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Roll No. ....

## PHY-503

### Solid State Physics

M. Sc. PHYSICS (MSCPHY-12/13/16/17)

First Year, Examination, 2018

**Time : 3 Hours**

**Max. Marks : 80**

**Note :** This paper is of **eighty (80)** marks containing **three (03)** Sections A, B and C. Learners are required to attempt the questions contained in these Sections according to the detailed instructions given therein.

### Section-A

#### (Long Answer Type Questions)

**Note :** Section 'A' contains four (04) long answer type questions of nineteen (19) marks each. Learners are required to answer *two* (02) questions only.

1. Explain the Bravais lattice in three dimension. Draw and explain the NaCl structure.
2. Explain the dynamics of linear chain of identical atoms.
3. For two-dimensional structure, find the variation of density of states with respect to frequency. Calculate electronic specific heat capacity.
4. What is effective mass ? Explain the Kronig-Penny model for solids.

**Section-B****(Short Answer Type Questions)**

**Note :** Section 'B' contains eight (08) short answer type questions of eight (08) marks each. Learners are required to answer *four* (04) questions only.

1. What do you mean by Co-ordinate Numbers ? Find out the co-ordinate number of simple cubic, body centered and face centered crystal structure.
2. Assuming that the lattice points of BCC crystal of lattice parameter  $a$  are occupied by spherical atoms of radius  $R$ , determine the free volume per unit cell.
3. Explain the terms edge dislocation, screw dislocation, stacking fault, Burger's vector.
4. Obtain an expression for the energy of attractive interaction in crystal of inert gas solids. Why do these solids exist only at very low temperature ?
5. Explain the motion of an electron in a solid on the basis of band theory.
6. Show that for an intrinsic semiconductor Fermi level lies at the middle of band gap.
7. Give the theory of Ferromagnetism.
8. What is a Plasma ? Define plasma oscillations and plasmons.

**Section-C****(Objective Type Questions)**

**Note :** Section 'C' contains ten (10) objective type questions of one (01) mark each. All the questions of this Section are compulsory.

Choose the correct alternative :

1. The atomic radius for fcc lattice is :

(a)  $\frac{a}{2}$

(b)  $\frac{\sqrt{3}}{4}$

(c)  $\frac{\sqrt{2}}{4} a$

(d)  $\frac{\sqrt{2}}{3} a$

2. bcc lattice is reciprocal of :
- (a) bcc lattice
  - (b) sc lattice
  - (c) fcc lattice
  - (d) None of these
3. The magnetic moment of an electron is due to :
- (a) Orbital motion of electron only
  - (b) Spin motion of electron only
  - (c) Both orbital and spin motion
  - (d) None of these
4. Which of the following substances can have positive permeability and negative susceptibility ?
- (a) Ferromagnetic
  - (b) Paramagnetic
  - (c) Diamagnetic
  - (d) None of these
5. As the temperature approaches zero, the lattice contribution to heat capacity of solids approaches :
- (a) Infinity

- (b) Zero
  - (c) Any value between zero to one
  - (d) One
6. Average kinetic energy of an electron at 0K in three dimension is :
- (a)  $\frac{1}{3}$  of Fermi energy
  - (b)  $\frac{1}{2}$  of Fermi energy
  - (c)  $\frac{2}{5}$  of Fermi energy
  - (d)  $\frac{3}{5}$  of Fermi energy
7. In Kronig-Penny model of electron in a linear lattice if the strength of the periodic potential increases, the width of the allowed energy band :
- (a) increases
  - (b) decreases
  - (c) remains constant
  - (d) None of these
8. If the dielectric constant in real, the reflectivity of the crystal is given by :
- (a)  $\frac{\sqrt{\epsilon_r} - 1}{\sqrt{\epsilon_r} + 1}$
  - (b)  $\frac{\sqrt{\epsilon_r} + 1}{\sqrt{\epsilon_r} - 1}$

$$(c) \left( \frac{\sqrt{\epsilon_r} - 1}{\sqrt{\epsilon_r} + 1} \right)^2$$

$$(d) \left( \frac{\sqrt{\epsilon_r} + 1}{\sqrt{\epsilon_r} - 1} \right)^2$$

9. Above the Neel temperature :

- (a) The diamagnetism vanishes
- (b) The paramagnetism vanishes
- (c) The ferromagnetism vanishes
- (d) The antiferromagnetism vanishes

10. Critical magnetic field :

- (a) increases if temperature decreases
- (b) increases if temperature increases
- (c) does not depend on temperature
- (d) does not depend on transition temperature