St. Joseph's College of Arts & Science (Autonomous)
Cuddalore – 607001

SUBJECT: MOLECULAR PHYSICS
SUBJECT CODE: EPPH808S
STAFF INCHARGE: Rev. Fr. S.Xavier

2 MARKS

1. What is centrifugal distortion? Write its expression.

2. Why anti-Stoke lines are less intense than Stoke lines?

3. Draw the level diagram of Stoke line anti-Stoke line and Rayleigh line?

4. Give ideas about the dissociation energy.

5. What is Fortrat parabola?

6. Write the two advantages of NMR.

7. Write the resonance condition in NMR.

8. What is isomer shift?

9. What do you mean by anisotropic systems?

10. Diatomic molecules such as CO, HF will show a rotational spectrum, where as N_2, O_2, H_2 will not ,why?

11. Whar are hot bands? Why are they called so?

12. State the condition for a vibration to be Raman active.

13. Explain ν' progression and ν'' progression.

14. Distinguish between spin lattice and spin-spin relaxations.

15. Define chemical shift.

16. Explain the Principle of ESR.

17. What is Zero field splitting?

18. What is Stark effect?

19. What is Moment of inertia?

20. What is Raman effect?

21.Mention any two applications of Raman spectroscopy.

22. State Frank Condon principle.

23. Define "Dissociation energy".

24. Brief about spin-spin coupling.

25. What is Mossbauer effect?

26. Explain micro wave spectroscopy.

27. Write principle of stark modulation microwave spectrometer.

28. Write principle of Hyper Raman effect?

29. Write principle of Frank condon.

30. Define molecular quantum number.

31. Define NMR spectroscopy.

32. Write the general principle of NQR spectroscopy.

33. Define Zeeman splitting.

34. What types of Electromagnetic Spectral regions used in rotational spectroscopy and vibration spectroscopy?

35. Why Br_2, Cl_2 will be inactive in microwave region?

36. What is Stoke and anti stoke line? Write the Selection rule for Rayleigh Scattering and Raman scattering.

37. Is that the spherical top molecule shows no Raman Spectrum? Why?

38. Write a note on azimuthal quantum number.

5 MARKS

1. What is Stark effect? Briefly explain the importance of Stark effect in microwave spectroscopy.

2. The fundamental band for HCl is centred at 2886 cm^{-1}. Assuming that the internuclear distance is 1.276 Å, calculate the wave number of the first two lines of the P and R branches of HCl?

3. Explain the classical theory of Raman scattering.

4. The Raman line associated with a vibrational mode which is both Raman and infrared active is found at 4600 Å when excited by light of wavelength 4358 Å. Calculate the wavelength of the corresponding infrared band .

5. Explain band origin and band head in the rotational fine structure of electronic vibration spectra.

6. The absorption spectrum of oxygen consists of a series of bands which terminates in continuous absorption at 1761 Å. the zero point energy in the ground state corresponds to 793cm^{-1} and the difference in potential energy minima for the two electronic state corresponds to 49800. Determine D$_c^{'}$ of O_2.

7. Explain the chemical shift in NMR.

8. Calculate the strength of the magnetic field required to give a processional frequency of 100MHz for 17$_O$ nucleus g-factor=0.757; Nuclear magneton=5.051x10^{-27}JK^{-1}; I=5/2.

9. Explain the concept and principle of ESR spectroscopy.

10. The ^{14}N resonance of a compound showed 3 lines at 5997 and 2496 MHz, calculate the quadrupole coupling constant e^{2}Qq/h and asymmetric parameter.

11. Compare the rotational spectra of linear symmetric top and asymmetric top molecules.

12 . Give the energy levels and selection rules for the microwave spectra of rigid diatomic molecules.

13. What is Raman effect ? Give the quatum theory of Raman effect.

14. Irradiation of carbon tetrachloride by 4358 Å radiation gives Raman lines at 4400, 4419 and 4447 Å. Calculate the Raman shift for each of these lines.

15. State and Explain Frank Condon Principle.

16. The band origin of a transition in C_2 is observed at 19.378Cm^{-1}, while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively B'=1.7527 Cm^{-1} and B''= 1.6326 Cm^{-1}. Estimate the position of the band head, which state has the larger intermolecular distance?

17. 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

18. In the NMR spectrum of ^{14}N with I=1, how many spectral lines will be observed ? Calculate the frequency required for NMR line at an external field of 1.4 T (g =0.403).

19. What is g factor? Explain anisotropy of g factor.

20. Calculate the recoil velocity and energy of the free Mössbauer nucleus ^{119}Sn when emitting a gamma ray of frequency $5.76*10^8$ Hz. What is the Doppler shift of the gamma ray frequency to an outside observer ? Avogadro number is $6.02*10^{23} mol^{-1}$.

21. Obtain the transition frequency in terms of "B" and "J" for a symmetric molecule.

22. Describe the working of spectrum analyser microwave spectroscopy.

23. Discuss molecular polarizability.

24. Explain how Raman spectroscopy confirms molecular structure of water and CO_2.

25. Derive the Molecular quantum number.

26. Briefly explain the Fortrat parabola and band head formation.

27. Explain spin – spin and spin lattice relaxation processes.

28. Explain FT NMR principle.

29. Write detail note on factors responsible for the hyperfine structure in ESR spectra.

30. Describe the functional units of Mossbauer spectrometer.

31. Explain rotational spectra of linear and symmetric top molecule.

32. Explain IR spectroscopy.

33. Expalin Photoacoustic Raman scattering.

34. Explain electronic spectra of diatomic molecule.

35.A diatomic molecule, AB, has a UPESNspectrum which contains two main features. The first shows only one sharp line, while the other is a cluster of peaks separated by 2300 cm^{-1}.interpret the spectrum in terms of the orbitals from which the features arise, given that the vibrational frequency of the neutral molecule in the ground state is about 2100 cm^{-1}.

36. Write application of structural determination of molecule.

37. Explain measurement of relaxation time by pulse sequence technique.

38. Explain Mossbauer spectrometer.

39.Explain Isomer shift.

40. Explain the fundamental vibrations of Diatomic molecules.

41.Find the moment of Inertia of the first line in the rotational spectra of CO is 3.842 Cm^{-1}.

42. Explain pure rotational Raman spectra of Diatomic molecule.

43. Calculate the Oppenheimer approximation for magnitude of the charge and give a note on coarse fine structures.

44.Fined the Lande g factor for the $^{3}P_1$ level of an atom and the degeneracy of j state arising from the ^{3}P term with spin orbit interaction.

45. Explain the concept and principle of ESR spectroscopy.

46.For one electron system, write down the spectroscopic symbols
for the possible energy levels of electron with **L=2** and which of these levels of electron has the higher energy level?

10 MARKS

1. Explain the effect of anharmonicity on the vibrational spectra of diatomic molecules and explain the dipole change in CO_2 molecules.

2. Explain Raman effect with the help of an energy level diagram..

3. Explain the intensity distribution in and electronic band – dissociation energy.

4. Explain the principle of NMR? How does the NMR frequency related to the external magnetic field?

5. Explain the principle of ESR and explain the Mossbauer spectrometer with its block diagram.

6. Explain the vibrational-rotational energy levels of linear polyatomic molecules.

7. Draw the schematic diagram of Laser Raman Spectrometer.

8. Describe the function of the various parts of it.

9. Expalin the rotational fine structure of electronic vibrational spectra allows one to determine the intermolecular distance of the electronic states.

10. Derive the Bloch Equations.

11. Explain in detail the free radical studies and biological application in ESR spectroscopy.

12. Describe the FT IR spectrometer with a neat diagram. Discuss the sampling techniques.

13. What is Coherent Antistoke's Raman scattering? Explain its experimental arrangements.

14. Explain the electronic spectra of diatomic molecules.

15. Discuss the concepts of NMR spectroscopy and explain its application to structural determination of molecules.

16. Explain the principle of NQR. What are the differences between NMR and NQR? Explain the transition frequencies and energy levels of axially symmetric systems.

17. Explain diatomic diatomic molecules as harmonic and an harmonic oscillator.

18. Explain rotation Raman spectra of diatomic and polyatomic molecules?

19. Explain Fortrat and band head formation.

20. Write the concepts of NMR spectroscopy and chemical shift spin- spin coupling between two more nuclei.

21. Explain Hyperfine and fine structure. General principle of NQR spectroscopy and its applications.

22. Explain the principle of NQR. What are the differences between NMR and NQR? Explain the transition frequencies symmetric systems.