(EL2-1) Diode Characteristics

Aim of experiment

Study the characteristics of a diode.

Apparatus

DC Power Supply – Ammeter – Voltmeter – Diode.

Theory of experiment

A diode can be considered to be an electrical one-way valve. They are made from a large variety of materials including silicon, germanium, gallium arsenide, silicon carbide, *Figure 1* .

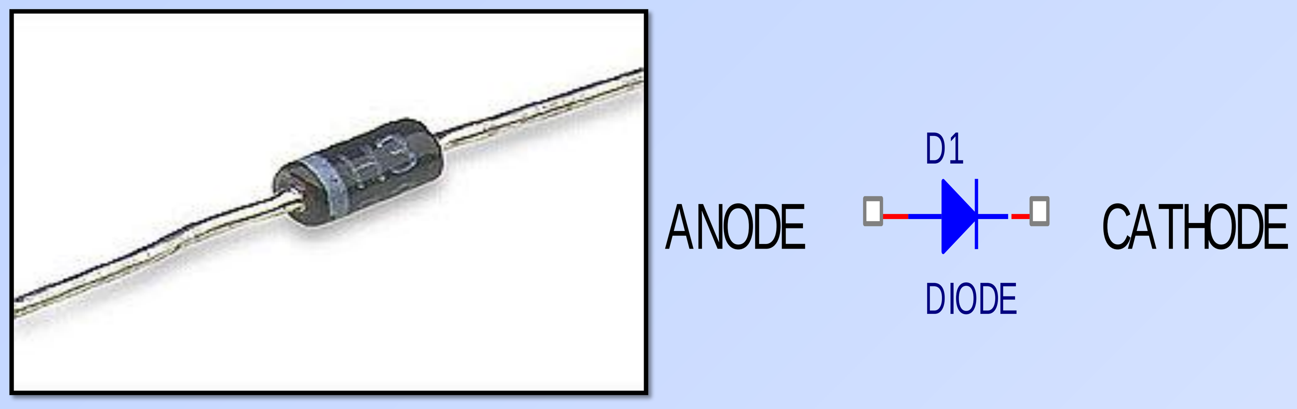

Figure 1 Diode and its symbol

In effect, diodes act like a flapper valve (Note: this is the simplest possible model of a diode).

For the flapper valve, a small positive pressure is required to open. Likewise, for a diode, a small positive voltage is required to turn it on. This voltage is like the voltage required powering some electrical device. It is used up turning the device on so the voltages at the two ends of the diode will differ.

The voltage required to turn on a diode is typically around *0.6 - 0.8 Volt* for a standard silicon diode and a few volts for a light emitting diode (LED).

Diodes are typically a *P-N* junction. At the junction, free electrons from the *N-type* material fill holes from the *P-type* material. This creates an insulating layer in the middle of the diode called the depletion zone, as shown in *figure 2.*

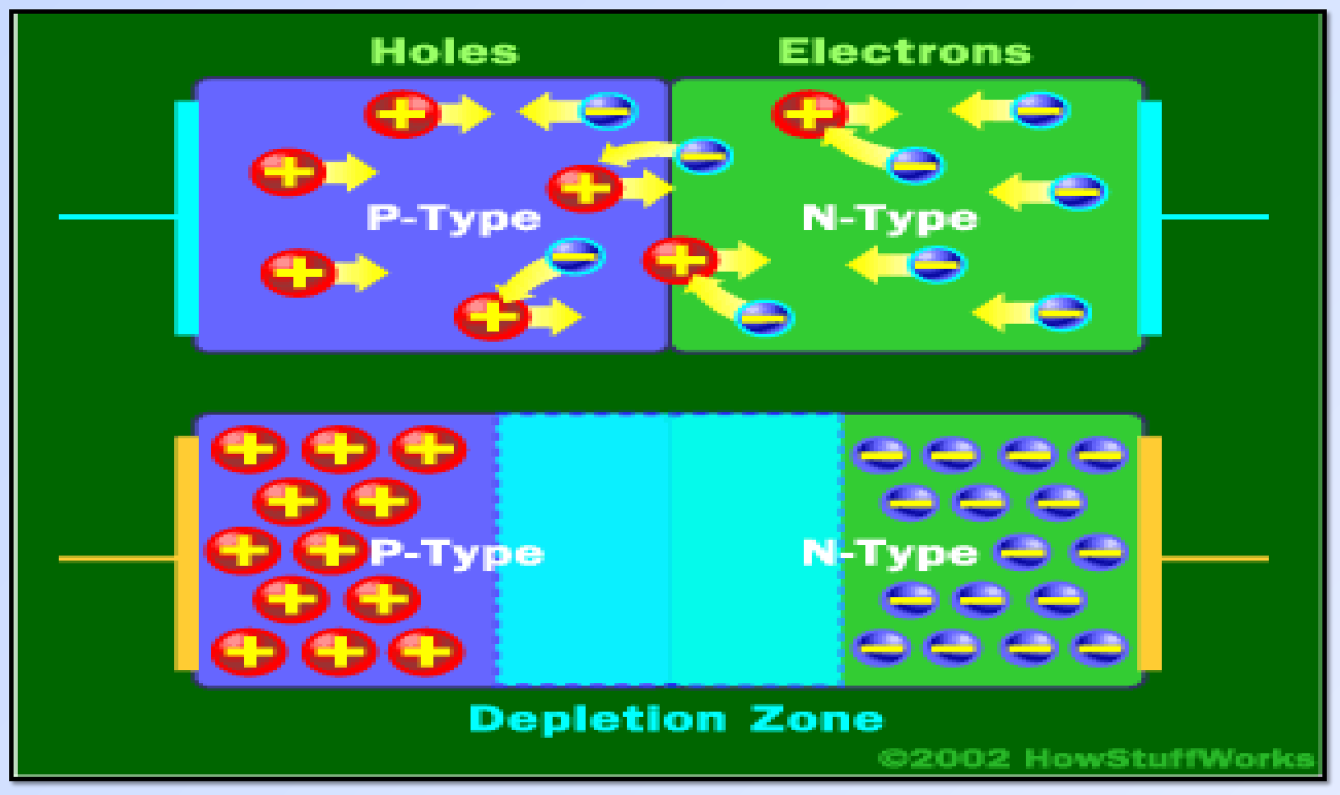

Figure 2 A schematic diagrams for a diode showing the mobile charges

When the negative end of the circuit is connected to the *N-type* layer and the positive end is connected to *P-type* layer, electrons and holes start moving and the depletion zone disappears, as shown in *Figure 3.*

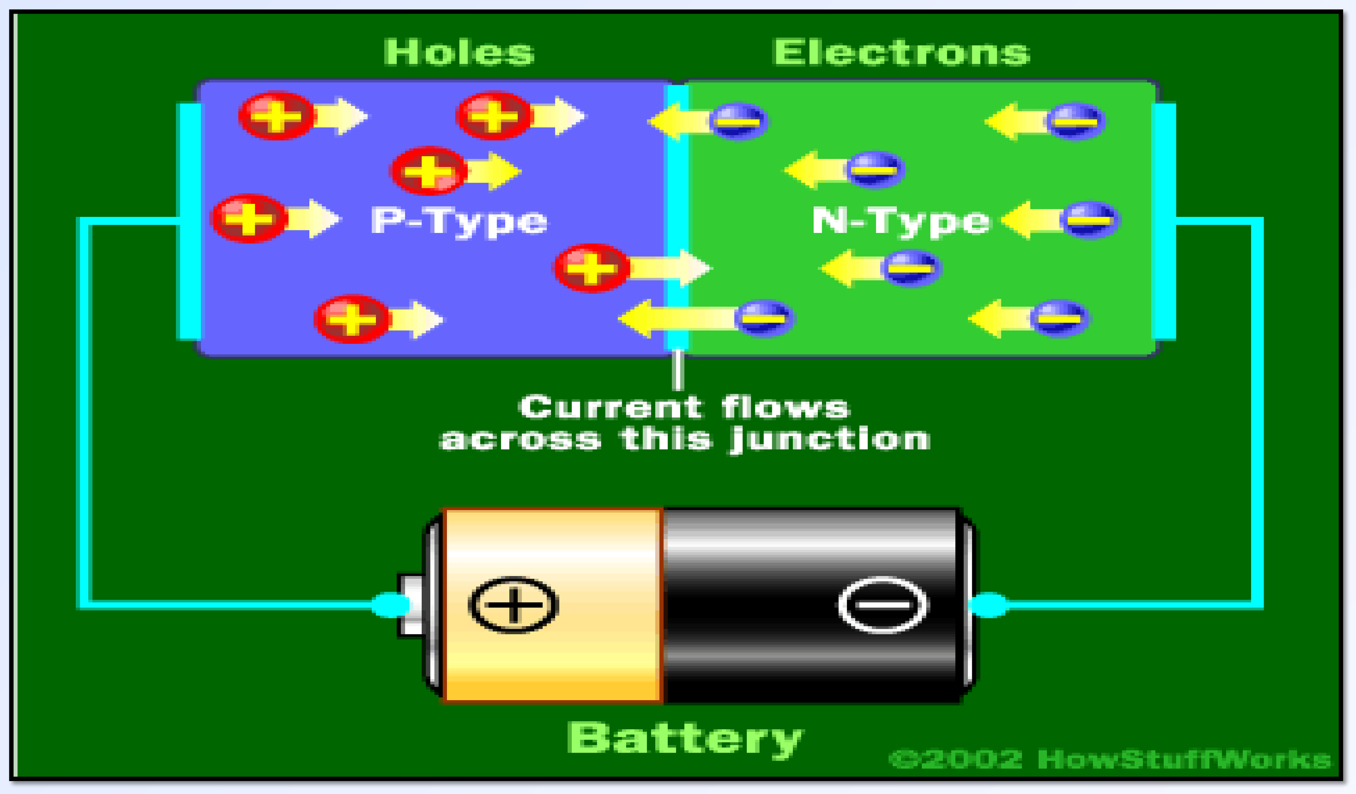

Figure 3 A schematic diagrams for a diode showing the mobile charges motion under the effect of forward biasing

When the positive end of the battery is hooked up to the N-type layer and the negative end is hooked up to the P-type layer, free electrons collect on one end of the diode and holes collect on the other. The depletion zone gets bigger and no current flows, as shown in *figure 4.*

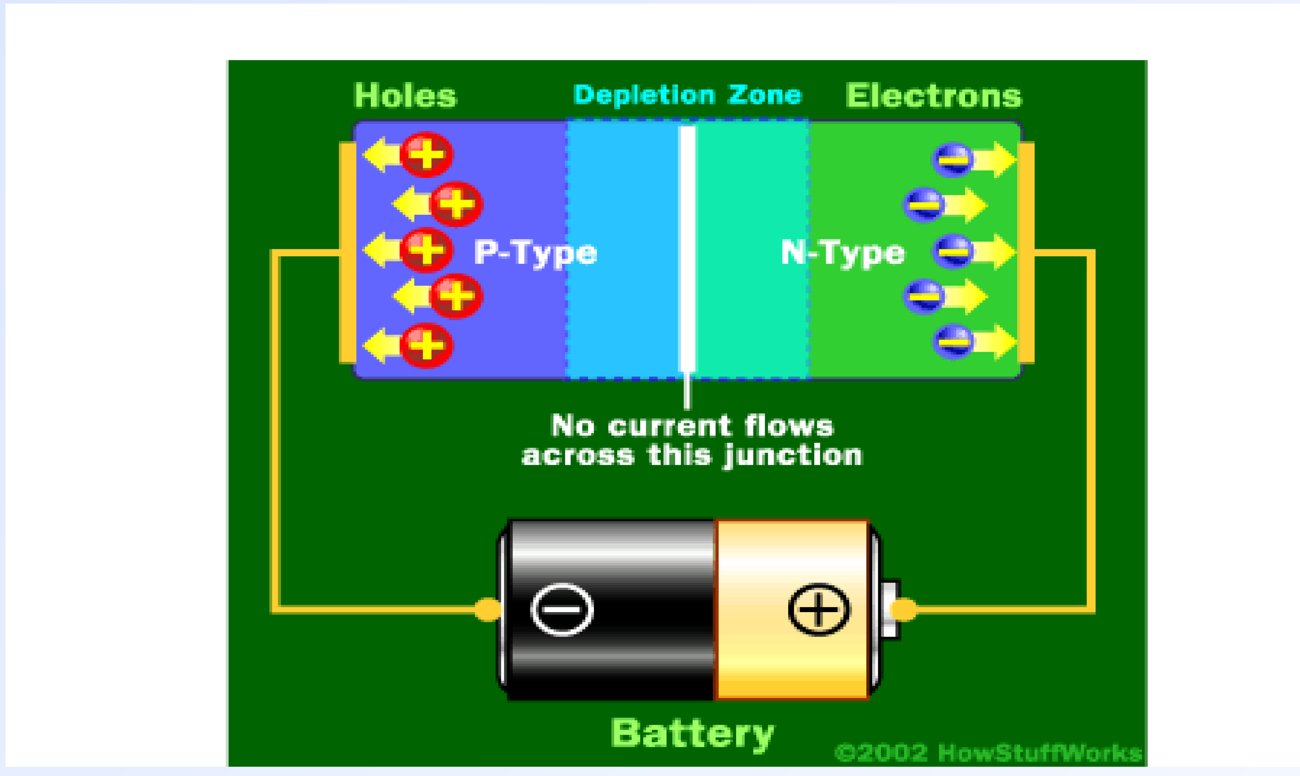

Figure 4 A schematic diagrams for a diode showing the mobile charges motion under the effect of reverse biasing

A semiconductor diode's behavior in a circuit is given by its current–voltage characteristic, or *I–V* graph, as shown in *figure 5*. This curve show that in *ideal diode*, when voltage across the diode is negative, the diode looks like an open circuit and when voltage across the diode is positive, the diode looks like a short.

A very large current can flow when the diode is forward biased. For power diodes, currents of a few amps can flow with bias voltages of *0.6* to *1.5V.* Note that the textbook generally uses *0.6V* as the standard value, but *0.7V* is more typical for the devices we will use in class.

(EL2-1) Diode Characteristics

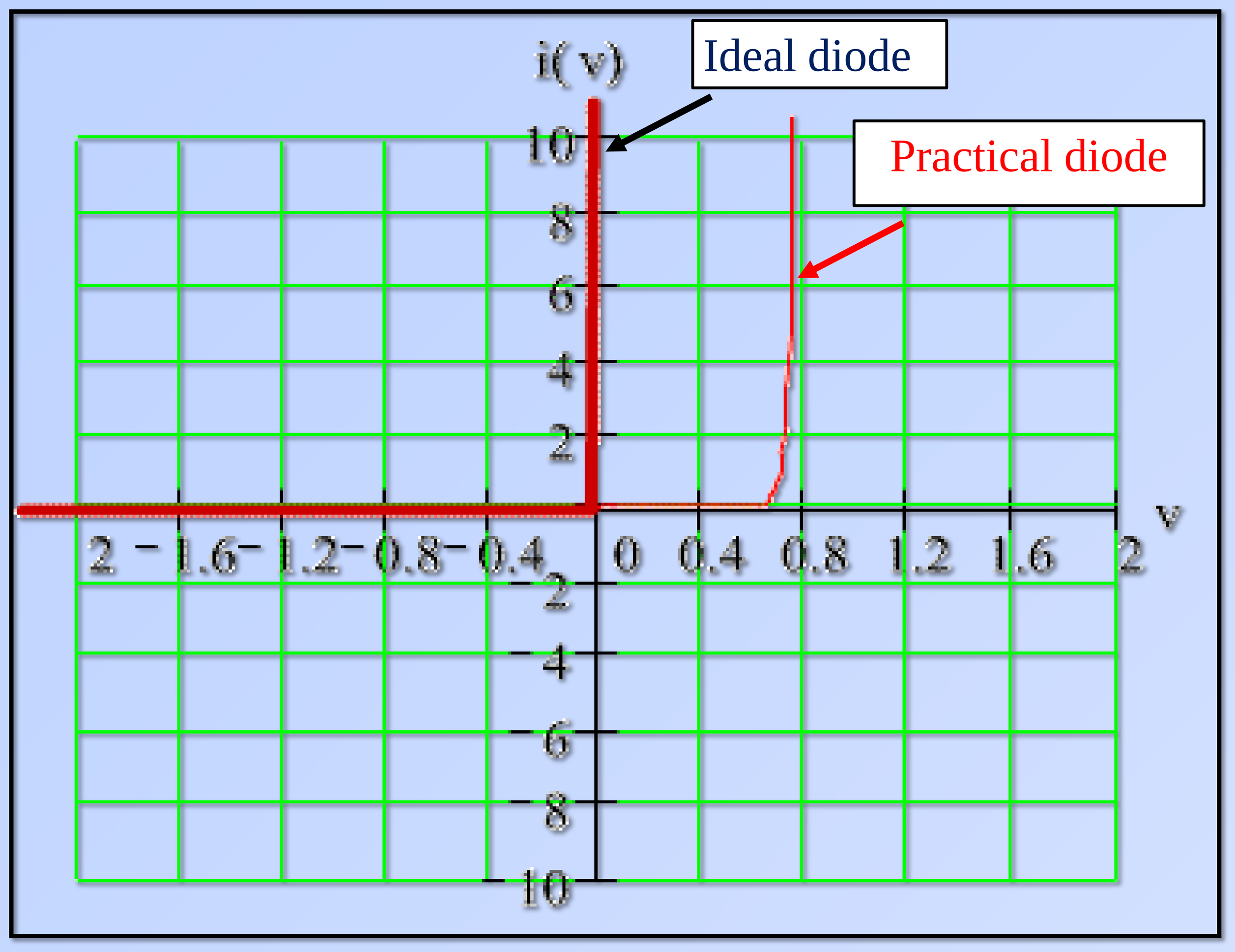

Figure 5 Ideal and practical I-V characteristic of a diode

The I_D-V_D relationship can be written simply as:

$$I_D = I_S\,(e^{V_D/nV_T} - 1)$$

Where V_D is the voltage across the diode and I_D is the current through the diode. n and I_s are constants. V_T is a voltage proportional to the temperature, we use *0.0259V*.

Note that for V_D less than zero, the exponential term vanishes and the current I_D is roughly equal to minus the saturation current. For V_D greater than zero, the current increases exponentially.

Procedure

1. Connect the circuit in *figure 6*.
2. Change the potential each *0.1* V up to *1* V and record the corresponding current in each case.
3. Tabulate the results.
4. Invert the polarity of the diode.
5. Repeat step 2 and tabulate the obtained results.
6. Draw a graph between the potential V_d on x-axis and the current I_d on y-axis.
7. Comment on the obtained results.

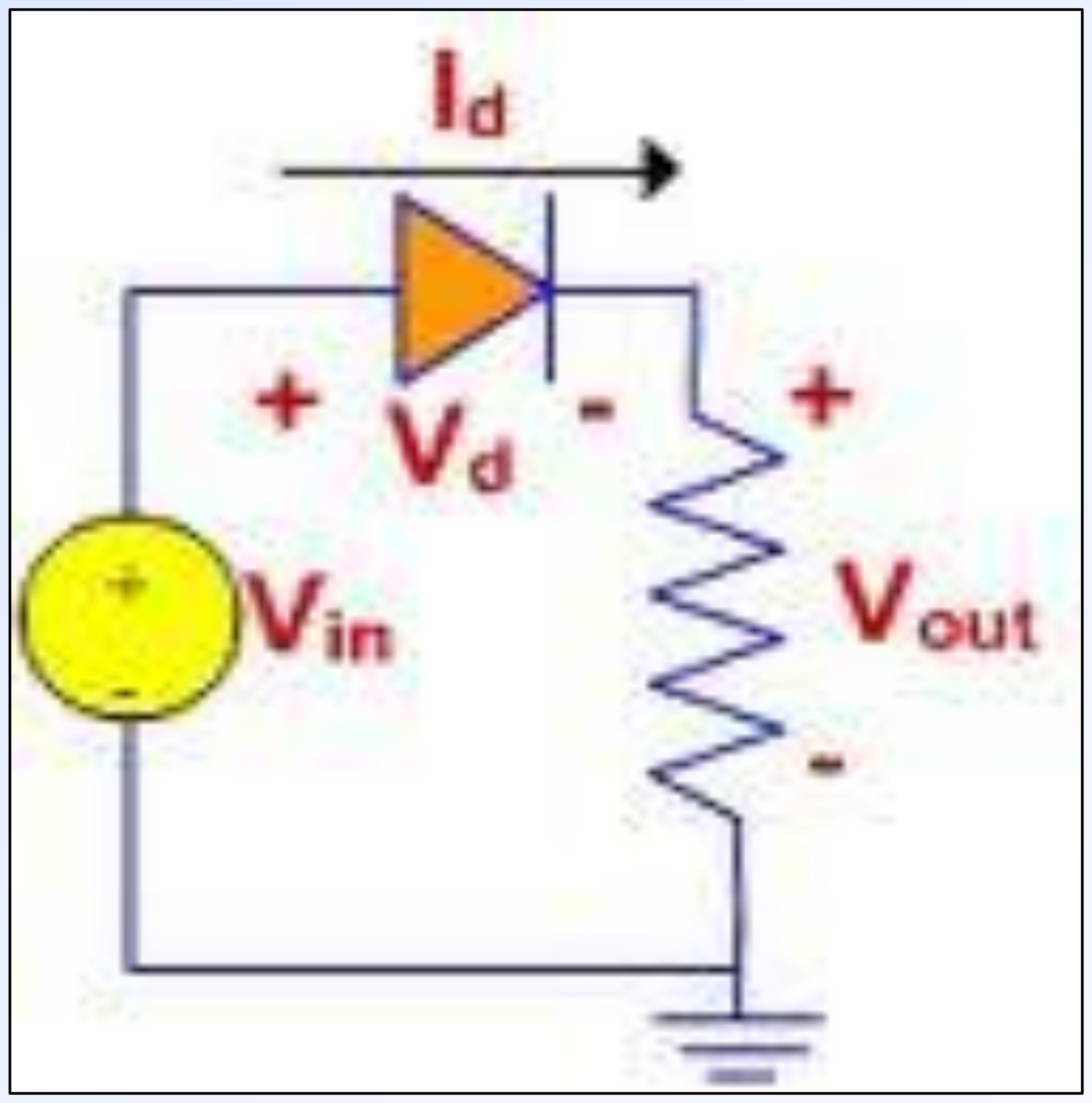

Figure 6 A circuit diagram to determine the characteristics of a diode

Results

Forward bias

V_d (V)	I_d(A)

Reverse bias

V_d (V)	I_d(A)