PHY 471 Friday, Oct 19

Exam 2

1. A particle, with mass m and energy $E = 2V_0$, approaches the potential step from the left ($x = -\infty$). What is the probability that the particle will be reflected? Express the answer in percent.

2. As precisely as you can, write the wave function for a particle of mass m in the ground state of the harmonic oscillator potential $V(x) = \frac{1}{2}kx^2$.

3. Which of the operators A, B, and C are Hermitian? ($x =$ position and $p =$ momentum.) You must justify your answer.

$$\begin{aligned} A &= xp \\ B &= xp + px \\ C &= xp - px \end{aligned}$$

4. An electron is in a harmonic oscillator potential. The ground state energy is 10 eV. Assuming one photon is emitted in the transitions, what are the photon energies if the electron makes the following transitions?

(a) $n = 1$ to $n = 0$

(b) $n = 2$ to $n = 1$

(c) $n = 2$ to $n = 0$.

5. A particle (mass m) is bound in the square well potential shown in the figure. The particle is in the first excited state. Write the form of the wave function in each of the three regions where $V(x)$ is constant. Sketch a graph of the wave function.

Information

$\hbar c = 2 \times 10^{-5}\,\mathrm{eV\,cm}$

$mc^2 = 0.5 \times 10^{6}\,\mathrm{eV}$

$$\frac{e^2}{\hbar c} = \frac{1}{137}$$

$$\int_{-\infty}^{\infty} e^{-bx^2} dx = \sqrt{\frac{\pi}{b}}$$

$$\int_{-\infty}^{\infty} \frac{e^{iux} dx}{x^2 + a^2} = \frac{\pi}{a}\, e^{-a|u|}$$