D 140220 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER (CBCSS—U.G.) DEGREE EXAMINATION
APRIL 2026

Physics/Applied Physics

PHY6B14 (EL3)—MATERIALS SCIENCE

(2020 Admission onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in this question paper have their usual meanings.

Section A (Short Answer Type)

Answer **all** *questions in two* **or** *three sentences, each correct answer carries a maximum of* 2 *marks.*

1. Define smart materials.
2. How do metals differ from ceramics in terms of atomic bonding and properties ?
3. What are van der Waals forces ?
4. Explain why are metals good conductors of electricity based on their bonding nature ?
5. What is meant by atomic packing factor (APF) ?
6. What is the difference between polymorphism and allotropy ?
7. What is a permanent dipole bond, and how does it affect intermolecular interactions ?
8. Define anisotropy in crystalline materials.
9. Define a vacancy defect in a crystal structure.
10. How do edge and screw dislocations differ ?
11. Compare the mechanical properties of diamond and carbon nanotubes.
12. State Fick's first law of diffusion.

(Ceiling - 20)

Turn over

Section B (Paragraph/Problem Type)

Answer **all** *questions in a paragraph of about* **half a page** *to* **one page**, *each correct answer carries maximum of* 5 *marks.*

13. Explain the concept of bonding forces and energies in solids. How does the balance between attractive and repulsive forces determine bond strength ?

14. The potential energy between two atoms in a solid is given by the equation :

    $U(r) = -\frac{A}{r} + \frac{B}{r^n}$, where A and B are constants, and r is the interatomic distance. Explain what happens to the energy when r increases or decreases. Derive the expression for equilibrium bond length.

15. Water expands upon freezing, unlike most substances that contract. Explain the molecular structure and bonding interactions responsible for this behaviour.

16. How do grain boundaries in polycrystalline materials influence their mechanical strength and electrical properties ?

17. A monochromatic X-ray beam of wavelength 1.54 Å is used in a powder diffraction experiment. If the first-order diffraction peak is observed at a Bragg angle of 30°, calculate the interplanar spacing (d) of the crystal.

18. Why are polycrystalline materials typically isotropic, while single crystals exhibit anisotropic behaviour ?

19. The diffusion co-efficients of copper in aluminium are 2.0×10^{-14} m^2/s at 500°C and 7.0×10^{-13} m^2/s at 700°C. Determine the activation energy for diffusion.

(Ceiling - 30)

Section C (Essay Type)

Essays - Answer in about **two pages**, *any* **one** *question.*
The question carries 10 *marks.*

20. Explain the principles and working of Laue's technique and the rotating crystal method for X-ray diffraction. Compare their advantages and limitations in determining crystal structures.

21. Discuss the bonding characteristics in diamond and graphite. Analyze how the nature of bonding contributes to their hardness, electrical conductivity, and thermal properties.

(1 × 10 = 10 marks)