Problem Set 9: Interaction of Light and Matter

HCHE 111L: Introduction to Elementary Inorganic Chemistry

Due Date: Friday November 3rd, 2017

Problem 1

Photogray lenses incorporate small enough amounts of silver chloride in the glass of the lens. When light hits the AgCl particles, the following reaction occurs:

$$\mathrm{AgCl} \xrightarrow{h\nu} \mathrm{Ag} + \mathrm{Cl}$$

The silver metal that is formed causes the lenses to darken. The energy change for this reaction is 3.10×10^2 kJ/mol. Assuming all this energy must be supplied by light, what is the maximum wavelength of light that can cause this reaction. (*BIG HINT*: To find the "maximum" wavelength, rearrange Planck's Law to solve for ν... now ask yourself, at what value of n would this be the largest.)

Problem 2

Calculate the de Broglie wavelength for each of the following:

a) A proton that is traveling at 5.0% of the speed of light

b) A 5.2 oz baseball with a velocity of 100.8 mi/hr

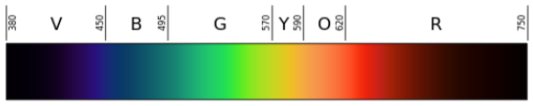
Problem 3

An AM radio station broadcasts at 1440 kHz and its FM partner broadcasts at 94.5 MHz. Calculate and compare the energy of the photons emitted by these two radio stations.

Problem 4

a) Excited mercury atoms emit light strongly at a wavelength of 436 nm. What is the frequency of this radiation? Using the figure below, predict the color associated with this radiation.

b) An argon ion laser emits light at 489 nm. What is the frequency of this radiation? Is this emission in the visible spectrum? If yes, what color?



Color	Wavelength	Frequency	Photon energy
violet	380–450 nm	668–789 THz	2.75–3.26 eV
blue	450–495 nm	606–668 THz	2.50–2.75 eV
green	495–570 nm	526–606 THz	2.17–2.50 eV
yellow	570–590 nm	508–526 THz	2.10–2.17 eV
orange	590–620 nm	484–508 THz	2.00–2.10 eV
red	620–750 nm	400–484 THz	1.65–2.00 eV

Problem 5

A red laser pointer emits light with a wavelength of 700nm. A fancy green laser pointer emits light with a wavelength of 500nm. Which emits more energy per photon? (Express final answers in Joules)

Problem 6

A student removes the spinning plate from his microwave oven. He places a chocolate bar inside on a paper plate and zaps it for 10 seconds. Removing the candy, he sees two melted spots approximately 6cm apart. The microwave says on the back that it operates at 24.5 GHz. Considering that the speed of light in air is very close to the speed of light in a vacuum, he calculates the wavelength of a microwave. Show his work.....and maybe try this out for yourself! :)