

ENTRANCE EXAMINATIONS, February 2013

QUESTION PAPER


M.Tech. (Nano Science and Technology) and

Ph.D.(Nano Science and Technology)

Marks: 75

Time: 2.00 hrs

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 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.
2. **Part 'B':** It consists of 50 objective questions of one mark each.
There is no negative marking in this part.
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 and rough work sheets provided at the end of the booklet.

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

PART 'A'

1. The unit vector \hat{w} orthogonal to both $\bar{u} = \hat{i} + \hat{j}$, $\bar{v} = \hat{j} + \hat{k}$ is
- A. $\frac{\hat{i} - \hat{j} + \hat{k}}{\sqrt{3}}$
 - B. $\frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{3}}$
 - C. $\frac{\hat{i} - \hat{j} - \hat{k}}{\sqrt{3}}$
 - D. $\frac{\hat{i} + \hat{j} - \hat{k}}{\sqrt{3}}$
2. If $\frac{a}{2} [111]$ is the Burgers vector of a dislocation in bcc lattice, the magnitude of the Burgers vector is
- A. $\frac{a}{\sqrt{3}}$
 - B. $\frac{a\sqrt{3}}{2}$
 - C. $\frac{a\sqrt{3}}{4}$
 - D. $a\sqrt{3}$
3. The ability of a material to absorb energy in the plastic range during tension test is defined as
- A. Toughness
 - B. Resilience
 - C. Malleability
 - D. Self energy.
4. The unit of entropy is
- A. Joule/K
 - B. Dynes/K
 - C. Calorie
 - D. Pascal

5. The first law of thermodynamics is represented by
- A. $dQ = TdS$
 - B. $dQ = dU + dW$
 - C. $PV = \text{constant}$
 - D. $PV = nRT$
6. A material which develops a voltage when subjected to mechanical compression, twisting or distortion is known as
- A. Piezoelectric material
 - B. Pyroelectric material
 - C. Magnetostrictive material
 - D. Ferroelectric material
7. The units of magnetic flux density are
- A. Ampere
 - B. Weber
 - C. Tesla
 - D. Faraday
8. Which one of the following elements has the highest electro-negativity?
- A. Arsenic
 - B. Bismuth
 - C. Calcium
 - D. Phosphorous
9. Selenium is
- A. Intrinsic semiconductor
 - B. Extrinsic semiconductor
 - C. p-type semiconductor
 - D. n-type semiconductor

10. The vectors $\bar{u} = \hat{i} + \hat{j}$ and $\bar{v} = \hat{i} - \hat{j}$
- A. Are perpendicular to each other
 - B. Are parallel to each other
 - C. Make an angle of 30° between them
 - D. Make an angle of 45° between them
11. Bonding between water molecules is
- A. Ionic
 - B. Hydrogen bonding
 - C. Metallic
 - D. Covalent bonding
12. Which of the following statements is true?
- A. Dislocations are non equilibrium defects
 - B. Stacking faults are equilibrium defects
 - C. Vacancies are non equilibrium defects
 - D. None of the above
13. In the hard sphere model, the density of a body centred cubic metal with atomic radius R nm and mass of atom M g, is
- A. $\frac{9M}{4R^3}$ (g/cm^3)
 - B. $\frac{3\sqrt{3}M}{32R^3}$ (g/nm^3)
 - C. $\frac{9M}{8R^3}$ (g/mm^3)
 - D. $\frac{3M}{4R^3}$ (g/nm^3)
14. Which one of the following elements has the lowest ionization energy?
- A. Pb
 - B. Sr
 - C. B
 - D. Al

15. What is the atomic characteristic that determines the element?
- A. Number of protons
 - B. Number of neutrons
 - C. Number of mesons
 - D. The mass
16. How much of the total volume is occupied by hard spheres in contact in a BCC arrangement?
- A. $\frac{\pi}{6}$
 - B. $\sqrt{3}\frac{\pi}{6}$
 - C. $\sqrt{3}\frac{\pi}{8}$
 - D. $\sqrt{3}\frac{\pi}{4}$
17. Cermet is a
- A. Polymer
 - B. Metal
 - C. Ceramic
 - D. Combination of ceramic and metal
18. In arc welding, dark glass is used to protect eye from
- A. X-rays
 - B. Gamma rays
 - C. Infra red rays
 - D. Visible and ultra-violet rays
19. An example of amorphous material is
- A. Zinc
 - B. Lead
 - C. Glass
 - D. Brass

20. With increase in temperature, the surface tension of water above 4° C
- A. Increases
 - B. Decreases
 - C. Remains constant
 - D. Increases linearly
21. $\frac{\partial G}{\partial P}$ at constant temperature is:
- A. Entropy
 - B. Negative entropy
 - C. Volume
 - D. Negative of volume
22. Which one is the 'Grignard Reagent'?
- A. C_2H_5MgBr
 - B. $FeCl_3$
 - C. $MgCl_2$
 - D. Fe_3O_4
23. Which of the following stainless steels is non-magnetic?
- A. Ferritic
 - B. Martensitic
 - C. Austenitic
 - D. None of these
24. Which one of the following processes is associated with nano particle synthesis?
- A. Sol-gel
 - B. Melting
 - C. Casting
 - D. All the above

25. Rate determining step in a reaction consisting of a number of steps in series is the

- A. Fastest step
- B. Slowest step
- C. Intermediate step
- D. Cannot be predicted

PART 'B'

26. Radiation shield in a nuclear power reactor is made of
- A. Concrete
 - B. Aluminium alloys
 - C. Cobalt
 - D. Zircalloy
27. $\lim_{x \rightarrow 0} \frac{1}{2x} \ln \frac{1+x}{1-x}$ is
- A. 1
 - B. 0
 - C. ∞
 - D. $-\infty$
28. Plasma sintering
- A. Promotes fast grain growth
 - B. Ensures very limited grain growth
 - C. Decomposes the material
 - D. Is not recommended for production of nano-structured materials
29. Grain size distribution in nanomaterials is close to
- A. Parabolic
 - B. Lognormal
 - C. Exponential
 - D. Bimodal
30. Closed pores in materials can be eliminated
- A. By applying high temperature and low pressure
 - B. By applying high temperature
 - C. By applying high pressure and high temperature
 - D. By doping

31. The solution of the ordinary differential equation $\frac{dy}{dx} + \frac{y}{x} = \frac{1}{x}$ satisfying the condition $y(x=1)=2$ is
- $y(x) = 1 + 1/x$
 - $y(x) = \ln(x) + 2/x$
 - $y(x) = x + 1/x$
 - $y(x) = \ln(x) + \frac{1}{x} + x^2$
32. Fatigue limit is exhibited by
- Copper alloys
 - Aluminium alloys
 - Mild steel
 - Magnesium alloys
33. Inverse Hall – Petch effect is seen in nanocrystalline metals when the grain size is
- Less than 10 – 15 nm
 - Above 100 nm
 - Between 15 nm and 100 nm
 - Equal to 50 nm
34. Which of the following equations admit plane wave solution?
- $\nabla^2 u = a \frac{\partial^2 u}{\partial t^2}; a > 0$
 - $\nabla^2 u = a \frac{\partial u}{\partial t}; a > 0$
 - $\nabla u = 0$
 - $\nabla \times \nabla u = 0$
35. [111] direction in a cubic crystal lies on the following planes
- $(\bar{1}\bar{1}0)$ and $(11\bar{2})$
 - $(1\bar{1}0)$ and (112)
 - (110) and $(11\bar{2})$
 - $(1\bar{1}0)$ and $(\bar{1}\bar{1}2)$

36. The Eigen values of the matrix $M = \begin{pmatrix} c^2 & cs \\ cs & s^2 \end{pmatrix}$, where c and s are real numbers satisfying the condition $c^2 + s^2 = 1$, are
- A. 0 and 1
 - B. c^2 and s^2
 - C. c and s
 - D. 0 and cs
37. Fermi level of a metal defines
- A. The highest occupied level of electron energies at absolute zero
 - B. The lowest occupied level of electron energies at absolute zero
 - C. The highest occupied level of electron energies at room temperature
 - D. The band gap in an intrinsic semi-conductor
38. Resolution of a scanning electron microscope is determined by the
- A. Wavelength of the electron beam
 - B. Objective lens
 - C. Condenser lens
 - D. Beam size
39. Quenching of plain carbon steel is a process that
- A. Softens the material
 - B. Produces Pearlite
 - C. Hardens the material
 - D. Spherodizes the carbides
40. If the coordination numbers of two unit cells are same, they both will have similar
- A. Atomic weight
 - B. Ductility
 - C. Packing factor
 - D. Density

41. Age hardening occurs in alloys because of
- A. Excess vacancies in the system
 - B. Excess solutes above solubility limit nucleating as precipitates
 - C. Solid solution of solutes
 - D. Small grain size
42. Soft iron is used as core of transformers because of its
- A. Low hysteresis loss and low permeability
 - B. Low hysteresis loss and high permeability
 - C. High hysteresis loss and low permeability
 - D. High hysteresis loss and high permeability
43. The change of magnetic susceptibility of a material when subjected to mechanical stress is known as
- A. Villari effect
 - B. Thompson effect
 - C. Curie effect
 - D. Bitter powder effect
44. Izod test is used to measure
- A. Shear strength
 - B. Impact strength
 - C. Tensile strength
 - D. Compressive strength
45. One of the following is a microstructure-sensitive property
- A. Density
 - B. Melting point
 - C. Yield stress
 - D. Coefficient of thermal expansion

46. Which bond is not present in all the three states of matter?
- A. Van der Waals' bond
 - B. Ionic bond
 - C. Covalent bond
 - D. Metallic bond
47. For a simple cubic lattice $d_{100}:d_{110}:d_{111}$ equals to
- A. $\sqrt{2}:\sqrt{3}:\sqrt{6}$
 - B. $\sqrt{3}:\sqrt{3}:\sqrt{6}$
 - C. $\sqrt{6}:\sqrt{3}:\sqrt{2}$
 - D. $\sqrt{3}:\sqrt{6}:\sqrt{2}$
48. The electronic specific heat in non-metals is
- A. Infinity
 - B. Negative and very high
 - C. Positive and very high
 - D. Negligible
49. Induction hardening is the process of
- A. Increasing hardness throughout
 - B. Hardening the core
 - C. Hardening of surface of work-piece
 - D. Hardening the precipitates
50. Ferromagnetic alpha iron exists in the temperature
- A. Range of 910 - 1400°C
 - B. Above 1539°C
 - C. Below 770°C
 - D. Range of 1400 - 1539°C

51. The property of corrosion resistance in stainless steel is due to
- A. Predominating nature of iron present in stainless steel
 - B. The formation of atmosphere of oxygen and moisture on the surface
 - C. The formation of a thin film of Cr_2O_3 on the surface of steel
 - D. The inherent property of chromium to resist corrosion
52. With increase in porosity, thermal spalling resistance of fireclay brick
- A. Increases
 - B. Decreases
 - C. Remains same
 - D. May increase or decrease
53. X-rays of wavelength 1.75 \AA are diffracted by (111) planes in a cubic crystal at an angle 30° in the first order. Calculate the interatomic spacing.
- A. 3.03 \AA
 - B. 3.75 \AA
 - C. 3.78 \AA
 - D. 3.5 \AA
54. The dimensionality of Bulk Modulus of Elasticity is same as that of
- A. Pressure
 - B. Density
 - C. Force
 - D. None of these
55. As the temperature increases, the electrical resistivity of germanium
- A. Increases exponentially
 - B. Decreases
 - C. Does not vary
 - D. Increases linearly

56. The average amplitude of vibrations of Al atoms at its melting point (660°C) is 0.35\AA . Lattice parameter of Al is 4.04\AA . What percentage is the average amplitude with respect to interatomic spacing in Al?
- A. 10%
 - B. 12%
 - C. 14%
 - D. 16%
57. Which of the following statements is correct at room temperature (D_g and D_l represent grain boundary and lattice diffusivities respectively)
- A. $D_g < D_l$
 - B. $D_g > D_l$
 - C. $D_g = D_l$
 - D. $D_g / D_l = \infty$
58. Which of the following statements is false?
- A. Single crystal contains dislocations
 - B. Single crystal contains grain boundaries
 - C. Single crystal contains vacancies
 - D. Single crystal contains stacking faults
59. Intergranular corrosion occurs
- A. Within the grain
 - B. Along grain boundaries
 - C. At the surface
 - D. In the bulk of material
60. Na atoms exhibit more pronounced chemical activity than Na ions because
- A. Na ions have closed shells, while Na atoms each have a single outer electron
 - B. Na atoms have closed shells, while Na ions each have a single outer electron
 - C. Na ions have three outer electrons
 - D. Na ions have five outer electrons

61. At frequencies $\sim 5 \times 10^{14}$ Hz, the ionic polarization in dielectric materials becomes
- A. Negative
 - B. Unity
 - C. Infinity
 - D. Zero
62. Which type of bond is formed during sintering?
- A. Diffusion bond
 - B. Solid state bond
 - C. Slag or glass bond
 - D. All of the above
63. Cobalt in steel
- A. Improves wear resistance cutting ability and toughness
 - B. Gives ductility, toughness, tensile strength and anti-corrosion properties
 - C. Improves cutting ability and reduces hardenability
 - D. None of the above
64. Stress is
- A. A vector
 - B. A tensor
 - C. A scalar
 - D. Dimensionless unit
65. Which of the following process is not related to improving the fatigue resistance?
- A. Shot peening
 - B. Cold extrusion
 - C. Sand blasting
 - D. Drop forging

66. The technique which can be used for the direct observation of dislocations is
- A. Scanning electron microscopy
 - B. Transmission electron microscopy
 - C. Scanning tunneling microscopy
 - D. Electron probe micro analysis
67. Which of the following statements is true?
- A. For isentropic and reversible process, $dQ > 0$
 - B. For isentropic and reversible process, $dQ < 0$
 - C. For isentropic and irreversible process, $dQ = 0$
 - D. For isentropic and reversible process, $dQ = 0$
68. Dislocation cross-slip is difficult in those materials which have
- A. Large number of slip systems
 - B. High work-hardening rate
 - C. Coarse grain size
 - D. Low stacking fault energy
69. A jet engine turbine blade is normally manufactured by
- A. Forging
 - B. Shell moulding
 - C. Investment casting
 - D. Pressure die casting
70. Thermoplastic materials are produced by
- A. Diecasting process
 - B. Shell moulding process
 - C. Cold forming process
 - D. Injection moulding process

71. For good dimensional stability at high temperatures, a material should have
- A. Fine grain size alone
 - B. Coarse grain size alone
 - C. Fine grain size with large precipitates at grain boundaries
 - D. Coarse grains and fine precipitates pinning the grain boundaries
72. Which of the following is not a colligative property?
- A. Osmotic pressure
 - B. Depression of freezing point
 - C. Lowering of vapor pressure
 - D. None of the above
73. Nickel at room temperature is
- A. Ferroelectric
 - B. Paramagnetic
 - C. Ferromagnetic
 - D. Dielectric
74. Sea water in comparison with fresh water
- A. Is less corrosive
 - B. Is more corrosive
 - C. Shows same degree of corrosion
 - D. None of the above
75. Schottky defect is
- A. Extra atom in interstitial site
 - B. Atom missing from correct lattice site
 - C. Atom displaced to interstitial site creating nearby vacancy
 - D. Row of interstitials