

(6 pages)

Reg. No. :

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M.Sc. (CBCS) DEGREE EXAMINATION,
NOVEMBER 2013.

Third Semester

Physics

QUANTUM MECHANICS – I

(For those who joined in July 2012 onwards)

Time : Three hours

Maximum : 75 marks

SECTION A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. $\psi(x,t)$ must be _____ in regions where the particle is likely to be found
(a) Large (b) Small
(c) Zero (d) Infinity
2. Ehrenfest's theorem are the quantum equivalent of the equations of a _____
(a) Quantum particle
(b) Classical particle
(c) Semi classical particle
(d) Semi quantum particle

3. The normalization constant A in the wave function $\phi = Ae^{im\phi}$ is

- (a) $\sqrt{\pi}$ (b) $\sqrt{2\pi}$
(c) $\frac{1}{\sqrt{\pi}}$ (d) $\frac{1}{\sqrt{2\pi}}$

4. A particle is said to be free when $V(r)$ is

- (a) α (b) 0
(c) Proportional to $\frac{1}{r}$ (d) Proportional to $\frac{1}{r^2}$

5. From the definition of scattering cross section $\sigma(\theta, \phi)$ is equal to

- (a) $|f(\theta)|^2$ (b) $|f(\phi)|^2$
(c) $|f(\theta, \phi)|^2$ (d) $|f(\theta, \phi)|$

6. Total scattering cross section in the case of scattering by a perfect rigid sphere is

- (a) $4a^2$ (b) $4\pi a$
(c) 4π (d) $4\pi a^2$

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7. The α s and β s appearing in Dirac equation are

- (a) Matrices
- (b) Square matrices with constant elements
- (c) Simple numbers
- (d) Vectors

8. Dirac matrices

- (a) commute (b) do not commute
- (c) anti commute (d) do not have inverse

9. Angular momentum matrices are valid for

- (a) any j value
- (b) only when j is an integer
- (c) only when j is a half integer

10. In Hilbert space the Clebsch Gordan coefficients represent

- (a) unitary transformation
- (b) operators
- (c) basis vectors
- (d) momentum matrices

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SECTION B — (5 × 5 = 25 marks)

Answer ALL questions choosing either (a) or (b).

11. (a) Derive the one dimensional time dependent Schrodinger equation.

Or

(b) Explain the normalization of ψ .

12. (a) Describe the concept of degeneracy of hydrogenation.

Or

(b) What is called parity of eigen function? Explain the briefly.

13. (a) Write short notes on scattering cross section.

Or

(b) Explain the Ramsauer - four star effect.

14. (a) Discuss briefly the representation of operators.

Or

(b) Show that $(W)_{K\mu} = \int_{\tau} U_{K\lambda} (V^T)_{\tau\mu}$.

15. (a) Describe the rotation and angular momentum groups.

Or

(b) Explain the spin of vector particle.

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[P.T.O.]



SECTION C — (5 × 8 = 40 marks)

Answer ALL questions choosing either (a) or (b).

16. (a) Normalize the wave function $\psi(x) = Ae^{-ax^2}$, A and a are constants over the domain $-\infty \leq x \leq \infty$.

Or

- (b) State and prove Ehrenfest's theorem.
17. (a) Using the minimum uncertainty product, obtain the eigen functions and position probability of the motion of a free wave packet in one dimension.

Or

- (b) Obtain the harmonic - Oscillator wave functions and explain the correspondence of it with classical theory.
18. (a) Deduce the scattering coefficients of the one dimensional Collision of a particle with the square potential barrier.

Or

- (b) Explain the Gaussian wave - packet scattering from a square barrier.
19. (a) State and prove the Virial theorem.

Or

- (b) Explain the quantization of the motion of a particle under electro magnetic field.

20. (a) State the commutation relations obeyed by the components of angular momentum and express them in vector notation.

Or

- (b) What are Clebsh- Gordan coefficients? Explain their significance.
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