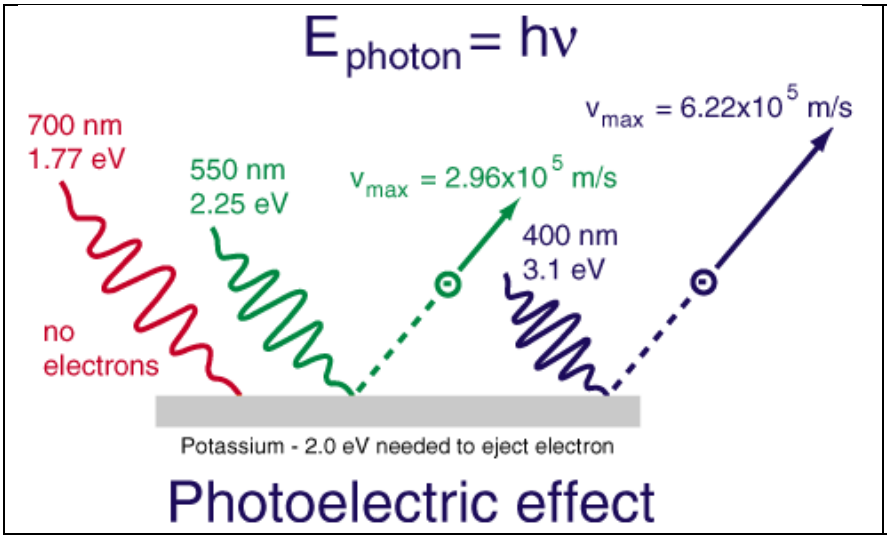
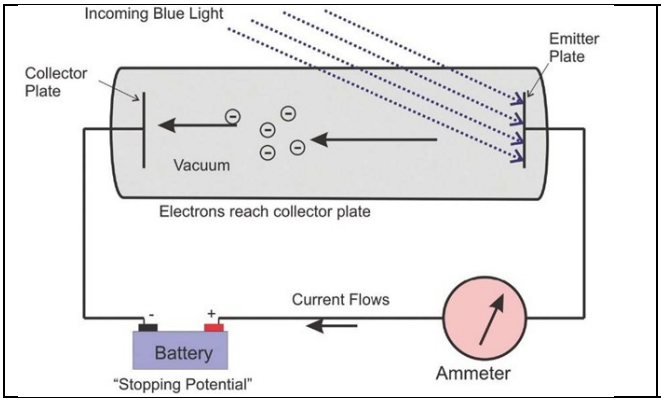
Photoelectric Effect https://phet.colorado.edu/en/simulation/legacy/photoelectric



$\nu = c/\lambda$ $c = 3.00 \times 10^8$ m/s
$h = 6.626 \times 10^{-34}$ J sec
1 J = 1 Nm, 1 N= kgm/s^2

The Photoelectric Effect is the observation that many metals emit electrons when light shines upon them. For chemists, the Photoelectric Effect provides information about how much energy is required to remove an outermost electron in a metal atom.



When a "packet of energy" strikes an electron at the surface of a metal, the electron absorbs all of the energy. Some of the energy is used to overcome the *binding energy* of that electron and some of the energy is used to impart kinetic energy to the ejected electron. Remember, the Law of Conservation of Energy applies. The kinetic energy of an ejected electron can be measured using an electron energy analyzer.

$KE_{\text{ejected electron}} = h\nu_{\text{incoming energy}} - \Phi$ where Φ is the *binding energy* of an electron, also known in physics as the work function.

According to classic physics wave theory, a) when dim light is shined on a metal surface there should be a delay in time until the emission of electrons and b) only the intensity of light, not the wavelength, affects the emission of electrons. GOTO the PHET Computer Simulation URL.

1. What actually happens in a photoelectron experiment? Watch the computer simulation. First experiment. The metal selected is _____. A. Starting with red light, as the frequency increases, at what frequency do electrons start to be ejected? _____ This is called the threshold frequency, which is the incoming energy. Calculate the energy of this light, E = hv, in units of Joules.

B. As the frequency of light increases, what happens to the speed of the ejected electrons?

C. Does the number of ejected electrons increase, decrease or stay the same when the frequency of light above the threshold energy increases with the same intensity

D. Does the number of electrons increase, decrease or stay the same when the frequency of light above the threshold energy is kept constant, and the intensity of light increases?

2. Repeat the experiment using a different metal. The metal selected is _____.

A. Threshold frequency _____sec^{-1}. Energy = _____ J

B. Speed of the ejected electrons _____

C. Number of electrons _____ when the frequency of light above the threshold energy increases, keeping the intensity of light the same.

D. Number of electrons _____ when the frequency of light above the threshold energy is kept constant, and the intensity of light (brightness) increases.

3. For each of the above metals, is there a delay in time when the threshold frequency of light is activated, keeping the intensity low (dim light)? Is there a delay in time using a higher frequency, low intensity light shining on the metal?

4. Explain how the results of a photoelectric experiment leads to Einstein's idea that light must be quantized (light behaves a packet or a particle).

5. Do your calculations above support the relationship that when $KE_{\text{ejected electron}} = 0$, $h\nu_{\text{incoming energy}} = \Phi$? Table 1. Work functions for various metals.

sodium	3.65×10^{19} J
zinc	6.89×10^{-19} J
copper	7.53×10^{-19} J
platinum	1.02×10^{-18} J
calcium	4.6×10^{-19} J