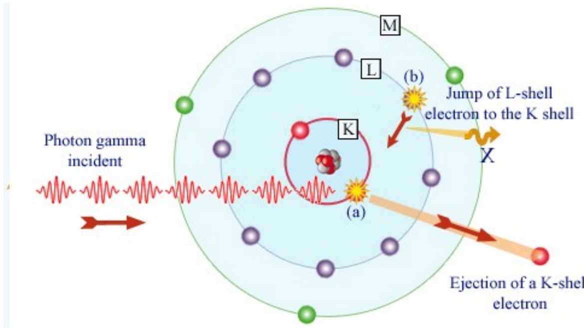
Physics 12-05 Photoelectric Effect **Name: ______________**



- When a photon of light hits an ___________, the electron absorbs the energy and jumps to a higher ___________
- If the photon has enough ___________, the electron can completely leave the atom
- If there is a wire for the electrons to move through, then there will be a ___________
- This the is ______________________effect
- Energy of photon from photoelectric effect is ___________

1. For a given material, there is a threshold frequency f_0 for the EM radiation below which ___________electrons are ejected, regardless of intensity. Using the photon model, the explanation for this is clear. Individual ___________interact with individual ___________. Thus if the energy of an individual photon is too low to break an electron away, no electrons will be ejected. However, if EM radiation were a simple wave, sufficient energy could be obtained simply by increasing the ___________.
2. Once EM radiation falls on a material, electrons are ejected ___________delay. As soon as an individual photon of sufficiently high frequency is ___________by an individual electron, the electron is ejected. If the EM radiation were a simple wave, several ___________would be required for sufficient energy to be deposited at the metal surface in order to eject an electron.
3. The number of electrons ejected per unit time is proportional to the ___________of the EM radiation and to no other characteristic. High-intensity EM radiation consists of large numbers of photons per unit area, with all photons having the same characteristic energy, *hf*. The increased number of photons per unit area results in an increased number of electrons per unit area ejected.
4. The maximum ___________energy of ejected electrons is independent of the ___________of the EM radiation. Instead, as noted in point 3 above, increased intensity results in more electrons of the same energy being ejected. If EM radiation were a simple wave, a higher intensity could transfer more energy, and ___________-energy electrons would be ejected.
5. The kinetic energy *KE* of an ejected electron equals the ___________energy minus the ___________energy *BE* of the electron in the specific material. An individual photon can give all of its energy to an electron. The photon's energy is partly used to break the electron away from the material. The remainder goes into the ejected electron's kinetic energy. In equation form, this is given by
$$KE_e = hf - BE$$
where KE_e is the maximum kinetic energy of the ejected electron, hf is the photon's energy, and *BE* is the binding energy of the electron to the particular material.

What is the energy in joules and electron volts of a photon of 250 nm ultraviolet light?

What is the maximum kinetic energy of electrons ejected from cesium by 250 nm UV light, given that the binding energy of electrons from silver is 3.894 eV?

- Uses of the photoelectric effect
  - Photovoltaic solar cells
- Electric eye
  - Lights turn on in the dark
  - Automatic faucets, paper towels, toilets, etc.

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Practice Work	

1. Is visible light the only type of EM radiation that can cause the photoelectric effect? (OpenStax C29.2)
2. Is the photoelectric effect a direct consequence of the wave character of EM radiation or of the particle character of EM radiation? Explain briefly. (OpenStax C29.8)
3. What is the longest-wavelength EM radiation that can eject a photoelectron from silver, given that the binding energy is 4.73 eV? Is this in the visible range? (OpenStax 29.4)
4. Find the longest-wavelength photon that can eject an electron from potassium, given that the binding energy is 2.24 eV. Is this visible EM radiation? (OpenStax 29.5) **555 nm**
5. What is the binding energy in eV of electrons in magnesium, if the longest-wavelength photon that can eject electrons is 337 nm? (OpenStax 29.6) **3.69 eV**
6. Calculate the binding energy in eV of electrons in aluminum, if the longest-wavelength photon that can eject them is 304 nm. (OpenStax 29.7) **4.09 eV**
7. What is the maximum kinetic energy in eV of electrons ejected from sodium metal by 450-nm EM radiation, given that the binding energy is 2.28 eV? (OpenStax 29.8) **0.48 eV**
8. UV radiation having a wavelength of 120 nm falls on gold metal, to which electrons are bound by 4.82 eV. What is the maximum kinetic energy of the ejected photoelectrons? (OpenStax 29.9) **5.53 eV**
9. What is the wavelength of EM radiation that ejects 2.00-eV electrons from calcium metal, given that the binding energy is 2.71 eV? What type of EM radiation is this? (OpenStax 29.12) **264 nm, UV**
10. Find the wavelength of photons that eject 0.100-eV electrons from potassium, given that the binding energy is 2.24 eV. Are these photons visible? (OpenStax 29.13) **531 nm, Yes**
11. What is the maximum velocity of electrons ejected from a material by 80-nm photons, if they are bound to the material by 4.73 eV? (OpenStax 29.14) $\mathbf{1.95 \times 10^{6}}\ \boldsymbol{m/s}$
12. Photoelectrons from a material with a binding energy of 2.71 eV are ejected by 420-nm photons. Once ejected, how long does it take these electrons to travel 2.50 cm to a detection device? (OpenStax 29.15) $\mathbf{8.47 \times 10^{-8}}\ \boldsymbol{s}$