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QUANTUM MECHANICS H.W №4

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PROBLEM (1)

An electron with kinetic energy $E = 5.00eV$ is incident on a barrier with thikness $L = 0.1$ nm and hight $V_o = 7eV$. Calculate the tunneling probability. If you know the reflection probability is given by the formula:

$$R = \frac{V_o^2 \sinh^2(\alpha L)}{V_o^2 \sinh^2(\alpha L) + 4(V_o - E)E}$$

Where α is the absorption coefficient.

PROBLEM (2)

Using the above formula for reflection of particle with energy less than the potential hight. Derive R and T for a particle with energy higher than the potential hight.
Hint: You might want to use the identity :

$$\sinh ix = \sin x$$

PROBLEM (3)

Proton and electron with same kinetic energy passing through an potential barrier with hight higher than their kinetic energy, which of them has higher probability of tunneling ?

PROBLEM (4)

Show that for a particle **bounded** in a finite well has a wavefunction that extends outside the well. What does that mean ?

PROBLEM (5)

We define the quantum revival time, by the time in which the system evolving in time returns to its initial configuration.
Show that the quantum revival time for a particle in an infinite well in the ground state is given by:

$$T = \frac{4mL^2}{\pi\hbar}$$

PROBLEM (6)

Consider a particle of a potential energy $V(x) = \lambda\hat{x}$ where λ is a positive constant. (V arises, for example from a force field - e.g a uniform electric field).
Write Ehrenfest theorem for $\langle\hat{x}\rangle$ and $\langle\hat{p}\rangle$. Integrate these equations and compare the results to the classical results.

PROBLEM (7)

Consider a particle described by the normalised wavefunction:

$$\psi(x) = N\frac{e^{ip_0x/\hbar}}{\sqrt{x^2+a^2}}$$

1. Find N - the normilisation constant.
2. Compute $P(-a/\sqrt{3} \leq x \leq +a/\sqrt{3})$
3. Calculate $\langle\hat{p}\rangle$.

PROBLEM (8)

If a quantum SHO was charged by a charge q and put in a uniform electric field of magnitude ε. Show that the energy spectrum of this harmonic oscillator is shifted by the quantity:

$$E'_n = E_n + \frac{q^2\varepsilon^2}{2m\omega^2}$$