

M. SC. (PHYSICS) (MSCPH)

Term-End Examination

June, 2026

MPHE-027 : NANOSCIENCE

Time : 2 Hours

Maximum Marks : 50

Note : (i) *Attempt any **five** questions.*

(ii) *You can use a calculator.*

(iii) *Symbol have their usual meanings.*

(iv) *Marks for each question are indicated against it.*

1. (a) Consider an icosahedral structure for a cluster. Calculate the number of atoms present in the 5th shell of the cluster, and the total number of atoms in this

cluster. What will be the bulk to surface atom ratio ? 5

(b) Explain the following terms related to nano-synthesis : 5

(i) Precursors

(ii) Surfactants

(iii) Sols

2. (a) Distinguish between top-down and bottom-up approach of nanostructure synthesis. List *five* synthesis methods each for these approaches. 5

(b) With the help of schematic diagram explain the set-up used for molecular beam epitaxy (MBE) deposition system.

5

3. (a) Which chemical components in the plant extracts make them active for metal nanoparticle synthesis ? What are dynamic self assemblies ? 2+3
- (b) Explain the micro-reactor (lab-on-chip) method of nanoparticle synthesis. State *two* advantages of this method. 3+2
4. (a) State the Pentagon rule proposed by Euler. How is it useful in explaining the structure of various fullerenes ? 5
- (b) If the density of free electrons in a metal is $8.2 \times 10^{28} \text{ m}^{-3}$, find the surface plasmon energy. 5
5. What is localized surface plasmon resonance (LSPR) ? Explain its mechanism with the help of an appropriate diagram. How does

the geometry of the nanoparticles influence the LSPR spectra ? 3+3+4

6. Describe any *five* applications of nanotechnology in the field of environment. 10
7. (a) What is a memristor ? How is a memristor realized in practice ? Explain why a memristor is useful as a data storage cell. 5
- (b) How can the blue colour of morpho butterfly be explained using the concept of a photonic crystal ? 5
8. (a) What is giant magnetoresistance (GMR) ? Describe the structure and basic characteristics of a system that exhibit GMR. 5

(b) What are van der Waal's materials ?

Give any *two* examples of these materials. Why are they particularly useful for creating novel heterostructures ?

5

Physical constants :

$$h = 6.62 \times 10^{-34} \text{ Js}$$

$$k_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ or C}^2 \text{ kg}^{-1} \text{ m}^{-3} \text{ s}^2$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

$$N_A = 6.022 \times 10^{26} \text{ k mol}^{-1}$$

× × × × ×