Homework #1   Chem 524   2011

To be handed in when requested, as problems build up

Homework link to set #1 ***Assignment – Notes 1 (background):***

Read in Text: **this section covers: Chapter1, Chapter 2-2, 2-3, 2-5**

Study on your own: ***Chap.2-4*** Selection of information (we will do later)

Chap.2-5 Analytical signal — Sorting out various contributions to the signal measured from background, etc. — This topic will recur and be tested.

Homework: (For discussion only: Chap. 1: #3, 4, 6, 10, Chap. 2: #5, 10**;**

Chap2: #1, good model test question, previously on 1st exam)

You should already know how to solve/use: Chap 1: #1,12, Chap 2: #6,13, 14

To *eventually* hand in: Chap.2: # 4, 7, 11, 15, plus

a. Consider H_2O, calculate the population of the v = 0 and 1 molecular states for the vibrational states corresponding to ν = 3600 and 1650 cm^{-1} for T = 1000K and 300K (room temperature). Do the same for the J = 1, 2 and 3 rotational states of HCl, assuming B is ~20 cm^{-1}.

b. I have a glower in my IR spectrometer with a heated area roughly 3x5 mm. The lamp is rated at 50 W. If its color temperature is 1500K, calculate the wavelength of maximum intensity, assuming blackbody character, and then determine the radiance assuming that 70% of the power comes out as light and that you can use λ_{max} as an average wavelength/frequency mark.

Homework for Notes 2 (incoherent sources):

Read Chapter 4 Section 1,2, also look at ***sources tutorial on Oriel/Newport*** site

Problems in the book:

For discussion: Ch. 4 - #12,

To hand in eventually: Ch. 4 - # 1

Homework for Notes 3 (laser sources)

3. Laser light sources:

Text reading this section covers: Chapter 4-3 – pretty inadequate, out of date

Also review Kansas State web pages provided in links,

http://www.phys.ksu.edu/perg/vqm/laserweb/Preface/Toc.htm

Problems in the book - For discussion Ch. 4-18 ***and***

Consider best choice laser sources for the following, rationalize your selection:

a. Raman spectrometer, routine with microsocpe for materials
b. Resonance Raman spectrometer for small molecules
c. T-jump fluorimeter for biological systems, like proteins
d. 2D IR correlation IR of fs pulses,
e. Very high resolution IR of gases for polution detection
f. laser ablation/ pulsed beam measurements
g. MPI molecular beam studies of small molecules

To hand in eventually: textbook: Ch. 4 - # 2,14 and ***a and b*** below:

a. from O. Svelto and D.C. Hanna, *Principles of Lasers, 2nd Ed*, Plenum, 1982.

1.4 If two levels at 300^o K are in thermal equilibrium with $n_2/n_1 = 0.2$, calculate the frequency of the transition from 1$\rightarrow$2. In what part of the spectrum does this occur? Change this to 0.005 and recalculate.

2.0 Calculate the number of longitudinal modes that occur in $\Delta\nu$= 1 cm^{-1} at λ_0=488 nm for a 0.7 m long laser cavity.

1.6. Ultimate limit of divergence of a laser is diffraction $\theta_d = \beta\lambda/D$ where

θ_d = divergence, λ = wavelength, $\beta \sim 1$ optimal design, D = diameter

If a YAG:Nd laser beam (λ = 1.06 μ) is sent to the moon (384,000 km) from an oscillator of D = 1 mm , calculate its diameter on arrival.

b. from Kansas State site **Question 4.4: Ar+ Ion laser**

The difference between adjacent modes in Ar+ Ion laser is 100 MHz. The mirrors are at the end of the laser tube. **Calculate:**

1. The length of the laser cavity.
2. The mode number of the wavelength 488 [nm].
3. The change in separation $\Delta\lambda$ of adjacent modes when the cavity is shortened to half its length.