Q- Light from a laser hits the surface of cesium, with minimum photon energy of 2.5 eV being required to remove photons. When the surface of cesium is illuminated with this light photoelectrons are emitted with a max kinetic energy of 0.75eV. What would be the energy and the wavelength of the photons comprising the beam of light from the laser?

Reading:

When light of sufficiently large frequency incident on the metal plate, the emission of electrons from the surface of metal takes place. This phenomenon is called photoelectric effect. For every metal there is a cut off frequency called threshold frequency bellow that no emission of electrons takes place.

The energy of photon of light is directly proportional to the frequency of light hence energy of photons of the light increases with the frequency. If the frequency of light is smaller than threshold frequency, the photons are not having sufficient energy to extract electrons from the surface of that metal. This minimum energy required to extract electron from the surface of metal is called work function.

The energy of photons is given by E = h*ν where h is Plank constant and ν is the frequency of the light.

If the frequency of photons is more that the threshold frequency, the additional energy given to the electrons remains with them in form of their kinetic energy

The Einstein's equation of photoelectric equation is relating the kinetic energy of emitted electrons, the work function ϕ of the surface and the energy of incident photon hν as

$$h\nu - \phi = \frac{1}{2}mv^2$$

Or $$\frac{hc}{\lambda} - \phi = \frac{1}{2}mv^2$$ [speed of light c = $\nu\lambda$]

Where h is the plank's constant, λ is the wavelength of light incident and (1/2)*mv^2 is the maximum kinetic energy of emitted electrons.

Solution:

In our problem the work function of the surface is ϕ = 2.5 eV

Maximum kinetic energy of emitted photoelectrons ½ mv^2 = 0.75 eV

Hence using Einstein's equation the energy of incident photon is given by

$$h\nu - \phi = \frac{1}{2}mv^2$$

Or $h\nu = \phi + \frac{1}{2}mv^2$ = 2.5 + 0.75 = **3.25 eV**

Substituting the value of plank's constant h in above result, the frequency ν of the incident laser can be given as

ν = 3.25/(4.14x10^{-15}) = 7.85*10^{14} Hz (h = 4.14*10^{-15} eV.s)

And the wavelength of the laser will be

λ = c/ ν

Or λ = 3*10^8/(7.85*10^{14}) = 3.82*10^{-7} m = 382 nm