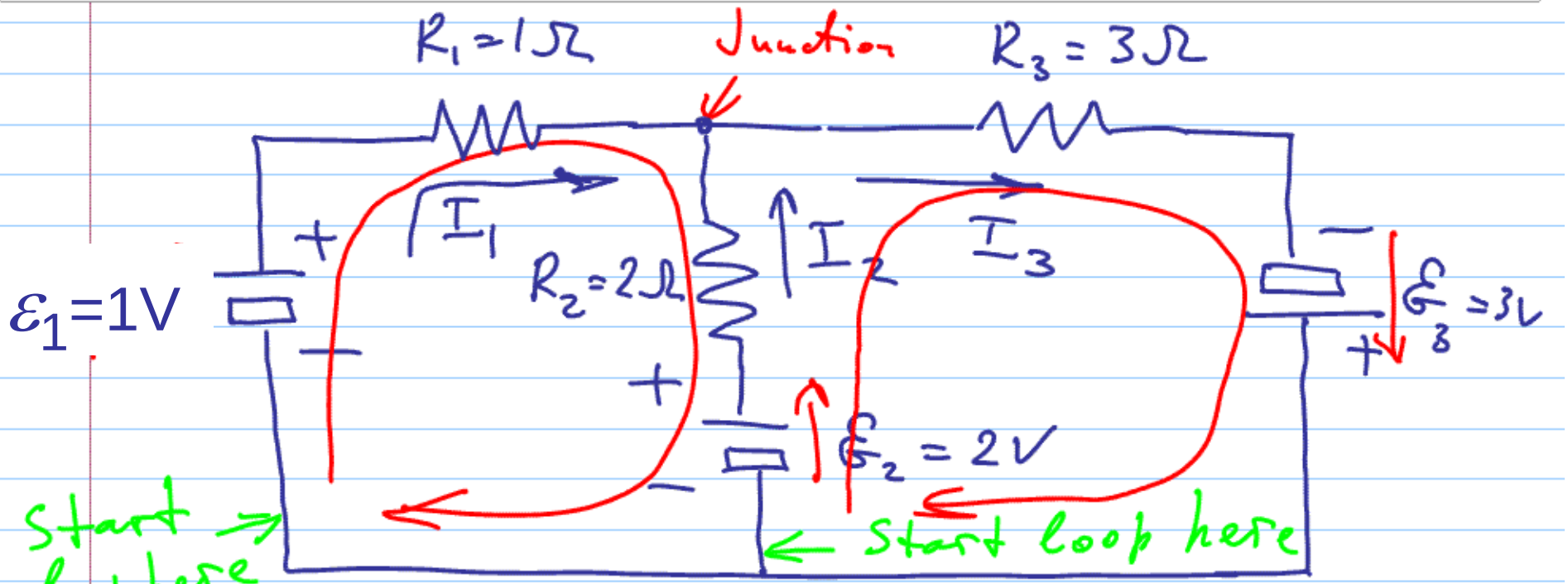
Note Title 10/13/2005



Question! Find currents in branches

Steps

1. Select directions for the currents I_1, I_2 and I_3
   It turns out that the directions in the

figure are correct, but we might had selected wrong directions instead. Check that in this case the solution for such current would have been with the negative sign.

2. Select directions of making loops

Only two loops out of three are independent. We selected two loops shown by red. Clock- or anticlockwise direction is not important. However the signs of ALL terms would be opposite if we changed the direction.

3. To obtain 3 <u>independent</u> equations for three unknown currents we use 2 loop rules and 1 junction rule:

Eq. 1 (Left loop) $R_1 = 1\Omega$ $R_2 = 2\Omega$

$$1 - I_1 \cdot 1 + I_2 \cdot 2 - 2 = 0 \quad (1)$$

$\mathcal{E}_1 = 1V$ Sign "+" since we move through the battery from "−" to "+"

Sign "−" since we move through R_1 with the current I_1

Sign "+" Since we move through R_2 against the current I_2

$\mathcal{E}_2 = 2V$ Sign "−" Since we move through the battery from "+" to "−"

Eq. 2 (Right loop)

$$2 - I_2 \cdot 2 - I_3 \cdot 3 + 3 = 0 \qquad (2)$$

Eq. 3 (Junction law)

$$I_1 + I_2 = I_3 \qquad (3)$$

To solve we express I_2 and I_3 via I_1, and then substitute I_2, I_3 in (3) to find I_1.

From (1): $I_2 = \frac{1}{2}(I_1 + 1)$

From (2): $I_3 = \frac{1}{3}(5 - 2I_2) =$

$= \frac{1}{3}\left[5 - 2\frac{1}{2}(I_1 + 1)\right] = \frac{1}{3}\left[5 - I_1 - 1\right] = \frac{1}{3}(4 - I_1)$

By substituting expressions for I_2 and I_3 in (3):

$$I_1 + I_2 = I_3$$

$$I_1 + \frac{1}{2}(I_1 + 1) = \frac{1}{3}(4 - I_1) \quad \times 6$$

$$6I_1 + 3I_1 + 3 = 8 - 2I_1$$

$$11 I_1 = 5 \Rightarrow I_1 = \frac{5}{11} \text{ A}$$

Use again expressions for I_2 and I_3:

$$I_2 = \frac{1}{2}(I_1 + 1) = \frac{1}{2}\left(\frac{5}{11} + 1\right) = \frac{1}{2}\,\frac{5+11}{11} = \frac{16}{22} = \frac{8}{11} \text{ A}$$

$$I_3 = \frac{1}{3}(4 - I_1) = \frac{1}{3}\left(4 - \frac{5}{11}\right) = \frac{1}{3}\,\frac{44-5}{11} = \frac{39}{33} = \frac{13}{11} \text{ A}$$

Check: indeed $I_1 + I_2 = I_3$

$$\frac{5}{11} + \frac{8}{11} = \frac{13}{11}$$