Marks scored:

KATHMANDU UNIVERSITY
End Semester Examination [C]
July, 2017

Level : B. Sc.
Year : III
Course : PHYS 303
Semester : I

Exam Roll No. :
Time: 30 mins.
F. M. : 20

Registration No.:
Date JUL 13 2017

SECTION "A"
[20 Q. × 1 = 20 marks]

Choose and tick the most appropriate answer.

1. The coordination number of the simple cubic crystal is
[a] 1 [b] 2 [c] 6 [d] 12

2. The packing fraction of the face centered cubic crystal structure is
[a] 34% [b] 52% [c] 68% [d] 74%

3. The Miller indices of a plane parallel to X and Y-axes are
[a] (100) [b] (010) [c] (001) [d] (101)

4. Electron behaves as a wave because they can be
[a] deflected by electric field [b] diffracted by crystal
[c] deflected by magnetic field [d] ionize the gas

5. The primitive translation vectors in the reciprocal lattice have the dimensions of
[a] length [b] $(\text{length})^2$ [c] $(\text{length})^{-1}$ [d] $(\text{length})^{-2}$

6. The temperature dependence of the classical expression of electrical resistivity of a metal is
[a] $\rho \propto T^2$ [b] $\rho \propto T^{1/2}$ [c] $\rho \propto 1/T$ [d] $\rho \propto T$

7. Ionic solids with Schottky defects contain in their structures
[a] equal number of cation and anion vacancies
[b] interstitial anions and anion vacancies
[c] cation vacancies only
[d] cation vacancies and interstitial cations

8. The relation between electric field, electrical conductivity and current density is
[a] $J = \frac{E}{\sigma}$ [b] $J = \sigma E^2$ [c] $J = \sigma E$ [d] $J = \frac{\sigma}{E}$

9. The value of Fermi function in Fermi level is
[a] 0 [b] 0.5 [c] 0.75 [d] 1

10. For elastic wave in monoatomic linear lattice only those values of phonon wave vectors are allowed for which the phase *ka* lies between
[a] $-\pi \text{ to } \pi$ [b] $-\frac{\pi}{a} \text{ to } \frac{\pi}{a}$ [c] $-\frac{2\pi}{a} \text{ to } \frac{2\pi}{a}$ [d] $-\frac{a}{\pi} \text{ to } \frac{a}{\pi}$

11. When the mobility of electrons increases, the resistivity
[a] increases [b] decreases
[c] remains constant [d] first increases then decreases

12. At low temperature, the lattice specific heat varies as
[a] T [b] T^2 [c] T^{-1} [d] T^3

13. The shape of the first Brillouin zone of body centered cubic crystal is
[a] simple cubic [b] truncated octahedron
[c] Rhombic dodecahedron [d] square

14. The relation between compressibility and elastic stiffness constant is
[a] $K=\frac{C_{11}+C_{12}}{3}$ [b] $K=\frac{3}{C_{12}+2C_{11}}$ [c] $K=\frac{3}{C_{11}+2C_{12}}$ [d] $K=\frac{3}{C_{11}+2C_{44}}$

15. If λ be the wavelength associated with an electron and V be the applied electric potential, then which of the following relation is correct?
[a] $\lambda=\sqrt{\frac{V}{150}}$ [b] $V=\sqrt{\frac{\lambda}{150}}$ [c] $\lambda=\sqrt{\frac{150}{V}}$ [d] $V=\sqrt{\frac{150}{\lambda}}$

16. When the temperature of pure semiconductor is increased, its resistance
[a] decreases [b] increases [c] remains constant [d] can't be estimated

17. The energy in the lowest state in one-dimensional potential box of length L is
[a] 0 [b] $\frac{\hbar^2\pi^2}{mL^2}$ [c] $\frac{m\hbar^2}{\pi^2L^2}$ [d] $\frac{\hbar^2L^2}{m\pi^2}$

18. The temperature at which a conductor becomes a superconductor is called
[a] superconducting temperature [b] Curie temperature
[c] transition temperature [d] Onn's temperature

19. The magnetic material in which the permanent magnetic dipoles are already aligned due to bonding forces are known as
[a] diamagnetic material [b] paramagnetic material
[c] ferromagnetic material [d] anti-ferromagnetic material

20. At Neel temperature
[a] permeability is maximum [b] permeability is minimum
[c] susceptibility is maximum [d] susceptibility is minimum

KATHMANDU UNIVERSITY
End Semester Examination [C]
July, 2017

JUL 1 3 2017

Level : B. Sc.
Year : III
Time : 2 hrs. 30 mins.

Course : PHYS 303
Semester : I
F. M. : 55

SECTION "B"
[5Q × 4 = 20 marks]

Attempt *ALL* questions.

1. Three dimensional lattice has the basis vectors $\vec{a}_1 = 2\hat{x}$, $\vec{a}_2 = \hat{x} + 2\hat{y}$ *and* $\vec{a}_3 = \hat{z}$. Find the reciprocal lattice vectors.

2. Show that five-fold rotation does not exit in the crystal lattice.

OR

Explain the Van der Waals bonding in molecular crystal.

3. Define superconductivity? What is the effect of an external magnetic field on the superconducting state of material?

4. What is density of states in metals? Show that the density of states for free electron can be written as $D(E) = \frac{3N}{2E}$.

OR

What is ferromagnetism? Discuss Weiss field theory of ferromagnetism.

5. Derive an expression for an electron concentration in intrinsic semiconductors.

SECTION "C"
[5Q × 7 = 35 Marks]

Attempt *ALL* questions.

6. State and prove the Bragg's diffraction condition.

7. What are Miller indices? How the orientation of plane is specified by Miller indices? Find the Miller indices of a crystal plane that makes intercepts a on x-axis, $2b$ on y-axis and $3c$ on z-axis respectively.

OR

Define Fermi energy and obtain the general expression for Fermi energy of electrons in solids. Show that the average kinetic energy in the ground state of electron is one third of Fermi energy.

8. Distinguish between Schottky and Frenkel defects with suitable diagram. Show that the number of Frenkel defects in equilibrium at a given temperature is

$$n = (NN_i)^{1/2} \exp(-E_i/2k_BT).$$

9. A magnetic material has a magnetization of 3300 ampere/meter and the flux density of 0.0044weber/meter^2. Calculate the magnetizing field and the relative permeability of the material. (Given: $\mu_0 = 4\pi \times 10^{-7}$ henry/meter)

10. What is Wiedmann-Franz law? Apply Fermi distribution function to the electron gas in metals and show that the general expression for thermal conductivity is $\frac{\pi^2}{3}\left[\frac{nk_B^2\tau_{F.}T}{m}\right]$.

OR

Write down the basic assumptions of Einstein's theory of specific heat of solids. Derive an expression for lattice heat capacity according to this model. Discuss the relation at very high and very low temperatures.