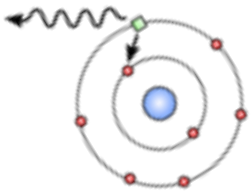
Name_____Pd_____

The Photoelectric Effect in Practice

1. Calculate the energy of a photon of blue light that has a wavelength of 450 nm in both eVs and Joules.



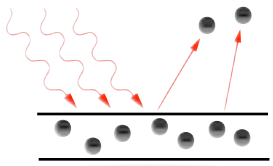
$\Delta E = hc/\lambda$

$\Delta E = (1.24 \cdot 10^{3})/(450) = 2.76$ eV

and $\Delta E = (1.99 \cdot 10^{-25})/(450 \cdot 10^{-9}) = 4.42 \cdot 10^{-19}$ J

2. When a photon with a greater frequency than the threshold frequency is incident upon an atom, the excess energy becomes the kinetic energy of the electron. This is equal to the difference between the energy of the photon and the work function of the atom. If the light has less energy than that amount, an electron will not be ejected/emitted/released from the atom.

3. Ultraviolet light of wavelength 350 nm hits a metal plate with a work function of 12.3 eV. Determine the kinetic energy (in eV) of the electrons released from the metal.



$\Delta E = hc/\lambda$

$\Delta E = (1.24 \cdot 10^{3})/(350) = 3.54$ eV

No electrons will be released; they need an additional 8.76 eV to be ejected.

4. Electrons with a kinetic energy of $3.4 \cdot 10^{-19}$ J are released from a plate of copper (ϕ=4.7 eV). What were the wavelength, frequency, and speed of the incident photons? 2.125 eV

$E_{ph} = \phi + E_K = 4.7 + 2.125 = 6.825$ eV

$6.825 = hf$

$f = 1.65 \cdot 10^{15}$ Hz

$v = f\lambda$

$3 \cdot 10^{8} = 1.65 \cdot 10^{15}\lambda$

$\lambda = 1.82 \cdot 10^{-7}$ m

$v = 3 \cdot 10^{8}$ m/s

5. How many green photons with a wavelength of 540 nm are required to have a total energy of 1 Joule?

$\Delta E = hc/\lambda = (1.99 \cdot 10^{-25})/(540 \cdot 10^{-9}) = 3.685 \cdot 10^{-19}$ J

$1 \text{ J} / (3.685 \cdot 10^{-19} \text{ J/photon}) = 2.72 \cdot 10^{18}$ photons

6. Determine the **maximum** wavelength of light that will produce the photoelectric effect for platinum (ϕ=6.35). What do you think this wavelength is called?

$\phi = hc/\lambda_o$

$\lambda_o = (1.242 \cdot 10^{3})/(6.35) = 195.6$ nm

This is the threshold wavelength

7. Automatic flushing toilets use the photoelectric effect. When there's a change from darkness to light, they flush automatically! Most AFTs use reflected light of a 950 nm wavelength to trigger the flush. The site of one manufacturer says they use titanium as the sensing element. Find the work function of the metal needed for the 950 nm light to set off the flushing toilet's circuit, then find the work function for titanium (WEB TIME). Does the company use pure titanium for its flushing circuitry?

$\phi = hc/\lambda_o$

$\phi = (1.242 \cdot 10^{3})/(950) = 1.307$ eV

$\phi_{Ti} = 6.83$ eV [www.nist.gov] So, it's not pure titanium