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PD - 09

Total No. of Pages : 16

School of Nanoscience and Biotechnology
Ph.d Entrance Examination March - April, 2026
Subject Code: 81175

Day and Date : Wednesday, 07-10-2026

Total Marks : 100

Time : 01.00 p.m. to 03.00 p.m.

Instructions :

- 1) All questions are compulsory.
 - 2) Each question carries 2 marks.
 - 3) Answers should be marked in the given OMR answer sheet by darkening the appropriate option.
 - 4) Use black ball point pen only for marking the circle. Do not make any stray mark on the OMR answer sheet.
 - 5) Follow the instructions given on OMR Sheet.
 - 6) Rough work shall be done on the sheet provided at the end of question paper.
 - 7) Only non-programmable calculators are allowed.
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Q. 1) Select the most correct alternative.

Q.1 Choose correct alternatives

1. A study focuses entirely on elucidating the quantum mechanical tunneling probability of excitons across transition metal dichalcogenide interfaces without addressing device integration or operational scalability. This study is best classified as:

A) Applied research.

B) Basic research

C) Action research

D) Evaluative research
2. Which of the following best differentiates a "novel" research finding from an incremental advancement in applied science?

A) Verification of known empirical laws using identical parameters

B) Utilization of proprietary rather than open-source computational codes

- C) Introduction of an unprecedented paradigm, reaction pathway, or mechanism
 - D) Optimization of an existing synthesis route yielding marginal gains in yield
3. In rigorous scientific inquiry, how does an "aim" fundamentally contrast with an "objective"?
- A) The aim lists step-by-step statistical procedures, whereas objectives denote the ultimate vision.
 - B) The aim defines the overarching target, whereas objectives are concrete, measurable operational milestones.
 - C) An aim is strictly quantitative, whereas objectives are strictly qualitative.
 - D) There is no functional distinction in formal grant proposals
4. Conflict of interest (COI) disclosure in scientific journals requires authors to:
- A) Name their personal laboratory staff
 - B) Disclose any financial, commercial, or personal relationships that could inappropriately influence their work
 - C) Surrender all proprietary raw data to competitors
 - D) Re-test every cited reference
5. What is the fundamental risk of relying solely on review papers rather than primary research articles during topic formulation?
- A) Review articles are not subjected to peer review.
 - B) Nuances, boundary constraints, and primary experimental errors may be obscured or misinterpreted by tertiary synthesis.
 - C) Primary literature lacks experimental methodology details.
 - D) Citation indexing prohibits citing primary articles directly

6. An author who contributed significantly to data acquisition, analysis, and drafting is excluded from the author list. This represents:
- A) Guest authorship
 - B) Ghost authorship
 - C) Gift authorship
 - D) Corresponding authorship
7. Assigning authorship to an influential department head who contributed no intellectual input to the research paper is designated:
- A) Ghost authorship
 - B) Gift (honorary) authorship
 - C) Lead authorship
 - D) Ethical recognition
8. An essential personal and intellectual quality of an objective researcher is:
- A) Confirmation bias favoring preferred theories
 - B) Critical thinking and intellectual skepticism
 - C) Blind reliance on traditional textbooks
 - D) Reluctance to share reproducible methodologies
9. Inventing fictitious data or lab results and recording them as authentic findings constitutes:
- A) Paraphrasing
 - B) Plagiarism
 - C) Fabrication
 - D) Bias
10. A pilot study is conducted during the research design phase to:
- A) Produce final publishable statistics
 - B) Pre-test experimental protocols, detect procedural flaws, and evaluate feasibility
 - C) Replace the main investigation
 - D) Formulate the theoretical thesis title

11. Dynamic Light Scattering (DLS) is used in colloidal nanotechnology to measure:
- A) Thin film thickness
 - B) The hydrodynamic diameter and size distribution of nanoparticles dispersed in a liquid suspension
 - C) The unit cell lattice constants
 - D) The work function of metal electrodes
12. In electrospinning of continuous nanofibers, what term describes the conical meniscus formed by the polymer fluid droplet under high critical electrostatic potential?
- A) Marangoni cone
 - B) Taylor cone
 - C) Rayleigh jet
 - D) Debye meniscus
13. Successive Ionic Layer Adsorption and Reaction (SILAR) relies fundamentally on which mechanistic feature?
- A) Simultaneous high-temperature co-evaporation of cations and anions
 - B) Alternating immersion in cationic and anionic precursor baths separated by thorough rinsing to avoid homogeneous precipitation
 - C) High-voltage pulsed discharge inside an electrolytic autoclave
 - D) Continuous photochemical reduction of precursor salts
14. What condition defines the "hydrothermal" or "solvothermal" synthesis regime inside a sealed autoclave?
- A) Room temperature crystallization under continuous laminar gas purge
 - B) Temperatures exceeding the normal boiling point of the solvent, generating autogenous autogenous/supercritical pressures

- C) Zero pressure under liquid nitrogen cryo-conditions
D) Synthesis conducted solely in molten salt fluxes above 100 °C
15. Supercritical drying of a wet alcogel during sol-gel processing yields which class of ultra-low-density materials?
- A) Xerogels
B) Aerogels
C) Cryogels
D) Dense single crystals
16. According to the Beer-Lambert law, a solution with an absorbance of $A = 2.0$ permits what percentage of incident light transmittance (T)?
- A) 20%
B) 10%
C) 1%
D) 0.1%
17. Which selection rule rigorously differentiates Raman spectroscopy from Fourier-Transform Infrared (FTIR) spectroscopy?
- A) Raman requires a change in permanent net dipole moment; FTIR requires a change in polarizability.
B) Raman requires a change in molecular polarizability; FTIR requires a non-zero dynamic molecular dipole moment transition.
C) Raman only probes electronic transitions; FTIR only probes nuclear spins.
D) Raman requires isotopic substitution: FTIR does not.
18. Using the Scherrer equation, if an XRD diffraction peak shows significant peak broadening, what does this indicate regarding the crystalline domains?
- A) Crystallite size has drastically increased.
B) Apparent crystallite size has decreased (or microstrain has increased).

- C) The material has shifted from polycrystalline to an ideal single crystal.
- D) The incident X-ray wavelength has doubled.
19. Why does Transmission Electron Microscopy (TEM) achieve significantly higher spatial resolution than classical optical microscopy?
- A) TEM utilizes optical immersion oils with refractive indices exceeding 10.0.
- B) Relativistic de Broglie wavelengths of high-energy electrons are orders of magnitude smaller than visible photons.
- C) Photons in optical microscopy undergo severe nuclear capture.
- D) TEM lenses have zero spherical and chromatic aberration.
20. Photoluminescence (PL) spectroscopy of a direct-bandgap semiconductor reveals a red-shift in emission peak energy as nanoparticle diameter increases.
- This is an explicit manifestation of:
- A) Surface plasmon resonance quenching
- B) Quantum confinement effect
- C) Rayleigh scattering
- D) Auger recombination dominance
21. When defining the "scope and delimitations" of a research project, the delimitation refers specifically to:
- A) Uncontrollable limitations imposed by device malfunctions
- B) Conscious choices and boundary conditions set by the researcher to narrow the study focus
- C) Systemic calibration errors in scientific hardware
- D) Rejection criteria imposed by journal editors

22. 13. Which of the following describes an inductive approach to scientific research?
- A) Formulating a hypothesis from existing theory and testing it empirically
 - B) Moving from specific empirical observations to broad generalizations and theoretical models
 - C) Deriving numerical proofs strictly from first-principles mechanics
 - D) Falsifying existing hypotheses using control groups
23. When searching for an unexplored research topic, what is the primary structural limitation of relying solely on printed reference textbooks compared to peer-reviewed journals?
- A) Textbooks undergo zero peer review or fact-checking
 - B) Textbooks summarize established, consolidated knowledge and often lag behind current research frontiers by several years
 - C) Textbooks contain only opinionated perspectives rather than scientific methodologies
 - D) Textbooks cannot be indexed in bibliographic databases
24. In size-exclusion chromatography (gel permeation chromatography), in what order do molecules elute from the column?
- A) Smallest molecules elute first, followed by medium, then largest
 - B) Largest molecules elute first because they are excluded from the internal porous volume of the stationary beads
 - C) Positively charged molecules elute first, followed by neutral, then negative
 - D) Molecules elute strictly according to their relative boiling points.

25. What structural information does the mutual exclusion rule provide when combining IR and Raman spectroscopy on an unknown molecule?
- A) If the molecule is chiral, it is inactive in both techniques
 - B) If the molecule has a centre of inversion (centrosymmetric), no vibrational mode can be both IR and Raman active
 - C) Raman lines always appear at twice the energy of IR peaks
 - D) The molecule contains only ionic bonds
26. What is the theoretical specific surface area reported for graphene, which is noted as being much larger than carbon black or carbon nanotubes?
- A) 900 m²/g
 - B) 1000 m²/g
 - C) 2630 m²/g
 - D) 1587 m²/g
27. According to the sources, a Natural Nanocomposite is defined as a material made up of two or more phases, at least one of which must generally have a scale smaller than
- A) 10 nanometer
 - B) 100 nanometers
 - C) 100 micrometers
 - D) 1 millimeter
28. Which of the following favourable properties are associated with natural nanocomposites?
- A) High specific resistance and low-cost
 - B) Durability and low weight
 - C) Good mechanical properties and biodegradability
 - D) All of the above

29. CNT possesses high Young's modulus due to
- A) Four valence electronic bonds of carbon atoms that equally share stress in any direction
 - B) A perfect construction in a tubular manner
 - C) Covalent sp^2 bonds formed between individual carbon atoms to increase strength
 - D) Delocalization of π electrons that travel across several carbon atoms to increase strength
30. Who accidentally discovered graphitic carbon needles using arc-discharge?
- A) Kroto
 - B) Iijima
 - C) Smalley
 - D) Dresselhaus
31. In the Linear Combination of Atomic Orbitals (LCAO) model, why does the bonding state have a lower energy than the antibonding state?
- A) The bonding state has a higher electron probability density in the region of lowered potential energy between the nuclei.
 - B) The antibonding state experiences stronger Coulombic repulsion from the nuclei.
 - C) The Pauli exclusion principle forces bonding electrons into a higher kinetic energy state.
 - D) The bonding orbital is antisymmetric, leading to destructive interference of the wave functions.

32. Which statement accurately describes the difference between direct and indirect semiconductors in terms of electron transitions?
- A) Direct transitions are slower because the electron must find a defect state to drop to the valence band.
 - B) Indirect transitions require a change in both energy and momentum, often involving a defect state or phonon.
 - C) The propagation constant k must remain constant for indirect transitions.
 - D) Direct semiconductors like GaAs cannot emit light because their band gap is too small.
33. For the ternary alloy $\text{Al}_x\text{Ga}_{1-x}\text{As}$, at what approximate aluminum fraction x does the material transition from a direct to an indirect semiconductor?
- A) 0.28
 - B) 0.55
 - C) 0.38
 - D) 0.25
34. For an intrinsic semiconductor, why is the intrinsic level E_i usually not located exactly at the midpoint of the band gap?
- A) The band gap E_g is temperature-dependent and shifts the center point.
 - B) The effective densities of states N_c and N_v are unequal due to differences in electron and hole effective masses.
 - C) The presence of donor impurities pulls E_i toward the conduction band.
 - D) The Pauli exclusion principle only applies to the conduction band.
35. In coating rheology, a fluid that displays a reversible decrease in viscosity over time under a constant shear rate is classified as:
- A) Pseudoplastic
 - B) Dilatant
 - C) Thixotropic
 - D) Rheopectic

36. The Critical Pigment Volume Concentration (CPVC) represents the transition point where:
- A) The binder volume exceeds the void volume between pigment particles
 - B) There is just enough binder to wet all pigment particles and fill all interstitial spaces
 - C) The coating exhibits purely Newtonian flow characteristics
 - D) Volatile organic content drops to zero
37. If the spatial wavefunction of a particle is strictly real-valued everywhere, the net probability current density J is:
- A) Non-zero and uniform
 - B) Identically zero everywhere
 - C) Divergent at the boundary
 - D) Proportional to the local potential
38. If an electron is confined inside a nuclear dimension (10^{-14} m), relativistic quantum kinematics dictates that its minimum kinetic energy must be of the order of:
- A) 1 eV
 - B) 100 eV
 - C) 10 keV
 - D) Tens of MeV
39. The concept of wave-particle duality is exemplified in electron biprism interference experiments. If the beam intensity is reduced so that only one electron passes through the apparatus at a time:
- A) No interference pattern ever emerges
 - B) The statistical accumulation of single-electron detection events reproduces the wave interference pattern over time
 - C) Electrons behave purely as classical localized particles hitting two distinct lines
 - D) The de Broglie wavelength drops to zero

40. When switching a BJT from the deep saturation state to the cut-off state, the "storage time delay" is primarily caused by:
- A) Charging the collector-base junction depletion capacitance
 - B) The time required to remove excess minority carrier charge stored in the quasi-neutral base region.
 - C) The velocity saturation of majority carriers in the sub-collector drift zone
 - D) Avalanche transit-time ionization
41. A Metal-Semiconductor Field-Effect Transistor (MESFET) differs structurally from a standard MOSFET because:
- A) It uses a heavily doped polysilicon gate separated by a thick oxide layer
 - B) It utilizes a metal-semiconductor Schottky barrier directly on the channel instead of an insulating oxide gate
 - C) It relies exclusively on inversion layer formation in wide-bandgap ceramics
 - D) It cannot operate in depletion mode
42. Because of the transferred-electron effect, the drift velocity versus electric field curve of GaAs displays:
- A) A monotonic linear increase obeying Ohm's law up to breakdown
 - B) A threshold electric field beyond which the differential electron mobility becomes negative
 - C) A strictly flat constant velocity at all applied field strengths.
 - D) An exponential decrease initiating from zero electric field.

43. The Langmuir adsorption isotherm derivation relies on which fundamental set of assumptions?
- A) Multilayer adsorption with variable adsorption energy per layer
 - B) Energetically equivalent (homogeneous) sites, localized monolayer adsorption, and no lateral interactions between adsorbed species
 - C) Lateral repulsive forces proportional to fractional surface coverage
 - D) Fractal surface roughness where adsorption enthalpy decreases exponentially with coverage
44. What is the principal role of a "capping agent" or stabilizer coating in a modern nanomedicine platform?
- A) To increase the final size of the delivery system to visible scales.
 - B) To protect the therapeutic payload and prevent uncontrolled aggregation of particles.
 - C) To ensure that chemical waste accumulates in healthy tissues.
 - D) To transform the active drug compound into an inert solid crystal.
45. Which specific combination of components is required to produce localized toxic Reactive Oxygen Species (ROS) during Photodynamic Therapy (PDT)?
- A) Infrared heat rays and structural lipids.
 - B) A light-activated photosensitizer and tissue oxygen.
 - C) High-intensity X-rays and liquid nitrogen.
 - D) Magnetic field pulses and chemical saline.

46. Which of the following is NOT explicitly listed in the text as a key factor influencing the size and shape of nanoparticles?
- A) Reaction temperature B) pH level
C) Reaction time D) Container volume
47. Compared to traditional chemical synthesis, which of the following is an advantage of biological green synthesis?
- A) It requires extreme temperatures and pressures
B) It maximizes chemical waste output
C) It eliminates the use of toxic chemicals and consumes less energy
D) It relies exclusively on dangerous organic solvents
48. What is a primary pharmacokinetic limitation of conventional chemotherapy drugs that nanoparticle-based drug delivery systems aim to overcome?
- A) Excessive intracellular accumulation within non-target healthy tissue parenchyma
B) High systemic toxicity due to lack of specificity and rapid systemic clearance
C) Inability to cross the lipid bilayer of tumor cells under any circumstances
D) Permanently stable half-life preventing any therapeutic release
49. By which physical phenomenon do polymer nanoparticles predominantly accumulate passively within solid tumor interstitium?
- A) Active retrograde lymphatic transport
B) The Enhanced Permeability and Retention (EPR) effect
C) Receptor-mediated transcytosis across intact arterial walls
D) Osmotic gradient-driven back-filtration from venous return

50. What specific term is used to describe metal nanoparticles synthesized using fungal species?

- A) Bacterioform nanoparticles
- B) Mycogenic nanoparticles
- C) Phytogenic nanoparticles
- D) Bio-templated nanoparticles



- Rough Work -