**Ch 8 The Quantum-Mechanical Model of the Atom Name:**

*8.1 Schrӧdinger’s Cat*

Read this section to learn about the absurdity of the quantum world.

*8.2 The Nature of Light*

Electromagnetic radiation “light” is composed of \_\_\_\_\_\_s which move at \_\_\_\_\_\_\_\_\_\_\_\_m/s.

\_\_\_\_\_\_\_\_\_\_\_\_\_ determines the light’s \_\_\_\_\_\_\_\_\_\_\_ or brightness while wave\_\_\_\_\_\_\_\_ determines \_\_\_\_\_\_\_\_

(if visible). What is frequency? *(symbol “ν” which is Greek letter nu)*

How does frequency relate to wavelength (symbol “λ” Greek letter lambda)?

Write the equation calculating frequency:

What is the mnemonic for remember the order of colors from long wave to short? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Figure 8.5 show that the visible spectrum runs from 400-750nm (many references use 700nm)*

*Practice 8.1 (note nm must be converted to m)*

*Figure 8.5* shows the complete electromagnetic spectrum. Be familiar with the different types of EM radiation and their positions with respect to frequency, energy, and wavelength. Starting UV and moving towards shorter wavelengths are classified as “ionizing” radiation (have enough energy to remove electrons from atoms).

Read *Chemistry and Medicine: Radiation Treatment for Cancer* as an example.

*Interference and Diffraction* shows the wave behavior of light (electrons also can exhibit these properties).

How did “classical EM theory” explain the photoelectric effect?

Experiments found that it was not intensity, but that light must react a \_\_\_\_\_hold. What did Einstein propose?

Write the equation to calculate EM radiation in 2 different forms:

*Practice 8.2 (find the E of one photon using E = hc/λ then divide into total energy: units J/s/J/photon = photon/s)*

*More Practice 7.2 (find E of the 1photon to remove the e−  1e− x 1mol/6.02x1023e−x 275kJ/mol x 1000J/1kJ*

*then find λ using E = hc/λ)*

*Practice 8.3*

We will discuss binding energy and ionization energy in class.

*CC 8.3 Match EACH wavelength to an observation. A\_\_\_\_\_\_nm B\_\_\_\_\_\_\_nm C\_\_\_\_\_\_\_nm D\_\_\_\_\_\_nm*

*8.3 Atomic Spectroscopy and the Bohr Model*

*Figure 8.10* shows spectrum tubes for various elements. The light from these tubes can be separated as shown in

*Figure 8.11* the light is NOT \_\_\_\_\_\_\_\_\_\_ous but consist of bright \_\_\_\_\_\_s and specific \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_s.

J. Rydberg developed an equation to predict wavelengths of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ emission spectrum. Bohr

developed a model to explain the spectra where electrons could only exist in \_\_\_\_\_\_\_\_\_s with fixed \_\_\_\_\_\_\_\_\_\_\_\_s

and \_\_\_\_\_\_\_\_\_\_ (the orbit is \_\_\_\_\_\_ized). No energy is emitted by electrons as they move in their orbits (a

contradiction to classical theory). When radiation is \_\_\_\_\_\_\_\_\_\_\_\_\_ed the electron moves to a higher state(level)

when an electron moves to a lower state(level) radiation is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ed.

Where can electrons never be in this model?

*Figure 8.12* shows the transitions which produce 3 of the visible lines of the hydrogen spectrum.

Atomic spectroscopy is used in laboratories and astronomy to identify elements. *Figures 8.13-15*

*READ Chemistry in Your Day: Atomic Spectroscopy*

*8.4 The Wave Nature of Matter: The de Broglie Wavelength, the Uncertainty Principle, and Indeterminacy*

Electrons can have mass but also have a \_\_\_\_\_\_\_\_\_ nature. (one electron can go thru both slits simultaneously)

*Practice 8.4*

*CC 8.4\_\_\_\_ (look at #53 in the EXERCISES to help answer the question) λ = h/mv*

What does the uncertainty principle state about the position and velocity of an electron?

How does it help solve the contradiction?

*8.5 Quantum Mechanics and the Atom*

Electron paths are indeterminate. An electron orbital is essentially a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ map of where the electron is

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Schrӧdinger developed an equation where ψ2 plots the distribution.

Orbitals are specified by 3 \_\_\_\_\_\_\_\_\_\_\_\_\_ numbers and the 4th quantum number specifies the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of

the \_\_\_\_\_\_\_\_ of the electron. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_ quantum number basically corresponds to the\_\_\_\_\_\_\_\_\_\_

level of the electron (distance from nucleus). The \_\_\_\_\_\_\_\_\_\_\_ momentum number determines the \_\_\_\_\_\_\_\_\_ of

the orbital which have letter designations: \_\_, \_\_, \_\_, f. The \_\_\_\_\_\_\_\_\_\_\_\_\_ number specifies the

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the orbital (basically the “room” it occupies). The \_\_\_\_ number specifies the orientation of

\_\_\_\_\_\_\_ of the electron. Each orbital may contain only TWO electrons and they may spin “\_\_\_” (+1/2) or

“\_\_\_\_\_\_” (-1/2). (In an orbital one e− spins up while the other spins down to create stability.)

The diagram on pg 333 shows that as you increase in energy levels you gain a new sublevel (shape) so for n=4 you

would have 4s, 4p, 4d, and 4f sublevels available. *(Note: s has 1 “room”, p has \_\_\_ rooms, d has \_\_\_rooms)*

*Figure 8.21 shows that as electrons absorb and \_\_\_\_\_\_\_\_\_\_\_\_ energy they move between orbitals of different energy.*

This section shows how the wavelengths of light for the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ atom can be calculated by finding the change in energy (ΔE) between levels. We will complete a lab in class where we calculate these values. One problem with the Bohr model of the atom is that these values can only be calculated for hydrogen.

*8.6 The Shapes of Atomic Orbitals*

This section describes how the shape of each orbital is determined using probability. The S sublevel contains 1 orbital which is spherical in shape. *Figure87.25* shows that the probability of finding the 1s electron as some distance *r* from the nucleus is highest at 52.9pm. What is the probability of finding the electron in the nucleus?

As you move to higher energy levels (ex: 2s and 3s) the orbital is still spherical but the wave characteristics of electrons start to produce “nodes” *(diagram at the top of pg340).* What is the probability of finding an electron at a node?

*Figure 8.26* Shows a graphical representation of these nodal areas.

The p sublevel contains \_\_\_ orbitals *Px, Py, Pz* with \_\_\_ lobes each. (look like peanuts or dumbells)

The d sublevel contains \_\_\_ orbitals *(Figure 7.28)* four of them have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ shape (or double peanut)

with \_\_ lobes each. One orbital has \_\_ lobes and a \_\_\_\_\_\_\_\_-shaped ring. (Total of 5 orbitals.)

The f sublevel contains \_\_\_ orbitals. Four have \_\_ lobes (like flower petals) and three have 2 lobes with 2 donuts.

*Note: The letter designations for the sublevels comes from the line spectra observed by Bohr. Some lines were “sharp” (s), some were from “principle” level transitions (p), some lines were “diffuse” (d), and others were considered to be “fundamental” (f). More sublevels are possible and they have been designated alphabetically after f as g, h, i, and so on.*

Read about the “phases” of orbitals. We will come back to this when we study bonding.

*Note: Figure 8.30 shows that all of the sublevel shapes combine to make the overall spherical shape of an atom.*

*Exercises* (pgs 345-6) #35, 39c & 41c, 43, 51, 53, 73, 74