Course: BSO 203 Instructor: S. Raychaudhuri

SESSION 2002-2003, SEMESTER I

PROBLEM SET VII

One-dimensional Scattering and Discussions

1. Consider a delta function potential of the form

$$V(x) = \Omega \ \delta(x)$$

and consider scattering by this potential.

   (a) Write down the wavefunction on the left and right of the delta function, and relate the amplitudes using appropriate boundary conditions.

   (b) Obtain the transmission and reflection coefficients.

   (c) Write down the transfer matrix for a delta function potential and re-derive the transmission and reflection coefficients.

2. Consider a square *well* potential

$$V(x) = -V_0 \ \theta(a - |x|)$$

where V_0 and a are positive.

   (a) Solve the scattering problem and obtain expressions for the transmission and reflection coefficients.

   (b) Show that the transmission coefficent becomes unity for certain values of the energy. This phenomenon is called a *resonance*.

   (c) Comment on the resonant values of the energy.

3. Discuss the following propositions from a physics viewpoint.

   (a) Quantum mechanics is applicable only to microscopic systems.

   (b) We cannot get rid of the disturbance induced by a measurement by using smaller and smaller probes.

   (c) The wavefunction is a measure of the probability of existence of the state it describes.

   (d) The collapse hypothesis is consistent with special relativity, but not with microcausality.

   (e) In the limit $\hbar \to 0$, the classical picture is restored.

4. Discuss the following propositions from a physics viewpoint.

   (a) There is no time-energy uncertainty relation.

   (b) The Schrödinger wavefunction must, in general, be complex.

   (c) For a non-zero potential, the eigenstates of energy are different from the eigenstates of momentum.

   (d) Stationary states correspond to probability distributions that are independent of time.

   (e) The larger the energy the greater is the number of nodes in the wavefunction.

5. Discuss the following propositions from a physics viewpoint.

   (a) Scattering phenomena are the best probes of the microsopic world.

   (b) The quantum mechanical problem of scattering is analogous to the optical phenomena of reflection and refraction.

   (c) Barrier penetration is a consequence of the Uncertainty principle.

   (d) Tunneling through a barrier is a purely quantum mechanical phenomenon.

   (e) Resonances enable us to study bound states of a system from scattering data, especially when the bound states are unstable.