B. N. BANDODKAR COLLEGE OF SCIENCE, THANE

USPH403 June 2015

Additional ATKT.

Time: $2\frac{1}{2}$ hour | Total Marks:-75 Marks

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1. Attempt all questions.
2. Figure to the right indicate full marks.
3. Use of non programmable calculator is allowed.

Q.I.A) Attempt any TWO. (16 Marks)

1. What is Galilean transformation ? Derive Galilean transformation equation for two inertial frames. State and prove Galilean invariance.
2. Explain Michelson Morley experiment. Derive expression for fringe shift.
3. Explain Lorentz- Fitzgerald Contraction hypothesis and draw conclusions.
4. (a) A meter rule moves past an observer on a earth with a velocity of 2 x 10^8 m/s along the direction of its length. What is its apparent length with respect to the observer ? What is proper length of of rod. (Given c= 3 x 10^8m/s)

   (b) A circular lamina moves with its plane parallel to the x-y plane of a reference frame S at rest Assuming its motion to be along the x-axis. Calculate the velocity at which surface area would appear to be reduced to third half to an observer in frame S.

Q.I.B) Attempt any ONE. (04 Marks)

1. Explain Stellar aberration.
2. State and explain the postulates of relativity.

Q.II.A) Attempt any TWO. (16 Marks)

1. Normalize wave function and find out expectation value of momentum.
   $\psi(x) = Ae^{\left(\frac{\pi x}{l}\right)}; \qquad 0 \le x \le l$
2. Set up Schrödinger time independent equation.
3. $\psi(x) = Ae^{-\left(\frac{m\omega^2}{\hbar^2}x^2\right)}; \qquad -a \le x \le a$
   represent the state of an oscillator of angular frequency ω. Normalize the wave function and find expectation value for position.
4. What are operator ? Discuss their role in quantum mechanics. write down operator of momentum, total energy, kinetic energy and angular momentum.

P.T.O.

Q.II.B) Attempt any ONE. **(04 Marks)**

1. Discuss Max Born's interpretation of wave function.
2. What are the condition for a well behaved wave function?

Q.III.A) Attempt any TWO. **(16 Marks)**

1. Derive the expression for energy for particle in three dimensional rectangular box.
2. Set up Schrödinger time independent equation for one dimensional box. Solve it to obtaind energy functions and normalize them.
3. One dimensional rectangular potential barrier is given by:

$$V(x) = \begin{cases} 0 & x \le 0 \\ V_0 & 0 \le x \le a \\ 0 & x \ge a \end{cases}$$

A particle with energy $\mathbf{E_0}$ is incident on the barrier from the left. If $E_0 \ge V_0$, write down the Schrödinger time independent equation for the particle. Solve it.

4. Set up Schrödinger time independent equation for free particle solve the equation to obtain the eigenfunction. Find the expectation value for momentum.

Q.III.B) Attempt any ONE. **(04 Marks)**

1. Show that the energy state ,$E = 66\frac{h^2}{8mL^2}$ of a particle in a cubical box is 12 fold degenerate.
2. Estimate the zero point energy for neutron in a nucleus, by treating it as if it were in an infinite square well of width equal to nuclear diameter of 10^{-14} m.

Q.IV) A) Attempt any ONE. **(05 Marks)**

1. Distinguish between inertial and non-inertial frame of reference.
2. the length of rod is 100 m . If the rod is measured by the observer moving parallel to its length is 51 m, find the speed of observer.

Q.IV) B) Attempt any ONE. **(05 Marks)**

1. Calculate momentum,kinetic energy if wave function is $\psi(x) = e^{(-4x)}$.
2. (a) Calculate Uncertainty in energy if uncertainty in time is $\Delta t = 0.2\mu s$.

   (b) Calculate uncertainty in momentum if uncertainty in position is 10fm.

Q.IV) C) Attempt any ONE. **(05 Marks)**

1. Consider an atom as a cubical box of each side $10^{-10}m$. Calculate the energy of an electron trapped in the atom in the ground state and first excited state.
2. Show that expectation of momentum of a particle in one dimension box is zero.

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