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Reg. No. : .....

Code No.: 7399 **Sub. Code: ZPHM 41**

M.Sc. (CBCS) DEGREE EXAMINATION, NOVEMBER 2024

Fourth Semester

Physics – Core

QUANTUM MECHANICS – II

(For those who joined in July 2021 and 2022 only)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The value of zero point energy is

   (a) 7/2 $\hbar w$

   (b) 5/2 $\hbar w$

   (c) 3/2 $\hbar w$

   (d) 1/2 $\hbar w$

2. W.K.B. approximation is valid only

   (a) If the fractional change in momentum over λ is large

   (b) If Fractional change in momentum over λ is small

   (c) If the fractional change in momentum is same as λ

   (d) In a region where classical turning point

3. Born approximation is used

   (a) for low energy scattering

   (b) for high energy scattering

   (c) for tunneling

   (d) in relativistic quantum methods

4. In the Born approximation, the scattering amplitude by a Yukawa potential $V(r) = \beta r^{-\mu r}/r$

   (a) $2mg^2/\hbar^2(\alpha^2+q^2)$ (b) $4m^2g^4/\hbar^2(\alpha^2+q^2)$

   (c) $2mg^2/\hbar^2(\alpha^2+q^2)^2$ (d) $4m^2g^4/\hbar^2(\alpha^2+q^2)^2$

5. The eigen value of a Pauli matrix σ_y is

   (a) +1 (b) +2

   (c) 0 (d) ∞

6. Three non-interacting identical spin 3/2 particles are in the one-dimensional harmonic oscillator potential $V(x) = \frac{1}{2} m\omega^2 x^2$. The ground state energy of the system

(a) $7/2\ \hbar\omega$ (b) $5/2\ \hbar\omega$

(c) $3/2\ \hbar\omega$ (d) $1/2\ \hbar\omega$

7. Spin $\frac{1}{2}$ particles obey

(a) MaxWell–Boltzmann statistics

(b) Bose-Einstein statistics

(c) Bose-Einstein condensation

(d) Fermi-Dirac statistics

8. In the Schroedinger picture

(a) operators are time dependent

(b) state vectors are time dependent

(c) operators and state vectors are time dependent

(d) operators and state vectors are time independent

9. In the case of Dirac vacuum, which of the following is true?

(a) all negative energy states are filled

(b) all positive energy states are filled

(c) all negative and positive energy states are filled

(d) all negative and positive energy states are empty

10. Which of the following is the property of the Pauli matrix?

(a) $\sigma_x\sigma_y = i\sigma_z$ (b) $\sigma_y\sigma_z = -i\sigma_x$

(c) $\sigma_z\sigma_x = -i\sigma_y$ (d) $\sigma_x^2 \neq \sigma_y^2 \neq \sigma_z^2$

PART B — ($5 \times 5 = 25$ marks)

Answer ALL questions, choosing either (a) or (b).
Each answer should not exceed 250 words.

11. (a) Determine the energy levels of a one–dimensional potential well using W.K.B. method.

Or

(b) Determine the ground state energy of harmonic oscillator using variation method.

12. (a) Write a short note on Green's function.

Or

(b) Explain about the validity of Born approximation.

13. (a) Write a short note on Symmetric and anti–symmetric wave functions

Or

(b) Derive the spin matrices for S = 1/2 .

14. (a) Give a short note on the interaction picture.

Or

(b) Give the commutation relation between A and H in Schroedinger's picture.

15. (a) Construct the Klein-Gordon equation for a relativistic free particle.

Or

(b) Explain the properties of α and β matrices.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b)
Each answer should not exceed 600 words.

16. (a) Obtain the ground state energy of Helium using variational principle.

Or

(b) Explain the theory of α-decay using W.K.B. method.

17. (a) Give the asymptotic solution using partial wave analysis.

Or

(b) Explain briefly about scattering by a square well potential.

18. (a) What are identical particles? Give the physical meaning of identity. Also explain the distinguishability of identical particles.

Or

(b) Explain anti-symmetrization of wave functions in the case of identical particles.

19. (a) Derive the equations of motion in Heisenberg's picture.

Or

(b) Explain briefly about discrete symmetries.

20. (a) Deduce the Dirac's equation for a central field.

Or

(b) Deduce the Schroedinger's relativistic equation for a particle in electromagnetic field.

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