PHYSICS 101A – HOMEWORK SET 6

Due by the end of the day, Friday December 5, 2008.

Reading: Tipler and Llewellyn, Sections 6.1 – 6.3.

1.) Two possible forms with which to express complex numbers are $a + ib$ and $re^{i\theta}$. Find the values of r and θ for the following complex numbers α: a) $\alpha = 10$; b) $\alpha = -i$; c) $\alpha = 3 + 3i$. Also, find the values of a and b for d) $\alpha = \exp(i\pi)$; e) $\alpha = 4\exp(-i\pi/2)$; f) $\alpha = 2\exp(2.0944i)$, where 'exp(x)' means 'e^x' and θ is in radians. (Answers: 10,0; 1,$3\pi/2$; 4.24,$\pi/4$; -1,0; 0,-4; -1,1.732)

2.) Expanding the expression $\alpha = re^{i\theta}$ in terms of sines and cosines, show that $|\alpha|^2 = \alpha^*\alpha$ is real for any r and θ, and is equal to r^2. How would you demonstrate this even more easily *without* doing the expansion?

3.) When we introduced the Schroedinger Equation, which is complex, our oscillitory solutions went from sines and cosines to solutions of the form $\exp(\pm ikx)$. Show that this is still an oscillitory solution by expressing the general wave function

$$\psi = Ae^{ikx} + Be^{-ikx}$$

in the form

$$\psi = a\cos(kx) + b\sin(kx).$$

What is the relation between a,b and A, B? (Answer: $a = A + B$; $b = i(A - B)$.)

4.) Problem 6.3 (Answer: $(\bar{h}^2x^2)/(2mL^4)$.)

5.) Problem 6.5; this should read 'time-dependent *free-particle* Schroedinger Equation.

6.) Problem 6.6 (Answers: a)$2.64 \times 10{-}24$ kg-m/s; b) 23.9 eV; c) 0.251 nm)

7.) Problem 6.15 (Answers: a) 2L; b) 2L/3; c) h/2L; d) $h^2/8mL^2$)

8.) Problem 6.19 - note that for b), Δx is small enough that you need not integrate. (Answer to b): 0.02)

9.) Problem 6.50 (Answers: a) 204.6 MeV; c) 2.02 fm; d) 1.21 fm; e) 0.73 fm)