

Ch. 7 Problem 1

Maximum speed of photoelectron is $2.00 \times 10^5 \text{ m/s}$.

- a) What is KE? Note we can treat this classically (or rel) since the electron is moving slowly compared to the speed of light.

$$\begin{aligned} KE &= \frac{1}{2} m v^2 \\ &= 1.822 \times 10^{-20} \text{ J} \\ &= 0.114 \text{ eV} \end{aligned}$$

$$m = 9.11 \times 10^{-31} \text{ kg}$$

Absolutely know how to convert quickly

Also note that this is classical since the $KE \ll E_0$ which is 0.511 MeV

- b) Stopping potential is simply $V(\text{stop}) = 0.114 \text{ Volts}$ ($q\Delta V = \Delta PE$)
c) And why non rel---slow, or KE small compared to rest energy

Problem 7.2

Given frequency of $8.0 \times 10^{14} \text{ Hz}$, and intensity of 0.100 nW/m^2 , How many photons cross a square meter each second.

$$\begin{aligned} I_{\nu} &= 1.0 \times 10^{-10} \text{ W/m}^2 \\ &= \left(h\nu \frac{\text{J}}{\text{Photon}} \right) \left(\frac{\# \text{ Photons}}{\text{s m}^2} \right) \end{aligned}$$

$$\begin{aligned} \frac{\# \text{ Photons}}{\text{s m}^2} &= \frac{I_{\nu}}{h\nu} \\ &= 1.89 \times 10^8 \frac{\text{Photons}}{\text{m}^2 \text{ s}} \end{aligned}$$

Photon flux density

So, when we get down to detector sizes and picoWatts, we are talking about individual photons and slow count rates!!!!!!

7-7

Given a work function of 2.3eV, and frequency of 7.5E14Hz, determine the maximum KE of photoelectrons.

$$\phi = 2.3 \text{ eV}$$

$$\nu = 7.5 \times 10^{14} \text{ Hz}$$

$$KE_{\max} = h\nu - \phi$$

$$= 6.626 \times 10^{-34} \text{ J s} \times 7.5 \times 10^{14} / \text{s} - 2.3 (1.6 \times 10^{-19}) \text{ J}$$

$$= 1.29 \times 10^{-19} \text{ J}$$

$$= 0.81 \text{ eV}$$

$$= \frac{1}{2} m v^2$$

$$v = 5.32 \times 10^5 \text{ m/s}$$

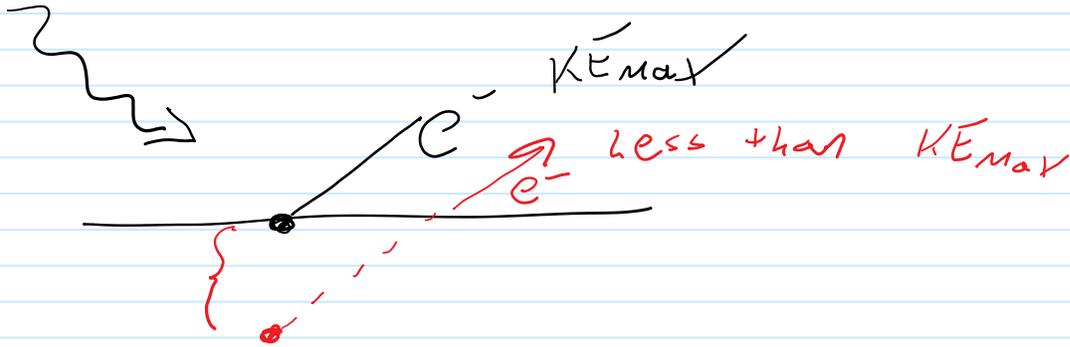
$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$= 4.136 \times 10^{-15} \text{ eV s}$$

7-9

Why do most photoelectrons have KE less than the maximum?

In either a classical or quantum picture we can consider there is extra energy required for "deeper" electron removal. Barrier penetration.



7-15

Given two stopping potentials and two frequencies, determine Planck's constant and work function.

Data:

$$V_{o_1} = 0.95 \text{ Volt} , \quad \lambda_1 = \frac{c}{313 \text{ nm}}$$

$$V_{o_2} = 0.35 \text{ Volts} \quad \lambda_2 = \frac{c}{369 \text{ nm}}$$

$$\frac{KE_{\max}}{eV} = h\nu - \Phi$$

↑
slope

$$\begin{aligned} \text{slope} &= \frac{(0.95 \text{ eV} - 0.35 \text{ eV})}{\frac{c}{313 \times 10^{-9}} - \frac{c}{369 \times 10^{-9}}} \times 1.6 \times 10^{-19} \frac{\text{J}}{\text{eV}} \\ &= 4.125 \times 10^{-15} \text{ eV s} \\ &= 6.6 \times 10^{-34} \text{ J s} \end{aligned}$$

Now use either point to get ϕ

$$\phi = 3.01 \text{ eV}$$