ENTRANCE EXAMINATION FOR ADMISSION, MAY 2010.

M.Phil. /Ph.D. (CHEMISTRY)

COURSE CODE : 244/107

Register Number :

Signature of the Invigilator
(with date)

COURSE CODE : 244/107

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. Which is the weakest among the following types of bonds?

(A) ionic bond (B) covalent bond

(C) hydrogen bond (D) metallic bond

2. The ground state term symbol for a d^2 ion is

(A) $^3F_2$ (B) $^3P_2$ (C) $^3F_4$ (D) $^3P_1$

3. For a linear molecule of 4 atoms, the number of fundamental vibrations is

(A) zero (B) four (C) six (D) seven

4. Which one of the following molecule has D_{3h} point group symmetry?

(A) SiF_4 (B) PF_5 (C) NH_3 (D) H_2O

5. The biological role of ferridoxin is

(A) iron storage (B) metal transport

(C) oxygen storage (D) electron transfer

6. For NQR spectroscopy, the nuclear spin value must be

(A) zero (B) half

(C) more than half (D) less than half

7. Which of the following ion has the smallest radius?

(A) Ti(II) (B) Pt(II) (C) Ni(II) (D) Cd(II)

8. The strongest interaction accompanying chemisorption would be for

(A) CO_2 on Pt (B) Ar on Pt

(C) N_2 on Pt (D) CO on Pt

9. In Mossabauer technique, the spin density of following orbital can be estimated

(A) s-orbital (B) p-orbital

(C) d-orbital (D) all three of them

10. Which one of the following pairs does not contain isoelectronic molecules?

(A) N_2, CO (B) NO^+, N_2

(C) NO, N_2^- (D) NO, CO

11. The *arachno* borane is

(A) $[B_6H_{12}]$ (B) $[B_5H_9]$

(C) $[B_2H_6]$ (D) $[B_6H_6]^{2-}$

12. The number of EPR lines expected for a Mn(II) complex are

(A) six (B) thirty

(C) thirty six (D) six + six

13. In photosynthesis, the predominant metal present in the reaction centre of photosystem II is

(A) zinc (B) copper

(C) manganese (D) iron

14. The compound which has four metal-metal bonds is

(A) $Fe_2(CO)_9$ (B) $[Re_2Cl_8]^{2-}$

(C) $Co_2(CO)_8$ (D) $Ru_3(CO)_{12}$

15. The violet colour of $[Ti(H_2O)_6]^{3+}$ is due to

(A) ligand to metal charge transfer transition

(B) metal to ligand charge transfer transition

(C) d-d transition

(D) f-f transition

16. The inert pair effect refers to

(A) a pair of valence shell s-electrons reluctant to ionize

(B) a pair of electrons on inert gas atoms

(C) an electron pair donated to inert gas atoms

(D) a pair of electrons in the triplet state

17. A molecule with d^2sp^3 hybridisation shows the bond angle of

(A) 120° (B) 60° (C) 109.5° (D) 90°

18. Photophysical process which leads to radioactive decay is called

(A) absorption (B) fluorescence

(C) internal conversion (D) inter system crossing

19. The metal present in hemocyanin is

(A) copper (B) iron

(C) magnesium (D) cobalt

20. The following group of ionic or neutral species which does not contain a hard acid or hard base is

(A) Li^+, Cu^{2+}, N_3^-, NH_3 (B) Mg^{2+}, OH^-, Ag^+, CH_3^-

(C) Na^+, Ag^+, CN^-, CO (D) Ag^+, Cu^+, CO, CN^-,

21. The biological function of rubredoxin is

(A) iron storage (B) electron transfer

(C) oxygen storage (D) oxygen transport

22. The correct order of ν_{CO} for the compounds $[Mo(CO)_3(NMe_3)_3]$, $[Mo(CO)_3(PMe_3)_3]$ and $[Mo(CO)_3(PCl_3)_3]$ in the IR spectrum is

(A) $[Mo(CO)_3(NMe_3)_3] > [Mo(CO)_3(PMe_3)_3] > [Mo(CO)_3(PCl_3)_3]$

(B) $[Mo(CO)_3(PCl_3)_3] > [Mo(CO)_3(NMe_3)_3] > [Mo(CO)_3(PMe_3)_3]$

(C) $[Mo(CO)_3(PCl_3)_3] > [Mo(CO)_3(PMe_3)_3] > [Mo(CO)_3(NMe_3)_3]$

(D) $[Mo(CO)_3(PMe_3)_3] > [Mo(CO)_3(NMe_3)_3] > [Mo(CO)_3(PCl_3)_3]$

23. Aluminum chloride melts at a much lower temperature than that of sodium chloride because

(A) the Al-Cl bond is more ionic than that of Na-Cl

(B) aluminium chloride is dimeric

(C) Al-Cl bond is highly covalent while NaCl is ionic

(D) aluminium chloride is polymeric

24. Rare earth ions are good NMR shift reagents because

(A) they have large magnetic moments arising from the presence of *f* electrons

(B) they have short electron spin-lattice relaxation times

(C) they have long electron spin-lattice relaxation times

(D) they have short nuclear spin-lattice relaxation times

25. The compound **X** upon heating is converted to **Y**, which has the same molecular formula as that of **X**. The ^1H NMR spectrum of **Y** shows two doublets centered at 3.0 ppm (separation of two lines ~20 Hz) and 4.0 ppm (separation of two lines ~15 Hz) respectively. The compound **X** is $(CH_3O)_3P$ and the compound **Y** is

(A) $(CH_3O)_2P(O)(OH)$ (B) $(CH_3O)_3P$

(C) $(CH_3O)_2(CH_3)P(O)$ (D) $(CH_3O)_2(CH_3)P(OH)$

26. Ligand field stabilisation energies are smaller for lanthanides compared to transition metals in the same oxidation state because

(A) size of lanthanide ions are larger

(B) *f* orbitals interact less effectively with ligands

(C) size of lanthanide ions are smaller

(D) lanthanides favour oxygen donor ligands

27. The most suitable route to prepare the *trans* isomer of $[PtCl_2(NH_3)(PPh_3)]$ is

(A) $[PtCl_4]^{2-}$ with PPh_3 followed by reaction with NH_3

(B) $[PtCl_4]^{2-}$ with NH_3 followed by reaction with PPh_3

(C) $[Pt(NH_3)_4]^{2+}$ with HCl followed by reaction with PPh_3

(D) $[Pt(NH_3)_4]^{2+}$ with PPh_3 followed by reaction with HCl

28. Of the following, the one with the largest crystal field splitting energy is

(A) $[Fe(NH_3)_6]^{3+}$ (B) $[Ru(CN)_6]^{3-}$

(C) $[Fe(CN)_6]^{3-}$ (D) $[Fe(H_2O)_6]^{2+}$

29. The neutral complex which follows the eighteen electron rule is

(A) $(\eta^5\text{-}C_5H_5)_2Co$ (B) $(\eta^5\text{-}C_5H_5)Fe(CO)_2$

(C) $(\eta^5\text{-}C_5H_5)Mo(CO)_3$ (D) $(\eta^5\text{-}C_5H_5)Re(\eta^6\text{-}C_6H_6)$

30. In the following reactions,

(i) $Mn_2(CO)_{10} + Na \rightarrow X$

(ii) $X + CH_3COCl \rightarrow Y$

X and Y respectively are,

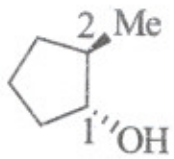
(A) $[Mn(CO)_4]^{2-}$, $[CH_3C(O)Mn(CO)_5]^-$ (B) $[Mn(CO)_5]^-$, $CH_3C(O)Mn(CO)_5$

(C) $[Mn(CO)_5]^-$, $ClMn(CO)_5$ (D) $[Mn(CO)_4]^{2-}$, $[ClMn(CO)_5]^-$

31. Cumene on reaction with oxygen followed by acid hydrolysis yields

(A) phenol and acetone
(B) phenol and isopropanol
(C) quinone and acetone
(D) quinol and acetone

32. Configuration around the carbon atoms 1 and 2 in the following compound are



(A) 1*R*, 2*R*
(B) 1*S*, 2*S*
(C) 1*R*, 2*S*
(D) 1*S*, 2*R*

33. Photolysis of E,E-2,4-hexadiene leads to

(A) 1,3-dimethyl-1-cyclobutene
(B) 1,2-dimethyl-1-cyclobutene
(C) *cis*-3,4-dimethyl-1-cyclobutene
(D) *trans*-3,4-dimethyl-1-cyclobutene

34. Predict the pair of reactants that give an enamine

(A) cyclopentanone and hydrazine
(B) benzophenone and phenylhydrazine
(C) cyclopentanone and diethylamine
(D) benzaldehyde and ethylamine

35. The terpenoid precursor for the steroid lanosterol is

(A) camphor
(B) nicotine
(C) carotene
(D) squalene

36. Choose the correct statement from the following

(A) 1,2-Diethylferrocene posses planar chirality
(B) 1,2-Diethyl-3-propylferrocene posses planar chirality
(C) 1,2-Diethyl-3-propylferrocene posses axial chirality
(D) 1,3-Diethyl-2-propylferrocene posses planar chirality

37. The condensation of acetophenone with formaldehyde and dimethylaniline to form 3-dimethylamino-1-phenyl-1-propanone is a name reaction called

(A) Mannich reaction
(B) Robinson annulation
(C) Perkin reaction
(D) Stobbe condensation

38. The carbene is the intermediate involved in

(A) Baylis-Hillman Reaction (B) Simmon-Smith reaction

(C) Cannizarro reaction (D) Schotton-Baumann Reaction

39. The amino acid that possess secondary amino group is

(A) proline (B) valine

(C) phenylalanine (D) glycine

40. The reaction of potassium phthalimide with ethyl 2-chloro propanoate followed by hydrolysis result in

(A) glycine (B) leucine (C) glutamic acid (D) alanine

41. The sequence of bases in a DNA strand is TTCG. In the complementary strand the sequence at that location is expected to be

(A) GCAA (B) AAGC

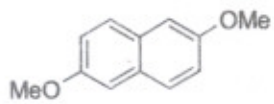
(C) TAGC (D) None of the above

42. Hydrolysis of lactose gives

(A) glucose and fructose (B) arabinose and fructose

(C) glucose and mannose (D) glucose and galactose

43. Number of ^{13}C NMR signals in the proton-decoupled NMR spectrum of the following compound is



(A) 12 (B) 10 (C) 8 (D) 6

44. 5-Methyl-1,3-cyclopentadiene rearranges to give a mixture of 1-methyl-1,3-cyclopentadiene and 2-methyl-1,3-cyclopentadiene. Such a rearrangement is an example for

(A) [1,5]-sigmatropic rearrangement (B) [1,3]-sigmatropic rearrangement

(C) [1,7]-sigmatropic rearrangement (D) [3,3]-sigmatropic rearrangement

45. The number of electrons present in the HOMO of first excited state of butadiene is

(A) 0 (B) 1 (C) 2 (D) 3

46. The reaction of 2,3-dimethylpyridine with sodium amide and ethyl iodide results in

(A) 2,3-dimethyl-4-ethylpyridine (B) 2,3-dimethyl-6-ethylpyridine

(C) 3-methyl-2-propylpyridine (D) 2-methyl-3-propylpyridine

47. α–D- Glucose with specific rotation of +112.2° changes to + 52.7° on standing as a solution in water. The process is called

(A) mutarotation
(B) epimerization
(C) diasteromerization
(D) enantiomer separation

48. The cholic acid is

(A) steroid
(B) terpenoid
(C) alkaloid
(D) antibiotic

49. Photolysis of 2-octanone yields acetone and 1-pentene. Such a cleavage is known as

(A) Norrish type I cleavage
(B) Norrish type II cleavage
(C) Eschenmoser Cleavage
(D) Grob fragmentation

50. The number of isoprene units that can be recognized in the natural product camphor is

(A) 1 (B) 3 (C) 2 (D) 4

51. The condensation of methyl vinyl ketone with cyclic ketones to provide cyclohexeneones is known as

(A) Mannich reaction
(B) Robinson annulation
(C) Claisen condensation
(D) Dieckmann condensation

52. The major product obtained in the thermal reaction between phenylhydrazine and 2-butanone in presence of zinc chloride would be

(A) 4-ethylindole
(B) 2-ethylindole
(C) 2,3-dimethylindole
(D) 2,4-diethylindole

53. The reaction of 1-octyne with catecholborane followed by oxidation with hydrogen peroxide/NaOH would result in

(A) 1-octanal (B) 1-octanol (C) 2-octanone (D) 3-octanone

54. Which of the following set represents all aromatic amino acids?

(A) Tryptophan, Histidine, Asparagines
(B) Tyrosine, Tryptophan, Histidine
(C) Tyrosine, Tryptophan, Proline
(D) Phenylalanine, Tyrosine, Lysine

55. Hydrolysis of cellobiose gives

(A) two molecules of D-Glucose

(B) two molecules of D-Mannose

(C) one molecule of D-Glucose and one molecule of D-Mannose

(D) one molecule of D-Galactose and one molecule of D-Mannose

56. Conversion of cholesterol to cholecalciferol involves

(A) 1,2-hydrogen shift

(B) 1,3-hydrogen shift

(C) 1,5-hydrogen shift

(D) 1,7-hydrogen shift

57. The reaction of an alkene with ozone followed by treatment with hydrogen peroxide resulted in adipic acid. The alkene is

(A) cyclopropene

(B) cyclobutene

(C) cyclopentene

(D) cyclohexene

58. The reagents necessary for the conversion of cyclohexene to *trans*-2-methylcyclohexanol would be

(A) i. *m*-CPBA and ii. $(Me)_2CuLi$

(B) i. H_2O_2 and ii. MeI

(C) i. $KMnO_4$ and ii. $NaBH_4$

(D) i. O_3 and ii. H_2 / Pd.C

59. The three-component condensation of 4-methylphenol with formaldehyde and dimethylamine is a reaction known as

(A) Robinson annulation

(B) Mannich reaction

(C) Claisen condensation

(D) Dieckmann condensation

60. A hydrocarbon C_8H_{10} exhibits base peak at m/z 91 in its mass spectrum. The hydrocarbon could be

(A) 1,2-diemthylbenzene

(B) 1,3-dimethylbenzene

(C) 1,4-dimethylbenzene

(D) ethylbenzene

61. The order of phase transition for melting is

(A) zeroth order

(B) first order

(C) second order

(D) third order

62. The numbers of radial nodes of 3d orbital is

(A) 3 (B) 2 (C) 1 (D) 0

63. If Ψa and Ψb are the atomic wave functions of two hydrogen atoms, then for the bonding sigma-bonding orbital of hydrogen molecule, the increase in the electronic probability density between the two hydrogen atoms is given by

(A) $\Psi a\ \Psi b$ (B) $2\ \Psi a\ \Psi b$

(C) $-\Psi a\ \Psi b$ (D) $-2\ \Psi a\ \Psi b$

64. Which of the following molecule does not have S_2 symmetry element?

(A) C_2H_2 (B) Ferrocene

(C) XeF_6 (D) CCl_4

65. The formula of Yttrium Iron Garnet (YIG) is

(A) $Y_5Fe_3O_{12}$ (B) $Y_3Fe_5O_{12}$

(C) $Y_3Fe_3O_{12}$ (D) $Y_5Fe_5O_{12}$

66. The total energy, E, and the wave vector, K, are related by the equation

(A) $E = (\hbar K)^2/2m$, where p is the linear momentum and m is the mass of the particle

(B) $E = (\hbar^2\ K)/2m$, where p is the linear momentum and m is the mass of the particle

(C) $E = (\hbar\ K^2)/2m$, where p is the linear momentum and m is the mass of the particle

(D) $E = (\hbar\ K)/2m$, where p is the linear momentum and m is the mass of the particle

67. The mean square average distance, $\langle x^2 \rangle$, of a diffusing species after time t is

(A) $\langle x^2 \rangle = 2Dt$ (B) $\langle x^2 \rangle = Dt$

(C) $\langle x^2 \rangle = 2Dt^2$ (D) $\langle x^2 \rangle = 3Dt$

68. The number of variables in phase space is

(A) 3 (B) 4 (C) 5 (D) 6

69. The total number of hyperfine lines in an isotropic EPR spectrum of V^{4+} ion with two equivalent nuclei is

(A) 12 (B) 13 (C) 14 (D) 15

70. Which of the following plane is not parallel to the z-axis?

(A) (001) (B) (110) (C) (100) (D) (010)

71. The Clausius –Clapeyron equation considers

(A) real gas behaviour of the vapour

(B) Van der Waals equation state of the vapour

(C) ideal gas behaviour of the vapour

(D) none of the above

72. A sample of wustite Fe_xO contains one Fe^{3+} for every three Fe^{2+}. The value of x is,

(A) 5/8 (B) 6/8 (C) 7/8 (D) 9/8

73. The standard reduction potentials of Mg/Mg^{2+} is -2.360 V, and Cu/Cu^{2+} is 0.337 V. The standard cell emf for the reaction $Mg + Cu^{2+} \longrightarrow Mg^{2+} + Cu$, is

(A) 2.697 V (B) – 2.697 V (C) – 2.023 V (D) 2.02 V

74. The Van der Waal force depends on distance r as

(A) $1/r^2$ (B) $1/r^3$ (C) $1/r^6$ (D) $1/r^8$

75. In a two component solid-solid phase diagram, the degrees of freedom at the eutectic point is/are

(A) 3 (B) 2 (C) 1 (D) 0

76. The SI unit of viscosity is

(A) $Kg\ S^{-1}m^{-1}$ (B) $Kg\ S\ m^{-1}$ (C) $Kg^{-1}\ S^{-1}m^{-1}$ (D) $Kg^{-1}S^{-1}m$

77. The order of the reaction $H_2 + Br_2 = 2HBr$ is

(A) first order (B) second order

(C) zeroth order (D) none of the above

78. The number of normal modes of vibration in H_2S molecule is

(A) 4 (B) 2 (C) 3 (D) 1

79. Debye specific heat of solid, C_v, depends on temperature T as,

(A) $C_v \propto T$ (B) $C_v \propto T^2$ (C) $C_v \propto T^3$ (D) $C_v \propto T^{-2}$

80. The molality of a solution containing 18 g of glucose (molar mass 180 g) in 500 g of water is

(A) 1 m (B) 0.5 m (C) 0.2 m (D) 1.2 m

81. The ΔG for a reaction at 300 K is -16 kcal and ΔH is -10 kcal. The entropy of the reaction is

(A) 20 cal deg^{-1} (B) 86.6 cal deg^{-1}

(C) 166 cal deg^{-1} (D) 100 cal deg^{-1}

82. The pH of 10^{-3} M NaOH solution is

(A) 10 (B) 11 (C) 12 (D) 13

83. Water boils at 100°C. Molal elevation constant for water is 0.513 K mol^{-1} kg. What is the boiling point of a solution containing 6 g of glucose (mol. Mass 180) per 100 g of water?

(A) 101.539°C (B) 100.017°C

(C) 100.171°C (D) 99.983°C

84. For the reaction A + B $\longrightarrow$ C + D, $\Delta H = -25$ kcal and $\Delta S = 90$ cal deg^{-1} at 27°C. The reaction

(A) is reversible at 27°C

(B) is not feasible at 27°C

(C) represents equilibrium state at 27°C

(D) can occur only at temperature higher than 27°C

85. The activation energy of certain reaction is 87 kJ/mol. What is the ratio of the rate constants when the temperature is decreased from 37°C to 15°C?

(A) 5/1 (B) 8.3/1 (C) 13/1 (D) 24/1

86. The latent heat of vaporization of water at 100°C is 540 cal g^{-1}. What will be the change in entropy when one mole of water at 100°C is evaporated?

(A) 260 cal K^{-1} mol^{-1} (B) 26 cal K^{-1} mol^{-1}

(C) 160 cal K^{-1} mol^{-1} (D) 360 cal K^{-1} mol^{-1}

87. In polar coordinates the ranges of the variables are

(A) $r = -\infty$ to ∞; $\theta = 0$ to 2π; (B) $r = -\infty$ to ∞; $\theta = 0$ to π;

(C) $r = 0$ to ∞; $\theta = 0$ to 2π; (D) $r = -\infty$ to ∞; $\theta = 0$ to 4π;

88. For a reversible isothermal expansion of an ideal gas

(A) $\Delta S_{sys} = \Delta S_{surr}$ = positive (B) $\Delta S_{sys} = -\Delta S_{surr}$

(C) $\Delta S_{sys} = \Delta S_{surr}$ = negative (D) $\Delta S_{sys} = \Delta S_{surr} = 0$

89. Nernst-Einstein relates, diffusion constant with

(A) coefficient of viscosity (B) conductivity

(C) resistivity (D) drift mobility

90. The hybrid orbital of the central atom in AlF_4^- is

(A) sp (B) sp^2 (C) sp^3 (D) sp^2d

91. The symmetry elements of T_d group falls in X number of classes where X is

(A) 4 (B) 5 (C) 6 (D) 8

92. The C_{2h} point group is isomorphic to

(A) D_2 (B) C_4 (C) D_{2h} (D) D_{2d}

93. The product of two rotations about axes that intersect at angle θ will give

(A) reflection in a plane perpendicular to the plane of the axes

(B) reflection in the plane of the axes

(C) rotation 2θ in an axis perpendicular to the plane containing the axes

(D) rotation by θ in an axis perpendicular to the plane containing the axes

94. The most bonding π-MO of benzene belongs to the irreducible representation

(A) A_{1g} (B) A_{1u} (C) A_1'' (D) A_{2u}

95. The T_{2u} symmetric stretching vibration of SF_6 (O_h) is

(A) IR Active (B) Raman Active

(C) Both IR and Raman Active (D) Both IR and Raman Inactive

96. The energy of hydrogen atom is a function of

(A) primary quantum number n (B) azimuthal quantum number l

(C) magnetic quantum number m (D) all of the above

97. Which of the following functions is not an eigen function of d^2/dx^2

(A) sin 2X (B) cos (X/2) (C) $5X^3$ (D) ln(2X)

98. The degeneracy of the ground state of Fe ($1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$) is

(A) singlet (B) triplet

(C) quintet (D) none of the above

99. For the three species O^2, O_2^+, O_2^- which one of the following orders for the bond energy (i.e., bond strength) is most reasonable?

(A) $O_2 > O_2^+ > O_2^-$ (B) $O_2^+ > O_2 > O_2^-$

(C) $O_2^- > O_2 > O_2^+$ (D) $O_2^- > O_2^+ > O_2$

100. The degeneracies of the eigen values obtained from Hückel method when compared to experiments is

(A) always equal (B) sometimes more

(C) sometimes less (D) no correlation