

**B.Sc. DEGREE EXAMINATION APRIL 2008**  
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:

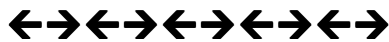
- For a non-relativistic free particle, the phase velocity is \_\_\_\_\_ the group velocity.  
a) equal to                      b) half                      c) twice
- The wavelength of an electron accelerated by a potential of  $10^2$  volts is  
a)  $12.28 \text{ \AA}$                       b)  $122.8 \text{ \AA}$                       c)  $1.228 \text{ \AA}$
- The average time of an electron remaining in an excited state in an atom is  $10^{-8}$  sec. If this the uncertainty in the measurement of time, the uncertainty in energy is  
a)  $5.6 \text{ eV}$                       b)  $6.59 \times 10^{-8} \text{ eV}$                       c)  $1.05 \text{ eV}$
- The wave function describing a physical system  
a) should be continuous      b) can have many values      c) should be real
- In Quantum Mechanics, the operator for  $p_x^2$  is  
a)  $\hbar^2 \partial^2 / \partial x^2$                       b)  $-\hbar^2 \partial^2 / \partial x^2$                       c)  $-i\hbar \partial / \partial t$
- The energy of a particle in a bound system are  
a) continuous                      b) discrete                      c) positive
- For a particle encountering a potential barrier, the sum of reflection and transmission coefficients is always  
a) zero                      b) less than 1                      c) 1
- The eigen functions of a Hermitian operator belonging to \_\_\_\_\_ eigen value(s) are orthogonal  
a) same                      b) distinct                      c) continuous



- 22. The Hamiltonian for a free particle is \_\_\_\_\_.
- 23. If  $\Psi$  is an normalized wave function, the expectation value of velocity is given as \_\_\_\_\_.
- 24. The potential of a linear harmonic oscillator is \_\_\_\_\_.
- 25. \_\_\_\_\_ is an example of a rigid rotator.

IV ANSWER THE FOLLOWING:

- 26. State Heisenberg's uncertainty principle.
  
  
  
  
  
  
  
  
  
  
- 27. Why should the wave function be finite everywhere?
  
  
  
  
  
  
  
  
  
  
- 28. Give the condition for a set of functions to be mutually orthogonal.
  
  
  
  
  
  
  
  
  
  
- 29. What is a linear operator?
  
  
  
  
  
  
  
  
  
  
- 30. What is 'quantum tunneling'?



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

SUBJECT CODE : PH/MC/QM64

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BRANCH III - PHYSICS  
SIXTH SEMESTER

COURSE : MAJOR – CORE  
PAPER : QUANTUM MECHANICS  
TIME : 2 ½ HOURS MAX. MARKS : 70

**SECTION – B**

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

1. Electrons of energy 60eV fall on the lattice planes of a crystal and give Bragg reflection in the first order. If the lattice spacing of the crystal is 0.91 Å, calculate the glancing angle at which the electrons must be incident.
2. The uncertainty in velocity is given to be 10 m/sec. Calculate the uncertainty in the position of a) an electron b) a 20 gm bullet. Comment on your result.
3. The width of a spectral line of wavelength 6000 Å is measured as 0.012 Å. Find the average time for which the system remains in the corresponding energy state.
4. Determine the degree of degeneracy of the energy level  $38\pi^2 \hbar^2 / 2mL^2$  of a particle of mass 'm' in a cubical box of side 'L'.
5. Calculate the probability of transmission for a 3MeV proton through a 6 MeV high and  $2 \times 10^{-14}$ m thick rectangular potential barrier.
6. Calculate the zero point energy of a system consisting of a mass of 1 gm connected to a fixed point by a spring which is stretched to 1 cm by a force of  $10^5$  Newtons. The particle is restricted to move in one direction only.
7. Obtain the commutation relation between any two components of angular momentum.

**SECTION – C**

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

8. State de Broglie's postulates. Describe Davission and Germer's experiment and explain its results.
9. Establish Schrodinger's time independent equation. Comment on 'probabilistic interpretation' and 'normalization' of the wave function.

10. Solve Schrödinger's equation for a particle in a 1-D box with impenetrable walls at  $x = 0$  and  $x = a$  and obtain its energy eigen functions. Show that the energy levels of this system are discrete.
11. Write down the radial part of the time independent Schrödinger equation for the hydrogen atom and find the relation between the energy levels  $E_n$  and the principal quantum number,  $n$ .
12. Discuss the properties of Hermitian operators. Evaluate a)  $[x^n, p_x]$  and b)  $[L_z, L_{\pm}]$ .

