

ENTRANCE EXAMINATION FOR ADMISSION, MAY 2010.

M.Tech. (NANO SCIENCES AND TECHNOLOGY)

COURSE CODE : 305

Register Number :

Signature of the Invigilator
(with date)

COURSE CODE : 305

Time : 2 Hours

Max : 400 Marks

Instructions to Candidates :

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you -1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

- Select all correct matches for the elements and the type of group to which they belong

A. Cesium	E. Transition Metal
B. Barium	F. Lanthanide Metal
C. Cerium	G. Alkali metal
D. Palladium	H. Alkaline Earth metal

(A) A = E; B = H; C = F; D = G (B) A = G; B = H; C = F; D = E
 (C) A = G; B = F; C = H; D = E (D) A = F; B = H; C = G; D = E
- Bond angle between A. HCH in methane, B. HOH in water, C. HNH in ammonia, D. OCO in carbon dioxide respectively are (Select all correct matches):

(A) A = 180°; B = 107°; C = 104°; D = 109°
 (B) A = 107°; B = 109°; C = 107°; D = 180°
 (C) A = 109°; B = 104°; C = 107°; D = 180°
 (D) A = 109°; B = 107°; C = 104°; D = 180°
- Match the bio-systems with the metal that they contain

A. hemocyanin	E. copper
B. rubridoxin	F. zinc
C. carboxypeptidase A	G. molybdenum
D. aldehyde oxydase	H. iron

(A) A = G; B = H; C = E; D = F (B) A = F; B = G; C = H; D = E
 (C) A = H; B = G; C = E; D = F (D) A = E; B = H; C = F; D = G
- Match the following compounds with their shape

A. triiodide anion	E. trigonal bipyramidal
B. borohydride anion	F. trigonal
C. boron tribromide	G. linear
D. sulphur tetrafluoride	H. tetrahedral

(A) A = G; B = H; C = F; D = E (B) A = G; B = E; C = F; D = H
 (C) A = G; B = F; C = H; D = E (D) A = F; B = H; C = G; D = E

5. Match the compounds with the hybridization of the element indicated.
- | | |
|---|--------------------------|
| A. S in SO_3 | E. sp |
| B. P in PCl_5 | F. sp^3d |
| C. carbon in $\text{H}_2\text{C}=\text{CH}_2$ | G. sp^2 |
| D. carbon in $\text{HC}\equiv\text{CH}$ | H. sp^3 |
- (A) A = G; B = H; C = F; D = E (B) A = G; B = E; C = F; D = H
(C) A = F; B = G; C = H; D = E (D) A = H; B = F; C = G; D = E
6. Match the electric conductivity of solids with their values in ohm cm^{-1}
- | | |
|--------------------|----------------------|
| A. sodium | E. 1.7×10^5 |
| B. sodium chloride | F. 10^{-14} |
| C. quartz | G. 10^{-7} |
| D. zinc | H. 2.4×10^5 |
- (A) A = G; B = H; C = F; D = E (B) A = H; B = G; C = F; D = E
(C) A = F; B = G; C = H; D = E (D) A = F; B = H; C = G; D = E
7. Match the metals with their melting points given in degrees centigrade ($^\circ\text{C}$)
- | | |
|--------------|---------|
| A. Beryllium | E. 30 |
| B. Potassium | F. 64 |
| C. Magnesium | G. 650 |
| D. Gallium | H. 1277 |
- (A) A = G; B = H; C = F; D = E (B) A = H; B = G; C = F; D = E
(C) A = F; B = G; C = H; D = E (D) A = H; B = F; C = G; D = E
8. Correct molecular orbital representation for carbon monoxide is
- (A) $\sigma_g(1s), \sigma_u^*(1s), \sigma_g(2s), \sigma_u^*(2s), \pi_u(2p), \pi_u(2p), \sigma_g(2p)$
 (B) $\sigma_g(1s), \sigma_u(1s), \sigma_g(2s), \sigma_u^*(2s), \sigma_g(2p), \pi_u(2p), \pi_u(2p), \pi_u^*(2p), \pi_u^*(2p)$
 (C) $\sigma_g(2s), \sigma_u^*(2s), \sigma_g(1s), \sigma_u(1s), \sigma_g(2p), \pi_u(2p), \pi_u(2p)$
 (D) $\sigma_u(1s), \sigma_g^*(1s), \sigma_g(2s), \sigma_u^*(2s), \sigma_g(2p), \pi_u(2p), \pi_u(2p), \pi_u^*(2p), \pi_u^*(2p)$
9. The dimension of Plank's constant is
- (A) MLT^{-1} (B) ML^2T (C) $\text{M}^2\text{L}^2\text{T}^{-1}$ (D) ML^2T^{-1}

10. The normalized wave function can be represented as
 (A) $\int_0^{+\infty} \Psi^2 d\tau = 0$ (B) $\int_{-1}^{+1} \Psi^2 d\tau = 0$ (C) $\int_{-\infty}^{+\infty} \Psi^2 d\tau = 0$ (D) $\int_{-\infty}^0 \Psi^2 d\tau = 0$
11. The ground state term symbol of d^9 configuration is
 (A) $^2D_{5/2}$ (B) 2D_2 (C) $^2D_{3/2}$ (D) $^2D_{1/2}$
12. Which one of the following orbital does **not** have the angular node?
 (A) P_y orbital (B) dz^2 orbital (C) $1s$ orbital (D) dx^2-y^2 orbital
13. The Schrodinger wave function Ψ represents
 (A) Probability density (B) Probability amplitude
 (C) Probability distribution (D) Radical probability
14. If the radius of 1st Bohr's orbit is a_0 then the radius of 3rd Bohr's orbit is
 (A) $3 a_0$ (B) $6 a_0$ (C) $9 a_0$ (D) $19 a_0$
15. The splitting of spectral lines under the influence of magnetic field is known as
 (A) Stearic effect (B) Zeeman effect
 (C) Photoelectric effect (D) Crompton effect
16. In hydrogen spectrum, the series of lines appearing in visible region of spectrum are known as
 (A) Lyman (B) Paschen (C) P fund (D) Balmer
17. Azimuthal quantum number determines the
 (A) spin (B) angular momentum of orbitals
 (C) size (D) orientation
18. The spectrum of He^+ is expected to be similar to that of
 (A) Hydrogen atom (B) He
 (C) Li^+ (D) Li
19. In 1 eV energy is equivalent to a photon with a wavelength about
 (A) 30000 \AA (B) 3000 \AA (C) 12000 \AA (D) 1200 \AA

20. Among the following, conjugate pair of variable is
 (A) momentum and energy (B) potential energy and position
 (C) linear momentum and distance (D) time and energy
21. The maximum extent of hydrogen bonding is shown by
 (A) H_2O (B) HF (C) H_2Se (D) H_2S
22. Which of the following property **does not** have any unit?
 (A) Ionization potential (B) Electro-negativity
 (C) Atomic radii (D) Electron affinity
23. Among the following radiations the largest frequency is of
 (A) Radio wave (B) Micro wave (C) X-rays (D) IR
24. The number of replaceable protons in methanesulfonic acid is
 (A) one (B) two (C) three (D) four
25. The dimension of a first order chemical kinetics is
 (A) S^{-1} (B) $\text{M}^{-1}\text{S}^{-1}$ (C) M^{-1} (D) MS
26. A chemical reaction is said to be spontaneous if
 (A) $\Delta G < 0$ (B) $\Delta G = 0$ (C) $\Delta G > 0$ (D) $\Delta G \geq \Delta H$
27. Which of the following will have the maximum conductivity?
 (A) 1 M NaCl (B) 1 M Na_2SO_4 (C) 2 M NaCl (D) 1 M BaCl_2
28. The freezing of point water will
 (A) decrease on adding common salt
 (B) increase on adding common salt
 (C) does not change on adding common salt
 (D) depends on the amount of common salt added
29. The heat capacities of an ideal gas is described as
 (A) $C_p - C_v = R$ (B) $C_p + C_v = R$
 (C) $C_p = \frac{R}{C_v}$ (D) $C_v = \frac{R}{C_p}$

30. The process of isolating petrol from crude oil is
 (A) distillation (B) fractional distillation
 (C) sublimation (D) crystallization
31. Any two gases mix spontaneously at all conditions, because
 (A) entropy of mixing is always positive
 (B) entropy of mixing is always negative
 (C) entropy of mixing is always zero
 (D) free energy of mixing is always positive
32. Temperature is a measure of
 (A) melting point of a substance (B) boiling point of a substance
 (C) kinetic energy of an ideal gas (D) potential energy of an ideal gas
33. The ozone depletion potential is largest for
 (A) CF_2Cl_2 (B) CF_3Cl (C) CF_3Br (D) CCl_3F
34. Which of the following is not a definition of glass?
 (A) A glass has glass transition temperature
 (B) A glass is a X-ray amorphous material
 (C) A glass is supercooled liquid
 (D) A glass is an amorphous material prepared by quenching the melt
35. The formula of yttrium iron garnet is
 (A) $\text{Y}_3\text{Fe}_5\text{O}_{12}$ (B) $\text{Y}_2\text{Fe}_5\text{O}_{12}$ (C) $\text{Y}_3\text{Fe}_4\text{O}_{12}$ (D) YFeO_3
36. Which of the following equation characterizes phase transition from liquid to gas phase?
 (A) Helmholtz equation (B) Clayperon equation
 (C) Clausius–Clapeyron equation (D) Gibbs-Helmholtz equation
37. The Derivation of Debye formula for specific heat of solids is based on which of the following fact?
 (A) The internal energy of a solid resides in the standing waves in the solids
 (B) The internal energy is due to the individual atomic vibrations
 (C) The internal energy is due to the phonon
 (D) The internal energy is due to the temperature, T

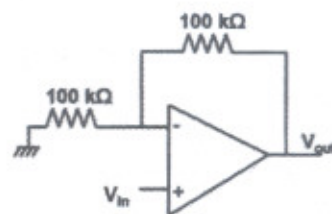
38. The unit cell reciprocal lattice is known as
 (A) Bravis lattice (B) First Brillouin zone
 (C) Second Brillouin zone (D) Wigner Seitz cell
39. For a ferromagnetic material the 'Hysteresis loss' is proportional to
 (A) Coercively (B) Retentively
 (C) Area of the loop (D) Saturation magnetization
40. For a diffusing particle which of the following relation is true?
 (A) $\langle z^2 \rangle = 2 Dt$, z is total distance covered in time t , and D is coefficient of diffusion
 (B) $\langle z^2 \rangle = 2 D^2 t$, z is total distance covered in time t , and D is coefficient of diffusion
 (C) $\langle z^2 \rangle = 2 D \tau t$, z is total distance covered in time t , and D is coefficient of diffusion, τ relaxation time
 (D) $\langle z \rangle = 2 Dt$, z is total distance covered in time t , and D is coefficient of diffusion
41. Which of the following is a not a quasi particle?
 (A) Polaron (B) Electron (C) Phonon (D) Magnon
42. Which of the following is not a color centre?
 (A) F-centre (B) V_k -centre (C) V_h -centre (D) Aliovalency
43. The total number of Bravis lattices in two (2)-dimension is
 (A) 4 (B) 5 (C) 6 (D) 7
44. Which of the following is not a thermoelectric effect?
 (A) Thomson effect (B) Seebeck effect
 (C) Peltier effect (D) Meissner effect
45. High T_c -superconductors are
 (A) defect perovskites (B) defect spinels
 (C) ferromagnetic materials (D) antiferromagnetic materials

46. The stacking fault in materials is
 (A) 0-dimensional defect (B) 1-dimensional defect
 (C) 2-dimensional defect (D) 3-dimensional defect
47. In a perovskite oxide $A^{2+}B^{3+}O_3$ structure if the cations are interchanged in lattice positions,
 (A) the structure will be a garnet structure
 (B) the structure will be a perovskite structure
 (C) the structure will be a spinel structure
 (D) the structure will be pyrochlore structure
48. In the case of polyhedral structures, the most stable configuration is due to
 (A) corner-shared polyhedra (B) interpenetrating polyhedra
 (C) face-shared polyhedra (D) edge-shared polyhedra
49. At the superconducting state a material is
 (A) paramagnetic (B) ferromagnetic
 (C) antiferromagnetic (D) diamagnetic
50. The specific conductivity is
 (A) Conductivity of a unit cube (B) Resistivity of a unit cube
 (C) 1/Resistance (D) 1/Capacitance
51. In solid argon the atoms are held together by
 (A) Ionic bond (B) Van der Waals forces
 (C) Hydrogen bonds (D) Crystal field effects
52. Which of the following does not exhibit metallic character?
 (A) Hf (B) Fr (C) Si (D) Pb
53. For a hexagonal unit cell the number of Miller indices is
 (A) 2 (B) 3 (C) 4 (D) 5

54. What is the dimensional formula of specific heat?
- (A) $[M L^{-2} T^{-2}]$ (B) $[M^0 L^2 T^{-2} K^{-1}]$
 (C) $[M^0 L T^{-2}]$ (D) $M L T^{-2}]$
55. Fraunhofer diffraction is observed
- (A) source and image are at infinite distance
 (B) image is at finite distance and source is infinite
 (C) source is at infinite distance and image is at infinite distance
 (D) source and image are at finite distance
56. An electron with a velocity of 1.5×10^7 m/s has a de-Broglie wavelength of
- (A) 9.1×10^{-57} m (B) 6.5×10^{-18} m
 (C) 4.9×10^{-11} m (D) 4.9×10^{-10} m
57. A double slit is illuminated with light of wavelength 649 nm; The slits are spaced apart a distance of 3.56μ . If the light starts at the two slits in phase at what two angles will we have the first minima?
- (A) 4.2° (B) 5.23° (C) 7.3° (D) 9.2°
58. Which of the following phenomenon is not possible for sound waves in air?
- (A) Polarisation (B) Diffraction
 (C) Refraction (D) Reflection
59. A simple harmonic oscillator has a period of 0.1 sec and amplitude of 0.2 m. The maximum velocity is given by
- (A) 100 ms^{-1} (B) $4 \pi \text{ ms}^{-1}$ (C) $100 \pi \text{ ms}^{-1}$ (D) $20 \pi \text{ ms}^{-1}$
60. The ground state energy of hydrogen atom is -13.6 eV. What is the kinetic energy of the electron in this state?
- (A) -13.6 eV (B) -27.2 eV (C) 0 eV (D) 13.6 eV
61. A particle in a box of size $2L$ is in its first excited state. If the size of the box is reduced to L by sudden perturbation, in which state of the new box does the probability of finding the particle is maximum?
- (A) Ground state (B) First excited state
 (C) Second excited state (D) Third excited state

62. As temperature increases, the Fermi level of an intrinsic semiconductor
 (A) moves towards the conduction band (B) moves towards the valence band
 (C) stays close to either of the bands (D) stays at the middle of the band gap
63. An emitter bypass capacitor is used in a CE amplifier to eliminate the
 (A) AC component of output (B) DC component of output
 (C) AC drop across R_E (D) DC drop across R_E
64. Emission of light waves from moving atoms leads to
 (A) Natural broadening (B) Doppler broadening
 (C) Crystal broadening (D) No broadening
65. We can measure _____ coherence using Michelson interferometer.
 (A) temporal (B) spatial
 (C) both (A) and (B) (D) none of the above
66. Separation between (Δt_{sep}) pulses for a mode-locked Helium-Neon operating at 632.8nm with mirror cavity spacing of $d = 1$ m is
 (A) 3.73×10^{-9} s (B) 6.62×10^{-9} s
 (C) 3.73×10^9 s (D) 6.62×10^9 s
67. The Lagrangian of a Simple Harmonic Oscillator is
 (A) $(1/2)mv_x + (1/2)kx$ (B) $(1/2)mv_x^2 + (1/2)kx^2$
 (C) $(1/2)mv_x^2 - (1/2)kx^2$ (D) $mv_x^2 - kx^2$
68. The speed of a particle with momentum m_0c is
 (A) c (B) $0.5c$ (C) $0.71c$ (D) 0
69. The Debye's frequency of a metal with Debye temperature 450 K is
 (A) 10^3 Hz (B) 10^{10} Hz (C) 10^{13} Hz (D) 10^{15} Hz
70. An uniform line charge distribution with linear charge density of 3.30 nano Coulombs per meter is located at $x=3$ meters and $y=4$ meters. The electric field strength at origin is thus
 (A) $-7.13 i - 9.50 j$ V/m (B) $+7.13 i - 9.50 j$ V/m
 (C) $+7.13 i + 9.50 j$ V/m (D) $-7.13 i + 9.50 j$ V/m

71. The number of atoms per unit cell of the reciprocal of bcc structure is
 (A) 1 (B) 2 (C) 3 (D) 4
72. A stone is let fall from the top of a tower 60 m high and at the same time another is projected vertically upwards with a velocity of 20 m/s. The two will meet after
 (A) 1 sec (B) 2 sec (C) 3 sec (D) 4 sec
73. Four balls A, B, C and D are projected with the same speed making angles 30° , 45° , 60° and 75° respectively with the vertical. Which ball will reach maximum height?
 (A) Ball A (B) Ball B (C) Ball C (D) Ball D
74. A pole 5 m long is carried by two men at the ends, with a weight of 90 kg at its middle, the weight of the pole being 10 kg. The weights carried by the men are
 (A) 90 kg, 10 kg (B) 55 kg, 45 kg (C) 50 kg, 50 kg (D) 45 kg, 55 kg
75. At all points along a streamline in an ideal fluid in steady flow, total energy per unit mass remains constant. This statement is called
 (A) Archimedes' principle (B) Bernoulli's principle
 (C) Poiseuille's law (D) Stoke's law
76. If the temperature of a gas occupying volume V is raised from 27°C to 627°C at constant pressure, its volume will become
 (A) 2 V (B) 3 V (C) 4 V (D) 10 V
77. One method of determining specific heat of a gas at constant volume is by using
 (A) Joule's calorimeter (B) Nernst calorimeter
 (C) Joly's calorimeter (D) Clement and Desorme's apparatus
78. The open loop gain (A_{ol}) of the Op-Amp shown in the figure is 100,000 then the closed loop gain (A_{cl}) of this circuit is
 (A) 1 (B) 2
 (C) 50,000 (D) 200,000



79. Curie temperature is the temperature above which
 (A) a paramagnetic material becomes diamagnetic
 (B) a ferromagnetic material becomes diamagnetic
 (C) a paramagnetic material becomes ferromagnetic
 (D) a ferromagnetic material becomes paramagnetic
80. A free electron is placed in a magnetic field of strength 1.3T. If $g=2.0023$ then the resonance of the frequency is
 (A) 36.43 Hz (B) 36.43 kHz (C) 36.43 MHz (D) 36.43 GHz
81. A gas has 300 molecules with 250 degrees of freedom. A suitable phase space to explain the gas is
 (A) h^{300} (B) h^{250} (C) h^{500} (D) h^{600}
82. The change of orientation takes place in _____ region of electromagnetic spectrum.
 (A) X-ray (B) Visible (C) γ -ray (D) Microwave
83. The half-life of an isotope of an element is 5 days. The mass of a 10 gram sample of this isotope remaining after 20 days is:
 (A) 0.312 grams (B) 0.625 grams (C) 1.25 grams (D) 2.50 grams
84. The electric field E at the centre of a uniformly charged conductor is _____.
 (A) Infinite (B) $\frac{q}{4\pi\epsilon_0 R^2}$ (C) $\frac{qr}{4\pi\epsilon_0 R^3}$ (D) Zero
85. A wall has two layers A and B of different materials, having the same thickness. The thermal conductivities of A and B are in the ratio of 2 : 1. During steady state, the temperature difference across the wall is 36°C . Temperature difference across the layer A is
 (A) 6°C (B) 12°C (C) 18°C (D) 24°C
86. Half-life of a radioactive element depends upon
 (A) the amount of element present (B) temperature
 (C) pressure (D) nature of material

87. Which of the following is not transducer?
 (A) Loudspeaker (B) Amplifier (C) Microphone (D) Diode
88. An antenna behaves as a resonant circuit only when its length
 (A) equal $\lambda/4$ (B) equal $\lambda/2$
 (C) equal $\lambda/2$ or its integral multiple (D) equal 2λ
89. What is the cause of 'Greenhouse effect'?
 (A) Infra-red rays (B) Ultraviolet rays
 (C) X-rays (D) Radio waves
90. Losses in optical fibers are caused by
 (A) impurities in the glass
 (B) imperfect transparency of the glass
 (C) area of cross-section
 (D) stepped index structure
91. Any system having an odd number of unpaired electrons, the zero field ground state will be at least two fold degenerate are known as
 (A) Zeeman splitting (B) Kramer doublets
 (C) Regular doublets (D) Irregular doublets
92. The fine independent equation of a system, represent the conservation of the
 (A) total binding energy of system
 (B) total kinetic energy of the system
 (C) total potential energy of the system
 (D) total energy of the system
93. A p-n diode is a _____.
 (A) linear device (B) unidirectional device
 (C) unipolar device (D) active device

94. Consider a series LCR circuit with $V_{rms}=10V$, $R=1K\Omega$, $L=ZmH$ and $C=1\mu F$. The rms current (I_{rms}) flowing through this circuit at resonance is _____.
 (A) 10 mA (B) 0 mA (C) 5 mA (D) 7.07 mA
95. The negative number of 23H in 8 bit signed arithmetic is _____.
 (A) 32H (B) DDH (C) DCH (D) 97H
96. A transistor is connected in _____ configuration to design an emitter follower.
 (A) common base (B) common emitter
 (C) common collector (D) base and emitter shorted
97. A resistor of length 'L' and area 'A' has a resistance 'R'. If the same volume of material is doubled in length, the new resistance
 (A) R (B) 2R (C) 3R (D) 4R
98. The input impedance (Z_{in}) and the output impedance (Z_{out}) of an ideal operational amplifier are expected to be _____.
 (A) $Z_{in} = 0$ & $Z_{out} = 0$ (B) $Z_{in} = 0$ & $Z_{out} = \infty$
 (C) $Z_{in} = \infty$ & $Z_{out} = 0$ (D) $Z_{in} = \infty$ & $Z_{out} = \infty$
99. Consider a J - K flip-flop with $J=1$ & $K=1$. Five clock pulses were given to its clock input after it was reset. The outputs (Q & \bar{Q}) of this flip-flop are _____.
 (A) 0,0 (B) 1,0 (C) 0,1 (D) 1,1
100. Which of the following logic gates are said to be universal gates?
 (A) OR gate & AND gate (B) OR gate & NOR gate
 (C) NOR gate & NAND gate (D) EX-OR gate & EX-NOR gate