Notes #19/Quantum Theory #1/ **AP CHEMISTRY**

I. Draw an Oxygen atom:

II. REVIEW OF ELECTROMAGNETIC RADIATION - Much of our understanding of how electrons behave in atoms comes from studies of how electromagnetic radiation and matter interact.

A. What is Electromagnetic radiation?
- It's energy traveling as electromagnetic waves.
- Electro-magnetic waves, not just *any* wave, it has both an

______________________________and a _______________________________.

B. Waves have four primary characteristics:
1. WAVELENGTH (λ) - the distance between two consecutive peaks or troughs
   - measured in length (m, cm, nm, etc)
2. FREQUENCY (ν) - number of waves (or cycles) that pass a given point
   - measured in cycles per unit time (1/s, s-1 or 1/s = 1 hertz (Hz))
3. SPEED (c) - ALL electromagnetic radiation (of which light is just one example)

travels as a speed of ____.

4. AMPLITUDE - the height of the wave, determines the ______________________ or

_______________________ of the electromagnetic radiation.

** *The relationship between the first three characteristics is:* **c = λν**

- Wavelength and frequency are _________________ proportional. The _____ λ, the _____ ν.

- Be able to do mathematical conversions between λ and ν.

ex 1: The wavelength of my least favorite radio station is 3.115 m. What is this radio station?
(Frequencies of radio stations are commonly given in MHz. 1 MHz = 1 x 10^6 Hz.)

C. The Electromagnetic Spectrum:

- You need to know the general organization of the ER spectrum:

III. ENERGY AND WAVES:

A. FIRST BIG IDEA: (Max) **Planck's Theory** - Energy is QUANTIZED.

- Atoms and molecules can ONLY emit or absorb energy in _____________________ which he called *quanta.*

- This explained the mystery of "The Heating Stove Coils."

room temp coils (black) --heat---> gives off IR radiation (heat, but still black) --heat----> Red glow --heat--->orange glow

* *Why at certain temp were only certain wavelengths of light permitted?*

- The energy of one quanta depends on it's ____________________. **E = hν**

h = Planck's constant = 6.63 x 10^{-34} Js   ν = frequency

** Energy and frequency are ______________________ proportional. As ν _________, E _________.

- Energy is always emitted in multiples of hu......1hu, 2hu, 3hu....but never 1.5hu.

B. PHOTOELECTRIC EFFECT - Einstein used the photoelectric effect to offer further proof of Planck's Theory of quantized energy.

- The photoelectric effect occurs when light strikes the surface of a metal and ___________ electrons. *The light has to be of a minimum frequency (threshold frequency)* to have enough energy to break the attraction of the electrons to the metal.

- Illustration of the photoelectric effect.

- Einstein suggested that a beam of light is really a stream of particles which he called PHOTONS.

  - What's a photon? Basically, a photon is just a __________________________________.

  - Like a quanta, the energy of a photon is determined by $E = h\nu$

  - Only if a photon is of the right _____________________, could an electron be ejected.

*** *Some thought-provoking and most interesting questions about the photoelectric effect….*

1.What would happen if you increased the intensity of Red light? Could you eject some electrons?

2.What would happen if you increased the intensity of Violet light? Would you eject more electrons?

3. What would happen if you increased the frequency of light…like UV radiation?
Would you eject more electrons?

C. Now, that you have some equations to work with ($E = h\nu$ and $c = \lambda\nu$) and a conceptual framework, you can perform some calculations.

ex 2: Would a photon in the IR region or the UV region have more energy? _____________

A. Calculate the energy in Joules of a photon with a wavelength of 5.00×10^4 nm (IR radiation).

B. Calculate the energy in Joules or kJ of a MOLE of the photons from part A.

ex 3: The Binding Energy (a measure of the attractive forces) for an electron on a metallic sodium surface is 3.9×10^{-19} J. Will light of 305 nm (in the UV range) be able to eject an electron from the metal surface? What amount of KE (extra energy from the photon) will be associated with the ejected photon?