

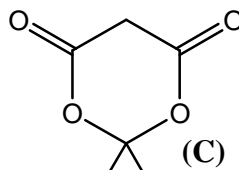
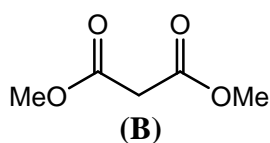
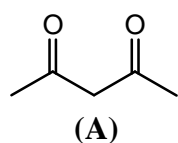
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CHEMICAL SCIENCES

PART-B

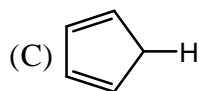
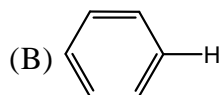
21. The total π -electron density on the four carbon atoms of trans butadiene are in the ratio
 (a) 1 : 1 : 1 : 1 (b) 1 : 2 : 2 : 1 (c) $1 : \sqrt{2} : \sqrt{2} : 1$ (d) 1 : 3 : 3 : 1

22. The pK_a values for the following compounds



- (a) B > C > A (b) A > B > C (c) C > B > A (d) B > A > C
23. The correct order of the electron affinity for one-electron gain of the elements is
 (a) F > Cl > Br (b) P > N > As (c) S > Se > O (d) K > Li > Na
24. The reactive cross section is expected to be the largest for the reaction
 (a) $\text{Li} + \text{Cl}_2 \longrightarrow \text{LiCl} + \text{Cl}$ (b) $\text{Na} + \text{Cl}_2$
 (c) $\text{K} + \text{Cl}_2$ (d) $\text{Rb} + \text{Cl}_2$
25. The correct match for the Bond Dissociation Energies (BDE) of the C–H bonds of compounds in **Column-I**, with the values in **Column-II** is (As an example, the BDE for Me–H is 105.0 kcal/mol)

Column-I



(a) A-III, B-IV, C-I, D-II

(c) A-III, B-I, C-IV, D-II

Column-II (BDE(kcal/mol))

(I) 110.9

(II) 71.1

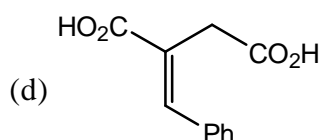
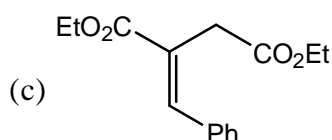
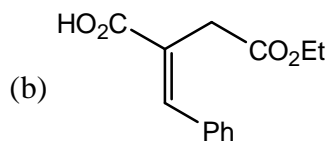
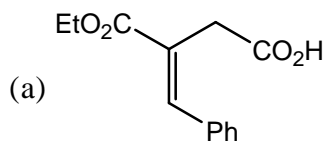
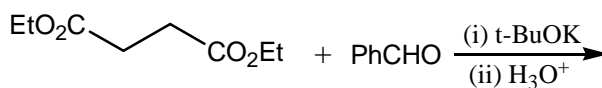
(III) 132.0

(IV) 90.6

(b) A-I, B-III, C-II, D-IV

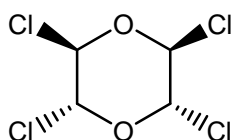
(d) A-IV, B-I, C-II, D-III

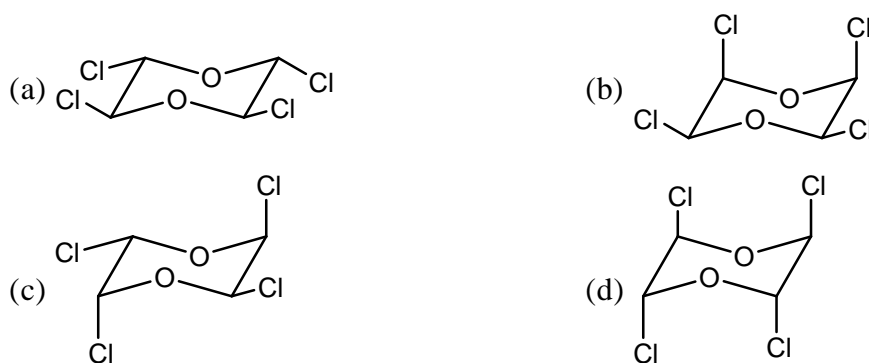
26. The major product formed in the following reaction



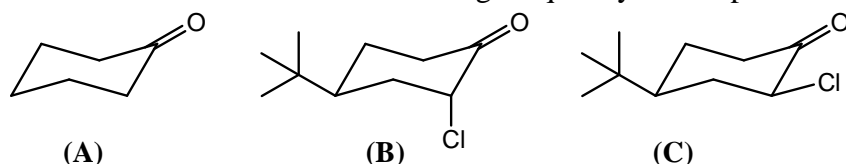


27. Match the items of **Column-I** with the applications given in **Column-II**
- | | |
|----------------------------|------------------------------|
| Column-I | Column-II |
| (A) Zeolite | (I) Solar Cell |
| (B) Indium tin oxide | (II) CO ₂ capture |
| (C) LiCoO ₂ | (III) Fuel cell |
| (D) Pt alloy | (IV) Battery |
| (a) A-III, B-IV, C-I, D-II | (b) A-I, B-III, C-II, D-IV |
| (c) A-II, B-I, C-IV, D-III | (d) A-IV, B-II, C-III, D-I |
28. The volume of nitrogen gas adsorbed at STP to form a monolayer on a porous solid surface is 22.4 cm³ g⁻¹. If the area occupied by one nitrogen gas molecule is 16.2 Å², then the surface area (in cm² g⁻¹) of the solid is close to:
- (a) 1.2×10⁷ (b) 9.8×10⁵ (c) 1.2×10⁵ (d) 9.8×10⁸
29. The total number of lone pairs of electrons on all the atoms in cyanogen azide and thiocyanogen respectively, are
- (a) 4 and 6 (b) 6 and 6 (c) 3 and 4 (d) 4 and 4
30. Among the following which set of molecular/ionic species all have a planar structure?
- (a) BrF₃, FClO₂ and [XeF₅]⁻ (b) XeO₃, [ClF₄]⁻ and FClO₂
- (c) [ClF₄]⁻, BrF₃ and [XeF₅]⁻ (d) FClO₂, [XeF₅]⁻ and XeO₃
31. The number of micro states corresponding to the atomic term symbol ⁴F is
- (a) 7 (b) 12 (c) 28 (d) 42
32. The penetrating power (R) and ionizing power (I) of α, β and γ rays follow the ordering
- (a) R_β > R_γ > R_α and I_β > I_γ > I_α (b) R_γ > R_β > R_α and I_β > I_γ > I_α
- (c) R_β > R_α > R_γ and I_α > I_β > I_γ (d) R_γ > R_β > R_α and I_α > I_β > I_γ
33. The ozonolysis of a hydrocarbon in the presence of water produced pentanoic acid and carbonic acid. The hydrocarbon is
- (a) 1-hexene (b) 1-hexyne (c) 5-decene (d) 5-decyne
34. Of the following statements regarding dissociative substitution in an octahedral transition metal complex,
- (A) High steric hindrance between ligands in the metal complex favors fast dissociation of ligand.
- (B) Increased charge on the metal atom/ion of the complex favours the acceptance of electron pair of the entering ligands.
- (C) A pentacoordinated intermediate is observed.
- (D) Nature of the entering ligand significantly influences the reaction.
- Which are correct?
- (a) A and D (b) A and C (c) A, C and D (d) A, B, C and D
35. The structure that corresponds to the most stable conformation of the following compound is



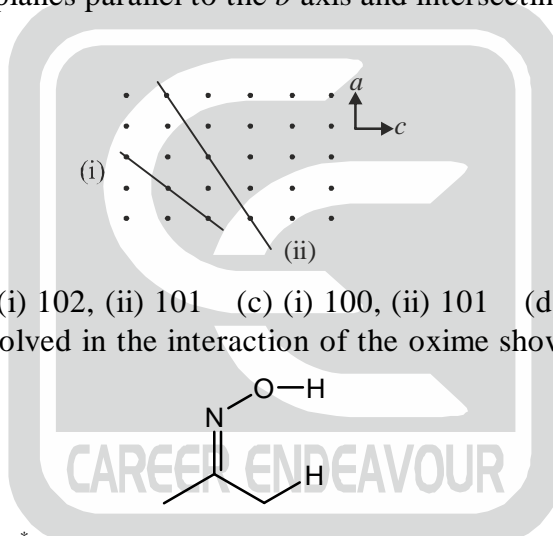


36. The correct order of C=O stretching frequency in IR spectrum for the following compounds is



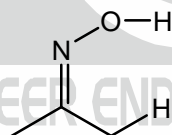
(a) $A > C > B$ (b) $B > C > A$ (c) $C > B > A$ (d) $B > A > C$

37. The Miller indices of the planes parallel to the b axis and intersecting the a and c axis, as shown in the figure, are



(a) (i) 101, (ii) 102 (b) (i) 102, (ii) 101 (c) (i) 100, (ii) 101 (d) (i) 100, (ii) 102

38. The molecular orbital involved in the interaction of the oxime shown below, with a base is



(a) σ^* of O-H (b) σ^* of C-H (c) σ of O-H (d) σ of C-H

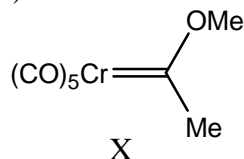
39. The commutator, $[\hat{x}, \hat{p}_x^2]$ is equivalent to

(a) $-2i\hbar\hat{p}_x$ (b) $2i\hbar\hat{p}_x$ (c) $-i\hbar\hat{p}_x$ (d) $i\hbar\hat{p}_x$

40. The effective magnetic moment (in BM) for a lanthanide f^{10} ion is approximately

(a) 10.6 (b) 9.92 (c) 9.59 (d) 7.94

41. Consider the following statement(s) in the context of organometallic complex (X):



(A) The carbene ligand donates two electrons to the metal and accepts d electrons to make a π -bond

(B) The C (carbene) is nucleophilic

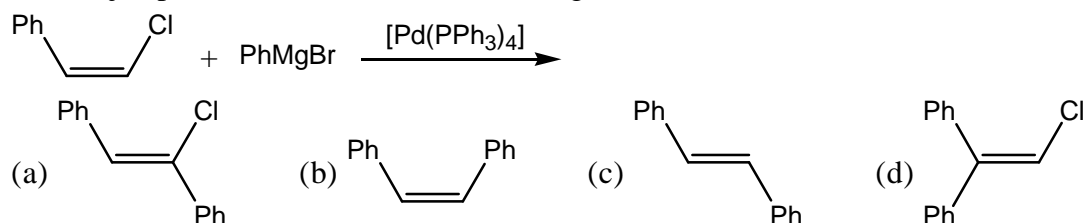
(C) Rotation around the Cr=C(OMe)Me double bond has low barrier (<10 kcal/mol)

Correct statement(s) is/are:

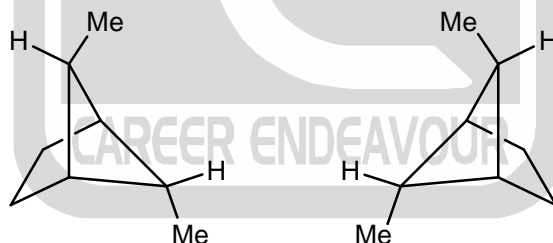
(a) A and B (b) A only (c) A and C (d) B and C



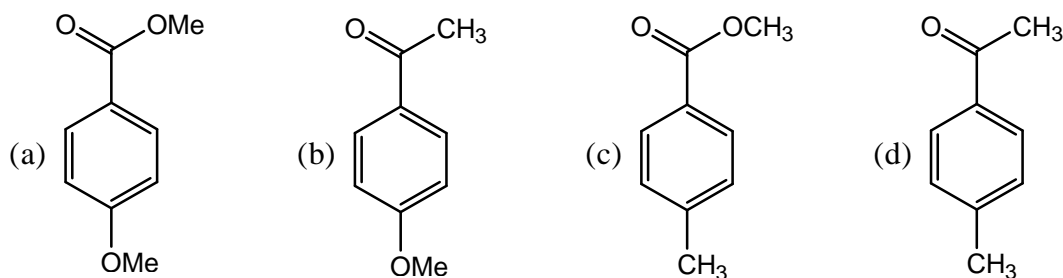
42. The major product formed in the following reaction



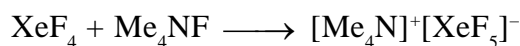
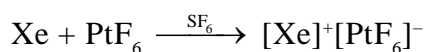
43. The rate of decomposition of a gas is 10 mM s^{-1} when 10% is reacted and it is 5 mM s^{-1} when 40% is reacted. The order of the reaction is
 (a) 2 (b) 1.71 (c) 0 (d) 2.15
44. The hypothetical NMR spectrum of ^1H in $^1\text{H}-\text{C}-^2\text{H}$ would consist of (spin of the ^2H is 1) a
 (a) Singlet (b) Doublet of 1:1 ratio
 (c) Triplet of 1:1:1 ratio (d) Triplet of 1:2:1 ratio
45. For a person weighing 70 kg the minimal volume (in mL) of a fatal dose of a compound with $\text{LD}_{50} = 80 \text{ mg.kg}^{-1}$, and density = 1.45 g.mL^{-1} is
 (a) 5.6 (b) 3.9 (c) 0.8 (d) 0.4
46. Consider an octahedral complex $\text{Ma}_2\text{b}_2\text{cd}$, where a , b , c and d are monodentate ligands. The number of enantiomeric pairs for the complex is
 (a) one (b) two (c) three (d) four
47. When three of the phases of a two component system are simultaneously in equilibrium the number of degrees of freedom is
 (a) 0 (b) 1 (c) 2 (d) 3
48. The amount of $\text{Ba}(\text{NO}_3)_2$ (molecular weight 261.32 amu) required to be added to 500g of a 0.11 mol kg^{-1} solution of KNO_3 in order to raise its ionic strength to 1.00 is approximately:
 (a) 38.8 g (b) 19.4 g (c) 76.2 g (d) 126.5 g
49. The **correct** relationship between the following structures is that they are



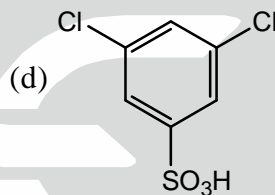
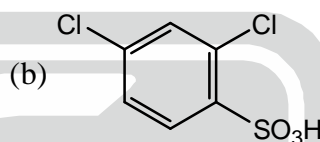
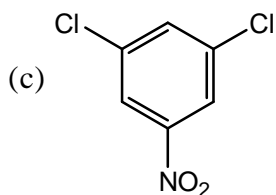
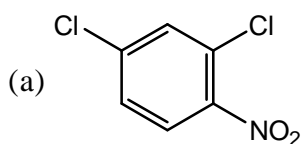
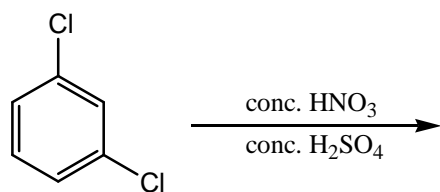
- (a) identical (b) enantiomers (c) diastereomers (d) constitutional isomers
50. For a micro-canonical system, the correct probability distribution function for energy is given by
 (a) Exponential distribution function (b) Gaussian distribution function
 (c) Poisson distribution function (d) Uniform distribution function
51. Which of the following compound has the ^1H NMR Spectrum ^1H NMR: δ 2.4 (s, 3H), 3.9 (s, 3H), 7.25 (d, $J = 7\text{Hz}$, 2H), 7.95(d, $J = 7\text{Hz}$, 2H) ppm.



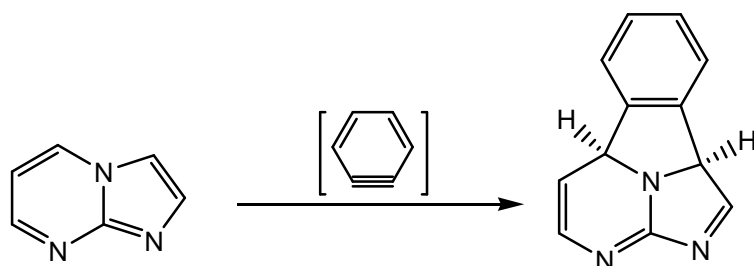
52. Identify the correct statement for the two reactions given below



- (a) Xe and XeF_4 both act as acids
 (b) Xe and XeF_4 both act as bases
 (c) Xe acts as an acid and XeF_4 acts as a base
 (d) Xe acts as an base and XeF_4 acts as a acid
53. When yellow phosphorous is converted to red phosphorous, the entropy and volume of the system do not change. The order of this phase transition is most likely to be
 (a) 3 (b) 2 (c) 1 (d) 0
54. The major product formed in the following reaction is



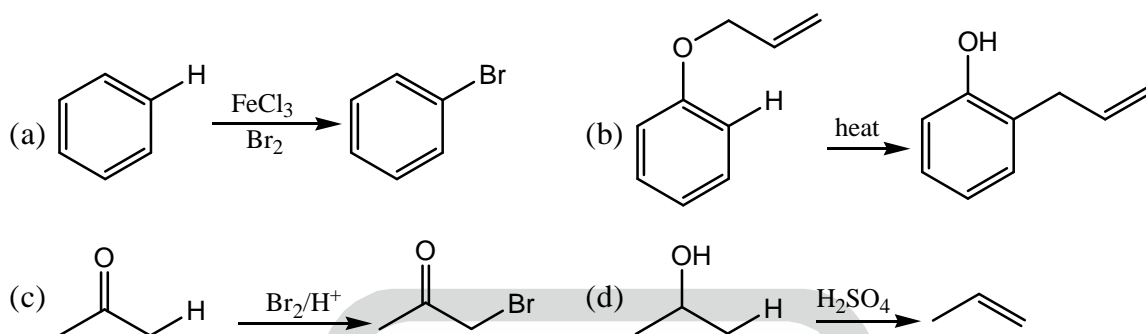
55. Consider following statement(s) in the context of NO and CO ligands
 (A) In the bent mode, NO donates three electrons to the metal center
 (B) In IR spectrum, the ν_{NO} for the bent nitrosyl ligand typically lies between 1525 and 1690 cm^{-1}
 (C) The HOMO of NO and CO are π^* and σ orbitals, respectively.
 (a) A only (b) B and C (c) A and C (d) A and B
56. The combination of two reflections, σ'_v, σ''_v , about an intersecting mirror plane is equivalent to
 (a) S_n (b) C_n (c) σ_h (d) i
57. For $[\text{Hg}_2]^{2+}$, the bond order and the orbitals involved in bonding are respectively
 (a) one; s and s (b) two; s and p (c) one; p and p (d) three; s and d
58. The following transformation



is an example of



- (a) $[3n + 2n]$ cycloaddition (b) $[6n + 2n]$ cycloaddition
 (c) $[8n + 2n]$ cycloaddition (d) $[8n + 4n]$ cycloaddition
59. For the ligand-to-metal charge-transfer (LMCT) transitions in the oxo-anions given below, the wavelength of the transitions are in the order
- (a) $\text{VO}_4^{3-} < \text{CrO}_4^{2-} < \text{MnO}_4^-$ and $\text{WO}_4^{2-} < \text{MoO}_4^{2-} < \text{CrO}_4^{2-}$
 (b) $\text{VO}_4^{3-} < \text{CrO}_4^{2-} < \text{MnO}_4^-$ and $\text{WO}_4^{2-} > \text{MoO}_4^{2-} > \text{CrO}_4^{2-}$
 (c) $\text{VO}_4^{3-} > \text{CrO}_4^{2-} > \text{MnO}_4^-$ and $\text{WO}_4^{2-} < \text{MoO}_4^{2-} < \text{CrO}_4^{2-}$
 (d) $\text{VO}_4^{3-} > \text{CrO}_4^{2-} > \text{MnO}_4^-$ and $\text{WO}_4^{2-} > \text{MoO}_4^{2-} > \text{CrO}_4^{2-}$
60. The reaction that is expected to show a primary kinetic isotope effect for the indicated H-atom (C-H) is



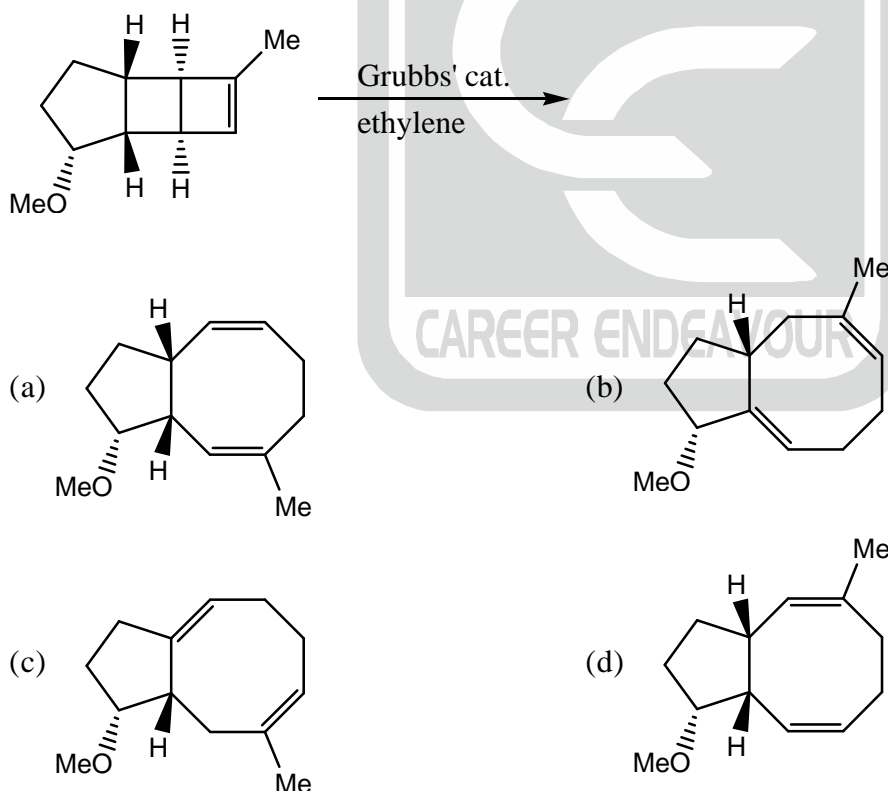
PART - C

61. The structure of the reactive intermediate generated by reaction of CHCl_3 and KOH is
- (a)
- (b)
- (c)
- (d)
62. The rate constant for the reaction, $\text{A}_2\text{B}_4\text{O} \rightarrow \text{AB}_4 + \text{AO}$, is described as, $\log k = 14.1 - \frac{10000K}{T}$. The activation energy for this reaction (in kJ mol^{-1}) is closest to
- (a) 191.4 (b) 83.14 (c) 382.8 (d) 166.28
63. The correct sequence of mechanistic steps involved in the formation of product in the following reaction is
-
- (a) Prins cyclization, formation of oxonium ion, pinacol rearrangement
 (b) Pinacol rearrangement, Prins cyclization and formation of oxonium ion
 (c) Formation of oxonium ion, Prins cyclization and pinacol rearrangement
 (d) Pinacol rearrangement, formation of oxonium ion and Prins cyclization
64. The following data is obtained for a light diatomic (AB) molecule from its rotational Raman spectrum. $B = 2\text{cm}^{-1}$; $x_e = 0.01$; $\bar{\nu}_e = 1600\text{cm}^{-1}$. If the molecule is irradiated by a laser of $20,000\text{cm}^{-1}$, the expected Stokes lines (in cm^{-1}) for this molecule are
- (a) 18348, 18356, 18368, 18380, 18388 (b) 18412, 18420, 18432, 18444, 18452
 (c) 18380, 18388, 18400, 18412, 18420 (d) 18416, 18424, 18430, 18440, 18452

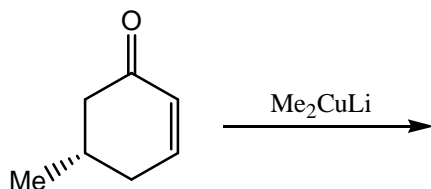


- (b) Soap molecules accumulate more in the bulk of the solution than on the surface
 (c) The soap molecules aggregate uniformly in the bulk and the surface
 (d) Soap molecules form micellar structures at low concentrations
72. For trigonal bipyramidal coordination complex (ML_5) the correct point group symmetry and the relative order of the energies of the 3d orbitals in that crystal field, respectively are
- (a) $D_{3h}; d_{x^2-y^2} > d_{z^2}, d_{xy} > d_{xz}, d_{yz}$ (b) $D_{3d}; d_{z^2} > d_{x^2-y^2}, d_{xz} > d_{xy}, d_{yz}$
 (c) $D_{3d}; d_{x^2-y^2} > d_{z^2} > d_{xy} > d_{xz}, d_{yz}$ (d) $D_{3h}; d_{z^2} > d_{x^2-y^2}, d_{xy} > d_{xz}, d_{yz}$
73. Consider the following statements for the self-exchange electron transfer reaction in $[Cr(H_2O)_6]^{2+/3+}$
- A) σ^* orbitals are only involved in electron transfer
 B) It involves large inner-sphere reorganization energy
 C) It involves no change in M-L bond lengths
 D) Rate of self-exchange electron transfer is fast
- The correct statements are
- (a) A, B and D (b) A and B (c) A and C (d) B and D
74. The major product formed in the following reaction is
-
- (a)
- (b)
- (c)
- (d)
75. Which of the statements (A-D) given below are correct for B_2H_6 molecule:
- A) Addition of $Et_2O \cdot BF_3$ to $NaBH_4$ in a polyether solvent produces B_2H_6
 B) It has D_{2d} symmetry
 C) Reaction of B_2H_6 with NMe_3 gives $Me_3N \cdot BH_3$
 D) It is diamagnetic
- (a) A, B and C (b) A, C and D (c) A and B only (d) B and D only
76. For the cell $Cd | CdCl_2 || AgCl | Ag$; $E_{cell}^0 = 0.675 V$ and $dE_{cell}^0/dT = -6.5 \times 10^{-4} VK^{-1}$ at $27^\circ C$. The ΔH ($kJ mol^{-1}$) value for the reaction $Cd + 2AgCl \rightarrow 2Ag + CdCl_2$ is closest to:
- (a) -168 (b) -123 (c) -95 (d) -234
77. For every atom that is not shifted under C_4 and σ symmetry operations, the characters are, respectively.
- (a) -1, -1 (b) 0, 0 (c) 1, 1 (d) -1, 1
78. In 3-iron ferredoxins, the number of sulfide bridges and cysteinyl ligands, respectively, are:
- (a) 3, 3 (b) 4, 3 (c) 3, 4 (d) 4, 4
79. A sample of polystyrene is composed of three weight fractions: 0.20, 0.50 and 0.30. The molecular weight of these fractions are 10,000, 40,000 and 60,000, respectively. The weight average molecular weight of this sample is
- (a) 40000 (b) 55000 (c) 50000 (d) 60000

80. Consider following statements
 A) PbCl_2 has low solubility in water
 B) Sulfides of As(III) and Sb(III) are soluble in ammonium sulfide
 C) SnS is soluble in yellow ammonium sulfide
 D) MnS is precipitated by passing H_2S through acidic MnCl_2
 Correct statements are
 (a) A, B and C (b) B, C and D (c) A, C and D (d) A and C only
81. The type of molecular orbitals in the allyl ligand ($\text{CH}_2=\text{CH}-\text{CH}_2^-$) that are used for σ -donation and π -back donation with metal d -orbitals, respectively are
 (a) 2π and 3π (b) 1π and 3π (c) 3π and 2π (d) 1π and 2π
82. When a hydrogen atom is exposed to a perturbation $V = E \cdot z$, the first order correction to the wave function comes only from the orbital
 (a) $2s$ (b) $2p_z$ (c) $3p_y$ (d) $3d_{z^2}$
83. The equivalent symmetry operations for S_6^3 and S_3^6 are, respectively
 (a) C_3 and C_2 (b) σ_h and i (c) σ_h and E (d) i and E
84. The quantum number corresponding to the z-component of the total electronic orbital angular momentum in the nitric oxide molecule is
 (a) 0 (b) 1 (c) 2 (d) 3
85. The major product formed in the following reaction is



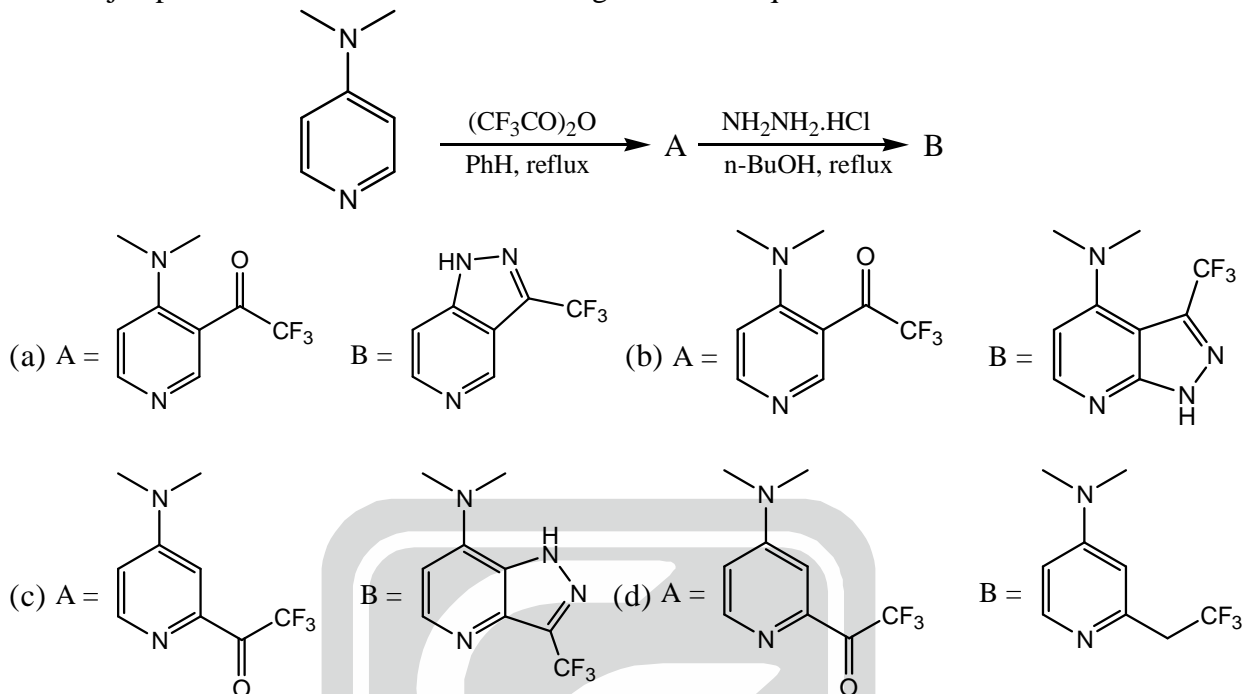
86. The major product formed in the following reaction is



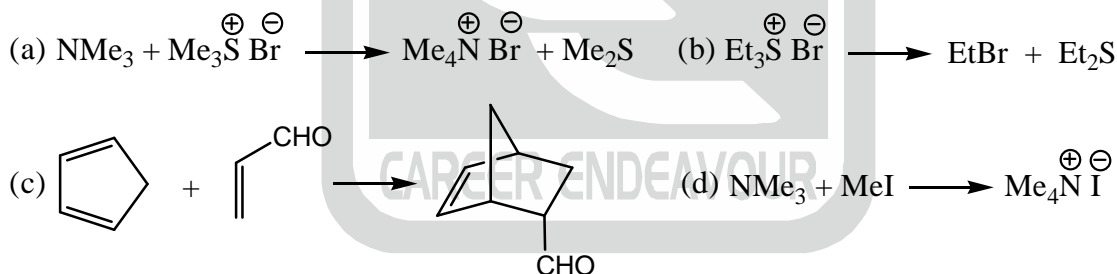


- (a) cis-3,5-dimethylcyclohexanone, which is chiral
 (b) trans-3,5-dimethylcyclohexanone, which is chiral
 (c) cis-3,5-dimethylcyclohexanone, which is achiral
 (d) trans-3,5-dimethylcyclohexanone, which is achiral

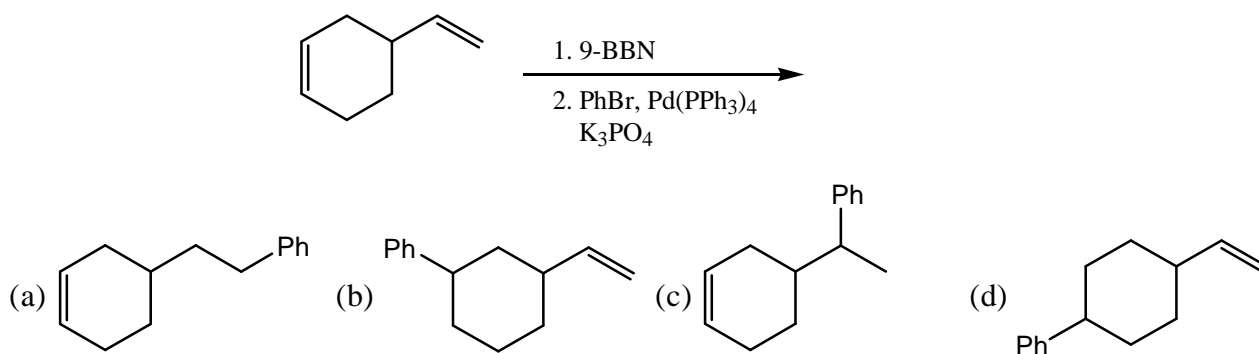
87. The major products A and B in the following reaction sequence are



88. The reaction that will show a large increase in rate when the reaction medium is changed from a non-polar to polar organic solvent is

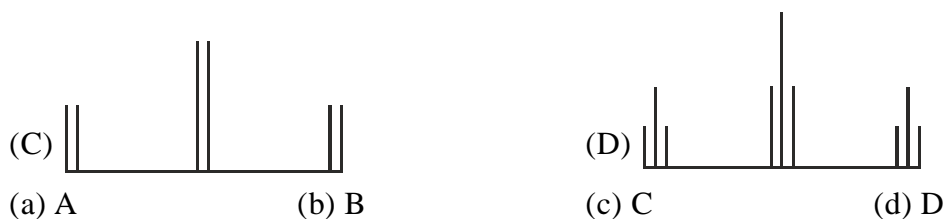


89. The major product formed in the following reaction is

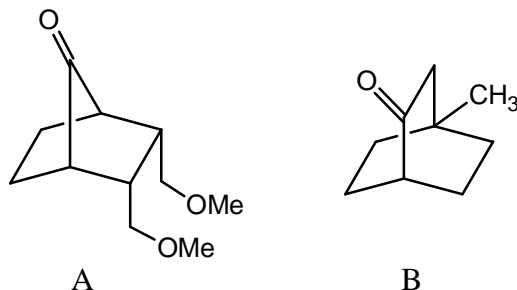


90. Which of the patterns (A, B, C or D) fits best with the ^{13}C NMR spectrum of $\text{TiCl}_3(\text{CDH}_2)$ [Given: $^1J(\text{C-H}) > ^1J(\text{C-D})$]





91. The correct relationship between the two faces of the C=O group in compounds A and B is



- (a) A = diastereotopic; B = enantiotopic (b) A = B = enantiotopic
 (c) A = enantiotopic; B = diastereotopic (d) A = B = diastereotopic

92. The correct statements from the following set (i) to (iv) is

(i) If q is the displacement from equilibrium for harmonic motion, the potential energy is proportional to q .

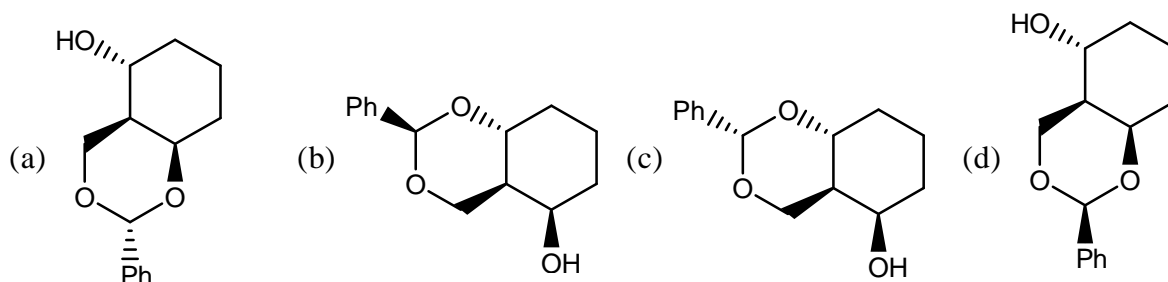
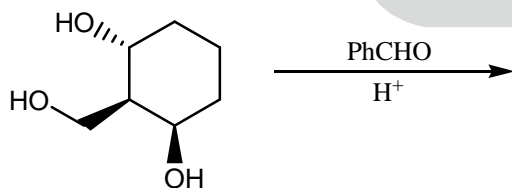
(ii) If the vibrational frequency ($\bar{\nu}$) of HCl is 2990 cm^{-1} , its zero point energy will be 1495 cm^{-1}

(iii) The correct order of vibrational frequency of $\text{O}-^1\text{H}$ (X_1), $\text{O}-^2\text{H}$ (X_2), and $\text{O}-^3\text{H}$ (X_3), is $X_1 > X_2 > X_3$.

(iv) The fundamental vibrational transition of a diatomic molecule appears at 1880 cm^{-1} . Its first overtone will be at 940 cm^{-1} (assuming anharmonicity constant as zero)

- (a) (i), (ii), (iii) only (b) (i), (ii), (iii), (iv)
 (c) (ii), (iii) only (d) (i), (ii), (iv) only

93. The major product formed in the following reaction is

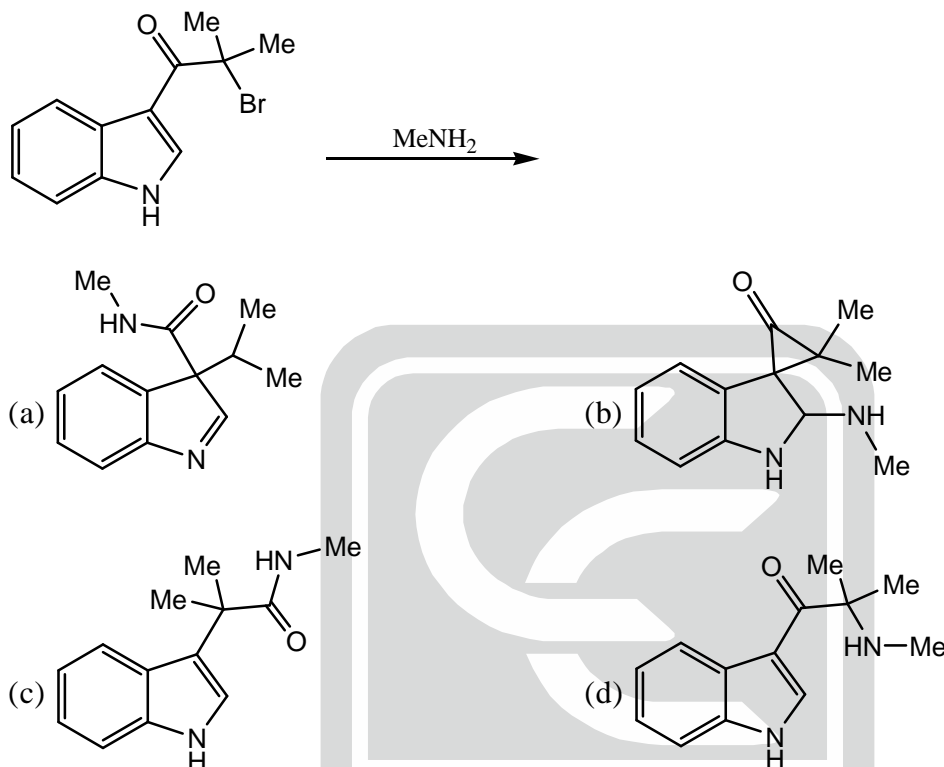


94. The absorption spectrum of $[\text{Cr}(\text{NH}_3)_6]^{3+}$ in water shows two bands around 475 and 365 nm. The ground term and the spin-allowed transitions, respectively, are

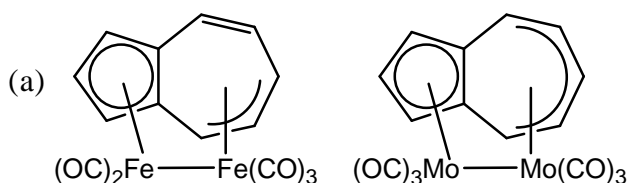
- (a) $^4\text{F}; ^4\text{T}_{1g}(\text{F}) \rightarrow ^4\text{T}_{2g}$ and $^4\text{T}_{1g} \rightarrow ^4\text{A}_{2g}$ (b) $^4\text{F}; ^4\text{A}_{2g} \rightarrow ^4\text{T}_{2g}$ and $^4\text{A}_{2g} \rightarrow ^4\text{T}_{1g}(\text{F})$
 (c) $^2\text{G}; ^2\text{E}_g \rightarrow ^2\text{T}_{1g}$ and $^2\text{E}_g \rightarrow ^2\text{T}_{2g}$ (d) $^2\text{F}; ^2\text{A}_{2g} \rightarrow ^2\text{T}_{2g}$ and $^2\text{A}_{2g} \rightarrow ^2\text{T}_{1g}(\text{F})$

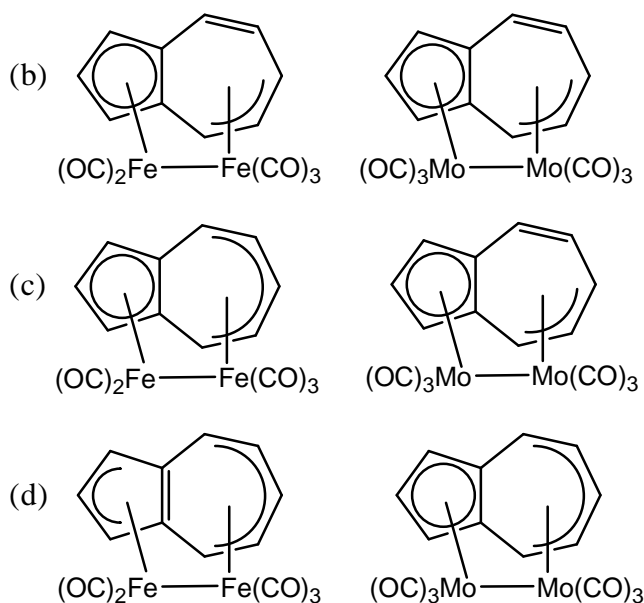


95. In a Langmuir-type adsorption, a solid adsorbs 0.25 mg of a gas when the pressure of the gas is 50 bar and 0.2 mg of the gas at 20 bar pressure. The percentage of surface coverage at 50 bar is close to
 (a) 75 (b) 38 (c) 57 (d) 83
96. Liquid A has half the surface tension and twice the density of liquid B at 30°C. The contact angles of A and B are same. If A rises 10 cm in a capillary then the rise (in cm) of liquid B in the same capillary at the same temperature will be equal to
 (a) 60 (b) 10 (c) 40 (d) 20
97. The major product formed in the following reaction is



98. Which of the following reaction(s) do(es) NOT occur
 (i) $[\text{NPCl}_2]_3 + 6\text{NaF} \xrightarrow[\text{reflux}]{\text{MeCN}} [\text{NPF}_2]_3 + 6\text{NaCl}$
 (ii) $n\text{PCl}_5 + n\text{NH}_4\text{Cl} \xrightarrow[\text{reflux}]{\text{C}_6\text{H}_5\text{Cl}} [\text{NPCl}_2]_n + 4n\text{HCl} [n = 3, 4, 5\dots]$
 (iii) $n\text{PF}_5 + n\text{NH}_4\text{F} \xrightarrow[\text{reflux}]{\text{C}_6\text{H}_5\text{Cl}} [\text{NPF}_2]_n + 4n\text{HF} [n = 3, 4, 5\dots]$
 (a) (i) and (iii) (b) (i) and (ii) (c) (i) only (d) (iii) only
99. The stopping potential for photoelectrons emitted from a surface illuminated by light of frequency 6.0×10^8 MHz is 0.72V. When the incident frequency is changed, the stopping potential is found to be 1.44 V. The new frequency is approximately ($e/h = 2.4 \times 10^{14} \text{ C J}^{-1} \text{ s}^{-1}$)
 (a) 7×10^8 (b) 4×10^8 (c) 2×10^9 (d) 7×10^{14}
100. The set of structures showing the correct hapticity of azulene on the basis of the $18 e^-$ rule, is





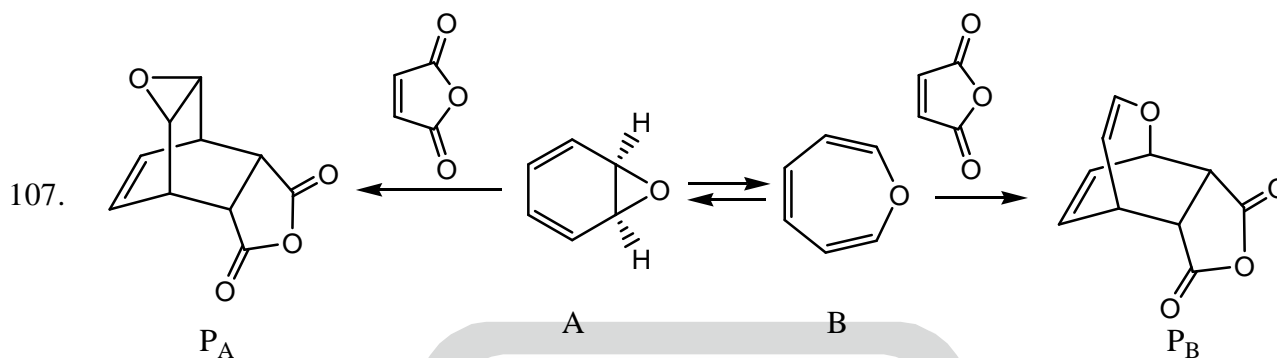
101. A compound shows $[M]^+$ at m/z 84 and has a base peak at 56. It exhibits only one signal in 1H NMR at δ 1.4 ppm and one signal in ^{13}C NMR at δ 35 ppm. The compound is
 (a) cyclobutane-1,3-dione (b) dichloromethane
 (c) cyclohexane (d) 1, 2, 3-trimethylcyclopropane
102. For the reaction,

$$[cis-M(en)_2(OH)_2]^+ \xrightleftharpoons[k_2]{k_1} [trans-M(en)_2(OH)_2]^+$$
 the equilibrium constant is 0.16 and k_1 is $3.3 \times 10^{-4} s^{-1}$. The experiment is started with pure *cis* form. The time taken for half the equilibrium amount of *trans* isomer to be formed is about
 (a) 290 s (b) 580 s (c) 190 s (d) 480 s
103. The number of CO bands for isomers from sets (i) and (ii) in their IR spectra
 Set (i) : Trigonal bipyramidal isomers, axial- $Fe(CO)_4L$ (A) and equatorial- $Fe(CO)_4L$ (B)
 Set (ii) : Octahedral isomers, *fac*- $Mo(CO)_3L_3$ (C) and *mer*- $Mo(CO)_3L_3$ (D)
 (a) A, 4 and B, 3; C, 3 and D, 2 (b) A, 4 and B, 3; C, 2 and D, 3
 (c) A, 3 and B, 4; C, 3 and D, 2 (d) A, 3 and B, 4; C, 2 and D, 3
104. Which of the following statements for rubredoxin
 A) Fe^{2+} center has a tetrahedral geometry
 B) Reduced form of iron is diamagnetic
 C) Fe^{2+} center undergoes Jahn-Teller distortion
 D) It is a $[2Fe-2S]$ cluster
 are correct?
 (a) A, B and C (b) A, C and D (c) C and D only (d) A and C only
105. The ore (X) gives a d-block metal (M) in the elemental form, following a chemical process. Which of the sets X/M/chemical process below is correct?
 (a) Ilmenite / Titanium / $2FeTiO_3 + Mg + O_2 \rightarrow 2TiO_2 + MgO + Fe_2O_3$ followed by reduction of TiO_2 with Mg
 (b) Rutile / Titanium / $TiO_2 + 2C + 2Cl_2 \rightarrow TiCl_4 + 2CO$ followed by reduction of $TiCl_4$ with Na or Mg
 (c) Rutile / Titanium / $TiO_2 + 4HCl(conc.) \rightarrow TiCl_4 + 2H_2O$ followed by electrolytic reduction of $TiCl_4$
 (d) Molybdenite/ Molybdenum $2MoS_2 + 7O_2 \rightarrow 2MoO_3 + 4SO_2$ followed by reduction of MoO_3 with carbon

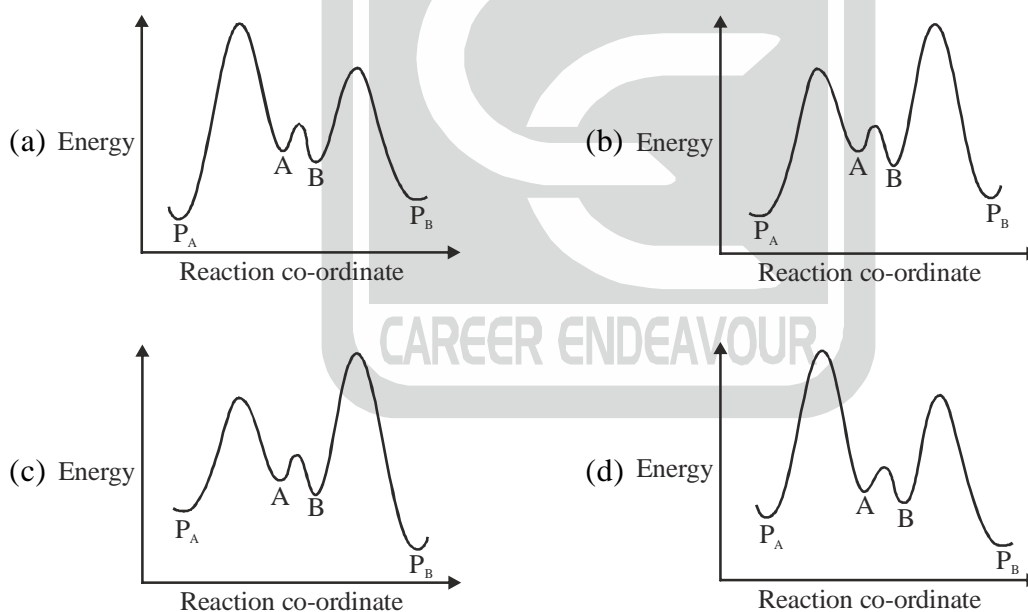
106. Consider the following statements regarding EPR spectra
- A) For allowed transitions, $\Delta M_s = \pm 1$ and $\Delta M_l = 0$
- B) For allowed transitions, $\Delta M_s = 0$ and $\Delta M_l = \pm 1$
- C) Tetragonally elongated Cu(II) complexes have $g_{\parallel} > g_{\perp}$
- D) The orbital considered as ground state for tetragonally compressed Cu(II) complexes is $d_{x^2-y^2}$

The correct statements are

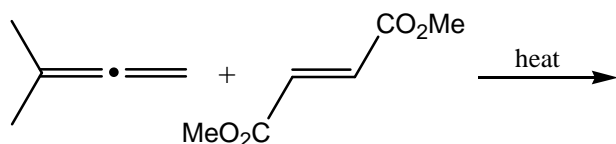
- (a) A, C and D (b) B, C and D (c) A and C only (d) B and D only

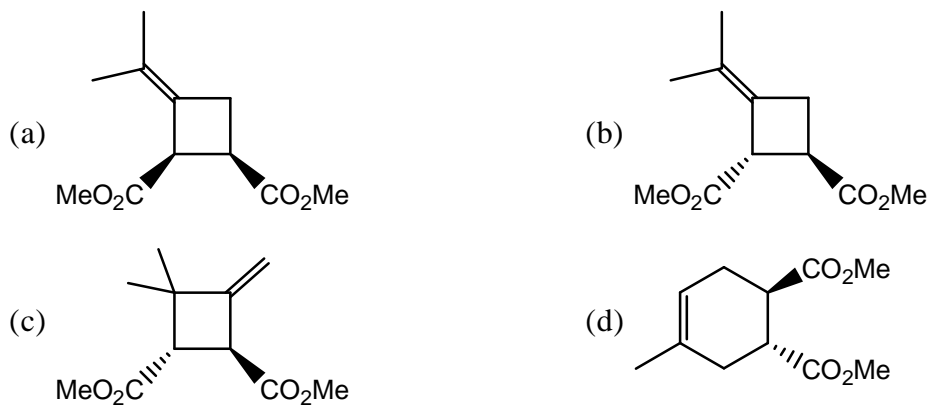


The correct energy profile diagram for the above reaction is

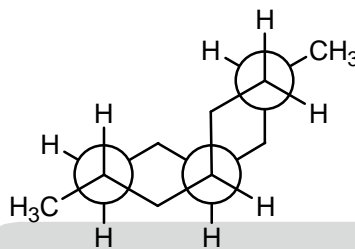


108. Consider an electron ($m_e = 9.1 \times 10^{-31}$ kg) having energy 13.6 eV, confined in an infinite potential well. If the potential energy inside the well is zero, the expectation value for the square of the electron speed, $\langle v^2 \rangle$, is
- (a) $3 \times 10^{12} \text{ m}^2 \text{ s}^{-2}$ (b) $4.3 \times 10^{-18} \text{ m}^2 \text{ s}^{-2}$
- (c) $4.7 \times 10^{12} \text{ m}^2 \text{ s}^{-2}$ (d) $4.7 \times 10^{31} \text{ m}^2 \text{ s}^{-2}$
109. The major product formed in the following reaction is

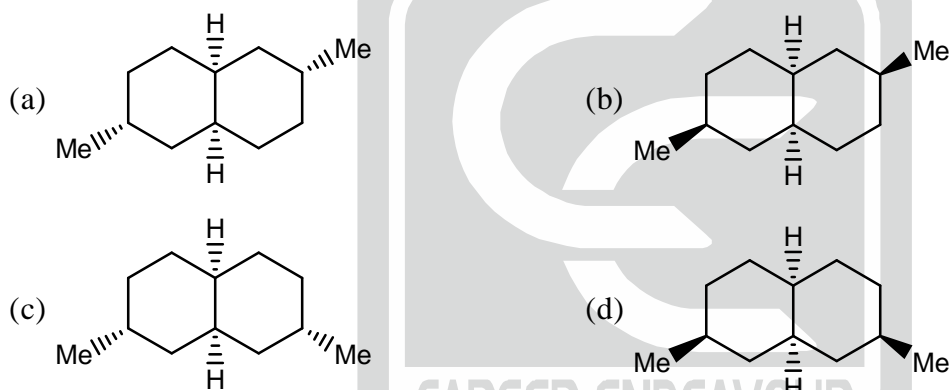




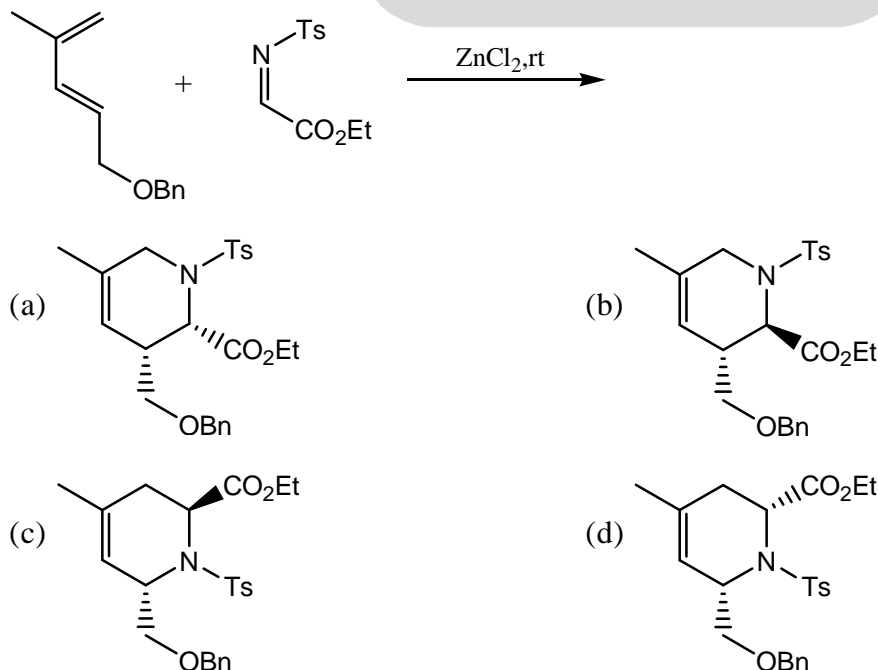
110. The Newman projection given below



corresponds to the compound

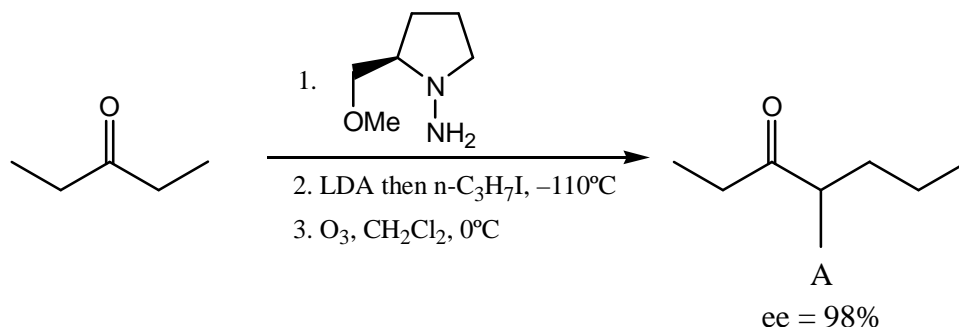


111. The major product formed in the following reaction is

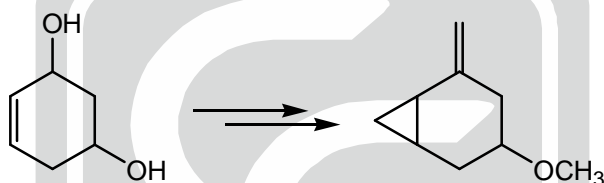




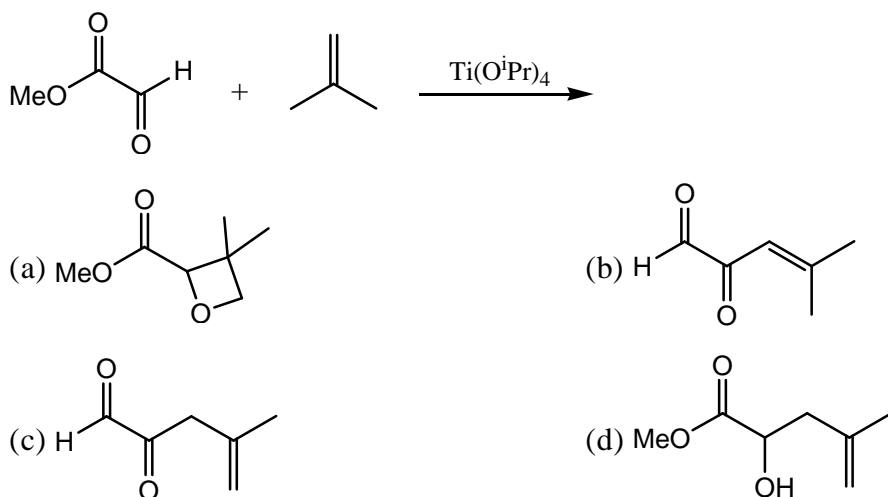
112. The molecule that will not absorb in the microwave region, but will absorb in the infrared is
 (a) N_2 (b) C_2H_2 (c) HCl (d) H_2O
113. Given the specific rotation $[\alpha]_D^{20}$ of (S)-4-methyl-3-heptanone in hexane as $+22^\circ$, the specific rotation $[\alpha]_D^{20}$, in hexane, of the product A ($ee = 98\%$) obtained from the following enantioselective alkylation reaction is



- (a) $+21.56$ (b) $+21.12$ (c) -21.56 (d) -21.12
114. The correct sequence of reagents that will lead to the formation of the given product in the following transformation is



- (a) (i) active MnO_2 ; (ii) MeI, NaH; (iii) $Me_3S(O)I$, NaH; (iv) $MePPh_3Br$, NaH
 (b) (i) MeI, NaH; (ii) active MnO_2 ; (iii) Me_3SI , NaH; (iv) $MePPh_3Br$, NaH
 (c) (i) CH_2I_2 , Zn-Cu; (ii) $MePPh_3Br$, NaH; (iii) active MnO_2 ; (iv) MeI, NaH
 (d) (i) $MePPh_3Br$, NaH; (ii) active MnO_2 ; (iii) CH_2I_2 , Zn-Cu; (iv) MeI, NaH
115. The correct geometries for the metal carbonyl clusters, A-C
 A) $[Ru_6(CO)_{17}B]^-$ B) $[Os_6(CO)_{18}P]^-$ C) $[Os_4(CO)_{16}]$
 (a) A: pentagonal bipyramidal, B : trigonal prismatic, and C : tetrahedral
 (b) A: pentagonal bipyramidal, B : octahedral, and C : square
 (c) A: octahedral, B : trigonal prismatic, and C : tetrahedral
 (d) A: octahedral, B : trigonal prismatic, and C : square
116. The major product formed in the following reaction is



117. Match the following
- | Measurement | Spectroscopic Technique |
|------------------------------------|--|
| A) Binding energy | i) NMR spectroscopy |
| B) Quadrupole splitting | ii) Energy-dispersive X-ray spectroscopy (EDS) |
| C) Contact shift | iii) X-ray photoelectron spectroscopy (XPS) |
| D) Elemental analysis | iv) Mössbauer spectroscopy |
| (a) A-(ii), B-(i), C-(iv), D-(iii) | (b) A-(iii), B-(iv), C-(i), D-(ii) |
| (c) A-(iv), B-(iii), C-(i), D-(ii) | (d) A-(i), B-(iv), C-(ii), D-(iii) |
118. Plutonium (atomic mass = 244 g mol⁻¹) crystallizes in monoclinic lattice ($a = 620$ pm; $b = 480$ pm, $c = 1100$ pm; $\beta = 102^\circ$) with 16 atoms per unit cell. The density in g cm⁻³ will be close to (Use $\sin \beta = 0.98$; $\sin \beta / 2 = 0.78$)
- (a) 25.38 (b) 16.12 (c) 12.69 (d) 20.26
119. For a weak electrolyte such as acetic acid, the relation among conductance (λ), equilibrium constant (K) and concentration (c) can be expressed as: (λ^0 is the conductance at infinite dilution).
- (a) $\frac{1}{\lambda} = \frac{1}{\lambda^0} - \frac{c\lambda}{K\lambda^0}$ (b) $\frac{1}{\lambda} = \frac{1}{\lambda^0} + \frac{c\lambda}{K\lambda^{0^2}}$
- (c) $\frac{1}{\lambda^0} = \frac{1}{\lambda} + \frac{c\lambda}{K\lambda^{0^2}}$ (d) $\frac{1}{\lambda} = \frac{c\lambda}{K\lambda^{0^2}}$
120. Choose the correct statement(s) from the following:
- (i) The trend in Lewis acidity among silicon halides is $\text{SiI}_4 < \text{SiBr}_4 < \text{SiCl}_4 < \text{SiF}_4$
- (ii) Tin(II) chloride can act as a Lewis acid and not as a Lewis base
- (iii) Aluminosilicates can display Bronsted acidity
- (a) (i) and (ii) (b) (i) and (iii)
- (c) (ii) and (iii) (d) (ii) only

