S.Y.B.Sc Physics - III SEM IV

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VCD 040315

VCD S.Y. B.Sc. PHYSICS-III IV- SEMESTER 2014-15 75 MARKS 2.30 HRS.

Note: i) All the questions are compulsory.

ii) Figures to the right indicate full marks.

iii) Use of non programmable calculator is allowed.

Q.1 Attempt the following:-

A) Attempt any 1:- 8M]

a) Derive schrodinger's time dependent equation.

b) If $\psi_1(x,t)$ and $\psi_2(x,t)$ are two solution of STDE for a particular V(x,t). show that $\psi(x,t) = a_1\psi_1(x,t) + a_2\psi_2(x,t)$ is a solution of that equation where a_1 & a_2 are arbitrary constants. Given $\partial^2 y/\partial x^2 = -k^2 y$. how is k related to momentum?

B) Attempt any 1:- 7M]

a) If $\psi_1(x)$ and $\psi_2(x)$ are the solutions of STIE for different energy eigen values E_1 & E_2 then $\int_{-\infty}^{\infty} \psi_1^* \psi_2 \, dx = 0$.

b) What is an eigenvalue equation? What are eigen functions and eigenvalues? What is meant by stationary states?

C) Attempt any 1:- 5M]

a) Find the expectation value of x for a wave function, $\psi(x) = \sqrt{2/l}\sin(\pi x/l)$. $0 < x < l$.

b) The wave function for a free particle in a box is given by $\psi_n = A \sin(n\pi x/2L)$, $n = 1,2,\ldots\ldots$ Find its allowed energies.

Q.2 Attempt the following:-

A) Attempt any 1:- 8M]

a) Describe the experiment of Fizeau convection coefficient with the help of diagram.

b) Prove that Newton's laws of motion are invariant under Galilean transformations.

B) Attempt any 1:- 7M]

a) Why the apparatus of Michelson – Morley experiment was rotated through 90°? Why did they repeat the experiment during day & night and during all season of the year?

b) What is Newtonian principle of relativity? Discuss with examples. Why should laws of nature be the same in all inertial frames of reference?

C) Attempt any 1:- 5M]

a) The length of the rod is 100 m. if the length of this rod is measured by the observer moving parallel to its length is 51 m. find the speed of the observer.

b) State and explain the fundamental postulates of special theory of relativity.

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Q.3 Attempt the following:-

A) Attempt any 1:- 8M]

a) What is meant by zero potential? Discuss classically & quantum mechanically the motion of a particle for zero potential. Find the expectation value of momentum and comment on it.

b) What is step potential? Discuss classical behavior of the motion of a particle when $E_0 > V_0$ & $E_0 < V_0$.

B) Attempt any 1:- 7M]

a) Set up schrodinger's equation for a particle in a one dimensional box. Solve it to obtain energy eigen functions and normalize them.

b) What is meant by finite square well potential? How does it differ from infinite square well potential in physical behaviour?

C) Attempt any 1:- 5M]

a) Show that expectation of momentum of a particle in a one dimensional box is zero. Comment on the statement.

b) Estimate the zero point energy for a neutron in a nucleus, by treating it as if it were in an infinite square well of width equal to a nuclear diameter of 10^{-14}m. [Given :- $m_n = 1.67 \times 10^{-27}$kg , $h = 6.62 \times 10^{-34}$ Js consider the problem to be one dimensional].

Q.4 Attempt any 3:- 15M]

a) What is meant by normalization of wave function?.

b) $\Psi(x) = \exp[(-m\omega^2/\hbar^2)x^2]$ represents the state of an oscillator of angular frequency ω. Normalize the wave function and find the expectations of position and momentum.

c) Calculate the percentage contraction of a rod moving with velocity 0.8 times the velocity of light in a direction at 60° to its own length.

d) A spaceship is 50m long on a ground, when it is in flight its length appears to be 49m to an observer on the ground. Find the speed of the spaceship.

e) An α – particle having energy 10 MeV approaches a potential barrier of height 50 MeV and width 10^{-15}m. determine the transmission coefficient ($m_\alpha = 6.68 \times 10^{-27}$kg).

f) A dust particle of mass 4×10^{-14} kg moving with velocity 10^{-2} m/s impinges on a potential step whose height is twice its kinetic energy. Estimate its penetration distance in the classically forbidden region.

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