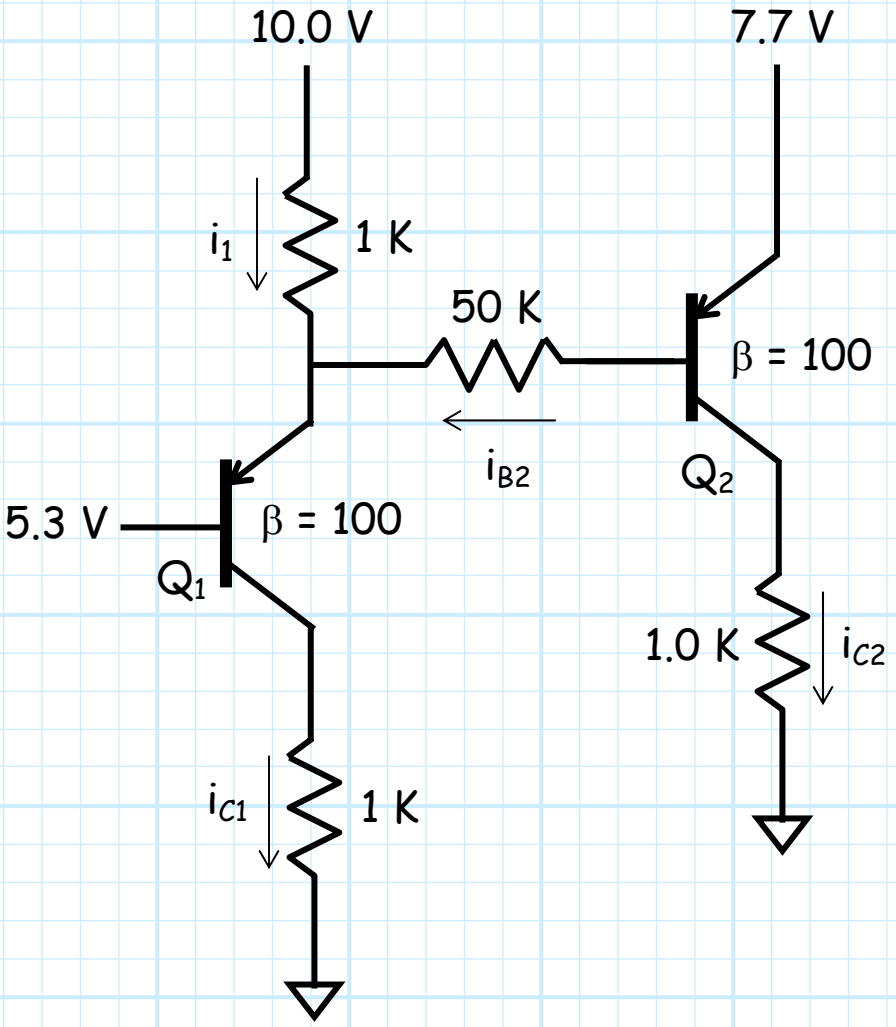
Example: Another DC Analysis of a BJT Circuit

Find the **collector voltages** of the two BJTs in the circuit below.



ASSUME both BJTs are in **active** mode, therefore ENFORCE

$$V_{EB}^{1} = V_{EB}^{1} = 0.7 \text{ V}, \quad i_{C1} = 100\, i_{B1}, \text{ and } i_{C2} = 100\, i_{B2}$$

Q: *Now, how do we ANALYZE the circuit ??*

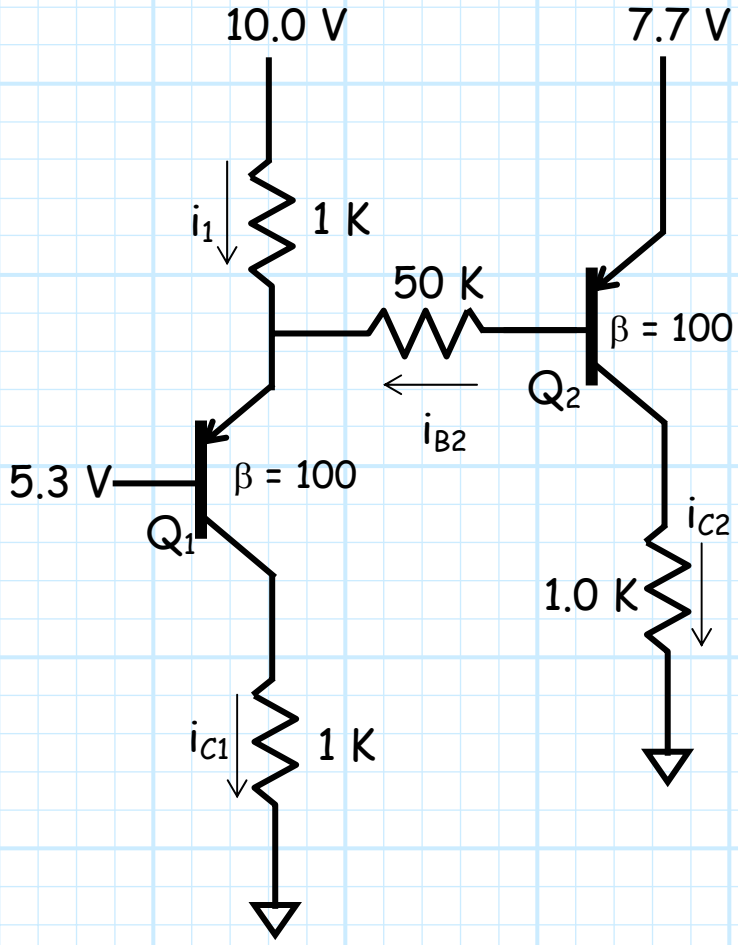
A: This seems to be a problem ! We cannot **easily** solve the emitter base KVL, as i_1 is NOT EQUAL to i_{E1} (make sure you understand this !). Instead, we find:

$$i_{E1} = i_1 + i_{B2}$$

So, what do we do ?

First, ask the question: **What do we know ??**

Look closely at the circuit, it is apparent that $\mathbf{V_{B1}}$ = **5.3 V** and $\mathbf{V_{E2}}$ = **7.7 V**.



Hey! We therefore also know $\mathbf{V_{E1}}$ and $\mathbf{V_{B2}}$:

$$V_{E1} = V_{B1} + V_{EB}^1 = 5.3 + 0.7 = 6.0 \text{ V}$$

$$V_{B2} = V_{E2} - V_{EB}^2 = 7.7 - 0.7 = 7.0 \text{ V}$$

Wow ! From these values we get:

$$i_1 = \frac{10 - V_{E1}}{1} = \frac{10-6}{1} = 4 \text{ mA}$$

and

$$i_{B2} = \frac{V_{B2} - V_{E1}}{50} = \frac{7-6}{50} = 0.02 \text{ mA}$$

This is easy! Since we know i_1 and i_{B2}, we can **find** i_{E1}:

$$i_{E1} = i_1 + i_{B2} = 4.0 + 0.02 = 4.02 \text{ mA}$$

Since we know **one** current for each BJT, we know **all** currents for each BJT:

$$i_{C1} = \alpha\, i_{E1} = \frac{\beta}{\beta+1}\, i_{E1} = \frac{100}{101}\, 4.02 = 3.98 \text{ mA}$$

$$i_{C2} = \beta\, i_{B2} = 100(0.02) = 2 \text{ mA}$$

Finally, we can determine the voltages V_{C1} and V_{C2}.

$$V_{C1} = 0.0 + 1\, i_{C1} = 0.0 + 1(3.98) = \underline{3.98 \text{ V}}$$

$$V_{C2} = 0.0 + 1\, i_{C2} = 0.0 + 1(2.0) = \underline{2.0 \text{ V}}$$

Now, let's CHECK to see if our assumptions were correct:

$i_{C2} = 2\text{mA} > 0$ ✓ $\qquad i_{C1} = 3.98 \text{ mA} > 0$ ✓

$V^1_{EC} = V_{E1} - V_{C1} = 6.0 - 3.98 = 2.02 \text{ V} > 0.7 \text{ V}$ ✓

$V^2_{BC} = V_{B1} - V_{C1} = 7.0 - 2.0 = 5.0 \text{ V} > 0$ ✓

Assumptions are **correct** !