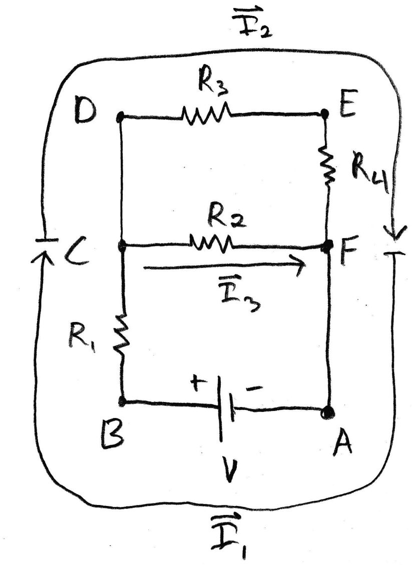
7-11-08



Given: V, R_2, R_3, R_4, I_1

We could do this with our simple addition rules, but we'll use Kirchoff to practice.

1) Label currents. There are 3 independant legs in this diagram. Because there is only one $\mathcal{E}$, we can tell the correct direction for each $\vec{I}$. We won't know normally and that is OK.

2) Identify Unknowns. I_2, I_3, R_1. This means I need 3 equations.

3) Apply Junction Rule. There are 2 junctions. Both have the same 3 currents and so have the same information content. Pick either but not both. I use C, and sum all <u>incoming</u> currents:

$$
C: \quad \left.\begin{aligned} I(DC) &= -I_2 \\ +\,I(FC) &= -I_3 \\ +\,I(BC) &= I_1 \\ \hline & \quad 0 \end{aligned}\right\} \rightarrow \underline{\text{1st eq:}} \quad I_1 - I_2 - I_3 = 0
$$

4) Apply Loop Rule. There are 3 possible loops here. One doesn't involve any potential source. That's ok, because inevitably there will be a reversed current so that something is negative, but its nice not to worry about it so we chose the 2 loops going through V.

Loop $\underline{A}BCF\underline{A}$:

$$\left.\begin{array}{ll} AB: & +V \\ -BC: & R_1 I_1 \\ -CF: & R_2 I_3 \\ -FA: & 0 \\ \hline & 0 \end{array}\right\}$$

2nd eq

$$V - R_1 I_1 - R_2 I_3 = 0$$

Loop $\underline{A}BCDEF\underline{A}$:

$$\left.\begin{array}{ll} AB: & +V \\ -BC: & R_1 I_1 \\ -CD: & 0 \\ -DE: & R_3 I_2 \\ -EF: & R_4 I_2 \\ -FA: & 0 \\ \hline & 0 \end{array}\right\}$$

3rd eq.

$$V - R_1 I_1 - I_2 (R_3 + R_4) = 0$$

5) Solve the equations.

eq 1) $I_3 = I_1 - I_2$

→ eq 2) $V - R_1 I_1 - R_2 (I_1 - I_2) = 0$

$$V = I_1 (R_1 + R_2) - I_2 R_2$$

eq 3) $V = I_1 R_1 + I_2 (R_3 + R_4)$

$$V = V \rightarrow \quad I_1(\cancel{R_1} + R_2) - I_2 R_2 = \cancel{I_1 R_1} + I_2 (R_3 + R_4)$$

$$I_1 R_2 = I_2 (R_2 + R_3 + R_4)$$

$$\boxed{I_2 = I_1 \frac{R_2}{R_2 + R_3 + R_4}}$$

I_2 in terms of knowns, 1 down!

Now eq 1. is all in terms of knowns except I_3:

$$\boxed{I_3 = I_1 - I_2}$$

We have an unknown left over but seem to have used all 3 eqs. What gives?

We set $V = V$ to combine eq. 2 + eq. 3, so we haven't used that information yet.

To do so, just grab one of the eqs with V (and R_1, the remaining unknown)

$$V = I_1 R_1 + I_2 (R_3 + R_4)$$

$$\boxed{R_1 = \frac{V}{I_1} - \frac{I_2}{I_1}(R_3 + R_4)}$$