

B.Sc. Semester - 6 (CBCS) Examination

May/June-2021 (OLD COURSE)

STATISTICAL MECHANICS AND SOLID STATE PHYSICS(CORE)

Time: 1:30 Hours

Marks: 42

Instructions:

1. Figure to the right indicate marks.
2. There are five questions in the question paper.
3. Answer any three of the following questions.

Q.1(A) **Answer The Following Questions. (Any One Out of Two)** (07)

1. Derive the most probable distribution formula for F-D statistics.
2. Derive the distribution law for M-B statistics.

Q.1(B) **Answer The Following Questions. (Any One Out of Two)** (04)

1. Discuss : The Stirling's theorem.
2. If an energy level having degeneracy $g_i = 4$ is to be occupied by 3 particles, then find the number of ways to arrange them in case of B-E and F-D statistics.

Q.1(C) **Answer The Following Questions. (Any Three Out of Five)** (03)

1. For the particles like photons , B-E statistics is applicable. --- Do you agree ?
2. In M-B statistics, internal energy of particles at absolute zero temperature is taken as _____. (infinite /zero)
3. At high temperature, F-D distribution reduces to B-E distribution. --- Is it true or false?
4. Phase space is a _____ dimensional space.
5. Change of phase points between two cell in a phase space give rise to new microstate. --- Is it true or false?

Q.2(A) **Answer The Following Questions. (Any One Out of Two)** (07)

1. Discuss Body Centered Cubic (bcc) crystal.
2. Describe : Ionic crystal.

Q.2(B) **Answer The Following Questions. (Any One Out of Two)** (04)

1. Show that the packing fraction in case of simple cubic structure is 52%
2. Write a note on Hydrogen bonding crystals.

Q.2(C) **Answer The Following Questions. (Any Three Out of Five)** (03)

1. Elements from group-IV(semiconductors) forms covalent bonds. --- Do you agree?
2. According to Einstein, the solid containing N atoms is considered to be equivalent to $3N$ harmonic oscillator. --- Is it true or false?
3. Which cubic structure has the minimum packing fraction?
4. The alkali metals like Na, Li have a *fcc* crystal structure.---Is it True or false?
5. The co-ordination number in case of *hcp* crystal structure is _____.

Q.3(A) **Answer The Following Questions. (Any One Out of Two)** (07)

1. Discuss free electron gas in one dimensional box and derive the equation of normalized wave function.
2. Discuss in detail : Hall effect

- Q.3(B) Answer The Following Questions. (Any One Out of Two)** (04)
1. Explain Density of states in one dimension.
 2. Show that the Fermi wavelength associated with an electron having an energy equal to Fermi energy is given by $\lambda_F = 2(\pi/3N)^{1/3}$.
- Q.3(C) Answer The Following Questions. (Any Three Out of Five)** (03)
1. Metals have very ____ electrical and thermal conductivities. (high / low)
 2. What is Wiedemann-Frantz law ?
 3. According to Sommerfield model, the work function $\phi =$ ____
 4. The Hall resistance depends on the sample thickness t . --- Is it true or false ?
 5. In Hall effect, magnetic field is applied ____ to the current. (parallel / perpendicular)
- Q.4(A) Answer The Following Questions. (Any One Out of Two)** (07)
1. Discuss: Electron-hole carrier concentration in intrinsic semiconductor.
 2. Discuss donor states in extrinsic semiconductor.
- Q.4(B) Answer The Following Questions. (Any One Out of Two)** (04)
1. The band gap of an alloy semiconductor is 1.98 eV. What is the wavelength of radiation emitted due to recombination of holes and electrons ?
 $h = 6.626 \times 10^{-34} \text{ J/s}$, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$
 2. Explain bonding in semiconductors
- Q.4(C) Answer The Following Questions. (Any Three Out of Five)** (03)
1. At absolute zero temperature, pure and perfect crystal of semiconductor is an insulator. --- Is it true or false?
 2. The ____ point in the valence band is called the valence band edge. (lowest/highest)
 3. Band gap energy (E_g) for Germanium is ____ eV.
 4. Where is the Fermi level exactly located in the band structure of insulators ?
 5. What is Fermi energy ?
- Q.5(A) Answer The Following Questions. (Any One Out of Two)** (07)
1. Explain : The London's theory for superconductivity.
 2. Discuss : Applications of superconductors
- Q.5(B) Answer The Following Questions. (Any One Out of Two)** (04)
1. Hg has isotopic mass 199 a.m.u. and critical temperature 4.185 K.
 If its isotopic mass changes to 202 a.m.u., determine new critical temperature.
 2. Explain : Meissner effect.
- Q.5(C) Answer The Following Questions. (Any Three Out of Five)** (03)
1. In case of superconductors, if atomic mass of isotopes increases, its critical temperature decreases --- Is it true or false?
 2. Kammerlingh found that the resistance of mercury drops suddenly to almost zero when the temperature falls below ____ K .
 3. When the dimension of a superconductor increases due to stress, its transition temperature T_c ____ . (increases / decreases)
 4. Superconductor behaves like a perfect paramagnetic material.---Do you agree?
 5. For alloys, the transition temperature is extremely ____ . (high / low)
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