Quiz 1 XRD 010330

In class we made an analogy between a pendulum and an electro-magnetic wave.

a) **-Explain** the similarity between an electro-magnetic wave and a pendulum.

b) **-Explain** the creation of an electromagnetic wave using the analogy to the initiation of a pendulum swinging.

c) **-How does** the energy involved in creating an electromagnetic wave relate to the type of radiation produced?

d) Light is a form of electromagnetic radiation. Visible light from a laser differs in several ways from visible light from a light bulb.
-List 4 ways that laser light differs from light from a light bulb.
-How do these differences allow laser light to travel long distances?

e) Bragg's law is used in XRD to relate repetitive structural size to the diffraction pattern.
-Give Bragg's Law.
-Sketch a diffractometer to explain the parameters in Bragg's Law.
-Explain how 3 of the 4 features listed for laser light might be useful in the application of Bragg's Law.

Answers: Quiz 1 XRD 010330

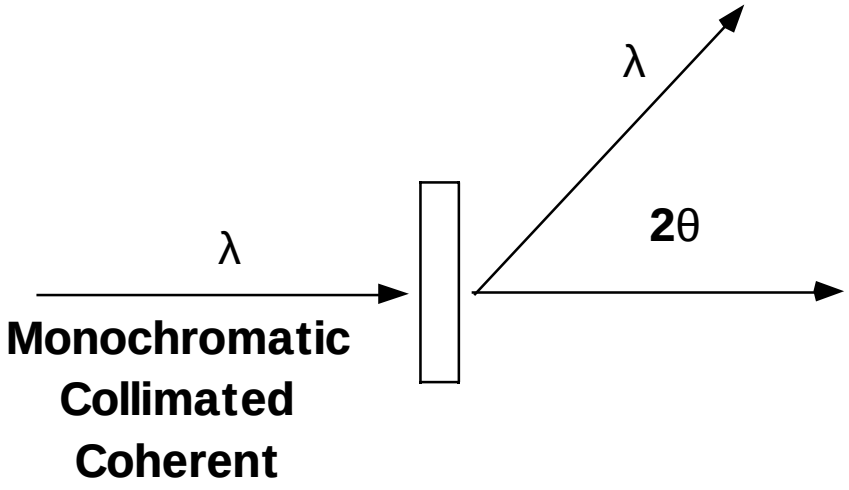
a) Both involve storage of energy through conversion from two forms. The pendulum converts from kinetic to potential energy and the two are related by a derivative. EM radiation converts from electric to magnetic energy and the two are related by a derivative relationship called the Maxwell equations.

b) A pendulum is initiated swinging by addition of either kinetic or potential energy through pushing or lifting the pendulum. EM radiation is initiated by an electric field or magnetic field pulse. Such a pulse can be created by change of momentum for a charged particle such as when an electron strikes a metal.

c) The energy involved in creating an EM wave decides the maximum energy that can be contained in the resulting EM radiation through $E = h\nu = hc/\lambda$. The type of EM radiation is decided by the wavelength or frequency.

d) Laser light is usually plane polarized, monochromatic, collimated and coherent. Light from a light bulb is unpolarized, polychromatic, uncollimated and incoherrent. Polarization and monochromicity don't really effect the distance traveled. Collimation ensures that the light doesn't dissipate by divergence and coherency ensures that the light doesn't decay due to interference with itself.

e) $d = \lambda/2\ 1/\sin\theta$



Bragg's law requires monochromatic light in order to fix λ, a collimated beam in order to fix the angle, and coherent radiation to have coherent interference between the waves. The coherence length must be larger than the size observed, i.e. d.