Experiment No. # 13

Object : *To study the characteristics of Light Emitting Diode (LED).*

Apparatus Required : Light Emitting Diode (LED), milliammeter or microammeter, voltmeter, 6 volt battery, rheostat, photo cell and connection wires.

Description of the Apparatus : (i) Light Emitting Diode : It is a forward biased P-N junction diode made up of gallium phosphide (GaP) or gallium arsenic phosphide (GaAsP) which emits visible light (red, green or yellow). In the forward biased,

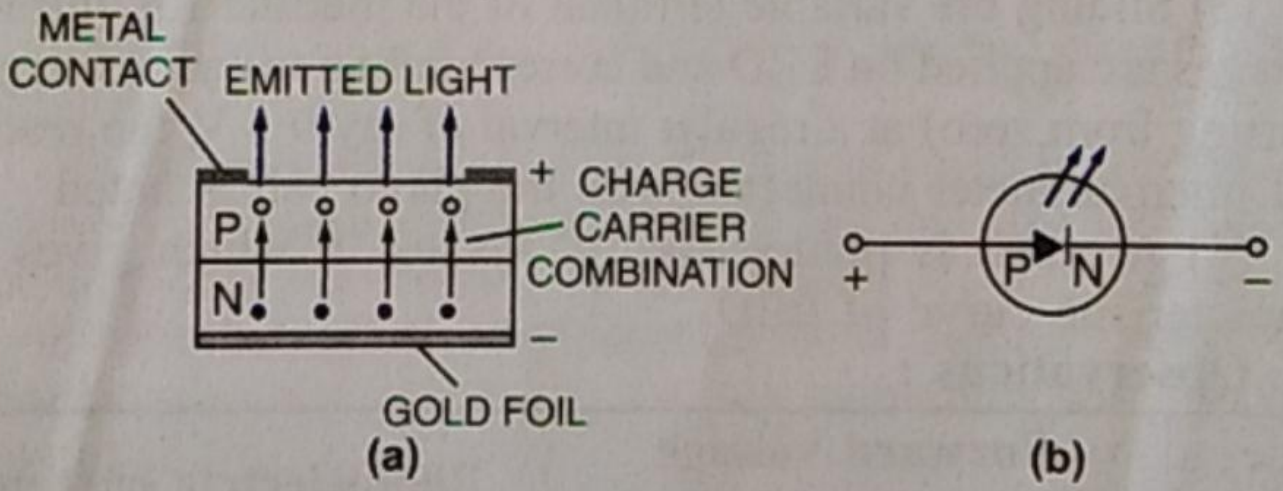

Fig. 41

when electrons from the 'N' side cross the junction, they combine with the holes on the 'P' side. Since, electrons on the 'N' side are in the higher conduction band while the holes on the 'P' side are in the lower valance band, therefore, during the recombination, the energy difference is given out in form of light. Fig. 41 (a) shows the working of LED. The symbol of LED is shown in Fig. 41 (b).

(ii) Photo cell : It is a device based on photo electric effect. When light of frequency greater than the threshold frequency

of its cathode, falls on cathode, electrons are emitted out by it which when reach anode, photoelectric current flows. The value of photoelectric current is directly proportional to the intensity of light falling on it.

Theory : When the forward bias voltage of a light emitting diode is gradually increased, first it does not operate at low voltage and then on further increasing the forward voltage, it begins to operate. Generally, a light emitting diode operates in the range of voltage 1·5 V to 3·3 V. The intensity of light emitted by LED can be measured by making the light emitted by it to fall on a photo cell connected with a microammeter. The microammeter measures the photoelectric current which is directly proportional to the intensity of light falling on the photo cell. Thus, the photoelectric current is measured for different forward voltage and a graph is plotted for the photoelectric current versus forward voltage which gives the characteristic curve of the given LED.

Procedure : (1) The light emitting diode and photo cell are placed inside a cardboard or wooden box with their terminals projected outside the box.

(2) The electric connections are made as shown in Fig. 42 in which a microammeter is connected across the photo cell and the light emitting diode is connected in the forward bias keeping its 'P' end connected to the positive terminal of the potential divider and 'N' end to the negative terminal. The voltmeter 'V' measures the forward bias voltage on LED, which can be varied by sliding the rheostat.

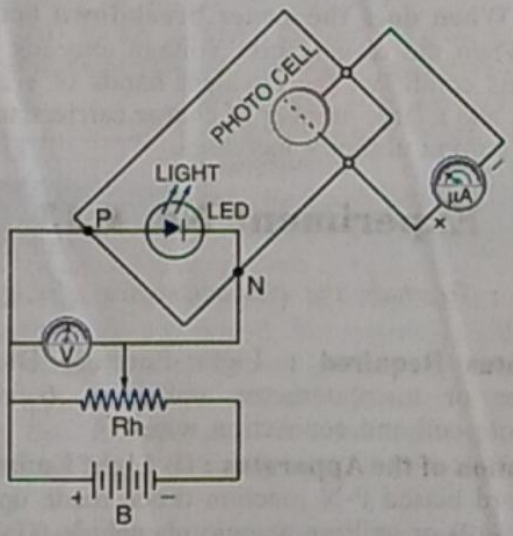

Fig. 42

(3) Sliding the variable terminal of the rheostat Rh, different voltages are applied on LED and corresponding to each voltage V (starting from zero) at a regular interval of say 0·5 V, the reading I of microammeter connected with the photo cell is noted.

(4) A graph is plotted for 'V' versus 'I' which gives the characteristic curve of LED.

Observations :

S.No.	Forward voltage applied on LED *i.e.*, voltmeter reading V (in volt)	Photoelectric current *i.e.*, ammeter reading I (in μA)
1.		
2.		
3.		
4.		
5.		
6.		

Graph : Taking the photoelectric current 'I' on Y-axis and the forward voltage 'V' on X-axis, a graph is plotted which is as shown in Fig. 43.

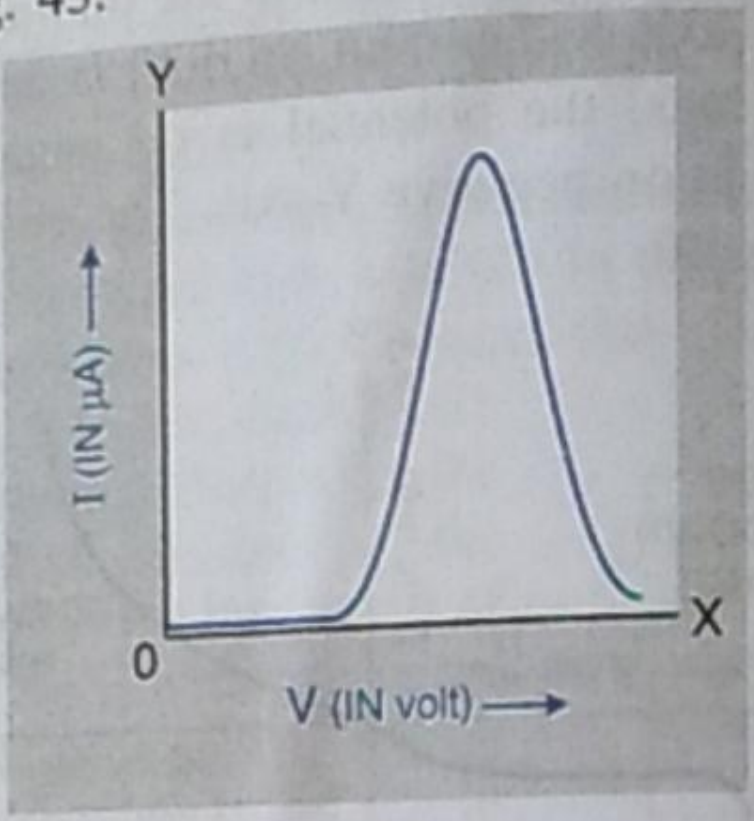

Fig. 43

Result : Fig. 43 shows the characteristic curve of a Light Emitting Diode (LED).

Precautions : (1) 'P' end of LED must be connected to the positive terminal of the battery and 'N' end to the negative terminal so that it is in the forward bias, otherwise in the reverse bias, LED may destroy.

(2) On the photo cell, no extraneous light must fall on the photo cell so it must be placed inside a box containing LED and a convex lens may be used to focus the light emitted by LED on the photo cell.

(3) The forward bias voltage on LED must be kept between 0 to 5 volt.

(4) The micrommeter used to measure the photoelectric current must be sensitive.