

Physics 370 Homework #6

6 problems

Due by Monday, October 3

▷ 1.

Prove that the force-less Schrodinger equation

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

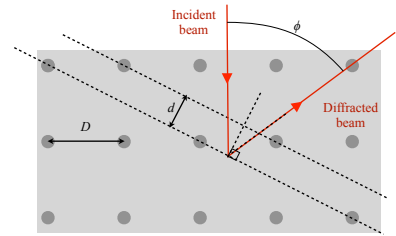
has the solution

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

and derive the relationship between k and ω .

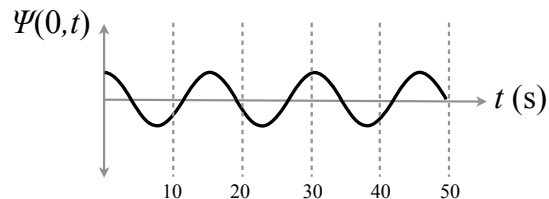
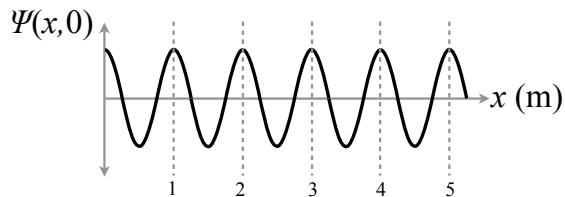
▷ 2.

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 ϕ 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 ω
- (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 ∞ , 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.)