

PHY-502**Statistical Mechanics and Quantum Mechanics****M. Sc. PHYSICS (MSCPHY-12/13/16/17)****First Year, Examination, 2018****Time : 3 Hours****Max. Marks : 80**

Note : This paper is of **eighty (80)** marks containing **three (03)** Sections A, B and C. Learners are required to attempt the questions contained in these Sections according to the detailed instructions given therein.

Section-A**(Long Answer Type Questions)**

Note : Section 'A' contains four (04) long answer type questions of nineteen (19) marks each. Learners are required to answer *two* (02) questions only.

1. What is the basic difference between the postulates of classical and quantum theory ? What are shortcomings of old quantum theory ?
2. Establish the steady state form of Schrödinger equation.
3. Giving suitable examples explain the macrostates and microstates of a system. What are accessible microstate ?
4. Explain and describe Lorentz covariance of Dirac equation.

Section-B

(Short Answer Type Questions)

Note : Section 'B' contains eight (08) short answer type questions of eight (08) marks each. Learners are required to answer *four* (04) questions only.

1. Determine the energy levels of a particle moving in a potential given by $V(r) = \frac{A}{r^2} + Br^2$.

2. Show that :

$$\vec{\sigma} \times \vec{\sigma} = 2i\vec{\sigma}$$

3. Calculate all the Clebsch-Gordan coefficients for $j_1 = j_2 = 1$.

4. Using Maxwell-Boltzmann partition function, deduce Maxwell's energy distribution law.

5. Calculate the de-Broglie wavelength of a proton moving with $\frac{1}{20}$ of the velocity of light.

6. Using uncertainty principle, prove that electron cannot reside inside the nucleus of the atom.

7. Show that $\psi = c x \exp\left(\frac{-x^2}{2}\right)$ is the eigen function of

$$\text{operator} \left[\frac{\partial^2}{\partial x^2} - x^2 \right].$$

8. Write notes on the following :

(a) Bound state

(b) Tunnel effect

Section–C

(Objective Type Questions)

Note : Section ‘C’ contains ten (10) objective type questions of one (01) mark each. All the questions of this Section are compulsory.

Choose the correct alternative :

- The direct evidence of existence of momentum of a photon is :
 - Photoelectric effect
 - Raman effect
 - Compton effect
 - Joule’s effect
- According to Schrödinger, a particle is equivalent to :
 - a single wave
 - a wave packet
 - light wave
 - cannot behave as wave
- Wave function may be valued.
 - single
 - double
 - many
 - None of the above
- If $x \exp \left(\frac{-x^2}{2} \right)$ is an eigen function of operator $-\frac{d^2}{dx^2} + x^2$, then corresponding eigen value will be :
 - 3

- (b) -3
 - (c) -16
 - (d) 0
5. The lowest energy that a neutron can have in a box of rigid walls of length 10^{-14} m is :
- (a) 3.3×10^{-13} joule
 - (b) 1.0×10^{-13} joule
 - (c) 3.3×10^{-10} joule
 - (d) 3.3×10^{-5} joule
6. The potential function of a harmonic oscillator is :
- (a) hyperbolic
 - (b) parabolic
 - (c) elliptical
 - (d) linear
7. The volume of a cell in six-dimensional phase space is :
- (a) h^3
 - (b) h^6
 - (c) h^{-3}
 - (d) h^{-6}
8. The spin of photon is :
- (a) $\frac{3}{2}$

(b) $\frac{1}{2}$

(c) 0

(d) 1

9. The Fermi-Dirac distribution is :

(a) $\frac{g_i}{n_i} = 1 + \exp (\alpha + \beta \epsilon_i)$

(b) $\frac{g_i}{n_i} + 1 = \exp (\alpha + \beta \epsilon_i)$

(c) $\frac{g_i}{n_i} = \exp (\alpha + \beta \epsilon_i)$

(d) $\frac{g_i}{n_i} = \exp (\alpha - \beta \epsilon_i)$

10. According to the F-D Statistics, the number of particles in a phase cell can be :

(a) any number

(b) only two

(c) only three

(d) only one

