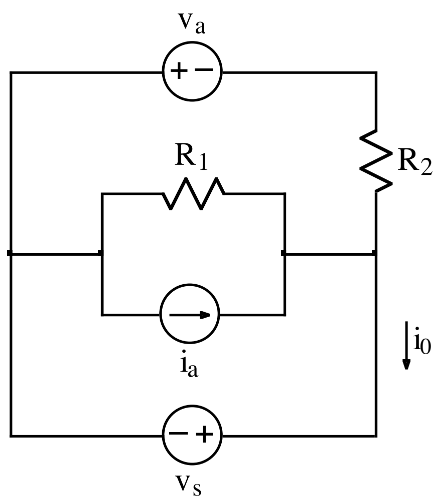
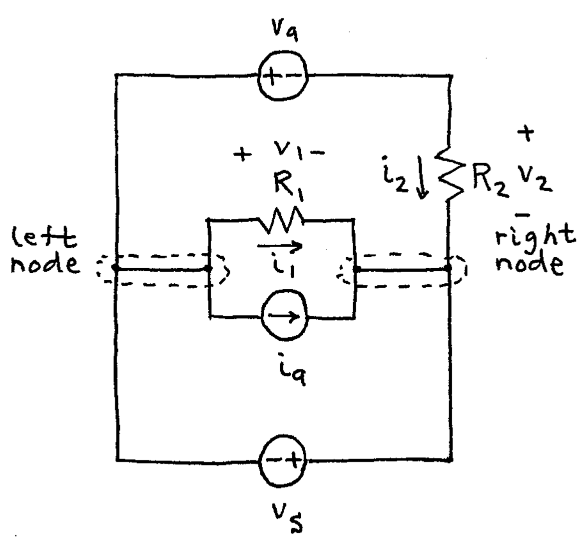
Ex:



Derive an expression for i_0. The expression must not contain more than the circuit parameters v_a, v_s, i_a, R_1, and R_2.

sol'n: Label R's first.



v-loops: (v_a and R_1, R_2; v_s and R_1)

$$-v_a - v_2 + v_1 = 0\,V$$

$$-v_1 - v_s = 0\,V$$

We observe that we can solve these 2 eq'ns in 2 unknowns without proceeding further.

$v_1 = -v_s$ from 2nd eq'n

$v_2 = -v_a + v_1 = -v_a - v_s$ from 1st eq'n

Note: If we try to write current-sum eq'ns, we find that the left node and right node and connected by only v-src v_s. Thus, we should not write i-sum eq'ns. (And we don't need them!)

Note: We also have no components in series that carry the same current, (except v-src v_a and R_2).

We now use Ohm's law:

$v_1 = i_1 R_1$

$v_2 = i_2 R_2$

Using v-eq'ns:

$$i_1 = \frac{v_1}{R_1} = \frac{-v_s}{R_1}$$

$$i_2 = \frac{v_2}{R_2} = \frac{-v_a - v_s}{R_2}$$

Now that we have solved the circuit, we can find i_o from an i-sum eq'n for the node on the right.

$$-i_2 - i_1 - i_a + i_o = 0\text{A}$$

or $$i_o = i_1 + i_2 + i_a$$

or $$i_o = -\frac{v_s}{R_1} - \frac{v_a + v_s}{R_2} + i_a$$