

PROBLEM SET #3

Speed of light  $c = 3.0 * 10^8$  m/sec

1 year  $\approx \pi * 10^7$  second

Charge per ion  $q = 1.6 * 10^{-19}$  Coulomb

Stefan-Boltzmann constant  $\sigma = 5.67 * 10^{-8}$  W m<sup>-2</sup> K<sup>-4</sup>

1. Calculate the minimum cation/anion radius ratio needed to have 4-fold square planar coordination.
2. Why is the first ionization potential of O less than that of N?
3. The distance from the Sun to the Earth is  $1.5 * 10^8$  km. At Earth, we receive 1.5 kW/m<sup>2</sup> of energy from the sun. Calculate the luminosity of the Sun in Kilowatts (kW). Jupiter is  $7.8 * 10^8$  km from the Sun. How much solar energy is received at Jupiter in kW/m<sup>2</sup>? How does this type of calculation relate to calculations of distance based on Cepheid Variables?
4. A Fraunhofer Line from a star from a distant galaxy is observed to have an apparent wavelength of 550 nm. By matching the pattern of lines between this star and the Sun, you determine that the true wavelength of this Fraunhofer Line is 440 nm. What is the velocity of the galaxy in the direction toward or away from us: 1) in fractions of the speed of light, and 2) in Km/sec?
5. For the galaxy in the previous problem, assuming that the Hubble Constant  $H = 22$  km/sec/10<sup>6</sup> light years (corresponding to an estimated 13 billion year old universe), how distant is the galaxy from the observer in light years and in km?
6. You are trying to create a saturated solution of sodium chloride. You have 1.00 Kg of water that has  $0.100 \pm 0.005$  moles Na<sup>+</sup> in it. You add  $6.00 \pm 0.010$  moles of solid Na<sup>+</sup> to that water (this can come in many forms, like NaOH or Na<sub>2</sub>CO<sub>3</sub>). How many moles of Cl<sup>-</sup> (this could come in the form of HCl) can you add before you start precipitating NaCl, given  $K_{sp} = 38.0 \pm 0.1$ ? (Propagate the error through this problem.)

(Don't think too hard about this, the  $K_{sp}$  calculation should be straightforward. There are no tricks. Assume the weight of water remains 1Kg, and assume there are no complications due to the other ions you are adding. ... This is really just a propagation of error problem!)