CLASS: M.Sc. PHYSICS **15A/ 324**

St. JOSEPH'S COLLEGE (AUTONOMOUS) TIRUCHIRAPPALLI – 620 002

SEMESTER EXAMINATIONS – APRIL 2015

TIME: 40 minutes **MAXIMUM MARKS: 30**

SEM	SET	PAPER CODE	TITLE OF THE PAPER
II	2014	14PPH2105	QUANTUM MECHANICS

SECTION - A

Answer all the questions: **$30 \times 1 = 30$**

Choose the correct answer:

1. If $\left\langle n \,|\, \frac{1}{2}m\omega^2 x^2 \,|\, n \right\rangle = \left\langle n \,|\, \frac{p^2}{2m} \,|\, n \right\rangle$, then the expectation value of

   a) Potential and kinetic energies are equal

   b) PE = 1/2KE c) PE = $\sqrt{2KE}$ d) PE = 2KE

2. The norm of a ket $|a\rangle$ is denoted by $\langle a|a\rangle$ is a real

   a) Negative number b) Positive number

   c) Non-negative number d) Non-positive number

3. Orthonormality relation is expressed as

   a) $\langle a_i \,|\, a_j\rangle = \delta_{ij}$ b) $\langle a_i \,|\, a_i\rangle = \delta_{ii}$

   c) $\langle a_i \,|\, b_j\rangle = \delta_{ij}$ d) $\langle a_j \,|\, a_i\rangle = \delta_{ji}$

4. All possible information about a quantum mechanical system can be derived from

   a) Operators b) Variables

   c) Wave functions d) Eigen values

5. The operators in QM are derived from ________ of the corresponding pair of classical variables

   a) Poisson bracket b) Hamiltonian's equation

   c) Lagrangian bracket d) Commutator bracket

6. Communting operators have common set of

a) Eigen form
b) Eigen value
c) Physical variables
d) Cannonically conjugate variables

7. Eigen value of the angular momentum operator L^2 acted on the eigen function $Y_{lm}(\theta, \phi)$ are

a) $\lambda\hbar$
b) $\lambda\hbar^2$
c) $\lambda(\lambda+1)\hbar$
d) $\lambda(\lambda+1)\hbar^2$

8. The commutator $[L_z, L_x]$ results a value in

a) L^2 b) L_x c) 0 d) L_y

9. The operators L_x, L_y and L_z are called the generators of infinitesimal rotation whose general representation to find $R_z,(\alpha)$ for some finite rotation α about z-axis is

a) $\exp(i\alpha L_z/\hbar)$
b) $\exp(-i\,\alpha L_z/\hbar)$
c) $\exp(\alpha L_z/\hbar)$
d) $\exp(i\alpha L_z)/\hbar$

10. The different forms of iso-spins of pi-mesons are

a) 1 b) 2 c) 3 d) 4

11. The total angular momentum are constants of motion is represented by

a) $[L^2, H] = 0$
b) $[L_z, H] = 0$
c) $[L, H] = 0$
d) $[L^3, H] = 0$

12. From Zeeman effect pattern, the number of multiplicity levels informed on the spin is

a) $(2l-1)$
b) $(2l+1)$
c) $l(2l-1)$
d) $l(2l+1)$

13. The first order of time dependent perturbation varying sinusoidally in time, leads to the

a) Emission of energy only
b) Absorption of energy only
c) Either emission or absorption of energy
d) Both emission and absorption of energy

14. The variational principle is particularly effective when estimating the energy of

a) The highest state of any symmetry

b) The lowest state of any symmetry

c) Any state of all symmetry

d) Any state all antisymmetry

15. There is no linear stark effect in the atoms of group 1 of the periodic table, since the energy levels of these atoms of energy E are determined only by

a) n b) 1 c) n & 1 d) m & s

16. Adiabatic approximation used in time dependent theory where perturbation is turned on

a) Fastly b) Slowly

c) Without any restriction d) Repeatedly

17. For a particle constrained to move between classical turning points x = x_1 and x = x_2 in a potential well, the energy levels are obtained from the condition

a) $\int_{x_1}^{x_2} p(x)dx = n\hbar$ b) $\int_{x_1}^{x_2} p(x)dx = n(n+1)\hbar$

c) $\int_{x_1}^{x_2} p(x)dx = (n+1/2)\hbar$ d) $\int_{x_1}^{x_2} p(x)dx = (n-1/2)\hbar$

18. The condition for the applicability of the perturbation theory is

a) $|\langle m|H_1|n\rangle^{(0)}\langle\langle E_1^{(0)} - E_2^{(0)}|$ b) $|\langle m|H_0|n\rangle^{(0)}\langle\langle E_n^{(0)} - E_m^{(0)}|$

c) $|\langle m|H_1|n\rangle^{(0)}\langle\langle E_n^{(0)} - E_m^{(0)}|$ d) $|\langle m|H_1|n\rangle^{(0)}\langle\langle E_0^{(0)} - E_1^{(0)}|$

19. Scattering cross sections are measured in BARNS.1 BARNS is equal to

a) 10^{-24}cm b) 10^{-24}cm^2 c) 10^{24}cm d) 10^{24}cm^2

20. Scattering amplitude is related to the experimentally observable differential scattering cross section, whose dimension is

a) L^0 b) L^1 c) L^2 d) L^3

21. Low energy scattering can be explained satisfactorily with

a) s-wave b) p-wave c) d-wave d) q-wave

22. Born's approximation is valid for ____ potential at _____energies.

a) Strong, low b) Weak, low

c) Weak, high d) Strong, high

23. Born's approximation is considered to be an integral equation of the potential function of well known

a) Laplace transforms b) Fourier transforms

c) Spherical coordinate transformation

d) Galilean transformation

24. Scattering cross section depends on the momentum of the incident particle $\hbar k$ and the scattering angle θ through the combination

a) $q = 2k \sin(\theta/2)$ b) $q = 2k \sin(\theta)$

c) $q = k \sin(\theta/2)$ d) $q = 2k \sin(\pi-\theta/2)$

25. Dirac equation describes the particles of

a) ½ integral spin b) Integral spin

c) Zero spin d) No restriction in spin

26. α_x, α_y and α_z in Dirac matrices are only

a) (4×4) Pauli matrices σ_i b) (2×4) Pauli matrices σ_i

c) (2×2) Pauli matrices σ_i d) (4×2) Pauli matrices σ_i

27. The magnetic moment of the charge particle is

a) $\frac{1}{2}\hbar\sigma'$ b) $\hbar\sigma'$ c) $\frac{e}{m_0 c}\left[\frac{1}{2}\hbar\sigma'\right]$ d) 0

28. The relativistic relation for the total energy E of a free particle with rest mass m is

a) $E^2 = c^2p^2 + m^2c^4$ b) $E^2 = c^2p^2 + m^2c^2$

c) $E^2 = m^2c^4$ d) $E^2 = cp + mc^2$

29. Which of the following is correct?

a) Trace α_i = Trace $\beta = 0$ b) Trace $\alpha_i = 0$ but Trace $\beta \neq 0$

c) Trace $\alpha_i \neq 0$ but Trace $\beta = 0$ d) Trace α = Trace $\beta \neq 0$

30. If H is the Dirac's Hamiltonian, the dx/dt will be

a) $c\bar{\alpha}$ b) α/c c) $c\hat{\beta}$ d) $1/c\hat{\beta}$

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