**CH301H – Principles of Chemistry I: Honors**
Fall 2016, Unique 50015

**Homework, Week 5**

1. On the first problem set of this semester, you compiled a conversion table between units of eV, J, and cal. We have now encountered more units of energy. Add units of $cm^{-1}$ and Hz to this table.

2. Chemists often speak of energies in units of nm, which are convenient for describing the visible region of the electromagnetic spectrum. Why are units of nm NOT ideal units for describing electromagnetic energy? (Hint: try adding nm to your units conversion chart from problem 1 – do your numbers make sense? What happens when you try to convert 100 $cm^{-1}$, 200 $cm^{-1}$, or 300 $cm^{-1}$ to nm?)

3. An argon ion laser emits light at a wavelength of 488 nm. Calculate the frequency of the light. Suppose a pulse of light is sent from Earth, is reflected from a mirror on the moon, and returns to its stating point. Determine how long the round trip takes, estimating the distance from the Earth to the moon as $3.8 \times 10^5$ km.

4. Plank determined that the maximum wavelength of blackbody radiation from an object was inversely proportional to the temperature of that object according to the following equation:

$$\lambda_{\max} = \frac{0.2hc}{k_B T}$$

In 1965, scientists discovered radiation with $\lambda_{max}$ = 1.05 mm throughout space. They termed this "background radiation." What region of the electromagnetic spectrum is this radiation in? What is the temperature of space?

5. Potassium atoms in a flame emit light as they undergo a transition from one energy level to another that is $4.9 \times 10^{-19}$ J lower in energy. What is the visible color of the flame?

6. Green plants contain derivatives of the molecule chlorophyll in their leaves. Plants usually have several different kinds of chlorophylls, but two of the most common are chlorophyll a and chlorophyll b. Chlorophyll a absorbs light at 430 and 662 nm, while chlorophyll b absorbs light at 453 and 642 nm.

a) Explain why a plant leaf with these two molecules will appear green.

b) Some people argue that plants should be black instead of green. Why would people say this?

7. The sodium-D line seen in the emission spectrum of Na is centered at 589.3 nm. The intensity of this emission makes it useful for lighting, such as with a sodium-D arc lamp.

a) What is the energy and color of this emission?

b) The Palomar Observatory, in San Diego County, CA, is one of the country's great observatories. Although the observatory is 60 miles north of the city of San Diego, in the 1970's and 1980's, light pollution from the city became a major problem for the function of the observatory. To ease this, in 1984 the city of San Diego replaced all public street lamps with sodium-D arc lamps. How would this affect the observatory?