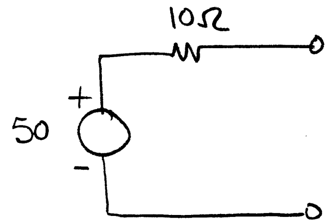
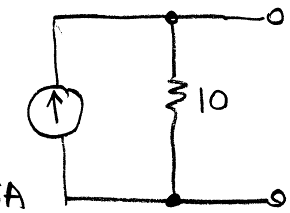
Example 2-12



is equivalent to

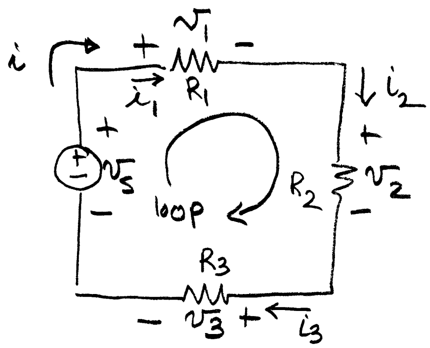
$i_s = \frac{v_s}{R}$

$i_s = \frac{50}{10} = 5A$



2.5 VOLTAGE DIVISION

A voltage divider is a simple, quick way to calculate voltages in a series circuit.



Typical voltage divider circuit

The elements are in series so $i = i_1 = i_2 = i_3$

Apply KVL $\sum_{\circlearrowleft} v = 0$

$$-v_s + v_1 + v_2 + v_3 = 0$$

$$-v_s + iR_1 + iR_2 + iR_3 = 0$$

$$i = \frac{v_s}{R_1 + R_2 + R_3} \qquad (1)$$

Using (1) we can compute all the voltages as

$$v_1 = iR_1 = \frac{R_1}{R_1 + R_2 + R_3} v_s$$

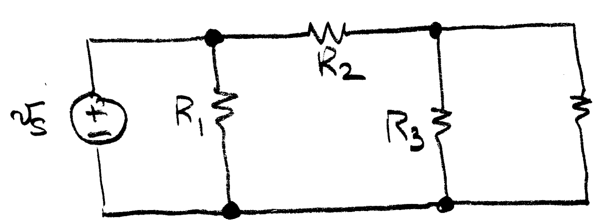
$$v_2 = iR_2 = \frac{R_2}{R_1 + R_2 + R_3} v_s$$

$$v_3 = iR_3 = \frac{R_3}{R_1 + R_2 + R_3} v_s$$

In a voltage divider

$$v_K = \frac{R_K}{\sum R_{series}} v_s$$

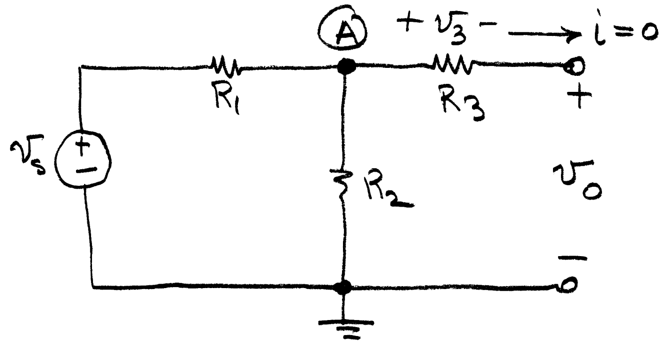
NOTE: There cannot be any nodes from which current is drawn out of the series circuit.



This is NOT a series circuit.

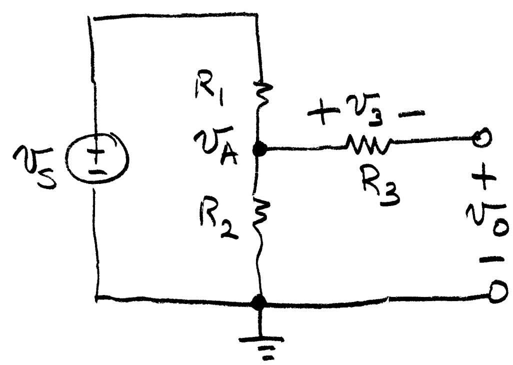
Example 2-15

Determine v_o.



This is a tricky circuit. There is nothing connected to the output so there is no current thru R_3. From Ohm's Law

$v_3 = i R_3 = 0$ so $v_A = v_o$.



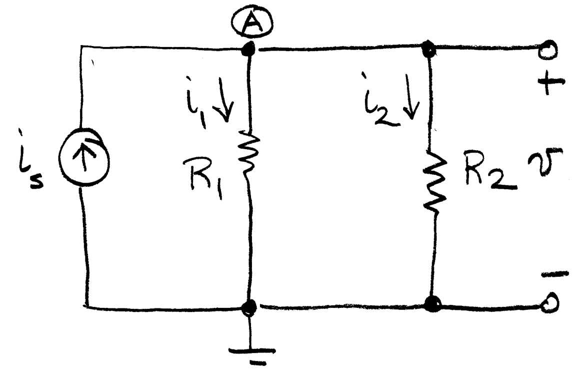
Redrawing the circuit we clearly see that this is a simple voltage divider as long as there is no current thru R_3.

Using the voltage divider rule $v_A = \frac{R_2}{R_1 + R_2} v_s$

The output is then $v_o = v_A$

CURRENT DIVISION

Current division is a simple, quick way to calculate currents in a parallel circuit.



Apply KCL @ node A $\sum_{in} i = 0$

$$+i_s - i_1 - i_2 = 0$$

$$i_s = i_1 + i_2$$

Since this is a parallel circuit we have the voltage v across R_1, R_2 and the current source.

Using Ohm's Law $i_1 = \frac{v}{R_1}$ and $i_2 = \frac{v}{R_2}$

$$i_s = \frac{v}{R_1} + \frac{v}{R_2} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right) v = \frac{R_1 + R_2}{R_1 R_2} v$$

Solving for v

$$v = \frac{R_1 R_2}{R_1 + R_2} i_s$$

Solving for i_1 and i_2 gives

$$i_1 = \frac{v}{R_1} = \frac{R_1 R_2}{R_1 + R_2} i_s \frac{1}{R_1} = \frac{R_2}{R_1 + R_2} i_s$$

$$i_2 = \frac{v}{R_2} = \frac{R_1 R_2}{R_1 + R_2} i_s \frac{1}{R_2} = \frac{R_1}{R_1 + R_2} i_s$$