STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2004-05 & thereafter)

SUBJECT CODE : **PH/MC/QM64**

B.Sc. DEGREE EXAMINATION APRIL 2010
BRANCH III - PHYSICS
SIXTH SEMESTER

REG. No._____

COURSE : **MAJOR – CORE**
PAPER : **QUANTUM MECHANICS**
TIME : 30 MINS. MAX. MARKS : 30

SECTION – A

TO BE ANSWERED IN THE QUESTION PAPER ITSELF

ANSWER ALL QUESTIONS: (30 x 1 = 30)

I **CHOOSE THE CORRECT ANSWER:**

1. For a dispersive medium v_g
   a. $< v_p$ b. $> v_p$ c.$=v_p$

2. DeBroglie wavelength velocity v_p must be
   a. $> c$ b.$< c$ c. $= c$

3. Heisenberg uncertainty relation for position and momentum is, $\Delta x \Delta p$
   a. $\geq \hbar/2$ b. $\geq 1/2$ c. $\geq 1/2\pi$

4. _____ is said to be a normalized wavefunction
   a. $\psi\, \psi^* d\tau = 1$ b. $\psi\, \psi^* d\tau = 0$ c. $\psi\, \psi^* d\tau \neq 1$

5. The expectation value of a dynamic variable A is
   a.$\langle A \rangle = \int \psi^* \psi\, d\tau$ b. $\langle A \rangle = \int \psi^* A \psi\, d\tau$ c. $\langle A \rangle = 1/\int \psi^* \psi\, d\tau$

6. The wavefunction $\psi(x)$
   a. must be single valued and continuous everywhere.
   b. need not be single valued and continuous everywhere.
   c. must be single valued and discontinuous everywhere.

7. The operator for momentum p is
   a.$-ih\, \Delta/2\pi$ b. $ih\Delta^2/2\pi$ c. $ih\, \Delta/2\pi$

8. The separation between any two consecutive energy levels for a rigid rotator is,
   a. $(l+1)\, \hbar^2/I$ b.$l(l+1)\, \hbar^2/2I$ c. $(l+1)\, \hbar/I^2$

9. The ratio $|C|^2/|A|^2$ Is called
   a. reflection coefficient b. penetrability c. transmission coefficient
   Where C is the amplitude of the transmitted wave , A is the amplitude of incident wave.

10. The permitted values of m_l are
    a. 0,1,2---(n-l) b. o, ±1, ±2---±l c. 1,2,3

11. The zero point energy of the harmonic oscillator is
    a. $h\nu/2$ b. $h\nu$ c. 0

..2..

12. If more than one linearly independent wavefunction belonging to the same energy level E, the energy level is said to be
a. non degenerate b. degenerate c. orthonormal

13. [H,p] is
a. $\neq 0$ b. $= 0$ c. $= 1$

14. If L is the total angular momentum operator, then L^2 =
a. $\hbar^2 l(l+1)$ b. $\sqrt{(l(l+1))}\,\hbar$ c. $1\,(l+1)\,\hbar$

15. $[L_Z, L_+]$ =
a. $h\,L_+$ b. $-h\,L_+$ c. 0

II. **STATE WHETHER TRUE OR FALSE:**

16. Wave nature has to be an inherent property of each particle.
17. The eigen values of a self ad joint operator are real.
18. For a linear harmonic oscillator, the occurrence of zero point energy is a direct consequence of uncertainty principle.
19. Parity operator is not a Hermitian operator.
20. For a rectangular potential well, when E > 0,the energy spectrum is a continuum.

III. **FILL IN THE BLANKS:**

21. The relation between group velocity and wave velocity is _____.
22. The eigen functions belonging to discrete energy values are ----------.
23. For a free particle , the energy and momentum are related as _____.
24. The Hamiltonian operator for a free particle is _____.
25. The ground state energy level for a particle in 3 dimensional box is _____.

IV. **ANSWER THE FOLLOWING:**

26. State complimentarity principle.

27. What do you understand by the term ‘eigen value’ and ‘eigen function’?

28. What is quantum mechanical tunnelling?

29. What is meant by a linear operator?

30. Write down the Schroringer’s time independent equation for a particle inside the box.

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SECTION – B

ANSWER ANY FIVE QUESTIONS: (5 x 5 = 25)

1. Show that the deBroglie wavelength associated with an electron energy V electron-volts is approximately $1.227/\sqrt{V}$ nm.
2. Write a note on expectation value of an dynamical variable.
3. Calculate the permitted energy levels of an electron in a box 1 $\mathring{A}$ wide.
4. The position and momentum of 1 KeV electron are simultaneously determined. If its position is located within 1 $\mathring{A}$,what is the percentage of uncertainty in its momentum?
5. What is the deBroglie wavelength of an electron of kinetic energy 120 eV ?
6. Prove that the eigen functions of a parity operator form a complete set.
7. Prove that $[L_x,x] = 0$

SECTION – C

ANSWER ANY THREE QUESTIONS: (3 x 15 = 45)

8. Describe Davison and Germer experiment for the study of electron diffraction.What are the results of the experiment? Derive an expression for deBroglie wavelength. Explain the superposition principle as applied in Quantum Mechanics.
9. Discuss the conditions to be satisfied by wavefunction.
10. Establish Schroringer's equation for a linear harmonic oscillator and solve it to obtain its eigen values and eigen functions.
11. Solve Schroringer's equation for the case of Hydrogen atom.
12. Obtain the commutation rules for the components of orbital angular momentum. Also prove that L^2 commutes with any of the three components of angular momentum operator.

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