

2023
B.Sc. (Honours)
B.Sc. Sixth Semester End Examination - 2023
PHYSICS
PAPER - CC12T

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks.
Candidates are required to give their answers in their own
words as far as practicable.
Illustrate the answers wherever necessary.

Group - A

1. Answer any five questions : **5×2=10**
- (a) How a Wigner Sietz unit cell is constructed?
 - (b) A substance has fcc lattice, its molecular weight 60.2 and density 6250 kg/m³. Now calculate its lattice constant.
 - (c) Why X-rays are used for crystal structure analysis?
 - (d) Explain the concept of phonon, which statistics does it obey?

(Turn Over)

(2)

- (e) How does the paramagnetic susceptibility of a material vary with temperature?
- (f) What are ferrites? Write its applications.
- (g) What is 'plasmons'?
- (h) Estimate the Debye temperature of gold if its atomic weight is 197, the density is $1.9 \times 10^4 \text{ kg/m}^3$ and the velocity of sound in it is 2100 m/s.

Group - B

Answer any four questions : 4×5=20

2. (a) What are the significances of Miller indices of a crystal plane?
- (b) Derive an expression for the inter planar spacing for planes of the (hkl) type for a cubic structure. 2+3
3. (a) Define geometrical structure factor. Derive an expression for the scattering amplitude in terms of geometrical structure factor.
- (b) Explain the fact that (100) , (300) reflection lines vanishes for metallic sodium but (200) , (110) lines are present. (1+3)+1

(3)

4. (a) What are Brillouin zones?
- (b) A three dimensional lattice has basis vectors $\vec{a} = \hat{i} - \hat{j}$, $\vec{b} = 2\hat{i} - \hat{j}$ and $\vec{c} = \hat{k}$
Find the basis vectors of reciprocal lattice. 2+3
5. (a) Write down the dispersion relation for the lattice wave in a monatomic linear lattice in terms of the wave velocity. Then discuss the dispersion behaviours
(i) at low frequencies (ii) at high frequencies of vibration.
- (b) Compute the cut off frequency for a linear monatomic lattice if the velocity of sound and interatomic spacing in the lattice are $3 \times 10^3 \text{ m/s}$ and $3 \times 10^{-10} \text{ m}$ respectively. 3+2
6. (a) What is piezoelectric effect?
- (b) Explain the origin of piezoelectric effect and discuss about the application of piezoelectric crystals. 2+(2+1)
7. (a) Why is ionic polarizability found to be rather insensitive to temperature?
- (b) Dy^{3+} has outer electric configuration of $4f^9 6s^0$. Calculate effective number of Bohr magneton and

(4)

magnetic susceptibility for a salt containing one kg mole
of Dy^{3+} ions at 300 k. 2+3

Group - C

Answer any one question :

1×10=10

8. (a) Derive the relation for lattice heat capacity following
instein model.
- (b) Discuss the relation at very high and very low
temperatures.
- (c) Give the predictions of the model and compare with
experimental observations.
- (d) Calculate the Einstein temperature for given Einstein's
frequency 9×10^{11} Hz. 5+2+2+1
9. (a) Write a short note on flux quantisation.
- (b) The transition temperature of mercury with an average
atomic mass of 200.59 amu is 4.153K. Determine the
transition temperature of one of its isotopes ${}_{80}Hg^{204}$.
- (c) Explain the differences between the type I and type II
super conductors using Meissner effect.
- (d) State and discuss Bloch theorem for the periodicity
character of potential in a crystal. 2+3+3+2