CHEM 571A - Problem Set #2

Due Friday August 31st

1. *McQuarrie 3-3:* In each case, show that $f(x)$ is an eigenfunction of the operator given. Find the eigenvalue.

$\hat{A}$	$f(x)$
(a) $\frac{d^2}{dx^2}$	$\cos(\omega x)$
(b) $\frac{d}{dt}$	$e^{i\omega t}$
(c) $\frac{d^2}{dx^2} + 2\frac{d}{dx} + 3$	$e^{\alpha x}$
(d) $\frac{\partial}{\partial y}$	$x^2 e^{6y}$

2. *McQuarrie 3-5:* Write out the operator for $\hat{A}^2$ for $\hat{A} =$

   (a) $\frac{d^2}{dx^2}$

   (b) $\frac{d}{dx} + x$

   (c) $\frac{d^2}{dx^2} - 2x\frac{d}{dx} + 1$

3. *McQuarrie 4-7:* Calculate the values of $\sigma_E^2 = \langle E^2 \rangle - \langle E \rangle^2$ for a particle in a box in the state described by

$$\psi(x) = \left(\frac{630}{a^2}\right)^{1/2} x^2(a-x)^2 \qquad 0 \le x \le a$$

4. *McQuarrie 4-9:* The momentum operator in two dimensions is

$$\hat{P} = -i\hbar\left(\mathbf{i}\frac{\partial}{\partial x} + \mathbf{j}\frac{\partial}{\partial y}\right).$$

   Using the wave function for a free particle constrained to move over a rectangular region $0 \le x \le a$ and $0 \le y \le b$, given as

$$\psi_{n_x,n_y}(x,y) = \left(\frac{4}{ab}\right)^{1/2} \sin\frac{n_x \pi x}{a} \sin\frac{n_y \pi y}{b} \qquad \begin{cases} n_x = 1,2,3,\ldots \\ n_y = 1,2,3,\ldots \end{cases} \quad ,$$

   calculate $\langle p \rangle$ and $\sigma_p^2 = \langle p^2 \rangle - \langle p \rangle^2$.