

J06Q.1 - Position and Momentum

Problem

- a) For a particle moving in three dimensions with Hamiltonian

$$H = \frac{p^2}{2m} + V(\vec{r}).$$

in an arbitrary quantum state, what are the time derivatives, $d\langle\vec{r}\rangle/dt$ and $d\langle\vec{p}\rangle/dt$, of the expectation values of the position and momentum?

- b) For times $t < 0$, a one-dimensional simple harmonic oscillator with mass m and frequency ω is in its ground state, at energy $\hbar\omega/2$, with $\langle x \rangle = 0$. At time $t = 0$ a uniform electric field E is instantaneously turned on and remains on for $t > 0$; it couples to the particle's charge q . What is the full time- and x -dependence of the particle's wave function $\psi(x, t)$? If its energy is measured at time t , what are the possible results and their probabilities?