D 100635 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER U.G. (CBCSS–UG) DEGREE EXAMINATION, MARCH 2024

Physics/Applied Physics

PHY6B11/APH 6B 11—STATISTICAL PHYSICS, SOLID STATE PHYSICS, SPECTROSCOPY AND PHOTONICS

(2019 Admission onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in this question paper have their usual meanings.

Section A - Short Answer type

Answer **all** *questions in two or three sentences, each correct answer carries a maximum of* 2 *marks.*

1. Explain the term distribution function.
2. What are Bosons ? Give two examples.
3. Differentiate between classical and quantum statistics.
4. What are Bravais lattices ? Give an example.
5. Define crystallographic axis.
6. What is meant by resolving power of an optical instrument ?
7. Give the selection rules for rotational spectroscopy.
8. What is an asymmetric top molecule ? Give an example.
9. What are hot bands ?
10. What is pumping ? Give two examples of pumping mechanisms.
11. What are Stokes' lines and anti-Stokes' lines ?
12. Which are the essential components of a laser ?

(Ceiling 20 marks)

Section B - Paragraph / Problem type

Answer **all** *questions in a paragraph of about half a page to one page, each correct answer carries a maximum of* 5 *marks.*

13. Comment on the applications of Bose-Einstein statistics.
14. On a simple cubic lattice of spacing = 1, draw the [100], [010], [110], and [111] directions.

Turn over

15. How does the Rayleigh - Jeans law fail to explain the black body spectrum ?

16. Explain the quantization of energy and the regions of the electromagnetic spectrum.

17. Explain the an harmonic vibration spectrum of a diatomic molecule.

18. Find the energy in cm^{-1} of the photon absorbed when an NO molecule undergoes transition $v = 0$, J" = 0 state to $v = 1$, J' = 1 state where v is the vibrational quantum number and J is the rotational quantum number. Assume that B is the same in both states. Given v_e = 1.904 cm^{-1} and χ_e = 0.00733, $_r$NO = 0.1151 nm, rotational constant of NO = 1.672 cm^{-1}.

19. Discuss the quantum theory of Raman scattering.

(Ceiling 30 marks)

Section C - Essay type

*Essays - Answer in about two pages, any **one** question.*
Answer carries 10 *marks.*

20. Obtain the Maxwell Boltzmann distribution law.

21. Explain, with necessary diagrams, the construction and working of a He- Ne Laser.

(1 × 10 = 10 marks

C 40626 **(Pages : 2)** **Name.....**

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SIXTH SEMESTER U.G. DEGREE EXAMINATION, MARCH 2023

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Physics/Applied Physics

PHY 6B 11/APH 6B 11—STATISTICAL PHYSICS, SOLID STATE PHYSICS, SPECTROSCOPY AND PHOTONICS

(2019 Admission onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in question paper have their usual meanings.

Section A (Short Answer Type)

Answer **all** *questions in two* **or** *three sentences.*
Each correct answer carries a maximum of 2 *marks.*

1. Explain the terms macrostate and microstate in statistical analysis.
2. Plot the Maxwell molecular speed distribution. Give an expression for the root-mean square speed and explain the terms involved.
3. What do you mean by the co-ordination number of a lattice ? What is the co-ordination number of an fcc lattice ?
4. Draw the atomic positions in the cubic cell of diamond projected on a face.
5. Indicate a (111) direction in a cubic crystal.
6. Give the block diagram of a typical emission spectrometer.
7. Give an expression for the rotational energy levels of a rigid diatomic molecule and explain the terms involved.
8. Explain why the rotational changes about the symmetry axis of symmetric top molecules do not give rise to rotational spectrum.
9. What is Born-Oppenheimer approximation ?
10. Mention the physical meaning of the Einstein's co-efficients.
11. Explain Raman effect.
12. List the properties of laser beams.

(Ceiling 20)

Turn over

Section B (Paragraph/Problem Type)

Answer **all** *questions in* **a paragraph** *of about* **half a page to one page**.
Each correct answer carries a maximum of 5 *marks.*

13. A certain atom with total atomic spin $\frac{1}{2}$ has a magnetic moment μ. A collection of such atoms is placed in a magnetic field of strength B. What is the ratio, at room temperature T, of the number of atoms with their spins aligned along the field to those with their spins aligned opposite to the field ?

14. Explain the reason for a very low value of electronic heat capacity of metals at ordinary temperatures.

15. A monochromatic beam of X ray of $\lambda = 0.7$Å undergoes first order Bragg reflection from the plane (3 0 2) of a cubic crystal at a glancing angle of 35°. Determine the lattice constant .

16. Explain the various regions of the electromagnetic spectrum.

17. Using a suitable energy level diagram, indicate the transitions between the rotational-vibrational energy levels of a diatomic molecule (lowest two rotational levels only required). Show the corresponding spectrum.

18. Write short note on (a) Principle of laser ; and (b) Metastable state.

19. Discuss the construction, energy levels involved in lasing action and emission wavelengths of a He-Ne laser.

(Ceiling 30)

Section C (Essay Type)

Answer in about **two pages**, *any* **one** *question.*
Answer carries 10 *marks.*

20. Explain the Einstein theory of heat capacity. Give a typical plot of heat capacity versus temperature.

21. Explain the atomic arrangements in an hcp structure and obtain the corresponding packing fraction.

(1 × 10 = 10 marks)

C 20659 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER U.G. DEGREE EXAMINATION, MARCH 2022

(CBCSS—UG)

Physics/Applied Physics

PHY 6B 11/APH 6B 11—STATISTICAL PHYSICS, SOLID STATE PHYSICS, SPECTROSCOPY AND PHOTONICS

(2019 Admissions)

Time : Two Hours Maximum : 60 Marks

The symbols used in question paper have their usual meanings.

Section A (Short Answer Type)

Answer at least **eight** *questions.*
Each question carries 3 *marks.*
All questions can be attended.
Overall Ceiling 24.

1. What are Fermions ? Give an example. What do you mean by Pauli principle ?
2. Plot the specific heat versus temperature graph of liquid helium at low temperatures. What do you mean by lambda point ?
3. Using a suitable figure, discuss the lattice parameters of a unit cell.
4. What do you mean by a symmetry operation in a unit cell ? What are the point group symmetry operations ?
5. Draw an NaCl lattice structure.
6. Distinguish between microwave active and microwave inactive molecules. Give examples.
7. Distinguish between symmetric top and spherical top molecules.
8. Explain the term “zero point energy” of an IR active molecule.
9. What are hot bands ? Why are they called so ?
10. Explain population inversion.
11. Discuss the basic components of a laser.
12. Mention any four applications of lasers.

(8 × 3 = 24 marks)

Turn over

Section B (Paragraph/Problem Type)

Answer at least **five** *questions.*
Each question carries 5 *marks.*
All questions can be attended.
Overall Ceiling 25.

13. Show that the most probable speed of the Maxwell speed distribution is $(2kT / m)^{1/2}$.

14. Using Fermi-Dirac distribution, obtain an expression for the Fermi energy at absolute zero.

15. 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 = 5.62Å.

16. Discuss the various regions of the electromagnetic spectrum.

17. Draw the energy levels and the allowed transitions between them in the rotational spectrum of a rigid diatomic molecule. Give the corresponding spectrum.

18. Explain the processes spontaneous emission and stimulated emission.

19. Discuss the construction, energy levels involved in lasing action and emission wavelengths of a ruby laser.

(5 × 5 = 25 marks)

Section C (Essay Type)

Answer any **one** *question.*
The question carries 11 *marks.*

20. Discuss briefly the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions. Plot the corresponding distribution functions.

21. Obtain Bragg's law of X-ray diffraction. Discuss the basic principle of powder method.

(1 × 11 = 11 marks)