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PHYSICS - II

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP - A (Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following:

 $10 \times 1 = 10$

- i) A constraint is holonomic when
 - a) they are integrable and equational form
 - b) they are non-integrable and inequational form
 - c) they are integrable and inequational form
 - d) they are non-linear equational form.
- ii) The number of lattice points in the cubic cell of an fcc latice is
 - a) 4

b) 14

c) 6

d) 2.

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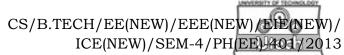
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- iii) The atomic radius of a face centred cubic crystal of lattice constant a is As Photograph (N'Exercising Stad E
 - a/2a)

 $\sqrt{3a}/4$ b)

- $\sqrt{2a}/4$ c)
- d) none of these.
- A crystal is equivalent to iv)
 - *n*-D grating a)
- 3-D grating b)
- 1-D grating c)
- 2-D grating. d)
- Hamiltonian is defined as v)
 - H = T Va)
- b) H = T + V
- c) H = 2T + L
- d) H = V T.
- Torque (t) on an electric dipole having dipole moment (p) in electric field E can be exposed as
 - $\overset{
 ightarrow}{ au} = -\overset{
 ightarrow}{p} \times \overset{
 ightarrow}{E}$
- b) $\overset{\rightarrow}{\tau} = -\vec{p} \cdot \vec{E}$
- $\overrightarrow{\tau} = \overrightarrow{p} \times \overrightarrow{E}$ c)
- d) $\overset{\rightarrow}{\tau} = \vec{p} \cdot \vec{E}$.
- The electrical conductivity of an insulator is zero due to the absence of
 - bound electrons a)
- free electrons b)
- c) protons
- d) neutrons.



- viii) The ionic polarizability is
 - a) dependent on temperature
 - b) independent on temperature
 - c) dependent on current density
 - d) dependent on the concentration of ions.
- ix) The degree of freedom of a phase space is
 - a) 6

b) 3

c) 2

- d) 1.
- x) Which one of the following is not an acceptable wave function of a quantum particle?
 - a) $\psi = e^x$

b) $\psi = e^{-x}$

c) $\psi = x^n$

- d) $\psi = \sin x$.
- xi) The probability of a particle in space at time t is
 - a) 0

b) 1

c) $\frac{1}{2}$

- d) ∞.
- xii) The wave functions of an one-dimensional box represent
 - a) progressive waves
 - b) standing waves
 - c) progressive and standing waves
 - d) none of these.

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xiii) The eigenvalues of Hermitian operator are

- imaginary a)
- b) real
- c) dependent upon the eigenvectors
- d) none of these.
- xiv) Maxwell-Boltzmann statistics is applicable for
 - a) ideal gas
- b) photons
- c) electrons
- d) none of these.
- xv) Pauli's exclusion principle is applied to
 - M.B. Statistics a)
- F. D. Statistics b)
- B. E. Statistics c)
- none of these. d)

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following

 $3 \times 5 = 15$

- 2. a) A bead of mass m slides without friction on a frictionless wire in the shape of cycloid with equations, $x = a(\theta - \sin \theta)$ and $y = a(1 + \cos \theta)$ where $0 \le \theta \le 2\pi$. Find the Lagrangian function and the Lagrangian equation of motion.
 - Derive the expression for energy operator. b)

3 + 2

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- 3. a) "All primitive cells are unit cells but all unit cells are not primitive cells." Justify.
 - b) If V is the volume of a primitive unit cell of a direct lattice, then show that the volume of a primitive unit cell of the reciprocal lattice is $8\pi^3/V$. 2+3
- 4. a) Why is diamagnetism almost independent of temperature?
 - b) What is Bohr magnetron? Show that Bohr magnetron represents the magnetic moment of an elementary dipole. 2+3
- 5. What do you mean by quantum mechanical operator? Find the eigenvalues of momentum and energy operators for a wave function $\psi(x,t) = Ae^{i(kx-\omega t)}$. 1+2+2
- 6. a) What are meant by degenerate and non-degenerate states?
 - b) Four distinguishable particles are distributed over two non-degenerate energy levels of energies *e*, 2*e* and 3*e*. Calculate the total number of microstates and the total energy of the distribution when the thermodynamic probability is maximum.

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) The lattice constant for unit cell of aluminium is 1.04Å.

What is the distance between planes with Miller indices (200)?

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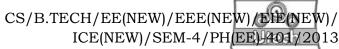


- b) Distinguish between metals, semiconductors.
- c) Define and discuss Wiedemann-Franz law.

$$4 + (2 + 2 + 2) + 5$$

- 8. a) Define displacement vector \overrightarrow{D} and show that for an isotropic dielectric $\overrightarrow{D} = \in_0 \overrightarrow{E} + \overrightarrow{P}$ where \overrightarrow{P} is the polarization vector.
 - b) For ferromagnetic substance how \vec{B} , \vec{M} and μ_r vary with magnetizing field \vec{H} ?
 - c) Assuming that the electric polarizibility of an Argon atom is $1.43 \times 10^{-40} \, \text{F.m}^2$, find the dielectric constant of solid Argon. Given density of Argon is $1.8 \, \text{g. cm}^{-3}$ and atomic mass of Argon is $39.95 \, \text{g.mol}^{-1}$.
 - d) Show that the electronic polarizability is proportional to the atomic volume. 3 + 3 + 5 + 4
- 9. a) Explain what you understand by hysteresis, remanence and coercivity. What is hysteresis loop? How will you determine the value of remanence and coercivity from a loop?
 - b) What are ferrites ? How do ferrites differ from ferromagnetic substances ? Why do we use ferrite material in radios and other communication equipment ? Discuss their other applications.

$$1 + 1 + 1 + 2 + 2 + 1 + 2 + 2 + 3$$



- 10. a) Discuss the basic postulate of quantum mechanics
 - b) Define expectation value of any observable.
 - c) If the wave function of a quantum mechanical particle is given by

$$\psi(x) = a \sin \frac{\pi x}{L}$$
 for $0 \le x \le L$

= 0, otherwise,

then determine the value of a.

Also determine the value of x where the probability of finding the particle is maximum. 5 + 3 + (5 + 2)

- 11. a) What are fermions and bosons? Give two examples of each of them.
 - b) Write the expressions for the distribution laws of MB, BE and FD Statistics. Sketch these distribution functions as functions of energy for their visual comparisons.
 - c) Derive Planck's black body radiation law using BE statistics.
 - d) How many photons are present in 1 cm^3 of radiation in thermal equilibrium at 100 K? What is their average energy? 2 + 5 + 4 + 4

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