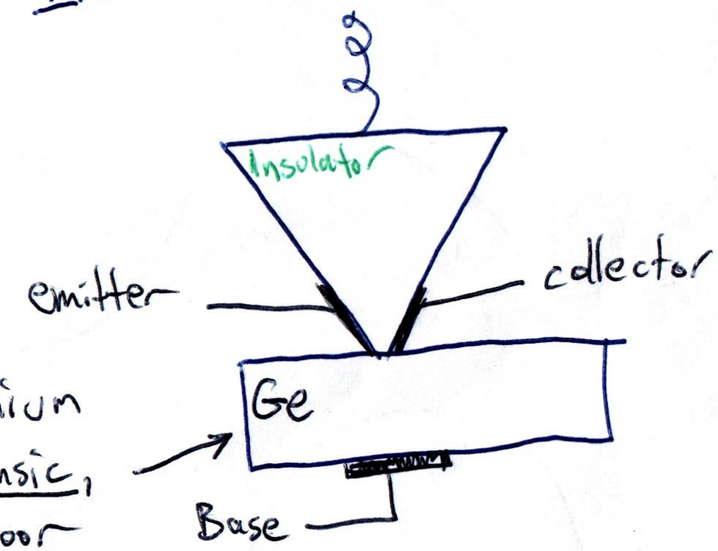
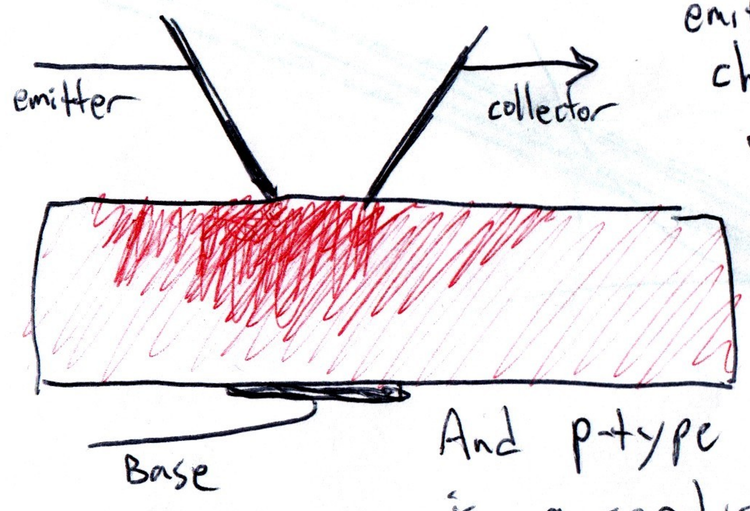
Quick Intro: THE FIRST TRANSISTOR



The Germanium slab is intrinsic, so a very poor conductor.

applying a positive voltage to the emitter injects holes, changing the behavior of the germanium to more p-type



And p-type germanium is a conductor.

All but the most radically experimental transistor replacements work this way: by manipulating effective doping levels.

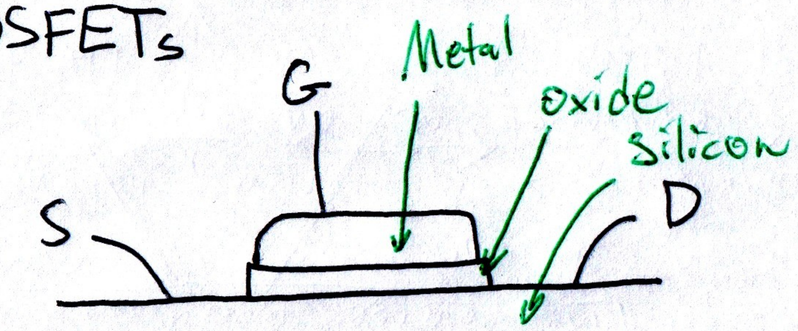
So now, Transistors! The basic concept of a transistor is the manipulation of a semiconductor's effective resistance with electricity

This is powerful because it forms the basic function of both Amplifiers and Switches.

In this lab we will look at two classes of these devices.

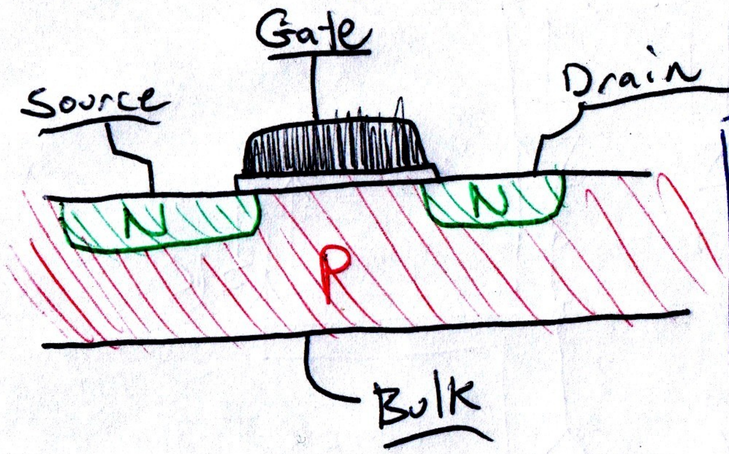
First, MOSFETs

Metal
Oxide
Silicon
Field
Effect
Transistor



(Silicon Dioxide, or Quartz crystal, is popularly referred to as "Oxide" or "Glass" by EEs and is a good insulator)

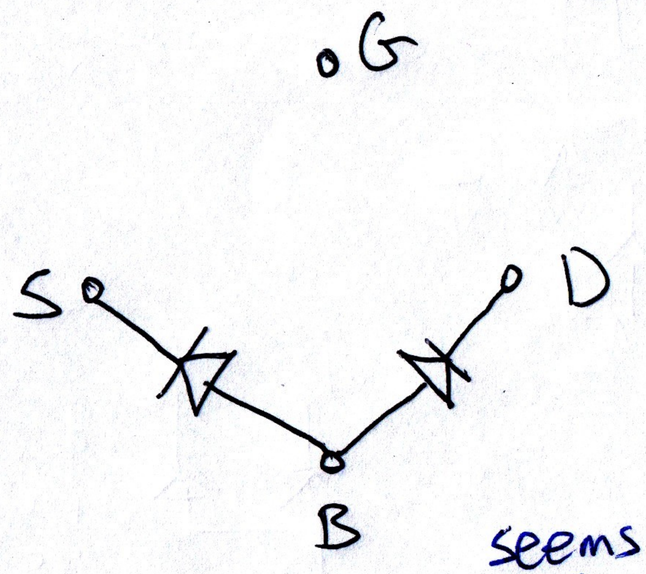
MOSFETs are 4-Terminal devices,



ASIDE

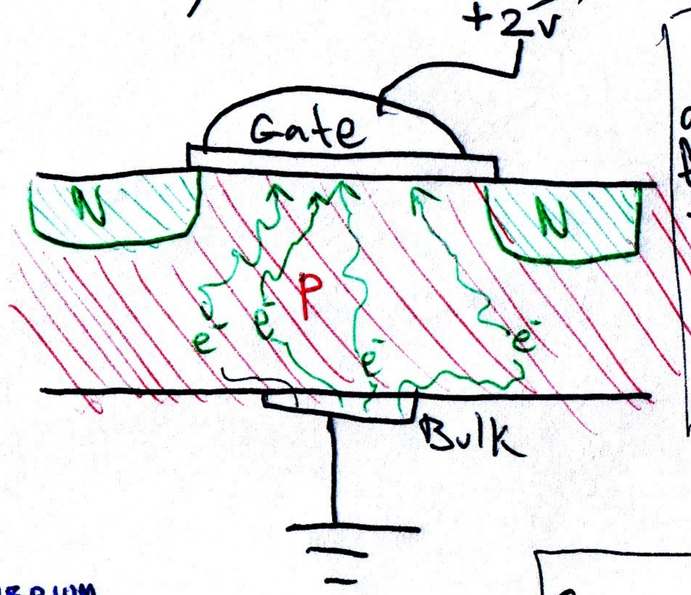
If "source" and "drain" look like arbitrary names tacked on to identical, symmetric terminals, that's just because they are! (more on this later.)

The MOSFET above is an N-Type, Enhancement-Mode device. Given what we know about diode junctions, we can try to draw this diagram:



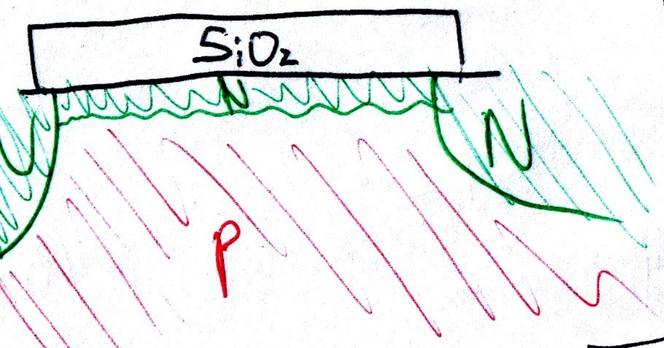
seems like a waste of time, huh?

Lets try something, though:



Electrons are drawn from ground into the area around the gate.

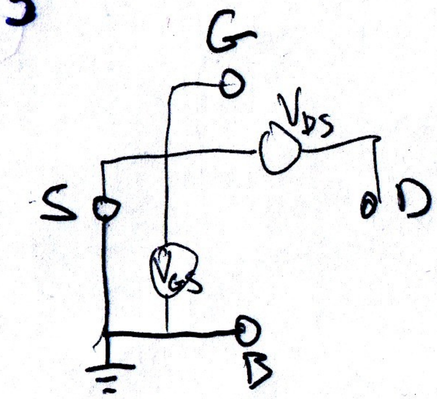
@EQUILIBRIUM



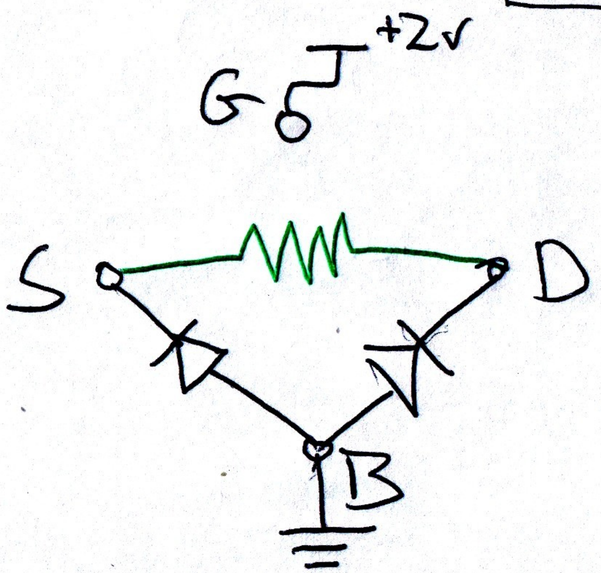
Since the oxide is non-conductive, the electrons cluster around the gate, and in high enough concentrations, REVERSE the polarity of the silicon there.

I-V Curve time:

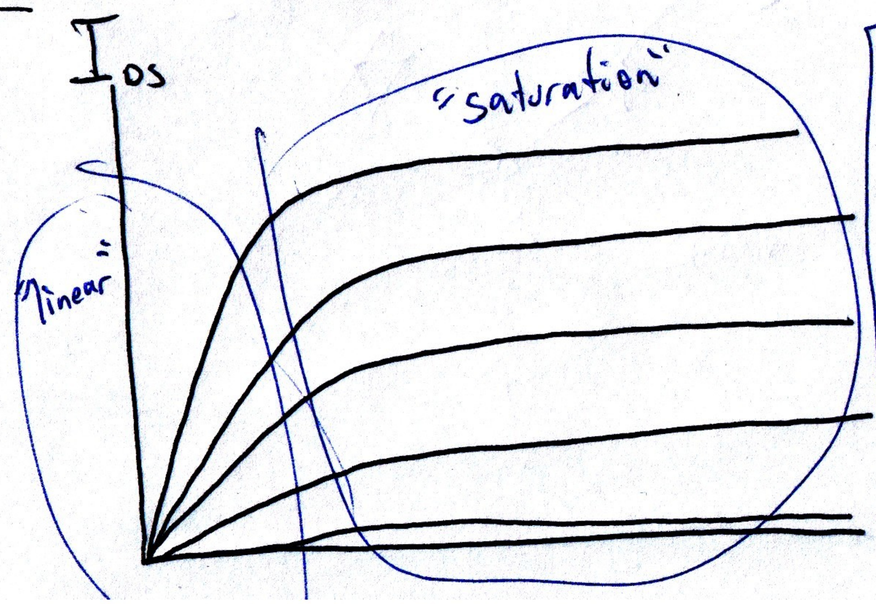
On N-MOSFETs, the Bulk is usually tied to ground or lower, so it doesn't move much. This still leaves us with **3** terminals, though.



The resistance is high with no voltage on the gate, but at higher gate voltages, it is reduced.



The path from source to drain is now mainly resistive, and its resistance is not very large.



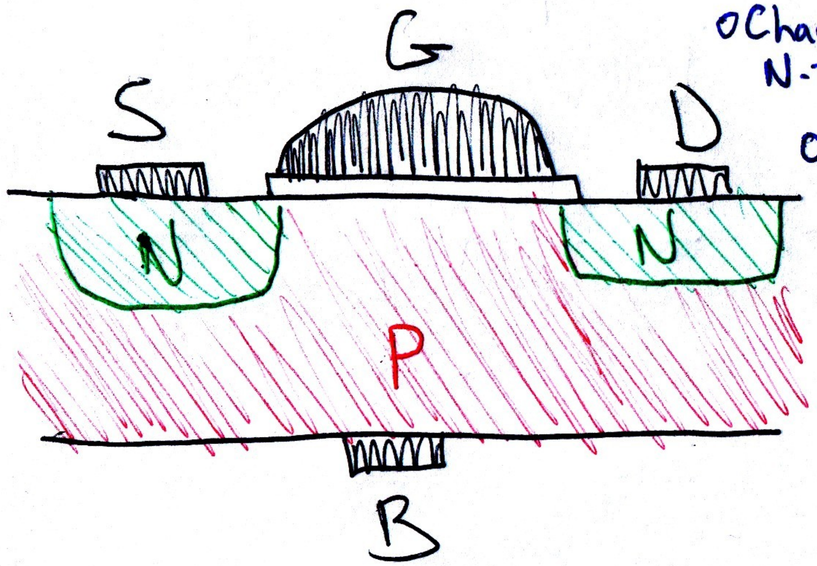
ASIDE

If you keep increasing V_{DS}, this "saturates" conduction. Note that in this region it looks like a current source.

TYPES OF MOSFETS

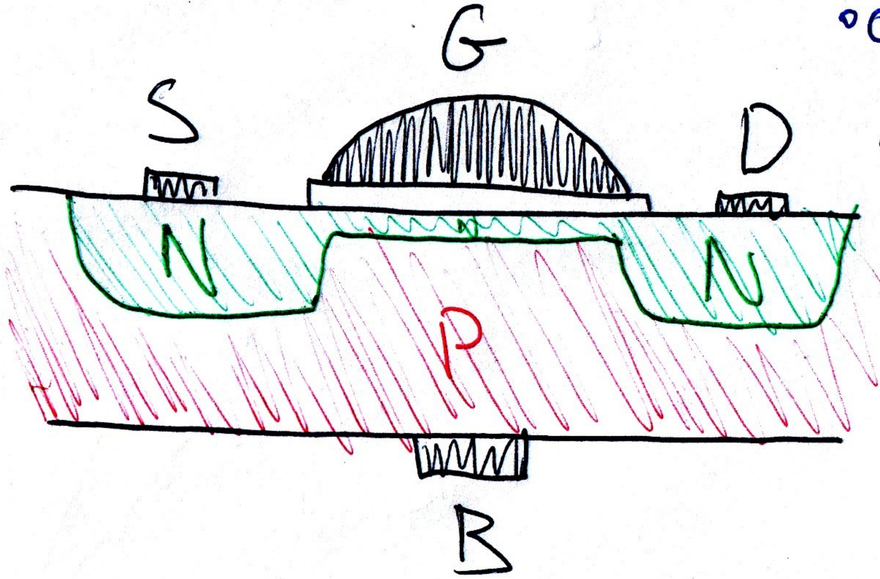
N-Type, Enhancement Mode

- Normally off
- Channel is N-Type
- high voltage to activate



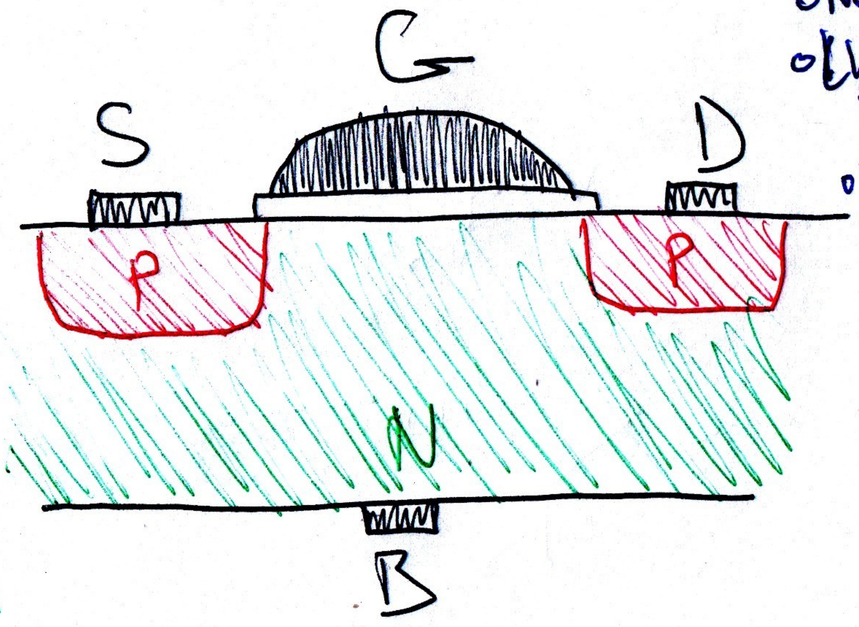
N-Type, Depletion Mode

- Normally On
- Channel is N-Type
- low voltage to deactivate



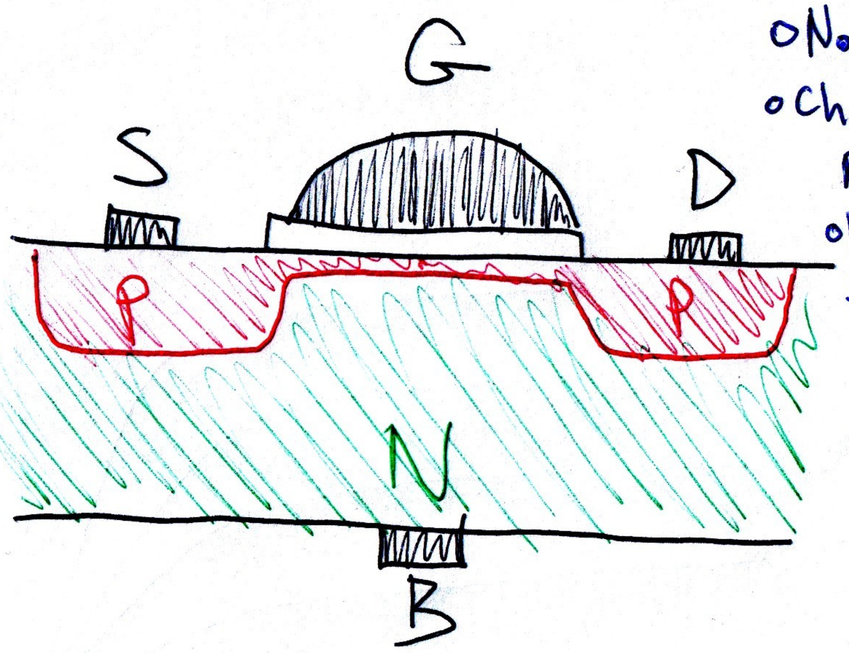
P-Type, Enhancement Mode

- Normally off
- Channel is P-type
- low voltage to activate

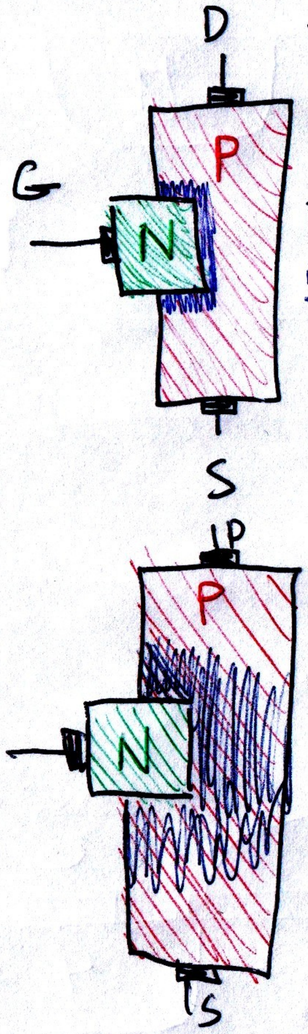


P-Type, Depletion Mode

- Normally on
- Channel is P-Type
- high voltage to deactivate



JFET Junction Field Effect Transistor

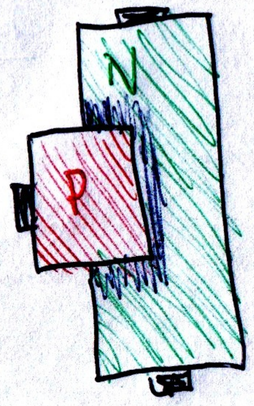


This is a depletion-mode p-channel
Because it is normally on.

Strongly reverse biasing the junction at the gate will block current flow.

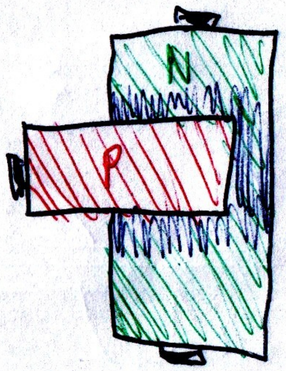
These are way less common than MOSFETs, but for completeness:

depletion-mode n-channel



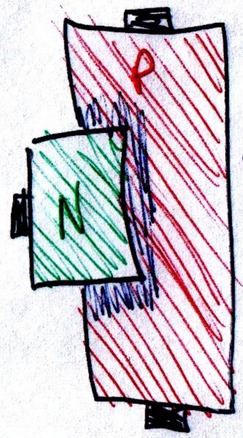
- Normally on
- Channel is N-type
- low voltage on gate to deactivate

enhancement-mode n-channel



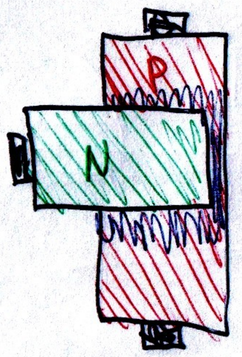
- Normally off
- Channel is N-type
- high voltage on gate to activate

depletion-mode p-channel



- Normally on
- Channel is p-type
- high voltage on gate to deactivate

enhancement mode p-channel



- Normally off
- Channel is p-type
- low voltage on gate to activate