(6 pages)

Reg. No. : .....

Code No. : 6392 **Sub. Code : ZPHM 32**

M.Sc.(CBCS) DEGREE EXAMINATION,
NOVEMBER 2022.

Third Semester

Physics

ATOMIC AND MOLECULAR SPECTROSCOPY

(For those who joined in July 2021 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. Find the true statement
   (a) An electron will not lose energy when jumping from the 1st orbit to the 3rd orbit
   (b) An electron will not give energy when jumping from the 1st orbit to the 3rd orbit
   (c) An electron will release energy when jumping from the 1st orbit to the 3rd orbit
   (d) An electron will absorb energy when jumping from the 1st orbit to the 3rd orbit

2. Calculate the ratio of the kinetic energy for the n = 2 electron for the Li atom to that of Be^+ ion
   (a) 9/16 (b) 3/4
   (c) 1 (d) ½

3. Zeeman effect is the splitting of spectral line in the presence of ——————
   (a) Electric Field (b) Magnetic Field
   (c) Inert Environment (d) Vacuum

4. Zeeman Effect could not be proved by
   (a) Quantum Mechanics
   (b) Bohr's Model
   (c) Hamiltonian operators
   (d) L-S coupling

5. The spectra caused in the infrared region by the transition in vibrational levels in different modes of vibrations are called
   (a) Rotational spectra
   (b) Electronic spectra
   (c) Vibrational spectra
   (d) None of these

6. The IR spectra of a compound helps in

(a) Proving the identity of compounds

(b) Showing the presence of certain functional groups in the molecule

(c) Neither of the above

(d) Both of the above

7. Which of the following is not a type of NMR spectrometer?

(a) Minimal type (b) Maximal type

(c) Multipurpose type (d) Wideline type

8. Which of the following NMR spectrometers have stressed reliability and ease of operation?

(a) Minimal type (b) Maximal type

(c) Multipurpose type (d) Wideline type

9. The elastic scattering of photons is called as

(a) Atmospheric scattering

(b) Rayleigh Scattering

(c) Conserved Scattering

(d) Raman Scattering

10. Which of the following cannot be conserved during Raman scattering?

(a) Total Energy (b) Momentum

(c) Kinetic Energy (d) Electronic Energy

PART B — (5 × 5 = 25 marks)

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

11. (a) For the $^2D_{5/2}$ state of the electron calculate the possible values of m_j and J_z.

Or

(b) Discuss in detail forbidden transitions and selection rules.

12. (a) Explain the normal Zeeman effect.

Or

(b) With a neat diagram explain the magnetic moment of the atom and 'g' factor.

13. (a) What is the change in the rotational constant B when hydrogen is replaced by deuterium in the hydrogen molecule?

Or

(b) Explain about basic principles of ESR.

14. (a) What is the nuclear g_N factor for ^{19}F nucleus which has a magnetic moment of 2.6273 μ_N nuclear spin quantum number I = 1/2.

Or

(b) Explain the magnetic properties of nuclei.

[P.T.O.]

15. (a) Give the classical theory of Raman effect.

Or

(b) Distinguish between spontaneous and stimulated emission.

PART C — (5 × 8 = 40 marks)

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

16. (a) A beam of silver atoms in a stern. Gerlach experiment obtained from an over heated to a temperature of 150k passes through an in homogeneous magnetic field having a field gradient of 20,000 gauss/cm (2×10^4 gauss = 2wb/m²/ perpendicular to the beam. The pole faces are 10 cm long. What is the separation between the two components of the beam at the end of the magnet?

Or

(b) Describe the stem and Gerlach experiment and indicate the importance of the results.

17. (a) State and explain the Paschen Back effect.

Or

(b) With a neat diagram explain the normal stark effect.

18. (a) The fundamental band for Hcl is central at 2886 cm^{-1} Assuming that the internuclear distance is 1.276A° calculate the wave number of the first two lines of each of the P and R branches of Hcl.

Or

(b) Explain in detail vibrating diatomic molecules.

19. (a) A particular NMR instrument operates at 30.256 MHz. What magnetic fields are required to bring a proton nucleus and 13_c nucleus to resonance at this frequency? Magnetic moment of proton= 2.7927 μ_N and magnetic moment of $13_c = 0.7022\,\mu_N$.

Or

(b) With a neat block diagram explain the ESR spectrometer.

20. (a) Obtain the rate equations of a two and three level laser.

Or

(b) Describe the rotational Raman spectra for symmetric top molecules.

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