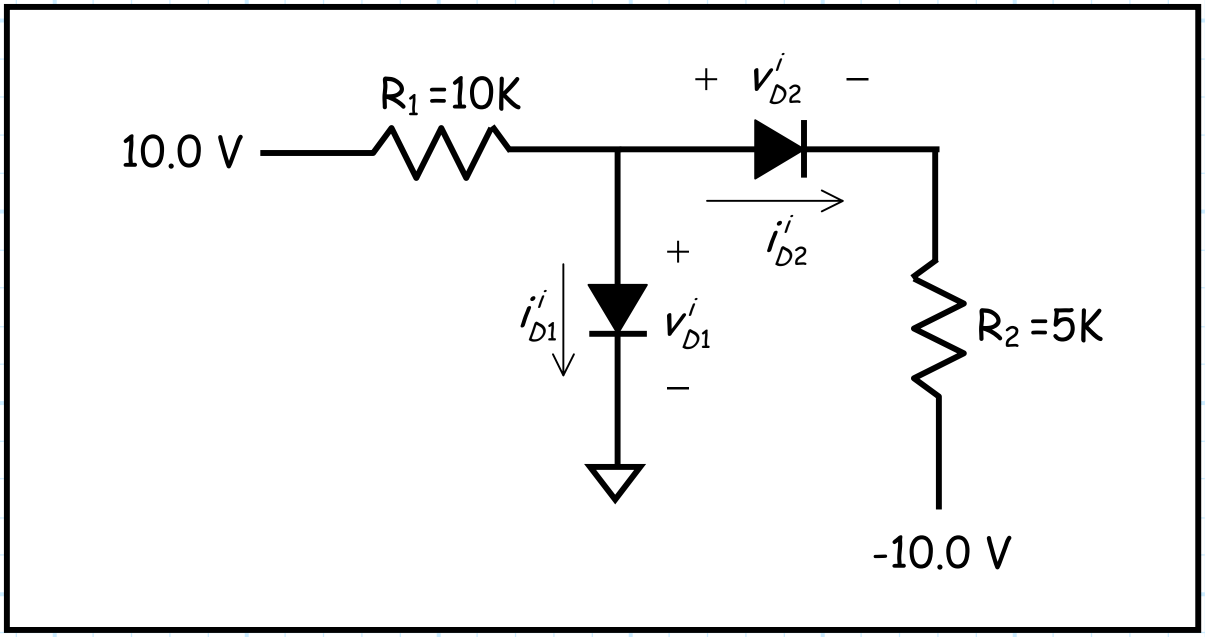
Example: Analysis of a Complex Diode Circuit

Consider this circuit with **two ideal diodes**:



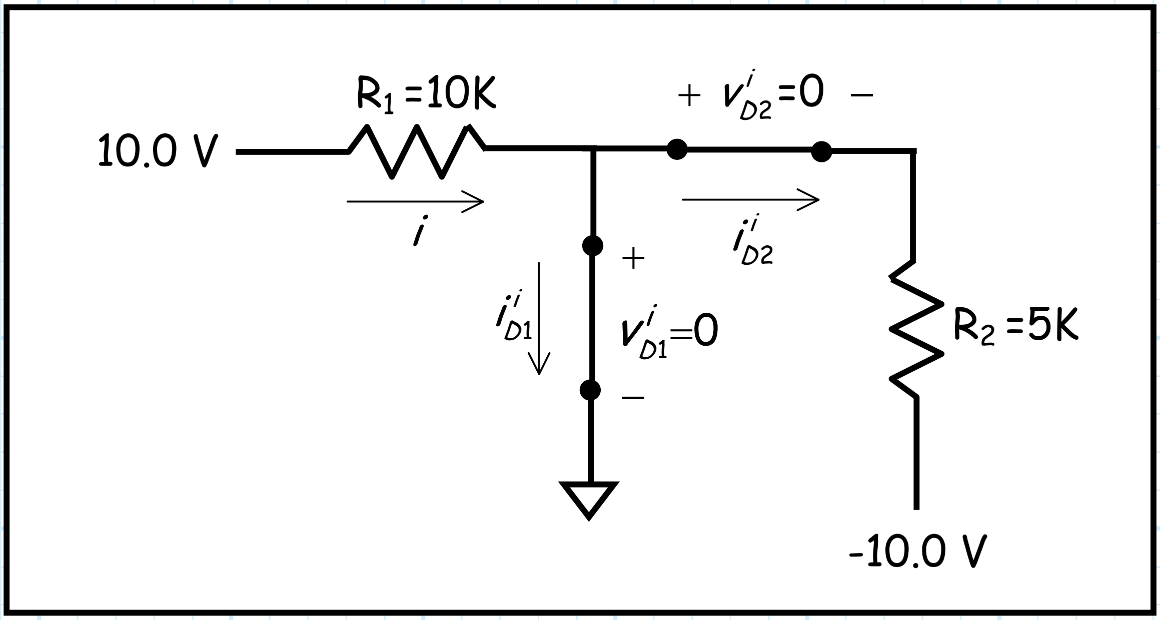
Let's analyze this circuit and find v_{D1}^i, i_{D1}^i, v_{D2}^i, and i_{D2}^i !

Remember, we must accomplish each of the **five** steps:

Step 1: *ASSUME* that both D_1 and D_2 are **"on"** (might as well!).

Step 2: *ENFORCE* the **equalities** $v_{D1}^i = 0 = v_{D2}^i$, by replacing each ideal diode with a **short** circuit.

Step 3: *ANALYZE* the resulting circuit, and find i^i_{D1} and i^i_{D2}.



Begin with **KCL**:

$$i = i^i_{D1} + i^i_{D2}$$

where $$i = \frac{10.0 - 0}{10} = 1.0\ mA$$

and $$i^i_{D2} = \frac{0-(-10)}{5} = \frac{10}{5} = 2.0\ mA$$

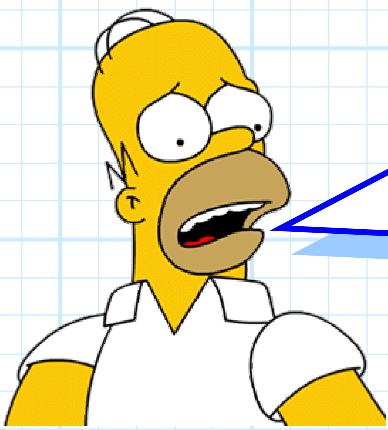
Therefore, $$i^i_{D1} = i - i^i_{D2} = 1.0 - 2.0 = -1.0\ \ mA$$

Step 4: Now we must *CHECK* **inequalities** to see if our assumptions are correct!

$$i_{D1}^{i} = -1.0 \; mA < 0$$

$$i_{D2}^{i} = 2.0 \; mA > 0$$

One assumption is therefore **INCORRECT**. We must proceed to **step 5**—change our assumptions and **completely** start again!



Q: *Wait a second! We don't have to **completely** start from the beginning, do we? After all, our assumption about diode D_2 turned out to be **true**—so we **already** know that $i_{D2}^{i} = 2.0$ and $v_{D2}^{i} = 0$, **right?***

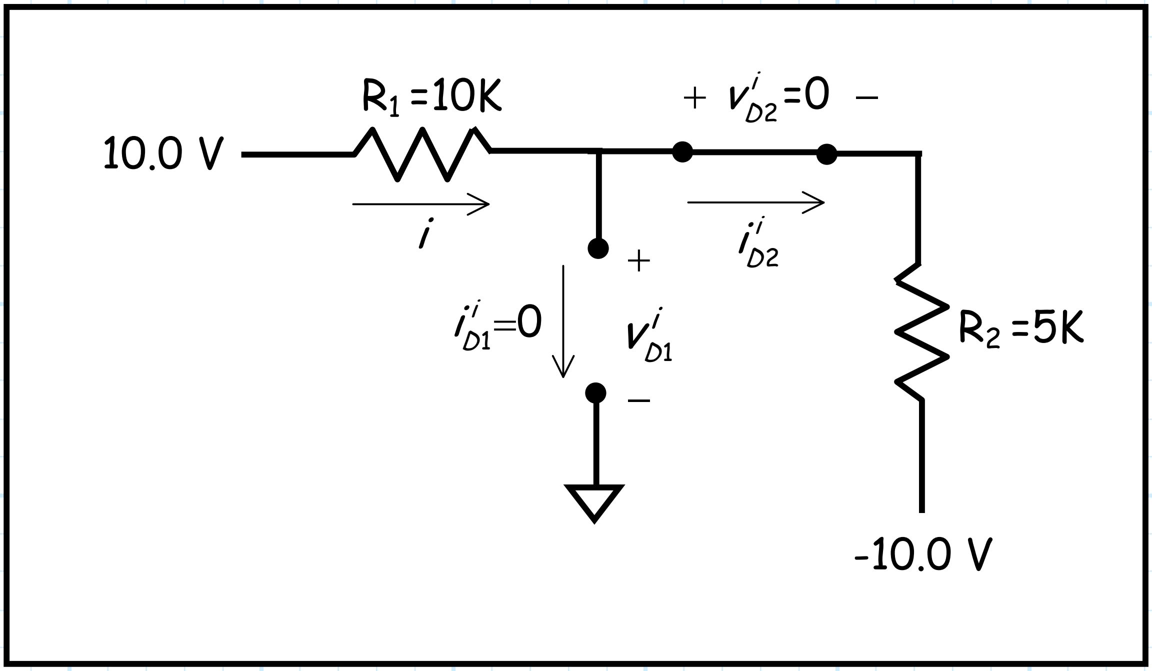
A: **NO!** The solution for diode D_2 is dependent on the state of both diodes D_1 and D_2. If the assumption of just **one** diode turns out to be incorrect, then the solutions for **all** diodes are **wrong**!

So, let's change our assumption and start all over again!

Step 1: Now *ASSUME* that D_1 is **"off"** and D_2 is **"on"**.

Step 2: *ENFORCE* $i_{D1}^i = 0$ (D_1 open) and $v_{D2}^i = 0$ (D_2 short).

Step 3: *ANALYZE* resulting circuit, and find v_{D1}^i and i_{D2}^i.



Note $i = i_{D2}^i = \frac{10.0-(-10.0)}{10+5} = \frac{20.0}{15} = 1.33\ mA$

and from KVL:

$$10.0 - 10i - v_D^i = 0$$

$$10.0 - 10(1.33) - v_D^i = 0$$

$$\therefore\ v_D^i = 10.0 - 10(1.33) = -3.33\ V$$

4) CHECK our assumptions.

$$i_{D2}^{i} = 1.33\ mA \quad > \quad 0 \quad \checkmark$$

$$v_{D1}^{i} = -3.33\ V \quad < \quad 0 \quad \checkmark$$

$\therefore$ Assumptions are **correct**! We are finished!

$v_{D1}^{i} = -3.33\ V$	$i_{D1}^{i} = 0$
$v_{D2}^{i} = 0$	$i_{D2}^{i} = 1.33\ mA$