Photons and the Photo-Electric Effect

**Reviewing Waves:**

v = fλ

v = c = speed of light = 3.00 x 108 m/s

f = frequency (Hz)

λ = wavelength (m) 1 nm = 1 x 10-9 m



**Photon Theory:** Light is made of particles.

 

E = Photon energy (Joules)

h = Planck’s constant = 6.626 x 10-34 Js

f = frequency of oscillations (Hz, s-1)

c = speed of light = 3.00x108 m/s

λ = Wavelength in m

Example 1: What is the energy (in eV) of a 460. nm photon?

Example 2: A photon has an energy of 13.6 eV. What is its wavelength?

|  |  |  |
| --- | --- | --- |
|  | **Wave Model** | **Photon Model** |
| **Color:** | **Wavelength changes**FG11_26Small λ = Blue FG11_26Big λ = Red  | **Energy per photon changes** (E = hf = hc/λ)High E = Blue/UV/X-raysLow E = Red/Microwaves/radio |
| **Brightness:** | **Amplitude Changes**Bright = bigFG11_26FG11_26Dim = small | **# of Photons changes**Bright = manyDim = few |

**Photo-Electric Effect** – Electrons being ejected from a metal by light.

Photon Energy = Work + Kinetic Energy

hf = φ + Emax

φ - Work function (Depends on material)

hf – photon energy

Emax – max KE of photoelectrons

(= eVs) – where Vs is the stopping potential

Example 1: A certain metal has a work function of 3.25 eV. When light of an unknown wavelength strikes it, the electrons have a stopping potential of 7.35 V. What is the wavelength of the light?

Example 2: 70.9 nm light strikes a metal with a work function of 5.10 eV. What is the maximum kinetic energy of the ejected photons in eV? What is the stopping potential?

Differing predictions:

|  |  |  |
| --- | --- | --- |
| Model | Photoelectron energy depends on: | Photoelectron energy is independent of: |
| Wave |  |  |
| Photon |  |  |