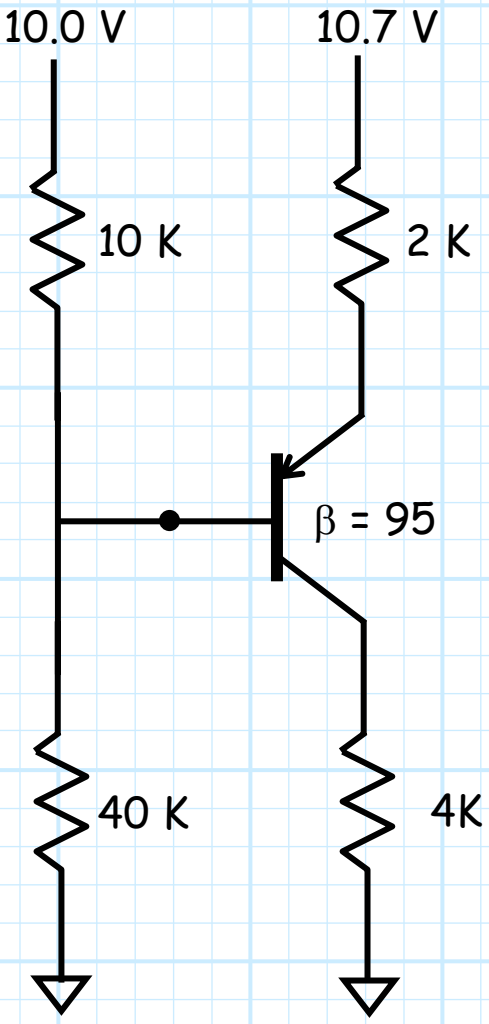
Example: An Analysis of a *pnp* BJT Circuit

Determine the **collector current** and **collector voltage** of the BJT in the circuit below.



1. ASSUME the BJT is in **active** mode.

2. ENFORCE the conditions:

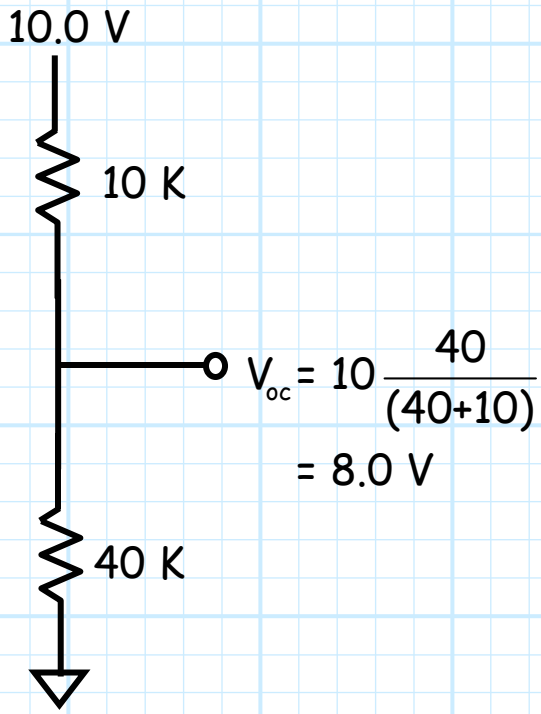
$$V_{EB} = 0.7\ V \quad \text{and} \quad i_C = \beta\, i_B$$

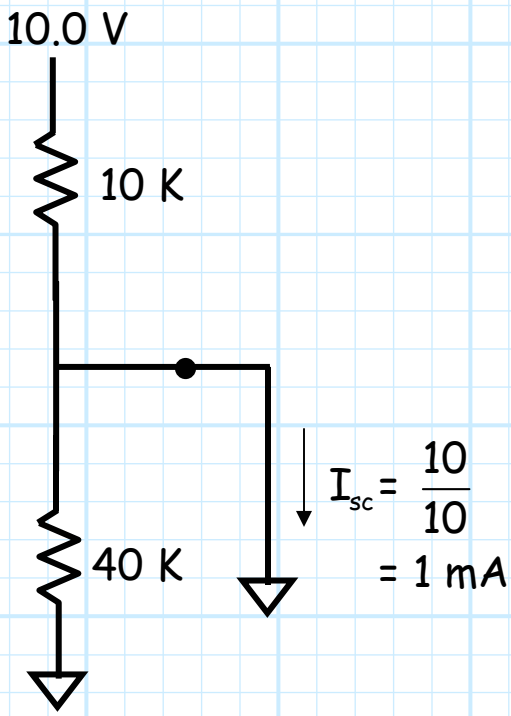
3. ANALYZE the circuit.

Q: *Yikes ! How do we write the base-emitter KVL ?*

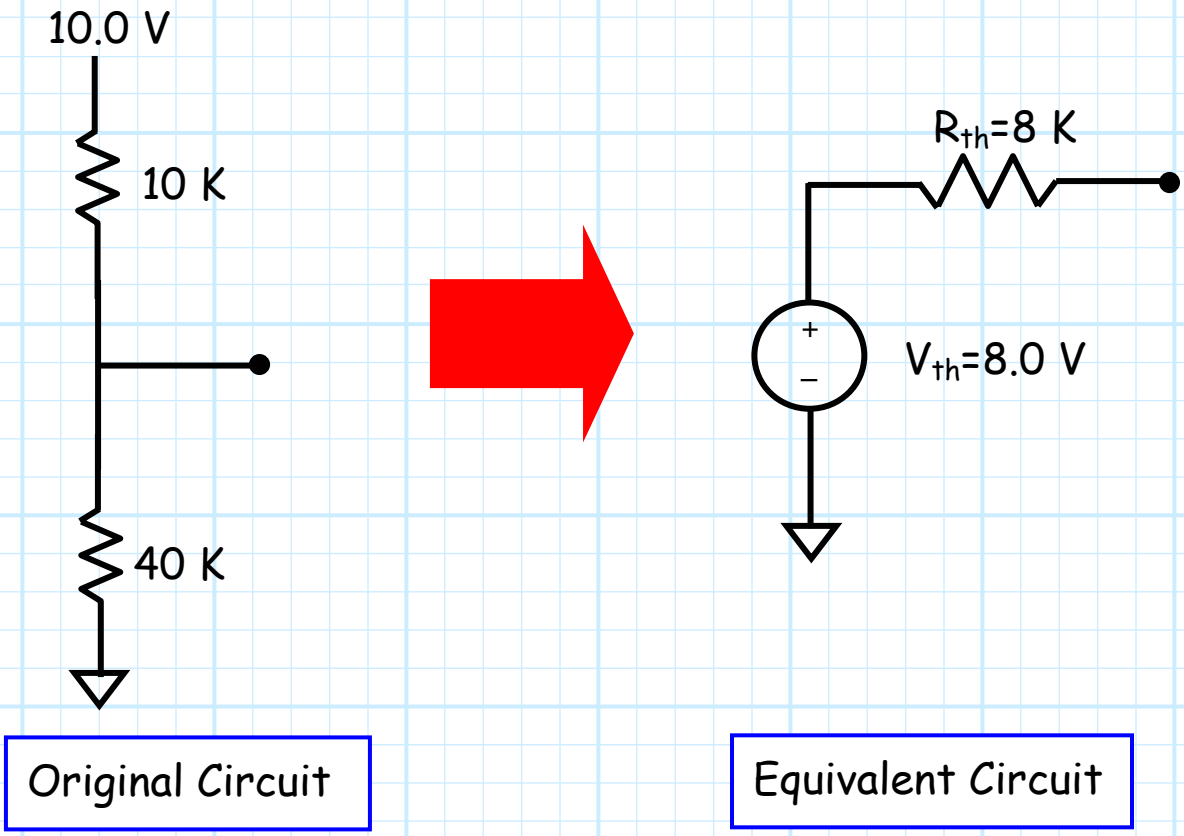
A: This is a perfect opportunity to apply the **Thevenin's** equivalent circuit!

Thevenin's equivalent circuit:

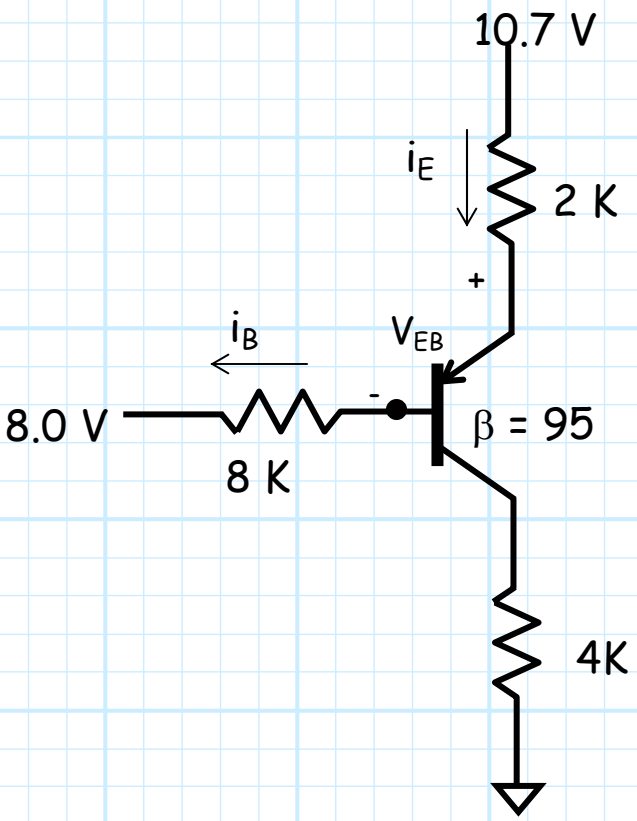




Where $V_{th} = V_{oc} = 8.0$ V and $R_{th} = V_{oc}/I_{sc} = 8/1 = 8$ K



Therefore, we can write the BJT circuit as:



NOW we can easily write the emitter-base leg KVL:

$$10.7 - 2i_E - v_{EB} - 8i_B = 8.0$$

Along with our enforced conditions, we now have **three** equations and **three** unknowns !

Combining, we find:

$$10.7 - 2(96)i_B - 0.7 - 8\,i_B = 8.0$$

Therefore,

$$i_B = \frac{10.7 - 0.7 - 8.0}{2(96) + 8} = \frac{2}{200} = 0.01 \text{ mA}$$

and **collector current** i_C is:

$$i_C = \beta\, i_B = 95(0.01) = \underline{0.95 \text{ mA}}$$

Likewise, the **collector voltage** (wrt ground) V_C is:

$$V_C = 0.0 + 4\, i_C = \underline{3.8 \text{ V}}$$

But wait ! We're **not** done yet ! We must **CHECK** our assumption.

First, $i_B = 0.01\ mA > 0$ ✓

But, what is V_{EC} ??

Writing the emitter-collector KVL:

$$10.7 - 2\,i_E - V_{CE} - 4\,i_C = 0$$

Therefore,

$V_{EC} = 10.7 - 2(96)\,(0.01) - 4(0.95) = 4.98\ V > 0.7\ V$ ✓

Our assumption was **correct** !