# Photoelectric Effect Simulation

Purpose:

We will study the photoelectric effect using computer stimulation. In particular we will look at the dependence on the kinetic energy with frequency and intensity.

Procedure:

1. Google "PhET" and click on the first search result. This should take you to the homepage of the Physics Education Technology. Alternatively you can enter the following address to the web browser directly:
http://www.colorado.edu/physics/phet/web-pages/index.html
2. Click on "Simulations" and then choose from the tabs on the left "Quantum Phenomena". Scroll down to the "Photoelectric Effect" simulation, double click it to start the program. You should see something similar to the screenshot in Figure 1.
3. Choose the same options in the right hand side as the screenshot below. Play with the program a little bit to get a feel for its operation. You can adjust the beam intensity (the first bar in the "Beam Control"), the wavelength of the light coming out of the flashlight, as well as the external potential across the two plates.
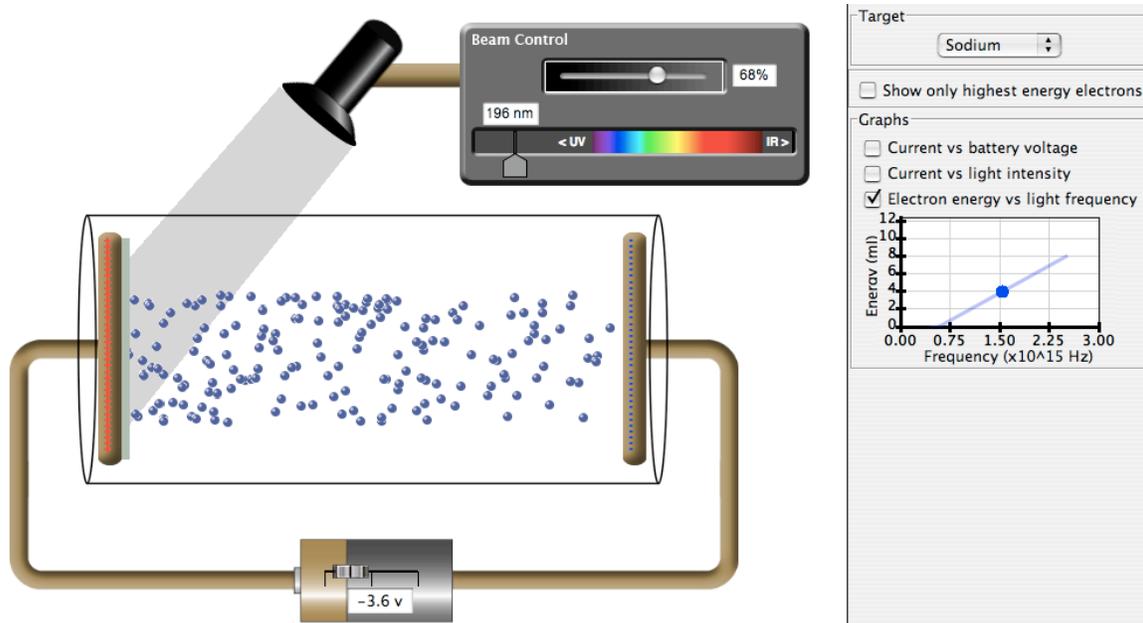
Figure 1

4. You will notice that when the voltage is very negative, electrons cannot reach the right. The absolute value of the voltage that is just able to stop even the most energetic electrons is called the "stopping potential", V_{stop} . You can find the stopping potential most easily by turning on the "Show only highest energy electrons" and adjust the potential so that the electrons <u>almost touch the plate</u> on the right before turning back. You will need to fine adjust the potential carefully to get an accurate reading. The kinetic energy of the most energetic electron K_{max} is given by eV_{stop}. Does the intensity affect K_{max}? _____

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5. Try seven different wavelengths for sodium. Record the stopping potential in Table 1 below. Remember that the frequency is related to the wavelength by $c = f \lambda$. **Make sure you include the cut-off frequency**, at which electrons are not released and the stopping potential is exactly zero.

Table 1

	λ (nm)							
Sodium	$f (10^{14} Hz)$							
	V_{stop} (V)							
	λ (nm)							
Zinc	$f (10^{14} Hz)$							
	V_{stop} (V)							
	λ (nm)							
Copper	$f (10^{14} Hz)$							
	V_{stop} (V)							
	λ (nm)							
Platinum	$f (10^{14} Hz)$							
	V_{stop} (V)							
	λ (nm)							
Magnesium	$f (10^{14} Hz)$							
	V_{stop} (V)							

6. Repeat the above measurements for the other four materials.
7. Plot K_{max} versus f for different materials **on the same graph**. The y-axis should be in the unit of eV and the x-axis should be in $10^{14} Hz$.
8. Find the slopes of the lines. Note that the unit of the slope plotted using the units specified here would be $\dfrac{eV}{10^{14} Hz}$. Do they all have the same slope? _____

9. Using $K_{max} = hf - \Phi$ and $\dfrac{eV}{10^{14} Hz} = 1.6 \times 10^{-33} Js$, find the value of the Planck's constant in Js and the work function of the metal inside the device in eV. Note that h and Φ are related to the slope and the y-intercept of the graph you plotted.