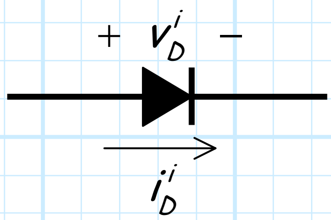
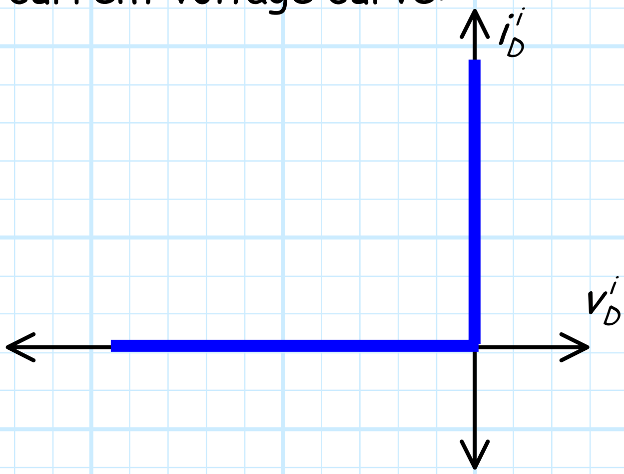
The Junction Diode Curve

In many ways, **junction** diode (i.e., real diode) behavior is **similar** to that of ideal diodes. However, there are some important and profound **differences**!

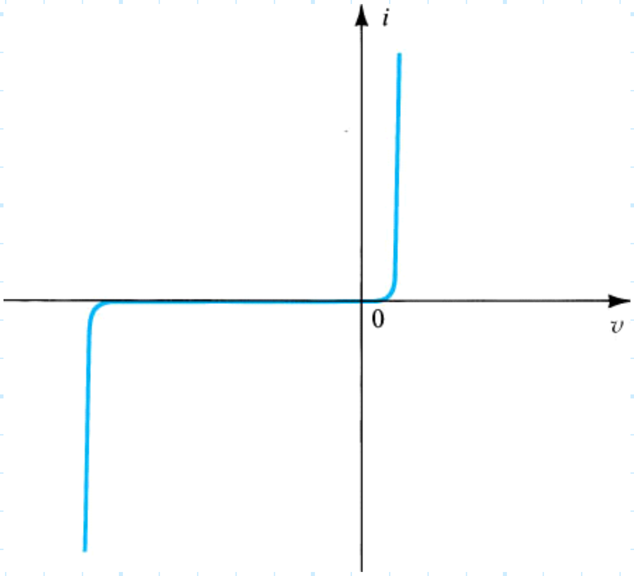
First, recall the **ideal** diode current voltage curve:

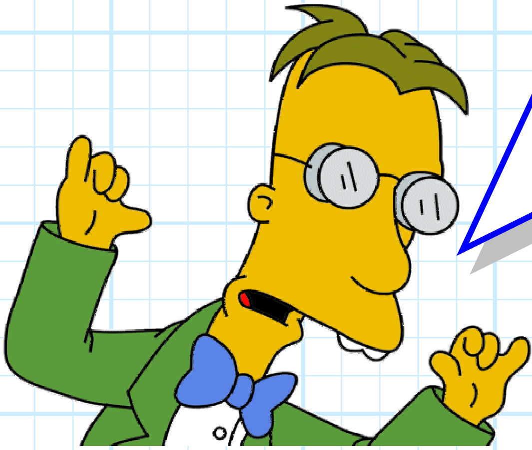




This curve is piece-wise linear, with two **unambiguous** regions—**reverse** bias (where $v < 0$ and $i = 0$), and **forward** bias (where $i > 0$ and $v = 0$).

Now consider the behavior of a **junction diode**:





Please note that unlike the ideal diode, the ***junction diode*** *curve:*

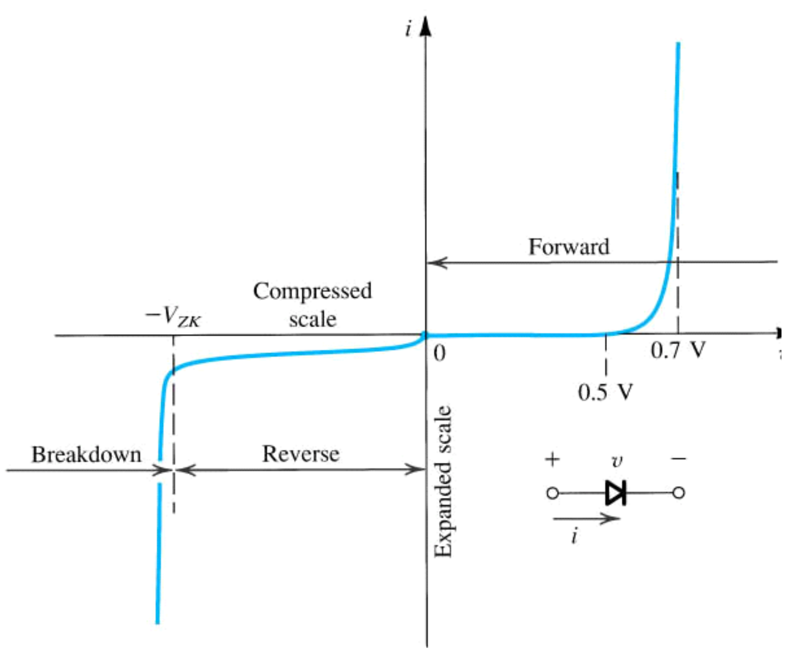
a) *is* ***continuous*** *(not piece-wise linear).*

b) *Has* ***three*** *apparent regions of operation (not two).*

c) *Has, therefore,* ***ambiguous*** *boundaries between regions (i.e., continuous* ***transitions*** *occur between regions—the curve has two "****knees****"!).*

By comparison to the ideal diode, we likewise define one region of the junction diode curve as the **forward bias** region, and another as the **reverse bias** region.

The **third** region has **no similarity** with ideal diode behavior (i.e., this is a "new" region). We call this region **breakdown**.



Note that the breakdown region occurs when the junction diode voltage (from anode to cathode) is **approximately** less than or equal to a voltage value $-V_{ZK}$. The value V_{ZK} is known as the **zener breakdown voltage**, and is a fundamental performance parameter of any **junction** diode.

As we shall see later, the behavior of a junction diode in the forward and reverse bias region is a **predictable** result of **semiconductor physics**! As such we can write an **explicit** mathematical expression, simultaneously describing the behavior of a junction diode in **both** the forward and reverse bias regions (but **not** in breakdown!):

$$i_D = I_s \left(e^{v_D / nV_T} - 1 \right) \qquad \text{for} \quad v_D > -V_{ZK}$$