K17P 0613

4. a) Define spherical top molecules.

b) Molecules having permanent dipole moment are microwave active and those not having permanent dipole moment are microwave inactive. Comment.

c) Rotational and centrifugal distortion constants of HCl molecule are 10.593 cm^{-1} and 5.3×10^{-4} cm^{-1} respectively. Estimate the vibrational frequency and force constant of the molecule.

5. a) What is pre-dissociation ?

b) Explain Fortrat parabola.

c) The spectroscopic bond dissociation energy of $^{35}ClO^{26}$ radical is 1.6 eV. Calculate the equilibrium bond dissociation energy of ClO, if the fundamental vibrational frequency is 780 cm^{-1}.

6. a) Give the principle of ESR.

b) What is Fermi contact interaction and hyperfine structure ?

c) A molecule AB_2 has the following IR and Raman spectra. Discuss the molecular structure and assign the observed lines to molecular vibrations.

Frequency (cm^{-1})	IR	Raman
3750	Very strong	–
3650	Strong	Strong, polarized
1595	Very strong	–

7. a) Give the principle of NMR.

b) Explain Larmour precession.

c) A system of protons at a temperature of 25°C is placed in a magnetic field of 2 T. What is the ratio of number of proton spins in the lower state to the number in the upper state.

8. a) What is Mössbauer spectroscopy ?

b) Explain isomer shift in Mössbauer's experiment.

c) Calculate the Doppler velocity corresponding to the natural line width of the γ-ray emission from 140.4 keV excited state of ^{57}Fe nucleus having a half life of 9.8×10^{-8} s. (4×9

K17P 0613

Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree (Regular/Supplementary/ Improvement) Examination, March 2017
(2014 Admission Onwards)
PHYSICS
PHY 2C09 : Spectroscopy

Time : 3 Hours Max. Marks : 60

SECTION – A

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

1. a) Discuss the rotational spectra of rigid diatomic molecules. Also estimate the relative intensities of the spectral lines.

OR

b) Explain band origin and band head in relation to the rotational fine structure of electronic vibration spectra.

2. a) Give the classical and quantum theory of Raman effect. Show that the Stokes lines are more intense than that of Antistokes lines.

OR

b) What are hot bands in a vibrating diatomic molecule. Draw a diagram showing the energy levels of vibrating diatomic molecule. **(2×12=24)**

SECTION – B

Answer **any four** (**One** mark for part **a**, **3** marks for part **b**, **5** marks for part **c**) :

3. a) Name the different series in alkali spectra.

b) Explain Stark effect.

c) Calculate the Zeeman shift observed in the normal Zeeman effect when a spectral line of wavelength 5000 Å is subjected to the magnetic field of 1.4 Wb/m^2 taking $e/m = 1.76 \times 10^{11}\ Ckg^{-1}$.

P.T.O.

4. a) State equipartition theorem.

   b) What is Gibb's paradox ?

   c) Derive the expressions for energy and energy fluctuations in a canonical ensemble.

5. a) What is BE statistics ?

   b) Show that for B-E condensation, the number of particles in the ground state is given by $n_0 = n\left[1-\left(\frac{T}{T_0}\right)^{\frac{3}{2}}\right]$.

   c) Find the degeneracy for Hydrogen molecule at boiling point T = 20.38 K at atmospheric pressure. When its molar-volume is 1400 cc.

6. a) What is Fermi Temperature ?

   b) Consider a free electron at the Fermi level in metal at 0K and show that the de Boglie wavelength associated with an electron is given by $2\left(\frac{\pi}{3n}\right)^{1/3}$, where n is the number of electrons per unit volume.

   c) Show that the ideal Fermi-Dirac gas deviates from ideal perfect gas by some factor. Determine this factor.

7. a) Define an ensemble.

   b) Derive the relation between canonical and microcanonical ensemble.

   c) Consider a solid surface to a two dimensional lattice with N_s sites. N_a atoms are absorbed on the surface, so that each site has either 0 or 1 absorbed atom. At absorbed atom has energy $E = -\epsilon$, where $\epsilon < 0$. Calculate chemical potential of the absorbed atoms as a function of temperature T, ϵ and N_a/N_s using the canonical ensemble, considering $N_a << N_s$.

8. a) What is phase transition ?

   b) Explain how Ising Model can be applied to lattice gas.

   c) Find the nature of the locus of a particle executing a simple harmonic motion (in Cartesian space) in the phase space.

(4×9=36 Marks)

K17P 0812

Reg. No.: ....

Name: ....

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2017
PHYSICS
(2014 Admission Onwards)
PHY2C08 – Statistical Mechanics

Time : 3 Hours Max. Marks : 5?

SECTION – A

Answer both questions (Either a or b).

1. a) Define the four thermodynamic potentials. Derive the four Maxwell's thermodynamical relations.

OR

b) Prove Liouvilles theorem and discuss its physical significance.

2. a) Distinguish between paramagnetism and diamagnetism. Apply FD distribution formula to obtain the theory of Pauli's paramagnetism.

OR

b) Discuss the effect of one dimensional Ising model. Show that it is not suitable for ferromagnetism. (2×12=24 Marks)

SECTION – B

Answer any four. (One mark for Part a, 3 marks for Part b, 5 marks for Part c)

3. a) Distinguish between micro and macro states.

b) Explain with example that a macrostate can have number of microstates.

c) A lattice contains N normal lattice sites and N intersticial lattices. N identical atoms are positioned on the lattice, M on the intersticial sites and N-M on the normal sites (N >> M >> 1). If an atom occupies a normal site its energy E = 0. If an atom occupies an intersticial site, its energy is E = C. Calculate the internal energy and heat capacity as a function of temperature for this lattice.

6. a) Write down a second order linear P D E.

   b) Mention a few contexts in Physics where Laplace' equation occurs.

   c) Solve the wave equation in three dimensions by the method of separation of variables.

7. a) Define discrete Fourier transform.

   b) What is meant by Fourier cosine transform.

   c) If f(s) is the Fourier transform of f(x) show that F{f(x) cos ax} = 1/2 [f(s + a) + f(s – a)].

8. a) What are conjugate classes.

   b) Show that the identity element is a class by itself.

   c) Prove that a group of prime order is cyclic.

(4x9=36)

K17P 0611

Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2017
PHYSICS
PHY2C07 : Mathematical Physics – II
(2014 Admission Onwards)

Time : 3 Hours Max. Marks : 60

SECTION – A

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

1. a) Explain uniform convergence and absolute convergence

   Show that the series $1/(1 + x^2) - 1/(2 + x^2) + 1/(3 + x^2)$ ________ converges uniformly.

   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 convolution theorem of Fourier transforms. Find the Fourier transform of the function defined by $f(x) = 1$ for $|x| < 1$ and $f(x) = 0$ for $|x| > 1$.

   b) Derive Schur's Lemmas. **(2×12=24)**

SECTION – B

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

3. a) State binomial theorem.

   b) Give an example for an oscillatory series.

   c) Discuss the convergence of $1 - 1/\sqrt{2} + 1/\sqrt{3} - 1/\sqrt{4} + \ldots$

4. a) Define Green's function.

   b) Prove the symmetry of Green's function.

   c) Obtain the Green's function solution of Poisson's equation.

5. a) Define Laplace' transform.

   b) Explain the change of scale property of Laplace' transform.

   c) Find the Laplace' transform of t cos at.

P.T.O.

2. a) What is a Hermitian operator ?

   b) Show that the eigen values of a Hermitian operator are real.

   c) Evaluate the commuters

      a) $[d/dx, d^2/dx^2]$

      b) $[d/dx, F(x)]$.

3. a) Outline 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.

4. a) Define a general angular momentum operator.

   b) Explain why the definition of angular momentum given by $\vec{L} = \vec{r} \times \vec{p}$ is not a general one.

   c) Derive expressions for L+, L– and L^2 in spherical polar coordinates.

5. a) What is symmetry transformation ?

   b) Prove that a symmetry transformation conserves probabilities.

   c) Prove that the parity operator is Hermitian and unitary.

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

$$V = \frac{1}{2} mw^2 x^2 + ax^3$$

Where $ax^3 << \frac{1}{2} mw^2x^2$. (4×9=36)

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K17P 0610

Reg. No. : ....

Name : ....

Second Semester M.Sc. Degree (Regular/Supplementary/Improvement) Examination, March 2017
PHYSICS
(2014 Admission Onwards)
PHY2C06 : Quantum Mechanics – I

Time : 3 Hours Max. Marks : 60

SECTION – A

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

1. a) Discuss the problem of similarity transformation. Prove that the matrix representing a similarity transformation in a unitary matrix. Show that a Hermitian operator remains Hermitian under a unitary transformation.

OR

b) Distinguish between Heisenberg and Schrodinger pictures. Show that the state vectors and operators are the same in both the pictures at t= 0.

2. a) What are Glebsh-Gordon coefficients ? Obtain the recursion relations and hence compute the Glebsh-Gordon coefficients.

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. Each** question carries **9** marks :
1 mark for Part – **a**, **3** marks for Part – **b**, **5** marks for Part – **c** :

1. a) Outline Dirac's bra and ket rotation.
   b) Explain the properties of ket and bra space.
   c) Prove that the two eigen vectors of a Hermitian operator belonging to different eigen values are orthogonal.