

ENTRANCE EXAMINATIONS, FEBRUARY 2014

QUESTION PAPER

M.Tech./Ph.D.(Nano Science and Technology)

Marks: 75

Time: 2.00 hrs

Hall Ticket no:

I. Write your Booklet Code and 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'**

- Part 'A':** It consists of 25 objective type questions of one mark each.
There is a negative marking of 0.33 marks for every wrong answer.
The marks obtained by a candidate in this part will be used for resolving tie cases.
- Part 'B':** It consists of 50 objective questions of one mark each.
There is no negative marking in this part.
- 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 and rough work sheets provided at the end of the booklet.

- Hand over the OMR answer sheet at the end of the examination to the Invigilator.
- Calculators are permitted. Log tables are not allowed. **Mobile phones are not permitted inside the Examination Hall.**
- This book contains 19 pages including this cover sheet.

Part 'A'

1. The potential energy of a particle restricted to move in a two-dimensional plane is $A(x^2 + y^2)^2$, where A is a constant. If E is the total energy of the particle, P is linear momentum vector and L is angular momentum vector, the constants of motion are
 - A. E and L
 - B. E and P
 - C. L and P
 - D. E, L and P

2. Suppose an atom A has an ionization energy of 5 eV and an atom B has an electron affinity of 4 eV. Let these two atoms be 0.5 nm apart. What is the energy required to transfer an electron from A to B.
 - A. -1.8 eV
 - B. 1.8 eV
 - C. 3.8 eV
 - D. 4.8 eV

3. The ratio of the volume of atoms to the total volume available in a simple cubic lattice is
 - A. 74%
 - B. 66%
 - C. 52%
 - D. 84%

4. Grain boundary is a
 - A. one dimensional defect
 - B. two dimensional defect
 - C. three dimensional defect
 - D. a defect of zero dimension

10. C_p/C_v for a diatomic gas is
- A. 1.67
 - B. 1.4
 - C. 1.0
 - D. 0.1
11. Both the ionic crystals KCl and KBr adopt fcc structure. In the X-ray powder diffraction pattern obtained with the θ - 2θ mode,
- A. both KCl and KBr will have the same number of diffraction peaks with equal intensities
 - B. KBr will have more peaks than KCl
 - C. KCl will have more peaks than KBr
 - D. the number of peaks will be the same for both KCl and KBr, but their intensities will be different
12. Thermocouples work on the basis of which of the following effects to generate electric voltage?
- A. Thomson effect
 - B. Peltier effect
 - C. Seebeck effect
 - D. Joule effect
13. At absolute zero of temperature a semiconductor acts
- A. as a conductor
 - B. same as semiconductor
 - C. as a super conductor
 - D. as an insulator
14. A 2×2 Hermitian matrix M satisfies $M^2 = I$, I being the identity matrix. The product of its eigen values must be
- A. -1
 - B. 1
 - C. 0
 - D. ± 1 .

15. Li and Na are chemically similar because
- A. both have the same number of electrons outside the closest inert gas atom configuration
 - B. both have the same ionic radius
 - C. bandgap is zero in both the elements.
 - D. both B and C
16. A piece of copper is dissolved in an acid and the resulting solid is recrystallized from water after the unreacted acid is evaporated out. A white precipitate is obtained when these crystals are added to a solution of barium chloride. From this observation, it may be inferred that the acid which was used for the dissolution of copper is,
- A. nitric acid
 - B. hydrochloric acid
 - C. sulphuric acid
 - D. carbonic acid
17. If x is a random variable and a is a constant, then the variance of ax is given by
- A. a^2 Variance $[x]$
 - B. a Variance $[x]$
 - C. Variance $[x]$
 - D. none of the above
18. Consider a single crystal loaded in tension or compression. Let ϕ be the angle between the normal to the slip plane and the direction of applied force and also let λ be the angle between the slip direction and the direction of applied force. Then the Schmid factor is given by
- A. $\cos \phi \cos \lambda$
 - B. $\sin \phi \sin \lambda$
 - C. $\cos \phi \sin \lambda$
 - D. $\sin \phi \cos \lambda$

19. Under equilibrium conditions, one of the following is not an interstitial solute in steels
- A. Carbon
 - B. Tungsten
 - C. Nitrogen
 - D. Oxygen
20. The following crystal system has no symmetry other than identity
- A. Monoclinic
 - B. Orthorhombic
 - C. Tetragonal
 - D. Triclinic
21. The von Mises criterion is also known as
- A. Tresca criterion
 - B. Mohr–Coulomb criterion
 - C. critical strain criterion
 - D. maximum distortion strain energy criterion
22. For an adiabatic process involving a gas with $\gamma = C_p/C_v$
- A. $PV = \text{constant}$
 - B. $PV^\gamma = \text{constant}$
 - C. $P/V = \text{constant}$
 - D. $P/V^\gamma = \text{constant}$
23. The crystal structures of the following materials are HCP except for
- A. Al
 - B. Zn
 - C. Mg
 - D. Graphite
24. In conducting polymer the charge carriers are
- A. valence electrons
 - B. lone pair electrons
 - C. electron of conjugated double bonds
 - D. both A and B

25. The change dU in internal energy U is given by

- A. $TdS - PdV + \sum_i \mu_i dn_i$
- B. $TdS + PdV + \sum_i \mu_i dn_i$
- C. $dH + TdS + \sum_i \mu_i dn_i$
- D. $dH = TdS + \sum_i \mu_i dn_i$

Part 'B'

26. Thermoelectric refrigerator devices makes use of
- A. Seebeck effect
 - B. Peltier effect
 - C. Thomson effect
 - D. none of these
27. When hydrogen peroxide is added to an acidified solution of potassium iodide, iodine is liberated. In this reaction hydrogen peroxide acts as
- A. reducing agent
 - B. oxidizing agent
 - C. a strong acid
 - D. a weak acid
28. Traditionally superplasticity occurs in
- A. fine grained metals with second phase along grain boundaries
 - B. low strain rates
 - C. high temperatures
 - D. all the above
29. The NDT technique used to detect defects situated deep in castings is
- A. liquid penetrant testing
 - B. magnetic particle tesing
 - C. neutron radiography
 - D. eddy current testing
30. The most probable decay mode of tritium is by emitting a
- A. beta particle
 - B. positron
 - C. neutron
 - D. proton

31. The relation between the minimum velocity of the photoelectrons (V_{\min}) and the stopping potential (V_0) is given by (Given charge of an electron = $1.6 \times 10^{-19}\text{C}$; mass of the electron = $9.1 \times 10^{-31}\text{kg}$)
- A. $\sim 5.92 \times 10^5 \sqrt{V_0} \text{ m/s}$
 - B. $\sim 2.5 \times 10^5 \sqrt{V_0} \text{ m/s}$
 - C. $\sim 2.43 \times 10^5 \sqrt{V_0} \text{ m/s}$
 - D. $\sim 6.25 \times 10^5 \sqrt{V_0} \text{ ms}$
32. Ionic crystals are very good insulators at room temperature but conducting at higher temperatures. This is due to,
- A. thermal expansion of the ionic solids
 - B. generation of more free electrons
 - C. transition of large number of electrons from valence band to the conduction band
 - D. movement of larger number of ions with the help of vacancies
33. Zener-Hollomon parameter is also known as
- A. grain size compensated strain rate
 - B. temperature compensated strain rate
 - C. grain size compensated temperature
 - D. strain to strain rate ratio
34. As $T \rightarrow 0 \text{ K}$, $S \rightarrow$
- A. ∞
 - B. 1
 - C. 0
 - D. 0.5
35. Fermi surface is observed in
- A. metals
 - B. semi-conductors
 - C. insulators
 - D. all materials

36. Which of the following statements is true?
- A. Climb of edge dislocation conserves total number of atoms.
 - B. Climb of edge dislocation does not conserve the total number of atoms.
 - C. Climb of edge dislocation conserve total number of vacancies.
 - D. Climb of edge dislocation conserves total number of jogs.
37. Consider bending a crystal with edge dislocations having the magnitude of their Burgers vector $\cong 3 \times 10^{-8}$ cm. What is the required density of dislocations so that the radius of curvature of the bent portion of the crystal is equal to 3 cm?
- A. $\cong 9 \times 10^8/\text{cm}^2$
 - B. $\cong 9 \times 10^7/\text{cm}^2$
 - C. $\cong 10^8/\text{cm}^2$
 - D. $\cong 10^7/\text{cm}^2$
38. Dislocations of the same sense
- A. attract
 - B. repel
 - C. are non-interacting
 - D. none of the above
39. The specific heat capacity is
- A. an extensive property
 - B. an intensive property
 - C. both A and B
 - D. none of the above
40. Consider a system H' obtained by replacing the proton in a hydrogen atom H by a positron. Then the ratio $E_n(H')/E_n(H)$ of the n^{th} energy levels of H' and H is approximately
- A. 0.5
 - B. 2.0
 - C. 0.25
 - D. 4.0

41. The mass of neutron is about 2000 times as large as that of an electron. The wavelength associated with the neutron is about
- A. $1/2000$ that for an electron of the same velocity
 - B. $1/4000$ that for an electron of the same velocity
 - C. $1/8000$ that for an electron of the same velocity
 - D. $1/16000$ that for an electron of the same velocity
42. In an oxide of Iron has 33.33% of Fe in +2 oxidation state and the remaining 66.67% in +3 oxidation state. What would be the probable formula of this oxide?
- A. FeO
 - B. Fe₃O₄
 - C. Fe₂O₃
 - D. FeO₂
43. Which of the followings is a structure in-sensitive magnetic property?
- A. magnetic susceptibility
 - B. magnetic coercivity
 - C. saturation magnetization
 - D. magnetic permeability
44. When a cavity containing blackbody radiation is heated to a higher temperature
- A. the average number of photons increases
 - B. the average number of photons in the cavity is conserved.
 - C. the average number of photons decreases, but the energy increases.
 - D. the average number of photons is conserved, but the energy increases.
45. The bandgap of diamond cubic crystals of C, Si, Ge, and Sn are 5.5, 1.2, 0.67, and 0.1 eV respectively at 300K. The crystal which will have the highest electrical conductivity at 300K is,
- A. Ge
 - B. Sn
 - C. C
 - D. Si

46. Wire drawing is a process in which the force of deformation is in the mode of
- A. direct compression
 - B. tension
 - C. indirection compression
 - D. torsion
47. Hot rolling capacity is often limited by
- A. torque
 - B. load
 - C. ductility
 - D. hardness
48. Metallic glass is
- A. amorphous
 - B. exhibits glass transition temperature
 - C. both A and B
 - D. none of these
49. The term in the nuclear liquid-drop model potential that prevents a stable nucleus from undergoing spontaneous fission into two equal parts is
- A. surface term
 - B. volume term
 - C. Coulomb term
 - D. asymmetry term
50. The consolidation of an oxide ceramic is carried out by following four different methods. The method which is expected to result in fine grained ceramics, after the consolidation process, is
- A. spark plasma sintering
 - B. microwave sintering
 - C. conventional ramp and hold sintering
 - D. conventional two stage sintering

51. Activation volume is a measure of the volume of the unit in the
- A. fastest process
 - B. slowest process
 - C. rate controlling process
 - D. none of the above
52. A metal nanopowder is produced by 4 different processes as given below. Spherical morphology of the powder is more likely in
- A. water atomization process
 - B. air atomization process
 - C. electrolytic reduction process
 - D. machining process
53. A particular sample of Silicon shows no Hall Effect. If the mobility of electrons in that sample is $3500 \text{ cm}^2/\text{V}\cdot\text{sec}$ and that of holes is $1500 \text{ cm}^2/\text{V}\cdot\text{sec}$, the fraction of the current in the sample carried by the electrons is
- A. 0.7
 - B. 0.3
 - C. 0.49
 - D. 0.09
54. Magnons in ferromagnets
- A. decrease the magnetization
 - B. increase the magnetization
 - C. stabilize the magnetization
 - D. none of the above
55. Embedded oxides are found after
- A. cold rolling
 - B. hot rolling
 - C. bending
 - D. shearing

56. The fatigue life of an engineering component
- A. increases in a corrosive environment
 - B. decreases in a corrosive environment
 - C. remains constant
 - D. none of the above
57. Magnetic long range order is typically exhibited by,
- A. noble metals
 - B. alkali metals
 - C. inert gas solids
 - D. transition metals
58. A percussion press is
- A. an energy bound machine
 - B. a stroke bound machine
 - C. a load bound machine
 - D. a fixed capacity machine
59. When a material sustains a steady load for a long time it may continue to deform until it may tend to fracture under the same load. This phenomenon is called as
- A. fatigue
 - B. creep
 - C. impact
 - D. malleability
60. IR absorption can be observed in which of the following molecules,
- A. N_2
 - B. O_2
 - C. HCl
 - D. C_2

61. $\lim_{x \rightarrow 0} \frac{\tan^{-1} \frac{2x}{1-x^2}}{\sin^{-1}(x)}$ is
- A. 2
 - B. 1
 - C. 0
 - D. Infinity
62. Which of the following is radioactive?
- A. Zirconium
 - B. Ruthenium
 - C. Astatane
 - D. Gadolinium
63. The mean free path of the particles of a gas at a temperature T_0 and pressure P_0 has a value λ_0 . If the pressure is increased to $1.5P_0$ and the temperature is reduced to $0.75T_0$, the mean free path
- A. remains unchanged
 - B. is reduced to half
 - C. is doubled
 - D. is equal to $1.125\lambda_0$
64. If the ionic radii of Mn and S are 0.80 and 0.184 nm respectively, the structure of MnS will be
- A. cubic close packed
 - B. body centered cubic
 - C. NaCl type
 - D. primitive cubic cell
65. Slip line field theory can account for deformation in
- A. one dimension
 - B. three dimensions
 - C. two dimensions
 - D. any dimension

66. Static tension tests are conducted at strain rates in the range of
- A. $10^{-8} - 10^{-9} \text{ s}^{-1}$
 - B. $10^{-5} - 10^{-1} \text{ s}^{-1}$
 - C. $10^4 - 10^8 \text{ s}^{-1}$
 - D. $10^2 - 10^3 \text{ s}^{-1}$
67. An external magnetic field of strength H is applied to a type-I superconductor at a temperature below the superconducting transition temperature. Which one of the following statements is NOT true for $H < H_c$
- A. The sample is diamagnetic
 - B. Its magnetization varies linearly with H
 - C. The lines of magnetic induction are pushed out from the sample
 - D. The sample exhibits mixed states of magnetization near H_c
68. Endurance strength and endurance limit for a metal are determined by using
- A. hardness test
 - B. bend test
 - C. impact test
 - D. fatigue test
69. An avalanche effect is observed in a diode when
- A. the forward voltage is less than the breakdown voltage
 - B. the forward voltage exceeds the breakdown voltage
 - C. the reverse voltage exceeds the breakdown voltage
 - D. the diode is heavily doped and forward biased
70. A hard beam universal testing machine is used for
- A. tensile testing
 - B. fatigue testing
 - C. torsion testing
 - D. bending experiments

71. Recrystallization temperature depends upon
- A. initial grain size
 - B. annealing time
 - C. purity of the metal
 - D. all of the above
72. The effective mass of an electron in a semiconductor
- A. can never be positive
 - B. can never be negative
 - C. can be positive or negative
 - D. depends on its spin
73. The static dielectric constant of NaCl crystal is 5.6 and its optical refractive index is 1.5. The ratio of its electronic polarizability to its total polarizability is
- A. 0.5
 - B. 0.7
 - C. 0.8
 - D. 0.9
74. Number of atoms per cm^3 for lead (Mass = 207.2 atomic mass units, density = 11.35 gm/cc) is
- A. 1.1×10^{25}
 - B. 3.3×10^{22}
 - C. 1.1×10^{22}
 - D. 3.3×10^{25}
75. Insulin, which is a protein, consisting of
- A. 2 polypeptide chains
 - B. 3 polypeptide chains
 - C. 4 polypeptide chains
 - D. none of the above