

MPHE-027

ASSIGNMENT BOOKLET

**M.Sc. (Physics) Programme
(MSCPH)**

NANOSCIENCE

Valid from 1st January, 2026 to 31th December, 2026



**School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2026)**

Dear Student,

Please read the section on assignments in the Programme Guide for M.Sc. (Physics). A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, **which would consist of one tutor-marked assignment** for this course. The assignment is in this booklet. The total marks for this assignment is 100, of which 40 marks are needed to pass it.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully:

- 1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ENROLMENT NO.:

NAME:

ADDRESS:

COURSE CODE:.....

COURSE TITLE:

ASSIGNMENT CODE:

STUDY CENTRE: **DATE:**

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

- 2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.
- 3) Leave 4 cm margin on the left, top and bottom of your answer sheet.
- 4) Your answers should be precise.
- 5) **Submit the complete assignment answer sheets containing Part A and Part B, within the due date.**
- 6) The assignment answer sheets are to be submitted to your Study Centre as per the schedule. **Answer sheets received after the due date shall not be accepted. We strongly suggest that you retain a copy of your answer sheets.**
- 7) This assignment is **valid from 1st January 2026 to 31st December 2026**. If you have failed in this assignment or fail to submit till its validity, then you need to get the assignment for the next year and submit it as per the instructions given in the Programme Guide.
- 8) For any queries, please contact: sgokhale@ignou.ac.in or slamba@ignou.ac.in. Please note that we do not provide answers to the questions asked in this Assignment.

We wish you a good luck.

Tutor Marked Assignment

NANOSCIENCE

Course Code: MPHE-027

Assignment Code: MPHE-027/TMA/2026

Max. Marks: 100

Note: Attempt all questions. The marks for each question are indicated against it.

PART A

1. a) For an icosahedral cluster calculate the number of atoms present in its 7th shell. Find the total number of atoms in this cluster and its surface to bulk atom ratio. (2+2+1)
b) Draw the LaMer diagram and explain the particle growth in its three regions. (5)
2. a) Describe the set up used for ionized cluster beam (ICB) deposition. What are the advantages of this method? (4+1)
b) Explain the steps of sol-gel synthesis of silica gel. Differentiate between the structure and method of formation of xerogel and aerogel. (3+2)
c) What is meant by bio-template? With an example explain how it can be used in nanostructure synthesis. State the advantages of using green methods for nanomaterial synthesis. (1+2+2)
3. a) Explain the structure and bonding pattern in C₆₀ Fullerene. Which nanocrystalline allotropes of carbon are obtained using the electric arc deposition set-up with graphite rods? (4+1)
b) What are Dirac point and Dirac cone in case of graphene? What are the specialties of a Dirac cone? What is the difference between graphene and graphyne? (2+1+2)
4. a) Explain with examples, what are Janus particles. Which synthesis methods can be used to form such particles? (3+2)
b) Calculate the surface plasmon energy of a metal with free electron density of $8 \times 10^{27} \text{ m}^{-3}$. (2)
c) What are surface plasmon polaritons (SPP)? State any two technological applications of SPP. (3)
d) What is exciton? What is the difference between Frenkel and Mott-Wannier excitons? Calculate the radius of an exciton in a semiconductor with dielectric constant $\epsilon = 9.1$, $m_e = 0.2$ and $m_h = 0.55$. (1+2+2)

PART B

5. a) Explain the difference between ballistic transport and normal (diffusive) transport in a material. Using the Landauer formula, calculate the conductance of a quantum device in which the conduction take place through three channels, each of which has a transmission coefficient $T=1$. (3+2)

- b) Derive the expression for the conductivity matrix in integer quantum Hall effect. (5)
6. a) What is the difference between single domain and superparamagnetic particles? A superparamagnetic material has a characteristic time of 10^{-11} seconds and a Néel relaxation time of 2.0 second at 300 K. Calculate
 i) the energy barrier (in eV); and
 ii) the blocking temperature if the measurement time is 120s.
 Take $k_B = 8.62 \times 10^{-5} \text{ eVK}^{-1}$. (5)
- b) What are single negative and double negative materials? Explain with the help of a diagram, the characteristics of the propagation of electromagnetic waves through a double negative material. (3+2)
- c) Describe the property of band inversion in a topological insulator. Hence explain why a topological insulator cannot be transformed into a normal insulator. (5)
7. a) Explain the construction and working principle of a microfluidic cantilever sensor. What is the resolution attained by such sensor? (4+1)
- b) Describe the detection mechanism of a virus with the use of Up-Conversion Nanoparticles (UCNPs). (5)
8. a) What are triboelectric nanogenerators? Explain the different modes of their operation. (5)
- b) Describe the role of Nanotechnology in the reduction of air pollution. (5)
- c) Explain the lotus effect based on contact angle. Describe two practical applications of lotus effect. (3+2)
