18U607 (Pages: 2) Name: ……..…….

Reg. No…….……

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, APRIL 2021

(CUCBCSS - UG)

(Regular/Supplementary/Improvement)

CC15U PH6 B11 - SOLID STATE PHYSICS, SPECTROSCOPY AND LASER PHYSICS

(Physics - Core Course)

(2015 Admission onwards)

Time: Three Hours Maximum: 80 Marks

Section A

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

1. The effective number of lattice points in a primitive cell is ……..
2. The number of lattice points in the cubic unit cell of an fcc-lattice is ……..
3. Larger the isotopic mass, …….. is the transition temperature.
4. The pumping mechanism in Ruby laser is ……..
5. …….. is an example for microwave active molecule.

Write true or false:

6. The frequency range corresponds to IR spectrum is 3 $X10^{14}$ to 3 $X10^{16.}$
7. Homonuclear diatomic molecules do not exhibit rotational Raman spectra.
8. Pure vibrational spectra are observed only in liquids.
9. Laser light is highly coherent.
10. Cooper pairs behave as a boson.

(10 × 1 = 10 Marks)

Section B

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

11. Define Bravais lattice and unit cell.
12. Define Glide plane and Screw axis.
13. Explain terms critical field and transition temperature. How are they related?
14. A superconductor is a perfect conductor. At the same time, it is a perfect diamagnet. Explain.
15. What is the significance of signal to noise ratio?
16. What is meant by collision broadening?
17. State Morse function and explain Morse curve for a diatomic molecule.

(7 × 2 = 14 Marks)

Section C

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

18. What are Miller indices? What are the steps involved in determining Miller indices of crystal lattice?

19. Distinguish between point groups and space groups.
20. Briefly explain density of states and energy gap in superconductors.
21. Discuss basic elements of practical spectroscopy.
22. Explain the isotope effect in rotational spectrum of a diatomic molecule.
23. Explain Born Oppenheimer Approximation.
24. Explain Einstein coefficients. How are they related?

(5 × 4 = 20 Marks)

Section D

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

25. Is rotations $2\pi/5$ or $2\pi/7$ possible through an axis passing through a lattice point for symmetry operation? Discuss your answer with a suitable theory.
26. Determine c/a ratio and atomic packing fraction of an hcp structure.
27. The critical fields at 6 K and 8 K for a superconducting alloy are 7.616 and 4.284 mA/m respectively. Determine critical temperature and critical field at 0K.
28. From the value of B_o of 1.923604 ± 0.000027 cm^{-1} obtained from the rotational Raman spectrum of $^{14}N^{15}N$, calculate bond length r_o. Why does it differ from r_o of $^{14}N_2$?
29. The value of $\overline{\omega_e}$ is 4395 cm^{-1} for H_2 molecule. Calculate appropriate zero point energy per mole of H_2. If $\overline{\omega}_e\chi_e$ is 118 cm^{-1}, what is the exact zero point energy?
30. Benzene is exposed to light of wavelength 5460×10^{-8} cm and the stokes line is observed at 5520×10^{-8} cm. Calculate the wavelength of antistokes line.
31. A gaseous medium gives a laser at an IR wavelength of 3.4 nm. What is the difference in energy between the upper and lower levels?

(4 × 4 = 16 Marks)

Section E

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

32. What are symmetry operations? Describe various types of symmetry elements and symmetry operations present in a cubic crystal.
33. Explain diatomic vibrating rotator. Discuss the spectrum and relevant selection rules.
34. Explain the quantum theory of Raman effect. Discuss rotational Raman spectra of symmetric top molecule.
35. Discuss theory and working of ruby laser with a neat diagram.

(2 × 10 = 20 Marks)

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