Homework 1
PHY 4605
Due Wednesday, January 18

1. The angular momentum $L_y$ of a system is exactly measured to be $3\hbar$. Determine from this information the minimum value of the uncertainty $\Delta L_x \Delta L_z$ for subsequent measurements of $L_x$ and $L_z$.

2. Consider the ladder operators $\hat{L}_+ = \hat{L}_x + i\hat{L}_y$ and $\hat{L}_- = \hat{L}_x - i\hat{L}_y$. Compute the following matrix elements. Use the normalized relations from Table 9.4 in Liboff.
   a) $\langle l + 1, m | \hat{L}_+ | l, m - 1 \rangle$
   b) $\langle l, m | \hat{L}_+ | l, m - 1 \rangle$
   c) $\langle l, m | (\hat{L}_x + \hat{L}_y) | l, m - 1 \rangle$
   d) $\langle l, m | \hat{L}_- | l, m + 1 \rangle$

3. Determine whether or not the following operators are Hermitian. You may use without proof that $\hat{L}_x^\dagger = \hat{L}_x$, $\hat{L}_y^\dagger = \hat{L}_y$, and $\hat{L}_z^\dagger = \hat{L}_z$. Also, recall that $\hat{L}^2 = \hat{L}_x^2 + \hat{L}_y^2 + \hat{L}_z^2$, $\hat{L}_+ = \hat{L}_x + i\hat{L}_y$ and $\hat{L}_- = \hat{L}_x - i\hat{L}_y$
   a) $\hat{L}_z \hat{L}^2$
   b) $\hat{L}_z \hat{L}^2 + \hat{L}^2 \hat{L}_z$
   c) $\hat{L}_+ + \hat{L}_-$
   d) $\hat{L}_+ \hat{L}_-$