Reg. No. : ....

Name : ....

Fifth Semester B.Sc. Degree Examination, December 2022

First Degree Programme under CBCSS

Physics

Core Course VIII

PY 1544 – ATOMIC AND MOLECULAR PHYSICS

(2018 Admission onwards)

Time : 3 Hours   Max. Marks : 80

SECTION A

Answer **all** questions in **one** or **two** sentences, each question carries **1** mark.

1.   What are the drawbacks of Bohr's atom model?

2.   What are the four different quantum numbers?

3.   What are singlet and triplet states?

4.   Define fine structure spectral lines.

5.   What are the reasons for hyperfine structure in an atom?

6.   Define spectroscopy.

7.   What is rotational constant? How does it influence a spectrum?

8.   What is the principle of IR spectroscopy?

9.   How does isotopic effect change the rotational spectra?

10. What do you mean by Stokes and anti-Stokes scattering?

(10 × 1 = 10 Marks)

SECTION B

Answer any **eight** questions, not exceeding **a** paragraph.   Each question carries **2** marks.

11.   State Bohr correspondence principle.

12.   Why the ground state is always singlet?

13.   State and explain Pauli's exclusion principle.

14.   Difference between band spectra and line spectra.

15.   Obtain an expression for Bohr electron magneton (μ_B) due to the motion of the electron.

16.   Explain Paschen-Back effect.

17.   Explain Stark effect.

18.   Explain anomalous Zeeman effect.

19.   List out the properties of X-rays.

20.   Explain Raman effect.

21.   Draw the block diagram of Raman spectrometer.

22.   Discuss the classical theory of Raman effect.

23.   What is the requirement for vibration to be Raman active? What is vibrational Raman spectra?

24.   Explain the principle of ESR spectroscopy.

25.   What are the applications of ESR spectroscopy?

26.   Define the term isometric shift Mossbauer spectroscopy.

(8 $\times$ 2 = 16 Marks)

SECTION C

Answer any **six**, each question carries **4** marks.

27. Explain the different classification of molecules.

28. Calculate the Vibrational energy levels of an HCl molecule, assuming the force constant to be 516 Nm^{-1}.

29. What is the minimum voltage to be applied to a X-ray tube to produce X-ray of $1A°$?

30. The CO molecule has a bond length of 0.113 nm and the mass of C^{12} and O^{16} atoms are 1.99×10^{-26} kg and 2.66×10^{-26} kg respectively. Find the energy of CO molecule, when it is in the lowest rotational state.

31. Explain in detail about L-S coupling and J-J coupling.

32. The rotational constant for CO molecule is 1.921 cm^{-1}. Find the ionic bond length of the molecule. Mass of Carbon and Oxygen atoms are 19.92×10^{-27} Kg and 26.56×10^{-27} Kg.

33. Explain the indirect spin-spin interaction of NMR spectroscopy. Write the applications of NMR spectroscopy.

34. OH radical has a moment of inertia of 1.48×10^{-47} Kgm^2. Calculate its inter nuclear distance. Also calculate its angular momentum and angular velocity for $J = -5$.

35. For the exciting light of 4358A, the Raman spectrum of benzene shows Raman lines of ΔV = 608, '846, 995, 1178, 1599, 3064 cm^{-1}. At what wavelength would these Raman lines appear if benzene is irradiated with monochromatic light of 5461 A.

36. The microwave spectrum of CN shows a series of lines separated by 3.7978 cm^{-1}. Calculate the internuclear distance.

37. Calculate the reduced mass and moment of inertia of HCl having bond distance 1.27 A. The atomic weights are 1.008 and 34.98 for H and Cl^{35} respectively.

38. Calculate the strength of the magnetic field required to give processional frequency of 100 MHz for ^{17}O nucleus. Given g_N = 0.757, μ_N = 5.051×10^{-27} JT^{-1}, I = 5/2.

(6 $\times$ 4 = 24 Marks)

SECTION D

Answer any **two** questions. Each question carries **15** marks.

39. Describe the Vector model of the atom and explain the different quantum numbers associated with it.

40. Give an account of Somerfield's atom model. How does it account for the fine structure of hydrogen?

41. Describe quantum mechanical explanation of Zeeman effect.

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

43. Draw the rotational energy levels of the vibrational states $v = 0 \rightarrow v = 1$. What is an IR Spectrometer? What are its essential components?

44. With block diagram explain the working at a NMR Spectrophotometer? List the application of NMR Spectroscopy.

(2 × 15 = 30 Marks)

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