19U612S (Pages: 2) Name: …….……

Reg. No: …….

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION- APRIL 2022

(CUCBCSS-UG)

CC15U PH6 B11 – SOLID STATE PHYSICS, SPRCTROSCOPY AND LASER PHYSICS

(Physics- Core Course)

(2016 to 2018 Admissions – Supplementary/Improvement)

Time: Three Hours Maximum: 80 Marks

Section A

Answer ***all*** questions. Each question carries 1 mark.

1. An orthorhombic crystal is designated by the lattice parameters …….
2. In a superconductor, the transition temperature is related to the atomic mass as …….
3. The wavenumber 3000 cm^{-1} corresponds to a wavelength of …….
4. The relation between the three moments of inertia of a symmetric top molecule is ……
5. Name two molecules which show infrared spectrum.
6. The selection rule for pure rotational Raman spectrum of a linear molecule is …….
7. In He-Ne laser population inversion is achieved by …….

Write True or False:

8. For a non –rigid rotator the spacing between the successive spectral lines decreases.
9. When placed in a magnetic field, field inside a superconductor will be large compared to that outside.
10. At room temperature the population at the first excited state of hydrogen is almost zero.

(10 × 1 = 10 Marks)

Section B

Answer ***all*** questions in two or three sentences. Each question carries 2 marks.

11. Distinguish between primitive cell and unit cell.
12. Give three applications of superconductors.
13. What are the purposes of slits in a grating spectrometer?
14. What type of molecules are microwave active? Why?
15. What are hot bands in IR spectrum? Why are they called so?
16. Why stoke lines are more intense than anti-stokes lines?
17. Explain what is meant by metastable state.

(7 × 2 = 14 Marks)

Section C

Answer any ***five*** questions in a paragraph. Each question carries 4 marks.

18. Show that the packing factor of diamond cubic structure is only 34%.
19. What are the translational symmetry elements in a crystal?
20. Explain Josephson effect.

21. What are the factors affecting the width of spectral lines?
22. Explain the P and R branches of a rotation-vibration spectrum. Show that the spacing between any two adjacent lines in any branch are equal.
23. Explain the quantum theory of Raman effect.
24. What are the conditions to be satisfied for large stimulated emission? Explain using Einstein coefficients.

(5 × 4 = 20 Marks)

Section D

Answer any ***four*** questions. Each question carries 4 marks.

25. The first order spectrum of a beam of X-rays diffracted from a crystal corresponds to an angle 6.833° and the distance between the Bragg planes is 2.81Å. At what angle, the second order diffraction happens?
26. The miller indices for a plane in a simple cubic crystal are (6 3 2). Find the intercepts of the plane on the crystallographic axes.
27. The critical field of a superconductor at 8 K is 42.84 $x10^5 Am^{-1}$ Determine (1) the transition temperature and (2) the critical field at 0 K.
28. The average spacing between successive rotational lines of CO molecule is 3.8626 cm^{-1}. Determine the transition which gives the most intense spectral line at 300 K.
29. The fundamental and first overtone frequencies of $^{14}N^{16}O$ molecule are centered at 1876 cm^{-1} and 3724 cm^{-1}. Evaluate the equilibrium vibrational frequency, the anharmonicity constant and the force constant of the molecule.
30. The bond length of N_2 molecule is 1.09 Å. Find the position of the first three rotational Raman lines.
31. Find the relative population of the two states in a ruby laser that produces a light beam of wavelength 694.3nm at 500K.

(4 × 4 = 16 Marks)

Section E

Answer any ***two*** questions. Each question carries 10 marks.

32. Distinguish between crystalline and amorphous solids. How are crystals classified according to their internal structural symmetries? Explain each of them.
33. Obtain the expression for the rotational energy levels of a diatomic molecule taking it as a rigid rotator. Explain the effect of isotopic substitution in the rotational spectrum.
34. Explain the formation of cooper pairs in a superconductor. Explain Meissner effect and distinguish between type I and type II superconductors
35. Explain the construction and working of a Ruby laser, mentioning clearly how the essential conditions for laser emission are satisfied.

(2 × 10 = 20 Marks)

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