PS Photoelectric Effect Sim Guide 2018

Name Key

The **photoelectric effect** can be explained in the following way: when light strikes a metal surface, the surface gives off electrons (scientists refer to these electrons as photoelectrons) and is considered a photosensitive surface.

The photoelectric effect is considered an example of the particle behavior of light because it cannot be explained by classical physics.

The Photoelectric Effect			
#	Idea	Classical Predictions	Experimental evidence
1	Whether electrons are ejected is dependent on...	The intensity of light	The frequency of light
2	The kinetic energy of ejected electrons depends on...	The intensity of light	The frequency of light
3	At low intensities, electron ejection...	Takes time	Occurs most instantaneously above a certain frequency

Directions:

1. Click on the following link: https://connexions.github.io/simulations/photoelectric-effect/#sim-photoelectric-effect
2. On the right side, select electron energy vs light frequency from the graphs menu. Remember, wavelength is related to frequency by c = λf. 1×10^{-9} m = 1 nm
3. On the left side of the screen, you can select your metal from the drop down menu. Start with Sodium.
4. To turn on the light, select the wavelength of light from the color slider and then slide the intensity up from 0%.

Questions:

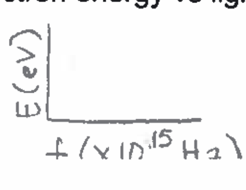
1. What wavelengths cause photoelectrons to be emitted for sodium, zinc, copper, platinum, and calcium. What frequency range does this correlate to?

Material	Wavelength Range (short λ – long λ)	Frequency Range (high f – low f)
Sodium	100 nm – 538 nm GBIV UV	3.0×10^{15} Hz – 5.58×10^{14} Hz
Zinc	100 nm – 287 nm UV	3.0×10^{15} Hz – 1.05×10^{15} Hz
Copper	100 nm – 261 nm UV	3.0×10^{15} Hz – 1.15×10^{15} Hz
Platinum	100 nm – 193 nm UV	3.0×10^{15} Hz – 1.55×10^{15} Hz
Calcium	100 nm – 426 nm BIV UV	3.0×10^{15} Hz – 7.04×10^{14} Hz

??? 100 nm – 332 nm UV 3.0×10^{15} Hz – 9.04×10^{14} Hz

2. How does your measured frequencies compare with the electron energy vs light frequency graph?

When f ↑ ⇒ E ↑ as well



3. The threshold frequency is the minimum frequency of light that will cause the material to emit. What is the threshold frequency for each of the materials?

Material	Threshold Frequency
Sodium	5.58×10^{14} Hz
Zinc	1.05×10^{15} Hz
Copper	1.15×10^{15} Hz
Platinum	1.55×10^{15} Hz
Calcium	7.04×10^{14} Hz

↑f = ↑E & speed of e-
↑I = ↑ # e-

4. Explore the three ideas listed above and compare the classical predictions to the experimental evidence. Does your exploration support what is listed at the experimental evidence? Describe how you tested the three ideas above and the evidence you found:
   a. Idea 1: Changing the intensity did not cause e- emission. Only when the threshold f was reached did e- emission occur.
   b. Idea 2: Changing the intensity not affect the KE of e-, but the f did. ↑f = ↑KE
   c. Idea 3: As long as the f threshold is reached, e- emission occurred immediately.

5. What effect does changing the intensity have? Does it change your electron energy? ~~The current measured?~~

If the freq of EM waves is higher than the threshold freq then ↑ light intensity will ↑ the # of e- emitted (but not v). If the freq threshold is not reached, the intensity does nothing.

6. The photoelectric effect is used in many applications today. Look up three different uses for the photoelectric effect and explain how it's used.
   a. Solar energy which is produced by photovoltaic cells. These cells are made of semi-conducting material which produce electricity when exposed to sunlight. (solar powered calc or satellit that orbits Ear
   b. Photo-multiplier tubes - convert sm. intensities of light to electrical currents that can be analyzed. The e- hit CCD (charged coupled device) where they are stored, processed, and an image is read.
   c. Automatic Garage Door safety feature - as long as the beam of light strikes the photocell, the photoelectric effect generates e- to produce current. If someone blocks it, the current is interrupted & door opens up

Intrusion alarms is similar