PROBLEM SET 3   Due Friday October 14

Physics 115B– FALL 2011

Anecdote:

Hendrik Kramers was once of the important names in quantum mechanics. His work included perturbation theory calculations of the fine structure of the Hydrogen atom, a problem we shall consider in the next week or two. Van Kampen tells a story in "Remembering Kramers":

When Kramers wrote his paper on Brownian motion in 1940 I did not yet know him. Only in 1945, after the war, was it possible for me to go to his lectures without risk of life and limb. Unfortunately, I was not very assiduous, because the newly discovered freedom gave birth to an exuberant student's life. Once I had a celebration that lasted all night and after I came home in the morning I dreamt that I was at a lecture, listening to Kramers. Unfortunately when I woke up it turned out to be true.

Analytic:

[**1.**] Griffiths Problem 4.5

[**2.**] Griffiths Problem 4.8

[**3.**] Write down the Schroedinger equation in a two dimensional circular well: $V(r) = 0$ for $r < a$ and $V(r) = \infty$ for $r > a$. Begin the process of solving it by separation of variables. What can you say about the angular part of the wave function? What equation does the radial part satisfy?

Numeric:

Comment: For the first part of the course, as you develop skill in programming, the computational problems will not necessarily have anything to do with quantum mechanics.

[**4.**] Modify your C or C++ program for the classical harmonic oscillator $F = -kx$ to include an anharmonic term $F = -cx^3$. Can this problem be solved analytically? For the case $c = 0$ you know the period T is independent of the amplitude. Is the same true for $c \neq 0$? Run your program to find out. That is, pick a value of c (it might require a bit of experimentation to find one which most simply illustrates the physics) and then run your code with $v_0 = 0$ and increasingly large values for x_0. Determine T for different x_0. Provide one check on your code by verifying that the maximum velocity the mass attains agrees with energy considerations.

[**5.**] Modify your C or C++ program for the classical harmonic oscillator $F = -kx$ to include a damping term $F = -bv$. Make a plot of $x(t)$ for b nonzero. Can this problem be solved analytically? Can you show your program agrees with the analytic solution?