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D6BPH1802 (S3) (PAGES 2) Reg. No.....

Name: .....

SIXTH SEMESTER B.Sc DEGREE EXAMINATION, APRIL 2024

(Supplementary-2018 Admission)

PHYSICS

APHY6B11T: SOLID STATE PHYSICS, SPECTROSCOPY AND LASER PHYSICS

Time: 3 Hours **Maximum Marks: 80**

SECTION A: Answer *all* questions. Each carries *one* mark.

1. What is meant by basis in crystal structure?
2. What is a primitive cell?
3. Why X-rays are used for determining crystal structures?
4. What is coherence length?
5. What is Meissner effect?
6. What are the different factors leading to the broadening of spectral lines?
7. Name the different classes of molecules according to their rotational inertia.
8. What is a metastable state?

(8 x 1 = 8 Marks)

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

9. Explain Diamond structure.
10. Explain rotating crystal method.
11. What are the differences between Type I and Type II superconductors?
12. Explain BCS theory qualitatively.
13. What are the different factors affecting intensity of spectral lines? Explain briefly
14. How it is possible to find out the moment of inertia of a diatomic molecule from its rotational spectrum? Explain.
15. What is Morse function? Explain the vibrational spectrum of an anharmonic oscillator.
16. Discuss the rotational Raman spectra of linear molecule. Give examples.
17. Explain the concept of stimulated emission and how it is important in lasing action.

(6 × 4 = 24 Marks)

(PTO)

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

18. Copper has fcc structure and its atomic radius is 0.1278nm. Calculate its density. Take the atomic weight of copper as 63.5 amu (1amu=1.661×10^{-27}Kg).
19. A plane makes intercepts of 1, 2 and 3hÅ on the crystallographic axes of an orthorhombic crystal with a:b:c=3:2:1. Determine the Miller indices of this plane.
20. Find out the packing fraction for BCC and FCC lattices.
21. Calculate the glancing angle for the (110) planes of a rock salt crystal with cubic structure (a=0.2814 nm) corresponding to second order diffraction maximum for the X-rays of wavelength 0.071nm.
22. The critical temperature for mercury with isotopic mass 199.5 amu is 4.185 K. Calculate its critical temperature when its isotopic mass changes to 203.4 amu. The isotopic effect coefficient is 0.5.
23. An excited electronic state has a life time of 10^{-8}s. Find the uncertainty in the radiation frequency.
24. What is the change in rotational constant B when ^{12}C of carbon monoxide ($^{12}C^{16}O$) is replaced by ^{13}C. B of $^{12}C^{16}O$ is 1.9211 cm^{-1}
25. The moment of inertia of the CO molecule is $1.46\times10^{-46}kgm^2$. Calculate the energy in eV, and the angular velocity in the lowest rotational energy level of the CO molecule.
26. The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at 1876.06 cm^{-1} and 3724.20cm^{-1} respectively. Evaluate the equilibrium vibration frequency, the anharmonicity and the exact zero-point energy.
27. The first rotational Raman line of H_2 appears at 346cm^{-1} from the exciting line. Calculate the bond length of H_2 molecule. $^1H=1.673\times10^{-27}$kg.
28. Explain Einstein coefficients and derive the relations between them.
29. An atom has two atomic levels spaced by 3eV in energy. Calculate the ratio of population in higher energy and lower energy at 50°C. Boltzmann's constant = 1.38×10^{-23}J/K.

(8 x 4 = 32 Marks)

SECTION D: Answer any *two* in about two pages. Each carries *eight* marks.

30. Give a brief discussion on the fundamental symmetry elements of a crystal? Explain the various symmetry elements a cubic crystal has.
31. Discuss the spectrum of diatomic vibrating rotator and what are P and R branches?
32. Discuss the criteria for the vibrational modes of a molecules being Raman active. Discuss the vibrational Raman spectra in detail by taking $CHCl_3$ as an example.
33. What is the basic working principle of laser? Explain the working of He-Ne laser.

(2 x 8 = 16 Marks)