C 81350 (Pages : 2) Name..................................

Reg. No..............................

FOURTH SEMESTER P.G. DEGREE EXAMINATION, MARCH 2020

(CCSS)

Physics

PHY 3C 17—SPECTROSCOPY

(2017 Admissions)

Time : Three Hours Maximum : 80 Marks

Section A (12 Short Questions Answerable within 5 Minutes)

Answer **all** *questions.*
Each question carries 2 *marks.*

1. Define symmetric top molecule. Give one example.
2. Write the equation for the energy levels of a rigid diatomic molecule. Draw the energy levels.
3. Draw the block diagram of microwave spectrometer.
4. Discuss normal modes of vibration of CO_2.
5. What Born Oppenheimer approximation ?
6. Why anti-stokes lines are less intense than stokes lines ?
7. Give the mutual exclusion principle.
8. Differentiate stimulated Raman effect and inverse Raman effect.
9. What is Deslander's table ?
10. What is predissociation ?
11. Write note on nuclear spin and magnetic field interaction.
12. Write a note on hyperfine structure of spectral lines.

(Total Marks 12 × 2 = 24)

Section B (4 Essay Questions Answerable within 30 Minutes)

Answer any **two** *questions.*
Each question carries 14 *marks.*

13. Discuss the rotational spectra of a rigid diatomic molecule. Explain the isotope effect on the spectra and give an account of intensity of rotational lines obtained.
14. Explain in detail, the basic principle of Mössbauer spectroscopy. Discuss Mössbauer effect and chemical shift. Give block diagram of Mössbauer spectrometer.

Turn over

15. Discuss vibrational-rotational spectrum by considering a diatomic vibrating rotator. Explain the effect of anharmonicity on the vibrational spectra of diatomic molecules.

16. For diatomic molecule, obtain the expression for wave numbers of P, R and Q branches in the rotational fine structure of electronic vibration spectra. Discuss the spectrum.

(Total Marks $2 \times 14 = 28$)

Section C (6 Problems Answerable within 15 Minutes)

Answer any **four** *questions.*

Each question carries 7 marks.

17. The spectroscopic bond dissociation energy of $^{35}Cl^{16}O$ radical is 1.9 eV. Calculate the equilibrium bond dissociation energy of $^{35}Cl^{16}O$, if the fundamental vibrational frequency is 780 cm^{-1}.

18. Discuss quadrupole and magnetic hyperfine interactions associated to Mössbauer spectroscopy.

19. What is the average period of rotation of HCl molecule if it is in the J = 1 state. The internuclear distance of HCl is 0.1274 nm. Given the mass of hydrogen and chlorine atoms are 1.673×10^{-27} kg. and 58.06×10^{-27} kg. respectively.

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

21. The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at 1,876.06 cm^{-1} and 3,724.20 cm^{-1} respectively. Evaluate the equilibrium vibration frequency, anharmonicity constant, zero point energy and the force constant of the molecule. Mass of $^{14}N = 23.25 \times 10^{-27}$ kg, Mass of $^{16}O = 26.56 \times 10^{-27}$ kg.

22. Consider the ESR spectrum of the free radical CH_3 observed in a magnetic field of 0.34T. (i) If $g = 2.0023$ for free electron, find the frequency at which resonance is obtained ; (ii) How many hyperfine components one observes due to hyperfine interaction ? ; and (iii) Represents the transitions in an energy level diagram. Given $\mu_B = 9.274 \times 10^{-24}$ JT^{-1}.

(Total Marks $4 \times 7 = 28$)