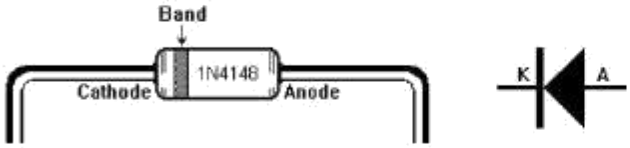
Objectives: *The objective of this experiment is to become familiar with the properties of diodes. In this experiment the V-I and other characteristics of a diode will be obtained. Characteristics of zener diodes and rectifier circuits will be examined.*

Materials:

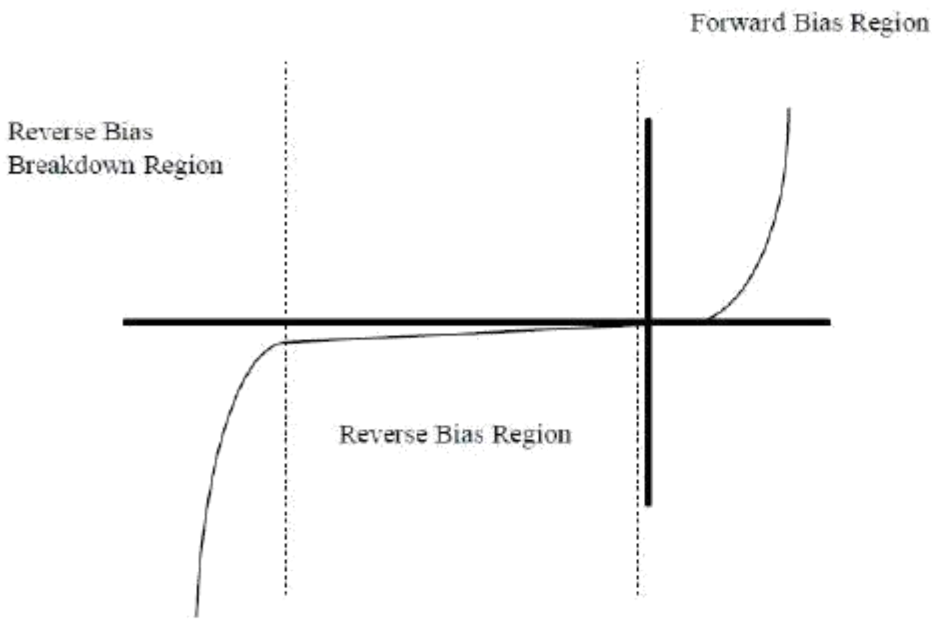
Breadboard
DMM (Digital multi-meter)
DC Power Supply
Function Generator
Oscilloscope
1N4148 diode
1N4001 diode
Zener diode
Resistor(s)

Background:

The diode is a device formed from a junction of n-type and p-type semiconductor material. The lead connected to the p-type material is called the anode and the lead connected to the n-type material is the cathode. In general, the cathode of a diode is marked by a solid line on the diode.



The primary function of the diode is rectification. When it is forward biased (the higher potential is connected to the anode lead), it will pass current. When it is reversed biased (the higher potential is connected to the cathode lead), current flow is blocked. The characteristic curve for a real diode is seen in figure below.



Non-linear V-I characteristic of diode is modelled with the equation below:

$$I = I_S * (\exp^{(V/(n*k*T/q))} - 1)$$

where:

I is the current through the diode
I_S is the reverse saturation current
V is the voltage across the diode (can be positive or negative)
n is a junction constant (typically around 2 for diodes, 1 for transistors)
k is Boltzmann's constant, 1.38e-23 Joules/Kelvin
T is temperature in Kelvins
q is the magnitude of an electron charge, 1.609e-19 coulombs

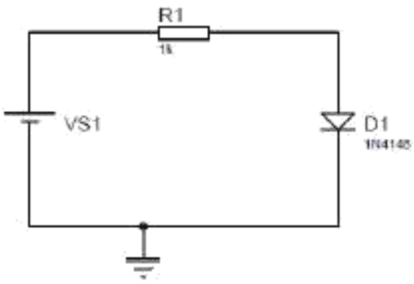
The resistance of a particular diode can be determined using a tangent line. The resulting voltage (ΔV) and current (ΔI) deviations can then be measured and the following equation is approximated:

$$r_D = \frac{\Delta V}{\Delta I} = \frac{26mV}{I_D} ohms$$

Procedure:

In this part of the experiment we will measure and record required data to plot the forward-bias characteristics of the 1n4148 and of the zener,

1. Construct the circuit given below with the supply (E) set at 0 V. record the measured value of the resistor.

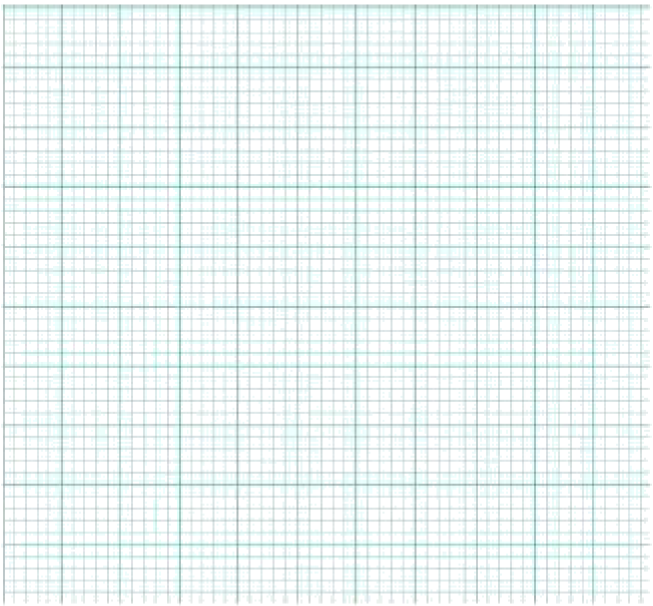


2. Increase the supply voltage E until V_R equals 0.1 V. Then measure V_D and record its voltage in table below. Calculate the value of the corresponding current I_D with the equation given in table.

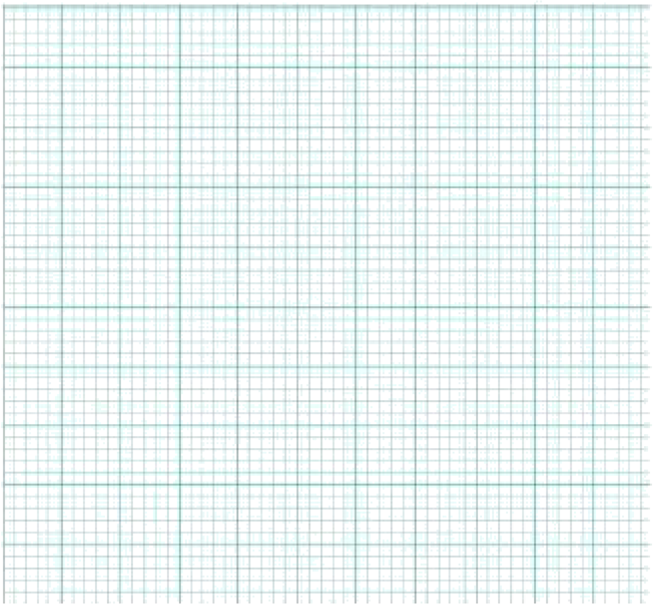
V_R (V)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
V_D (V)								
$I_D=\frac{V_R}{R_{meas}} (mA)$								

V_R (V)	0.9	1	2	3	4	5	6	7	10
V_D (V)									
$I_D=\frac{V_R}{R_{meas}} (mA)$									

3. Plot V_R versus V_D and V_D versus I_D on given graphs below.

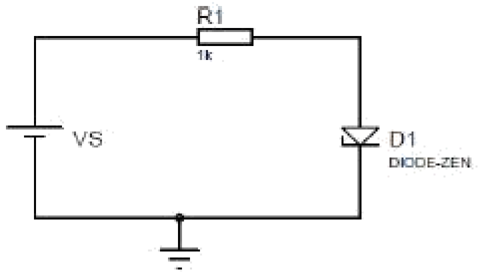


V_R versus V_D



V_D versus I_D

4. Construct the circuit given below with the supply (VS) set at 0 V and record the measured value of the resistor.

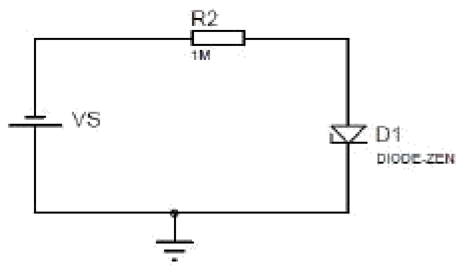


5. Increase the supply voltage E until V_R equals 0.1 V. Then measure V_D and record its voltage in table below. Calculate the value of the corresponding current I_D with the equation given in table.

V_R (V)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
V_D (V)								
$I_D=\frac{V_R}{R_{meas}}(mA)$								

V_R (V)	0.9	1	2	3	4	5	6	7	10
V_D (V)									
$I_D=\frac{V_R}{R_{meas}}(mA)$									

6. Construct the circuit given next with the supply (VS) set at 0 V and record the measured value of the resistor. Note that the source is reversed and 1k resistor substituted with 1M.

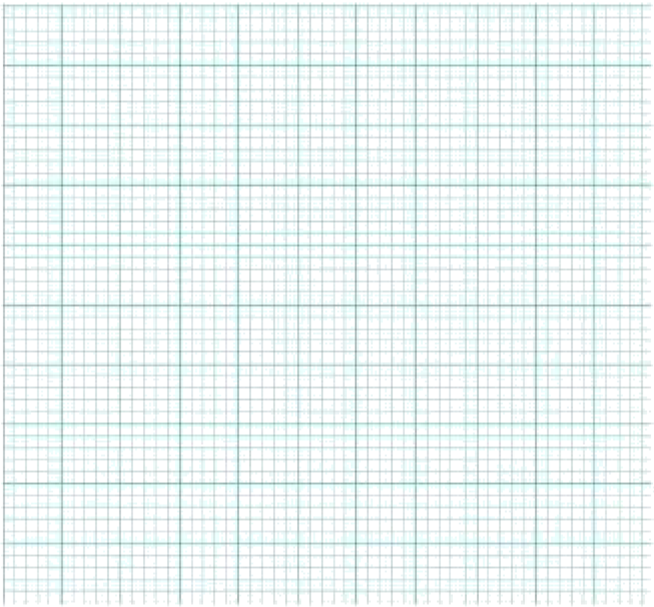


7. Increase the supply voltage E until V_R equals -0.1 V. Then measure V_D and record its voltage in table below. Calculate the value of the corresponding current I_D with the equation given in table.

V_R (V)	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8
V_D (V)								
$I_D = \frac{V_R}{R_{meas}} (mA)$								

V_R (V)	-0.9	-1	-2	-3	-4	-5	-6	-7	-10
V_D (V)									
$I_D = \frac{V_R}{R_{meas}} (mA)$									

8. Plot forward and reverse bias results together (V_D versus I_D only)



V_D versus I_D