Reverse Bias Characteristic of Photo-Diode

Object: To study the reverse bias characteristic of Photo-diode for different intensity of incident light on it.

Apparatus used: Photo-diode, voltmeter (0-10volt), mili-ammeter, variable DC source(0-10 volt), wires/leads.

Theory: ***Photo-Diode:*** It is a silicon or germanium PN junction diode which is photo-sensitive in reverse bias condition. i.e. The reverse current in a photodiode depends on the intensity of light falling on it or exposure of light. The application of this diode is in its reverse biased condition.

V-I characteristics: The voltage-current equation for photodiode is given by following equation.

$$I = I_0 (e^{V/\eta V_T} - 1) - I_P \qquad (1)$$

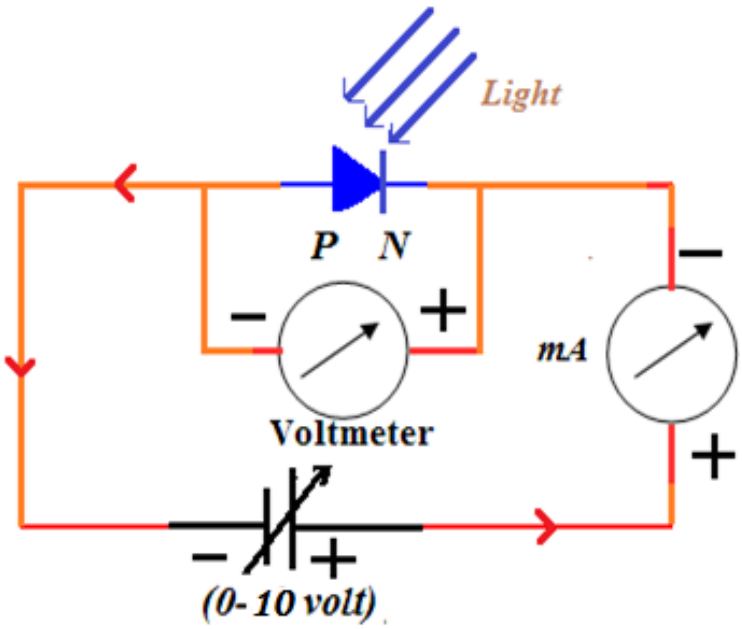
Here I_0 : reverse saturation current, V: applied potential to diode, V_T: voltage equivalent to temperature=KT/e, η:constant (=1 for Ge and 2 for Si), I_P: photo current.

When, V =(-)ve then $e^{V/\eta V_T} << 1$ hence equation (1) becomes as,

$$I_R = -I_0 - I_P \qquad (2)$$

Equation (2) indicates that in reverse biased photo-diode the total current is sum of reverse saturation current and photo-current. In absence of light, the photo-current becomes zero and the total current flowing through diode is equal to reverse saturation current. This current is known as ***dark current***.

Circuit Diagram:



Observation:

1. Least count of voltmeter= 0.1 V
2. Least count of ammeter= 0.02mA
3. *V_R and I_R at Intensity $I=0<I_1<I_2<I_3$*

Intensity I→	*I=0*		*I_1*		*I_2*		*I_3*	
Sr. No.	*V_R (Volt)*	*I_R (mA)*	*V_R (Volt)*	*I_R (mA)*	*V_R (Volt)*	*I_R (mA)*	*V_R (Volt)*	*I_R (mA)*
1.	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2.	*0.5*	*0.02*	*0.5*	*0.06*	*0.5*	*0.12*	*0.5*	*0.18*
3.	*1.0*	*0.04*	*1.0*	*0.12*	*1.0*	*0.24*	*1.0*	*0.36*
4.	*1.5*	*0.06*	*1.5*	*0.18*	*1.5*	*0.36*	*1.5*	*0.54*
5.	*2.0*	*0.06*	*2.0*	*0.20*	*2.0*	*0.40*	*2.0*	*0.60*
6.	*2.5*	*0.06*	*2.5*	*0.20*	*2.5*	*0.40*	*2.5*	*0.60*
7.	*3.0*	*0.06*	*3.0*	*0.20*	*3.0*	*0.40*	*3.0*	*0.60*
8.	*3.5*	*0.06*	*3.5*	*0.20*	*3.5*	*0.40*	*3.5*	*0.60*
9.	*4.0*	*0.06*	*4.0*	*0.20*	*4.0*	*0.40*	*4.0*	*0.60*
10.	*4.5*	*0.06*	*4.5*	*0.20*	*4.5*	*0.40*	*4.5*	*0.60*
11	*5.0*	*0.06*	*5.0*	*0.20*	*5.0*	*0.40*	*5.0*	*0.60*

Result: ***The following results can be written on the basis of photo-diode characteristic curve.***

(A) Since the reverse saturation current at zero intensity of light is 0.06mA=60μA. Thus dark current for photo diode is 60μA.

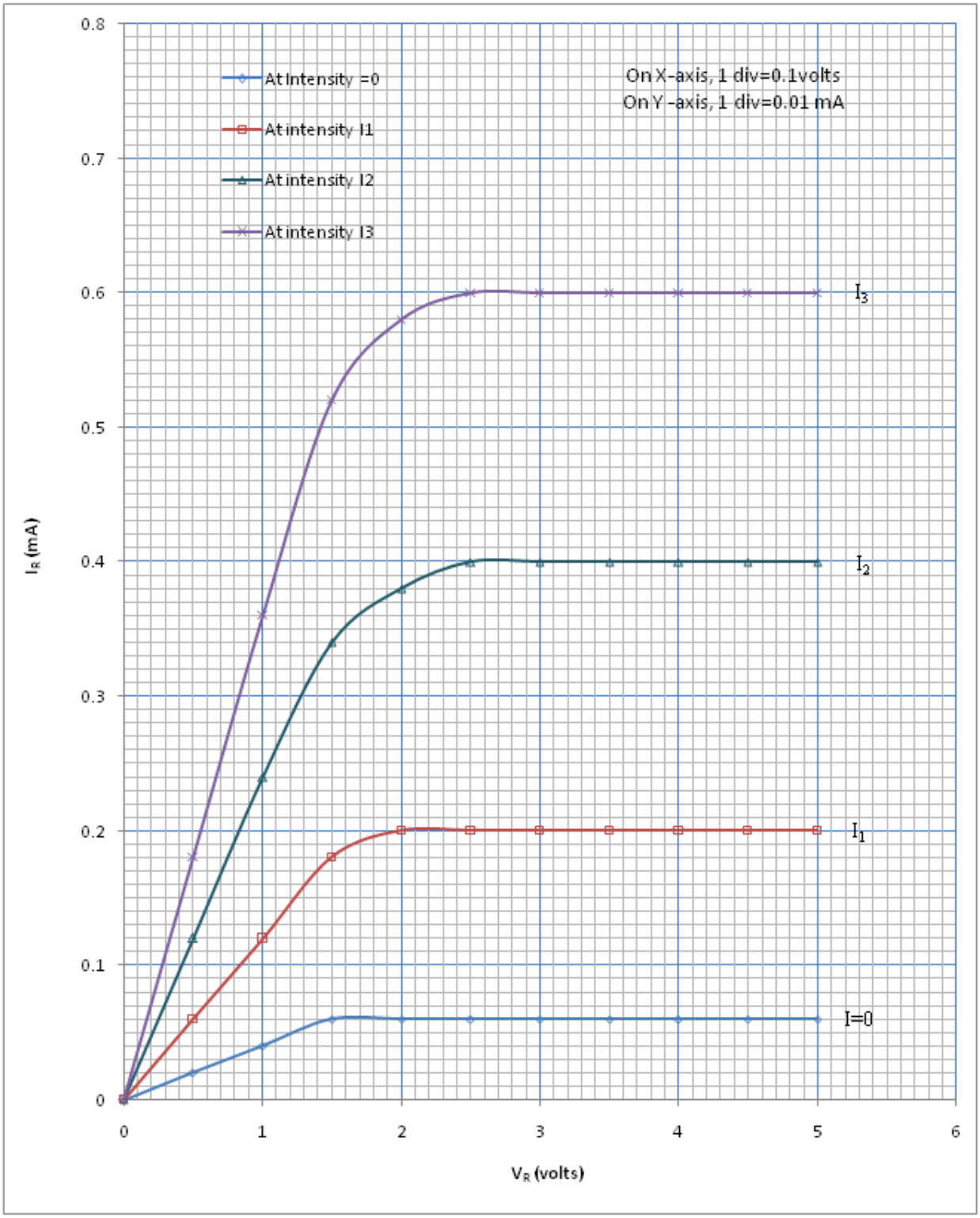
(B) The reverse bias current increases with increase in intensity of incident light. Due to increase in intensity of light, the number of photon incident per unit area per unit time increases. Therefore the photo-generation of charge carriers (electron-hole pairs) increases, hence the current increase.

(C) At fixed intensity of light, the reverse bias current increases initially but after few volts it becomes constant. The number of charge carriers generated at fixed intensity of light is fixed. Initially, the number of charge carrier crossing the junction increases with increase in reverse bias voltage, thus firstly, the current increases. When all the generated charge carrier are able to cross the junction and are involved for current flow then due to no increase in charge carrier flow per unit time, the current becomes independent of voltage.

Precautions:

1. The connection should be tight otherwise fluctuation in voltage and current will happen.
2. At the turning point of curve, more reading should be taken.
3. For the accuracy, current should be taken both in mA and μA..
4. The reading should be in multiple of least count.

Graph:


At Intensity =0
At intensity I1
At intensity I2
At intensity I3
On X-axis, 1 div=0.1volts
On Y -axis, 1 div=0.01 mA
I_3
I_2
I_1
I=0
I_R (mA)
V_R (volts)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
1
2
3
4
5
6