

Total No. of printed pages = 7

3 (Sem 6) PHY M2

Bijni College Library
P.O. Bijni, Dist. Chirang
(B.T.A.D) Assam

2015

PHYSICS

(Major)

Theory Paper : M-6.2

Full Marks – 60

Time – Three hours

The figures in the margin indicate full marks for the questions.

GROUP – A

(Mathematical Methods)

1. Answer any *two* from the following : $1 \times 2 = 2$

(a) Evaluate the following sum,

$$\sum_{j=1,2,3} \delta_j^1 A^j$$

(b) Give two physical examples of a second rank tensor.

[Turn over

(c) Show that

$$\left(\delta_m^i \delta_p^k + \delta_p^i \delta_m^k \right) w_{ik} = w_{mp} + w_{pm}$$

2. Answer any *four* from the following : $2 \times 4 = 8$

(a) Show that $\delta_i^j U^i V^j$ behaves like dot product of $\vec{U} = U^1 \hat{i} + U^2 \hat{j} + U^3 \hat{k}$ and

$$\vec{V} = V^1 \hat{i} + V^2 \hat{j} + V^3 \hat{k}.$$

(b) If $T_{mn}^{ij} = A^{ij} B_{mn}$ is a mixed tensor of rank 4 constructed by outer product of A^{ij} and B_{mn} construct a tensor of rank 0 by the process of contraction.

(c) g_j is a symmetric covariant tensor in 3-dimension ($i, j=1,2,3$). Expressing it in a matrix form, show that it has 6 independent components.

(d) If $x = x^1, y = x^2, z = x^3$, show that

$$\sum_{i,j=1,2,3} \frac{\partial^2 \phi}{\partial x^i \partial x^j} \delta_j^i = \nabla^2 \phi$$

(e) What is the rank of the quantity $A^{ijkl} B_{ijkp}$?
What do you mean by an invariant ?

3. Answer any *one* of the following : $5 \times 1 = 5$

(a) If A^i and B_i are two contravariant and covariant tensors respectively, show that $A^i B_i$ is invariant under coordinate transformation $x^i \rightarrow x'^i$.

(b) If $A^i + B^i = 0$ in a coordinate system x^i , show that $A'^i + B'^i = 0$ after a coordinate transformation, $x^i \rightarrow x'^i$.

(c) If $\frac{\partial x^p}{\partial x'^q} = \delta_q^p$ and A_j is a covariant tensor of rank 1, show that

$C^i = B^{ij} A_j$ transforms like a contravariant tensor of rank 1 under coordinate transformation $x^i \rightarrow x'^i$. Here B^{ij} is an arbitrary contravariant tensor of rank 2.

GROUP - B

(Solid State Physics)

1. Choose the correct answer from the following :

$1 \times 7 = 7$

(a) All crystals must possess

(A) Translational symmetry

- (B) *Rotational symmetry*
- (C) Reflection symmetry
- (D) Inversion symmetry
- (b) Madelung constant relates to the strength of bonding energy in
- (A) Van der Waals solids
- (B) Hydrogen bonded solids
- (C) Ionic solids
- (D) Covalent solids
- (c) Root cause of presence of energy bands in solids is
- (A) bonding in solids
- (B) periodicity of atoms / molecules
- (C) presence of free electrons
- (D) presence of ion cores
- (d) In intrinsic semiconductors
- (A) number of electrons is much larger than the number of holes
- (B) number of holes is much larger than the number of holes
- (C) These numbers are nearly equal
- (D) These numbers are exactly equal

- (e) Meissner effect ensures that a superconductor is .
- (A) a perfect conductor
 - (B) a perfect diamagnet
 - (C) a perfect insulator
 - (D) a perfect paramagnet
- (f) The type of magnetism that is present in all materials is
- (A) diamagnetism
 - (B) paramagnetism
 - (C) ferromagnetism
 - (D) ferrimagnetism
- (g) Susceptibility of a ferromagnetic material is
- (A) small positive quantity
 - (B) small negative quantity
 - (C) very large positive quantity
 - (D) nearly zero.

2. Give very short answers to the following questions : 2×4=8

- (a) Differentiate amorphous and crystalline solids giving examples.

- (b) What do you understand by cohesive energy of ionic crystals ?
- (c) What are type-II superconductors ?
- (d) Draw hysteresis loop for ferromagnetic material and label different parts.
3. Give short answers to any *two* of the following questions : 5×2=10
- (a) Calculate the glancing angle on the cube surface of a rock salt crystal with $a = 2.814 \text{ \AA}$ corresponding to second order diffraction of 0.710 \AA wavelength X-ray.
- (b) Illustrate briefly the Sommerfeld free electron model for metals.
- (c) Differentiate metal, insulator and semiconductor in terms of their electrical conductivity and its temperature dependence.
- (d) What is Larmor frequency ? Calculate the Larmor frequency for the orbital momentum of the electron in a magnetic field $B = 1 \text{ w/m}^2$.

4. Answer any *two* questions from the following :
 $10 \times 2 = 20$

(a) What is a Bravais lattice ? What are different Bravais lattices in three dimension ? Explain with suitable example that no other Bravais lattices apart from those listed will be possible.
 $2+6+2=10$

(b) Write an essay on bonding in solids. 10

(c) Obtain expressions for electrical and thermal conductivity of metals and thence derive Wiedemann-Franz relatio. $4+4+2=10$

(d) What are ferromagnetic materials ? Illustrate in detail about Weiss molecular theory of ferromagnetism. $2+8=10$