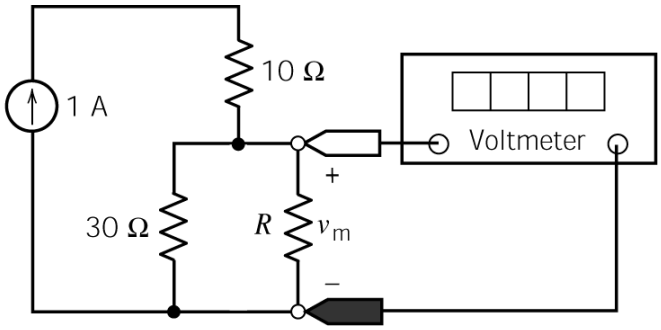
ES 250 First Midterm Bonus Practice Problems

1. The voltage measured by the voltmeter is

$$v_m = 20 \text{ V}$$

The value of the resistance R is ___60___Ω.

The current source is supplies _____30___ W of power.



$$20 = v_m = (30 \,\|\, R)(1) = \frac{30R}{30+R} \quad \Rightarrow \quad 30 + R = \frac{30}{20}R = \frac{3}{2}R \quad \Rightarrow \quad R = 60 \ \Omega$$

$$\text{Power supplied} = (1)\left[(1)(10 + 30 \,\|\, R)\right] = 10 + \frac{30(60)}{30+60} = 30 \text{ W}$$

---

2. Given that

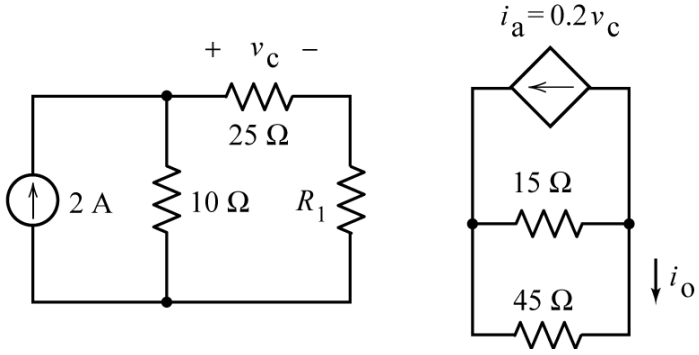
$$i_a = 2 \text{ A},$$

Determine the values of R_1 and v_o:

$$R_1 = \_\_\_\_15\_\_\_\_ \ \Omega,$$

and

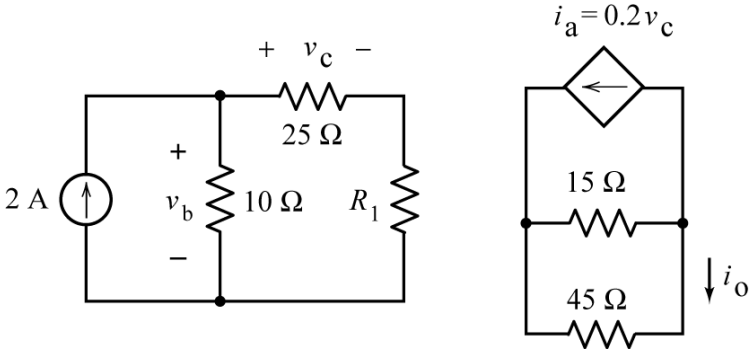
$$i_o = \_\_\_–0.5\_\_\_ \text{ A}$$



First,

$$i_o = -\frac{15}{15+45}2 = -0.5 \text{ A}$$

Next,



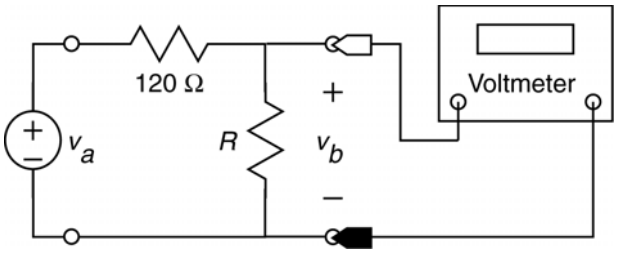
$$\frac{2}{0.2} = v_c = \frac{25}{25+R_1}v_b = \frac{25}{25+R_1}\left(2\left(10 \,\|\, 25+R_1\right)\right) = \frac{50}{25+R_1}\left(\frac{10\left(25+R_1\right)}{10+\left(25+R_1\right)}\right) = \frac{500}{35+R_1}$$

then

$$\frac{2}{0.2}=\frac{500}{35+R_1} \quad \Rightarrow \quad 35+R_1=50 \quad \Rightarrow \quad R_1=15\ \Omega$$

---

3. The input to this circuit is the voltage of the voltage source, v_a. The output of this circuit is the voltage measured by the voltmeter, v_b. This circuit produces an output that is proportional to the input, that is



$$v_b = k\, v_a$$

where k is the constant of proportionality.

a.) When R = 240 Ω and v_a = 18 V, the output is v_b = ___12___ V.

b.) When R = 240 Ω and v_a = 18 V, the power supplied by the voltage source is __0.9___W.

c.) When R = __15___ Ω and v_a = 18 V, the output is v_b = 2 V.

d.) When R = __30___ Ω, the output is $v_b = 0.2\, v_a$. (That is, the constant of proportionality is $k = 0.2$.)

$$v_\mathrm{b}=\frac{R}{R+120}v_\mathrm{a}.$$

When R = 240 Ω and v_a = 18 V then $v_\mathrm{b}=\frac{240}{240+120}18=\frac{2}{3}18=12\ \mathrm{V}$.

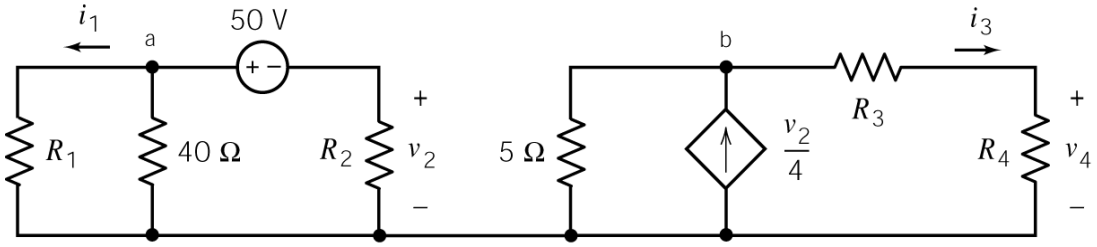
When v_a = 18 V and v_b = 18 V then $2=\frac{R}{R+120}18 \quad \Rightarrow \quad R+120=\frac{18}{2}R \quad \Rightarrow \quad R=15\ \Omega$.

When $v_b = 0.2\, v_a$ then $0.2=\frac{R}{R+120} \quad \Rightarrow \quad R+120=5R \quad \Rightarrow \quad R=30\ \Omega$.

When R = 240 Ω and v_a = 18 V, the power supplied by the voltage source is

$$v_\mathrm{a}\left(\frac{v_\mathrm{a}}{120+R}\right)=18\left(\frac{18}{120+240}\right)=\frac{18^2}{360}=0.9\ \mathrm{W}$$

4.

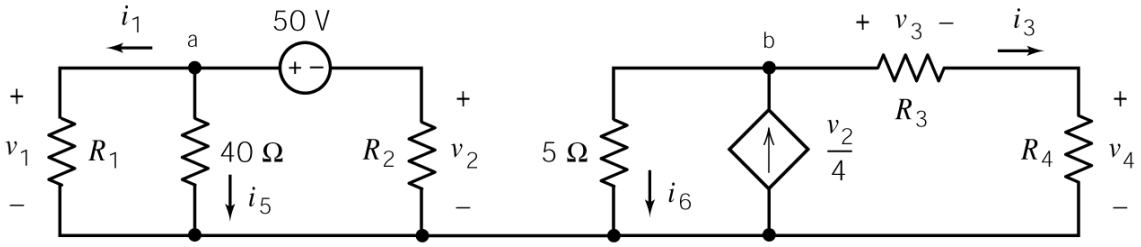


Given that

$$i_1 = 0.625 \text{ A}, \quad v_2 = -25 \text{ V}, \quad i_3 = -1.25 \text{ A} \quad \text{and} \quad v_4 = -18.75 \text{ V}$$

Determine the values of R_1, R_2, R_3 and R_4:

$R_1 =$ _____40____ Ω, $R_2 =$ _____20____ Ω, $R_3 =$ _____5_____ Ω and $R_4 =$ _____15____ Ω.



From KVL $\quad 50 + v_2 - v_1 = 0 \quad \Rightarrow \quad v_1 = 50 + (-25) = 25 \text{ V}$

From Ohm's law $\quad R_1 = \dfrac{v_1}{i_1} = \dfrac{25}{0.625} = 40 \ \Omega$

From KCL

$$i_1 + i_5 + i_2 = 0 \quad \Rightarrow \quad i_2 = -(i_1 + i_5) = -\left(0.625 + \frac{v_1}{40}\right) = -\left(0.625 + \frac{25}{40}\right) = -1.25 \text{ A}$$

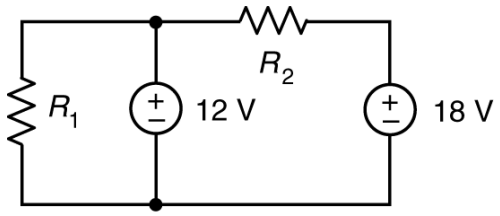
From Ohm's law $\quad R_2 = \dfrac{v_2}{i_2} = \dfrac{-25}{-1.25} = 20 \ \Omega$

From KCL $\quad \dfrac{v_2}{4} = i_6 + i_3 \quad \Rightarrow \quad i_6 = -i_3 + \dfrac{v_2}{4} = -(-1.25) + \dfrac{-25}{4} = -5 \text{ A}$

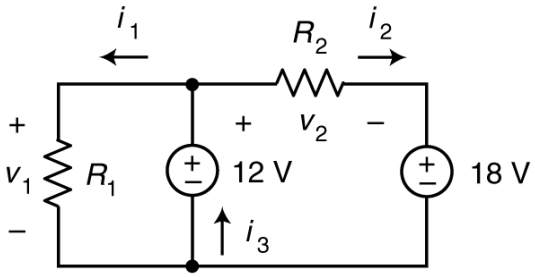
From KVL $\quad v_3 + v_4 - 5i_6 = 0 \quad \Rightarrow \quad v_3 = -v_4 + 5i_6 = -(-18.75) + 5(-5) = -6.25 \text{ V}$

From Ohm's law $\quad R_3 = \dfrac{v_3}{i_3} = \dfrac{-6.25}{-1.25} = 5 \ \Omega \quad \text{and} \quad R_4 = \dfrac{v_4}{i_3} = \dfrac{-18.75}{-1.25} = 15 \ \Omega$

5. The 12 V source supplies 720 mW and the 18 V source supplies 4.32 W. Determine the values of the resistances R_1 and R_2.



R_1 = ____40____ Ω and R_2 = ____25____



Using KVL: $v_1 = 12$ V and $v_2 + 18 - 12 = 0 \Rightarrow v_2 = -6$ V

Using the specified powers:

$$i_3 = \frac{0.72}{12} = 0.06 = 60 \text{ mA} \text{ and } i_2 = -\frac{4.32}{18} = -0.24 = -240 \text{ mA}$$

Using KCL: $i_1 = 0.06 - (-0.240) = 0.3 = 300$ mA

Using Ohm's law: $R_1 = \frac{12}{0.3} = 40\ \Omega$ and $R_2 = \frac{-6}{-0.24} = 25\ \Omega$