

PHYSICS 435

SPRING 2008

PROBLEM SET 10

Due: Friday, May 2, 2008

1. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2$. The particle is initially in the ground state $\psi_0(x)$. At $t=0$, the potential is suddenly changed to $V(x) = \frac{1}{2}k'x^2$, where $k' > k$. Calculate the probability that the particle is found in the ground state of the new potential at a later time t .

2. (10 points) Consider a particle in a one-dimensional infinite potential well of width L . The particle is initially in the state $\psi(x,0) = \sqrt{\frac{2}{L}} \sin\left(\frac{\pi x}{L}\right)$. Calculate the expectation value of the momentum $\langle p \rangle$ at $t=0$ and at a later time t .

3. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2 + \frac{1}{4}\alpha x^4$. Calculate the energy levels to first order in α .

4. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2$. The particle is initially in the state $\psi(x,0) = \frac{1}{\sqrt{2}}(\psi_0(x) + \psi_1(x))$. Calculate the probability that the particle is found in the ground state at a later time t .

5. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2$. The particle is initially in the state $\psi(x,0) = \sqrt{\frac{2}{L}} \sin\left(\frac{\pi x}{L}\right)$. Calculate the expectation value of the energy $\langle E \rangle$ at $t=0$ and at a later time t .

6. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2$. The particle is initially in the state $\psi(x,0) = \frac{1}{\sqrt{2}}(\psi_0(x) + \psi_1(x))$. Calculate the probability that the particle is found in the ground state at a later time t .

7. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2$. The particle is initially in the state $\psi(x,0) = \sqrt{\frac{2}{L}} \sin\left(\frac{\pi x}{L}\right)$. Calculate the expectation value of the momentum $\langle p \rangle$ at $t=0$ and at a later time t .

8. (10 points) A particle of mass m moves in a one-dimensional potential $V(x) = \frac{1}{2}kx^2$. The particle is initially in the state $\psi(x,0) = \frac{1}{\sqrt{2}}(\psi_0(x) + \psi_1(x))$. Calculate the probability that the particle is found in the ground state at a later time t .