

Quantum Physics - The Photoelectric Effect

A Physics

The basic idea

gas. →

photon

energy $E = hf$

velocity v m/s

work function, Φ Joules

① all photon energy given to electron - photon ceases to exist.

② a certain minimum energy is needed, just to extract the electron from the metal, this is the work function.

③ whatever photon energy is left over, gives the electron kinetic energy.

$c_{light} = 3 \times 10^8$ m/s

$h_{planck} = 6.6 \times 10^{-34}$ Js

$m_{electron} = 9.1 \times 10^{-31}$ kg.

1. So photon energy = work function (Φ) + max. electron k.e.

In practice, the emitted electrons have a range of speeds (k.e. values), because ...

(a) the work function, Φ , is the minimum energy needed to extract the electron, and it may need more

(b) some electrons are slowed by collisions with gas molecules

2. There is a minimum frequency (f_0) below which the photon does not have enough energy to extract the electron.

$$hf_0 = \frac{hc}{\lambda_0} = \Phi \quad \text{— just extract electron, no more}$$

Threshold — λ_0

3. Different metals have different work functions, and hence different threshold frequencies

4. Photoelectric emission will only occur if the photon energy (frequency) is big enough. After that, making the light brighter, only increases the number of emitted electrons, their maximum speed is the same.