BHU M.Sc. CHEMISTRY ENTRANCE - 2011

Time : 2½ Hours **Full Marks : 450**

Instructions:

(i) Attempt as many questions as you can. Each question carries **3 marks**. **One mark** will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

(ii) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

1. The change in entropy when two moles of a monatomic perfect gas is compressed to half its volume and simultaneously heated to twice its initial temperature is

   (1) $R\ln 2$ (2) $3R\ln 2$ (3) $5R\ln 2$ (4) $7R\ln 2$

2. A heat engine operates between 1000 K and 600 K. The heat discharged into the cold sink in a reversible process when 5 kJ of heat is supplied by the hot source, is

   (1) 2 kJ (2) 2.5 kJ (3) 3 kJ (4) 5.5 kJ

3. For which of the following processes $q = 0, w = 0, \Delta U = 0$ and $\Delta H = 0$?

   (1) Reversible isothermal process in a perfect gas
   (2) Reversible adiabatic process in a perfect gas
   (3) Adiabatic expansion of a perfect gas into vacuum
   (4) Reversible constant-volume process in a perfect gas

4. The fugacity of a certain gas at 200 K and 50 bars is 25 bars. The difference of its chemical potential from that of a perfect gas in the same state is

   (1) $200R\ln 25$ (2) $200R\ln 2$ (3) $-200R\ln 2$ (4) $-200R\ln 25$

5. The entropy of mixing 1 mole of hexane with 1 mole of heptane at 298 K is 11.4 JK^{-1}. The Gibbs energy of mixing (assuming the solution to be ideal) is

   (1) –1.72 kJ (2) –3.44 kJ (3) 1.72 kJ (4) 3.44 kJ

6. The number of degrees of freedom of the system $KClO_3(s) \rightleftharpoons 2KCl(s) + 3O_2(g)$ is

   (1) zero (2) one (3) two (4) three

7. The expression that relates the partial molar properties of the components in a mixture is known as

   (1) van't Hoff equation (2) Gibbs-Duhem equation
   (3) Duhem-Margules equation (4) Raoult's law

8. For a very dilute electrolyte solution with $\gamma_+ < 1, \gamma_+$ should increase with increase in

   (1) solvent's density (2) solvent's dielectric constant
   (3) ionic strength (4) cationic charge

9. Which of the following statements is *not* correct?

(1) ΔG_{mix} at constant temperature and pressure must be negative

(2) Intermolecular interactions are negligible in an ideal solution

(3) Solute-solute interactions are negligible in an ideally dilute solution

(4) Activity coefficients are never negative

10. Which of the following statements is correct?

(1) If $\Delta G^{o} > 0$, no amount of products can be obtained when the reaction is run at constant temperature and pressure

(2) It is possible for the entropy of a closed system to decrease substantially in an irreversible process

(3) In any closed system with $P - V$ work only, G is always minimised at equilibrium

(4) $\Delta(TS) = T\Delta S + S\Delta T$

11. The condition for the attainment of phase-equilibrium in a closed electrochemical system is the equality of

(1) surface potentials (2) electric potentials

(3) chemical potentials (4) electrochemical potentials

12. The direction of a chemical reaction at constant temperature and pressure is the direction of

(1) decrease of Gibbs free energy of the system (2) decrease of Helmholtz free energy of the system

(3) increase of entropy of the system (4) decrease of enthalpy of the system

13. The quantum yield of the photochemical decomposition of HI

$$HI + h\nu \rightarrow H + I$$
$$H + HI \rightarrow H_2 + I$$
$$I + I + M \rightarrow I_2 + M$$

with respect to HI is

(1) 0.5 (2) 1 (3) 1.5 (4) 2

14. HI is absorbed strongly on gold. Assuming Langmuir isotherm to apply, the order of the reaction $2HI \rightarrow H_2 + I_2$ on gold is

(1) zero (2) 0.25 (3) 0.5 (4) 1

15. Which of the following statements is *not* correct for Langmuir isotherm?

(1) It applies to monolayer adsorption

(2) Under conditions $\theta \ll 1$ and α (Freundlich exponent) ≈ 1, it reduces to Freundlich isotherm

(3) It applies to dissociative adsorption

(4) It applies to chemisorption

16. The activation energy and entropy of a bimolecular gas phase reaction at 600 K are 200 kJ mol^{-1} and –200 JK^{-1} mol^{-1} respectively. The free energy of activation is

(1) 70 kJ mol^{-1} (2) 80 kJ mol^{-1} (3) 310 kJ mol^{-1} (4) 320 kJ mol^{-1}

17. Among the following statements which is the correct one?

(1) The heat of chemisorption is always larger than that of physisorption

(2) Langmuir isotherm specifically assumes the existence of active centres

(3) Promoters are themselves catalysts

(4) Increase in surface tension with concentration leads to negative adsorption

18. The activation energy of the gas-phase association between F_2 and IF_5, a first-order reaction in each of the reactants, is 58.6 kJ mol^{-1}. The activation enthalpy at 340 K is

(1) 53 kJ mol^{-1} (2) 55.8 kJ mol^{-1} (3) 58.6 kJ mol^{-1} (4) 61.4 kJ mol^{-1}

19. In a photochemical reaction $A \rightarrow 2B + C$, the quantum efficiency with 500 nm light is 2×10^2 mol einstein^{-1}. After exposure of 300 m moles of A to the light, 2 m moles of B is formed. The number of photons absorbed by A is
(1) 1×10^{18} (2) 3×10^{18} (3) 6×10^{18} (4) 9×10^{18}

20. The condition for which the reaction rate of an enzymolysis that follows Michaelis-Menten kinetics, is half its maximum value, is
(1) $[S] \ll K_M$ (2) $[S] = K_M$ (3) $[S] = K_M / 2$ (4) $[S] \gg K_M$

21. For the mechanism

$A_2 \rightleftharpoons 2A$ (fast)
$A + B \rightarrow P$ (slow)

the reaction order with respect to A_2 is
(1) 0 (2) 0.5 (3) 1 (4) 2

22. Which of the following relations does not hold for the activity (A) of a radioactive substance?
(1) $\frac{A}{A_0} = \left(\frac{1}{2}\right)^{t/t_{1/2}}$ (2) $\frac{A}{A_0} = \exp\left(-0.693\frac{t}{t_{0.5}}\right)$
(3) $t_{0.5} / t_{0.1} = \ln 2$ (4) $\frac{A}{A_0} = 1 - 0.693\frac{t}{t_{0.5}}$ at $t \rightarrow 0$

23. A powder diffraction photograph from tungsten shows lines which indices as (110), (200), (211), (220), (310), (222), (321), (400), ... The symmetry of the unit cell is
(1) primitive (2) end-centred (3) face-centred (4) body-centred

24. Among the following halides which one forms van der Walls crystals?
(1) NaCl (2) $BeCl_2$ (3) $HgCl_2$ (4) HF

25. A form of $CaCO_3(c)$ has orthorhombic lattice with a = 5.0 Å, b = 8.0 Å, c = 5.6 Å and density = 3.0 gm cm^{-3} at room temperature. The number of Ca^{2+} ions per unit cell of the crystal is
(1) 1 (2) 2 (3) 4 (4) 8

26. The ratio of the translational partition functions of D_2 and H_2 at the same temperature and volume is
(1) 2 (2) 1.414 (3) 2.83 (4) 4

27. In which of the following systems is the energy level separation the largest?
(1) an electron in a radical in a field of 0.300 T (2) a ^{14}N nucleus in 600 MHz NMR spectrometer
(3) a proton in the same spectrometer (4) a deuteron in the same spectrometer

28. Which of the following functions is not an eigenfunction of $\frac{d^2}{dx^2}$?
(1) cos kx (2) exp($-kx^2$) (3) kx (4) exp(ikx)

29. The ratio of mean molar masses of a given polymer sample as determined by light scattering, sedimentation and osmotic pressure measurement methods is
(1) 1:1:2 (2) 2:1:2 (3) 1:2:1 (4) 2:2:1

30. In milk at 37ºC Lactobacillus acidophilus has a generation time of 75 minutes. What is the population relative to the initial value at 150 minutes?
(1) 4.0 (2) 2.25 (3) 2.0 (4) 1.75

31. If the pressure of a gas at constant temperature is doubled, the viscosity of the gas will be
(1) quadrupled (2) doubled (3) halved (4) unchanged

32. Among the following molecules which one shows pure rotation spectra?
(1) N_2 (2) H_2S (3) CO_2 (4) CH_4

33. The SI unit of radiation dose is
(1) becquerel (2) curie (3) rad (4) gray

34. It is found that a particle in a one-dimensional box of length of L can be excited to $n = 2$ state from the ground state by the light of frequency v. If the box length is doubled, the frequency needed to produce the above transition becomes
(1) $v/4$ (2) $v/2$ (3) $2v$ (4) $4v$

35. For a hydrogen atom in an $n = 4$ state, the maximum possible z-component of orbital angular momentum is
(1) $2\hbar$ (2) $3\hbar$ (3) $\sqrt{12}\hbar$ (4) $\sqrt{6}\hbar$

36. Which one of the following is an acceptable approximate wave function for a state of the helium atom?
(1) $[1s(1)1s(2) - 1s(1)1s(2)][\alpha(1)\beta(2)]$
(2) $[1s(1)1s(2)][\alpha(1)\alpha(2) + \beta(1)\beta(2)]$
(3) $[1s(1)2s(2) + 2s(1)1s(2)][\alpha(1)\alpha(2)]$
(4) $[1s(1)2s(2) + 2s(1)1s(2)][\alpha(1)\beta(2) - \beta(1)\alpha(2)]$

37. Which one of the following statements concerning H_2^+ is incorrect?
(1) The non-degenerate LCAO–MOs (without spin) must be either symmetric or anti-symmetric for inversion
(2) The lowest energy MO (without spin) of the molecule is anti-symmetric for inversion
(3) The ground state has a multiplicity of two
(4) The MOs transform into AOs of the helium ion as the two nuclei are fused together

38. Which one of the following is the correct formula for the lowest energy eigenfunction for a particle in a one-dimensional box having infinite barriers at $x = -L/2$ and $L/2$?
(1) $\sqrt{\frac{2}{L}}\sin\left(\frac{\pi x}{L}\right)$ (2) $\sqrt{\frac{2}{L}}\cos\left(\frac{\pi x}{L}\right)$
(3) $\sqrt{\frac{2}{L}}\exp\left(\frac{i\pi x}{L}\right)$ (4) $\sqrt{\frac{2}{L}}\exp\left(\frac{-i\pi x}{L}\right)$

39. Which of the following equations is used to calculate the number of theoretical plates?
(1) $\frac{t_R - t_0}{t_0}$ (2) $16\left(\frac{t_R}{W}\right)^2$
(3) $\frac{k_2}{k_1}$ (4) $2(t_{R_2} - t_{R_1})/(W_1 + W_2)$

40. Which of the following techniques is based on selectively inducing radioactivity and measuring the emitted radiation?
(1) Isotope dilution analysis (2) Radiometric titration
(3) Neutron activation analysis (4) All of the above

41. Which of the following techniques can be used only for volatile compounds?
(1) Gas chromatography (2) HPLC
(3) Ion chromatography (4) All of the above

42. Which of the following refers to ion exchange capacity?
(1) Nature of exchanging ions
(2) Nature of strong cation exchanger
(3) Nature of strong anion exchanger
(4) Total number of ion active groups per unit length of material

43. In electrogravimetry of cations the working electrode is
(1) anode (2) cathode
(3) both cathode and anode (4) neither anode nor cathode

44. Which of the following techniques is / are feasible approach in the determination of a substance that cannot be isolated in pure form for gravimetry or for determination by other methods?
(1) Neutron activation analysis (2) Isotope dilution analysis
(3) Radiometric titration (4) All of the above

45. Which of the following frequencies corresponds to carbonyl stretch vibration in acids?
(1) 1625 cm^{-1} (2) 1715 cm^{-1}
(3) 1745 cm^{-1} (4) 1800 cm^{-1}

46. A particular vibration in a polyatomic molecule is IR active if during vibration, there is a change in
(1) polarizability (2) dipole moment
(3) frequency (4) potential energy

47. Moisture in a drug can be determined by
(1) Malaprade reagent (2) EDTA reagent
(3) Karl Fischer reagent (4) chloramine-T reagent

48. Which one is more toxic?
(1) Hg (2) $(CH_3)_2Hg$ (3) Hg^{2+} (4) Hg_2^{2+}

49. The most efficient technique for the separation of amino acids is
(1) adsorption chromatography (2) partition chromatography
(3) ion-exchange chromatography (4) paper chromatography

50. Which one is not a pollutant?
(1) CO (2) CO_2 (3) SO_3 (4) NO_2

51. Which one is the sink of CO_2?
(1) Plant (2) Ocean (3) Air (4) Soil

52. Ozone layer is a protective shield against
(1) visible light (2) ultraviolet light (3) infrared rays (4) cosmic rays

53. Nessler's reagent is
(1) $KHgI_4$ (2) $K_2HgI_4 + NH_4OH$
(3) K_2HgI_4 (4) $KHgI_4 + NH_4OH$

54. Which of the following statements is *not* correct?
(1) In instrumental methods of analysis visual indicators are not required
(2) In classical volumetric titrations visual indications are not required
(3) In classical qualitative analysis removal of interfering radicals is essential
(4) Spectroanalytical techniques can be applied for qualitative and quantitative analysis

55. Visible region in the electromagnetic spectrum extends from
(1) 200-400 nm (2) 800-900 nm
(3) 400-4000 cm^{-1} (4) 400-800 nm

56. Hard water can be softened in
(1) a calorimeter (2) a chromatograph
(3) an ion exchanger (4) an earthen ware pot

57. The technique used for the separation of components of a mixture is called
(1) chromatography (2) IR spectroscopy
(3) electronic spectroscopy (4) polarography

58. Essential constituent of an amalgam is
(1) Ag (2) Hg (3) Mg (4) Fe

59. Potential of which of the following electrodes does not depend on pH of the solution?
(1) Glass electrode (2) Hydrogen electrode
(3) Quinhydrone electrode (4) calomel electrode

60. The unit of equivalent conductance is
(1) $ohm^{-1}\ cm^{-1}$ (2) $ohm^{-1}\ cm^{-2}$
(3) $ohm^{-1}\ cm^{2}$ (4) None of the above

61. Which quantity remains unchanged on changing temperature?
(1) Mole fraction (2) Molarity
(3) Normality (4) None of the above

62. The strongest ligand in spectro-chemical series is
(1) F^- (2) OH^- (3) H_2O (4) CO

63. The iron is rusted, then it is
(1) oxidized (2) reduced (3) evaporated (4) decomposed

64. Two elements cannot be combined chemically to make
(1) a compound (2) another element (3) a gas (4) a liquid

65. Choose the law that states, "effective chemical changes are brought about by absorbed radiations only"
(1) Beer's law (2) Grotthus-Draper law
(3) Lambert's law (4) law of photochemical equivalence

66. What quantity of limestone on heating will give 56 kg of CaO?
(1) 10 kg (2) 55 kg (3) 44 kg (4) 100 kg

67. The unit of absorptivity is
(1) $cm^{-1}\ g^{-1}L$ (2) $cm^{-1}\ mol^{-1}L$ (3) $cm^{-1}\ g\ L^{-1}$ (4) No unit

68. Oxine is a
(1) precipitating reagent (2) redox reagent (3) drug (4) dye

69. Free radicals may be detected by
(1) mass spectrometry (2) NMR spectroscopy
(3) ESR spectroscopy (4) infrared spectroscopy

70. Lead can be the best analysed colorimetrically using which of the following reagents?
(1) Dithizone (2) EDTA (3) DMG (4) Acetyl acetone

71. Which of the following is a hydride ion donor?
(1) NAD (2) ATP (3) NADH (4) Coenzyme A

72. Na and K can be estimated using

(1) X-ray fluorescence (2) IR spectroscopy

(3) ion selective electrode (4) All of the above

73. How many mL of concentrated HCl (density = 1.18 g/mL, 36.0 wt % HCl, MW = 36.5) should be diluted to 1.00 L to produce a 0.100 M solution?

(1) 8.59 mL (2) 85.9 mL (3) 0.859 mL (4) 17.18 mL

74. A 1.00×10^{-3} M solution of HCl includes $^{36}_{17}Cl$ ($t_{1/2} = 3.09\times10^{5}$y). The specific activity (the activity per unit mass or unit volume) of the solution is 5000 decays min^{-1} mL^{-1}. What fraction of Cl atoms in solution are ^{36}Cl atoms?

(1) 0.194 (2) 0.0194 (3) 1.940 (4) 0.00194

75. A 6.44×10^{-4} M solution of Ti-peroxide complex had $T = 0.340$ when measured in a 1.00 cm cell at 410 nm. What is the concentration of Ti-peroxide complex in a solution that had $T = 0.516$ when measured at 410 nm in a 0.500 cm cell?

(1) 7.89×10^{-2} M (2) 15.78×10^{-2} M (3) 7.89×10^{-4} M (4) 3.95×10^{-3} M

76. The partition coefficient for ethyl iodide, *E*, between octanol and water is

$$K_p = \frac{[E]_0}{[E]_w} \approx 100$$

What percent of *E* present in 50.00 mL of water would remain if the water was extracted with 10.00 mL of octanol?

(1) 47.6% (2) 4.76% (3) 9.52% (4) 95.2%

77. Arrange the ionization energies of the following ions in increasing order

(A) $Fe^{2+} \rightarrow Fe^{3+}$

(B) $Mn^{2+} \rightarrow Mn^{3+}$

(C) $Fe^{+1} \rightarrow Fe^{2+}$

Choices are

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

(At. No. of Fe and Mn are 26 and 25)

78. In the first row transition metal ion (2+) having four electrons in 3*d* orbitals (with 4*s* and 4*p* orbitals empty), the metal ion forms a hypothetical diamagnetic tetrahedral complex $[MA_4]^{2-}$ with A^- anion. The electronic configuration of the M^{2+} ion in the complex is

(1) $[Ar]3d^2_{xy}3d^2_{xz}3d^0_{yz}3d^0_{z^2}3d^0_{x^2-y^2}4s^04p^0$ (2) $[Ar]3d^0_{xy}3d^0_{xz}3d^2_{yz}3d^2_{z^2}3d^0_{x^2-y^2}4s^04p^0$

(3) $[Ar]3d^0_{xy}3d^0_{xz}3d^0_{yz}3d^2_{z^2}3d^2_{x^2-y^2}4s^04p^0$ (4) $[Ar]3d^1_{xy}3d^1_{xz}3d^2_{yz}3d^0_{z^2}3d^0_{x^2-y^2}4s4p^0$

79. Out of the following which has the least tendency to form M = O species?

(I) Sc = O (II) P = O (III) Ln = O (IV) Ac = O

(1) Sc = O and P = O (2) Ln = O

(3) Ac = O (4) Sc = O, P = O and Ac = O

(Ln = Lanthanides and Ac = actinides)

80. The magnetic properties of lanthanides are largely determined by the formula

(1) $\mu_{eff} = \sqrt{n(n+2)}$

(2) $\mu_{eff} = \sqrt{n(n+2)}$ + some contribution of orbital contribution

(3) $\mu_{eff} = \sqrt{L(L+2)}$

(4) $\mu_{eff} = g_J\sqrt{J(J+1)}$, where $g_J = \frac{3}{2} + \frac{S(S+1) - L(L+1)}{2J(J+1)}$

81. Ln^{2+} ions are largely coloured while Ln^{3+} ions are not coloured. The colour of Ln^{2+} compounds are due to transition

(1) $4f \rightarrow 5d$ (2) $4f \rightarrow 4f$

(3) charge transfer from liquid to metal ion (4) $5d \rightarrow 5d$ transition

82. Transition metals (some ions) form complexes with molecular N_2. There are two modes of coordination of N_2 in the complexes of the type $[M(N_2)(L)_n]$. These modes are (a) end-on and (b) side-on. The stability of these complexes in these two modes is

(1) end-on more stable than side-on

(2) side-on more stable than end-on

(3) both are highly unstable (the relative stability depends on ligands)

(4) both are equally stable

(L = ligand)

83. The structure of hyponitrous acid molecule ($H_2N_2O_2$) is

(1) linear (A–B–C–D type) (2) bent (⌒ type)

(3) square planar (□ type) (4) triangular (△ type)

84. We have two complexes $[Mn(H_2O)_6]^{3+}$ ion (d^4 system) and $[Re(H_2O)_6]^{3+}$ ion (d^4 system). Their CFSE and the pairing energy (per pair of electrons) are given below

$[Mn(H_2O)_6]^{3+}$ – 10Dq = 250 kJ/mol; Pairing energy = 300 kJ/mol

$[Re(H_2O)_6]^{3+}$ – 10Dq = 400 kJ/mol; Pairing energy = 180 kJ/mol

Predict from their data, the complexes are

(1) both high spin (2) Mn-high spin and Re-low spin

(3) both low spin (4) Mn-low spin, Re-high spin

85. $[NiCl_2(PPh_3)_2]$ is paramagnetic with $\mu_{eff} = 2.9\,BM$. All the four ligands are monodentate. The geometry of the molecule is

(1) square planar (2) octahedral

(3) square pyramidal (4) tetrahedral

86. There is no *d-d* transition in $[Mn(H_2O)_6]^{2+}$ (d^5 system). This is high spin complex. The absence of any transition in the visible region is due to breaking of

(1) Laporte rule

(2) parity selection rule ($g \rightarrow g$ and $u \rightarrow u$ not allowed)

(3) spin selection rule (spin of the electron cannot be changed during transition)

(4) All the above three rules (1, 2 and 3)

87. According to the IUPAC system which is the correct formula for the complex [diaquadibromodi (methylamine) cobalt (III) nitrate?

(1) $[Co(H_2O)_2Br_2(MeNH_2)_2]NO_3$ (2) $[CoBr_2(H_2O)_2(MeNH_2)_2]NO_3$

(3) $[Co(H_2O)_2(MeNH_2)_2Br_2]NO_3$ (4) $[Co(MeNH_2)_3(H_2O)_2Br_2]NO_3$

88. $[Cr(H_2O)_6]^{3+}$ is violet whereas $[Cr(NH_3)_6]^{3+}$ is yellow. The wavelength absorbed by $[Cr(NH_3)_6]^{3+}$ as compared to that by $[Cr(H_2O)_6]^{+3}$ in their absorption spectra will be

(1) higher (2) lower (3) same

(4) These complexes will not show any absorption in the visible region

89. Although fluorine is better oxidizing agent than oxygen, but Mn_2O_7 exists and MnF_7 does not. This is because of

(1) steric crowding and difficult to fitting seven fluoride ions around Mn centre

(2) very high electron affinity of fluorine as compared to oxygen

(3) very low lattice energy of MnF_7 compared to oxygen compound

(4) very low bond energy of Mn–F bond compared to Mn–O bond

90. Covalent radius of gold (125 pm) is less than that of silver (1.33 pm). This is because of

(1) transition metal contraction

(2) lanthanide contraction

(3) lack of shielding of 4*d* orbitals compared to 5*d* orbitals

(4) relatively less effective shielding by 3*p* and 3*s* orbitals in silver as compared to that by 4*s*, 4*p* and 4*d*

91. Using VSEPR model, the shaper of the following molecules

$IF_5^{-2}(A), XeF_4(B), IO_3^-(C), BrF_3(D)$

are

(1) (A) pentagon shape, (B) square planar, (C) trigonal pyramid, (D) T-shape

(2) (A) trigonal bipyramid, (B) tetrahedral, (C) planar, (D) planar

(3) (A) square pyramid, (B) tetrahedral, (C) trigonal pyramid, (D) planar

(4) (A) pentagonal pyramid, (B) tetrahedral, (C) trigonal pyramid, (D) planar

92. Arrange the hydrides of 15-group elements (NH_3, PH_3, AsH_3, SbH_3 < BiH_3) in increasing contribution of *p*-orbital of X in the X–H bond. Choose the correct alternative from the following alternatives given below

(1) Bi < Sb < As < P < N (2) P < N < As < Bi < Sb

(3) N < P < As < Sb < Bi (4) Bi < Sb < N < P < As

93. What are *A*, *B* and *C* in the following reactions?

(I) $B_2H_6 + NH_3 \rightarrow (A)$

(II) $B_2H_6 + H_2O \rightarrow (B)$

(III) $B_2H_6 \xrightarrow[\text{in the absence of air}]{\text{Heated at } 100^oC} (C)$

Here *A*, *B* and *C* respectively are

(1) borazine, B_2O_3 and B_4H_8 (2) $2BH_3 \cdot NH_3$, $H_3BO_3 + H_2$, $B_{10}H_{14}$

(3) BN, H_3BO_3 only, B_4H_8 (4) BN, $H_3BO_3 + H_2$, B_4H_8

94. Which one of the following contain (3*c* – 2*e*) bonds?

(a) $Mg(CH_3)_2$, (b) $BeCl_2$, (c) BeH_2, (d) $Be(NO_3)_2$

(1) (a), (b) and (c) (2) (a) and (c)

(3) (a), (c) and (d) (4) (b) and (c)

95. Which one of the following orders of two properties of 14- and 15-group elements is *not* correct?

(A) $BI_3 < BBr_3 < BCl_3 < BF_3$ (Lewis acidity)

(B) $Pb(CH_3)_4 < Sn(CH_3)_4 < Ge(CH_3)_4 < Sc(CH_3)_4$ (thermal stability)

The correct alternative from the following ones is

(1) (B) (2) (A)

(3) No one is wrong (4) Both are wrong

96. Which ones of the following compounds do not exist?

$[AuXe_4]$, $[KrF_2]$, $[ArF_2]$ [He–F]

Choose the correct choice out of the following

(1) $[AuXe_4]$ and [He–F] (2) $[KrF_2]$ and $[ArF_2]$

(3) $[Ar–F_2]$, and [He–F] (4) $[ArF_2]$ [He–F], $[AuXe_4]$

97. Alkalides and electrides are crystalline compounds of

(1) alkali metals in (+1) oxidation states and electrons respectively

(2) alkali metals in (–1) oxidation states and electron acting as anion

(3) methyl group and electron acting as anion respectively

(4) methyl group and alkali metal group

98. Among the molecules, BiF_3, $BiCl_3$, $BiBr_3$ and BiI_3, the one which is most coloured is

(1) BiF_3 (2) $BiBr_3$ (3) $BiCl_3$ (4) BiI_3

99. $[CrO_8]^{3-}$ ion is known. This ion probably is

(1) complex of peroxide ion with Cr^{5+} ion

(2) polymeric complex with oxide ion acting as bridges

(3) complex of molecular oxygen and oxide ion (e.g. $Cr^{5+}(O_2)_2O_4)^{3-}$

(4) complex of molecular oxygen and peroxide ions

100. Iodine dissolves in oleum to give bright blue colour. The blue colour is due to the formation of A, where A is

(1) I^- ion (2) I_3^- ion (3) I_2^+ ion (4) I_4^+ ion

101. The order of increasing size of V, Nb, Ta, Db (at. no. 106) is

(1) V < Nb < Ta < Db (2) Db < Ta < V < Nb

(3) V < Nb ≈ Ta ≈ Db (4) V < Db < Ta < Nb

102. Given the following reaction conditions for the formations of the fluorides of Xe

$$Xe(g) + F_2(g) \xrightarrow[\text{one atm pressure}]{400^\circ C} A\text{... (Xe in excess)}$$

$$Xe(g) + F_2(g) \xrightarrow[\text{six atmosphere}]{600^\circ C} B\text{... (Xe : } F_2 = 1{:}1.6)$$

$$Xe(g) + F_2(g) \xrightarrow[\text{60 atmosphere}]{300^\circ C} C\text{... (Xe : } F_2 = 1{:}20)$$

A, B and C in these reactions respectively are

(1) XeF_4, XeF_2, XeF_6 (2) XeF_2, XeF_4, XeF_6

(3) XeF_6, XeF_4, XeF_2 (4) XeF_2, XeF_6, XeF_4

103. In the preparation of P_4O_6, a mixture of N_2 and oxygen is used instead of pure oxygen. The reason is

(1) pure oxygen will form ozone in presence of P

(2) pure oxygen will form P_4O_{10} despite excess of P_4, in pure oxygen

(3) pure oxygen will form $[P(O_3)_4]$ ozonide

(4) pure oxygen will not react with P. N_2 acts as a catalyst

104. Arsenic, antimony and bismuth react with concentrated HNO_3. These give respectively
(1) H_3AsO_4, H_3SbO_2, $(BiO_3)^-$ ion (2) H_3AsO_4, Sb_2O_3, $(BiO_3)^-$ ion
(3) As_2O_3, Sb_2O_3, Bi_2O_3 (4) H_3AsO_4, Sb_2O_5 and Bi^{3+} ion

105. In borazine ($B_3N_3H_6$) molecule, the number of isomers which are possible of its disubstituted borazine molecule of the formula $[B_3N_3H_4X_2]$ without changing its ring structure is
(1) one (2) two (3) four (4) six

106. Solution of alkali metals in liquid NH_3 conducts electricity. It is due to formation of
(1) $Na^+ + Na^-$ ion in liquid ammonia
(2) $Na^+ + e^- (NH_3)_x$ in liquid ammonia
(3) Na^-, $(NH_2)^-$ and NH_4^+ ion in liquid NH_3
(4) The solution conducts like a metallic conductor with solvated electrons carrying the charge

107. A compound alloy of metals P and Q has a unit cell containing P atoms at the corners, while atom Q are present at the face centres. The formula of the compound should be
(1) PQ (2) PQ_2 (3) PQ_3 (4) P_3Q

108. A complex of a certain metal ion has a magnetic moment of 4.90 BM (4 unpaired electrons) and another complex of the same metal ion in the same oxidation state is diamagnetic. The complex is octahedral. The central metal could be one of the following
(Cr^{3+}, Mn^{2+}, Fe^{2+}, Mn^{3+}, Fe^{3+}, Co^{2+})
Cr^{3+} ion is [Ar]$4d^3$ system. The metal ion is
(1) Mn^{2+} (2) Fe^{2+} (3) Co^{2+} (4) Fe^{3+}

109. The enthalpy of hydration (ΔH) of Cr^{2+} [(d^4 system octahedral complex $(Cr(H_2O)_6)^{2+}$] is –460 kcal/mol. In the absence of CFSE, this value of ΔH is (–435) kcal/mole. The value of 10Dq (or Δ_0) is
(1) 14600 cm^{-1} (2) 21500 cm^{-1} (3) 9525 cm^{-1} (4) 25252 cm^{-1}
(1 kcal = 350 cm^{-1})

110. Which of the d^n ion will have the smallest CFSE if Δ (or 10Dq) is greater than pairing energy d^6, d^7, d^8, d^9, d^{10}?
(1) d^6, d^{10} (2) d^7, d^9 (3) d^{10} (4) d^5, d^8, d^{10}

111. During excessive physical stress (like running), the body makes A which reacts with water to form its conjugate base and B ions. These, in turn, lowers the pH in the muscles which causes pain in the muscles. Here A and B respectively are
(1) citric acid and H_3O^+ (2) lactic acid and H_3O^+
(3) enzyme and NH_4^+ (4) gluconic acid and NH_4^+

112. Which ones of the following are closed packed structures?
(a) AABB AABB... (b) ABAC ABAC...
(c) AB AB AB... (d) ABC ABC ABC...
Choose the correct choice out of the following
(1) a, b, c (2) a, c, d (3) b, c, d (4) b, c

113. Out of following actinides (I) Np, (II) Pu, (III) Es, (IV) Am one having +2 oxidation state as the only relatively important state is
(1) Np (2) Pu (3) Es (4) Am

114. Which is not an ambident nucleophile?

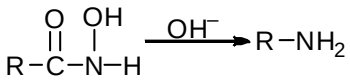
(1) CN^- (2) SCN^- (3) NO_2^- (4) DMSO

115. What is the increasing order of stability of following carbocations (give least stable first)?

(I) Tropylium cation (II) $CH_2=CH-CH_2^+$ (III) $(C_6H_5)_2C^+$ (IV) CH_3^+

(1) III<I<II<IV (2) IV<II<III<I (3) I<III<II<IV (4) IV<III<II<I

116. The type of rearrangement



is

(1) Lossen (2) Beckmann (3) Schmidt (4) Curtius

117. What is the nucleophilicity order for S_N2 reaction?

(I) $C_6H_5S^-$ (II) $C_2H_5O^-$ (III) NO_3^- (IV) CN^-

(V) I^-

(1) V > II > IV > I > III (2) III > IV > V > II > I

(3) I > IV > V > II > III (4) II > IV > V > III > I

118. Select order of effectiveness of Lewis acid catalyst in Friedel-Crafts reaction

(1) $AlCl_3 > FeCl_3 > ZnCl_2 > BF_3$ (2) $AlCl_3 > BF_3 > ZnCl_2 > FeCl_3$

(3) $AlCl_3 > ZnCl_2 > BF_3 > FeCl_3$ (4) $AlCl_3 > FeCl_3 > BF_3 > ZnCl_2$

119. One of the modern methods of studying free radical is

(1) IR spectra (2) CIDNP

(3) UV spectra (4) microwave spectra

120. For a reaction between alkyl halide and OH^- increase in solvent polarity generally

(1) decreases the rate of S_N1 reaction

(2) increases the rate of S_N1 reaction

(3) increases the rate of S_N2 reaction

(4) does not alter the rate of S_N1 and S_N2 reactions

121. Ethyl acetoacetate is prepared from ethyl acetate by

(1) Benzoin condensation (2) Aldol condensation

(3) Claisen condensation (4) Dieckmann condensation

122. Conversion of acetophenone to acetanilide is best accomplished by using

(1) Curtius (2) Hofmann

(3) Lossen (4) Beckmann

123. The order of the ease of the following leaving groups would be

(I) CH_3COO^- (II) CH_3O^-

(III) $CH_3SO_3^-$ (IV) $CF_3SO_3^-$

(1) IV > III > I > II (2) I > II > III > IV

(3) I > III > II > IV (4) I > II > IV > III

124. In an S_N2 reaction there is

(1) complete racemisation (2) mostly inversion and little racemisation

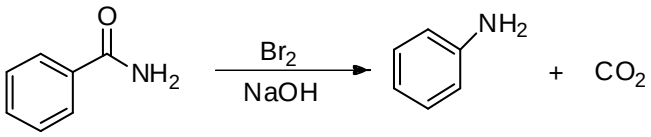
(3) partial racemisation (4) a little inversion and mostly racemisation

125. The number of carbon atoms in piperine is
(1) 13 (2) 15 (3) 17 (4) 19

126. In Beckmann rearrangement, the migrating group
(1) is always syn to the hydroxyl group
(2) is always anti to the hydroxyl group
(3) is either anti or syn
(4) depends on the stereochemistry of the molecule

127. In Baeyer-Villiger oxidation, rate of reaction is accelerated by
(1) electron donating groups in the ketone
(2) electron withdrawing groups in the peracid
(3) Both 1 and 2 are correct
(4) None of these

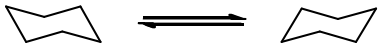
128. Reactive intermediate formed in the following reaction is



(1) carbene (2) nitrene (3) carbocation (4) carbanion

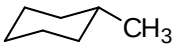
129. The increasing order of energy of various conformations of cyclohexane molecule is
(1) twist boat < boat < chair < half chair (2) boat < twist boat < half chair < chair
(3) chair < half chair < twist boat < boat (4) chair < twist boat < boat < half chair

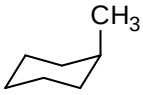
130. In cyclohexane molecule, when one chair conformation changes to other

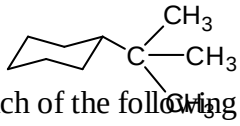


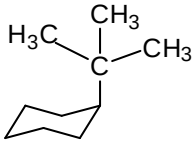
(1) all hydrogens originally axial become equatorial
(2) potential energy of chair conformation increases
(3) angle strain reduces
(4) None of the above

131. Which of the following is least stable?

(1) 

(2) 

(3) 

(4) 

132. Which of the following is not an alkaloid?
(1) Quinine (2) Reserpine (3) Camphor (4) Piperine

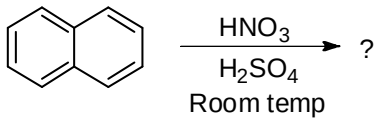
133. Indigo dye is deep blue colored due to
(1) conjugation of double bond and non-planarity of molecule
(2) conjugation of double bond and planarity of molecule
(3) hydrogen bonding and planarity of molecule
(4) None of the above

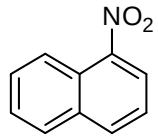
134. A powerful anti-malarial agent obtained from cinchona bark is
(1) emetine (2) piperine (3) quinine (4) colchicine

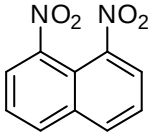
135. A polynuclear compound having three benzene rings fused angularly is
(1) naphthalene (2) anthracene (3) phenanthrene (4) chrysene

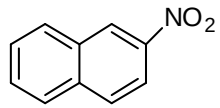
136. IUPAC name of nicotine is
(1) *N*-methyl-(3′-pyridyl)-2-pyrrolidine (2) 2′-(*N*-methylpyrrolidyl)-3-pyridine
(3) *N*-methyl-(2′-pyrrolidyl)-3-pyridine (4) *N*-methyl-(5′-pyridyl)-2-pyrrolidine

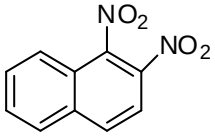
137. Predict the product for the following reaction



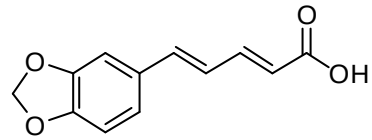
(1) 

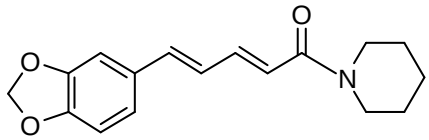
(2) 

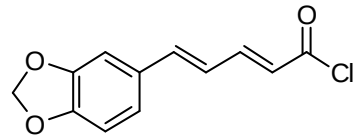
(3) 

(4) 

138. Structure of piperine is

(1) 

(2) 

(3) 

(4) None of these

139. In Chichibabin reaction, base used is
(1) KNH_2 (2) $NaNH_2$ (3) $C_6H_5NH_2$ (4) NH_3

140. Sulphonation in indole takes place at
(1) position-2 (2) position-3 (3) both (4) None of these

141. Isoquinoline on oxidation with alkaline $KMnO_4$ gives
(1) phthalic acid (2) benzoic acid
(3) cinchomeric acid (4) both 1 and 3

142. α-Terpeneiol gives *p*-Cymene on treatment with
(1) HNO_3 (2) H_2SO_4 (3) HCl (4) CH_3COOH

143. The sweetest sugar amongst the following is
(1) lactose (2) fructose (3) glucose (4) sucrose

144. The bond that determines the secondary structure of protein is
(1) coordinate bond (2) covalent bond (3) hydrogen bond (4) ionic bond

145. The main structural feature of protein is
(1) ester linkage (2) ether linkage (3) peptide linkage (4) ionic linkage

146. Buna-S is obtained by the polymerization of butadiene and
(1) chloroprene (2) styrene (3) acrylonitrile (4) adipic acid

147. Terylene is a polymer of
(1) adipic acid and hexamethylene diamine (2) terephthalic acid and ethylene glycol
(3) phenol and formaldehyde (4) adipic acid and ethylene glycol

148. Which is an example of thermosetting polymer?
(1) Polyethene (2) Neoprene
(3) Polyvinyl chloride (4) Bakelite

149. Which of the following is chain growth polymer?
(1) Glyptal (2) Nylon-66
(3) Nylon-6 (4) Polypropylene

150. Alkaloids are found in
(1) seeds (2) root
(3) bark (4) All of the above