Seat No. : _____

NN-124

November-2013

B.Sc. Sem.-V (CBCS)

302 : Physics

Time : 3 Hours] [Max. Marks : 70

સૂચના : (1) સંજ્ઞાઓ પ્રચલિત અર્થ ધરાવે છે.

Instruction : Symbols have their usual meanings.

(2) દરેક પ્રશ્નના ગુણ સમાન છે.

Each question carries equal marks.

1 (a) ભ્રમકીય વર્ણપટ માટે આણ્વિક જરૂરીયાતની ચર્ચા કરો. દ્વિ-પરમાણ્વીક અણુના શુદ્ધ ભ્રમકીય વર્ણપટના અભ્યાસ માટેની પ્રાયોગિક રીતનું વર્ણન કરો. 7

Discuss the molecular requirement for rotational spectra. Describe an experiment for the study of pure rotational spectra of di-atomic molecule.

અથવા/OR

ભ્રમકીય વર્ણપટની લાક્ષણિકતાઓ આપો.

Give the salient features of rotational spectra.

(b) અણુને કંપિત પૂર્ણક તરીકે સમજાવો R-શાખા તથા P-શાખાના તરંગ સંખ્યાના સમીકરણો મેળવો. 7

Explain the molecule as vibrating rotators and obtain the equations of wave numbers of R-branch and P-branch.

અથવા/OR

કંપિત-ભ્રમકીય વર્ણપટની લાક્ષણિકતાઓ આપો.

Give the salient features of vibrational rotational spectra.

2 (a) ઇલેક્ટ્રોનિક ટ્રાન્ઝીશનની પસંદગીના નિયમો જણાવો. તેના આધારે દર્શાવો કે, ટ્રાન્ઝીશન $Eu^+ \rightarrow Eg^+$ સ્વીકૃત છે. 7

State the selection rules for electronic transition and hence show that the transition $Eu^+ \rightarrow Eg^+$ is allowed.

અથવા/OR

રામન-વર્ણપટ અને પ્રસ્ફુરણ વર્ણપટની સરખામણી કરો.

Compare Raman spectra and fluorescent spectra.

P.T.O.

(b) નીચે દર્શાવેલ ક્વૉન્ટમ સ્થિતિ માટે પેટા સ્થિતિના ઘટકોની ગણતરી કરો : 7

Calculate the components for substates for the following quantum states :

(i) 2π (ii) 3π

(iii) 4π (iv) 4Δ

અથવા/OR

ક્લાસિકલ વાદ મુજબ રામન અસર સમજાવો.

What is Raman effect ? Explain the classical theory of Raman effect.

(a) બોઝ આઈન્સ્ટાઈન અને ફર્મી ડીરાક વિતરણ વિધેયના સૂત્ર મેળવો. 7

Obtain the expression for Bose-Einstein and Fermi-Dirac distribution functions.

અથવા/OR

સમિત અને અસંમિત અવસ્થા વિધેયોનો ભેદ સ્પષ્ટ કરો.

Discuss the symmetric and anti-symmetric state functions.

(b) વાયુના અણુઓની કંપિત ગતિ માટે પાર્ટીશન વિધેયનું સૂત્ર મેળવો. તે પરથી હેલ્મહોલ્ટ્ઝ મુક્ત ઊર્જા અને એન્ટ્રોપીના સમીકરણો મેળવો. 7

Obtain the expression for partition function of vibrational motion of gas molecule and hence derive expression for Helmholtz free energy and entropy.

અથવા/OR

વાયુના અણુઓની ભ્રમકીય ગતિ માટે પાર્ટીશન વિધેયનું સૂત્ર મેળવો.

Obtain the expression for partition function of rotational motion of gas molecules.

(a) સ્થિતિ સ્થાપક ઊર્જા ઘનતા અને સંમિતિ દલીલોની મદદથી સાબિત કરો કે ઘન સ્ફટીકો માટેના 36 દૃઢસ્થિતા અચળાંકો 3 સ્વતંત્ર અચળાંકોમાં ફેરવાય જાય છે. 7

Prove with the help of elastic energy density and symmetry arguments that for a cubic crystal 36 elastic stiffness constants are reduced to 3 independent ones.

અથવા/OR

મુક્ત ઈલેક્ટ્રોન માટે ત્રિપરીમાણમાં શ્રોડીંજર સમીકરણનો ઉકેલ મેળવો, તે પરથી ફર્મી-ઊર્જા અને અવસ્થા ઘનતાના સમીકરણ મેળવો.

Solve the Schrödinger equation for free electron gas in three dimensions and hence obtain equations of Fermi-energy and density of States.

(b) ફર્મી-ડીરાક વિતરણ વિધેય પર તાપમાનની અસર વર્ણવો. 7

Describe the effect of temperature on Fermi-Dirac distribution function.

અથવા/OR

ઘન સ્ફટીકમાં [100] દિશામાં પ્રસરતા સ્થિતિસ્થાપક તરંગોનું સમીકરણ મેળવો.

Derive the equation of elastic waves propagating in crystal along [100] direction.

Seat No. : _____

N14-118

November-2014

B.Sc., Sem.-V

302 : Physics

Time : 3 Hours] [Max. Marks : 70

Instructions : (1) **All** questions carry equal marks.
(2) Symbols have usual scientific meanings.

1. (a) Explain salient features of Rotational spectra with a suitable example. 5

OR

Explain salient features of Vibrational-Rotational spectra with a suitable example.

(b) Describe an experimental arrangement to obtain pure rotational spectra in absorption. 6

OR

Explain with necessary expression how vibrational constant could be determined from infrared spectrum of anharmonic oscillator.

(c) The transition J = 3 to J = 4 in HC*l* is associated with radiation of 80 cm^{-1}. Using the rigid rotator approximation, calculate the moment of inertia of HC*l*.
Given that : reduced mass of HC*l* molecule = 1.60×10^{-27} kg, h = 6.64×10^{-34} J. sec, C = 3×10^{8} m/s. 3

OR

The force constant of the bond in CO molecule is 1870 N/m. Calculate the frequency of vibration of the molecule.

2. (a) What is Raman Effect ? Discuss the classical theory of Raman Effect. 6

OR

Explain pure rotational Raman spectra in brief. With necessary expressions, show that rotational Raman lines are equidistant.

(b) Discuss the experimental arrangement for Raman spectra. 4

OR

Describe the phenomenon of Phosphorescent emission.

(c) With exciting line 4358 Å, a sample gives Stokes line at 4458 Å. Deduce the wavelength of the anti-stokes line. 4

OR

Calculate the components for substates for the following quantum numbers :
(i) $^{1}\pi$,
(ii) $^{2}\pi$
(iii) $^{3}\pi$
(iv) $^{4}\Delta$

3. (a) What are symmetric and anti symmetric wave functions and hence distinguish Bose-Einstein & Fermi-Dirac statistics. 8

OR

Obtain the quantum mechanical analogue of Liouville's theorem. 6

(b) Obtain the expression for Rotational partition function.

OR

Obtain the expression for vibrational partition function.

4. (a) Define the term Bulk modulus and hence show that for a cubic crystal, the Bulk modulus $B = (1/3)\,[C_{11} + 2C_{12}]$. 6

OR

Discuss the effect of temperature on Fermi-Dirac distribution.

(b) Write Schrödinger equation for free electron gas in three dimensions. Solve it to obtain eigen values and eigen functions. Hence obtain the expression for Fermi energy. 8

OR

Write general matrix equation for stress components. Prove with the help of elastic energy density and symmetry arguments that for 36 elastic stiffness constants reduces to 3 independent one for cubic crystal.

14

5. Answer in short :

(i) Define the term Dilation.

(ii) Define elastic energy density.

(iii) Define density of States.

(iv) What is Lorentz Number ?

(v) Define characteristic vibrational temperature of a molecule.

(vi) What are Fermions ?

(vii) Define reduced mass.

(viii) Define Fluorescence.

(ix) Designate the electronic state of a molecule corresponding to $\wedge = 0$.

(x) "The molecules have rotational and vibrational states but atoms do not". Comment.

(xi) What is Raman Shift ?

(xii) Define Fermi energy.

(xiii) What is Degeneracy ?

(xiv) Define Thermal conductivity.

Seat No. : _____

MC-118

November-2016

B.Sc., Sem.-V

CC-302 : Physics

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) **All** questions carry equal marks.
(2) Symbols have their usual meaning.

1 (a) Describe a suitable experimental arrangement for the study of pure rotational spectra of a di-atomic molecule. 4

OR

Discuss the salient features of vibrational rotational spectra.

(b) (i) Discuss the vibrational frequency and force constant for an harmonic oscillator. 7

(ii) In the near infrared spectrum of HCl molecule there is a single intense band at 2885.9 cm^{-1}. Assuming vibrational levels show that the force constant K is 4.8×10^5 D/cm. ($mH = 1.68 \times 10^{-24}$ gm) 3

OR

Discuss in detail how the line structure of infrared spectra can be explained by considering molecule as vibrating rotor. 10

2. (a) What are Raman shifts ? Give the classical theory of Raman Effect ? What are its limitations ? 7

OR

Explain in detail mechanism of Fluorescent emission.

(b) What is Raman effect ? Give quantum theory of Raman effect. 7

OR

State the selection rules for electronic transition and hence show that the transition $EV^+ \longrightarrow Eg^+$ is allowed.

3. (a) Obtain the expressions for Bose-Einstein and Fermi-Dirac distribution functions. 7

OR

Obtain quantum mechanical analogue of Lowville's theorem.

(b) Obtain the expression for partition function of Rotational motion of gas molecules. 7

OR

Discuss symmetric and anti-symmetric state functions.

4. (a) Explain :

(i) Stress components

(ii) Strain components

(iii) Dilation

(iv) Elastic energy density

(v) Young modulus

OR

What is Hall effect ? Obtain expression for Hall co-efficient and Hall voltage. 7

(b) Obtain the differential equation for elastic waves propagating in cubic crystals and obtain equation of wave velocity for the waves propagating along [100] direction.

OR

Explain Free electron Fermi gas, and solve Schrödinger equation for free electron in three dimensions. 7

5. Answer the following questions very shortly :

(1) Give types of spectra.

(2) Give types of motion of Di-atomic molecule.

(3) What is Band Head ?

(4) What is Raman Shift ?

(5) What is Transition ?

(6) Give names of different types of partition function.

(7) Give conditions for Canonical ensemble.

(8) What is grand Canonical Ensemble ?

(9) Write formula of free energy of system.

(10) Define Stress.

(11) Give unit of Young modulus.

(12) Give unit of Bulk modulus.

(13) What is Fermi-energy ?

(14) What is Hall effect ?

Seat No. : 4241

NL-110

November-2017

B.Sc., Sem.-V

CC-302 : Physics

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) Symbols have their usual meanings.
(2) **All** questions carry equal marks.

1. (a) Give reasons why energy level scheme of molecule is different from that of atom. Write short note on type of molecular spectra. – 2015 **7**

OR

Discuss salient features of Vibrational Rotational Spectra. Find the Vibrational and Force constant for an unharmonic oscillators. Find the frequency W_c of unharmonic oscillator for a hypothetical state.

(b) Discuss in detail how the line structure of infrared spectra can be explained by considering the molecule as vibrating rotor. **7**

OR

Explain the molecule as rigid rotor and hence discuss pure rotational spectrum.

2. (a) Define Raman lines, Raman displacement and Rayleigh lines. Is it necessary to have permanent dipole moment to produce Raman spectra in molecule ? – 2015 **7**

OR

Explain in detail mechanism of Fluorescent emission. – 2015

(b) Write selection rules for the electronic transition. Obtain the correct designations for substates (i) 2π (ii) 4π (iii) 4Δ. 2015 **7**

OR

What is Raman Effect ? Give quantum theory of Raman Effect. – 2015

3. (a) Derive an expression for partition function of vibrational motion of gas molecule and hence obtain expressions for different thermodynamic quantities. Discuss at low temperature. **7**

OR

Derive Quantum analogue of Liouville's theorem.

(b) Derive expressions for Bose-Einstein and Fermi-Disac distribution functions. **7**

OR

Derive expression for electronic partition function and hence obtain expressions for Helmholtz free energy and entropy.

4. (a) Give statement of Hooke's law. Write 36 components of strain and 36 components of stress in cubic crystal in terms of elastic compliance and elastic stiffness constants. Define Bulk modulus for uniform dilation in cubic crystal. 7

OR

Taking Quantum theory in to account, discuss the energy levels for free-electron gas in one dimension. Define Fermi-energy.

(b) Derive differential equation for waves propagating in cubic crystals. And obtain the equation of wave velocity for a wave propagating along [100] direction in cubic crystal. 7

OR

On the basis of free-electron theory, derive equation of electrical conductivity and write down equation of thermal conductivity. Derive Widemann-Franz law.

5. Answer the following questions in very short : 14

(1) Why do we use Born-oppenheimer approximation in molecular spectra.

(2) Write equation of reduced mass.

(3) What is Band head ?

(4) Give the statement of 'mutual exclusion rule'.

(5) Write selection rules for vibrating rotor spectra.

(6) Give the S.I. unit of electric dipole moment.

(7) Define Luminescence.

(8) What is Heteronucleus Atom ?

(9) Give conditions for micro-canonical ensemble.

(10) Write equation of Degeneracy criterion.

(11) Define strain

(12) Give dimensions of C_{44}.

(13) In which orbit Fermi-electrons are found ?

(14) Write down formula for Fermi temperature.
