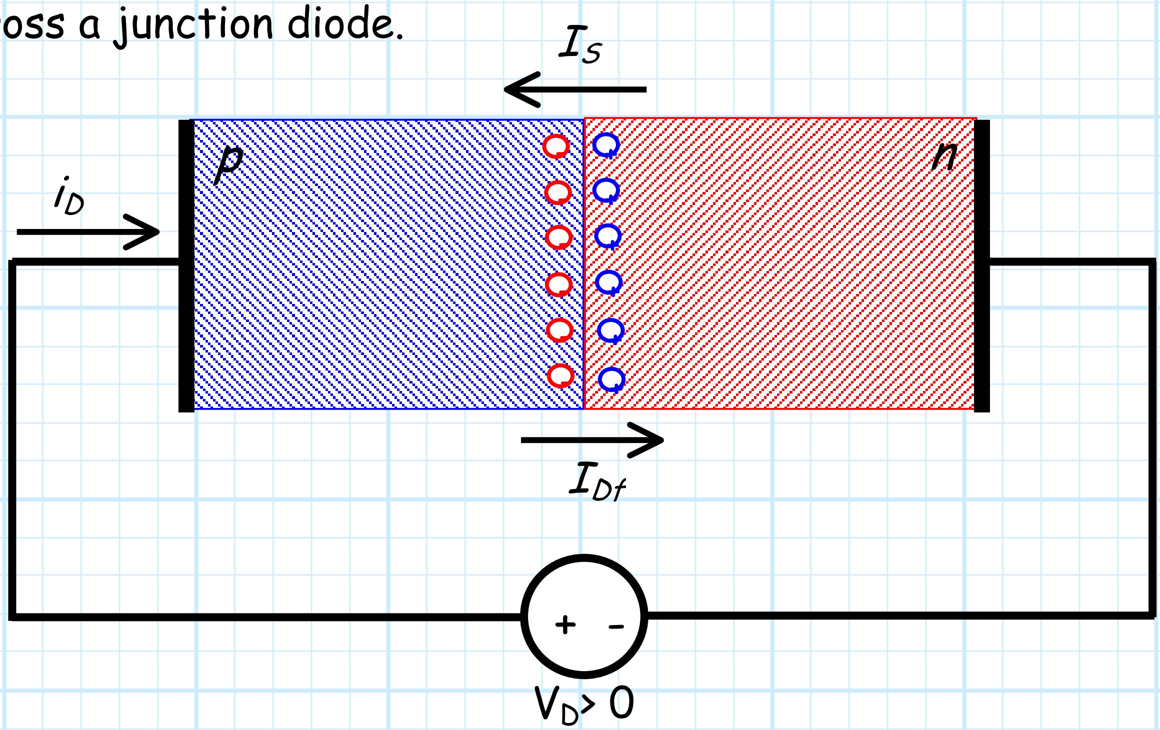
The *p-n* Junction in Forward Bias

Now consider the case where we place a **small, positive voltage** across a junction diode.



1) This voltage **reduces** the **barrier** voltage, i.e., the electric field that **holds back** the **diffusion** of holes from the anode to the cathode, as well as holds back the **diffusion** of free electrons from the cathode to the anode.

2) Thus, diffusion current **increases** as diode voltage increases. In fact, this increase is **exponential** with the diode voltage! :

$$I_{Df} = I_s \, e^{v_D / nV_T}$$

3) But, the **drift** current does **not** change if v_D is increased! The **reduced** electric field moves charges with **less** force, but the **number** of holes and free electrons swept across the depletion region does not change. Therefore, drift current I_S remains at its same **small** value, **independent** of diode voltage v_D.

The total current i_D through the diode is therefore:

$$
\begin{aligned}
i_D &= I_{Df} - I_S \\
&= I_S \, e^{v_D / nV_T} - I_S \\
&= I_S\left(e^{v_D / nV_T} - 1\right)
\end{aligned}
$$

Hey! this result is ***very familiar*** *!!*