INDIAN INSTITUTE OF TECHNOLOGY MANDI

QUIZ - I

Introduction to Theoretical Chemistry (CY 714)

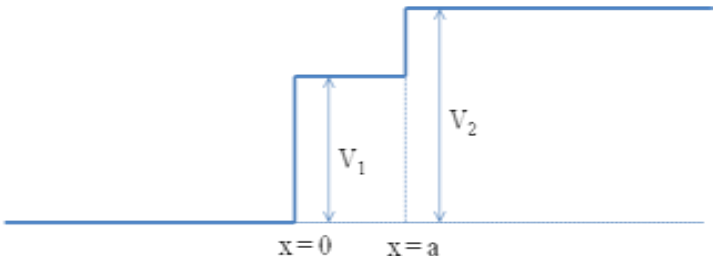
Full Marks: 20 **Date: 16.09.2011** **Time 50 min.**

Answer *ALL* Questions:

1. Suppose we have a potential of the form $V(x) = - K_0 \delta(x)$, where K_0 is a positive number. Search for the bound states ($E < 0$), which are localized at this potential.

[5]

2. Find the reflection coefficient through the following potential barrier, for $E > V_2$.



[5]

3. The operator $\tilde{\mathbf{A}}$ has only non degenerate eigenvectors $\{\varphi_n\}$ and eigenvalues $\{a_n\}$. What are the eigenvectors and eigenvalues of the inverse operator $\tilde{\mathbf{A}}^{-1}$? Is your answer consistent with the commutator theorem?

[2]

4. A particle moving in one dimension has the wave function $\Psi(x, t) = N e^{[i (a x - b t)]}$, where 'a' and 'b' are real constants,
   (a) what is the potential field V(x) in which the particle is moving ?
   (b) if the momentum is measured, what value is found (in terms of 'a' and 'b') ?
   (c) if the energy is measured, what value is found ?

[3]

5. What is the eigenfunction of the operator **x** corresponding to the eigenvalue x_0?
   (a) In the momentum representation.
   (b) In the position representation.

[2]

6. Consider time independent Schrödinger equation with a periodic potential. Are the eigenfunctions of this potential necessarily periodic? Justify your answer.

[1]

7. Over a very long interval of the x-axis, a uniform distribution of 10^4 electrons is moving to the right with velocity 10^8 cm/sec and 10^4 electrons are moving to the left with velocity 10^8 cm/sec. Assuming that electrons do not interact with one another, construct a state function that yields the preceding properties for the combined beam. Calculate $\langle \mathbf{p} \rangle$ for this state.

[2]