NAME: _____ DATE: _____

IB Physics

12.1 THE INTERACTION OF MATTER WITH RADIATION

Class Lecture Examples

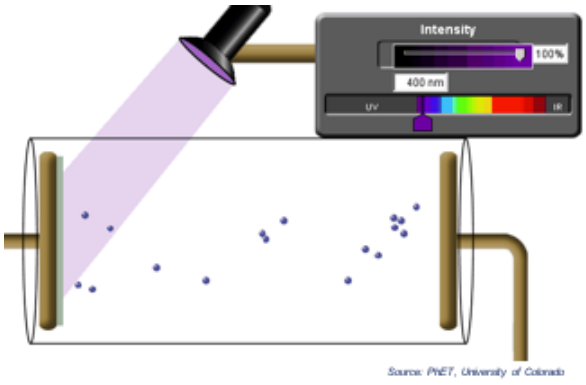
EXAMPLE 1

In converting electrical energy into light energy, a 60.0 W incandescent light bulb operates at about 2.10% efficiency. Assuming that all the light is green light (vacuum wavelength = 555 nm), determine the number of photons per second given off by the bulb.

EXAMPLE 2

If a photoemissive surface has a threshold wavelength (λ_0) of 0.65×10^{-6} m, calculate:

a) its threshold frequency f_0.



b) its work function φ in both Joules and electron volts.

c) the maximum speed of the e^-s emitted by violet light of $\lambda = 4.0 \times 10^{-7}$ m.

EXAMPLE 3

Monochromatic light of intensity 4.0 W and wavelength 4.0×10^{-7} m falling on a photosurface whose critical frequency is 6.0×10^{14} Hz releases 10^{10} electrons per second.

a) What is the current collected in the anode?

b) If the intensity of the light is increased to 8.0 W, what will the current be?

c) If light of intensity 8.0 W and wavelength 6.0×10^{-7} m falls on this photosurface, what will the current be?

EXAMPLE 4

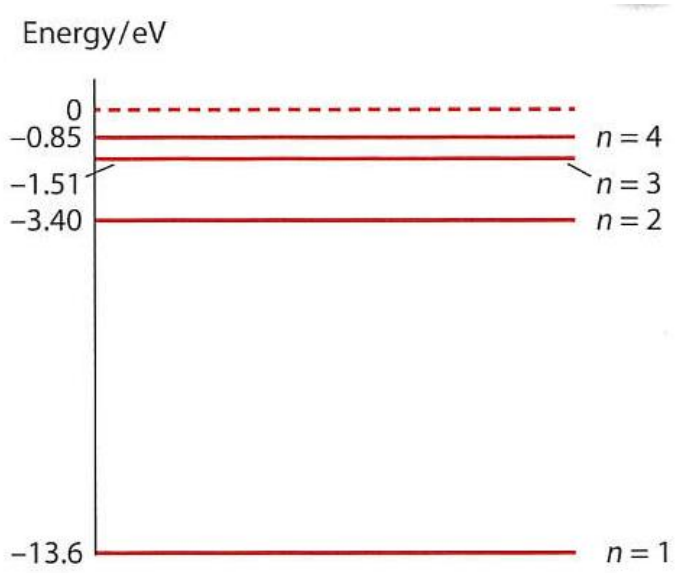
Find the de Broglie wavelength of an electron that has been accelerated from rest by a potential difference of 54 V.

EXAMPLE 5

Estimate the wavelength of a photon that can just produce an electron-positron pair, and explain why this is only an estimate, and not an entirely accurate result.

EXAMPLE 6

Verify the electron energy levels for n = 2 through n = 4 for atomic Hydrogen using the quantisation of angular momentum.



Source: Physics for the IB Diploma, Hamper

EXAMPLE 7

Before Bohr, Johann Balmer (1825-1898) deduced experimentally that the photons emitted in transitions from a level n to a level n = 2 of hydrogen have wavelengths given by:

$$\lambda = \frac{Bn^2}{n^2 - 4}$$

where B is a constant. Justify this formula on the basis of the Bohr theory for hydrogen and find an expression for the constant B.

EXAMPLE 8

Show that the Bohr condition for the quantisation of angular momentum is equivalent to $2\pi r = n\lambda$ where λ is the de Broglie wavelength of the electron and r the radius of its orbit.

EXAMPLE 9

A very fine beam of electrons with a speed 10^6 ms^{-1} is directed towards a slit with an opening of 10^{-10} m. Electrons are observed on a screen at a distance of 1.0 m from the slit. Estimate the length on the screen where 'appreciable' numbers of electrons will be observed.

EXAMPLE 10

In the decay $\rho^0 \rightarrow \pi^+ + \pi^-$

the uncertainty in the energy released is 153 mEv. Calculate the expected lifetime of the ρ^0 meson and hence identify the interaction through which the decay takes place.