**ENTRANCE EXAMINATION FOR ADMISSION, MAY 2013.**

**Ph.D. (NANO SCIENCE AND TECHNOLOGY)**

**COURSE CODE : 160**

Register Number : [ ]

*Signature of the Invigilator*
*(with date)*

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COURSE CODE : 160

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.

1. Density of 2.05M solution of acetic acid in water is 1.02g/mL. The molality of solution is

(A) 2.28 mol/Kg (B) 0.044 mol/Kg
(C) 1.14 mol/Kg (D) 3.28 mol/Kg

2. Vapour pressure of solution containing 18g of glucose and 178.2g of water at 100°C is

(A) 76.0 Torr (B) 759.0 Torr
(C) 752.40 Torr (D) 7.60 Torr

3. Concentrated aqueous sulphuric acid is 98% $H_2SO_4$ by mass and has a density of 1.80g/mol. The volume of acid required to make one liter of 0.1M$H_2SO_4$ solution is

(A) 5.56ml (B) 11.10ml
(C) 16.65ml (D) 22.20ml

4. Dissolution of sugar in water can be explained by

(A) Hydrogen bonds (B) Ion-ion interaction
(C) Vander waals force (D) Ion-dipole interaction

5. The mathematical relation, $P=K_HX_B$ is based on

(A) Babo's law (B) Henry's law
(C) Raoult's law (D) Kohlrausch law

6. Which of the following ions has zero CFSE

(A) $Fe^{2+}$ (B) $Zn^{2+}$
(C) $Co^{3+}$ (D) $Ni^{2+}$

7. Which of the following conditions are suitable for ideal solution?

(A) $\Delta Hmix > 0$ (B) $\Delta Smix < 0$
(C) $\Delta Gmix < 0$ (D) $\Delta Vmix = 0$

8. Hydrogen bonding is maximum in

(A) $(CH_3)_3N$ (B) $(C_2H5)_2O$
(C) $C_2H_5OH$ (D) $CH_3Cl$

9. An example for highly polar aprotic solvent is

(A) $CH_3CN$ (B) $CCl_4$
(C) $C_6H_{12}$ (D) $NH_3$

10. Superconductors are

(A) Diamagnetic (B) Paramagnetic
(C) Ferromagnetic (D) Anti-Ferromagnetic

11. A liquid was mixed with ethanol and a drop of concentrated $H_2SO_4$ was added. A compound with a fruity smell was formed. The liquid was

(A) $CH_3COOH$ (B) $CH_3OH$

(C) HCHO (D) $CH_3COCH_3$

12. Which of the following on heating with aqueous KOH, produces acetaldehyde?

(A) $CH_3CHCl_2$ (B) $CH_3COCl$

(C) $CH_3CH_2Cl$ (D) $CH_2ClCH_2Cl$

13. Which of the following reactions does NOT give $H_3PO_4$?

(A) $Ca_3(PO_4)_2 + H_2SO_4 \rightarrow$ (B) $P_4O_6 + H_2O \rightarrow$

(C) $PCl_5 + H_2O \rightarrow$ (D) $P_4S_{10} + H_2O \rightarrow$

14. The complex with the most intense colour among the following is

(A) $[FeF_6]^{3-}$ (B) $[MnCl_4]^{2-}$

(C) $[CoCl_4]^{2-}$ (D) $[CoF_6]^{3-}$

15. On addition of a solution of $AgNO_3$ to a solution of $Na_2S_2O_3$, it turns black on standing due to the formation of

(A) Ag (B) $Ag_2S$

(C) $Ag_2S_2O_3$ (D) $Ag_2SO_4$

16. The electronic configurations that have orbital angular momentum contribution in an octahedral environment are

(A) $d^1$ and high spin $d^4$ (B) $d^1$ and $d^2$

(C) $d^2$ and high spin $d^6$ (D) high spin $d^4$ and high spin $d^6$

17. The unit of rate constant (k) for zero-order reaction is

(A) $s^{-1}$ (B) $L\ mol^{-1}s^{-1}$

(C) $s$ (D) $mol\ L^{-1}s^{-1}$

18. Which of the following statements about the Eigenfunctions is NOT true

(A) Eigen functions belonging to different eigenvalues are orthogonal

(B) No two Eigen functions can have the same eigenvalue

(C) An Eigenfunction is normalized if $\int \psi_n * \psi_n d\tau = 1$

(D) A constant multiplied by an Eigen function is still an Eigen function

19. In van der Waals equation of state of the gas law, the constant 'b' is a measure of

(A) Intermolecular repulsions

(B) Intermolecular attraction

(C) Volume occupied by the molecules

(D) Intermolecular collisions per unit volume

20. The enthalpies of combustion of carbon and carbon monoxide are -393.5 and -283 $kJmol^{-1}$ respectively. The enthalpy of formation of carbon monoxide per mole is

(A) 110.5 kJ (B) 676.5 kJ

(C) -676.5 kJ (D) -110.5 KJ

21. An arithmetic progression consists of 21 terms. The sum of three terms in the middle is 129 and the sum of the last three terms is 237. The series is

(A) 2,7,12,17,.... (B) 3,7,11,15....

(C) 4,9,14,19.... (D) 6,10,14,18....

22. If $\alpha$ and $\beta$ are the roots of quadratic equation $ax^2 + bx + c = 0$ then $\alpha^2 + \beta^2$ is equal to

(A) $\sqrt{\frac{b^2 - 4ac}{a}}$ (B) $\sqrt{\frac{b^2 - 4ac}{2a}}$

(C) $\frac{b^2 - 4ac}{a^2}$ (D) $\frac{b^2 - 2ac}{a^2}$

23. If $x + iy = \sqrt{\frac{a + ib}{c + id}}$ then $(c^2 + d^2)(x^2 + y^2)$ is equal to

(A) $a^2 - b^2$ (B) $a^2 + b^2$

(C) $(a + b)^2$ (D) $(a - ib)^2$

24. The cube roots of equation $x^3 + 8 = 0$ are

(A) -2, -3, -1 (B) $-2, (1 \pm i\sqrt{2})$

(C) $-2, (1 \pm i\sqrt{3})$ (D) $-2, (1 \pm i\sqrt{4})$

25. Matrix $A = \begin{pmatrix} 5 \\ -3 \end{pmatrix}$, Matrix $B \begin{pmatrix} -1 \\ 7 \end{pmatrix}$ find matrix (X) such that $A+2X=B$

(A) $\begin{pmatrix} 3 \\ 5 \end{pmatrix}$ (B) $\begin{pmatrix} 5 \\ 3 \end{pmatrix}$

(C) $\begin{pmatrix} -3 \\ 5 \end{pmatrix}$ (D) $\begin{pmatrix} 5 \\ -3 \end{pmatrix}$

26. The values of x which satisfy the equation $5x^2 - 2x - 3 = 0$ are

(A) (1, -3/5)
(B) (-1, -3/5)
(C) (-1, 3/5)
(D) (1, 3/5)

27. $\csc(A) + \cot(A) =$

(A) $\dfrac{1}{\csc(A) - \sec(A)}$
(B) $\sec(A) + \tan(A)$
(C) 1
(D) $\dfrac{1}{\csc(A) - \cot(A)}$

28. Cos (C) - Cos (D) is

(A) $2\left(\sin\left(\dfrac{C+D}{2}\right)\right)\left(\cos\left(\dfrac{C-D}{2}\right)\right)$
(B) $2\left(\cos\left(\dfrac{C+D}{2}\right)\right)\left(\sin\left(\dfrac{C-D}{2}\right)\right)$
(C) $2\left(\cos\left(\dfrac{C+D}{2}\right)\right)\left(\cos\left(\dfrac{C-D}{2}\right)\right)$
(D) $2\left(\sin s\left(\dfrac{C+D}{2}\right)\right)\left(\sin\left(\dfrac{D-C}{2}\right)\right)$

29. $Cos(3x)$ is

(A) $4(\cos(x))^3 - 3\cos(x)$
(B) $4\cos(x) - 3(\cos(x))^3$
(C) $4(\cos(x))^3 - 4\ \sin(x)$
(D) $4(\cos(x))^3 - 3\ \sin(x)$

30. $2Sin(A)\ Sin(B)$ is

(A) $\sin(A + B) + \sin(A - B)$
(B) $\sin(A + B) - \sin(A - B)$
(C) $\cos(A + B) + \cos(A - B)$
(D) $\cos(A - B) + \cos(A + B)$

31. $y = \csc(x)$ then $\dfrac{dy}{dx}$

(A) $-\csc(x)\cot(x)$
(B) $\csc(x)\cot(x)$
(C) $-(\csc(x))^2$
(D) $(\sec(x)^2)$

32. $\int \dfrac{1}{x}dx$ is

(A) $\dfrac{1}{x^2}$
(B) $x$
(C) $x\log(x)$
(D) $\log(x)$

33. $\int \cos(x)\, dx$ is

(A) $\sin(x)$ (B) $-\sin(x)$

(C) $\csc(x)$ (D) $\sec(x)$

34. $\int (\sec(x))^2 dx$ is

(A) $\sec(x)\tan(x)$ (B) $-\tan(x)$

(C) $\cot(x)$ (D) $\tan(x)$

35. Two straight lines $y_1 = m_1x + c_1$, $y_2 = m_2x + c_2$ then are parallel to each other if

(A) $m_1 = m_2$ (B) $m_1m_2 = 1$

(C) $m_1m_2 = -1$ (D) $m_1m_2 = 0$

36. If you have two straight lines $y_1 = m_1x + c_1$, $y_2 = m_2x + c_2$ then the angle between the lines is given by

(A) $\dfrac{m_1 + m_2}{1 + m_1m_2}$ (B) $\dfrac{m_1 - m_2}{1 - m_1m_2}$

(C) $\dfrac{m_1 + m_2}{1 - m_1m_2}$ (D) $\dfrac{m_1 - m_2}{1 + m_1m_2}$

37. Choose the in-correct answer

(A) No tangent can be drawn to a circle through a point inside the circle

(B) One and only one tangent can be drawn through a point on the circumference of the circle.

(C) Only one tangent can be drawn to a circle through a point outside the circle

(D) Any number of tangents can be drawn to a circle through a point outside the circle.

38. Choose the incorrect answer

If two tangents are drawn to a circle from an exterior point

(A) The tangent are equal in length

(B) The tangent subtend equal angles at the centre of the circle

(C) The tangents are unequally inclined to the line joining the point and centre of the circle

(D) The tangents are eqaully inclined to the line joining the point and centre of the circle

39. The roots of the equation $x^2 - 2x + 7 = 0$ are

(A) (2,1)

(B) $\left(1 + i\sqrt{6}, 1 - i\sqrt{6}\right)$

(C) $\left(1 + i\sqrt{5}, 1 - i\sqrt{4}\right)$

(D) (3, -1)

40. Some properties of the complex numbers are given below. Choose the incorrect one.

(A) If $(x + iy) = \left(5 + i\sqrt{3}\right)$ , then $x = 5$ , $y = \sqrt{3}$

(B) If $(a + ib) = (c+id)$, then $(a-ib) = (c-id)$

(C) $(a+ib)\ X\ (c+id) = (ac-bd) + i(ad+bc)$

(D) If $(a+ib) = (c+\text{id})$, then $a^2 + b^2 \neq c^2 + d^2$

41. Which of the following statement is correct

(A) Dielectric constant and permeability are the same

(B) Dielectric constant and relative permittivity are the same

(C) Permittivity and permeability are the same

(D) Dielectric constant and susceptibility are the same

42. The source of H is

(A) Q

(B) M

(C) I

(D) B

43. Commutation $(L^2, L_z)$ is

(A) $Lz$

(B) $ihL_x$

(C) $ihL_z$

(D) 0

44. Two wave functions $\psi_1$ and $\psi_2$ are orthogonal if

(A) $\int \psi_1^* \psi_2 \, d\tau = 0$

(B) $\int \psi_1^* \psi_2 \, d\tau = 1$

(C) $\int \left|\psi_1^2\right| d\tau = 1$

(D) $\int \left|\psi_2\right|^2 d\tau = 0$

45. Entropy of the Universe tends to

(A) A minimum

(B) Zero

(C) No particular value as it remains constant

(D) A maximum

46. For a gas obeying Vanderwall's equation the critical constants can be related correctly by

(A) $\frac{RT}{P_cV_c} = \frac{8}{3}$ (B) $\frac{P_cV_c}{RT_c} = \frac{8}{3}$

(C) $\frac{RT_c}{P_cV_c} = \frac{3}{8}$ (D) $\frac{P_cV_c}{RT_c} = \frac{3}{8}$

47. A state of collective oscillation of valence electrons is

(A) Magnons (B) Plasmons

(C) Polaritons (D) Polarons

48. Meissner effect is observed in

(A) Metals (B) Insulators

(C) Super-conductors (D) Semi-metals

49. If a magnet is broken into two pieces, each piece possesses two poles. The strength of the new poles is ———— as the poles of the original magnet

(A) Same (B) 1/2

(C) Double (D) 1/4

50. The minimum number of NAND gates required to implement $A+A\bar{B}+A\bar{B}C$ is

(A) 4 (B) 2

(C) 3 (D) 0

51. Which are the following can be used to change data from spatial code to temporal code

(A) D/A converters (B) Counters

(C) Shift Registers (D) A/D converter

52. The mean momentum of a nucleon in a nucleus with mass number A varies as

(A) A (B) $A^{-1/3}$

(C) $A^2$ (D) $A^{-2/3}$

53. A very long solenoidal with $n$ turns per unit length carries a current $I$. The magnetic field at a point, which is on its axis and its end face is

(A) $\frac{1}{2}\mu_0 nI$ (B) $\mu_0 nI$

(C) $\frac{1}{3}\mu_0 nI$ (D) $\frac{3}{2}\mu_0 nI$

54. In canonical ensemble,

(A) The energy and temperature are constants

(B) The entropy and the energy are constants

(C) The temperature and the density are constants

(D) The density and entropy are constants

55. Determine the missing "fission fragment" in the reaction

$${}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{137}_{55}Cs + {}^{A}_{Z}X + 3{}^{1}_{0}n$$

(A) ${}^{93}_{37}Rb$ (B) ${}^{94}_{37}Rb$

(C) ${}^{95}_{37}Rb$ (D) ${}^{96}_{37}Rb$

56. An atom ${}^{219}_{85}Y$ decays by □ decay, followed by γ decay, followed by β decay. What isotope X remains after the decays?

(A) ${}^{219}_{85}X$ (B) ${}^{215}_{83}X$

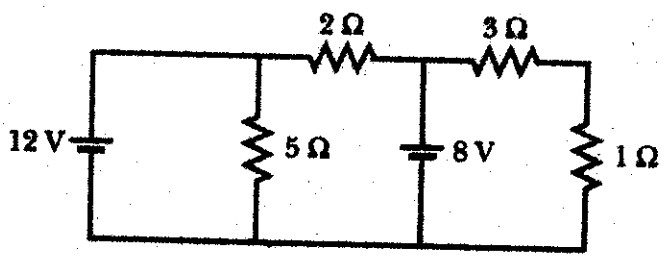
(C) ${}^{219}_{80}X$ (D) ${}^{215}_{84}X$

57. How much phosphorus must be added to 2 grams of silicon to create a doped semiconductor with a charge carrier density $n = 10^{21}/m^3$?

(A) $4.4 \times 10^{-8}$ g (B) $6.26 \times 10^{-23}$ g

(C) $44 \times 10^{-8}$ g (D) $1.6 \times 10^{-19}$ g

58. The current through the 5 Ω and 2 Ω resistors in the following diagram are, respectively




(A) 2.4 A and 2 A (B) 2 A and 2.4 A

(C) 2.2 A and 2 A (D) 2 A and 2.2 A

59. A thief travels at 80 mph passes a policeman. The policeman, initially at rest, accelerates at10 mi/h/s. How long will it take the policeman to catch the thief?

(A) 10 seconds (B) 12 seconds

(C) 14 seconds (D) 16 seconds

60. A 30 g ice cube at -5°C is placed in 508 g of 23°C water. Find the change in entropy $\Delta S$ of the water and ice as the ice melts and the system comes to equilibrium

(A) 7.58 J/K
(B) −43.48 J/K
(C) 3.01 J/K
(D) 0 J/K

61. The constant used in determining the electrostatic potential of a single ion in a crystal by apporoximating the ions by point charges is known as

(A) Pauling
(B) Schrodinger
(C) Madelung
(D) Depre

62. Stress amplitude (S) versus number of cycles to the fatigue failure (N) plot provides the information about the following property

(A) Hardness
(B) Roughness
(C) Creep
(D) Fatigue

63. For complete wetting of solid surface the contact angle should be

(A) 0°
(B) 45°
(C) 90°
(D) 180°

64. Liquid metals such as molten sodium is preferred as a coolant in case of ———— reactor

(A) Fast breeder
(B) Homogenous
(C) Enriched uranium fueled
(D) Uranium fueled

65. For the cutting tools, tool life primarily influenced by

(A) Tool dimension
(B) Lubricant
(C) Cutting speed
(D) Microstructure of the job

66. The mean crystallite size of a nanocrystalline material is determined by ———— formula

(A) Scherrer
(B) Young
(C) Pilling-Bedworth
(D) Arrhenius

67. Friction factor for fluid flow in pipe does not depend upon the

(A) Pipe roughness
(B) Mass flow rate of the fulid
(C) Length of the pipe
(D) Density and molecular weight of the fluid

68. To understand the oxidation state of the element which one among the following technique useful

(A) Mass spectroscopy
(B) X-ray spectroscopy
(C) X-ray photoelectron spectroscopy
(D) Electron diffraction

69. In a diffraction experiment reflections form (111),(200),(220),(311) was observed. The crystal structure likely to be

(A) Face Centered Cubic
(B) Body Centered Cubic
(C) Simple Cubic
(D) Diamond Cubic

70. Burger vector represents the magnitude and direction of ———— in a crystal lattice

(A) Lattice parameter
(B) Dislocation
(C) Weldment
(D) Diffusion

71. Ceramics have higher compressive strength than tensile strength due to

(A) Dislocation moment
(B) Ionic bonding
(C) Elasticity
(D) Oxide layer

72. Calculate the volume of the FCC unit cell, if atomic radius and the unit cell length are represented as 'r' and 'a'

(A) $16r^3\sqrt{2}$
(B) $2r^3\sqrt{2}$
(C) $4r^3$
(D) $8r^3$

73. The equilibrium concentration of vacancies for a given quantity of the material does not change with

(A) Pressure
(B) Temperature
(C) Total number of atomic sites
(D) Energy required for the formation of a vaccancy

74. Which among the following techniques would provide the best resolution?

(A) Scanning Electron Microscope
(B) Scanning Probe Microscope
(C) Transmission Electron Microscope
(D) Optical Microscope

75. The relation between grain size number (n) and the average number of grains per square inch (N) at 100 X magnification is given by

(A) $N=2^{n-1}$ (B) $N=2^{n}$

(C) $N=2^{n+1}$ (D) $N=2^{n-2}$

76. Electro migration is one of the major issue with

(A) Super capacitor (B) Microelectronics

(C) Magnetics (D) LASER

77. Shape memory effect involves

(A) Phase transformation (B) Congruent melting point

(C) Ductile to brittle transformation (D) Eutectic transformation

78. Substitutional solid solution formation does not depend on

(A) Atomic radii (B) Electronegativity

(C) Lattice parameter (D) Crystal structure

79. For a fixed quantity of materials which one of the following will have higher surface area

(A) Cubic (B) Spherical

(C) Tubes (D) Thin films

80. The property of large change in electrical resistance in the presence of a magnetic field is known as

(A) Nuclear magnetic resonance (B) Colossal mangnetoresistance

(C) Supercapacitors (D) Electrostriction

81. Protoplasm is

(A) Alveolar (B) Granular

(C) Crystallo-colloidal (D) Fibrillar

82. An acaryotic cell is

(A) Single nucleated (B) Proacryotic

(C) Denucleated (D) Both (B) & (C)

83. Plasmasol or sol part of cytosol is known as

(A) Hyalosome
(B) Hyaloplasm
(C) Endoplast
(D) Both (B) & (C)

84. Percentage of cell membrane contained in Endoplasmic reticulum is

(A) 10 -20 %
(B) 20 -30 %
(C) 30 -60 %
(D) 60 -75 %

85. Sarcoplasmic reticulum is Endoplasmic recticulum of

(A) Adipose cells
(B) Muscle cells
(C) Nerve cells
(D) Leucocytes

86. Membrane thickness of Endoplasmic reticulum is

(A) 75 Å
(B) 90 Å
(C) 30-40 Å
(D) 50-60 Å

87. Sedimentation unit of ribosome is

(A) Micron
(B) Milli micron
(C) Angstrom
(D) Svedberg

88. Polysome is a chain of

(A) Oxysomes
(B) Sphaerosomes
(C) Ribosomes
(D) Dicytosomes

89. Element required for bringing about union of ribosome subunit is

(A) $Ca^{2+}$
(B) $Mg^{2+}$
(C) $Fe^{3+}$
(D) $Cu^{+}$

90. rRNA present in 60 S subunit of ribosome is

(A) 5 S
(B) 5.8 S
(C) 28 S
(D) All of these

91. Metallic stain used by Golgi was

(A) Lead Acetate
(B) Osmium chloride and silver salts
(C) Phosphotungstate
(D) Palladium

92. Space between adjacent cisternae of Golgi apparatus is

(A) 15 Å (B) 30 Å

(C) 80-100 Å (D) 100-300 Å

93. Lysosomes are absent in animal cells

(A) Erythrocytes (B) Plasma cells

(C) Nerve cells (D) Muscle cells

94. pH of lysosome interior is

(A) 10 - 12 (B) 8 - 10

(C) 4 - 5 (D) 4 -5

95. In the inner mitochondrial membrane, proton channel is constituted by

(A) $F_0$ (B) $F_1$

(C) NADH ($H^+$) (D) Cytochrome oxidase

96. Glycoprotein is a

(A) Transmembrane protein (B) Peripheral protein

(C) Cytosolic protein (D) Triple α-helix

97. Spectrin is attached to the membrane through

(A) Phosphodiester bond (B) Ankyrin

(C) Hydrogen bond (D) Covalent bond

98. Membrane proteins are

(A) Symmetrically placed (B) Asymmetrically placed

(C) Aligned diagonally (D) Arranged in zig-zag manner

99. The ions traverse through the membrane faster through

(A) Channel protein (B) Carrier protein

(C) G-protein (D) Free lipid bilayer

100. The transport by carrier proteins is

(A) Active (B) Passive

(C) Both (A) & (B) (D) None of these