

P. R. Thakur Govt. College
Department of Physics
B.Sc. Semester-V Internal Examination, 2023-24
Paper - **PHSACOR12T**
SOLID STATE PHYSICS

Time: 1 Hour

Full Marks: 20

1. Answer any *five* questions from the following: 2 x 5=10

- (a) Why Weiss field cannot be simply due to magnetic dipole-dipole interaction?
- (b) Explain why quantum theory of paramagnetic is unable to account for the experimental observation of susceptibility for the ions of iron group.
- (c) What is Curie-Weiss law. Discuss its application for ferromagnetic material.
- (d) Explain the difference between Curie temperature and Neel temperature?
- (e) Explain the cause of hysteresis phenomenon in ferromagnetic materials. What does area of loop signify?
- (f) How does the exchange interaction explain ferromagnetism?
- (g) Define Coercivity and Remanence.

2. Answer any *one* question from the following: 10

- (a) The paramagnetism in copper sulphate arises mainly from copper ions with $S = \frac{1}{2}$. Derive an expression for Magnetisation vector. 4
- Europium oxide is ferromagnetic with the Curie temperature of 70K. An Europium ion has $J = \frac{7}{2}$ and $g = 2$. Calculate the internal magnetic flux density. Also determine the ratio of magnetisation at 300K in a field 0.05T to that of 0K.

Department of Physics
P.R. Thakur Govt. College

3+3

- (b) Consider a line of alternate positive and negative ions each carrying a charge q . the repulsive potential energy between the nearest neighbours is given by $\frac{A}{r^n}$. Find the equilibrium potential energy of the $2N$ ions system.

(10)

INTERNAL ASSESMENT 2022-23

Department Of Physics
P R T G COLLEGE

Paper:PHSACOR12T SOLID STATE PHYSICS

Full Marks -20

Time- 1 hr

Date-17/12/2022

Answer any six questions from the following questions ($6 \times 3 = 18$)
[2 marks are assigned for overall performance]

1. The lattice parameters a, b, c of an orthorhombic crystal are related by $a = 2b = 3c$. Determine the interplanar separation between the (110) planes in units of a .
2. Atoms, which can be assumed to be hard spheres of radius R , are arranged in an fcc lattice with lattice constant a , such that each atom touches its nearest neighbours. Take the center of one of the atoms as the origin. Another atom of radius r (assumed to be hard sphere) is to be accommodated at a position $(0, a/2, 0)$ without distorting the lattice. Calculate the maximum permissible value of r/R .
3. The atomic mass and mass density of Sodium are 23 and 0.968 g/cm^3 , respectively. Find The number density of valence electrons .
Department of Physics
P.R. Thakur Govt. College
4. The real space primitive lattice vectors are $\vec{a}_1 = a\hat{x}$ and $\vec{a}_2 = \frac{a}{2}(\hat{x} + \sqrt{3}\hat{y})$. Find the reciprocal space unit vectors $\vec{b}_1$ and $\vec{b}_2$ for this lattice.
5. A metal with body centered cubic (bcc) structure show the first (i.e. smallest angle) diffraction peak at a Bragg angle of $\theta = 30^\circ$. The wavelength of X-ray used is $2.1\text{\AA}$. Find the volume of the PRIMITIVE unit cell of the metal.
6. Find the Miller indices of a plane passing through the three points having coordinates $(0, 0, 1)$ $(1, 0, 0)$ $(\frac{1}{2}, \frac{1}{2}, \frac{1}{4})$.
Department of Physics
P.R. Thakur Govt. College
7. Find the value of θ at which the first-order peak in X-ray ($\lambda = 1.53$) $\text{\AA}$ diffraction corresponding to (111) plane of a simple cubic structure with the lattice constant, $a = 2.65\text{\AA}$.
8. Calculate the fraction of volume unoccupied in the unit cell of the body centered cubic lattice.
9. The number of second-nearest neighbor ions to a Na^+ ion in NaCl crystal.

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-V Internal Examination, 2021

Paper - PHSACOR12T

Solid State Physics

1. Answer any five (5 × 2 = 10)

- A) what is phonon? Give an indirect evidence in favour of existence of phonon.
- B) Sketch the spontaneous magnetization as a function of temperature.
- C) KBr has a cubic structure. If its density is $2.75 \times 10^3 \frac{\text{kg}}{\text{m}^3}$, and molecular weight 119. Calculate the lattice constant.
- D) What is Brillouin zones?
- E) Define Miller Indices
- F) Define Van der Waals bonding
- G) Define Fermi level
- H) Determine the value of Fermi function for an energy kT above the Fermi energy.

Department of Physics
P.R. Thakur Govt. College

2. Answer any two. (2 × 5 = 10)

- A) The magnetic field intensity in a piece of ferric oxide is 10^6 . If the susceptibility of the material at room temperature is 1.5×10^{-3} . Calculate the magnetization and flux density in the material. Write down the vector form of Bragg's law. (3+2)
- B) Set up Laue's equation for X-ray diffraction. Derive Bragg's law from it. Write down Bragg's law in reciprocal lattice. (2+2+1)
- C) What is effective mass. Derive the quantum expression for paramagnetic susceptibility of a sample. (1+4)
- D) In the Kronig-Penny model the following equation is obtained it after simplification

Department of Physics
P.R. Thakur Govt. College

$$\frac{P}{\alpha a} \sin \alpha a + \cos \alpha a = \cos ka$$

what is the dimension of P? what is its physical significance? Plot the left hand side of the above equation as a function of αa . Hence discuss the allowed region and forbidden region in the graph.

(1+1+2+1)