PHYS2210Spring2024_HomeworkSet05_Problems27to31

27) Townsend 4.06 – Verify the large x asymptotic solution for the harmonic oscillator potential.

28) Townsend 4.10

The energy eigenvalues and eigenfunctions of the simple harmonic oscillator are given in section 4.3.

a) What are the energy eigenvalues for the half harmonic oscillator potential energy

$$V(x) = \begin{cases} \infty & x < 0 \\ \frac{1}{2} m\omega^2 x^2 & x > 0 \end{cases}$$

b) Sketch the eigenfunctions for the three lowest eigenstates.

29) Townsend Problem 4.12 – Time dependence of mixed harmonic oscillator states.

30) Townsend Problem 4.17 – Oscillatory motion of a mixed state.

31) Townsend Problem 4.20 – Energy eigenfunction expansion for a Dirac delta function wavefunction in the middle of an infinite well.

Extra practice – <u>not to be handed in</u>

A) Townsend Problem 4.14 – Estimating states for a linear potential well.

B) Townsend Problem 4.18 – Excited state of a double delta function potential.

C) Devise a simple argument verifying that the exponent in the decreasing exponential, which governs the behavior of simple harmonic oscillator eigenfunctions in the classically excluded region, is proportional to x^2. Hint: Take the finite square well eigenfunctions and treat the quantity $(V_0 — E)$ as if it increased with increasing x in proportion to x^2.

D) Verify the eigenfunction and eigenvalue for the $n = 2$ state of a simple harmonic oscillator by direct substitution into the time-independent Schrodinger equation.

E) An electron is bound to a region of space by a springlike force with an effective spring constant of $k = 95.7$ eV/nm2. (*a*) What is its ground-state energy?
(*b*) How much energy must be absorbed for the electron to jump from the ground state to the second excited state?