Physics 322
WS2

On what wave property does the rate of energy delivery of the wave (power) depend?  Explain.

Consider a metal plate.  If this metal plate is illuminated by light, electrons are ejected.  However, electrons are bound to the surface and require a certain amount of energy to remove them from the surface.  Based on this information, what can you conclude about the rate of electrons that would be emitted from the surface if the amplitude of red wavelength light is varied, starting from very low amplitude and increasing?

Suppose that the experiment were repeated using blue wavelength light.  What would you expect to see based on the wave model of light?

What really happens is that the red light is unable to cause any electrons to be ejected regardless of its amplitude.  However, the blue light is able to cause electrons to be ejected from the surface regardless of its intensity.

Einstein interpreted this as indicative of light being granular, being made of packets of energy.  The energy of an individual packet depends upon the frequency of that light and is given by the relation: $E=hf$, where E is the energy of the photon, h is Planck's constant ($6.626\times10^{-34}$ J-s) and is very small, and f is the frequency of the light.

How can we relate the power that we observe in a beam of light to the rate of photons?

Based on this information, imagine that we have two lights of the same amplitude but different wavelengths.  One wavelength is twice the other.  Both beams are measured to have the same power.  How do you compare the number of photons per second in each beam?

Imagine that you take a beam of monochromatic light and start to reduce the power of this beam of light.  As you get the power (intensity) lower and lower, what will happen to your observations of the beam of light with regards to observing individual photons?