Physics III
Homework Six
Due Friday 4 May, 2007

1. 1.1 from McIntyre
2. 1.3 from McIntyre
3. 1.5 from McIntyre. (Just do the stuff for ψ_1 and ψ_2. Skip ψ_3.)
4. Consider the following ket:

$$|\psi\rangle \;=\; a(\,2i|+\rangle - i|-\rangle\,)\;. \tag{1}$$

   Solve for the a that normalizes $|\psi\rangle$.
5. Using the normalized $|\psi\rangle$ from the previous problem, answer the following questions:
   (a) If the atom is in state $|\psi\rangle$, what is the probability of measuring $S_z = 1$?
   (b) If the atom is in state $|\psi\rangle$, what is the probability of measuring $S_z = -1$?
   (c) Do the probabilities add up to 1?
6. **(Optional)** Here is another handy use of Euler's formula,

$$e^{ix} \;=\; \cos(x) + i\sin(x)\;. \tag{2}$$

   Consider the following integral:

$$\int e^{ax}\sin(bx)\,dx\;. \tag{3}$$

   Ordinarily, you would do this integral using integration by parts. But there is another way to do it. Re-write the $\sin(bx)$ term in the integrand using Euler's formula. I.e.,

$$\sin(bx) \;=\; \Im e^{ibx}\;, \tag{4}$$

   where $\Im$ means "imaginary part of." You have now converted the integral into something involving only exponentials. Do the integral and you will get an algebraic expression. Solve for the imaginary part of this expression, and you'll have the answer to the integral of Eq. (3). To do so, you'll need to use Euler's formula in reverse, and will also need to get rid of any i's in the denominator of any fractions.