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LAB. PHOTOELECTRIC EFFECT

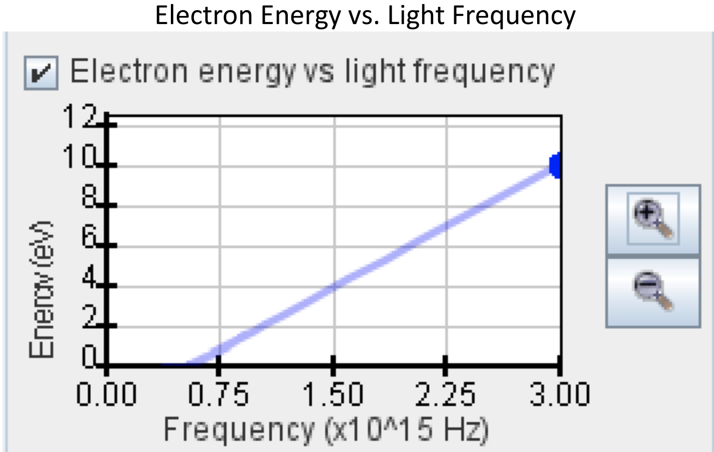
AP PHYSICS II

Driving Question | Objective

The Electromagnetic radiation can only give electrons energy at certain frequencies. Let's create a graph that interprets this relationship. You can access the lab at https://phet.colorado.edu/en/simulation/photoelectric

1. With the intensity of the light fixed at maximum, what happens to the electron energy as the frequency is varied? You can vary the frequency of light by adjusting the wavelength of the incident light. What does this Electron Energy vs. Light Frequency graph look like?

Electron Energy vs. Light Frequency



a) With the Target set to Sodium, around what frequency of light does the photoelectric effect cease?

555,171,218 MHz

b) Does changing the intensity of light affect this graph? If so, how?

No

c) The minimum amount of electromagnetic energy to free an electron is called the **work function** and is directly related to the frequency of light. $E_{photon} = hf$, where h is Planck's Constant: $h = 6.63 \times 10^{-31} \frac{m^2 \cdot kg}{s} = 4.14 \times 10^{-15} eV \cdot s$. What is the work Function of Sodium, in eV?

E = $4.14 \times 10^{-15} eV \cdot s$ (555,171,218 MHz) = 2.298 eV

d) This was only tested using a surface of Sodium. What happens if you change the material? Do this with the drop-down menu at the top right corner of your window. How would you rank their work functions of each of these materials?

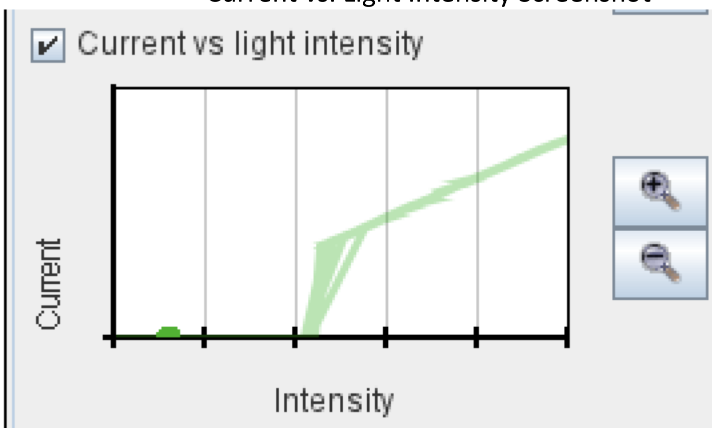
The speed changes as the material changes. The current only changes when the material is platinum. Since the speed is changing.

The speed of platinum decreases so the frequency decreases which means that the work decreases as well because $E= hf$

Sodium = Calcium = Zinc = Copper > Platnium

2. Next, what is the relationship between current and light intensity at a given frequency? Set the frequency to one which satisfies the work function and emits photoelectrons from whatever surface you are testing. What does this graph look like as you vary the light intensity?

Current vs. Light Intensity Screenshot

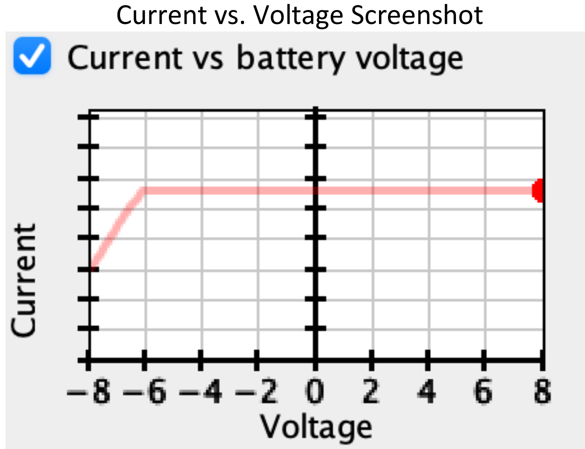


   a. Does changing the frequency affect this graph? If so, how?

Yes, a shorter frequency decreases the slope.

3. Lastly, what will happen if we apply a potential difference across our parallel plates? Does this affect the current in the circuit? With a given frequency that satisfied the Work Function of the metal you chose, begin to vary the potential difference of the *emf* source. What does this graph look like?

Current vs. Voltage Screenshot



   a. Is there a “stopping voltage” in which the no electrons traverse to the other side of the parallel plate (or V_{stop})?

Yes, it’s -7 for sodium.

   b. Is there anything you can do to change the value of this stopping voltage?

We can change the wavelength.

   c. Why do you think the graph looks the way it does after crossing the y-axis?

It flattens out because it reaches the max current. After a certain point increasing the voltage will have no impact.