Homework week 3 (Part A) Due Thursday Chemistry 455A
These are problems from Engel and Reid (or Engel in parentheses)
P12.17 , P12.20, P13.13 P13.17
(or P1.17, P1.20, P2.13, P2:17)

P12.17) The observed lines in the emission spectrum of atomic hydrogen are given by $\tilde{\nu}\left(\text{cm}^{-1}\right) = R_H\left(\text{cm}^{-1}\right)\left(\frac{1}{n_1^2} - \frac{1}{n^2}\right)\text{cm}^{-1}$, $n > n_1$. In the notation favored by spectroscopists, $\tilde{\nu} = \frac{1}{\lambda} = \frac{E}{hc}$ and $R_H = 109,677\,\text{cm}^{-1}$. The Lyman, Balmer, and Paschen series refer to n_1 = 1, 2, and 3, respectively, for emission from atomic hydrogen. What is the highest value of $\tilde{\nu}$ and E in each of these series?

P12.20) What is the maximum number of electrons that can be emitted if a potassium surface of work function 2.40eV absorbs 3.25×10^{-3} J of radiation at a wavelength of 300 nm? What is the kinetic energy and velocity of the electrons emitted?

P13.13) Determine in each of the following cases if the function in the first column is an eigenfunction of the operator in the second column. If so, what is the eigenvalue?

a) $e^{-i(3x+2y)}$ $\quad\quad$ $\frac{\partial^2}{\partial x^2}$

b) $\sqrt{x^2+y^2}$ $\quad\quad$ $\frac{1}{x}\left(x^2+y^2\right)\frac{\partial}{\partial x}$

c) $\sin\theta\ \cos\theta$ $\quad\quad$ $\sin\theta\frac{d}{d\theta}\left(\sin\theta\frac{d}{d\theta}\right) + 6\sin^2\theta$

P13.17) If two operators act on a wave function as indicated by $\hat{A}\hat{B}\,f(x)$, it is important to carry out the operations in succession with the first operation being that nearest to the function. Mathematically, $\hat{A}\hat{B}\,f(x) = \hat{A}\left(\hat{B}\,f(x)\right)$and $\hat{A}^2\,f(x) = \hat{A}\left(\hat{A}\,f(x)\right)$. Evaluate the following successive operations $\hat{A}\hat{B}\,f(x)$. The operators $\hat{A}$ and $\hat{B}$ are listed in the first two columns and $f(x)$is listed in the third column.

a) $\frac{d}{dx}$ $\quad\quad$ x $\quad\quad$ $x e^{-ax^2}$

b) x $\quad\quad$ $\frac{d}{dx}$ $\quad\quad$ $x e^{-ax^2}$

c) $y\frac{\partial}{\partial x}$ $\quad\quad$ $x\frac{\partial}{\partial y}$ $\quad\quad$ $e^{-a\left(x^2+y^2\right)}$

Note that your answers to parts (a) and (b) are not identical.