6

A photodiode is a circuit component used to convert a light signal into an electrical one. Fig. 6.1 shows an enlarged cross-section through a photodiode to illustrate how it is constructed.

Light incident on the thin transparent conducting surface layer of the diode passes through it to be absorbed in the insulating layer. The energy of each photon is sufficient to release one electron in the insulating layer. The potential difference *V*, applied across the insulating layer, causes these electrons to move to one of the conducting layers.

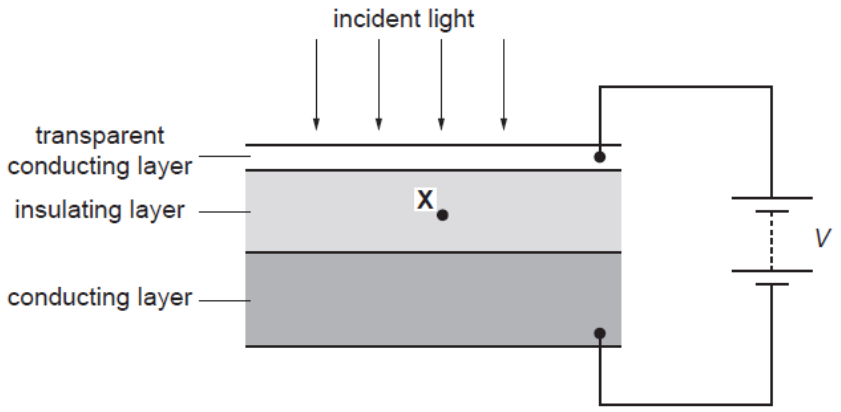

Fig. 6.1

In one particular application, red light of wavelength 6.33×10^{-7} m, from a helium-neon laser, is incident on the photodiode. The power of the laser beam is 1.0 mW.

(a)

Explain what is meant by a *photon.*

……..

…….[1]

(b)

Calculate the energy of one photon emitted by the helium-neon laser.

energy = ……..J [2]

(c)

Show that about 3×10^{15} photons are emitted by the helium-neon laser each second.

[1]

(d)

The energy level diagram of the neon atom is shown in Fig. 6.2.

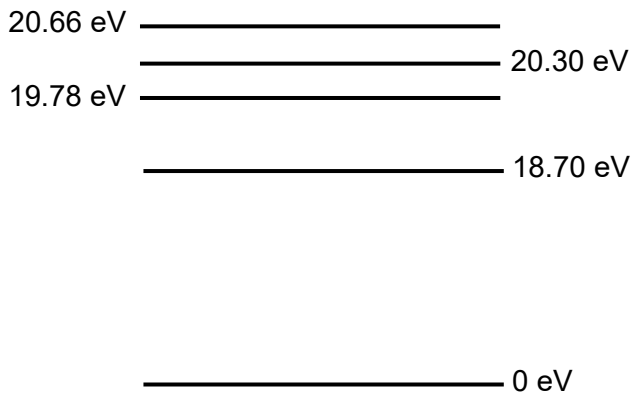

Fig 6.2

On Fig 6.2, draw an arrow to indicate the transition that gave rise to the photon of wavelength 6.33×10^{-7} m emitted by the helium-neon laser. [1]

(e)

(i)

On Fig. 6.1, draw an arrow to show the direction of motion of an electron released at point **X** in the centre of the insulating layer. [1]

(ii)

Experiments show that only 20% of the red light photons incident on the photodiode release electrons in the insulating layer.

Calculate the current through the photodiode.

current =…… A [3]

(iii)

Suggest one reason why the efficiency of the photodiode is less than 100%.

…….

…….

…….

.....[1]

[Total: 10]