

(7 pages)

Reg. No. : .....

Code No. : 7396

Sub. Code : ZPHM 32

M.A. (CBCS) DEGREE EXAMINATION,  
NOVEMBER 2023.

Third Semester

Physics – Core

ATOMIC AND MOLECULAR SPECTROSCOPY

(For those who joined in July 2021-2023)

Time : Three hours

Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer:

1. According to wave mechanics, selection rules for electric dipole radiation are
- (a)  $\Delta L = 0, \pm 1$  and  $\Delta J = 0, \pm 1$
  - (b)  $\Delta L = 0, 1, 2 \dots$   $\Delta J = 0, \pm 1$
  - (c)  $M_J = J, J-1, \dots, -J$
  - (d)  $\Delta M_J = 0, \pm 1$

2. The direct and convincing experimental proof for space quantization of angular momentum is,

- (a) Photoelectric effect
- (b) Zeeman effect
- (c) The Stern-Gerlach experiment
- (d) None

3. The splitting of the energy levels or spectral lines of atoms in a magnetic field is called,

- (a) Atomic Spectra
- (b) Zeeman effect
- (c) Stark effect
- (d) Hyperfine structure

4. Convert the spectroscopic quantity  $2000 \text{ cm}^{-1}$  into  $\mu\text{m}$ .

- (a)  $3 \mu\text{m}$
- (b)  $4 \mu\text{m}$
- (c)  $5 \mu\text{m}$
- (d)  $6 \mu\text{m}$

5. \_\_\_\_\_ molecules have all three moment of inertia different.

- (a) Linear
- (b) Symmetric top
- (c) Spherical top
- (d) Asymmetric top

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6. Mid - IR region mainly consists of

- (a) 400 - 100  $\text{cm}^{-1}$
- (b) 4000 - 400  $\text{cm}^{-1}$
- (c) 14000 - 4000  $\text{cm}^{-1}$
- (d) 4000 - 100  $\text{cm}^{-1}$

7. The intensity of an electronic absorption is,

- (a)  $\Sigma = \frac{1}{Cl} \log_{10} \frac{I_0}{I} . l \text{ mol}^{-1} \text{ cm}^{-1}$
- (b)  $\Sigma = \frac{1}{Cl} \log_{10} \frac{I_0}{I} . l \text{ cm}^{-1}$
- (c)  $\Sigma = \frac{1}{Cl} \log_{10} \frac{I_0}{I} . l \text{ mol}^{-1} . \text{cm}^{-1}$
- (d)  $\Sigma = \frac{1}{Cl} \log_{10} \frac{I_0}{I} . l \text{ mol} . \text{cm}$

8. According to Born - Oppenheimer approximation,

- (a)  $E_{\text{total}} = E_{\text{electronic}} + E_{\text{vibration}} + E_{\text{rotation}}$
- (b)  $\Delta E_{\text{Total}} = \Delta E_{\text{elec.}} + \Delta E_{\text{vib.}} + \Delta E_{\text{rot.}} J$
- (c)  $\Delta E_{\text{Total}} = \Delta E_{\text{elec.}} + \Delta E_{\text{vib.}} + \Delta E_{\text{rot.}} \text{ cm}^{-1}$
- (d) All the above

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9. The induced dipole moment of a molecule,  $\mu$  is equivalent to

- (a)  $\alpha E$
- (b)  $\Delta E$
- (c)  $1/\alpha E$
- (d)  $h\nu$

10. The natural life time of level  $n$  is,

- (a)  $Z_n = 1/An$
- (b)  $Z_n = A_n$
- (c)  $Z_n = 1/A_n^2$
- (d) None

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Make a short note on orbital magnetic moment of an atom.

Or

(b) Give a short account of hydrogen spectrum.

12. (a) What is the difference between anomalous Zeeman effect and Paschen Back effect?

Or

(b) What causes hyperfine structure in spectral lines? Explain.

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[P.T.O.]





13. (a) Briefly explain about the isotope effect in rotational spectra.

Or

- (b) The frequencies of vibration of the following molecules in their  $v=0$  states are  $HCl : 2,885\text{ cm}^{-1}$ ;  $D_2 = 2,990\text{ cm}^{-1}$ ;  $DCl : 1,990\text{ cm}^{-1}$  and  $HD : 3,627\text{ cm}^{-1}$ . Calculate the energy change of the reaction  $HCl + D_2 \rightarrow DCl + HD$ .
14. (a) What are the information one can get from vibrational analysis of electronic vibrational spectra?
- Or
- (b) What are the basic requirements needed for a typical NMR spectrometer?
15. (a) Briefly explain the Quantum theory of Raman Effect.

Or

- (b) Write a brief account on Fabry – Perot resonator.

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PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) Explain the Spectra of the alkali metal vapours.

Or

- (b) Discuss on forbidden transitions and selection rules of an atom.
17. (a) State and explain the anomalous Zeeman effect.

Or

- (b) State and explain the Stark effect.
18. (a) Discuss on the information, which can be derived from rotational spectra.

Or

- (b) Give an account of vibrating diatomic rotator.

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19. (a) Describe instrumentation of NMR.

Or

(b) Derive Bloch equations.

20. (a) Elaborate about the intensity alternation in Raman Spectra.

Or

(b) Explain the laser operation on four level.

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