

Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Level : B. Sc.

Year : III

Exam. Roll No. :

Time: 30 mins.

Course : PHYS 303

Semester : I

F. M. : 20

Registration No. :

Date. MAR 09 2018

SECTION "A"

[20Q × 1 = 20 marks]

Choose and tick the most appropriate answer.

- If n is the number of atoms per unit cell of the cubic system. N and M are the Avogadro's number and atomic weight respectively and ρ is the density of the element, then the lattice constant a is given by
[a] $\left(\frac{M\rho}{nN}\right)^{1/3}$ [b] $\left(\frac{nN}{M\rho}\right)^{1/3}$ [c] $\left(\frac{nM}{N\rho}\right)^{1/3}$ [d] $\left(\frac{N\rho}{nM}\right)^{1/3}$
- The coordination number in the case of simple cubic crystal structure is
[a] 1 [b] 2 [c] 6 [d] 12
- Which one of the following statement is correct?
[a] Dislocation is point defect in the crystal
[b] In edge dislocation Burger's vector is parallel to dislocation line
[c] In screw dislocation Burger's vector is perpendicular to dislocation line
[d] Dislocation is said to be unit strength when the displacement is equal to one lattice spacing
- The unit cell of aluminum is face centered with lattice constant $a = 0.405\text{nm}$. How many unit cells are there in an aluminum foil 0.005cm thick and side 25cm^2 ?
[a] 4.7×10^{16} cells [b] 4.7×10^{19} cells [c] 4.7×10^{21} cells [d] 4.7×10^{22} cells
- If X-rays of wavelength 0.5\AA are diffracted at an angle of 5° in the first order, then the spacing between the adjacent planes of the crystal is
[a] $2.87 \times 10^{-8}m$ [b] $2.87 \times 10^{-10}m$ [c] $2.82 \times 10^{-8}m$ [d] $1.24 \times 10^{-10}m$
- The average kinetic energy in the ground state for one-dimensional crystal is equal to
[a] Fermi energy [b] one half of the Fermi energy
[c] one third of the Fermi energy [d] one fifth of the Fermi energy
- The electrostatic potential energy of an electron in the field of positive ion core is
[a] positive [b] negative [c] zero [d] infinite
- At finite temperature T , the probability of occupation $[F(E)]$ of a state with energy $E = E_F$ is
[a] 0 [b] 0.5 [c] 1 [d] 2
- The bonding which is responsible for binding among the inert gas atoms in the inert gas crystal is
[a] covalent bonding [b] Van der Waal bonding
[c] metallic bonding [d] ionic bonding

10. At the zone boundary (boundary of Brillouin zone), i.e. $k = \pm \frac{\pi}{a}$,
- [a] group velocity is finite and phase velocity is zero
 - [b] both group velocity and phase velocity are zero
 - [c] phase velocity is finite and group velocity is zero
 - [d] both group velocity and phase velocity are equal
11. The average drift velocity v of electron in a metal is related to the electric field E and collision time τ is
- [a] $\sqrt{\frac{eE\tau}{m}}$
 - [b] $\sqrt{\frac{m}{eE\tau}}$
 - [c] $\frac{eE\tau}{m}$
 - [d] $\frac{m}{eE\tau}$
12. If E_1 is the lowest energy value of the electron in a one-dimensional potential box of side L and E_2 is the lowest energy value of the electron in a cubical box of side $L/2$, then E_2/E_1 is
- [a] 2
 - [b] 3
 - [c] 4
 - [d] 12
13. Einstein's theory concludes that at lower temperatures the specific heat
- [a] drops linearly with increase in temperature
 - [b] drops linearly with decrease in temperature
 - [c] drops exponentially with decrease in temperature
 - [d] remains constant
14. The temperature below which certain materials are antiferromagnetic and above which they are paramagnetic is called
- [a] Curie temperature
 - [b] Neel temperature
 - [c] Transition temperature
 - [d] Weiss temperature
15. The relation between critical magnetic field (H_c) and transition temperature (T_c) for a superconductor is
- [a] $T_c = T \left[1 - \left(\frac{H_o}{H_c} \right) \right]$
 - [b] $T_c = T \left[1 - \left(\frac{H_o}{H_c} \right)^2 \right]$
 - [c] $H_c = H_o \left[\left(1 - \frac{T}{T_c} \right)^2 \right]$
 - [d] $H_c = H_o \left[1 - \left(\frac{T}{T_c} \right)^2 \right]$
16. A plane parallel to one of the coordinate axis has an intercept of.....
17. Two adjacent F-centre forms a
18. The magnetic material in which the permanent magnetic dipoles (due to electron spin) are already aligned due to bonding forces are known as.....
19. In an intrinsic semiconductor, the Fermi level lies almost midway between the.....
20. The distance inside the surface of superconductor at which the magnetic field reduces to $1/e$ times its value at the surface is called.....

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F. M. : 55

SECTION "B"

[5Q × 4 = 20 marks]

1. What are Miller indices? Obtain the Miller indices of a plane which intercepts at a , $b/2$, $3c$ in a simple cubic unit cell. Draw the neat diagram showing the plane.
2. State and prove Bragg's diffraction condition.

OR

Explain the Hall effect. Show that for n-type semiconductor the Hall coefficient (R_H) is equal to $1/ne$.

3. Define reciprocal lattice. Show that every reciprocal lattice vector is perpendicular to the direct lattice plane.
4. What is diamagnetism? Discuss quantum theory of diamagnetism.

OR

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

5. What is Meissner effect? Prove that superconductors are diamagnetic in nature.

SECTION "C"

[5Q × 7 = 35 marks]

6. Distinguish between Schottky and Frenkel defects in a crystal. Show that the number of Frenkel defects in equilibrium at given temperature T is $n = (NN_i)^{1/2} \exp(-E_i / 2k_B T)$.
7. What are the assumptions of Einstein's theory of specific heat? Derive an expression for lattice specific heat capacity according to Einstein's model. Discuss low and high temperature limit.

OR

Show that the dispersion relation for phonons in diatomic linear lattice is

$$\omega^2 = \left[\frac{m+M}{mM} \pm \sqrt{\left(\frac{m+M}{mM} \right)^2 - \frac{4\sin^2 ka}{mM}} \right], \text{ where symbols carry their usual meanings. Also}$$

discuss when $ka \rightarrow 0$ and $\pi/2$.

8. What do you mean by dilation? Show that the relation between stiffness constants and compliance constants for cubic crystal are $C_{44} = S_{44}^{-1}$ and $C_{11} + 2C_{12} = (S_{11} + 2S_{12})^{-1}$.

9. Derive an expression for the density of electrons in the conduction band of n-type semiconductor.
10. Zinc has hcp structure. If height of the unit cell is 0.494nm, nearest neighbor distance is 0.27nm and atomic weight of zinc is 65.37 respectively. Calculate the volume of the unit cell and density of zinc.

OR

A copper wire of length 0.5m and diameter 0.3mm has a resistance 0.12Ω at 20°C . If the thermal conductivity of copper at 20°C is $390\text{Wm}^{-1}\text{K}^{-1}$, Calculate the electrical conductivity and Lorentz number. (Given: $K_B = 1.38 \times 10^{-23} \text{ J/k}$)