

UNIVERSITY OF HYDERABAD

School of Physics

Jan 2010 - Apr 2010
M.Sc. II-Semester

Quantum Mechanics-I

Time : 1hr
MM : 20

Solved Examples : Dirac δ function potential

⊙ Following the methods outlined below solve the Schrodinger equation

$$\frac{-\hbar^2}{2m} \frac{d^2 u(x)}{dx^2} + V(x)u(x) = Eu(x)$$

for delta function potential problem

$$V(x) = -g\delta(x)$$

in one dimension and

- (i) find bound state energies and wave functions,
- (ii) give two linearly independent solutions for $E > 0$.

- [1] Integrate the Schrodinger equation directly and show that the value of the discontinuity must satisfy

$$u'(\epsilon) - u'(-\epsilon) = -gu(0).$$

Using this, and solving the Schrodinger equation separately for $x > 0$ and $x < 0$, find the energy eigen- functions for the bound states as well as for continuum energies.

- [2] Write the solution of the square well problem

$$V(x) = \begin{cases} 0 & |x| > a \\ -V_0 & |x| \leq a \end{cases}$$

and consider the limit in which $V_0 \rightarrow \infty, a \rightarrow 0$ and the product $2V_0a$ remains constant equal to g .

- [3] Write the Schrodinger equation in momentum space and obtain the momentum space energy eigenfunction directly. Find the x - space solution by taking suitable Fourier transform.