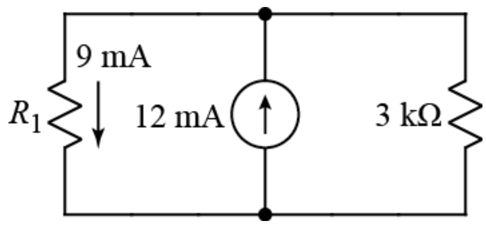
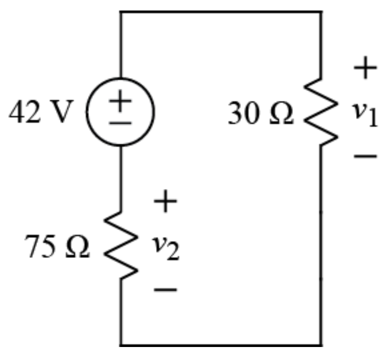
HOMEWORK #3 prob 2 solution

Ex:



a) Use the current-divider formula to determine what the value of R_1 must be.



b) Use the voltage-divider formula to calculate v_1 and v_2. (Be careful about signs.)

SOL'N: a) The two resistors are in parallel across the current source. Current flows up through the current source and back down through the two resistors. The current-divider formula gives the value of the current on the left side:

$$9\,\text{mA} = 12\text{ mA}\cdot\frac{\dfrac{1}{R_1}}{\dfrac{1}{R_1}+\dfrac{1}{3\text{ k}\Omega}}$$

We wish to solve this equation for R_1, which appears in two places. If we multiply top and bottom by R_1, we are left with only one R_1 in the equation:

$$9\,\text{mA} = 12\text{ mA}\cdot\frac{\dfrac{1}{R_1}}{\dfrac{1}{R_1}+\dfrac{1}{3\text{ k}\Omega}}\cdot\frac{R_1}{R_1} = 12\text{ mA}\frac{1}{1+\dfrac{R_1}{3\text{k}\Omega}}$$

Multiplying both sides by the denominator of the right side brings R_1 into the numerator.

$$9\,\text{mA}\cdot\left(1+\frac{R_1}{3\text{k}\Omega}\right)=12\ \text{mA}$$

The remaining steps are straightforward.

$$9\,\text{mA}+\frac{9\,\text{mA}}{3\text{k}\Omega}R_1=12\ \text{mA}$$

or

$$9\,\text{mA}+\frac{9\,\text{mA}}{3\text{k}\Omega}R_1=\frac{12\,\text{mA}-9\,\text{mA}}{\frac{9\,\text{mA}}{3\text{k}\Omega}}=\frac{3\,\text{mA}}{3\,\mu\text{A}/\Omega}=1\text{k}\Omega$$

NOTE: The ratio of the resistances in a current divider is the inverse of the ratio of the currents.

b) This is a standard voltage divider configuration for v_1:

$$v_1=42\ \text{V}\cdot\frac{30\ \Omega}{30\ \Omega+75\ \Omega}=12\ \text{V}$$

For v_2, we must reverse the sign of the answer.

$$v_2=-42\ \text{V}\cdot\frac{75\ \Omega}{30\ \Omega+75\ \Omega}=-30\ \text{V}$$

NOTE: To determine whether the sign of the answer must be reversed, trace a path from the + sign of the measurement back to the source. (Go in the direction away from the resistor and the – sign of the resistor's voltage drop.) If the path leads to the + sign of the voltage source, then all is well. If the path leads to the – side of the voltage source, then use a minus sign in your answer. Of course, "voltage source" may be any total voltage drop across series resistors. It need not be a voltage source.