KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

03 MAR 2019

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. Prove that crystal lattice cannot have five-fold symmetry.

2. State and prove Bragg's diffraction condition.

OR

Show that for one dimensional crystal, the average kinetic energy in ground state is one third of Fermi energy.

3. Prove that the reciprocal lattice to BCC lattice is FCC lattice. Also calculate the volume of primitive cell of the lattice in reciprocal space.

4. What is ferromagnetism? Derive Curie-Weiss law.

OR

Distinguish between conductor, semiconductor and insulator on the basis of band theory.

5. Write three differences between type-I and type-II superconductors.

SECTION "C"

[5Q. × 7 = 35 marks]

Attempt *ALL* questions.

6. What do you mean by defects in a crystal? Show that the number of Schottky defects in equilibrium at given temperature T is $n = N\exp(-E_v / k_B T)$.

7. What are the assumptions of Debye's theory of specific heat? Derive an expression for lattice specific heat capacity according to Debye's model. Show that at low temperature specific heat capacity varies as cube of the temperature.

OR

What is Wiedmann-Franz law? Apply Fermi Dirac distribution function to the electron gas in metal and show that the general expression for thermal conductivity is $\dfrac{\pi^2 n k_B \tau_F T}{3m}$.

8. What is phonon? Show that the dispersion relation for phonons in monatomic linear lattice is

$\omega = \sqrt{\dfrac{4C}{M}}\left|Sin\dfrac{ka}{2}\right|$. where symbols carry their usual meaning. Also plot the dispersion relation curve.

9. Distinguish between intrinsic and extrinsic semiconductor. Derive an expression for hole concentration in an intrinsic semiconductor.

10. The unit cell of aluminum is face centered with lattice constant $a = 0.405\text{nm}$.
(a) How many unit cells are there in an aluminum foil 0.005cm thick and side 25cm square?
(b) If the weight is 0.0085Kg. How many atoms are present?
(c) How many atoms are in each unit cell?

OR

Define cohesive energy for inert gas crystal. State Lenard Johns two body potential and use it to obtain expression for the cohesive energy of an inert gas crystal. (Given for FCC crystal: $\sum_j p_{ij}^{-12} = 12.132$ and $\sum_j p_{ij}^{-6} = 14.454$)

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Mark Scored:

Level : B.Sc.
Year : III

Course : PHYS 303
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration no.:

Date 03 MAR 2019

SECTION "A"

[20Q. × 1 = 20 marks]

Choose and tick the most appropriate answer.

1. If the interplanar spacing of (220) planes of a face centered cubic (FCC) structure is 1.7458Å, then the lattice constant is
[a] 4.983Å [b] 2.458Å [c] 3.152Å [d] 5.125Å

2. In three dimensional crystal structure there are
[a] four crystal system and seven Bravais lattices
[b] seven crystal system and ten Bravais lattices
[c] seven crystal system and fourteen Bravais lattices
[d] fourteen crystal system and seven Bravais lattices

3. The appearance of colour in solid alkali metal halides is generally due to
[a] Schottky defect [b] Frenkel defect
[c] Interstitial position [d] F-centres

4. The position of the Fermi level in N-type semiconductor at T = 0 lies between the energy levels of
[a] conduction band and acceptor level [b] valence band and acceptor level
[c] conduction band and donor level [d] donor level and acceptor level

5. X-rays are used for producing diffraction effect in crystal because
[a] the wavelength of X-rays is comparable to the lattice spacing of the crystal
[b] X-rays is deflected by electric and magnetic field
[c] X-rays are scattered elastically
[d] the wavelength of X-rays is greater than the lattice spacing of the crystal

6. Density of states function implies the number of available
[a] energy levels of electrons in unit volume per unit temperature
[b] energy levels of electrons in unit volume
[c] energy levels of electrons in unit volume per unit energy interval
[d] electrons per unit volume of the solid

7. If the strength of the magnetic field is increased, the hall voltage developed
[a] decreases [b] increases
[c] remains constant [d] changes the direction

8. The probability of occupancy of electrons below Fermi level at T=0°K is
[a] 0 % [b] 25 % [c] 50 % [d] 100 %

9. Which one of the following is the property of an ionic compound?
[a] high melting and boiling points [b] low melting and boiling points
[c] weak inter-atomic forces [d] non-conductors of electricity

10. In acoustical branch, the two atoms of different masses move in
[a] opposite direction with same amplitude
[b] same direction with same amplitude
[c] same direction with different amplitudes
[d] opposite direction with different amplitudes

11. For metals conduction band and valence band are
[a] fully occupied [b] partially occupied
[c] empty [d] overlapping

12. The wave function for the motion of particle in one-dimensional potential box of length L is given by $\psi_n = A\sin(n\pi x/L)$, where A is the normalization constant. The value of A is
[a] $\frac{1}{L}$ [b] $\sqrt{\frac{2}{L}}$ [c] $\sqrt{\frac{L}{2}}$ [d] L

13. According to Einstein's theory of specific heat, the atoms of solid vibrate simple harmonically
[a] in a complex manner [b] in many different modes
[c] all with the same frequency [d] like longitudinal wave

14. The temperature above which the ferromagnetic material becomes paramagnetic is called
[a] curie temperature [b] Neel temperature
[c] Transition temperature [d] Weiss temperature

15. The London penetration depth and temperature are related as
[a] $\lambda_L(T) = \frac{\lambda_L(0)}{\sqrt{1-\left(\frac{T}{T_c}\right)}}$ [b] $\lambda_L(T) = \frac{\lambda_L(0)}{\sqrt{1-\left(\frac{T}{T_c}\right)^2}}$
[c] $\lambda_L(T) = \frac{\lambda_L(0)}{\sqrt{1-\left(\frac{T_c}{T}\right)^4}}$ [d] $\lambda_L(T) = \frac{\lambda_L(0)}{\sqrt{1-\left(\frac{T}{T_c}\right)^4}}$

Fill in the blanks.

16. The atomic packing fraction of a diamond cubic crystal structure is ....

17. If 1eV energy is required to move an atom from the crystal's interior to the surface, then the proportion of vacancies present in the crystal at 1000°k is ....

18. The magnetic material whose susceptibility is positive and low is called ....

19. The bond that exists in a semiconductor is called ....

20. The temperature at which the material undergoes a phase transition from a state of normal resistance to the state of superconductivity is called ....