Which Chapter/Sections are covered?

All of Chapter 1 – that's it. All material covered on homeworks 1-3. Concentrate on the subject matter I emphasized in class and on the homeworks. Come in mentally prepared to answer at least 20 questions, maybe more. Yes, there will be calculations, but most of the exam will be theory and concepts. You need to *understand* the theory and concepts – getting a homework question right does not necessarily mean you really understand the material.

Energy traveling at the speed of light

Know what electromagnetic radiation is and how we depict it on the page and conceptually.

Know the basics of the entire electromagnetic spectrum (see Figure 1.3, p. 3). Know the approximate wavelengths for each type of radiation given (LOOK at that figure). Know also, that visible light is in the 400-700 nm range (that's blue end to red end). Other than the two ends, I do not expect you to know the wavelengths of all the colors of the rainbow – however, you SHOULD know the ordering of the colors (think Roy G. Biv).

Know the two basic equations that describe electromagnetic radiation:

$$E = h\nu \qquad c = \lambda\nu$$

Know how to use this equations to calculate various wavelengths, frequencies, and energies of photons.

Know the two views of electromagnetic radiation: as a wave and as a particle (photons)

All moving particles have wavelength?

Yes. Louis de Broglie said if light can be treated as a particle (photon) then why not the other way around? Any moving particle with mass and velocity should have a corresponding wavelength.

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$ where p is momentum ($p = mv$)

The most important moving object for us is the electron. Now we can treat the electron as a wave. When confined to the region around the nucleus, the electron behaves as a *standing* wave.

What is the essence (observations) of the photoelectric effect? (p. 6)

How did Einstein explain this effect?

How does this relate to the work function (Φ) of a metal: $\frac{1}{2}mv^2 = h\nu - \Phi$

Be able to calculate any part of this equation (m, v, Φ, or ν) if given any 3 of the 4 variables in it

That thing is RED-hot!

What are the characteristics of black-body radiation? See Figure 1.4, p. 4 for a good idea. Note the range of wavelengths for a black-body radiator. They depend on the temperature. How does the spectrum shift with temperature? Where is the maximum intensity of radiation? Use Wein's law for that one:

$T\lambda_{max} = \frac{1}{5}c_2$ where c_2 is the second radiation constant. Realize the stark contrast in spectra between black-body radiation and . . .

The Emission Spectrum of Hydrogen

Check out those lines. Lines I tell you. Not broad bands of continuous wavelengths but very very narrow precise lines. It's like hydrogen is speaking to us. What is it saying? It is saying, "I have quantized energy levels!" "When I'm excited, I spit out very specific quanta of energy." Who listened? Several smart guys but lets chalk one up for Bohr for realizing that the photon that is emitted is due to the energy difference in quantum levels within the atom. As an electron falls from an excited state to a lower energy state, a photon is emitted that corresponds to the energy gap. Other's put some real math on the energies (Balmer) but Rydberg came up with a very insightful equation:

$$\nu = \mathcal{R}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \quad n_1 = 1, 2, \ldots \quad n_2 = n_1+1,\ n_1+2, \ldots$$

You can use this equation to calculate all kinds of energy transitions. You need to know the fundamental difference in the Balmer series and the Lyman series (p. 18).

But WHERE exactly IS the electron?

What is the Heisenberg uncertainty principle? Yes, the equation is $\Delta p \Delta x \geq \frac{1}{2}\hbar$, but what does this really mean? Can we precisely know the momentum AND position of the electron in the atom?

Schrödinger's Equation

$$-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2}+V(x)\psi=E\psi$$

Impressive, isn't it? Can you say differential equation? I knew you could. What's it for? What comes out of it? Can it be solved exactly for all atoms?

Particle in a box - Standing Waves

Yes, if we confine a particle, in a very very small space, its wavelike behavior starts taking over. Only certain waves will fit into the "box". Tada! These waves are quantized. Each wave has a specific wavelength and energy associated with it. Once solved, let's look at the formula for the energy levels:

$$E_n=\frac{n^2h^2}{8mL^2} \qquad n = 1, 2, 3, \ldots$$

What is so significant about this equation? Why did we even bother to talk about it? What can be learned from this? How is this a nice "friendly" segue into the various solutions to the Schrödinger equation? Compare and contrast the similarities of this equation and the equation that Schrödinger arrived at for the energy levels within the hydrogen atom:

$$E_n=-\frac{h\mathcal{R}}{n^2} \qquad \mathcal{R}=\frac{m_e e^4}{8h^3\varepsilon_0^2} \qquad n = 1, 2, 3, \ldots$$

How would these two solutions look graphically? See Figure 1.17 (p. 14) and Figure 1.22 (p. 18).

Quantum Numbers

Know the names, symbols, and values for the four quantum numbers n, l, m_l, and m_s .

Principal Quantum Number

$n = 1, 2, \ldots$

Angular Momentum Quantum Number

$l = 0, 1, 2, \ldots n\text{-}1$

Magnetic Quantum Number

$m_l = -l \ldots -1, 0, 1, \ldots l$

Spin Quantum Number

$m_s = +1/2, -1/2$

Out from these quantum numbers and the solution to the Schrödinger equation comes wavefunctions. What does the wavefunction, ψ, tell us? Ultimately it allows us to map out in three dimensions the likelihood of finding an electron in a given amount of space. This is what gives us the orbitals of the hydrogen atom that we are (now) all familiar with.

Know your orbitals

Know the basic differences in each orbital type: *s, p, d,* and *f*. Your should even be able to follow the trend to *g, h, i*, etc. . . What do nodes have to do with the shapes of these orbitals? What kind of nodes are there in these orbitals? Answer: There are nodal planes, nodal cones, and nodal spheres (aka: radial nodes). How do these influence the shapes of atomic orbitals?

More questions to get straight. What's the maximum number of electrons that will fit into ANY orbital? Each orbital type (*s, p, d*, . . .) comes in sets. How many orbitals per set? What is the maximum number of electrons per set? What are the relative energies of the various orbitals for the hydrogen atom? for other atoms?

Electron Configurations

You should be able to write (OK, pick out the answer from a list) out the electron configuration of any element on the periodic table. Yes, you WILL have your own copy of the periodic table to use. You should also be able to write out electron configurations for various ions whether cations or anions. Know which ions are isoelectronic with one another.

The Periodic Table

First off, this thing will really help you out with those electron configurations. Second, you can really learn a lot about elements by studying the trends in the table. What do you know? You know what and where are the alkali metals. Same goes for the alkaline earth metals, the halogens, and the noble gases. Where are the metals, nonmetals, and metalloids? What are the *d*-transition metals? *f*-transition metals? Know what the following are (definitions) AND what their trends are on the periodic table.

Atomic Radii, Ionic radii, ionization energies, electron affinities.

What Equations do you have to memorize?

You should memorize all the equations on this review sheet with the green background

green background. Other equations will be given if necessary. ALL constants that go into the equations will be given.

Standand Disclaimer

Any mistakes on this review sheet are NOT intentional. You should crosscheck all stated information. You should double check your book too (see errata).