

6/PHY-351 Syllabus-2023

2026

(May-June)

FYUP : 6th Semester Examination

PHYSICS

(Atomic and Molecular Physics)

(PHY-351)

Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions.

Answer any ten questions

1. Describe the Stern-Gerlach experiment and its findings. How does it support the concept of vector atom model? 5+2½=7½
2. What is Zeeman effect? Distinguish between normal and anomalous Zeeman effect. Give the quantum mechanical theory of anomalous Zeeman effect for one-electron system. 1+2+4½=7½
3. (a) State and explain linear Stark effect. 1+3½=4½
(b) Find Lande's g -factor for the states
(i) 3F_2 and (ii) $^2G_{9/2}$. 1½+1½=3

26D/1847

(Turn Over)

(2)

4. (a) Explain $L-S$ and $j-j$ coupling schemes. $3+3=6$

(b) State Larmor's theorem. $1\frac{1}{2}$

5. (a) What are characteristic X-rays? Distinguish between continuous X-radiations and characteristic X-ray emission spectra. $1+3=4$

(b) Derive Moseley's law from Bohr's theory. $3\frac{1}{2}$

6. Assuming the harmonic oscillator approximation, obtain an expression for the allowed vibrational energy levels of a diatomic molecule and hence show that for smaller values of vibrational quantum number the energy levels are equispaced. $7\frac{1}{2}$

7. How is Raman effect explained on the basis of quantum theory? Explain the origin of Stokes' and anti-Stokes' lines in Raman spectrum. $5+2\frac{1}{2}=7\frac{1}{2}$

8. What is Compton effect? Obtain an expression for the Compton shift in wavelength of X-rays using non-relativistic mechanics only. $1+6\frac{1}{2}=7\frac{1}{2}$

9. (a) A substance shows a Raman line at $4567 \text{ \AA}$ when an exciting line of $4358 \text{ \AA}$ is used. Deduce the positions of Stokes and anti-Stokes lines for the same substance when the exciting line of $4047 \text{ \AA}$ is used. 4
- (b) State the differences between Raman spectra and IR spectra. $3\frac{1}{2}$
10. State and explain the Franck-Condon principle in electronic spectra of molecules. $7\frac{1}{2}$
11. Discuss the basic theory and principle of working of NMR spectroscopy. Discuss one application of NMR spectroscopy. $5+2\frac{1}{2}=7\frac{1}{2}$
12. What is population inversion? Describe one method of obtaining population inversion in lasers. Explain the function of resonance cavity in laser. $2+3+2\frac{1}{2}=7\frac{1}{2}$
13. Describe the construction and principle of operation of a He-Ne laser. $7\frac{1}{2}$
14. (a) The force constant of the bond in CO molecule is 187 N/m and its reduced mass is $1.14 \times 10^{-26} \text{ kg}$. Compute the frequency of vibration of the CO molecule and find the spacing between its vibrational energy levels in eV. $4\frac{1}{2}$

(4)

- (b) Explain which of the following molecules are expected to show rotational spectra in the infrared region : 3

CO, O₂, N₂, HBr, NH₃

15. (a) Deduce an expression for the orbital magnetic moment of an electron in an atom. What is Bohr magneton? 4

- (b) Explain the origin of the doublet structure of the sodium D lines. 3½

16. What is vector atom model? State the key concepts related with this model. Discuss the physical significance of the quantum numbers associated with this model. 1+1+5½=7½

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