

Physics 471 – Fall 2008

Homework #5, due Friday, October 3

(Point values are in square brackets)

1. [2] Do problems 3-4 from Section 2 (Differential Equations) of the Math Review sheet.
2. [3] Griffiths problem 2.23. This problem is very easy, but watch out on part (c)!
3. [5] Griffiths problem 2.27. Because $V(-x) = V(x)$, we know that the solutions are either even or odd in x . Just restrict yourself to the even solutions for now. Here are a few hints:
 - i) Solve the time-independent Schrodinger equation for all x ; i.e. write down the general form of a stationary state, $\psi(x)$
 - ii) Simplify your expression, given that you are looking for even solutions with $\psi(-x) = \psi(x)$.
 - iii) Take into consideration the boundary conditions at either $x = -a$ or $x = a$. (You no longer need boundary conditions at both places, since the wavefunction is even.)
 - iv) You will eventually find a transcendental equation for κ . Draw graphs of the left-hand side and right-hand side and see if they intersect. The intersection points are your solutions.
 - v) To get quantitative answers to the last part with specific values for α , solve your transcendental equation using either a graphing calculator or Mathematica (see below).
4. [5] Griffiths problem 2.34. Skip part (c), but use the answer given for part (c) to do part (d).
5. [5] Griffiths problem 2.29. You may use the graphical method I used in class or the one in Griffiths. (They are equivalent.) “Solve it graphically” means estimate the energies from your graph.

Now take a concrete example. Let $V_0 = 32\hbar^2 / ma^2$. How many bound states are there in the well? Use Mathematica or any other numerical analysis program (MatLab, Maple) to calculate the energies of those bound states in terms of V_0 . Here are a few hints about using Mathematica:

- i) It's best to use dimensionless variables everywhere, so you don't have to worry about units. If you use my solution, let $z = la$, and solve your equation for z .
- ii) All functions in Mathematica are capitalized. Examples are FindRoot, Tan, Cot, Sqrt, etc.
- iii) To find the correct syntax for any function, use the Help menu. For example, the FindRoot command takes two arguments: the first is the equation you want to solve with double equal signs, and the second includes the variable and starting point in curly brackets. To find the lowest even state (the ground state), I used:
$$\text{FindRoot}[\text{Sqrt}[64 - z^2] = z * \text{Tan}[z], \{z, 1\}].$$
- iv) Once you've typed in your command, use Shift-Enter to execute it.