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Name:

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, APRIL 2020

(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 in a word or a phrase each)

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

1. The atomic radius for fcc-lattice is
2. The number of atoms present in the unit cell of hcp structure is
3. The energy difference between free state of electron and Cooper pair appears as at Fermi surface.
4. Inside Ruby laser population inversion is achieved through pumping.
5. In He-Ne laser, lasing emission is obtained from ions.

Write true or false:

6. HCl molecule is microwave inactive.
7. Rotation transitions occur only in those molecules which possess a permanent electric dipole moment.
8. Raman scattering is due to collision between the molecules of the scatterer and the phonon.
9. At thermal equilibrium the coefficients of induced absorption and stimulated emission are not equal.
10. Soft superconductors completely expel the magnetic field from the interior of the superconducting phase.

(10 x 1 = 10 Marks)

Section B

(Answer in two or three sentences each)

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

11. What are Symmetry operations? Distinguish between rotation and reflection symmetry operations.
12. Define Glide plane and Screw axis.

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Turn Over

13. Good conductors in normal state are relatively poor superconductors. But why?
14. Distinguish between spherical top and symmetric top molecules? Give Example
15. What is meant by collision broadening?
16. Distinguish between Raman Effect and fluorescence.
17. Define population inversion and stimulated emission

(7 x 2 = 14 Marks)

Section C

(Answer in a paragraph of about half a page to one page each)

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

18. Show that five-fold rotation axis does not exist in a crystal lattice.
19. What are Miller indices? What are the steps involved in determining Miller indices of crystal lattice.
20. Describe the principle underlying a SQUID. Mention its applications
21. Using the example of suitable molecule explain the basic process involved in the emission or absorption of microwave radiations of the electromagnetic spectrum.
22. Discuss vibrating diatomic molecule by considering the system as anharmonic.
23. Explain the isotope effect in rotational spectrum of a diatomic molecule.
24. Explain the principle of semiconducting laser.

(5 x 4 = 20 Marks)

Section D

(Problems: write all relevant formulas, all important steps carry separate marks)

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

25. Obtain the Miller indices of a plane which intercepts at $a, b/2, 3c$ and $2a, \infty, c$ in a simple cubic unit cell. Draw a neat diagram showing plane.
26. The lattice constant of a cubic lattice is 'a'. Calculate the spacing between (211), (001), (100), and (101) planes.
27. 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.
28. The first line in the rotation spectrum of carbon monoxide has a frequency of 3.8424 cm^{-1} . Calculate the rotational constant and hence the C-O bond length in carbon monoxide. Avogadro number is 6.023×10^{23}
29. Rotational and centrifugal distortion constants of HCl molecule are 10.593 cm^{-1} and $5.3 \times 10^{-4} \text{ cm}^{-1}$ respectively. Estimate vibrational frequency and force constant of the molecule.

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30. The fundamental band for HCl is centered at 2886 cm^{-1} . Assuming that the inter nuclear distance is 1.276 \AA . Calculate the wave number of the first two lines of each of the 'P' and 'R' branches of HCl.
31. A Ruby laser emits one J pulses of light whose wavelength is 694 nm. What is the minimum number of chromium ions in the Ruby?

(4 x 4 = 16 Marks)

Section E

(Essays - answer in about two pages each)

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

32. Explain Bragg's law of X-ray diffraction in crystals. How is it verified? Describe and explain X-ray spectrometer method of determining λ of X-rays.
33. Explain rotational energy levels and rotational vibrational transitions of a diatomic molecule.
34. Briefly explain the quantum theory of Raman effect. Also discuss the rotational Raman spectra of symmetric top molecule.
35. Explain the theory and working of He-Ne laser.

(2 x 10 = 20 Marks)

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