Laude CH301 Fall 2005, Worksheet 1 Key: EMR and Waves

1. Planck proposed that energy is transferred in quanta, or discrete packets, and *there is a minimum energy threshold that should be reached before transferring of energy happens.* An atom oscillating at a frequency ν can exchange energy with its surroundings only in *packets of magnitude E=h ν*, with h is the Planck's constant. *At low temperature, there is not enough energy available to stimulate oscillations at very high frequencies, and so the object does not generate high-frequency, ultraviolet radiation.*

2. Diffraction. Passing monochromic light through two closely spaced slits creates a pattern of dark and light bands on the screen. The dark and light bands have different intensities of light, caused by the interference between the peaks and troughs of waves traveling along different paths.

Waves can enhance or cancel each other out. If the peaks of one wave coincide with the troughs of another wave, the amplitude of the wave is diminished by destructive interference, resulting in destructive interference. If the peaks coincide, the amplitude of the waves is enhanced, resulting in constructive interference. Particles (assuming that they are not matter and anti-matter, but we need not to confuse our poor freshman) cannot do this.

3. Poor Johnny will never be able to accurately predict the velocity if he has a precise fix on position, due to the Uncertainty Principle. The following equation:

$$\Delta h \, \Delta x \geq \tfrac{1}{2} h/ (2\pi)$$

explains that the more accurate you know the position of a particle, the less accurate your knowledge of its velocity is and vice versa. For the Bevo atom, the uncertainty in position Δ x is very small, so the uncertainty in linear momentum must be large.

By the way, there is no such thing as a Bevo atom. Be stands for Beryllium.

4. Several applications:
- The probability of finding the particle in a region—in our case, an electron around a nucleus
- The discrete energy levels, which are also known as the quantum number

5. An atom loses energy only in certain discrete amounts, suggesting that the excited electron of a hydrogen atom can only occupy a series of discrete energy levels. Each energy amount has a certain wavelength, thus, a different color band. The Balmer series is the spectrum created when electron jumps from higher energy levels down to n=2, creating visible light, and the Lyman series is the spectrum created when electron jump from higher energy levels to n=1, which is the ground state. This spectrum is ultra violet.

6.

Wavelength (m)	Frequency(Hz)	Radiation type
5.2 e-7	5.8 e14	Visible light
3.5 e-2	9.4 e9	Microwave and radio wave
5.0 e-10	6.0e17	X rays and gamma ray
7.0 e-8	4.3 e15	Ultra violet
3.8 e-7	7.9 e14	violet

7. Use Wien's law, fill in the blank: (similar questions in the text: 1.5-1.10 pg. 47)

Material	Wavelength(m)	Temperature(K)	Make sense?
Magma	7.0e-7	4114.2	Yes
Steam at 1atm	8.2e-6	351.2	No, temp only 78.2 C^{o}
Sodium light	5.0e-6	576K	No, yellow is about 5.8e-8 m

8. From the Louis de Broglie matter wave equation:

$\lambda = h/ (m v) = 6.626 e\text{-}34$ J.s / (.1 kg x 27.2 m/s) = 2.43 e-34 m

This is about e24 times smaller than the covalent radius of chorine. The wave is too small to show any wavelike effect.

9.
a. m_l can only be -1, 0 or 1 when l = 1
b. l can only be 0 and m_l also 0 when n = 1, also m_s can only be -1/2 or ½
c. n can't be less than 1
d. l must be – when n = 1
e. there is nothing wrong, this is one of those annoying trick questions.