The Photoelectric Effect

The **photoelectric effect** is a phenomenon that occurs when light shone on a metal surface causes electrons to be emitted from the surface.
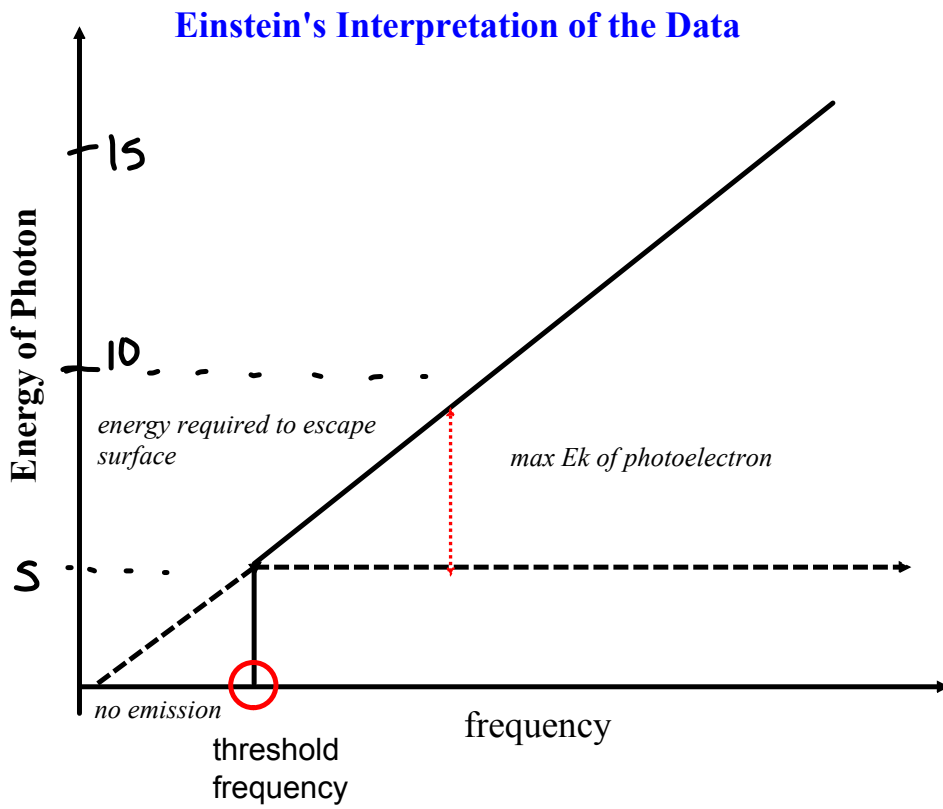
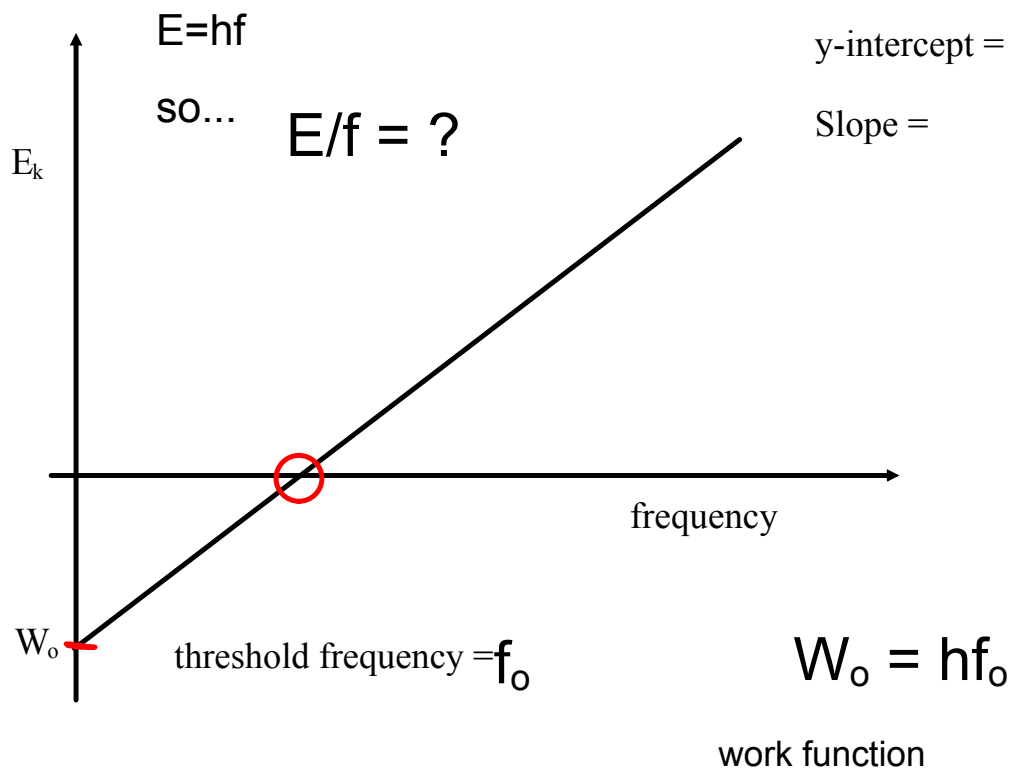First observed by Hertz, explained by Einstein

http://media.pearsoncmg.com/bc/aw_young_physics_11/pt2a/Media/ModernPhysics/1703PhotoEffect/Main.html

Einstein won the Nobel Prize in 1921 for his work on the Photoelectric Effect

Observations	Explanations
1) electrons are emitted immediately	1) absorption of photon is 'all-or-none" - only one photon is absorbed by each electron
2) brighter light gives more current more Intensity	2) brighter light means more photons, more photons free more electrons...more current
3) there is a threshold frequency below which no current flows (no matter how bright the light)	3) If frequency is too low, the photon does not have enough energy to dislodge an electron (Recall E= hf)
4) increasing frequency (above threshold frequency) gives electrons more kinetic energy	4) Increasing frequency increases energy (E=hf). If photons have more than enough energy an electron is dislodged and the excess energy is transformed into kinetic energy of that electron.

Einstein's Interpretation of the Data

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Energy of Photon

10

*energy required to escape
surface*

max Ek of photoelectron

S

no emission

frequency

threshold
frequency

E=hf

so...   E/f = ?

y-intercept =

Slope =

E_k

frequency

W_o ⊸

threshold frequency = f_o

$W_o = hf_o$

work function

Mathematics of the Photoelectric Effect

The minimum energy needed to free an electron = Work function W_o

so...

$$hf = Wo + (E_k)_{max}$$

Stopping Potential (V_{stop}) the voltage of the source can be increased so that the ejected electrons are stopped *(see simulation)*

This will happen when $EPE = E_k$

$qV_{stop} = E_k$ (no I flows)

Ex.1 A photoelectric surface has a work function of 2.00eV. What is the threshold frequency for this surface?

Ex.2 What is the stopping potential of an electron that has 7.30×10^{-19}J of kinetic energy?

Ex.3 Light with a frequency of 5.00×10^{14} Hz illuminates a surface with a work function of 2.10×10^{-19} J. What is the max kinetic energy of the ejected electrons?