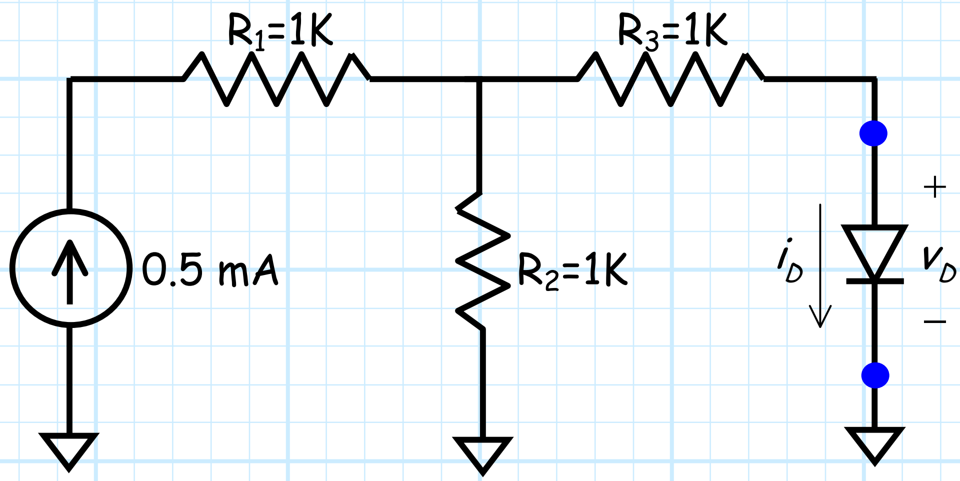
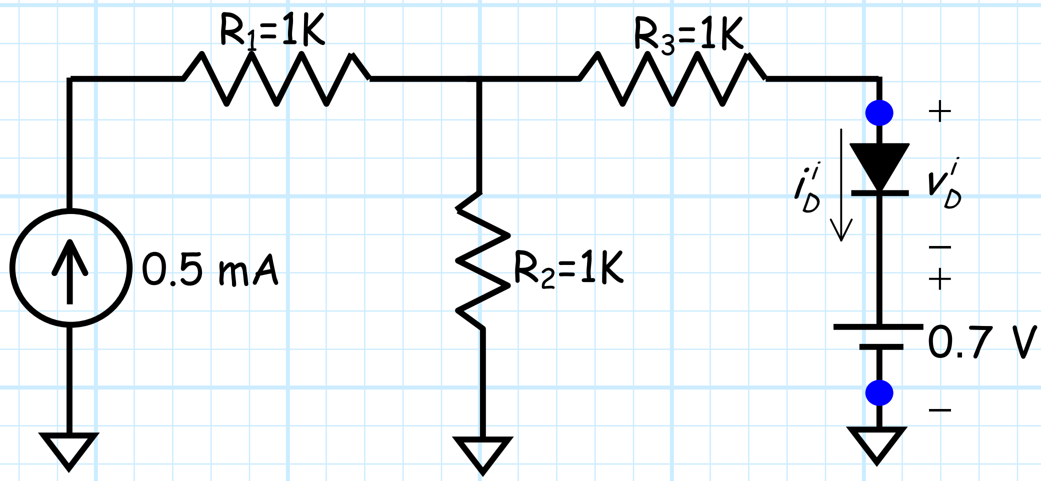
Example: Another Junction Diode Model Example

Consider now **this** circuit:



Using the **CVD model**, let's estimate the **voltage** across, and **current** through, the **junction diode**.

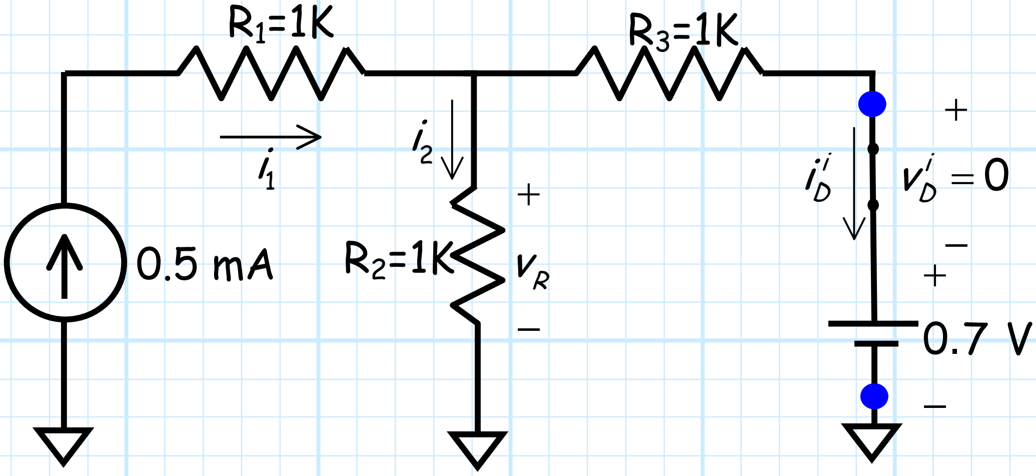
First, replace the junction diode with the **CVD model**:



Now we have an **IDEAL** diode circuit, and therefore we analyze it **precisely** as we did in section 3.1 !!

ASSUME the **IDEAL** diode is forward biased (why not ?).

ENFORCE the condition that $v_D^i = 0.0\text{ V}$ (a **short** circuit).



ANALYZE the IDEAL diode circuit:

From KCL → $i_1 =$

Where → $i_1 = 0.5\text{ mA}$

$i_2 =$

$i_D^i =$

Therefore → $0.5 =$

And thus: $v_R =$

So that: $i_D^i =$

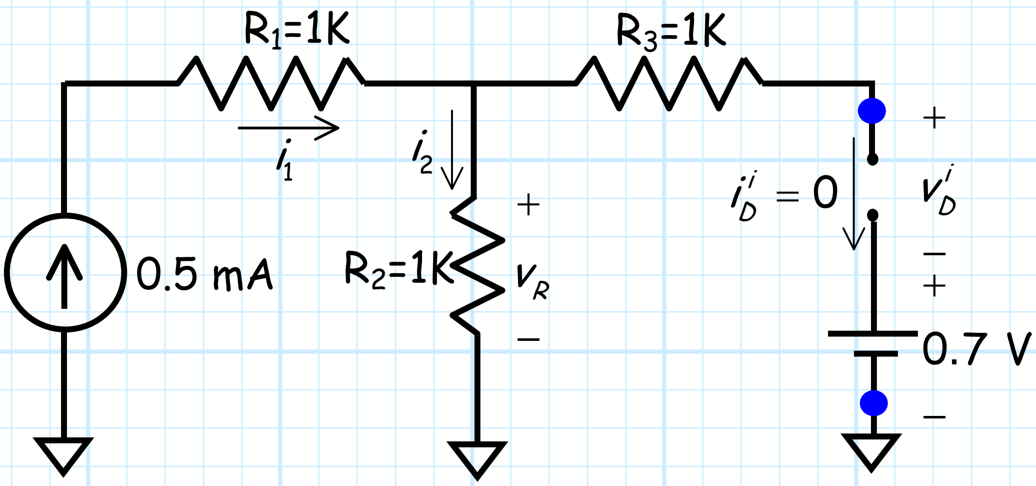
CHECK the **IDEAL** diode assumption:

$$i_D^i = -0.1\text{ mA} < 0 \quad \text{X}$$

Yikes! We made the **wrong** assumption! Let's change our assumption and try again.

Now **ASSUME** the **IDEAL** diode is **reverse** biased.

ENFORCE the condition that $i_D^i = 0.0$ mA (an **open** circuit).



ANALYZE the **IDEAL** diode circuit:

From KCL → $i_1 = i_2 + i_D^i$

Where → $i_1 = 0.5 \text{ mA}$

$$i_2 = \frac{v_R}{R_2} = \frac{v_R}{1} = v_R$$

$$i_D^i =$$

Therefore → $0.5 =$

Note that we must find the numeric value of v_D^i, the **voltage** across the reverse biased **IDEAL** diode.

From KVL: $v_R - R_3\, i_D^i - v_D^i - 0.7 = 0$

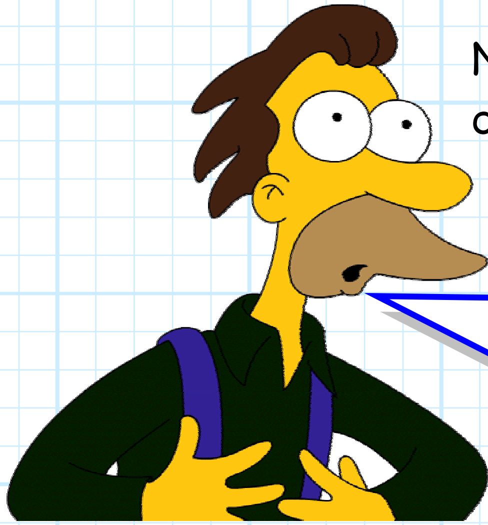
And since $i_D^i = 0$, we find that:

$$\begin{aligned} v_D^i &= v_R - R_3\, i_D^i - 0.7 \\ &= v_R - 0.7 \\ &= 0.5 - 0.7 \\ &= -0.2 \text{ V} \end{aligned}$$

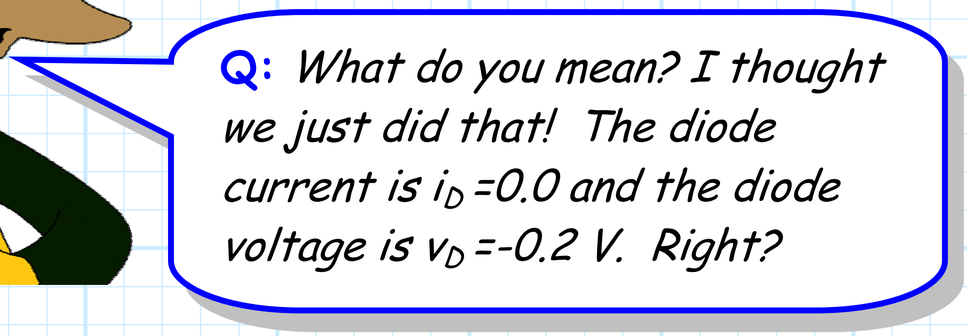
CHECK the **IDEAL** diode assumption:

$$v_D^i = -0.2 \text{ V} < 0 \quad \checkmark$$

Our assumption was **correct**!



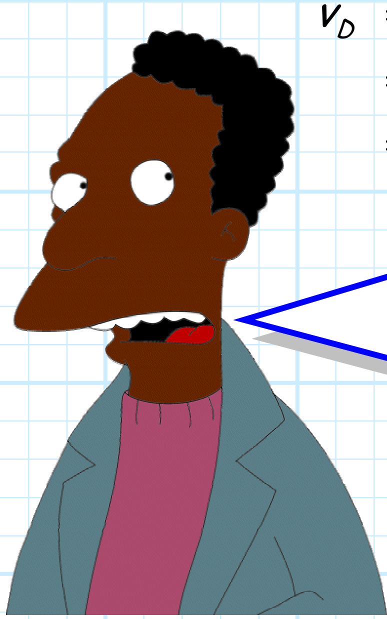
Now, we must estimate the **junction** diode **current** and **voltage**!

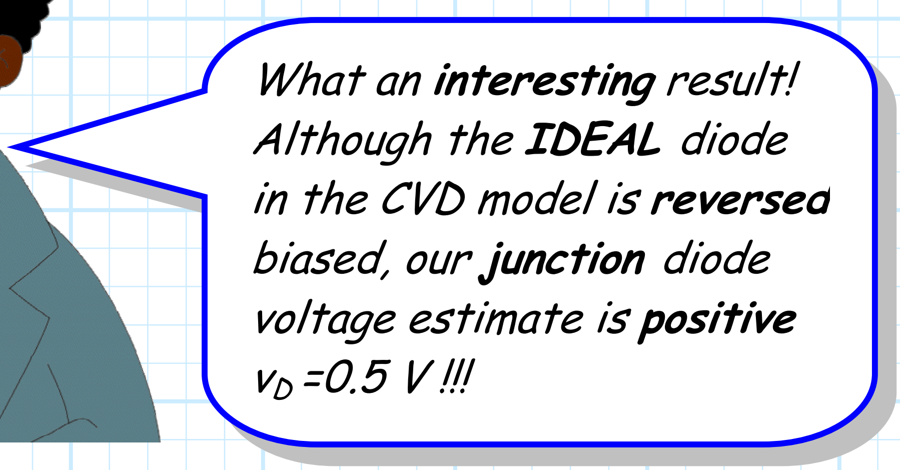


A: NO! We have **only** determined the current and voltage of the **IDEAL** diode voltage in our CVD model. These are **not** the estimated values of the **junction** diode in our circuit!

Instead, we estimate the **junction** diode voltage by calculating the voltage across the **entire CVD model** (i.e., ideal diode and 0.7 V source):

$$\begin{aligned} v_D &= v_D^i + 0.7 \\ &= -0.2 + 0.7 \\ &= 0.5 \; V \end{aligned}$$





We likewise estimate the **current** through the junction diode by determining the current through the **PWL model** (OK, the current through the model is **also** the current through the **ideal** diode):

$$i_D = i_D^i = 0$$

Hopefully, this example has convinced you as to the **necessity** of carefully, patiently and precisely applying the junction diode **models**—models that include IDEAL diodes only. Then, you must use the model results to carefully, patiently and precisely determine **approximate** values for the **junction** diode.

Each and every step of this process is required to achieve the correct answer—I'll find out **later** in the semester if **you** have been paying attention!