

## Review Sheet for Exam 4 in Chem 3620

The main area covered on this exam is Quantum Mechanics with a few questions concerning the field trip to the Zn Plant. Only topics that we have covered in class and I have assigned homework over will be covered on the exam. Although certainly not an all inclusive list, among the things you should be able to understand, explain, or do are:

### Translational Motion

Use the particle in the box analysis to explain the quantization of translational motion and energy.

For the particle in the box wave functions apply the normalization conditions to derive equations for the wavefunctions. Explain the concept of orthogonality and Dirac bracket notation.

Derive the equations for the energy levels of a particle in the box and use them to explain how entropy changes if the box size changes.

Be able to calculate the probability of a particle being at a particular location in the box.

### Vibrational Motion

Use the harmonic oscillator to explain the quantization of vibrational motion and energy. Derive the classical equations for vibrational motion from Hooke's Law and Newton's 2<sup>nd</sup> Law.

Use the Born-Oppenheimer approximation to explain how we get the Potential Energy curve for 2 nuclei sharing 1 electron.

Explain the form of the vibrational wave functions for a molecule.

Show how the energies of the molecular vibrational states are similar to the classical harmonic oscillator equations. Summarize the trends of the equations for E and  $\Delta E$ .

Apply the selection rules for molecular vibrational spectra. Determine what molecules would be IR active as in the homework.

Work problems involving wavenumber, energy, and force constant for vibrational spectra as in the homework.

### Rotational Motion

Know how the angular equations for mass, velocity, momentum, and KE relate to the translational equations.

Use the particle on a ring to explain the quantization of rotational motion and energy.

Derive the energy states for the quantum mechanical particle on a ring. Summarize the trends of the equations for E and  $\Delta E$ .

Explain the quantization of the energies for a particle on a sphere and how they are different than a particle on a ring.

Know the different types of molecular rotors.

Apply the selection rules for molecular rotational spectra. Determine what molecules would be microwave active as in the homework.

Work problems involving the rotational constant, energy, moment of inertia, and bond length for linear rotors as in the homework.

### Electronic Spectra for atoms

Explain why not all transitions between atomic orbitals are possible and give the basis for atomic orbital selection rules for allowed transitions.

Explain why multiple energy states exist for even 1 unpaired electron configurations using the concept of spin orbit coupling.

Explain term symbols and calculate term symbols for electron configurations using Russell-Saunders coupling.

Use selection rules to determine allowable spectral transitions.

### Zn Plant Field trip

Explain the RLE process for production of zinc metal from ZnS ore.

Have a general knowledge of the information on the handout sheet about amount of energy used, source of ore, and byproducts.