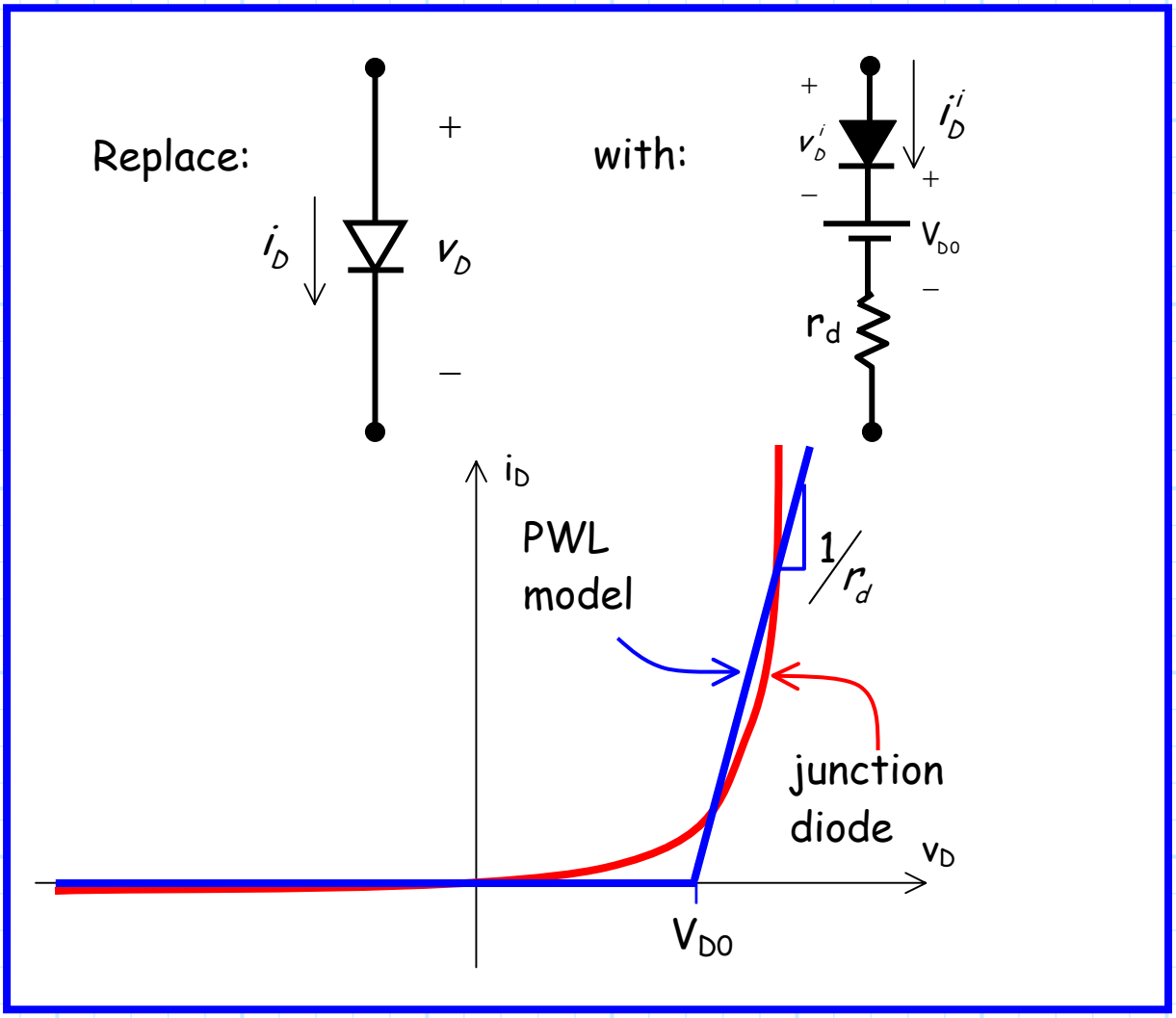
The Piece-Wise Linear Model

Q: *The CVD model approximates the forward biased junction diode voltage as* $v_D = 0.7$ V *regardless of the junction diode current. This of course is a good approximation, but in reality, the junction diode voltage* ***increases*** *(logarithmically) with increasing diode current. Isn't there a more* ***accurate*** *model?*

A: Yes! Consider the **Piece-Wise Linear (PWL)** model.



In other words, replace the junction diode with **three** devices—an **ideal diode**, in series with some **voltage source** (**not** 0.7 V!) and a **resistor**.

To find **approximate** current and voltage values of a junction diode circuit, follow these steps:

Step 1 - **Replace** each junction diode with the **three** devices of the **PWL model**.

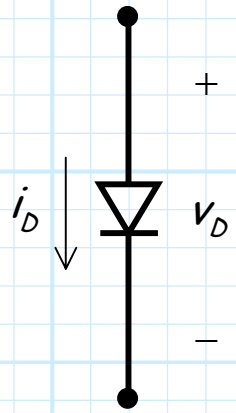
Note you now a have an **IDEAL** diode circuit! There are **no junction diodes** in the circuit, and therefore **no junction diode** knowledge need be (or should be) used to analyze it.

Step 2 - **Analyze** the **IDEAL** diode circuit. Determine i_D^i and v_D^i for **each IDEAL** diode.

IMPORTANT NOTE !!! PLEASE READ THIS CAREFULLY:

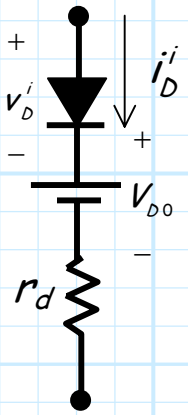
Make sure you analyze the resulting circuit **precisely** as we did in section 3.1. You **assume** the same **IDEAL** diode modes, you **enforce** the same **IDEAL** diode values, and you **check** the same **IDEAL** diode results, **precisely** as before. Once we replace the junction diodes with the CVD model, we have an **IDEAL** diode circuit—**no junction diodes** are involved!

Step 3 - Determine the **approximate** values i_D and v_D of the **junction** diode from the **ideal** diode values i_D^i and v_D^i:



$$i_D \approx i_D^i$$

$$v_D \approx v_D^i + V_{D0} + i_D^i r_d$$



Note therefore, **if** the **IDEAL** diode (note here I said **IDEAL** diode) is **forward** biased ($i_D^i > 0$), then the **approximation** of the **junction** diode current will likewise be positive ($i_D > 0$), and the **approximation** of the **junction** diode voltage (unlike the **ideal** diode voltage of $v_D^i = 0$) will be:

$$\begin{aligned} v_D &= v_D^i + V_{D0} + i_D^i r_d \\ &= 0.0 + V_{D0} + i_D^i r_d \\ &= V_{D0} + i_D^i r_d \end{aligned}$$

However, **if** the **IDEAL** diode is **reversed** biased ($i_D^i = 0$), then the **approximation** of the **junction** diode current will likewise be zero ($i_D = 0$), and the approximation of the junction diode voltage (unlike the **ideal** diode voltage of $v_D^i < 0$) will be:

$$\begin{aligned} v_D &= v_D^i + V_{D0} + i_D^i r_d \\ &= v_D^i + V_{D0} + 0 \\ v_D &< V_{D0} \end{aligned}$$

NOTE: Do **not** check the resulting **junction** diode approximations. You do **not** assume anything about the **junction** diode, so there is **nothing** to check regarding the junction diode answers.