Electron-volt

The electron-volt (eV) is a unit of energy that is particularly useful for problems involving subatomic particles. One electron-volt is equal to the amount of energy needed to change the potential of an electron by one volt.

$$1.00 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$$

Quantization of Energy

Quantized means a quantity can only have a multiple of some minimum value.

Max Planck - light is quantized into packets of energy which depends on the frequency of light
- each packet was called a quantum of energy

$$E = hf$$

E -> energy in a single packet or quantum of energy (J or eV)
f -> frequency of light (Hz or s^{-1})
h -> Planck's constant

$h = 6.63 \times 10^{-34}$ Js
$h = 4.14 \times 10^{-15}$ eVs

Remember: $c = f\lambda$ where λ is the wavelength of light

$c = 3.00 \times 10^{8}$ m/s

[1 nm = 10^{-9} m]

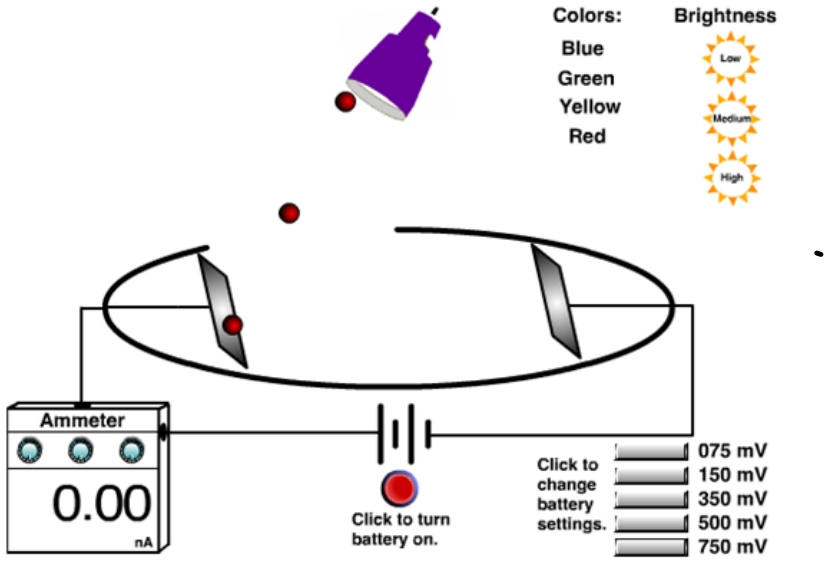
$$E = \frac{hc}{\lambda}$$

Photons

Einstein - light consists of a stream of photons (quanta)
- explained the Photoelectric Effect

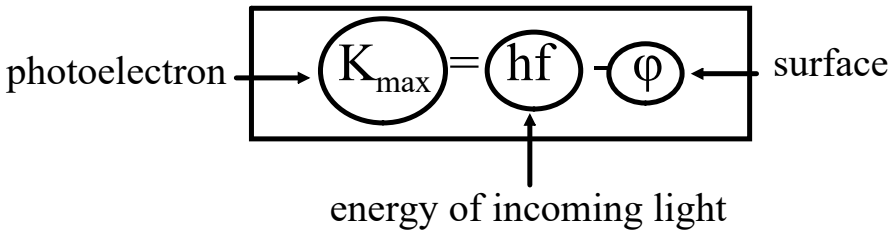
THE PHOTOELECTRIC EFFECT

When light hits certain metallic targets, electrons called photoelectrons are ejected and can be used to create an electric current in a circuit. The phenomenon is called the photoelectric effect.



The animation above is a representation of the **photoelectric effect**. The large oval with an opening represents a tube with a window to let light in and two metal plates on either end. When light from the lamp enters the opening and hits the plate on the left, electrons are emitted. They cross the tube and hit the plate at the right end of the tube. A current is then measured by the ammeter. The wave theory of light says that since light is a wave, the energy of the light (wave) depends on the amplitude (or brightness) of the light (wave). The kinetic energy of the resulting electrons (called **photoelectrons**) is equal to the energy of the incoming light minus the amount of energy needed to free the electrons from the atoms of the plate (called the **work function**). The kinetic energy of the photoelectrons can be experimentally measured by using a battery to make the plate on the right negatively charged. The electrons can still hit the plate if they have enough energy. As the plate is made more and more negative, fewer and fewer electrons have enough energy to hit the plate. Finally, the plate can be made so negative that even the electrons with the most energy are unable to hit the plate and the current in the circuit (measured by the ammeter) goes to zero. The negative voltage that causes the current to go to zero is called the **stopping potential**.

Each material has an inherent property that restricts the emission of photoelectrons. The minimum amount of energy needed to pop an electron free of a material's surface is called its work function, φ (phi).



K_{max} -> maximum kinetic energy of photoelectron (J or eV)
h -> Planck's constant (6.63×10^{-34} Js, 4.14×10^{-15} eVs)
f -> frequency of incoming light (Hz)
φ -> work function of surface (J or eV)