

ENTRANCE EXAMINATIONS – 2020

Y-101

(Ph.D. Admissions - January 2021 Session)

Ph.D. (Nano Science 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 with no negative marking.
2. Part 'B': It consists of 35 objective questions of one mark each with no negative marking.
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 12 pages including this cover sheet.

PART A

1. A body weights 72 N on the surface of earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface?
 - A. 72 N
 - B. 28 N
 - C. 16 N
 - D. 32 N

2. Which of the following is the material of mobile phone touchscreen?
 - A. Indium tin oxide
 - B. Indium silicide
 - C. Indium copper sulphate
 - D. Indium silver nitride

3. It is hotter at the same distance over the top of a fire than it is on the side of it mainly because:
 - A. Heat is radiated upwards
 - B. Air conducts heat upwards
 - C. Convection takes more heat upwards
 - D. Conduction, convection and radiation all contribute significantly in transferring heat upwards

4. Water is filled in a glass beaker at room temperature and the beaker is heated. The level of water in the beaker:
 - A. Rises
 - B. Does not change at all
 - C. First rises and then falls
 - D. First falls and then rises

5. A R. Rahman is conducting a musical night in an open auditorium in New York. If two persons, one who is sitting in the auditorium at a distance of 250 m from the stage and the other who is watching the live program on a television set sitting in front of it in Hyderabad, then which person will hear him first:
 - A. Person sitting in the auditorium in New York
 - B. Person sitting in front of the TV set in Hyderabad
 - C. Both will hear at same time
 - D. Cannot be said from the given information

6. The size of an air bubble rising up in water
- Decreases
 - Increases
 - Remains same
 - May increase or decrease
7. Multiplication of which of the following, with the matrix $A = \begin{bmatrix} 3 & 2 \\ 1 & 2 \end{bmatrix}$, will yield the identity matrix I of same size.
- $\begin{bmatrix} 1/3 & -1/2 \\ -1 & 1/2 \end{bmatrix}$
 - $\begin{bmatrix} 3/4 & -1/2 \\ -1/4 & 1/4 \end{bmatrix}$
 - $\begin{bmatrix} 1/3 & 0 \\ 0 & 1/2 \end{bmatrix}$
 - $\begin{bmatrix} 1/2 & -1/2 \\ -1/4 & 3/4 \end{bmatrix}$
8. Dot product of two vectors $\vec{m} \cdot \vec{n}$ represents
- Magnitude of the area covered by \vec{m} and \vec{n}
 - Direction of the area covered by two vectors
 - Magnitude of the projection of \vec{n} on \vec{m} multiplied by magnitude of \vec{m}
 - Magnitude of the sum of two vectors
9. Function described at n discrete data points, can be approximated to a polynomial of degree
- $= n$
 - $\leq n - 1$
 - $> n$
 - $\geq n$
10. The velocity v of a body is given by $v = t^2 + 3 \text{ ms}^{-1}$, where t is time in s. How far (in m) it moves in the interval from $t = 0$ to $t = 3$?
- 18
 - 12
 - 9
 - 27

11. 25 persons are in a room, 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is

- A. 2
- B. 3
- C. 17
- D. 13

12. Let $a=(4,5,6)$ and $b=(-1,2,-4)$ calculate the tensor product

A. $\begin{bmatrix} -4 & -5 & -6 \\ 8 & 10 & 12 \\ -16 & -20 & -24 \end{bmatrix}$

B. $\begin{bmatrix} -4 & 8 & -16 \\ -5 & 10 & -20 \\ -6 & 12 & -24 \end{bmatrix}$

C. $\begin{bmatrix} 8 & 10 & 12 \\ -4 & -5 & -6 \\ -16 & -20 & -24 \end{bmatrix}$

D. $\begin{bmatrix} 8 & -4 & -16 \\ 10 & -5 & -20 \\ 12 & -6 & -24 \end{bmatrix}$

13. The equation of alternating voltage for an alternating current circuit is given by $V = 200 \sin 314 t$, where t is time then the frequency of voltage is

- A. 50 Hz
- B. 60 Hz
- C. 314 Hz
- D. 157 Hz

14. If the diameter of the lens aperture of an optical microscope is doubled, then the angular resolution of the microscope for a fixed incident wavelength

- A. Decreases by a factor of 2
- B. Decreases by a factor of 4
- C. Increases by a factor of 2
- D. Increases by a factor of 4

15. If the equation of a circle in rectangular coordinates is

$$\left(x - \frac{1}{2}\right)^2 + y^2 = \frac{1}{4},$$

the corresponding equation in polar coordinates (r, θ) is

- A. $r = \cos\theta$
- B. $r(1 - \cos\theta) = 0$
- C. $r = \sin\theta$
- D. $r^2(1 - \cos\theta) = 0$

16. When a sonometer wire of length L is plucked at a distance $L/12$ from one end then it vibrates with a minimum frequency n_1 . If the same wire is plucked at a distance $L/3$ from the other end, the minimum frequency with which it vibrates is n_2 , then the ratio of n_1 to n_2 is
- 1:4
 - 4:1
 - 1:2
 - 3:1
17. If \vec{a} , \vec{b} and \vec{c} are unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{0}$, then which of the following is correct?
- $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} = \vec{0}$
 - $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} = \vec{c} \times \vec{a} \neq \vec{0}$
 - $\vec{b} \times \vec{b} = \vec{b} \times \vec{c} = \vec{a} \times \vec{c} = \vec{0}$
 - $\vec{a} \times \vec{b}, \vec{b} \times \vec{c}, \vec{c} \times \vec{a}$ are mutually perpendicular
18. A steady current flows in a non-uniform cross section metallic conductor. Which of the following statement is correct
- Current is constant along the length of the conductor
 - Drift speed is constant along the length of the conductor
 - Current and drift speed both are constant along the length of the conductor
 - Both current and drift speed are not constant along the length of the conductor
19. The compound that is not a Lewis acid is
- BF_3
 - AlCl_3
 - BeCl_2
 - SnCl_4
20. The sum of the ages of 3 children born at the intervals of 5 years, each, is 60 years. What is the age of the youngest child in years?
- 20
 - 25
 - 15
 - 35

PART B

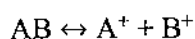
21. The magnetic induction at magnetic poles is along:
- A. Vertical only
 - B. Horizontal only
 - C. Both vertical and horizontal
 - D. Neither vertical nor horizontal
22. Umklapp process is related to:
- A. Electronic conductivity in materials
 - B. Ionic conductivity in materials
 - C. Thermal conductivity in materials
 - D. Optical conductivity in materials
23. Pauli susceptibility of a magnetic material
- A. Increases with increase in temperature
 - B. Decreases with increase in temperature
 - C. Increases with increase in electronic density of states at the Fermi level
 - D. Decreases with increase in electronic density of states at the Fermi level
24. In a natural process, the overall value of
- A. Entropy always decreases
 - B. Entropy always increases
 - C. Entropy remains constant
 - D. Entropy may increase
25. Which of the following is involved in a Carnot's cycle
- A. Two isothermal steps
 - B. Two isobaric steps
 - C. Two isochoric steps
 - D. Only one adiabatic step
26. Diamond is transparent. Which of the following is a valid reason?
- A. Bandgap of diamond > 3 eV, no visible light is absorbed
 - B. Bandgap of diamond > 3 eV, all the visible light is absorbed
 - C. Bandgap of diamond has no role on the transparency of diamond
 - D. Bandgap of diamond > 3 eV, some of the visible light is absorbed
27. The kinetic energy of the ejected photoelectron is dependent upon the energy of
- A. Ions around
 - B. Photons around
 - C. Material
 - D. Impinging photon

28. The scanner of atomic force microscope is made of which kind of material
- Spring
 - Photosensitive material
 - Plasmonic material
 - Piezoelectric material
29. How does the nature of Lennard Jones (L-J) potential curve for two particles differ from the one for two surfaces
- The attractive part is steeper for two particles
 - The attractive part is steeper for two surfaces
 - The repulsive part is steeper for two surfaces
 - The repulsive part is steeper for two particles
30. Which imaging mode suits for a specimen with two phases widely separated by atomic number
- Auger electrons
 - Back scattered electrons
 - Secondary electrons
 - Cathodoluminescence
31. Metals are mostly transparent to which of the following electromagnetic radiation
- Infrared
 - Visible
 - Radio waves
 - X-ray
32. Which of these statements regarding debonding (spallation) of coatings is incorrect
- If the residual stress in a coating is compressive, rather than tensile, then it is likely to debond from the substrate.
 - Coatings are more likely to debond if the coating/substrate interface is brittle
 - The main driving force for debonding of many coatings is stored energy elastic energy associated with the residual stresses
 - Thick coatings tend to debond more readily than thin ones
33. In a circuit containing a complex impedance, maximum power transfer takes place when
- Load is a pure resistance
 - Load impedance is purely capacitive
 - Load impedance is equal to the complex conjugate of the circuit impedance
 - Load impedance is zero

34. For an infinitely thick perfect conductor, skin depth is the distance from the surface at which
- The current density starts decreasing
 - The current density starts increasing
 - The current density decreases to 1/e of its value on the surface
 - The current density increases by 1/e of its value at the surface
35. In a linear molecule, which of the following is valid.
- The symmetric stretching vibration is IR-inactive due to dipole moment change
 - The symmetric stretching vibration is IR-inactive due to dipole moment does not change
 - The asymmetric stretching vibration is IR-inactive due to dipole moment does not change
 - The asymmetric stretching vibration is IR-inactive due to dipole moment change
36. Ultrasonic beam generated through transducer will emerge initially parallel which later diverges. This divergence can be calculated according to which of the following the formula?
- $\sin \frac{\alpha}{2} = \frac{1.12\lambda}{d}$
 - $\sin \frac{\alpha}{4} = \frac{1.12\lambda}{2d}$
 - $\cos \frac{\alpha}{2} = \frac{1.12\lambda}{d}$
 - $\cos \frac{\alpha}{2} = \frac{1.12\lambda}{2d}$
37. The iron pillar in Delhi famous for rust-resistant composition is manufactured by
- Casting
 - Forging
 - Rolling
 - Extrusion
38. The density of the metals in the increasing order.
- Magnesium>Aluminum>Titanium>Iron
 - Aluminum>Magnesium>Titanium>Iron
 - Iron>Aluminum>Titanium>Magnesium
 - Titanium>Aluminum>Magnesium>Iron
39. Conversion formula for temperature unit Fahrenheit to Celsius
- $C = \frac{5}{9} (F - 32)$
 - $C = \frac{7}{9} (F - 23)$
 - $C = \frac{2}{9} (F - 23)$
 - $C = \frac{3}{9} (F - 23)$

40. The potential difference applied to an X-ray tube is 5 kV and the current passed through it is 4.8 mA. Then the number of electron striking the target per second is
- 2×10^{16}
 - 3×10^{16}
 - 4×10^{16}
 - 1×10^{17}
41. The figure of merit (ZT) of a thermoelectric materials is given by (S, σ, κ are Seebeck's coefficient, electrical conductivity, thermal conductivity and T is temperature)
- $ZT = \left(\frac{S^2 \sigma}{\kappa} \right) T$
 - $ZT = \left(\frac{\sigma^2 S}{\kappa} \right) T$
 - $ZT = \left(\frac{S^2 \kappa}{\sigma} \right) T$
 - $ZT = \left(\frac{\sigma^2 \kappa}{S} \right) T$
42. Which of the following is a narrow bandgap semiconductor
- Si
 - GaN
 - SiC
 - Bi_2Te_3
43. Which of the following is a 2D nanomaterial
- Nanosheet
 - Nanorod
 - Nanobelt
 - Nanofiber
44. Which of the following is the correct order for the electron mobility at room temperature
- $\text{Si} < \text{PbTe} < \text{InP} < \text{Ge}$
 - $\text{Si} < \text{Ge} < \text{InP} < \text{PbTe}$
 - $\text{Si} < \text{PbTe} < \text{Ge} < \text{InP}$
 - $\text{Si} < \text{Ge} < \text{PbTe} < \text{InP}$
45. The wavenumber of mid-IR region of the electromagnetic spectrum is about
- $4000 - 200 \text{ cm}^{-1}$
 - $12,500 - 4000 \text{ cm}^{-1}$
 - $200 - 50 \text{ cm}^{-1}$
 - $50 - 10 \text{ cm}^{-1}$

46. The equilibrium is established between the undissolved salt and the ion in solution



The equilibrium constant (K) is given as

A. $K = \frac{[AB]}{[A^+][B^+]}$

B. $K = \frac{[A^+][B^+]}{[AB]}$

C. $K = \frac{[A^+]}{[AB]}$

D. $K = \frac{[B^+]}{[AB]}$

47. The wavelength falls in the range 200-800 nm of the electromagnetic spectrum is

- A. IR
- B. UV
- C. Visible
- D. Near IR

48. Which of the following is applied for classical particles?

- A. Bose-Einstein statistics
- B. Fermi-Dirac Statistics
- C. Gaussian statistics
- D. Maxwell-Boltzmann statistics

49. In inelastic collision

- A. Kinetic energy is not conserved
- B. Kinetic energy is conserved
- C. Potential energy is conserved
- D. Heat energy is conserved

50. Which is not organic?

- A. Humans, plants and other animals
- B. Most of the plastics
- C. Most of the petroleum products
- D. Common concrete and brick

51. Which one of the following is the most brittle

- A. Steel
- B. Ceramic
- C. Bronze
- D. Nylon

52. Which of the following is deduced from the plastic regime of a stress-strain curve?
- A. Young's modulus
 - B. Shear modulus
 - C. Resilience
 - D. Toughness
53. Which of the following is wrong about grain boundary in an alloy?
- A. Provides strengthening
 - B. Acts as a nucleating site for phase transformations
 - C. Has atoms in crystalline order
 - D. Provides easier path for atomic diffusion
54. Bauschinger effect refers to
- A. Hysteresis loss during loading and unloading
 - B. Anelastic deformation
 - C. Dependence of yield stress on path and direction
 - D. Elastic deformation
55. Following condition represents onset of necking
- A. $\epsilon_u = n$
 - B. $\epsilon_u = 1-n$
 - C. $\epsilon_u = 1+n$
 - D. $\epsilon_u = \ln(1+n)$

Key for NST_JAN 2021 (Y-101)

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