

ENTRANCE EXAMINATIONS 2022
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 one 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. Mobile phones, log tables and calculators of any type are NOT permitted inside the Examination Hall.
 6. This book contains 11 pages including this cover sheet.

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PART A

1. Mass of a solid body always scales as the
 - A. volume of the body
 - B. area of the body
 - C. surface area of the body
 - D. inverse of the volume of the body
2. When a horse pulls a cart, the force that helps the horse to move forward is the force exerted by
 - A. the horse on the ground
 - B. the ground on the cart
 - C. the cart on the horse
 - D. the ground on the horse
3. A material that has a minimum of two macroscopically distinguishable constituents that have distinct chemical and physical properties is called as
 - A. a mixture
 - B. a composite
 - C. an alloy
 - D. a doped material
4. A body of weight w_1 is suspended from the ceiling of a room by a chain of weight w_2 . The ceiling pulls the chain by a force
 - A. $(w_1+w_2)/2$
 - B. w_2
 - C. w_1+w_2
 - D. w_1
5. A block of mass 'm' is placed on a smooth inclined plane of inclination angle θ with the horizontal. The force exerted by the plane on the block has a magnitude of
 - A. mg
 - B. $mg \cos\theta$
 - C. $mg/\cos\theta$
 - D. $mg \tan\theta$
6. In a situation the contact force by a rough horizontal surface on a body placed on it has constant magnitude. If the angle between this force and the vertical direction is decreased, the frictional force between the surface and the body will
 - A. increase
 - B. decrease
 - C. remain the same
 - D. may increase or decrease
7. While walking on ice, one should take small steps to avoid slipping. This is because smaller steps ensure
 - A. smaller normal force
 - B. larger normal force
 - C. larger friction
 - D. smaller friction

8. Two cars of unequal masses use similar tyres. If they are moving at the same initial speed, the minimum stopping distance
- is smaller for the heavier car
 - is smaller for the lighter car
 - depends on the volume of the car
 - is same for both cars
9. A heavy stone is thrown from a cliff of height 'h' with a speed 'v'. The stone will hit the ground with maximum speed if it is thrown
- horizontally
 - vertically upward
 - vertically downward
 - in any random initial direction
10. 540 g of ice at 0°C is mixed with 540 g of water at 80°C . The final temperature of the mixture is (specific heat of water = $1 \text{ cal/g}^{\circ}\text{C}$, specific heat of ice = $0.5 \text{ cal/g}^{\circ}\text{C}$, latent heat of fusion of ice = 80 cal/g)
- 40°C
 - 80°C
 - 0°C
 - Less than 0°C
11. Two wires A and B are made of same material. The wire A has a length 'l' and diameter 'r' while the wire B has a length '2l' and diameter 'r/2'. If the two wires are stretched by the same force, the elongation in A divided by the elongation in B is
- 4
 - 8
 - $1/4$
 - $1/8$
12. Statement 1: A is older than B. Statement 2: B is older than C. Statement 3: C is older than A. If the statement 1 and 2 are true, then statement 3 is
- correct
 - false
 - not clear
 - not possible
13. Pointing to a photograph, a man said, "I have no brother and that man's father is my father's son." Whose photograph, was it?
- His son
 - His nephew
 - His grand father
 - His own
14. Which one are twin primes?
- 5,7
 - 79,97
 - 19,91
 - 21,23

15. Which of the following statement is false about the scientific method?
- A. If an hypothesis is supported by experimental evidence, it is a scientific fact
 - B. Peer review is part of the method
 - C. Reporting experimental errors is a crucial part of reporting the experimental results
 - D. If an hypothesis is formulated by an authority, the hypothesis is a scientific fact
16. Which of the following is a 2D nanomaterial?
- A. CNT
 - B. Graphene
 - C. Nanoparticles
 - D. Nanocube
17. For a non-zero second order polynomial, the number of roots can be maximum
- A. 1
 - B. 2
 - C. 0
 - D. 3
18. Crystal structure is used to represent
- A. periodic arrangement of atoms
 - B. periodic arrangement of grains
 - C. periodic arrangement of electrons
 - D. configuration of electrons
19. An exam paper has 150 multiple choice questions of 1 mark each, with each question having four choices. Each incorrect answer fetches -0.25 marks. Suppose 1000 students choose all their answers randomly with uniform probability, the sum total of the expected marks obtained by all the students is
- A. 2550
 - B. 9375
 - C. 1323
 - D. 7300
20. Which of the following representations of a function is through an explicit formula?
- A. verbal representation
 - B. numerical representation
 - C. algebraic representation
 - D. visual representation

PART B

21. $A = \begin{pmatrix} \frac{3}{2} & 0 & \frac{1}{2} \\ 0 & -1 & 0 \\ \frac{1}{2} & 0 & \frac{3}{2} \end{pmatrix}$ has three distinct eigenvectors. One of its eigenvectors is $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$.

Which of the following can be another eigenvector?

A. $\begin{pmatrix} 0 \\ 0 \\ -1 \end{pmatrix}$

B. $\begin{pmatrix} -1 \\ 0 \\ 0 \end{pmatrix}$

C. $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$

D. $\begin{pmatrix} 1 \\ 0 \\ -1 \end{pmatrix}$

22. Young's modulus of a metal is not

- A. measured in the elastic deformation regime
- B. related to stiffness
- C. related to bond energy of atoms
- D. used to measure toughness

23. Kelvin temperature scale is considered to be the most accurate because of which reason?

- A. It depends on the triple point of water
- B. It depends on the freezing point of water
- C. It depends on the melting point of water
- D. It does not depend on any property of water

24. Two springs A and B ($k_A = 2k_B$) are stretched by applying forces of equal magnitudes at the four ends. If the energy stored in A is E, that in B is

- A. 2E
- B. E/2
- C. E
- D. E/4

25. The lengths of edges of a unit cell, a, b, and c of a crystal are 11.6 Å, 8.5 Å, and 7.4 Å, respectively, and the angles α , β , and γ between the unit cell edges are 52°, 79° and 95°, respectively. What is the crystal system?

- A. face-centered cubic crystal system
- B. hexagonal crystal system
- C. triclinic crystal system
- D. tetragonal crystal system

26. If $2N$ is the number of primitive cells in a specimen, then what is the number of orbitals in an energy band of the specimen?
- A. N
 - B. $2N$
 - C. $3N$
 - D. $4N$
27. The indentation hardness of a material can be increased by increasing which of the following?
- A. density
 - B. elastic modulus
 - C. shear modulus
 - D. bulk modulus
28. What is the electron concentration for an alloy $\text{Cu}_{0.2}\text{Zn}_{0.8}$?
- A. 1.8
 - B. 0.8
 - C. 5
 - D. 0.2
29. If σ is the electrical conductivity, K is the thermal conductivity, and L is the Lorentz number, then as per Wiedeman-Franz law which of the following is correct?
- A. the ratio between K and σ is directly proportional to T above the Debye temperature
 - B. the ratio between σ and K is directly proportional to T above the Debye temperature
 - C. the ratio between K and σ is directly proportional to $1/T$ above the Debye temperature
 - D. the ratio between σ and K is directly proportional to $1/T$ above the Debye temperature
30. If $n - 1$ is the electron concentration in an intrinsic semiconductor, then what is the hole concentration?
- A. $n - 1$
 - B. $n + 1$
 - C. n
 - D. $\frac{n}{n-1}$
31. The free energy of a nano-sized system compared to its bulk counterpart
- A. is no longer intensive
 - B. continues to be intensive
 - C. is no longer extensive
 - D. continues to be extensive

32. Which of the following is the correct relation between the de Broglie wavelength and momentum?

- A. $\lambda = h \cdot p$
- B. $\lambda = h/p$
- C. $\lambda = p/h$
- D. $\lambda = 2\pi p$

33. Which of the following conditions has to be satisfied for a normalized wave function?

- A. $\iiint_V |\psi(\mathbf{r})|^2 dx dy dz = 1$
- B. $\iiint_V |\psi(\mathbf{r})|^2 dx dy dz = 0$
- C. $\iiint_V |\psi(\mathbf{r})| dx dy dz = 1$
- D. $\iiint_V |\psi(\mathbf{r})| dx dy dz = 1$

34. The potential given in the following equation is

$$U(R) = 4\epsilon \left[\left(\frac{\sigma}{R} \right)^{12} - \left(\frac{\sigma}{R} \right)^6 \right]$$

- A. Lennard-Jones potential
- B. Jones- Lennard potential
- C. Periodic potential
- D. Electronic potential

35. If there are n atoms in the primitive cell then the phonon dispersion relation has

- A. 2 acoustical phonon and 2n-2 optical phonon branches
- B. 2 acoustical phonon and 3n-3 optical phonon branches
- C. 3 acoustical phonon and 2n-2 optical phonon branches
- D. 3 acoustical phonon and 3n-3 optical phonon branches

36. The mean free path of the conduction electrons in a highly pure metal is

- A. lower than impure metal
- B. same as impure metal
- C. higher than impure metal
- D. not dependent on the purity of the metal

37. The thermal conductivity can be expressed as (C - heat capacity per volume, l - mean free path and v - velocity)

- A. $K = 1/3 C v l$
- B. $K = 3 C v l$
- C. $K = 2/3 C v l$
- D. $K = C v l$

38. The free electron wavefunction is expressed in which of the following form?
- A. $\psi(r) = \exp(k.r)$
 - B. $\psi(r) = \exp(r)$
 - C. $\psi(r) = \exp(k)$
 - D. $\psi(r) = \exp(ik.r)$
39. The bound electron-hole pair is known as
- A. Phonon
 - B. Polaron
 - C. Exciton
 - D. Muon
40. In the second order Raman effect,
- A. three phonons are involved in the inelastic scattering
 - B. two phonons are involved in the inelastic scattering
 - C. one phonon is involved in the inelastic scattering
 - D. zero phonons are involved in the inelastic scattering
41. Which of the following process involves a photon-in and an electron-out?
- A. UV spectroscopy
 - B. XPS
 - C. FT IR
 - D. Raman spectroscopy
42. Electron work function for Cu is
- A. higher in (100) plane
 - B. higher in (110) plane
 - C. higher in (111) plane
 - D. plane independent
43. Aqueous solutions of two compounds $M_1 - O - H$ and $M_2 - O - H$ are prepared in two different beakers. If, the electronegativity of $M_1 = 3.4$, $M_2 = 1.2$, $O = 3.5$ and $H = 2.1$, then the nature of two solutions will be respectively:
- A. acidic, acidic
 - B. basic, basic
 - C. acidic, basic
 - D. basic, acidic
44. An element has 9 positive charges in its nucleus, its common oxidation state is
- A. -1
 - B. +5
 - C. +7
 - D. +1
45. Which of the following oxides is most acidic?
- A. Cl_2O_7
 - B. P_4O_{10}
 - C. N_2O_5
 - D. SO_3

46. A wire elongates by 1.0 mm when a load W is hung from it. If this wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be
- 2.0 mm
 - 1.0 mm
 - 4.0 mm
 - 0.5 mm
47. Scanning electron microscope is operated at which of the following accelerating voltages for characterization of metallic materials?
- 1-100 KV
 - 100-1000 KV
 - 0.1-40 KV
 - 40-100 KV
48. What is the magnitude of absolute value function?
- square of distance to the origin on a number line
 - square root of distance to the origin on a number line
 - cube of distance to the origin on a number line
 - distance to the origin on a number line
49. Identify 'self-duals' among the following
- hexagonal and simple cubic
 - hexagonal and face centered cubic
 - face centered cubic and body centered cubic
 - body centered cubic and hexagonal
50. Calculate the flux ratio of the reactant R and the product P in a reactor in which the steady state reaction $6R + 5D + G \rightarrow 2P + 3M$ is occurring.
- 6
 - 3
 - 6
 - 2
51. Which of the following increases in a spontaneous process?
- Enthalpy
 - Entropy
 - Gibbs energy
 - Helmholtz energy
52. What are degenerate energy levels?
- Energy levels having same energy
 - Energy levels constituted by electrons with the same spin
 - Energy levels constituted by equal number of electrons
 - Energy levels having different energy but represented by same quantum numbers

53. Due to the viscous friction in a fluid, a spherical body falls vertically in the fluid with a constant velocity after a certain time. If L is any linear dimension in the falling body, then the transient time taken by the body scales as
- A. L
 - B. L^2
 - C. $1/L^2$
 - D. $1/L$
54. What is the full form of CSL boundary
- A. Common Site Lattice
 - B. Coincident Site Lattice
 - C. Crystal Site Lattice
 - D. Common Site Line
55. Which of the following cation distribution is true for an inverse spinel lattice?
- A. All divalent cations in Tetrahedral interstitials and half trivalent cations in Tetrahedral interstitials and another half in Octahedral interstitials
 - B. All divalent cations in Octahedral interstitials and half trivalent cations in Tetrahedral interstitials and another half in Octahedral interstitials
 - C. All trivalent cations in Tetrahedral interstitials and half divalent cations in Tetrahedral interstitials and another half in Octahedral interstitials
 - D. All trivalent cations in Octahedral interstitials and half divalent cations in Tetrahedral interstitials and another half in Octahedral interstitials

Key for NST Oct 2022

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