

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

DEPARTMENT OF PHYSICS

M.Sc. I Sem II PHY- 4202 Atoms, Molecules and Lasers

(QUESTION BANK)

Answer in one sentence

(1 chapter)

1. State Pauli's exclusion principle.
2. State Hund's Rule for Maximum Multiplicity.
3. Give the electronic configuration for Ti, Si, S, etc.
4. State the Bohr's Postulate.
5. What does the Franck and Herz experiment demonstrate?
6. Find the orbital angular momentum of 'd' electron.
7. Find the electronic angular momentum of a one electron $^2D_{5/2}$,etc.
8. Find S, L, & J values for $^3D_{3/2}$, 2P_2 , etc.
9. Write down the spectral notation for i) $l=0, s=1/2$ ii) $l=3, s=1/2$ iii) $l=2, s=1/2$
10. Determine the ground state of Al atom. Represent it using spectral notation form.

(2 chapter)

11. State Frank-Condon principle
12. State principle of ESR.
13. State principle of NMR.
14. What do you mean by molecular spectroscopy?
15. Define reduced mass.
16. State application for fluorescence & phosphorescence.

(3 chapter)

17. Explain the characteristics of laser & state long form of laser
18. What do you mean by metastable state?
19. What do you mean by gain.
20. State the rate equation for two / three / Four / level laser.
21. State the types of pumping.
22. What do you mean by population inversion.
23. What do you mean by rate equation.

(4 chapter)

24. Give the types of laser.
25. State the application of laser.
26. State the principles of laser.
27. State the principles of holography.
28. State the principles of He-Ne laser / CO_2 / Dye laser etc.
29. State the principle of semiconductor laser.
30. State the application of He-Ne laser / CO_2 / Dye laser etc.

Short notes (1 chapter)

31. Describe the atomic spectra.
32. Explain the quantum state of an electron with one example.
33. Explain the LS-JJ coupling scheme.
34. Explain the origin of Spectral line.
35. Write a Short note on Stark effect.

(2 chapter)

36. Explain the origin of molecule spectra.
37. Explain the vibrational course structure.
38. Explain the principle & Working of ESR.
39. Explain Construction of NMR & write Down the basic Requirements of NMR spectrometer.
40. Write a Note on Chemical Shift in NMR & hence give formulae's for chemical shift.

(3 chapter)

41. Write a short note on population inversion & Metastable state.
42. Explain the terms spontaneous & stimulated emission.
43. Deduce the expression for Einstein coefficient & state their physical significance.
44. What are the properties of laser.
45. Describe the characteristics of laser beam.

(4 chapter)

46. What is holography? How it differ from photography?
47. Discuss the application of laser in medicine.
48. Discuss the application of laser in industry.
49. Explain the working of CO_2 laser.
50. Explain the working of Nd-YAG laser.

Short answers

(1 chapter)

51. What is Lande's g-factor? Derive it for $^2P_{1/2}$ state.
52. List four quantum numbers, their allowed values & their functions.
53. What is anomalous Zeeman effect? Derive formula for it.
54. State and explain Hund's rule for maximum multiplicity.
55. Calculate the wavelength separation of unmodified lines of wavelength 6000\AA & modified lines when magnetic induction 1 wb/m^2 in normal Zeeman effect.
56. Calculate the wavelength separation between two component lines which are observed in normal Zeeman effect. The magnetic field used is 0.4 wb/m^2 . The specific charge $e/m = 1.76 \times 10^{11}\text{ C/kg}^{-1}$ $\lambda = 6000\text{\AA}$.
57. The red line of cadmium splits into three component separated by 120 mHz. When the source is placed in magnetic field of flux density 8.6 mT. The light being examined in a direction perpendicular to magnetic field. Calculate ratio of charge to mass.

(2 chapter)

58. Explain the information derived from vibrational analysis of electronic vibration spectra.
59. Write a short note on vibrational coarse structure.
60. In ESR write a note on different contribution to the total hamiltonian of the electron in a system.
61. Draw a block diagram of NMR spectrometer & explain it's working.
62. "The intensity distribution of lines in electronic spectra of molecules is not same" comment.
63. Discuss the rotational fine structure of electronic vibrational transition.

(3 chapter)

64. Differentiate between spontaneous & stimulated emission.

65. Differentiate between spatial coherence & temporal coherence.
66. What are Einstein coefficients. Derive relation between them.
67. The ratio of population of two energy levels out of which upper one corresponds to metastable state is 1.059×10^{-30} . Find wavelength of light emitted at temperature = 330K
68. State the types of pumping & explain any one in detail.

(4 chapter)

69. Discuss the construction and working of He-Ne laser.
70. Find relative population of two states in a ruby laser that produces a light of wavelength 6493 \AA at 300K and at 500K comment on relative population at these temperature.
71. Explain the construction & working of Nd-YAG laser.
72. Explain the construction & working of semiconductor laser.
73. Explain the principle & construction of holography.

Long answers

(1 chapter)

74. Explain the Paschen-back effect for 2s-2p transition
75. Explain anomalous Zeeman effect & hence derive a formula for wave number shift in spectral line.
76. What is Zeeman effect? Discuss anomalous Zeeman effect.
77. Explain the normal Zeeman effect on the basis of quantum theory and deduce the expression for shift in wavelength $\Delta\lambda$.
78. Explain the Stark effect.
79. Explain He spectra of alkali atoms.
80. Explain the concept of hyperfine structure by drawing a suitable energy level diagram.
81. With the help of suitable energy level diagram explain fine structure of a spectral line.

(2 chapter)

82. "In rotational fine structure of electronic vibration spectra in certain molecules, the band appears on the violet side of the spectrum and in certain other molecules the band head appears at the red end of spectrum". Explain with diagram
83. Explain the principle, construction & working of ESR.
84. Explain the principle, construction & working of NMR.
85. State & explain the Frank-Condon principle in molecular spectra.
86. Explain band origin and band head in relation to rotational fine structure of electronic vibrational spectra.
87. Discuss the rotational fine structure of electronic vibrational transition.

(3 chapter)

88. Show that threshold condition for laser action is

$$\alpha_{th} = \alpha + \frac{1}{2l} * \ln \frac{1}{r_1 r_2}$$

89. where symbols have usual meaning.
90. What is metastable state? Explain its role in laser beam.
91. Explain why two level laser pumping is not possible
92. Explain two level & three level laser system in short.
93. Obtain the rate equation for two/three/four level laser.

(4 chapter)

94. Discuss the industrial application of laser.
95. With energy level diagram of Neodymium ion in crystal ,explain working of Nd-YAG laser
96. Explain principle construction and working of Nd-YAGlaser.
97. Explain principle ,construction and working of He-Ne laser.
98. Explain principle ,construction and working of Ruby laser.
99. Explain principle ,construction and working of CO₂ laser.
100. Find relative population of the two states in a ruby laser that produces a light of wavelength 6943A° at 300k & 500 k comment on the relative population at these temperature.
101. Explain medical application of laser.
102. Explain principle ,construction and working of semiconductor laser
103. Explain the industrial application of laser.
104. Explain the principle ,construction and working of Dye laser & give it's application.
105. State & explain the principle & properties of laser.