## A Part

1. Four distinguishable particles are distributed in two states. Find the total number of microstates.

2. N particles share Q integral units of energy. How will you calculate the multiplicity of the system?

3. Define the microstate of a system.

4. What is statistical mechanics?

5. Although all microstates are equally probable, why are all macrostates not equally probable?

6. Define multiplicity. Give an example.

7. Distinguish between Macrostate and Microstate.

8. What is meant by macroscopic property of a system?

9. Show graphically how the classical probability p(E) vary with energy.

10. Why should classical statistics differ from quantum statistics?

11. What is meant by statistical analysis?

12. How can the probability to measure any particular value of energy of a particle be obtained from multiplicity?

13. Write down three phenomena which essentially require statistical mechanics to explain them.

14. What is the physical implication of increasing multiplicity?

15. Define the macrostate of a system.

16. Distinguish between classical and quantum particles.

17. Four indistinguishable particles obeying Pauli's exclusion principle are distributed in quantum states. Find the total number of microstates possible.

18. Write down an expression for calculating the multiplicity of each microstate in the macrostate and explain the symbols.

19. What is Maxwell's Boltzmann distribution function?

20. Define density of states.

21. What is the root-mean-sqaure speed?

22. What does MB statistics deal with?

23. Define the most probable speed.

24. What is degeneracy?

25. Explain why Helium behaves like a boson.

26. What is Bose-Einstein distribution?

27. When does Bose-Einstein distribution reduce to Maxwell-Boltzmann distribution?

28. What is Bose condensation?

29. What does BE statistics deal with?

30. What are bosons? Give two examples.

31. What are fermions? Give two examples.

32. What happens to the Fermi energy when the temperature of the system increases?

33. What is Fermi energy?

34. Plot the Fermi-Dirac distribution function for temperatures $T = 0$ and $T>0$. Show the region affected by termperature change by shading.

35. What is Fermi-Dirac Distribution?

36. Write down Planck blackbody formula.

37. What is a blackbody?

38. Distinguish between crystallie and amorphous solids?

39. Distinguish between a primitive cell and a unit cell.

40. What is meant by unit cell?

41. Define crystallographic axis and lattice parameter.

42. Define (i) a crystal (ii) lattice points and (iii) crystal lattice?

43. What are crystalline and amorphous solids? Give Examples?

44. How would you generate a crystal structure from lattice and basis?

45. What is meant by cubic crystal system? What are its bravais lattices?

46. What is glide plane symmetry?

47. What is screw axis symmetry?

48. When does a crystal is said to possess a rotation-inversion axis?

49. Draw unit cells corresponding to sc, bcc and fcc crystal systems.

50. What is (i) inversion symmetry (ii) reflection symmetry (ii) rotation symmetry?

51. Define (i) point group symmetry and (ii) space group symmetry.

52. What are bravais lattices? Mention the seven crystal systems.

53. Name two translational symmetry elements.

54. Differentiate between (i)point group symmetry and (ii)space group symmetry.

55. What is meant by coordination number? Give its significance.

56. How does hcp structure differ from bcc structure?

57. Calculate the distance between two atoms of a basis of the diamond structure. The lattice constant of the structure is 5 Å.

58. Write down the coordinates of Zn and S atoms in the unit cell of ZnS.

59. What is atomic packing fraction? What does it indicate?

60. Draw the unit cell of caesium chloride crystal.

61. What is meat by atomic packing fraction? What does it indicate?

62. Draw the (2 0 0) plane of a unit cubic crystal.

63. Define interplanar distance and explain the symbols used.

64. Draw the direction [110] in a cubic crystal?

65. What are lattice planes?

66. What is meant by Miller indices ? What is their importance?

67. Draw the following planes of a unit cubic crystal (i) (100) (ii) (010) (iii) (001).

68. Write down Braggs equation and explain the symbols.

69. Ordinary optical gratings cannot be used in X-ray diffraction. Why?

70. What are the uses of X-ray diffraction?

71. What is Spectroscopy?

72. What is the function of modulator in spectrometer?

73. What is meant by Quantization of energy?

74. How is the intensity of spectral lines related to transition probability?

75. How is the intensity of spectral lines related to population of state?

76. Define Absorbance.

77. Define Transmittance.

78. What are linear molecules? Give example.

79. What is a selection rule? Write down the selection rules for a rigid rotator.

80. Distinguish between prolate and oblate molecules.

81. What are asymmetric top molecules? Give example.

82. What is a rigid rotator?

83. What kind of molecules  exhibit rotational spectrum? Explain with an example.

84. What are symmetric top molecules? Give example.

85. Spherical top molecules do not show rotational spectrum. Explain.

86. How can we classify molecules according to their three moments of inertia?

87. Comment on the rotational quantum number and rotational energy levels of a molecule.

88. What are spherical top molecules? Give example.

89. What is infrared spectroscopy?

90. Explain the diatomic molecule as a simple harmonic oscillator model.

91. Show that the vibrational energy levels of a diatomic molecule modelled as a harmonic oscillator are equally spaced.

92. What is zero point energy? What is its significance?

93. Homonuclear diatomic molecules do not show vibrational spectra. Why?

94. Write down the expression for the vibrational energy of a harmonic oscillator system and explain the symbols.

95. Write down the selection rule for a harmonic oscillator undergoing vibrational changes.

96. Real molecules do not obey exactly the laws of simple harmonic motion. Why?

97. What is a vibrational spectrum? What informations can be obtained from it?

98. What is meant by the fundamental absorption of an anharmonic oscillator?

99. What is meant by an anharmonic oscillator?

100. Write down the expression for energy eigen value of a diatomic molecule modelled as an anharmonic oscillator.

101. What are first and second overtones of absorption of a anharmonic oscillator?

102. What are hot bands? Why are they called so?

103. Write down the selection rules for the vibrational transitions of an anharmonic oscillator and obtain an expression for the first overtone.

104. What are the selection rules for the infrared spectra of a molecule modelled as (1) harmonic oscillator and (2) anharmonic oscillator?

105. What is Morse function?

106. What are the selection rules for the rotation-vibration spectra of a diatomic molecule? What are P and R branches in the spectrum?

107. What is Born- Oppenheimer approximation?

108. Explain spontaneous emission. What are the factors on which it depends?

109. What is the difference between spontaneous emission and stimulated emission?

110. Explain with neat diagram, absorption, spontaneous emission and stimulated emission of radiation.

111. Write down Boltzmann's distribution law for population of energy levels and explain the symbols.

112. What are the characteristics of stimulated emission?

113. Explain the quantum behaviour of light.

114. Explain the Einstein coefficient for induced absorption.

115. What are Einstein coefficients? Define them.

116. What are the conditions to be satisfied to have large stimulated emission?

117. Explain the Einstein coefficient for stimulated emission.

118. What are the essential components of a laser? Explain their functions.

119. Why is the optical resonators required in lasers? Illustrate your answer with neat sketch.

120. What is Laser? What are its properties?

121. What is population inversion? What are the mechanisms used to attain population inversion?

122. Explain what is a metastable state.

123. What is the reason for monochromaticity of laser beam?

124. Define population inversion and stimulated emission.

125. What is population inversion? Why is it so important in laser action?

126. What is an active medium?

127. What is meant by optical resonant cavity? Explain.

128. What are the advantages of diode laser?

129. Draw the electronic energy levels diagrams showing the output wavelength / frequency of Ruby Laser.

130. In helium- neon laser, lasing is through neon gas. What is the the role ol helium gas?

131. What is the role of helium in He-Ne laser?

132. What is the active centre in a YAG laser? Explain its function.

133. ln helium - neon laser why is it necessary to use narrow tubes for the gas mixture?

134. Distinguish between stokes lines and antistokes lines.

135. What is Raman effect?

136. Give three applications of laser.

137. Why stokes lines are more intense than antistokes lines?

138. Distinguish between Raman scattering and Rayleigh scattering.

B Part

139. Consider a system consisting of two particles, one with spin s = 1 and another with spin s = 1/2. a) Considering a microstate to be an assignment of the z-component of the spins of each of the particles what is the total number of microstates of the two particle system. b) How many macrostates are there for the total spin at the two particle system? c) Find the number of states of each macrostate.

140. a) Considering the numbers of heads and tails, how many macrostates are there when 5 coins are tossed b) What is the total number of possible microstates in tossing 5 coins c) Find the number of microstates for each macrostate.

141. A system consists of two particles each of which has a spin of 3/2. a) Assuming the particles to be distinguishable, what are the macrostates of the total spin and what is the multiplicity of each? b) What are the possible values of total spin and what is the multiplicity of each value? c) Suppose the particles behave like indistinguishable quantum particles.  What is the multiplicity of the macrostates of the total spin?

142. A system containing 4 electrons and 5 alpha particles. Calculate the total number of microstates

143. Consider the distribution of two units of energy to a gas of four identical but distinguishable particles. With the help of this system explain microstate, macrostate and multiplicity.

144. A system contains 10 electrons. Calculate the total number of microstates possible.

145. Show that the most probable energy in the case of Maxwell-Boltzmann distribution is $\frac{1}{2}KT$.

146. Explain the experimental determination of molecular speeds.

147. Derive the condition for the limits of classical statistics.

148. Distinguish between classical and quantum statistical mechanics.

149. Discuss the requirement of separate statistics for classical and quantum particles.

150. A container holds one mole of helium gas at a temperature of 293 K. Calculate the mean energy of the molecules. How many molecules have energies in an interval of 0.01 times mean energy centred on mean energy?

151. Explain Fermi energy. Discuss the distribution of particles around the Fermi energy at temperature $T = 0$ and $T > 0$.

152. An object is at a temperature of 400°C. At what temperature would it radiate energy twice as fast?

153. Compare Maxwell – Boltzmann, Fermi-Dirac and Bose – Einstein statistics.

154. A metal sphere 4cm in diameter with emissivity 0.25 is heated in a furnace to 500°C. At what rate does it radiate?

155. Derive an expression for the average energy of gas molecules obeying Maxwell-Boltzmann disttribution

156. A certain metal has fermi energy 3 eV. Find the number of electrons per unit volume with energy between 5 eV and 5.10 eV for T=295 K

157. Derive Planck's radiation law by assuming Bose-Einstein distribution law and density of states. Arrive at Stefan's law using Bose-Einstein distribution law.

158. In copper, there is one free electron per atom. Caluclate the fermi energy of the electrons in copper

159. Compute the Fermi energy of sodium. Number of atoms per unit volume is 2.54 x $10^{28}$ m$^{-3}$.

160. Discuss the fermi energy of a system at 0K and at a finite temperature.

161. Derive an expression for Femi energy.

162. Fermi energy of conduction electrons in silver is 5.48 eV. Caluclate the number of such electrons per m$^3$

163. Show that five fold symmetry is not possible in a crystal.

164. Explain the crystal structure of zinc sulphide and ceasium chloride.

165. Obtain an expression for the packing fraction of hcp structure.

166. Explain the crystal structure of sodium chloride.

167. Show that the packing fraction of diamond cubic structure is only 34%.

168. Calculate the number of carbon atoms per unit cell of diamond.

169. Find the Miller indices for planes with intercepts.(i) (a, 2b, ∞) ( ii)( a, b, -c) (iii) (a/2, b, ∞)

170. Derive the packing fraction of FCC crystal.

171. Derive the packing fraction of BCC crystal.

172. Lithium crystallizes in BCC structure. Calculate the lattice constant. Given that the atomic weight and density for Li are 6.94 and 530 kgm$^{-3}$ respectively.

173. Derive an expression for the interplanar distance in a crystal.

174. Describe the important planes and directions in a cubic crystal.

175. Derive the packing fraction of simple cubic crystal.

176. Describe the scheme to determine the Miller indices of a plane. Show the following planes are in simple cubic lattice: (111), (120), (020)

177. A plane makes intercepts of l, 2 and 3Å on the crystallographic axes of an orthorhombic crystal with a: b: c=3:2:1. Determine the Miller indices of this plane

178. Gold has fcc structure. Its density is 19.3 gm/cc. Find the lattice constant.

179. If X-rays of wavelength 0.5Å are diffracted at an angle of 50 in the first order, what is the spacing between the adjacent planes of the crystal? At what angle will second maximum occur?

180. Derive Bragg's law. Derive an expression for the interplanar distance.

181. Calculate the glancing angle on the plane (110) of a cubic rock salt crystal (a = 2.81Å) corresponding to second order diffraction maxima of wavelength 0.71Å.

182. The first order spectrum of a beam of X-rays diffracted from a crystal corresponds to an angle 6.833° and the distance between the Bragg planes is 2.81Å. At what angle does the second order diffraction happens.

183. The spacing between successive (100) planes in NaCl is 2.82Å. X-rays incident on the surface of the crystal is found to give rise to first order Bragg reflection at glancing angle 8.8°. Calculate the wavelength of X-rays.

184. Discuss the powder method of X-ray diffraction.

185. Deduce Braggs law in X-ray diffraction. Describe Braggs spectrometer and explain how it is used to determine the wavelength of X-rays

186. The Bragg angle for the first order reflection from (111) plane in a crystal is 60°. Calculate the interatomic spacing if X-ray of wavelength 1.8 x 10$^{-10}$m is used.

187.  Name any two crystal systems. Give their unit cell characteristics.

188. Explain the different regions of electromagnetic spectrum.

189. Explain the recording of a spectrum in the frequency domain. What are the differences between an ideal spectrum and a real spectrum?

190. Draw the block diagram of an absorption spectrometer.

191. What are the factors affecting the ideal spectrum?

192. Give the different purposes of slits in a spectrometer.

193. Draw the block diagram of an emission spectrometer.

194. Discuss basic elements of absorption and emission spectrometer.

195. What do you understand by resolving power of a spectrometer?

196. Define signal to noise ratio. What is its physical significance?

197. Explain the Doppler broadening of spectral lines.

198. Explain how collisions of atoms or molecules in liquids and gases lead to broadening of spectral lines.

199. What is the relation between transmittance and absorbance?

200. What are the factors on which the intensity of spectral lines depends?

201. Explain the broadening of spectral lines due to uncertainity principle.

202. Obtain the Beer-Lambert law and explain the symbols.

203. Explain the factors on which the width and intensity of spectral lines depend.

204. The OH radical has a moment of inertia of $1.48 \times 10^{-47} kgm^2$. Calculate its inter-nuclear distance. Also calculate for J=5, its angular momentum and angular velocity.

205. What are the factors on which the intensity of rotational spectra depend?

206. The moment of inertia of the CO molecule is $1.46 \times 10^{-46} kgm^2$. Calculate the energy in eV, and the angular velocity in the lowest rotational energy level of the CO molecule.

207. The J=0→1 transition in HCl occurs at $20.68 cm^{-1}$. Considering the molecule to be a rigid rotator, calculate the wavelength of the transition J=10→11.

208. The rotational constant for $H^{35}Cl$ is found to be $10.5909 cm^{-1}$. What is the values of B for $H^{37}Cl$?

209. Calculate the rotational energy levels of HCl molecule in eV. Given bond length r=0.13nm.

210. How many revolutions per second does a CO molecule make when J=4? The rotational constant of CO molecule is $1.9313 cm^{-1}$.

211. What is the change in rotational constant B when hydrogen is replaced by deuterium in hydrogen molecule?

212. What is rotational constant? How does it influence the rotational spectrum of a molecule ?

213. The rotational constant of $H^{35}Cl$ is found to be $10.5009 cm^{-1}$. What is the value of $^2D^{35}Cl$ ?

214. The first rotational line of $^{12}C^{16}O$ is observed at $3.84235 cm^{-1}$ and that of $^{13}C^{16}O$ at $3.67337 cm^{-1}$. Calculate the atomic weight of $^{13}C$, assuming the mass of $^{16}O$ to be 15.9949.

215. Obtain the expression for energy eigen value of a rigid rotator and explain the terms.

216. Evaluate the moment of inertia of a diatomic molecule modelled as a rigid rotator.

217. How many revolutions per second does a CO molecule make when J=3. The CO bond length is 0.1131nm. Avogadro number $6.022 \times 10^{23}$.

218. What is meant by degeneracy of rotational energy levels?

219. The rotational spectrum of $^{79}Br \, ^{19}F$ shows a series of equidistant lines 0.71433cm$^{-1}$ apart. Calculate the rotational constant B, and hence moment of inertia and bond length of the molecule. Mass of $^{79}Br$=131.03x10$^{-27}$ kg, $^{19}F$= 31.55x10$^{-27}$ kg.

220. The microwave spectrum of CN radical shows a series of lines spaced by a nearly constant amount of 3.798cm$^{-1}$. What is the bond length of CN?

221. The separation between lines in the rotational spectrum of HCl molecule was found to be 20.92cm$^{-1}$. Calculate the bond length.

222. Draw the rotational energy levels and transitions for a rigid diatomic molecule.

223. The average spacing between successive rotational lines of carbon monoxide is 3.8626cm$^{-1}$. Determine the transition which gives the most intense spectral line at 300K.

224. Find the expression for the J value for which intensity of rotational spectral line is maximum.

225. How will you evaluate the bond length of of a molecule from rotational constant?

226. What is the change in rotational constant B when $^{12}C$ of carbon monoxide ($^{12}C^{16}O$) is replaced by $^{13}C$? B of $^{12}C^{16}O$ is 1.92118cm$^{-1}$.

227. Draw and explain with necessary equations the allowed vibrational energy levels and the transitions between them for a diatomic molecule undergoing simple harmonic motion.

228. The vibration frequency of $^{1}H \, ^{35}CI$ is 2990.6cm$^{-1}$ . Without calculating the bond force constant, estimate the vibration frequency of $^{1}H^{37}Cl$ and $^{2}D^{35}CI$.

229. The fundamental vibration frequency of HCI is 2989cm$^{-1}$, Find the force constant of HCl bond.

230. The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at 1876.06 cm$^{-1}$ and 3724.20cm$^{-1}$ respectively. Evaluate the equilibrium vibration fre quency, the anharmonicity and the exact zero point energy.

231. What is Morse fuction? Draw its graphical representation and explain its features.

232. The vibrational wave numbers of the following molecules in their v=0 states are HCl: 2885 cm$^{-1}$, DCI: 1990cm$^{-1}$, D$_2$: 2990cm$^{-1}$ and HD: 3627cm$^{-1}$. Calculate the energy change in kJ /mol of the reaction: HCI+D$_2$ → DCI + HD

233. State Morse function and explain Morse curve for a diatomic molecule.

234. The fundamental and first overtone transitions of CO are centred at 2143.3 cm$^{-1}$ and 4260.0 cm$^{-1}$. Calculate the equilibrium oscillation frequency, the anharmonicity constant and force constant of the molecule.

235. The fundamental absorption band for HCl is centred at 2886cm$^{-1}$. Assuming that the inter nuclear distance is 1.276A°. Calculate the wave number of the first two lines of each P and R branches of rotation- vibration spectrum of HCI.

236. Explain the P-branch and R branch of a rotation vibration spectrum.

237. Draw the rotational energy levels of the vibrational states v=0 and v=1 of a diatomic molecule. Using the selection rules, explain the allowed transitions and the spectral lines.

238. Explain the formation of IR spectra of a diatomic molecule.

239. The frequency of OH vibration in $CH_3OH$ is $3300cm^{-1}$. Estimate the frequency of OD stretching vibration in $CH_3OD$.

240. Calculate the energy in $cm^{-1}$ of the photon absorbed when NO molecule goes from the state v=0, J"=0→v=1, J'=1. Assume that the v= 0 and v= 1 states have the same B values. Given $v_e$ =$1904cm^{-1}$, $x_e$ = 0.00733, $r_{NO}$=0.1151nm and $\mu_{NO}$=$12.3975 \times 10^{-27}kg$.

241. Calculate the energy in $cm^{-1}$ of the absorbed when HCl molecule goes from the state v=0, J"=1→v=1, J'=0 and v=0, J"=1→v=1, J'=2. Given $v_e$=$2990cm^{-1}$, $x_e$ = 0.0174, $r_{HCl}$=0.1274nm and $\mu_{HCl}$=$1.6275 \times 10^{-27}$ kg

242. Show that the spacing between any two adjacement P lines or R lines in the rotation vibration spectrum of a diatomic molecule is equal to 2B.

243. The mean intermolecular distance for HCl in the v=0 and v= 1 level is 1.293A°. Calculate the difference in $cm^{-1}$ between the first P line and the first R line in the rotation - vibration spectrum. Given $\mu$ of HCl=$1.6275 \times 10^{-27}$ kg.

244. Obtain the expression for total energy of a diatomic molecule as a vibrating rotator in terms of wave number and explain the symbols.

245. Obtain an expression for the separation between the maxima of the P and R branches of the vibration-rotation spectrum of a diatomic molecule.

246. What are the characteristics of stimulated emission?

247. What are the characteristics of spontaneous emission?

248. What is meant by spontaneous emission? Explain with a two level diagram.

249. What is meant by induced absorption? Explain with a two level diagram.

250. Explain the different mechanisms involved in the light - matter interaction.

251. Explain the stimulated emission of radiation with a two level diagram.

252. Explain Einstein coefficients. How are they related?

253. What are the essential components of a laser? Explain their functions.

254. What are the characteristics of a laser beam?

255. Briefly explain optical pumping and electrical pumping in lasers.

256. A gaseous medium gives a laser at an IR wavelength of 351nm. What is the difference in energy between the upper and lower levels?

257. The energy level difference between two laser levels is 0.21 eV. Determine the wave length of radiation.

258. Explain the process of light amplification in laser.

259. Explain in brief the lasing action in a laser.

260. Show that stimulated emission is negligible compared to spontaneous emission at room temperature.

261. What are the conditions for stimulated emission to dominate over spontaneous emission and absorption?

262. Spontaneous emission dominates over stimulated emission under normal conditions. Explain.

263. Find the relative population of the two states in a ruby laser that produces a light beam of wavelength 6943 Å at 500 K.

264. Describe the working of semiconductor laser.

265. With the help of energy band diagram discuss the working of a semiconductor laser.

266. A Ruby laser emits 1 Joule pulses of light whose wavelength is 694 nm. What is the minimum number of chromium ions in the Ruby?

267. The He - Ne system is capable of lasing at $3.3913 \times 10^{-6}$m. Determine the energy difference in eV between the upper and lower levels of this wave length.

268. Describe the working of solid state ruby laser.

269. Explain the function of optical cavity resonator in a laser.

270. How is population inversion achieved in semiconductor lasers?

271. In a ruby laser, the ruby rod contains a total of $3 \times 10^{19}$ chromium ions. If laser emission is at a wavelength of 6943Å , find the energy of one emitted photon and the total energy available per pulse.

272. Describe the working of Nd-YAG laser.

273. Explain the principle and working of a He-Ne laser

274. Explain the formation of Stokes and anti-Stokes lines on the basis of quantum mechanics.

275. Explain the quantum theory of Raman effect.

276. Explain the quantum theory of Raman effect.

<div align="center">C Part</div>

277. Obtain the expressions for average speed , most probable speed and rms speed in Maxwell Boltzmann distribution

278. Derive the expressions for most probable energy and average energy  in Maxwell-Boltzmann distribution

279. Discuss the distribution of molecular speeds. How can the Maxwell's Boltzmann distribution be obtained from it?

280. Derive an expression for Planck blackbody formula using Bose-Einstein statistics.

281. Derive an expression for density of states of particles in a gas.

282. Derive Planck's radiation law using B.E. statistical distribution law. Also deduce Wein's displacement law from it.

283. What is F-D statistics? Derive an expression for Fermi-Dirac distribution law of electrons.

284. Using Fermi-Dirac statistics obtain an expression for fermi energy. Discuss how the temperature affects the Fermi-Dirac distribution curve.

285. What is atomic packing fraction? Obtain the packing factors for simple cubic, body centered and face centered cubic crystal structures.

286. Distinguish between crystalline and amorphous solids. How are crystals classified according to the structural symmetries? Explain each of them.

287. Draw (101) and (111) planes in a cubic unit cell. Determine the Miller indices of the directions which are common to both the planes.

288. What are Miller indices? Draw neat diagrams to indicate the indices of the important plane systems in a simple cubic crystal.

289. Describe the method to determine the Miller indices of crystallographic plane with example.

290. Derive an expression for the spacing between planes with same Miller indices.

291. Deduce Bragg's law in X-ray diffraction. Describe Bragg's spectrometer and explain how it is used to determine the wavelength of X-rays

292. Describe powder method of crystal structure analysis

293. Derive Bragg's law of X-ray diffraction in crystals. Give an account of powder method of crystal structure analysis.

294. What is grating spectrometer? Explain the recording of a spectrum with diagram.

295. Explain the factors affecting the width of spectral lines.

296. Obtain the expression for the rotational energy levels of a diatomic molecule taking it as a rigid rotator.

297. Discuss the vibrational spectra of a diatomic molecule as a (a) harmonic oscillator and (b) anharmonic oscillator.

298. Discuss the theory of rotation-vibration spectrum of a diatomic molecule.

299. Illustrate with theory how to determine the rotational constants of a diatomic molecule from the rotation vibration spectrum .

300. What are Einstein's coefficients? Derive the relation between them.

301. Explain the different components of a laser. Describe the construction and working of a He-Ne laser.

302. Discuss the theory and working of ruby laser with a neat diagram

303. Explain the principle, construction and working of a semiconductor laser.

304. Explain the classical theory and quantum theory of Raman effect.

D Part

E Part