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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)
