

CHEM 3420: Physical Chemistry II — Spring 2009

## Homework 1

Due in Class: Monday, January 26, 2009

For different experiments, energies for various phenomena are commonly expressed in different ways which may include units such as Å, nm,  $\mu\text{m}$ ,  $\text{cm}^{-1}$ ,  $\text{sec}^{-1}$ , Hz, J, erg, cal, J/mol, kJ/mol, kcal/mol, eV, and Kelvin. The SI unit of energy, Joules, is appropriate for comparisons of energies for individual changes, while J/mol gives a macroscopic basis for comparisons. Average thermal energies of systems are approximated as  $kT$  (for individual atomic or molecular processes) or  $RT$  (for molar quantities).

Listed below is a set of observable phenomena with the energies that are commonly used to describe them. For this assignment, you need to convert these values into common units (J and J/mol), determine their relative magnitudes, and arrange them in order in the EM spectrum. You will need to find or calculate conversion factors for different energies. The *Handbook of Chemistry and Physics* is a useful source of this information.

1. Complete the table below, showing each of the following experimental values in J and J/mol.
2. Show where in the electromagnetic spectrum each of these phenomena falls by entering its ID onto the figure shown below. Think about the relative magnitude of these phenomena.

ID	Phenomenon	Energy	J	J/mol
1	C-14 beta decay	0.156 MeV		
2	X-ray K line of Fe	7.11 keV		
3	UV absorption peak C <sub>2</sub> H <sub>4</sub>	162 nm		
4	AA analytic line, Li	670.78 nm		
5	Solar Na-D line	5893 Å		
6	C <sub>2</sub> H <sub>4</sub> ionization potential	10.5 eV		
7	HCl vibration (IR)	2886 $\text{cm}^{-1}$		
8	Bond energy, H <sub>2</sub>	3.67 eV		
9	Bond energy, N <sub>2</sub>	226 kcal/mol		
10	Red hot temperature	1200 K		
11	Rotation C≡O	115271 MHz		
12	Heat of fusion, water	6.02 kJ/mol		
13	Reaction enthalpy H <sup>+</sup> + OH <sup>-</sup> → H <sub>2</sub> O	55 kJ/mol		

