Introduction to Quantum

Quantum physics comes from the realization that through careful experimentation and observation, there are fundamental quantities of energy, charge, mass rather than an infinitely small continuum.

light comes in discrete packages of energy called photons and that there is a fundamental charge in electricity.

Quantum Theory

is the basis of modern physics that explains the behavior of matter and energy at the atomic and subatomic levels.

Currently we have yet to fully reconcile quantum theory (universe at the very small things) to general relativity (applies to big systems)

light is both a wave form but has a particle nature

it turns out that matter also has a particle and a wave nature. the smaller the particle, the more significant the wave nature.

Electron Interference

Double and single slit experiments have been done using electrons and the same interference are seen even though electrons are matter.

Work function

As scientists explored they came to understand more about the nature of the atom. It was discovered that there is a minimum energy required to remove an electron from a metal substance. This minimum energy is the work function. It was also found that

$$W = e\Delta V$$

different metals have different work function. This is due to the differences in the atomic makeup of the material. measured in electron volts

If a photon has sufficient energy it can knock out an electron.

It is shown that the energy required to get a electron to be emitted from light by the metal plate had a minimum frequency of light therefore the electron is emitted

Einstein figured out that the energy of the photon was the limiting factor in getting electrons emitted from the metal.

$$E = hf = \frac{hc}{\lambda}$$

The kinetic energy of an emitted electron can be determined by taking the energy of the photon and subtracting the work function of the material

$$E_{k(electron)} = Ef_{photon} - W_{material}$$

what is the kinetic energy of an electron released from a copper plate hit with 275 nm light?

$$E_{k(electron)} = Ef_{photon} - W_{material}$$

$$f = \frac{c}{v} = 1.091 \times 10^{15} Hz$$
$$E_k = hf - 4.48(eV)$$

$$E_k = 6.473 \times 10^{-21} J$$

Light has momentum

where $ p=mv$ light which is massless, actually is shown to have momentum.

$$P_{photon} = \frac{hf}{c} = \frac{h}{\lambda}$$

light having momentum means that light exerts pressure on materials it hits. DUe to the fact that momentum must be conserved. it means that light pushes on objects. And thus solar sails can be used in space, and radiometers can be used to measure the intensity of light.

what is the energy and momentum of each photon that a 375 nm laser emits?

practice questions

601 for work functions

- 597 q1-6
- 604 q11-15
- 608 q19-22