PHYS 4073 - Quantum Mechanics- Homework Set 1

Reading Assignment: Chapter 1

Due 5:45pm Monday August 30th in my box in the physics office or in office hours.

Griffiths' Problems

1.1

1.3

Additional Problems

Problem A1 - Complex Numbers A little practice with complex numbers.

- **(a)** Write $1/(1+i)$ in the form $a+bi$ and the form $\rho e^{i\theta}$
- **(b)** Write $2e^{i\pi/6}$ in the form $a+ib$
- **(c)** Compute $\sqrt{1+2i}$

Problem A2 - Complex Numbers, But More Interesting Use complex numbers to compute a more expressive form of the sum of two sine waves of different frequency ω and 3ω but equal amplitude A. Show the sum of the two waves $f = A\sin\omega t + A\sin 3\omega t$ can be written as the product of a wave with a frequency that is the average of the two frequencies multiplied by a wave whose frequency is one half the difference of the two frequencies. Start by writing f as the imaginary part of some complex exponentials.

Problem A3 - Wave Functions Consider the ground state of the infinite square well, $\psi(x) = A\sin(\pi x/a)$ for $0 < x < a$ and $\psi(x) = 0$ otherwise.

- **(a)** Find A.
- **(b)** Find $< x >$.
- **(c)** Find σ_x.
- **(d)** Find the probability the particle is found in the middle of the well from $a/4$ to $3a/4$.

Problem A4 - Double Slit Monochromatic (single frequency, ω) light is incident on two slits. The slits are a distance d apart, are very narrow, and are a distance ℓ from a screen. The electric field of the wave is given by $E(x,t) = E_0\sin(kx-\omega t)$ where k is the wavenumber $k = 2\pi/\lambda$ and λ is the wavelength. The intensity of the light on the screen in naturally proportional to E^2. Work out the location of the minima of the interference pattern as measured by the distance y from the central maximum. You may assume $d << \ell$ and naturally $c = \omega/k$, but that's not important.

Problem A5 - Baseballs The quantum (De Broglie) wavelength of anything is $\lambda = h/mv$ where m is the mass, v is the velocity, and h is Planck's constant. Compute the spacing of the central maximum and the first interference minima for a baseball thrown at 100mph at a wall containing two windows a distance 5ft apart. The interference pattern is observed on a wall a distance of 20ft from the windows.

Problem A6 - From the GRE Consider a stepwise wave function $\psi = 0$ for $x < 0$, $\psi = 1$ for $0 < x < 1$, $\psi = 2$ for $1 < x < 2$, $\psi = 5$ for $2 < x < 3$, $\psi = 1$ for $3 < x < 4$, and $\psi = 0$ for $x > 4$. Find the probability the particle is found between $x = 2$ and $x = 3$. Naturally, you are not going to consider working with a non-normalized wave function.