# Physics 370 Homework #6

**6 problems**

**Due by Monday, October 3**

▷ **1.**

Prove that the force-less Schrodinger equation

$$-\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2} = i\hbar\frac{\partial\Psi}{\partial t}$$

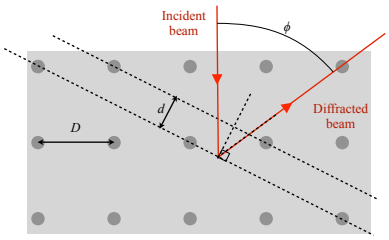
has the solution

$$Ae^{i(kx-\omega t)}$$

and derive the relationship between $k$ and $\omega$.

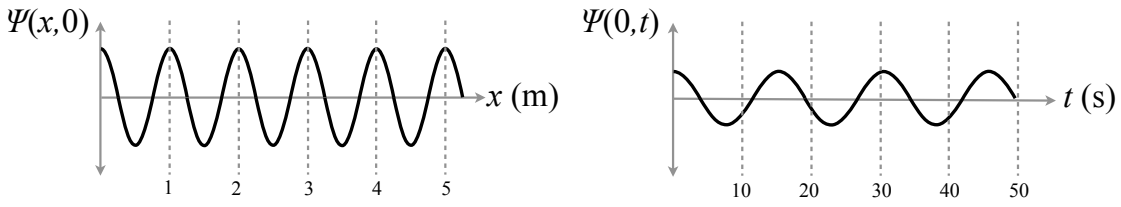
▷ **2.**

Atoms in a crystal form atomic planes at many different angles with respect to the surface. The figure shows the behaviors of representative incident and scattered waves in the Davisson-Germer experiment. A beam of electrons accelerated through 54 V is directed normally at a nickel surface, and strong reflection is detected only at an angle $\phi$ of 50°. Using the Bragg law, show that this implies a spacing $D$ of nickel atoms on the surface in agreement with the known value of 0.22 nm.




▷ **3.**

The following two graphs show a snapshot of a wave at $t = 0$, and the amplitude of a point on the wave at $x = 0$. Find the wave's




**(a)** wavenumber $k$
**(b)** angular velocity $\omega$
**(c)** velocity $v$

▷ **4.**

When you look at an object, we can establish its location by, at best, 550 nm (the wavelength of light).

**(a)** What is the minimum uncertainty in a nickel's velocity? (A nickel has a mass of 5 g.)

**(b)** If the average momentum of the nickel is zero, then $p \sim \Delta p$. What does the nickel's wavelength equal in that case? (Note that it isn't $\infty$, which we might expect if $\lambda = h/p$ and $p = 0$.)

▷ **5.**

Calculate, by hand, the mean and standard deviation of these two sets of numbers. Which has the larger standard deviation?

**(a)** $0, 2, 5, 9$

**(b)** $3, 3, 4, 6$

▷ **6.**

Consider the function

$$f(x) = \begin{cases} x, & -L < x < L \\ 0, & \text{otherwise} \end{cases}$$

This function can be written as an integral:

$$f(x) = \int_{-\infty}^{\infty} A(k) e^{ikx}\, dk$$

**(a)** Find $A(k)$.

**(b)** Find the value $k_{\max} > 0$ which maximizes $A(k)$. Show that it is inversely proportional to $L$. (Note: this function has many maxima and minima. A graph may help you find the true maximum.)