PAPER : CSIR-UGC-NET/JRF Dec. 2016

CHEMICAL SCIENCES BOOKLET-[A]

PART-B

21. The HOMO (highest occupied molecular orbital) to LUMO (lowest unoccupied molecular orbital) electronic transition responsible for the observed colours of halogen molecules (gas) is

(a) $\pi^* \rightarrow \sigma^*$ (b) $\pi^* \rightarrow \pi^*$ (c) $\sigma \rightarrow \sigma^*$ (d) $\pi \rightarrow \sigma^*$

22. In the hydrolysis of *trans*-$\left[Co(en)_2Cl(A)\right]^+$, if the leaving group is chloride, the formation of *cis* product is the least, when A is

(a) NO_2^- (b) NCS^- (c) Cl^- (d) OH^-

23. The expected number of ^{19}F NMR spectral lines, including satellites, for $\left[XeF_5\right]^-$ is [Abundance of ^{129}Xe (I = ½) = 26%]

(a) two (b) twenty one (c) three (d) one

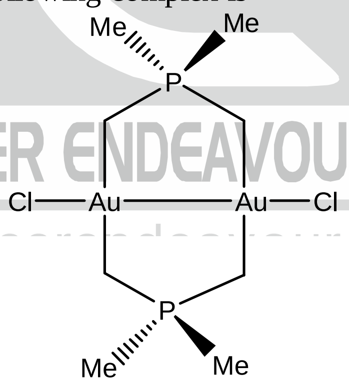
24. The expected H–H–H bond angle in $[H_3]^+$ is

(a) 180º (b) 120º (c) 60º (d) 90º

25. The number of bridging ligand(s) and metal-metal bond(s) present in the complex $\left[Ru_2(\eta^5-Cp)_2(CO)_2(Ph_2PCH_2PPh_2)\right]$ (obeys 18-electron rule), respectively, are

(a) 0 and 1 (b) 2 and 1 (c) 3 and 1 (d) 1 and 2

26. The oxidation state of gold in the following complex is



(a) 0 (b) 1 (c) 2 (d) 3

27. The rate of alkene coordination to $\left[PtCl_4\right]^{2-}$ is highest for

(a) norbornene (b) ethylene (c) cyclohexene (d) 1-butene

28. The nephelauxetic parameter β is highest for

(a) Br^- (b) Cl^- (c) CN^- (d) F^-

29. The $^2E_g \leftarrow {}^4A_{2g}$ transition in the electronic spectrum of $\left[Cr(NH_3)_6\right]^{3+}$ occurs nearly at

(a) 650 nm (b) 450 nm (c) 350 nm (d) 200 nm

30. In the catalytic hydration of CO_2 by carbonic anhydrase, CO_2 first interacts with
(a) OH group of the active site of the enzyme and then with zinc
(b) H_2O of the active site of the enzyme and then with zinc
(c) zinc of the active site of the enzyme and then with OH group
(d) zinc of the active site of the enzyme and then with H_2O

31. For the reaction,

$$HX_{(aq)} + H_2O_{(\ell)} \rightleftharpoons H_3O^+_{(aq)} + X^-_{(aq)}$$

the highest value of $\left[X^-\right]_{(aq)}$, when X^- is

(a) OCl^- (b) F^- (c) Cl^- (d) NO_2^-

32. The correct statement for d.c. polarography is
(a) $E_{1/2}$ is concentration dependent
(b) Dropping mercury electrode is a macro electrode
(c) Limiting current is equal to diffusion current
(d) A large excess of supporting electrolyte eliminates migration current.

33. Saturation factor in neutron activation analysis is
(A = induced radioactivity; φ = neutron flux; σ = effective nuclear cross section; N = no. of target atoms; λ = decay constant)

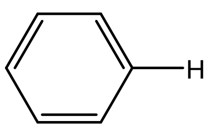
(a) $\dfrac{A}{\varphi\sigma N}$ (b) $\dfrac{\varphi\sigma NA}{\lambda}$ (c) $\dfrac{\lambda}{A\varphi\sigma N}$ (d) $\dfrac{\varphi\sigma N}{A}$

34. The primary analytical method (not using a reference) is
(a) inductively coupled plasma emission spectrometry
(b) energy dispersive X-ray fluorescence spectrometry
(c) anodic stripping voltammetry
(d) isotopic dilution mass spectrometry

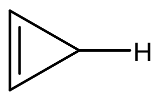
35. The number of inorganic sulphur (or sulphide) atoms present in the metalloprotein active sites of rubredoxin, 2-iron ferredoxin and 4-iron ferredoxin, respectively, are
(a) 0, 2 and 4 (b) 2, 4 and 3 (c) 0, 4 and 2 (d) 0, 2 and 3

36. The metal iodide with metallic lustre and high electrical conductivity is
(a) NaI (b) CdI_2 (c) LaI_2 (d) BiI_3

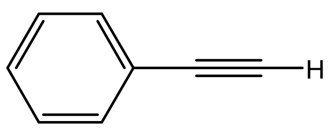
37. The correct order of the bond dissociation energies for the indicated C-H bond in following compounds is



(A)



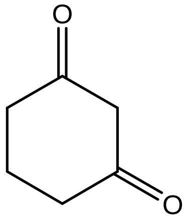
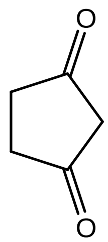
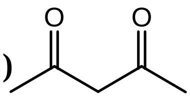
(B)



(C)

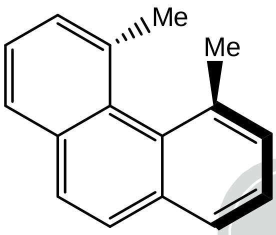
(a) C > B > A (b) A > B > C (c) A > C > B (d) C > A > B

38. The correct order of the acidity for the following compounds is

(A)  **(B)**  **(C)** 

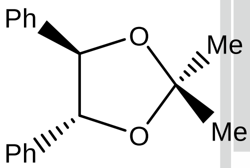
(a) B > C > A (b) C > B > A (c) B > A > C (d) C > A > B

39. The correct statement about the following compound is



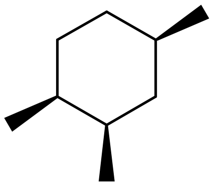
(a) compound is chiral and has P configuration
(b) compound is chiral and has M configuration
(c) compound is achiral as it possesses C_2-axis of symmetry
(d) compound is achiral as it possesses plane of symmetry

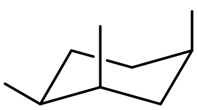
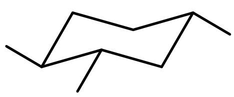
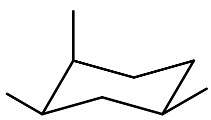
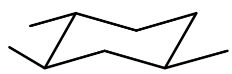
40. Methyl groups in the following compound are



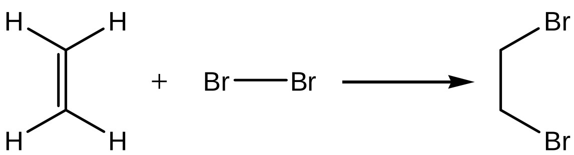
(a) homotopic (b) diastereotopic (c) enantiotopic (d) constitutionally heterotopic

41. Among the structures given below, the most stable conformation for the following compound is



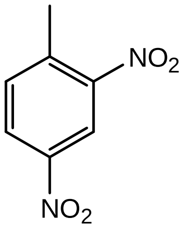
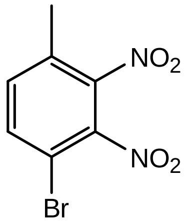
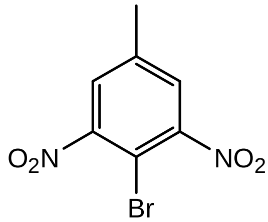
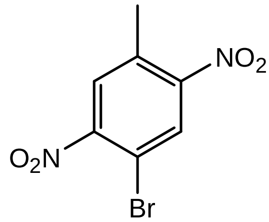
(a)  (b)  (c)  (d) 

42. Molecular orbital interactions involved in the first step of the following reaction is

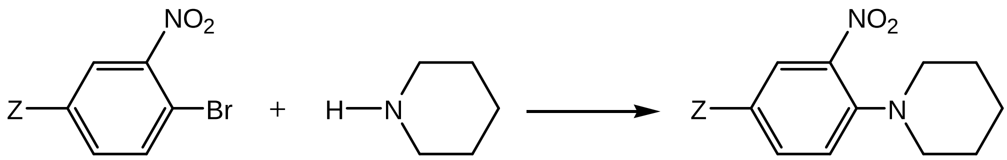


(a) $\pi_{C=C} \rightarrow \sigma^{*}_{Br-Br}$ (b) $n_{Br} \rightarrow \sigma_{C-C}$ (c) $\pi_{C=C} \rightarrow \sigma_{Br-Br}$ (d) $n_{Br} \rightarrow \pi_{C=C}$

43. The major product formed in the dinitration of 4-bromotoluene is

(a) 
(b) 
(c) 
(d) 

44. The correct order of the rate constants for the following series of reactions ($Z = CF_3/CH_3/OCH_3$) is

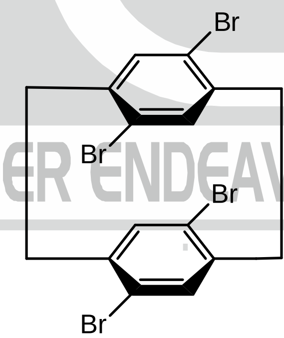


(a) $CF_3 > CH_3 > OCH_3$
(b) $CF_3 > OCH_3 > CH_3$
(c) $OCH_3 > CF_3 > CH_3$
(d) $CH_3 > OCH_3 > CF_3$

45. ^{1}H NMR spectrum of a mixture of benzene and acetonitrile shows two singlets of equal integration. The molar ratio of benzene : acetonitrile is
(a) 1 : 1 (b) 2 : 1 (c) 1 : 2 (d) 6 : 1

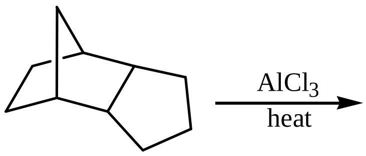
46. The compound which shows IR frequencies at both 3314 and 2126 cm^{-1} is
(a) $CH_3(CH_2)_4CH_2SH$
(b) $CH_3(CH_2)_4CH_2C\equiv N$
(c) $CH_3(CH_2)_4CH_2C\equiv C-H$
(d) $CH_3(CH_2)_2C\equiv C(CH_2)_2CH_3$

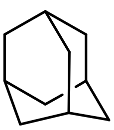
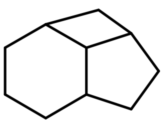
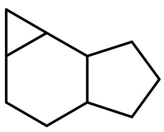
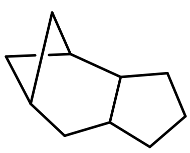
47. Number of signals present in the proton decoupled ^{13}C NMR spectrum of the following compound is



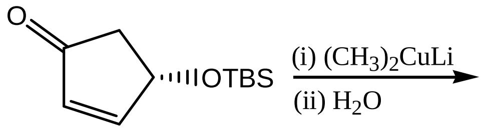
(a) four (b) six (c) eight (d) ten

48. The most stable product formed in the following reaction is

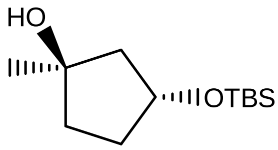
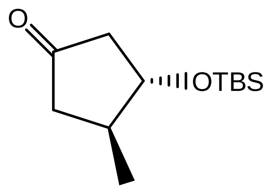
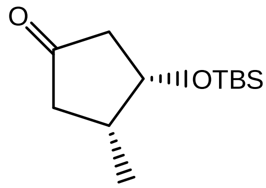
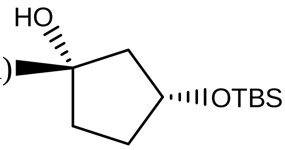


(a) 
(b) 
(c) 
(d) 

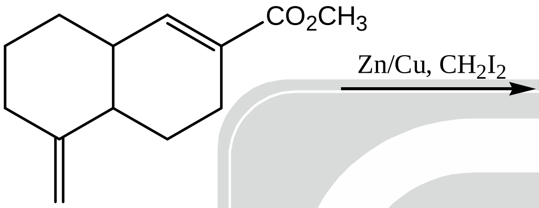
49. The major product in the following reaction is

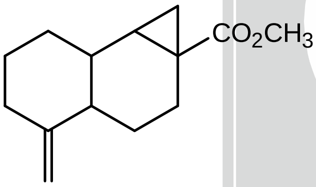


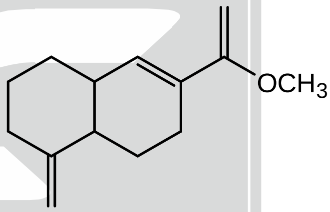
TBS = $Si(CH_3)_2t\text{-}C_4H_9$

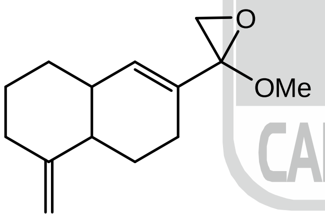
(a)  (b)  (c)  (d) 

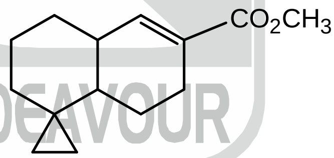
50. The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

51. Correct characteristics of the functional groups of adenine in DNA base pair are
(a) N(3) is a hydrogen bond acceptor and $C(6)NH_2$ is a hydrogen bond donor.
(b) N(1) is a hydrogen bond acceptor and $C(6)NH_2$ is a hydrogen bond donor
(c) Both N(3) and $C(6)NH_2$ are hydrogen bond acceptors
(d) Both N(1) and $C(6)NH_2$ are hydrogen bond acceptors

52. ^{1}H NMR spectrum of an organic compound recorded on a 500 MHz spectrometer showed a quartet with line positions at 1759, 1753, 1747, 1741 Hz. Chemical shift (δ) and coupling constant (Hz) of the quartet are
(a) 3.5 ppm, 6 Hz (b) 3.5 ppm, 12 Hz (c) 3.6 ppm, 6 Hz (d) 3.6 ppm, 12 Hz

53. The weight of the configuration with two up and three down spins in a system with five spin $\frac{1}{2}$ particles is
(a) 120 (b) 60 (c) 20 (d) 10

54. For a reaction with an activation energy of 49.8 kJ mol^{-1}, the ratio of the rate constants at 600 K and 300 K, (k_{600}/k_{300}), is approximately (R = 8.3 J mol^{-1} K^{-1})
(a) ln (10) (b) 10 (c) 10 + e (d) e^{10}

55. Covariance is defined by the relation $Cov(x,y) = \langle xy \rangle - \langle x \rangle \langle y \rangle$. Given the arbitrary constants A, B and C, $Cov(x,y)$ will be zero only when
(a) $y = Ax^2$ (b) $y = Ax^2 + B$ (c) $y = Ax + B$ (d) $y = Ax^2 + Bx + C$

56. Each void in a two dimensional hexagonal close-packed layer of circles is surrounded by
(a) six circles (b) three circles (c) four circles (d) twelve circles

57. The ionic mobilities of NH_4^+ and HCO_3^- are $6\times10^{-4}V^{-1}s^{-1}$ and $5\times10^{-4}V^{-1}s^{-1}$, respectively. The transport numbers of NH_4^+ and HCO_3^- are, respectively
(a) 0.545 and 0.455 (b) 0.455 and 0.545 (c) 0.090 and 0.910 (d) 0.910 and 0.090

58. The ionic strength of a solution containing 0.008 M $AlCl_3$ and 0.005 M KCl is
(a) 0.134 M (b) 0.053 M (c) 0.106 M (d) 0.086 M

59. The correct normalized wavefunction for one of the sp^2 hybrid orbitals is
(a) $\frac{1}{3}\psi_{2s} + \frac{1}{3}\psi_{2px} + \frac{1}{3}\psi_{2py}$ (b) $\frac{1}{\sqrt{3}}\psi_{2s} + \frac{2}{\sqrt{3}}\psi_{2px} + \frac{1}{\sqrt{6}}\psi_{2py}$
(c) $\frac{1}{\sqrt{3}}\psi_{2s} + \frac{1}{\sqrt{2}}\psi_{2px} + \frac{1}{\sqrt{6}}\psi_{2py}$ (d) $\frac{1}{\sqrt{3}}\psi_{2s} + \frac{1}{2\sqrt{3}}\psi_{2px} + \frac{1}{\sqrt{6}}\psi_{2py}$

60. The correct statement in the context of NMR spectroscopy is
(a) static magnetic field is used to induce transition between the spin states
(b) magnetization vector is perpendicular to the applied static magnetic field
(c) the static magnetic field is used to create population difference between the spin states
(d) static magnetic field induces spin-spin coupling.

61. The parameter which always decreases during a spontaneous process at constant S and V, is
(a) U (b) H (c) C_p (d) q

62. Triple point pressure of substances A, B, C and D are 0.2, 0.5, 0.8 and 1.2 bar, respectively. The substance which sublimes under standard conditions on increasing temperature is
(a) A (b) B (c) C (d) D

63. According to the transition state theory, the plot with slope equal to $\frac{-\Delta H^{\#}}{R}$ is
(a) ln k vs. T (b) $\ln\left(\frac{k}{T}\right)$ vs. T (c) $\ln\left(\frac{k}{T}\right)$ vs. $\frac{1}{T}$ (d) ln k vs. $\frac{1}{T}$

64. The transition that belongs to the Lyman series in the hydrogen-atom spectrum is
(a) $1s \leftarrow 4s$ (b) $1s \leftarrow 4p$ (c) $2s \leftarrow 4s$ (d) $2s \leftarrow 4p$

65. The molecule that possesses S_4 symmetry element is
(a) ethylne (b) allene (c) benzene (d) 1, 3-butadiene

66. Vibrations of diatomic molecules are usually modelled by a harmonic potential. If the potential is given by x^2, the correct statement is
(a) force is $2x$ and force constant is 2 (b) force is $-2x$ and force constant is 2
(c) force is $2x$ and force constant is -1 (d) force is $-2x$ and force constant is -1

67. When 1×10^{-5} g of a fatty acid (M = 602.3 g/mol) was placed on water as a surface film, a monomolecular layer of area 100 cm^2 was formed on compression. The cross-sectional area (in $Å^2$) of the acid molecule is
(a) 50 (b) 100 (c) 150 (d) 200

68. Mark-Houwink equation $\left([\eta] = KM^a\right)$ is used for the determination of
(a) number-average molar mass
(b) weight-average molar mass
(c) viscosity-average molar mass
(d) z-average molar mass

69. Many properties of nanoparticles are significantly different than the corresponding bulk materials due to
(a) smaller band gap of nanoparticles compared to bulk
(b) higher heterogeneity of the nanoparticle solutions
(c) larger ratio of surface area to volume of the nanoparticles compared to the bulk
(d) smaller ratio of surface area to volume of the nanoparticles compared to the bulk

70. The correct match for the following is

Column-A	Column-B
(i) camphor	(A) structural protein
(ii) insulin	(B) hormone
(iii) keratin	(C) enzyme
	(D) steroid
	(E) terpene

(a) (i)-(A); (ii)-(C); (iii)-(E) (b) (i)-(E); (ii)-(B); (iii)-(A)
(c) (i)-(D); (ii)-(C); (iii)-(A) (d) (i)-(E); (ii)-(B); (iii)-(D)

PART-C

71. Consider the following statements for KC_8:
(A) It is paramagnetic, (B) It has eclipsed layer structure, (C) Its electrical conductivity is greater than that of graphite. The correct answer is
(a) A and B (b) A and C (c) B and C (d) A, B and C

72. Among the following, choose the correct products that are formed in the reaction of S_2Cl_2 with ammonia in CCl_4:
NH_4Cl(A), S_4N_4(B), S_8(C), and $S_3N_3Cl_3$(D).
(a) A, B and C (b) A, B and D (c) B, C and D (d) A, C and D

73. For $[Ce(NO_3)_4(OPPh_3)_2]$, from the following
A. Its aqueous solution is yellow-orange in colour
B. Coordination number of Ce is ten
C. It shows metal to ligand charge transfer
D. It is diamagnetic in nature

The correct answer is

(a) A and B (b) A and C (c) A, B and D (d) B, C and D

74. Consider the following statements, I and II:

I: $[Rh(CO)_2I_2]^-$ catalytically converts CH_3I and CO to CH_3COI

II: $[Rh(CO)_2I_2]^-$ is diamagnetic in nature

The correct from the following is

(a) I and II are correct and II is an explanation of I

(b) I and II are correct and II is not an explanation of I

(c) I is correct and II is incorrect

(d) I and II are incorrect

75. In a direct isotopic dilution method for determination of phosphate, 2 mg of $^{32}PO_4^{3-}$ (specific activity 3100 disintegration s^{-1} mg^{-1}) was added to 1g of a sample solution. The 30 mg of phosphate isolated from it has an overall activity of 3000 disintegration s^{-1}. The % mass of PO_4^{3-} in the sample is

(a) 30 (b) 6 (c) 9 (d) 15

76. Consider the following statements for $[FeO_4]^{4-}$.

A. It is paramagnetic

B. It has T_d symmetry

C. Adopts distorted square planar geometry

D. Shows approximately D_{2d} symmetry

The correct answer is

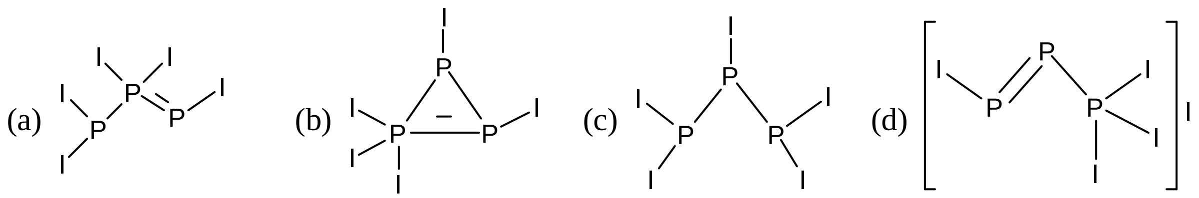
(a) A, B and C (b) A, C and D (c) A and D (d) A and B

77. The geometry of $[ReH_9]^{2-}$ is

(a) monocapped square antiprism (b) monocapped cube

(c) tricapped trigonal prism (d) heptagonal bipyramid

78. The reaction between PI_3, $PSCl_3$ and zinc powder gives P_3I_5 as one of the products. The solution state ^{31}P NMR spectrum of P_3I_5 shows a doublet (δ 98) and a triplet (δ 102). The correct structure of P_3I_5 is



79. Some molecules and their properties in liquid ammonia are given in columns A and B respectively. Match column A with column B

Column A	Column B
(A) Cl_2	(i) Weak acid
(B) S_8	(ii) Strong acid
(C) CH_3CO_2H	(iii) Disproportionation
(D) Urea	(iv) Solvolysis and disproportionation

The correct match is
(a) (A) – (i); (B) – (ii); (C) – (iii); (D) – (iv)
(b) (A) – (ii); (B) – (iii); (C) – (iv); (D) – (i)
(c) (A) – (iii); (B) – (iv); (C) – (i); (D) – (ii)
(d) (A) – (iv); (B) – (iii); (C) – (ii); (D) – (i)

80. The spectroscopic ground state term symbols for the octahedral aqua complexes of Mn(II), Cr(III) and Cu(II), respectively, are
(a) ^2H, ^4F and ^2D (b) ^6S, ^4F and ^2D
(c) ^2H, ^2H and ^2D (d) ^6S, ^4F and ^2P

81. From the following transformations,
A. Epoxidation of alkene
B. Diol dehydrase reaction
C. Conversion of ribonucleotide-to-deoxyribonucleotide
D. 1, 2-carbon shift in organic substrates
those promoted by coenzyme B_{12} are
(a) A and B (b) B, C and D (c) A, B and D (d) A, B and C

82. Match the items in column A with the appropriate items in column B

Column A		Column B	
(A)	Metallothioneins	(i)	*cis*-$[Pd(NH_3)_2Cl_2]$
(B)	Plastocyanin	(ii)	Cysteine rich protein
(C)	Ferritin	(iii)	Electron transfer
(D)	Chemotherapy	(iv)	Iron transport
		(v)	Iron storage
		(vi)	Carboplatin

The correct answer is
(a) (A) – (ii); (B) – (iii); (C) – (v); (D) – (iv)
(b) (A) – (ii); (B) – (iii); (C) – (iv); (D) – (i)
(c) (A) – (ii); (B) – (iii); (C) – (v); (D) – (vi)
(d) (A) – (iii); (B) – (v); (C) – (vi); (D) – (ii)

83. For OH^- catalysed S_N1 conjugate base mechanism of $\left[Co(NH_3)_5Cl\right]^{2+}$, the species obtained in the first step of the reaction is/are
(a) $\left[Co(NH_3)_5(OH)\right]^{2+} + Cl^-$ (b) $\left[Co(NH_3)_4(NH_2)Cl\right]^{+} + H_2O$
(c) $\left[Co(NH_3)_4(NH_2)\right]^{2+} + Cl^-$ (d) $\left[Co(NH_3)_5Cl(OH)\right]^{+}$ only

84. Match the species in column X with their properties in column Y

Column-X	Column-Y
(1) Heme A	(i) oxo-bridged, Mn_4 cluster
(2) Water splitting enzyme	(ii) tetragonal elongation
(3) $\left[Mn(H_2O)_6\right]^{2+}$	(iii) Predominantly $\pi \rightarrow \pi^*$, electronic transitions

(4) $\left[Cr(H_2O)_6\right]^{2+}$ (iv) $d \rightarrow d$ spin-forbidden transitions

(v) tetragonal compression

The correct answer is

(a) (1)-(iii), (2)-(i), (3)-(v), (4)-(ii)
(b) (1)-(iii), (2)-(i), (3)-(iv), (4)-(ii)
(c) (1)-(v), (2)-(iii), (3)-(iv), (4)-(ii)
(d) (1)-(iii), (2)-(i), (3)-(iv), (4)-(v)

85. According to isolobal analogy, the right set of fragments that might replace $Co(CO)_3$ in $\left[Co_4(CO)_{12}\right]$ is

(a) CH, BH and $Mn(CO)_5$
(b) P, CH and $Ni\left(\eta^5\text{-}C_5H_5\right)$
(c) $Fe(CO)_4$, CH_2 and $SiCH_3$
(d) BH, $SiCH_3$ and P

86. According to Wade's rules, the correct structural types of $\left[Co\left(\eta^5\text{-}C_5H_5\right)B_4H_8\right]$ and $\left[Mn\left(\eta^2-B_3H_8\right)(CO)_4\right]$ are

(a) closo and nido (b) nido and arachno (c) closo and arachno (d) nido and nido

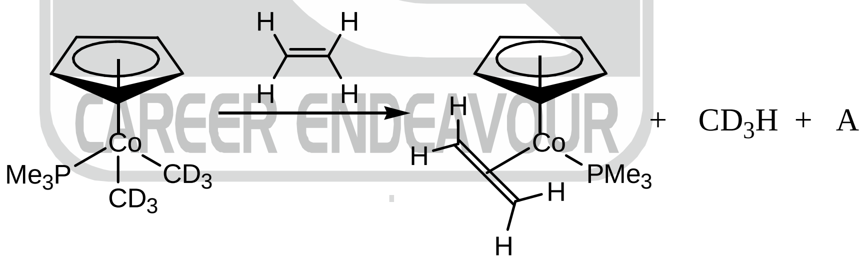
87. The correct geometry of $\left[Rh_6C(CO)_{15}\right]^{2-}$ is

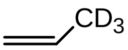
(a) octahedron (b) pentagonal pyramid (c) trigonal prism (d) monocapped square pyramid

88. The final product(s) of the reaction of arachno borane, B_4H_{10} with NMe_3 is/are

(a) $\left[BH_3.NMe_3\right]$ and $\left[B_3H_7.NMe_3\right]$
(b) $\left[BH_2(NMe_3)_2\right]^+\left[B_3H_8\right]^-$
(c) $\left[B_4H_{10}.NMe_3\right]$
(d) $\left[B_4H_{10}.NMe_3\right]$ and $\left[BH_2(NMe_3)_2\right]^+\left[B_3H_8\right]^-$

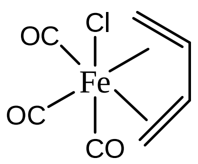
89. Product A in the following reaction is

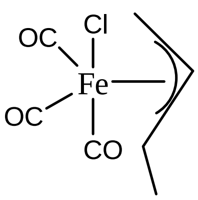


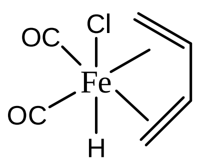
(a) $D_2C{=}CD_2$ (b) $D_3C{-}CD_3$ (c) 

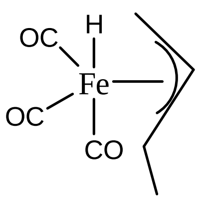
(d) $H_2C{=}CD_2$

90. Treatment of $Fe(CO)_5$ with 1, 3-butadiene gives B that shows two signals in its ^1H NMR spectrum. B on treatment with HCl yields C which shows four signals in its ^1H NMR spectrum. The compound C is

(a) 

(b) 

(c) 

(d) 

91. In the following redox reaction with an equilibrium constant K = 2.0 × 10^8,

$$\left[Ru(NH_3)_6\right]^{2+} + \left[Fe(H_2O)_6\right]^{3+} \rightleftharpoons \left[Ru(NH_3)_6\right]^{3+} + \left[Fe(H_2O)_6\right]^{2+}$$

the self exchange rates for oxidant and reductant are 5.0 $M^{-1}s^{-1}$ and 4.0×10^3 $M^{-1}s^{-1}$, respectively. The approximate rate constant ($M^{-1}s^{-1}$) for the reaction is

(a) 3.16×10^6 (b) 2.0×10^6 (c) 6.32×10^6 (d) 3.16×10^4

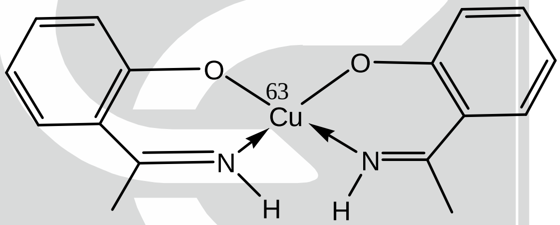
92. The correct statement for a Fischer carbene complex is

(a) the carbene carbon is electrophilic in nature
(b) metal exists in high oxidation state
(c) metal fragment and carbene are in the triplet states
(d) CO ligands destabilize the complex

93. The acidic solution containing trimethylamine (A), dimethylamine (B) and methyl amine (C) (pK_a of cations 9.8, 10.8 and 10.6, respectively) was loaded on a cation exchange column. The order of their elution with a gradient of increasing pH > 7 is

(a) A < C < B (b) B < C < A (c) B < A < C (d) C < B < A

94. For complex A, deuteration of NH protons does not alter the EPR spectrum. The number of hyper-fine lines expected in the EPR $\left[I\left({}^{63}Cu\right)=\frac{3}{2}\right]$ spectrum of A is

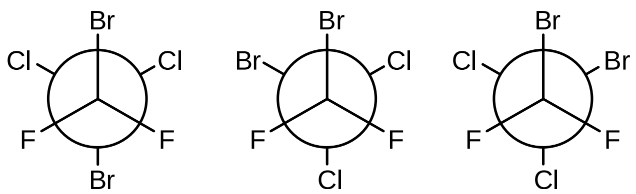


(a) 20 (b) 12 (c) 60 (d) 36

95. The numbers of triangular faces in square antiprism, icosahedron and tricapped trigonal prism (capped on square faces), respectively, are

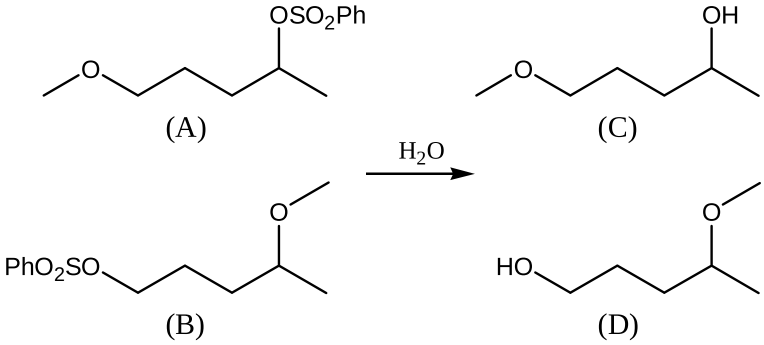
(a) 8, 20 and 14 (b) 8, 20 and 12 (c) 10, 12 and 14 (d) 10, 12 and 12

96. Number of lines in the ^{19}F NMR spectrum of $F_2C(Br)–C(Br)Cl_2$ at –120ºC assuming it a mixture of static conformations given below, are



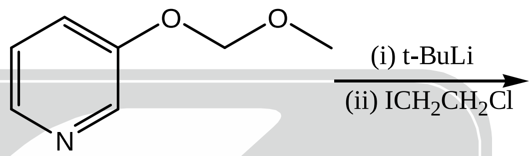
(a) one (b) two (c) four (d) five

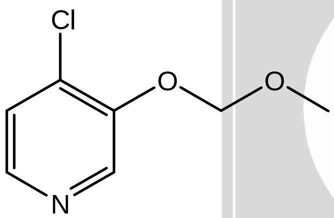
97. The correct statement for the reactants A, B to give products C, D is

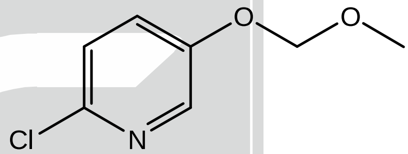


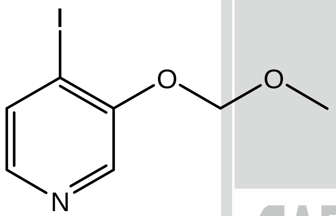
(a) A gives C and B gives D (b) A gives D and B gives C
(c) A and B give identical amounts of C and D (d) A and B give D

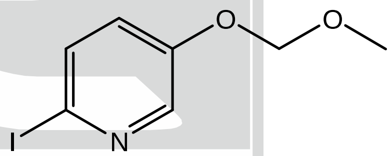
98. The major product formed in the following reaction is



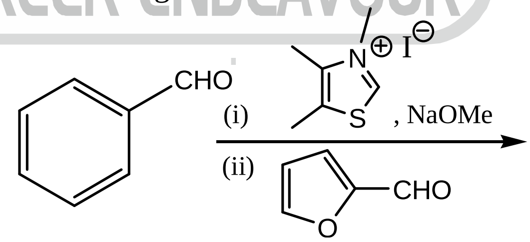
(a) 

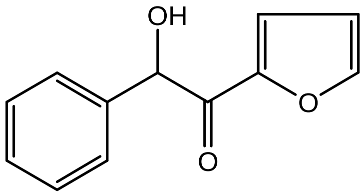
(b) 

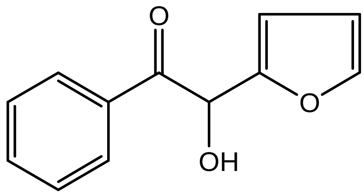
(c) 

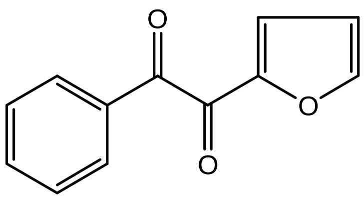
(d) 

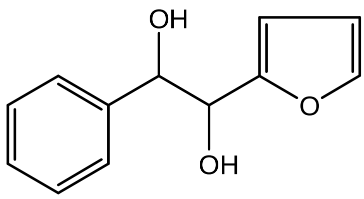
99. The major product formed in the following reaction is



(a) 

(b) 

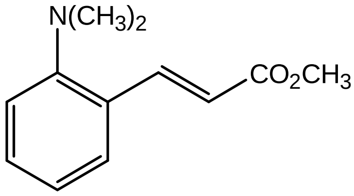
(c) 

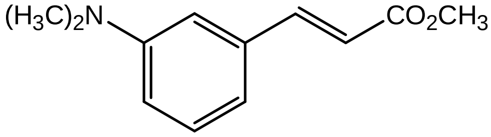
(d) 

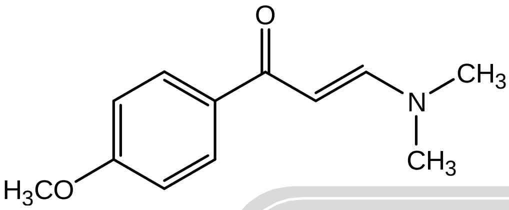
100. The compound that exhibits following spectral data is

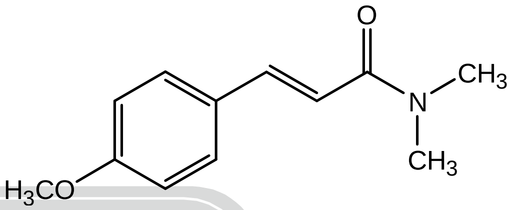
^{1}H NMR : δ 8.0(d, J = 12.3 Hz, 1H), 7.7(d, J = 8.0 Hz, 2H),

6.8(d, J = 8.0 Hz, 2H), 5.8(d, J = 12.3 Hz, 1H), 3.8(s, 3H), 3.0(s, 6H) ppm

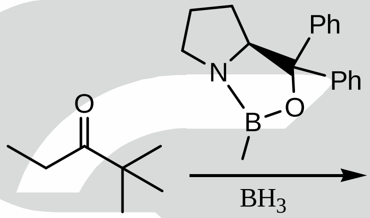
(a) 

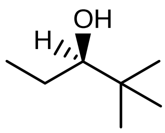
(b) 

(c) 

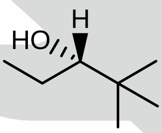
(d) 

101. The major product in the following reaction is

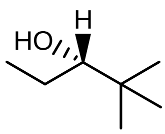


(a) 

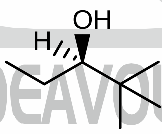
, by Re face attack

(b) 

, by Re face attack

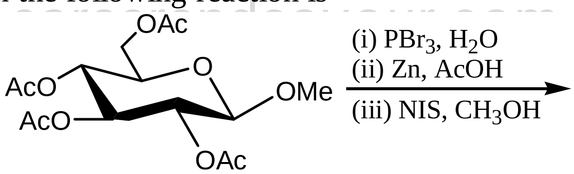
(c) 

, by Si face attack

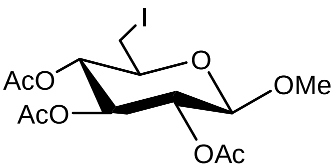
(d) 

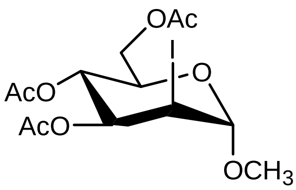
, by Si face attack

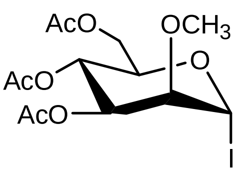
102. The major product formed in the following reaction is

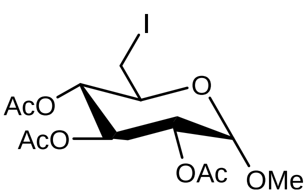


NIS : N-iodosuccinimide

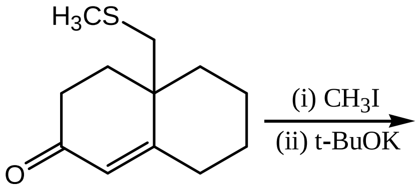
(a) 

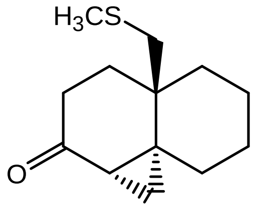
(b) 

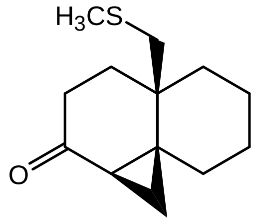
(c) 

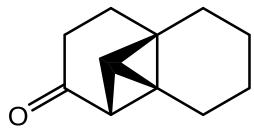
(d) 

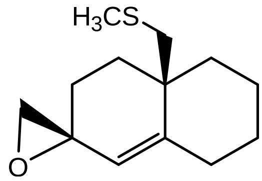
103. The major product formed in the following reaction is



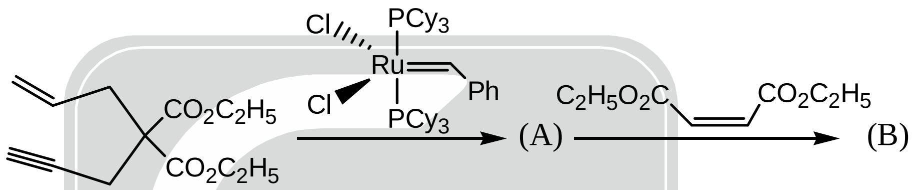
(a) 

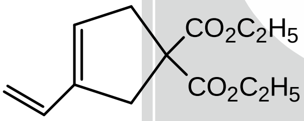
(b) 

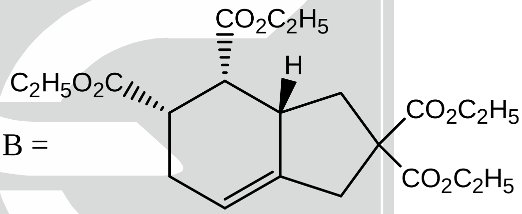
(c) 

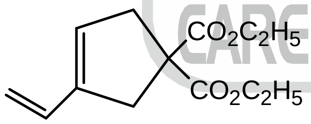
(d) 

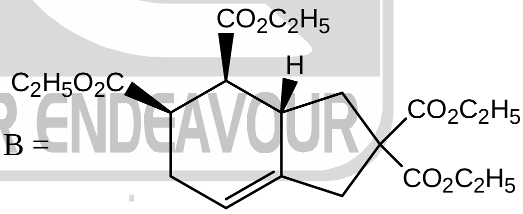
104. The major product formed in the following reaction is

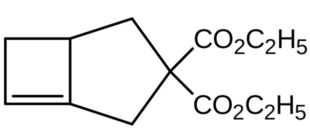


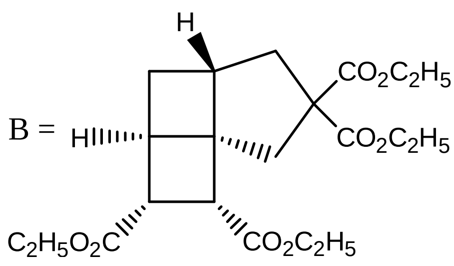
(a) A = 

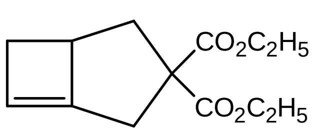
B = 

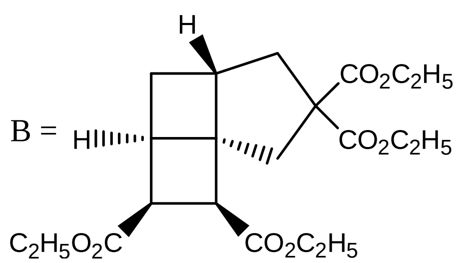
(b) A = 

B = 

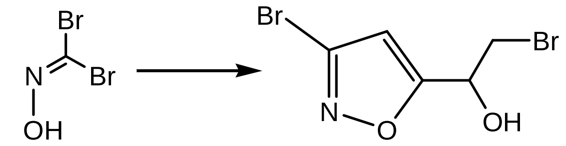
(c) A = 

B = 

(d) A = 

B = 

105. Correct sequence of reagents for the following conversion is



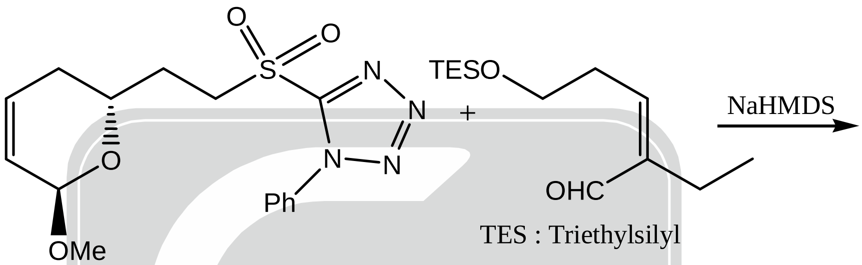
(a) (i) K_2CO_3, (ii) $HC \equiv CCOCH_3$, (iii) Br_2, (iv) $NaBH_4$

(b) (i) $NaBH_4$, (ii) $HC \equiv CCOCH_3$, (iii) Br_2, (iv) K_2CO_3

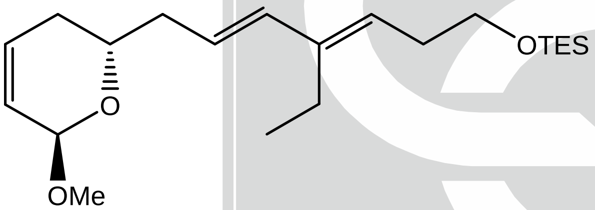
(c) (i) $HC \equiv CCOCH_3$, (ii) K_2CO_3, (iii) Br_2, (iv) $NaBH_4$

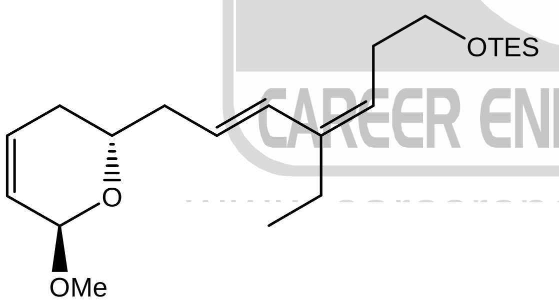
(d) (i) Br_2, (ii) $HC \equiv CCOCH_3$, (iii) K_2CO_3, (iv) $NaBH_4$

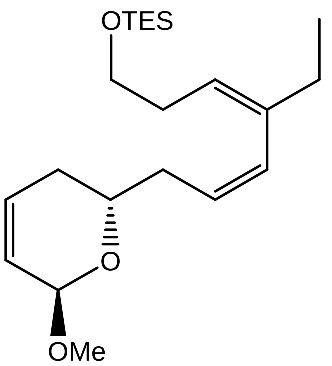
106. The major product in the following reaction is

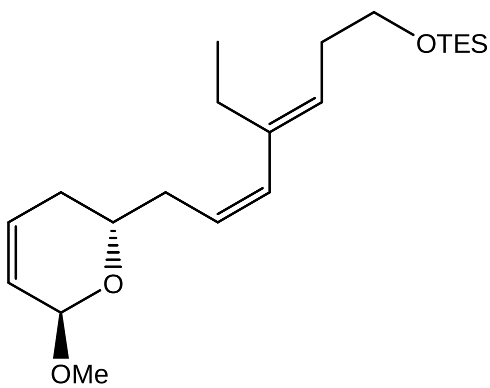


TES : Triethylsilyl

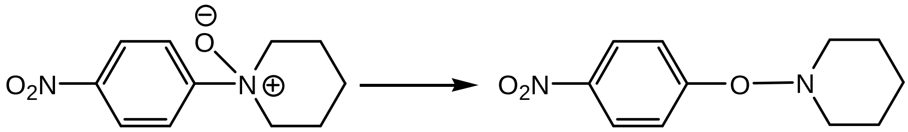
(a)


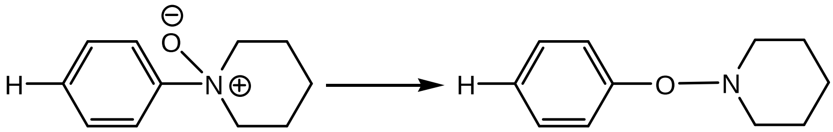
(b)


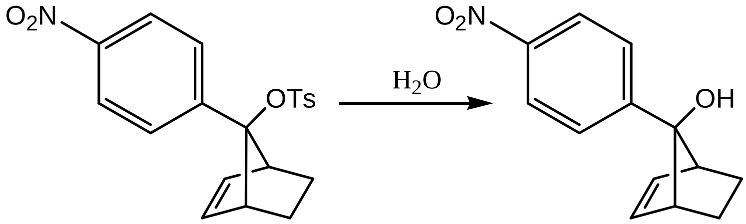
(c)


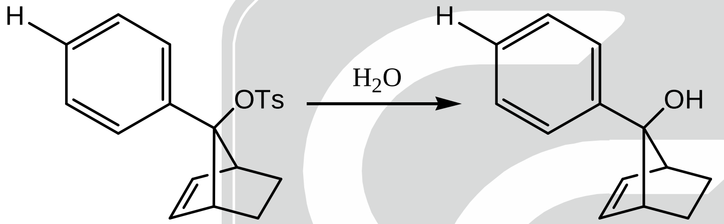
(d)


107. For the four reactions given below, the rates of the reactions will vary as

(1) 

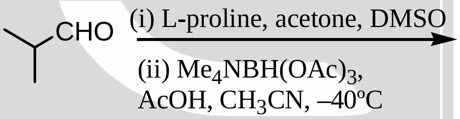
(2) 

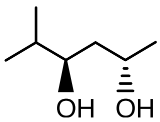
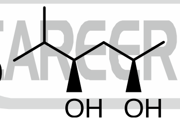
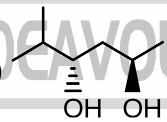
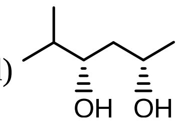
(3) 

(4) 

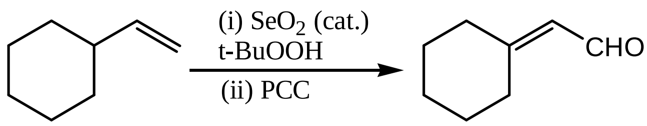
(a) 1 > 2 and 3 > 4 (b) 2 > 1 and 3 > 4 (c) 2 > 1 and 4 > 3 (d) 1 > 2 and 4 > 3

108. The major product formed in the following reaction is



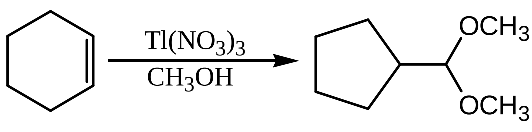
(a)  (b)  (c)  (d) 

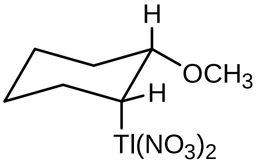
109. The correct sequence of pericyclic reactions involved in the following transformation is

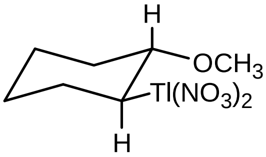


(a) (i) ene reaction, (ii) [2, 3]-sigmatropic shift, (iii) [3, 3]-sigmatropic shift
(b) (i) ene reaction, (ii) [3, 3]-sigmatropic shift, (iii) [1, 3]-sigmatropic shift
(c) (i) [2, 3]-sigmatropic shift, (ii) ene reaction, (iii) [1, 3]-sigmatropic shift,
(d) (i) [1, 3]-sigmatropic shift, (ii) [2, 3]-sigmatropic shift, (iii) [3, 3]-sigmatropic shift

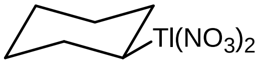
110. The intermediate that leads to the product in the following transformation is

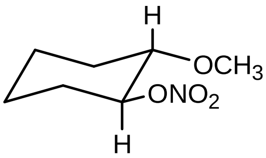


(a) 

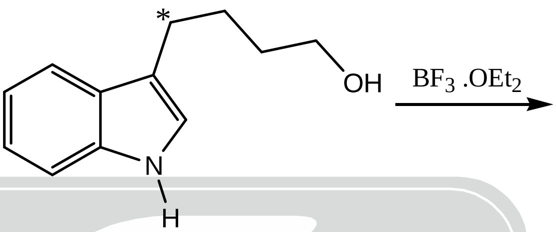
(b) 

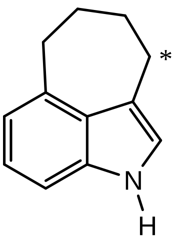
(c)

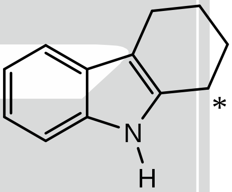
(c) 

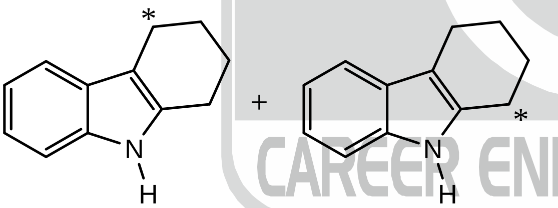
(d) 

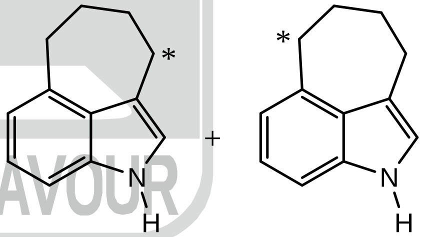
111. Product(s) of the following reaction is (are) [*-indicates isotopically labelled carbon]



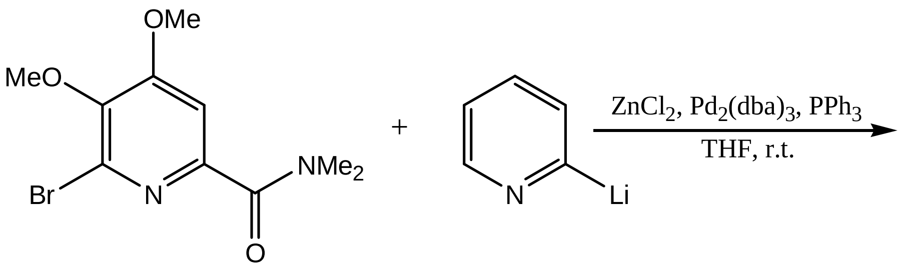
(a) 

(b) 

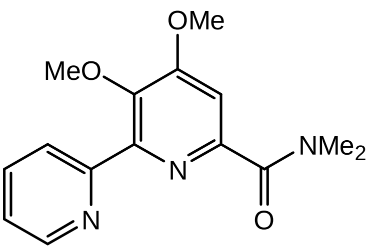
(c) 

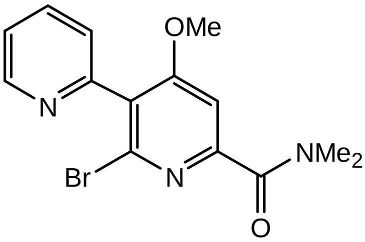
(d) 

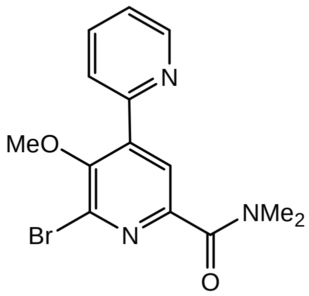
112. The major product formed in the following reaction is

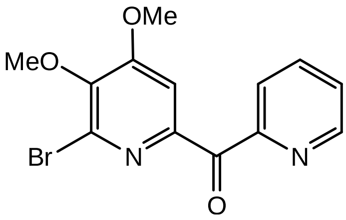


(dba = dibenzylidene acetone)

(a) 

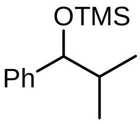
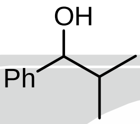
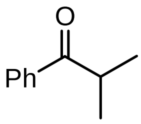
(b) 

(c) 

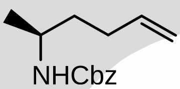
(d) 

113. The major product formed in the following reaction is

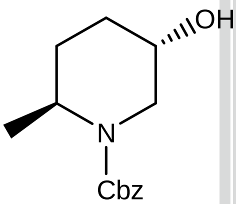
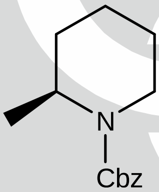
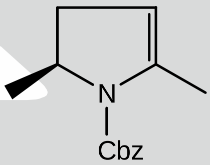
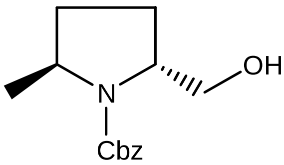
PhCHO → 1. TMSCN, ZnI_2 (cat.); 2.(i) LDA, THF, –78ºC to r.t. (ii) i-Pr-I; 3. (i) H^+, H_2O (ii) aq. NaOH

(a) 
(b) 
(c) 
(d) 

114. The major product formed in the following reaction is

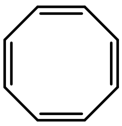


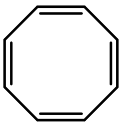
→ (i) $Hg(OAc)_2$ (ii) NaBr (iii) O_2, $NaBH_4$

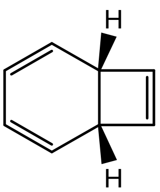
(a) 
(b) 
(c) 
(d) 

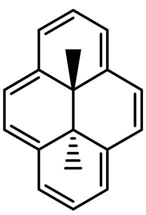
115. Correct match for the products of the reactions in Column-A with the properties in Column-B is

Column-A **Column-B**

(i)  + 2K → (P) aromatic

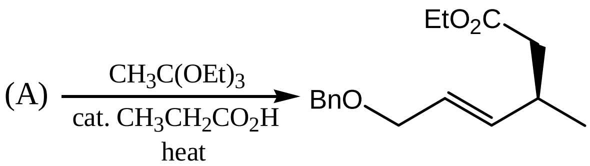
(ii)  + H_2SO_4 → (Q) antiaromatic

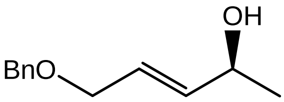
(iii)  —heat→ (R) non-aromatic

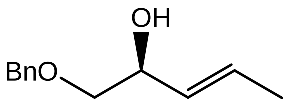
(iv)  + 2K —heat→ (S) homoaromatic

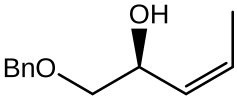
(a) (i)-P, (ii)-S, (iii)-R, (iv)-Q
(b) (i)-P, (ii)-R, (iii)-Q, (iv)-S
(c) (i)-Q, (ii)-R, (iii)-S, (iv)-P
(d) (i)-S, (ii)-Q, (iii)-R, (iv)-P

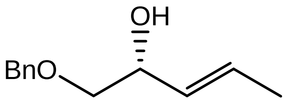
116. The correct starting compound A in the following reaction is



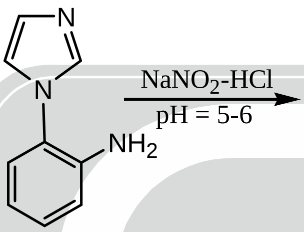
(a) 

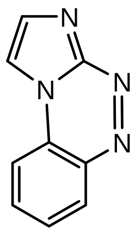
(b) 

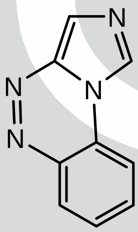
(c) 

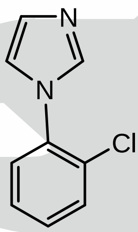
(d) 

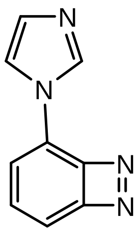
117. The major product formed in the following reaction is



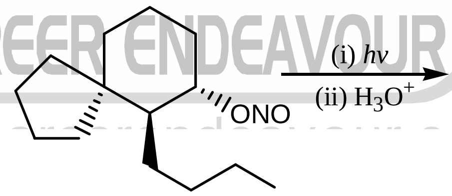
(a) 

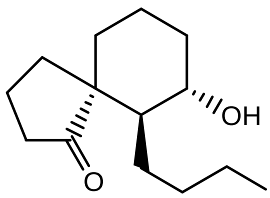
(b) 

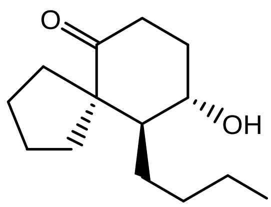
(c) 

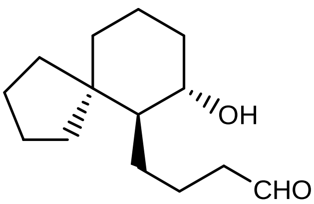
(d) 

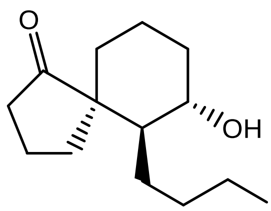
118. The major product formed in the following reaction is



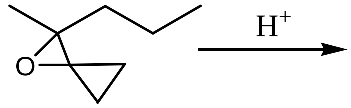
(a) 

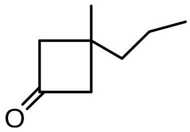
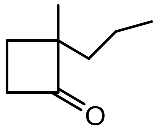
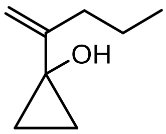
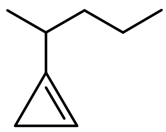
(b) 

(c) 

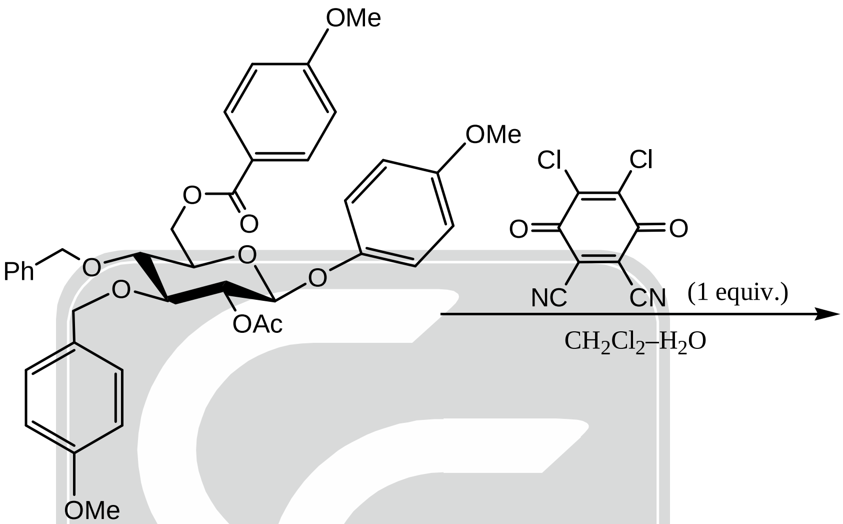
(d) 

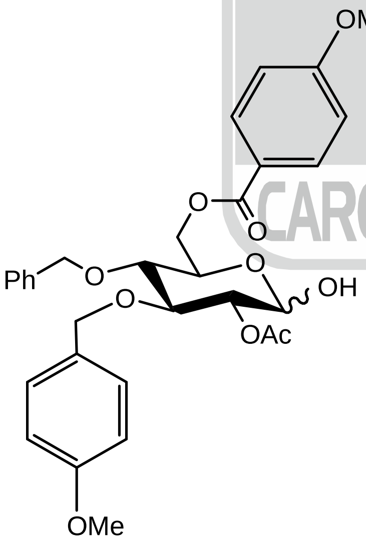
119. The major product formed in the following reaction is

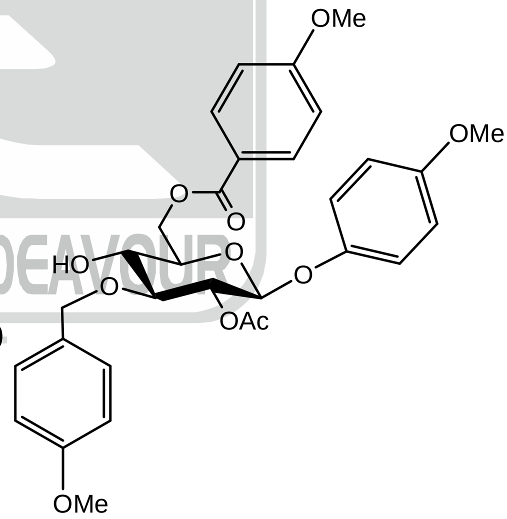


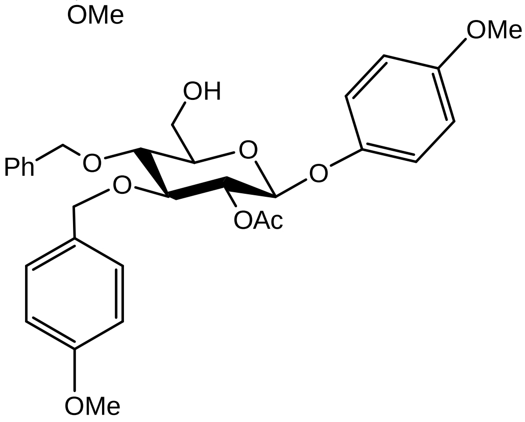
(a)  (b)  (c)  (d) 

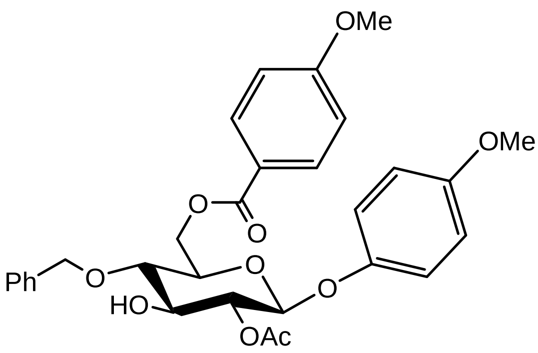
120. The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

121. A constant of motion of hydrogen atom in the presence of spin-orbit coupling is
(a) ℓ (b) s (c) $\ell + s$ (d) $\ell - s$

122. The orbital degeneracy of the level of a one-electron atomic system with Z = 5 and energy $\approx$ –13.6 eV, is
(a) 1 (b) 5 (c) 25 (d) 36

123. If we write a normalized wavefunction $\psi = \hat{A}\phi$, then ϕ is also normalized when
(a) $\hat{A}$ is hermitian (b) $\hat{A}$ is anti-hermitian
(c) $\hat{A}$ is unitary (d) $\hat{A}$ is any linear operator

124. The ground state of a certain system with energy $\in_0$ is subjected to a perturbation V, yielding a first-order correction $\in_1$. If E_0 is the true ground-state energy of the perturbed system, the inequality that always holds is
(a) $\in_1 \geq 0$ (b) $\in_1 \geq E_0$ (c) $\in_0 + \in_1 \leq E_0$ (d) $\in_0 + \in_1 \geq E_0$

125. The spatial part of an excited state $b\,^3\Sigma_u^+$ of hydrogen molecule is proportional to $\left[1\sigma_g(1)1\sigma_u(2) - 1\sigma_g(2)1\sigma_u(1)\right]$. Using LCAO–MO expansion of $1\sigma_g$ and $1\sigma_u$ in terms of 1s-atomic orbitals, one can infer that this wavefunction has
(a) only ionic parts (b) only covalent parts
(c) both ionic and covalent parts (d) neither ionic nor covalent parts

126. The highest molecular orbitals for an excited electronic configuration of the oxygen molecule are $\left[1\pi_g\right]^1\left[3\sigma_u\right]^1$. A possible molecular term symbol for oxygen with this electronic configuration is
(a) $^1\pi$ (b) $^3\Sigma$ (c) $^1\Delta$ (d) $^1\Sigma$

127. For H_2O molecule, the electronic transition from the ground state to an excited state of B_1 symmetry is

C_{2v}	E	C_2	σ_v	σ'_v	
A_1	1	1	1	1	z, z^2, x^2, y^2
A_2	1	1	−1	−1	xy
B_1	1	−1	1	−1	x, xz
B_2	1	−1	−1	1	y, yz

(a) not allowed (b) allowed with x polarisation
(c) allowed with y polarisation (d) allowed with z polarisation

128. The pair of symmetry points groups that are associated with only polar molecules is
(a) $C_{2v}, D_{\infty h}$ (b) C_{3v}, C_{2h} (c) D_{2h}, T_d (d) $C_{2v}, C_{\infty v}$

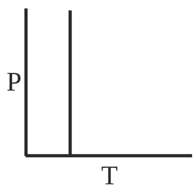
129. The rotational constant and the fundamental vibrational frequency of HBr are, respectively, 10 cm^{-1} and 2000 cm^{-1}. The corresponding values for DBr approximately are
(a) 20 cm^{-1} and 2000 cm^{-1} (b) 10 cm^{-1} and 1410 cm^{-1}
(c) 5 cm^{-1} and 2000 cm^{-1} (d) 5 cm^{-1} and 1410 cm^{-1}

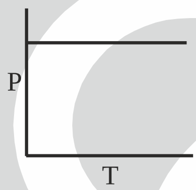
130. Among the following, both microwave and rotational Raman active molecule is
(a) CH_4 (b) N_2O (c) C_2H_4 (d) CO_2

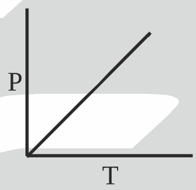
131. In a 200 MHz NMR spectrometer, a molecule shows two doublets separated by 2 ppm. The observed coupling constant is 10 Hz. The separation between these two signals and the coupling constant in a 600 MHz spectrometer will be, respectively
(a) 600 Hz and 30 Hz (b) 1200 Hz and 30 Hz
(c) 600 Hz and 10 Hz (d) 1200 Hz and 10 Hz

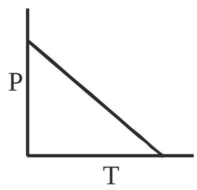
132. The equation of state for one mole of a gas is given by $P(V-b)=RT$, where b and R are constants.
The value of $\left(\frac{\partial H}{\partial P}\right)_T$ is
(a) $V-b$ (b) b (c) 0 (d) $\frac{RT}{P}+b$

133. The volume change in a phase transition is zero. From this, we may infer that the phase boundary is represented by

(a)


(b)


(c)


(d)


134. The partial derivative $\left(\frac{\partial T}{\partial V}\right)_P$ is equal to
(a) $-\left(\frac{\partial P}{\partial S}\right)_T$ (b) $-\left(\frac{\partial P}{\partial S}\right)_V$ (c) $-\left(\frac{\partial P}{\partial S}\right)_n$ (d) $-\left(\frac{\partial P}{\partial S}\right)_H$

135. If the energies of a bare proton aligned along and against an external static magnetic field (B_z) are $-\frac{\hbar\gamma B_z}{2}$ and $+\frac{\hbar\gamma B_z}{2}$, respectively, then the ratio of probabilities of finding the proton along and against the magnetic field is
(a) $e^{-\hbar\gamma B_z/4k_BT}$ (b) $e^{-\hbar\gamma B_z/2k_BT}$ (c) $e^{\hbar\gamma B_z/2k_BT}$ (d) $e^{\hbar\gamma B_z/k_BT}$

136. Partition function of a one-dimensional oscillator having equispaced energy levels with energy spacing equal to k_BT and zero ground state energy is
(a) e (b) $\frac{1}{(e-1)}$ (c) $\frac{e}{(e-1)}$ (d) $\frac{1}{(e+1)}$

137. A reaction goes through the following elementary steps

$$A+B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2C \qquad \text{(fast)}$$

$$A+C \xrightarrow{k_2} D \qquad \text{(slow)}$$

Assuming that steady approximation can be applied to C, on doubling the concentration of A, the rate of production of D will increase by (assuming $k_2[A] << k_{-1}[C]$)
(a) 2 times (b) 4 times (c) 8 times (d) $2\sqrt{2}$ times

138. The rate of an acid-catalyzed reaction in aqueous solution follows rate equation

$$r = k\left[X^+\right]\left[Y^{2-}\right]\left[H^+\right]$$

If k_{16} and k_4 are rate constants for the reaction at ionic strength of 16 $molL^{-1}$ and 4 $molL^{-1}$, respectively, $\ln\dfrac{k_4}{k_{16}}$, in terms of Debye-Hückel constant (B = 0.51), is

(a) 4B (b) 8B (c) 10B (d) 12B

139. For two reactions,

$$X(g)+Y(g)\longrightarrow Z(g) \qquad (1)$$

$$M(g)+N(g)\longrightarrow P(g) \qquad (2)$$

According to the collision theory, the ratio of squares of pre-exponential factors of reactions 2 (A_2) and 1(A_1) at the same temperature, $\left(\dfrac{A_2}{A_1}\right)^2$, is

Species	Mass (g/mol)	Diameter (nm)
X	5	0.3
Y	20	0.5
M	10	0.4
N	10	0.4

(a) 4/5 (b) 5/5 (c) 5/3 (d) 3/5

140. If the specific conductances of a sparingly soluble (1 : 1) salt (MW = 200 g mol^{-1}) in its saturated aqueous solution at 25ºC and that of water are 1.5×10^{-3} ohm^{-1} dm^{-1} and 1.5×10^{-5} ohm^{-1} dm^{-1}, respectively, and the ionic conductances for its cation and anion at infinite dilution are 0.485 and 1.0 ohm^{-1} dm^2 mol^{-1}, respectively, the solubility (in g L^{-1}) of the salt in water at 25º C is

(a) 1×10^{-6} (b) 1×10^{-3} (c) 2×10^{-1} (d) 2×10^{-4}

141. Given,

(i) $Zn + 4NH_3 \longrightarrow Zn(NH_3)_4^{2+} + 2e, \quad E^0 = 1.03$ V

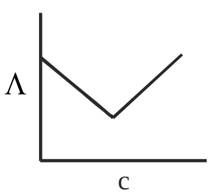
(ii) $Zn \longrightarrow Zn^{2+} + 2e, \quad E^0 = 0.763$V

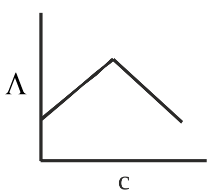
The formation constant of the complex $Zn(NH_3)_4^{2+}$ is approximately

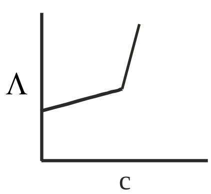
$$\left(\frac{2.303RT}{F} = 0.0591\right)$$

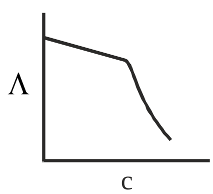
(a) 1×10^5 (b) 1×10^7 (c) 1×10^9 (d) 1×10^{12}

142. The molar conductivity (Λ) vs. concentration (c) plot of sodium dodecylsulfate in water is expected to look like

(a) 

(b) 

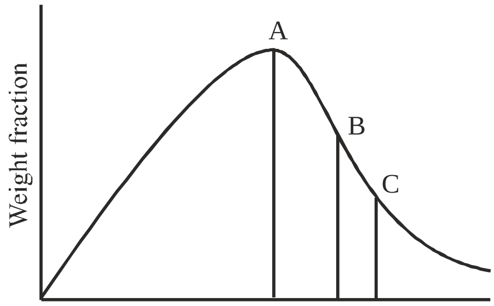
(c) 

(d) 

143. The $\sin^2\theta$ values obtained from X-ray powder diffraction pattern of a solid are 2x, 4x, 6x, 8x where x is equal to 0.06. The wavelength of X-ray used to obtain this pattern is 1.54Å. The unit cell and the unit cell length, respectively are

(a) BCC, 3.146Å (b) FCC, 3.146Å (c) SCC, 6.281 Å (d) BCC, 1.544Å

144. Distribution of molar masses in a typical polymer sample is shown below



The A, B and C represent

(a) $\bar{M}_w, \bar{M}_v$ and $\bar{M}_n$, respectively (b) $\bar{M}_n, \bar{M}_v$ and $\bar{M}_w$, respectively

(c) $\bar{M}_v, \bar{M}_w$ and $\bar{M}_n$, respectively (d) $\bar{M}_n, \bar{M}_w$ and $\bar{M}_v$, respectively

145. Two bound stationary states, 1 and 2, of a one-electron atom, with $E_2 > E_1$ (E is the total energy) obey the following statement about their kinetic energy (T) and potential energy (V)

(a) $T_2 > T_1; V_2 > V_1$ (b) $T_2 > T_1; V_2 < V_1$

(c) $T_2 < T_1; V_2 > V_1$ (d) $T_2 = T_1; V_2 > V_1$