5-7. A free proton moves back and forth between rigid walls separated by a distance $L = 0.01$ nm. (*a*) If the proton is represented by a one-dimensional standing de Broglie wave with a node at each wall, show that the allowed values of the de Broglie wavelength are given by $\lambda = 2L/n$ where n is a positive integer. (*b*) Derive a general expression for the allowed kinetic energy of the proton and compute the values for $n = 1$ and 2.

5-19. A radar transmitter used to measure the speed of pitched baseballs emits pulses of 2.0-cm wavelength that are 0.25 μs in duration. (*a*) What is the length of the wave packet produced? (*b*) To what frequency should the receiver be tuned? (*c*) What must be the minimum bandwidth of the receiver?

5-24. A particle moving in one dimension between rigid walls separated by a distance L has the wave function $\Psi(x) = A \sin(\pi x/L)$. Since the particle must remain between the walls, what must be the value of A?

5-27. If an excited state of an atom is known to have a lifetime of 10^{-7} s, what is the uncertainty in the energy of photons emitted by such atoms in the spontaneous decay to the ground state?

5-30. If the uncertainty in the position of a wave packet representing the state of a quantum-system particle is equal to its de Broglie wavelength, how does the uncertainty in momentum compare with the value of the momentum of the particle?

5-34. A neutron has a kinetic energy of 10 MeV. What size object is necessary to observe neutron diffraction effects? Is there anything in nature of this size that could serve as a target to demonstrate the wave nature of 10-MeV neutrons?