16A (04) 3/3/23

D6BPH1802 (S2) (Pages: 2) **Reg. No:.....**

Name: .....

SIXTH SEMESTER B. Sc DEGREE EXAMINATION, APRIL 2023

(Supplementary - 2018 Admission)

B.Sc. PHYSICS

APHY6B11T: SOLID STATE PHYSICS, SPECTROSCOPY AND LASER PHYSICS

Time: 3 hours **Maximum Marks: 80**

SECTION A: Short Answer: Answer *all* questions. Each carries 1 mark.

1. Define atomic packing factor.
2. What is meant by population inversion?
3. Explain zero-point energy, using uncertainty principle.
4. What is meant by coherence length?
5. Give an example for microwave inactive molecule.
6. What are hot bands?
7. Why are anti-stokes lines less intense than stokes lines?
8. Give a diffraction method suitable to analyse single crystal structure.

(8 × 1 = 8 Marks)

SECTION B: Paragraph questions: Answer any *six* questions. Each carries 4 marks.

9. Distinguish between Type I and Type II superconductivity.
10. Draw the first five vibrational levels of a molecule, assuming its vibrations are of harmonic nature.
11. What are Einstein's coefficients? Give the relation between them.
12. Explain quantum theory of Raman spectra.
13. With a neat sketch explain NaCl crystal structure.
14. Discuss the various regions of electromagnetic spectrum and classify spectroscopy in accordance with electromagnetic spectrum.
15. Briefly explain instrumentation involved in IR spectrometer.
16. Outline the effect of isotopic substitution on the rotational spectra of the molecules.
17. Write a short note on various symmetry elements of a cubic crystal.

(6 × 4 = 24 Marks)

SECTION C: Problems: Answer any *eight* questions. Each carries 4 marks.

18. Obtain atomic packing factor of a BCC structure.
19. For BCC iron, compute (a) the interplanar spacing and (b) the diffraction angle for the (220) set of planes. The lattice parameter for Fe is 0.2866 nm. Assume that monochromatic radiation having a wavelength of 0.1790 nm is used, and the order of reflection is 1.

(PTO)

20. The critical temperature, T_C for mercury with isotopic mass 199.5 is 4.185 K. Calculate its critical temperature when its isotopic mass changes to 203.4. The isotopic effect coefficient is 0.5.
21. Sketch (100), (110) and (111) planes of a cubic crystal.
22. In a material at 300 K, two energy levels have a wavelength separation of 1 μm. Determine
    (a) The ratio of upper to lower-level occupation densities when the material is in thermal equilibrium.
    (b) The effective temperature when the levels are equally populated.
23. The microwave spectrum of CN radical shows a series of lines spaced by a nearly constant amount of 3.798 cm^{-1}. What is the bond length of CN. The atomic mass of C and N are 12.01 amu and 14.01 amu respectively.
24. The fundamental and first overtones of CO are centred at 2143.3 cm^{-1} and 4260 cm^{-1}. Calculate the equilibrium oscillation frequency, the anharmonicity constant and force constant of CO molecule. The atomic mass of C and O are 12.01 amu and 15.999 amu respectively
25. London penetration depth in a superconducting material is 390 Å at 0 K. Calculate the magnitude of magnetic induction at a depth of 400 Å at 0 K when a magnetic induction of 0.75T is applied.
26. Find the interplanar spacing for the lattice planes of Miller indices (3, 2, 1), (2, 1, 0) and (1, 1, 1) for a cubic lattice with a=5.62 Å.
27. Show that c/a ratio for an ideal hcp lattice is $\sqrt{8/3}$
28. Explain working of a semiconductor laser.
29. What do you understand by space lattice? Enumerate different crystal systems.

(8 × 4 = 32 Marks)

SECTION D: Long answer: Answer any *two* in about two pages. Each carries 8 marks.

30. Explain rotational Raman spectrum of symmetric top molecule with example.
31. Explain the spectrum of non- rigid rotator.
32. Obtain Bragg's law of X-ray diffraction. Discuss the basic principle of powder method.
33. Explain with a schematic diagram the working of a He-Ne laser.

(2 × 8 = 16 Marks)