Chemistry 542
Fall, 2002
Problem Set 1
Due Wednesday, Sept. 4

Read chapter 1 of Levine and the handout from Feynman and Hibbs (*Quantum Mechanics and Path Integrals*, Chapter 1).

Answer questions 1.1, 1.4, and 1.10 in Levine.

Also answer the following questions. You will need a table of the error function to obtain numerical values for parts of questions 3 and 4. This can be found on the website for the course.

1. (a) The electric field of a certain laser is $10^6$ V/cm. What is the intensity in W/cm$^2$ ?
(b) What intensity is required for the laser field to equal that felt by a 1s electron in a hydrogen atom?

2. Express the following numbers in the form $re^{i\theta}$: (a) 3 + 2i (b) (1+i)/(2-i)

3. Consider the 3D Maxwell-Boltzmann distribution function,

$$f(v) = Cv^2 \exp(-v^2/\alpha^2).$$

Calculate the following quantities:
a) $\langle v \rangle$ (mean value, $v_{mean}$ )
b) $v_{mp}$ (most probable value)
c) $v_{med}$ (median value)
d) $\sigma$ (standard deviation)

Express your answers in units of $\alpha$ (that is, as multiples of $\alpha$). Note: The mean value of v is the quantity $\langle v \rangle = \int v\, f(v) dv$; the median has the property that $P(v > v_{med}) = P(v < v_{med})$; the standard deviation is defined as $\sigma^2 = \langle v^2 \rangle - \langle v \rangle^2$.

4. Calculate the following probabilities for the 3D Maxwell-Boltzmann distribution function:
a) $P(v > v_{mean})$
b) $P(v > v_{mp})$
c) $P(v > v_{med})$
d) $P(v > v_{mean} + \sigma)$
e) $P(v > v_{mean} - \sigma)$