Homework 3 (Due Wednesday 9 February 2005

1. In Feynman Chapter 1 there is a discussion of quantum mechanics for electrons which has no analogue in my discussion about quantum mechanics for photons. Identify that discussion, and explain whether in principle there should be an analogue for photons.
2. In Feynman Chapter 2 there is a discussion of indeterminacy in classical mechanics. Does this agree with what I said in class? What is the crucial point about why classical mechanics in many cases has to be treated as indeterminate? Does this still leave important problems that are determinate?
3. Consider a wave of particles in 1 space dimension with energy $E$. Assume a potential energy function $V = 0$ for $x < 0$, and $V = V_0 > E$ for $x > 0$. Require that the wave function and its first derivative be continuous at $x = 0$. Show that the solution involves an incident wave and an equal-amplitude reflected wave, and an exponentially decaying wave for $x > 0$. There is one crucial assumption, that there is no exponentially *growing* wave. Reasons for this will be discussed in class.
4. Imagine in problem 3 that the magnitude of $V_0$ grows towards infinity. Show that then there is no penetration into the region $x > 0$, and that the wave function vanishes at $x = 0$.
5. Now suppose that in problem 4 there is also an infinite positive $V$ for $x < -a$. This implies that the wave function also vanishes at $x = -a$. What is the lowest energy $E$ for which the Schrödinger equation has a solution? Have you seen a problem similar to this in introductory physics?