K16P 0426

Reg. No. : .....

Name : .....

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2016

PHYSICS (2014 Admn. Onwards)

PHY 2C06 : Quantum Mechanics – I

Time : 3 Hours

Max. Marks : 60

SECTION – A

Answer both questions (Either **a** or **b**). **Each** question carries **12** marks.

1. a) Obtain the energy eigen values of a linear harmonic oscillator by the Schrodinger method. How is the zero point energy of a harmonic oscillator explained ?

   OR

   b) Discuss the problem of conservation of angular momentum as a consequence of the rotational invariance of the system.

2. a) Outline the Schrodinger perturbation theory for non degenerate levels and apply it to explain first order Stark effect in hydrogen.

   OR

   b) Discuss the first order time independent perturbation theory for non degenerate stationary state. Obtain the corrected eigen functions and eigen value. **(2×12=24)**

SECTION – B

Answer **any four**. 1 mark for Part – **a**, 3 marks for Part – **b** and 5 marks for Part – **c**.

1. a) Define linear vector space.
   b) Explain the properties of linear vector space.
   c) Show that commuting operators posses simultaneous eigen functions.

P.T.O.

2. a) Out line the interaction picture.
   b) Obtain the equation of motion for the state vector in the interaction picture.
   c) Derive the equation of motion for operator in the interaction picture.

3. a) State the uncertainty principle.
   b) Prove that the simultaneous measurement of potential and kinetic energies is not possible.
   c) The wave function of a particle in a state is $\psi = Ne_{XP}\left(-\frac{x^2}{2\alpha}\right)$. Where $N = \left(\frac{1}{\pi\alpha}\right)^{1/4}$. Evaluate $\Delta P \Delta x$.

4. a) Define a general angular momentum operator.
   b) Explain why the definition of angular momentum given by $\overline{L} = \overline{r} \times \overline{P}$ is not a general one.
   c) Derive expressions for L^+, L^- and L^2 in spherical polar coordinates.

5. a) What do you mean by spin of an electron ?
   b) Explain spin up and spin down states. What are spinors ?
   c) Using Pauli's spin matrix reduce each of the operators :
      i) $S_x^2 S_y S_z^2$
      ii) $S_x^2 S_y^2 S_z^2$.

6. a) Give the principle of time independent perturbation theory.
   b) Determine the first order correction to wave function.
   c) Calculate the ground state energy of an anharmonic oscillator up to the first order. Whose potential energy is
      $V = \frac{1}{2} m w^2 x^2 + ax^3$ where $ax^3 << \frac{1}{2} m w^2 x^2$.

(4x9=36)

K16P 0427

Reg. No. : .....

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Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2016
(2014 Admn. Onwards)
PHYSICS
PHY 2C07 : Mathematical Physics – II

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (Either **a** or **b**) : **(2×12=24)**

1. a) Explain Raabe's test and Cauchy's root test for convergence. Test for convergence of $\sum n^3 / 3^n$ by Cauchy's method.
   b) Set up the partial differential equation for transverse vibrations in a stretched string and solve it by the method of separation of variables.

2. a) Derive the first shifting and change of scale properties of Laplace transforms. Find L (e^{at} sin bt).
   b) What are reducible and irreducible representations ? Show that every representation of a group is equivalent to a unitary representation.

SECTION – B

Answer **any four**. **1** mark for Section **a**, **3** marks for Section **b** and **5** marks for Section **c**. **(4×9=36)**

3. a) What is meant by uniform convergence of a series ?
   b) What is the Leibniz criterion for convergence of an alternating series ?
   c) Discuss the convergence of $1-1/\sqrt{2}+1/\sqrt{3}-1/\sqrt{4}+....$

4. a) Define Green's function.
   b) Prove that symmetry of Green's function.
   c) Obtain the eigen function expansion of Green's function.

P.T.O.

5. a) What is the Kernel of Laplace' transform ?
   b) If f(s) is the transform of f(t) show that $L\{f'(t)\} = s f(s) - f(o)$.
   c) Find the inverse Laplace' transform of $(s^2 + 3s + 4)/s^3$.

6. a) Write down a second order non linear PDE.
   b) Give an example for a boundary value problem.
   c) Solve Laplace' equation in polar coordinates r and θ.

7. a) Define discrete Fourier transform.
   b) What is the role of Fourier transform in DSP ?
   c) Find the Fourier transform of $f(x) = \exp(-a^2x^2)$, $a > 0$.

8. a) What are conjugate elements of a group ?
   b) Explain homomorphism.
   c) Show that the groups SU (2) and SO(3) are homomorphic.

Reg. No. : B.5P.SPHI816

Name : Saranya.ck

K16P 0428

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2016

PHYSICS

(2014 Admn. Onwards)

PHY 2C08 : Statistical Mechanics

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer both questions (either **a** or **b**). **Each** question carries **12** marks. (2×12=24)

1. a) Distinguish between microstates and macrostates. Derive an expression for entropy of a classical ideal gas.

   b) Explain the quantum mechanical ensemble theory. Explain density matrix.

2. a) Explain the thermodynamic behavior of an ideal Bose System. What is the condition for the onset of Bose condensation ?

   b) Define Fermi temperature and Fermi energy. Explain Pauli's theory of paramagnetism.

SECTION – B

Answer **any four**. **1** mark for Section **a**, **3** marks for Section **b**, and **5** marks for Section **c**.

(4×9=36)

3. a) Explain degenerate state and statistical weight factor.

   b) Derive the Gibbs-Duhem relation.

   c) The free energy F of a system depends on a thermodynamic variable ϕ as $F = -a\phi^2 + b\phi^6$ where $a, b > 0$. Find the value of ϕ when the system is in thermodynamic equilibrium.

P.T.O.

4. a) What are the parameters which describe a microstate ?

   b) Show that in a steady state probability density is independent of the coordinates of phase space.

   c) Two states with energy difference 4.83×10^{-17} J occurs with relative probability of e^2. Calculate the temperature of the system ($k = 1.38 \times 10^{-23}$ J/K).

5. a) What is meant by canonical ensemble ?

   b) Explain the term phase space of a classical system.

   c) Energy difference between the ground state $^1s_0$ and the first excited stae $^3s_1$ of He atom is 159843 cm^{-1}. Calculate the fraction of excited atoms in He at 6000 K.

6. a) What is meant by an ideal gas ?

   b) A Bose gas consists of 5 particles and 4 available energy states. How many macrostates are possible ?

   c) Show that for an ideal Bose gas $PV = \frac{2E}{3}$.

7. a) Define Fermi gas.

   b) Explain the main features of Pauli theory of paramagnetism.

   c) Derive the equation of state of an ideal Fermi gas.

8. a) What is meant by lattice gas ?

   b) What is the difference between simple and uni-axial ferromagnets?

   c) Give an exact treatment of one dimensional Ising model.

K16P 0429

Reg. No. : ..BBPSPHISIC..........

Name : ....Sanaya.ck.........

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2016
(2014 Admn. Onwards)
PHYSICS
PHY 2C09 : Spectroscopy

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (either **a** or **b**) :

1. a) Distinguish between Normal Zeeman effect and anomalous Zeeman effect. Discuss the theory of Normal Zeeman effect and prove that the frequency shift is the same for all Normal Zeeman effect lines.

OR

b) Discuss the rotation-vibration spectra of polyatomic linear molecules. Explain the effect of nuclear spin.

2. a) Describe the construction and working of a Raman spectrometer. Explain the importance of Raman effect for phase transition studies.

OR

b) Explain recoilless emission and absorption of gamma rays. Discuss the working of a Mossbauer spectrometer. **(2×12=24)**

SECTION – B

Answer **any four** :

(1 mark for part **a**, **3** marks for part **b**, **5** marks for part **c**) :

1. a) What are linear molecules ? Give example.
   b) Explain how rotational energy transitions take place.
   c) Discuss the rotational spectra of rigid molecules. Draw the rotational energy levels and transitions for a rigid diatomic molecule.

P.T.O.

2. a) What is vibrational spectra ?

   b) Derive an expression for the vibrational energy of a diatomic molecule.

   c) The normal modes of vibration of CO_2 molecule are $\bar{\upsilon}_1 = 1330\ cm^{-1}$, $\bar{\upsilon}_2 = 667\ cm^{-1}$ and $\bar{\upsilon}_3 = 2349\ cm^{-1}$. Calculate the zero point energy of CO_2 molecule.

3. a) What is a diatomic vibrating rotator ?

   b) In the vibration rotation spectrum of HBr, why is it that the rotational lines at the high frequency end of the R branch are closely spaced and those at the low frequency end of the P-branch widely spaced.

   c) The fundamental band for HCl is centered at $2886\ cm^{-1}$. Assuming that the inter nuclear distance is 1276 Å. Calculate the wave number of the first two liens of each of the P and R branches of HCl.

4. a) What is Raman effect ?

   b) Why are anti stokes linesless intense than stoke lines ?

   c) Explain a method for the determination of bond distance of a homo nuclear diatomic molecule.

5. a) What is a V′ progression ?

   b) Explain why the wave number separation of bands in the V′ progression decreases towards shorter wavelengths while the wave number separation in the V″ progression decreases towards longer wavelengths.

   c) The values of $\bar{\upsilon}_e$ for the lower and upper states of CO are $2170.21\ cm^{-1}$ and .0062. The (0, 0) transition observed at $64746.55\ cm^{-1}$. Estimate the energy difference of the two electronic states if for the lower and upper states of CO are $1515.61\ cm^{-1}$ and .0014.

6. a) What is NMR ?

   b) Explain how NMR frequency is related to the external magnetic field applied.

   c) Find the energy difference between the spin up and spin down states of a proton in a magnetic field of B = 1.00 Telsa. Estimate the Larmour frequency of the proton in the field (g = 5.586 and $\mu_n = 5.051 \times 10^{-27}$ J/T). (4×9=36)