

ENTRANCE EXAMINATIONS – 2023

(Ph.D. Admissions - January 2024 Session)

C-43

Ph.D. (Nanoscience and Technology)

Marks: 70

Time: 2 h Hall Ticket No:

- I. Write your Hall Ticket Number on the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the Space provided above.
 - II. Read the following instructions carefully before answering the questions.
 - III. This Question paper has TWO parts: PART 'A' AND PART 'B'
1. Part 'A': It consists of 20 objective type questions of 1.75 marks each.
 2. Part 'B': It consists of 35 objective questions of 1 mark each.
 3. All questions are to be answered. Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is D, it should be marked as below:



No additional sheets will be provided. Rough work can be done in the question paper itself.

4. Hand over the OMR answer sheet at the end of the examination to the invigilator.
5. Only non-programmable (only scientific) calculators are permitted inside the Examination Hall.
6. This book contains 10 pages including this cover sheet.

PART A

1. There are four prime numbers written in ascending order. The product of the first three is 385 and that of last three is 1001. The last number is
 - A. 11
 - B. 13
 - C. 17
 - D. 19
2. Find the angle between hour hand and the minute hand of a clock at twenty five minutes past three?
 - A. 45°
 - B. 47.5°
 - C. 37°
 - D. 35°
3. How many words can be formed by using all the letters of the word 'B I H A R' ?
 - A. 120
 - B. 100
 - C. 150
 - D. 165
4. A box contains 2 white balls, 3 black balls and 4 red balls. In how many ways can 3 balls be drawn from the box, so that at least one black ball is to be included in the draw?
 - A. 32
 - B. 48
 - C. 64
 - D. 84
5. What is the value of k , if 8 is 4% of i and 4 is 8% of j and k equals j/i ?
 - A. $1/4$
 - B. $1/2$
 - C. 2
 - D. 4
6. A rewording of something written or spoken is a _____.
 - A. paraphrase
 - B. quote
 - C. paradigm
 - D. paradox
7. A cylinder of volume 'V' containing a gas of pressure 'P' is subsequently connected to another cylinder of the same volume. Then the pressure of the gas in both the cylinders at a constant temperature will be
 - A. $P/2$
 - B. $P/4$
 - C. $2P$
 - D. P

8. Which of the following is correct?
- Specific gravity will not have the units
 - Density will not have the units
 - Both specific gravity and density will not have units
 - Both will have units
9. Which of the following is not true?
- Volume is an extensive quantity
 - Temperature is an intensive quantity
 - Pressure is an intensive quantity
 - Volume per unit mass is an extensive quantity
10. A sphere of diameter 'L' is machined out from a metallic cube of side 'L', then the volume of the sphere is approximately
- 50% of the cube
 - 45% of the cube
 - 25% of the cube
 - 40% of the cube
11. If 'g' at the earth's surface is 10 ms^{-2} and mass and radius of the earth is 80 and 4 times, respectively, that of moon, 'g' at the moon's surface will be
- 2 ms^{-2}
 - 4 ms^{-2}
 - 16 ms^{-2}
 - 27 ms^{-2}
12. If the radius of the earth shrinks by 1% while mass remains the same, the acceleration due to gravity on earth's surface
- increases by 1%
 - decreases by 1%
 - decreases by 2%
 - increases by 2%
13. Carbon nano tubes are the typical examples of
- zero-dimensional nano materials
 - two-dimensional nano materials
 - three-dimensional nano materials
 - one-dimensional nano materials
14. If the unit cell volume of the face-centered cubic structured material, the number of atoms associated with each unit cell, the atomic weight of the material, and Avagadro's number are V, n, A, and N, respectively, then which of the following represents the density of the material?
- nNA/V
 - nAV/N
 - nA/NV
 - NA/nV

15. Atomic weight of Fe is 56g. It means
- A. one Fe atom has 56g mass
 - B. one Fe atom has 56g weight
 - C. one Avogadro number of Fe atoms have 56g mass
 - D. one Avogadro number of Fe atoms have 56kg mass
16. The general solution of the differential equation $\frac{dy}{dt} = \frac{1+\cos 2y}{1-\cos 2x}$ is
- A. $\tan y - \cot x = \text{constant}$
 - B. $\tan x - \cot y = \text{constant}$
 - C. $\tan y + \cot x = \text{constant}$
 - D. $\tan y - 2 \cot x = \text{constant}$
17. Which of the given values of x and y make $\begin{pmatrix} 3x+7 & 5 \\ y+1 & 2-3x \end{pmatrix} = \begin{pmatrix} 0 & y-2 \\ 8 & 4 \end{pmatrix}$?
- A. $x = -0.3, y = 7.5$
 - B. $x = -0.3, y = -0.3$
 - C. No particular solution
 - D. $x = -0.3, y = 0.8$
18. A force acts on a body of mass 10 kg for 10 s, after which the force ceases and the body covers 50 m in the next 5 s. The magnitude of the force acted on the body is
- A. 1 N
 - B. 10 N
 - C. 5 N
 - D. 50 N
19. A body of mass 100 gm is dropped from a height of 10 m at a place where acceleration due to gravity is 10 ms^{-2} . The kinetic energy of the body just before it strikes the ground is
- A. 10 J
 - B. 100 J
 - C. 1 J
 - D. J
20. What is the force experienced when a 60 g of an ice-cream cup is placed on a human palm?
- A. 0.6 kN
 - B. 0.6 N
 - C. 6 N
 - D. 6 kN

Part B

21. The free energy of size-confined thermodynamic systems
- is no longer an extensive property but depends on the size of the system
 - is no longer an intensive property but depends on the size of the system
 - continues to be an extensive property while other properties change
 - continues to be an intensive property while other properties change
22. The lateral dimension of a feature on the surface of a material is 1 nm and the same on a micrograph is 1 cm. What is the resolution at which the micrograph was recorded?
- micron-level resolution
 - macro level resolution
 - sub-micron resolution
 - atomic resolution
23. Which of the following is incorrect with respect to a gold nanoparticle compared to its bulk counterpart?
- bandgap narrowing
 - bandgap broadening
 - reduced lattice constants
 - lower melting temperature
24. For a spherical nanoparticle (diameter D), the surface per mole can be expressed as (M is the molecular weight and ρ is the density of the material)
- $6M/\rho D$
 - $6\rho/MD$
 - $6M\rho/D$
 - $6MD/\rho$
25. The number of broken bonds per unit area (N) is expressed. γ_0 and u re the surface energy and bond energy to separate one bond, respectively.
- $N = \frac{2u}{\gamma_0}$
 - $N = \frac{\gamma_0}{2u}$
 - $N = \frac{2u}{\gamma_0}$
 - $N = \frac{2\gamma_0}{u}$
26. When the Al particle size reduces the melting temperature
- remains constant
 - increases
 - decreases
 - decreases up to certain size and then increases

27. The index of refraction (n) of the nanocomposite with low nanoparticles concentration (c) is
- $n_{\text{nanocomposite}} = (1-c) n_{\text{nanoparticle}} + c n_{\text{matrix}}$
 - $n_{\text{nanocomposite}} = (1-c) n_{\text{matrix}} + c n_{\text{nanoparticle}}$
 - $n_{\text{nanocomposite}} = c n_{\text{matrix}} + (1-c) n_{\text{nanoparticle}}$
 - $n_{\text{nanocomposite}} = c n_{\text{matrix}} + c n_{\text{nanoparticle}}$
28. De Broglie wavelength (λ) is
- $\lambda = h/p$
 - $\lambda = p/h$
 - $\lambda = c/P$
 - $\lambda = p/c$
29. In quantum confinement systems which is the correct expression (E_n - Energy level, k - constant, L - one dimensional box size, n - integer)
- $E_n = k \frac{L^2}{n^2}$
 - $E_n = kn^2 L^2$
 - $E_n = k \frac{n^2}{L^2}$
 - $E_n = k \frac{n^2}{L}$
30. C_{60} fullerene consists of
- 12 pentagons and 20 hexagons
 - 10 pentagons and 22 hexagons
 - 12 hexagons and 20 pentagons
 - 10 hexagons and 22 pentagons
31. The velocity (v) of the electrons accelerated with voltage V can be expressed as (e - charge of the electron, m - mass of the electron)
- $v = (2e m/V)^{1/2}$
 - $v = (2e V/m)^{1/2}$
 - $v = (2e V m)^{1/2}$
 - $v = (e V/m)^{1/2}$
32. The elastic electron scattering is proportional to (Z and V are the atomic number and beam energy in SEM, respectively.)
- $(Z/V)^2$
 - $(V/Z)^2$
 - $(VZ)^2$
 - Z/V
33. What is the main purpose of a clean room in nanotechnology research and manufacturing?
- to provide a space for chemical storage
 - to minimize the presence of environmental pollutants
 - to facilitate high-temperature experiments
 - to control humidity levels

34. The correct expression for the effective mass of the electron is (m^* - effective mass of the electron, $\hbar = h/2\pi$ where h - Plank's constant)
- $\frac{1}{\hbar^2} \frac{dy}{dx} = \frac{1}{m^*}$
 - $\frac{d^2y}{dx^2} = \frac{1}{m^*}$
 - $\frac{1}{\hbar^2} \frac{d^2y}{dx^2} = m^*$
 - $\frac{1}{\hbar^2} \frac{d^2y}{dx^2} = \frac{1}{m^*}$
35. Bond angle in the graphite sheet is
- 60°
 - 120°
 - 150°
 - $109^\circ 28'$
36. Statistical interpretation of entropy is
- The state with the maximum number of microstates is stable
 - The state with the minimum number of microstates is stable
 - The state with the infinite number of microstates is stable
 - The state without any microstates is stable
37. Bloch walls are an example of
- Polaron
 - Magnon
 - Exciton
 - Soliton
38. The Einstein relationship between the diffusion constant D and mobility μ for electron (E - electronic field, k_B - Boltzmann constant, T - absolute temperature and e - electronic charge) is
- $D/\mu = 2k_B T/e$
 - $D/\mu = k_B T/e$
 - $D/\mu = k_B T \cdot E$
 - $D/\mu = e/k_B T$
39. What is the maximum efficiency of a heat engine operating between 300 K and 600 K?
- 20%
 - 30%
 - 40%
 - 50%
40. The electronic polarizability at moderate temperature is
- independent of absolute temperature
 - linearly dependent on absolute temperature
 - inversely dependent on absolute temperature
 - linearly dependent on square of absolute temperature

41. Which of the following energy storage devices offers fastest storing of energy?
- Solid oxide fuel cell
 - Battery
 - Electrostatic capacitor
 - Electrochemical capacitor
42. According to Hall-Petch equation, the yield stress of a polycrystalline metal
- increases as the reciprocal of the square of the grain diameter
 - decreases as the reciprocal of the square root of the grain diameter
 - decreases as the reciprocal of the square of the grain diameter
 - increases as the reciprocal of the square root of the grain diameter
43. Even though in the donor exhaustion range the charge carriers remain the same, a slight decrease in the conductivity occurs as the temperature increases, because
- mobility increases
 - mobility decreases
 - lattice scattering decreases
 - charge of the carriers affects the scattering
44. Density of state for the 2D nanomaterials is
- independent of Energy (E)
 - proportional to \sqrt{E}
 - proportional to $1/\sqrt{E}$
 - proportional to E
45. The energy levels (E_n) of a particle trapped in one dimensional box (size L) is
- proportional to L
 - proportional to the $1/L$
 - proportional to L^2
 - proportional to $1/L^2$
46. The properties of the nanomaterials depend on
- the sizes, shapes, dimensionality and morphologies only
 - the sizes and shapes only
 - the sizes, shapes, dimensionality only
 - the sizes only
47. In the zero dimension nanomaterials, electrons are confined in
- only in one dimension
 - only in two dimensions
 - in all three dimensions
 - not confined in any dimensions
48. The degeneracy of 1st energy level in zero dimension nanomaterials is
- three-fold
 - two-fold
 - four-fold
 - nondegenerate

49. Raman Spectroscopy is a technique used in nanomaterial characterization to study
- A. vibrational, rotational, and other low-frequency modes
 - B. particle size distribution
 - C. electrical conductivity
 - D. surface topography
50. Dynamic Light Scattering (DLS) is typically used to measure what aspect of nanoparticles?
- A. Crystal structure
 - B. Particle size distribution
 - C. Magnetic properties
 - D. Elemental composition
51. Which technique is used to determine the optical properties of nanomaterials?
- A. Scanning Tunneling Microscopy (STM)
 - B. Raman Spectroscopy
 - C. Ultraviolet-Visible Spectroscopy (UV-Vis)
 - D. Atomic Force Microscopy (AFM)
52. The 'hydrothermal synthesis' method for nanomaterials involves
- A. high temperature and high pressure
 - B. UV light
 - C. deposition in a vacuum environment
 - D. low temperature and atmospheric pressure conditions
53. During the synthesis of nanomaterials, 'sintering' is a process used to:
- A. Disperse nanoparticles uniformly in a solution
 - B. Increase the crystallinity of the nanoparticles
 - C. Bind nanoparticles together at high temperatures
 - D. Reduce the size of nanoparticles
54. In the synthesis of quantum dots, what is the purpose of using a 'capping agent'?
- A. To facilitate the doping process
 - B. To control the size and prevent aggregation
 - C. To enhance electrical conductivity
 - D. To increase the melting point
55. Which of the following is a primary consideration in the safe handling of nanomaterials?
- A. Maintaining room temperature
 - B. Avoiding exposure to sunlight
 - C. Controlling potential exposure and inhalation
 - D. Ensuring electrical conductivity

University of Hyderabad
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Key for Ph.D. Nanoscience and Technology

Key for NST Winter 2024 (C-43)

Q No	Ans	Q No	Ans	Q No	Ans
1	B	21	A	41	C
2	B	22	D	42	D
3	A	23	A	43	B
4	C	24	A	44	A
5	A	25	D	45	D
6	A	26	B	46	A
7	A	27	B	47	C
8	A	28	A	48	A
9	D	29	C	49	A
10	A	30	A	50	B
11	A	31	B	51	C
12	D	32	A	52	A
13	D	33	B	53	C
14	C	34	D	54	B
15	C	35	B	55	C
16	C	36	A		
17	C	37	D		
18	B	38	B		
19	A	39	D		
20	B	40	A		