Chemical Sciences
Paper I(PART 'B')

41. Complexes of which of the following metals are used in the treatment of rheumatoid arthritis:

    1. Gold
    2. Ruthenium
    3. Iron
    4. Copper

42. Non-heme iron-sulfur proteins are involved in:

    1. Electron transfer.
    2. Proton transfer.
    3. Both electron and proton transfer
    4. Oxygen transfer.

43. Active catalytic species for hydroformylation is

    1. $RuCl_2(PPh_3)_3$
    2. $HCo(CO)_3$
    3. $RhCl(PPh_3)_3$
    4. K_2PtCl_6

44. The unit of molar absorptivity is:

    1. L mol^{-1} cm^{-1}
    2. L^{-1} mol cm^{-1}
    3. L mol cm^{-1}
    4. L mol cm

45. Gelatin is added during polarographic measurements to:

    1. reduce streaming motion of falling mercury drop
    2. increase I_d
    3. increase $E_{1/2}$
    4. eliminate residual current

46. The element that shows both +3 and +4 oxidation states is:

    1. Cerium
    2. Promethium
    3. Gadolinium
    4. Holmium

47. The number of 3c, 2e BHB bonds present in B_4H_{10} is

1. 2
2. 3
3. 4
4. 0

48. In BrF_3 as a solvent SnF_4 and KF behave as

1. acid and base, respectively
2. base and acid, respectively
3. acids
4. bases

49. The effective nuclear charge (Z^*) for the 1s electron of $_8O$ according to Slater's rules is nearly

1. 4.55
2. 3.45
3. 7.65
4. 5.45

50. Among the species O_2^+, O_2 and O_2^-, the order of first ionization energy is

1. $O_2^+ < O_2 < O_2^-$
2. $O_2^- < O_2 < O_2^+$
3. $O_2^- < O_2^+ < O_2$
4. $O_2^+ < O_2^- < O_2$

51. CO bond order is lowest in

1. uncoordinated CO
2. CO bonded to one metal
3. CO bridging two metals
4. CO bridging three metals

52. The most **unstable** species among the following is

1. $Ti(C_2H_5)_4$
2. $Ti(CH_2Ph)_4$
3. $Pb(CH_3)_4$
4. $Pb(C_2H_5)_4$

53. In which of the following species quadrupole bonding is involved?

1. $Mo_2(NMe_2)_6$
2. $Mn_2(CO)_{10}$
3. $Fe_2(CO)_9$
4. $Re_2Cl_8^{2-}$

54. In which one of the following pairs the species have similar geometry?

1. CO_2 and SO_2
2. NH_3 and BH_3
3. CO_3^{2-} and SO_3^{2-}
4. SO_4^{2-} and ClO_4^-

55. On oxidative addition of O_2 to $Ir(CO)Cl(PPh_3)_2$, the oxidation state and coordination number of Ir changes, respectively, by

1. 1 and 3
2. 2 and 2
3. 3 and 1
4. 2 and 3

56. In linear metal nitrosyls NO acts as a/an:

1. One electron donor
2. Two electron donor
3. Three electron donor
4. Four electron donor

57. Among the following molecules, the dipole moment is the highest for

1. NH_3
2. *trans*-$[PtCl_2(NH_3)_2]$
3. BF_3
4. NF_3

58. An element 'X' emits successively two β particles, one α particle, one positron and one neutron. The mass and atomic numbers of the element are decreased by, respectively,

1. 4 and 1
2. 5 and 1
3. 3 and 2
4. 3 and 1

59. The ^1H NMR spectrum of $(\eta^5\text{-}C_5H_5)_2Fe$ recorded at room temperature has

1. One singlet
2. One multiplet
3. Two singlets
4. Two multiplets

60. In the estimation of Fe^{2+} by $Cr_2O_7^{2-}$ using barium diphenylamine sulfonate as indicator, H_3PO_4 is added to

1. maintain the pH of the medium
2. decrease the $Fe^{2+/3+}$ potential
3. increase the oxidizing power of $Cr_2O_7^{2-}$
4. stabilize the indicator

61. The polymeric species $(SN)_n$ is a / an

1. three dimensional conductor
2. two dimensional conductor
3. insulator
4. one dimensional conductor

62. Among feldspar, muscovite mica and zeolite,

1. all are three dimensional silicates
2. feldspar and zeolite are three dimensional, while muscovite mica is layered
3. feldspar is three dimensional, while zeolite and muscovite mica are layered
4. all are layered silicates

63. The molar absorptivity at λ_{max} is minimum for

1. $[Mn(H_2O)_6]^{2+}$
2. $[Cr(H_2O)_6]^{2+}$
3. $[Co(H_2O)_6]^{2+}$
4. $[Fe(H_2O)_6]^{2+}$

64. The acid catalyzed hydrolysis of *trans*-$[Co(en)_2AX]^{n+}$ can give *cis*- product also due to the formation of

1. square pyramidal intermediate
2. trigonal bipyramidal intermediate
3. pentagonal bipyramidal intermediate
4. face capped octahedral intermediate

65. The total number of lines expected in ^{1}H NMR spectrum of HPF_2 is (I = 1/2 for both ^{19}F and ^{31}P)

1. six
2. four
3. five
4. three

66. In the inner sphere reduction of $[Co(NH_3)_5Cl]^{2+}$ with $[Cr(OH_2)_6)]^{2+}$, the chloride

1. bridges the metal centres only
2. mediates electron transfer only
3. bridges and mediates electron transfer both
4. does not play any role

67. The number of faces and edges in IF_7 polyhedron are, respectively

1. 15 and 15
2. 10 and 15
3. 10 and 10
4. 15 and 10

68. Among N_2, N_3^-, azobenzene and hydrazine, the shortest and longest N–N distances are found, respectively, in

1. N_3^- and hydrozine
2. N_2 and azobenzene
3. N_3^- and azobenzene
4. N_2 and hydrazine

69. O_2 can be converted to O_2^+ by using

1. PtF_6
2. KF
3. $Na_2S_2O_3$
4. Br_2

70. Only one absorption band is observed in visible region of spectrum of

1. $[Ni(H_2O)_6]^{2+}$
2. $[Ti(H_2O)_6]^{3+}$
3. $[Fe(CN)_6]^{4-}$
4. VO_4^{3-}

71. CFSE of transition metal complexes can be determined by

1. UV-visible spectroscopy
2. IR spectroscopy
3. Microwave spectroscopy
4. NMR spectroscopy

72. Which two among $[Fe(CN)_6]^{3-}$, $[FeF_6]^{3-}$, $[Cu(bpy)_2]^{2+}$ (bpy = 2,2'-bipyridine) and $[Mn(acac)_3]$ (acac = acetylacetonate anion) show the same spin-only magnetic moment?

1. $[Fe(CN)_6]^{3-}$ and $[FeF_6]^{3-}$
2. $[Fe(CN)_6]^{3-}$ and $[Cu(bpy)_2]^{2+}$
3. $[FeF_6]^{3-}$ and $[Mn(acac)_3]$
4. $[Cu(bpy)_2]^{2+}$ and $[Mn(acac)_3]$

73. In aqueous medium a mixture of KI and I_2 converts thiosulfate to

1. $S_4O_6^{2-}$
2. SO_4^{2-}
3. $S_2O_6^{2-}$
4. $S_2O_4^{2-}$

74. An exothermic reaction will necessarily follow the condition

1. $\Delta H < 0$
2. $\Delta H > 0$
3. $\Delta H = 0$
4. $\Delta S = 0$

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

1. s^{-1}
2. L mol^{-1} s^{-1}
3. s
4. mol L^{-1} s^{-1}

76. Heating is observed when N_2 gas at 200 atm is expanded at T > 600 K. It is because

1. inversion temperature is smaller than 600 K
2. N_2 is a real gas
3. Joule-Thomson coefficient is negative
4. Joule-Thomson coefficient is positive

77. Increase in disorder is more if

1. heat is absorbed reversibly at higher temperature
2. heat is absorbed reversibly at lower temperature
3. heat absorbed reversibly is independent of temperature
4. heat absorbed reversibly is independent of phase of the system.

78. The term symbol of Li_2^+ with configuration $(1\sigma_g)^2(1\sigma_u)^2(2\sigma_g)^1$ is

1. ${}^1\sum_g^+$
2. ${}^1\sum_g^-$
3. ${}^2\sum_g^-$
4. ${}^2\sum_g^+$

79. Which one of the following equations is used for the calculation of equilibrium constant (K) of an electrochemical cell reaction (n = number of electrons transferred, F = Faraday constant and E° = standard redox potential)?

1. $\ln K = (nFE^o / RT)$
2. $\ln K = -(nFE^o / RT)$
3. $\ln K = (RT / nFE^o)$
4. $\ln K = -(RT / nFE^o)$

80. Cubic close packing of n spheres generates the following number of interstitial sites

1. $2n$ octahedral and n tetrahedral sites
2. n octahedral and n tetrahedral sites
3. $2n$ octahedral and $2n$ tetrahedral sites
4. n octahedral and $2n$ tetrahedral sites

81. The point group symmetry of the molecule CH_2Cl_2 is

1. C_{2h}
2. C_{2v}
3. D_{2h}
4. D_{2d}

82. The point group symmetries of isosceles and equilateral triangles respectively are

1. C_{3v} and D_{2d}
2. D_{3h} and D_{2d}
3. D_{3h} and C_{2v}
4. C_{3v} and C_{2v}

83. The infrared spectrum of CO_2 exhibits the following number of absorptions:

1. one
2. two
3. three
4. four

84. The first line in the rotational Raman spectra of a diatomic molecule appears with a Stokes shift of 12 cm^{-1}. The Stokes shift for the second line is

1. 36 cm^{-1}
2. 24 cm^{-1}
3. 18 cm^{-1}
4. 20 cm^{-1}

85. Which of the following molecules shows EPR resonance?

1. H_2O
2. O_2
3. H_2O_2
4. CO_2

86. The R branch in the vibrational spectra of AX exhibits a set of equally spaced lines with a separation of 10 cm^{-1}. The rotational constant of AX is

1. 10 cm^{-1}
2. 20 cm^{-1}
3. 5 cm^{-1}
4. 15 cm^{-1}

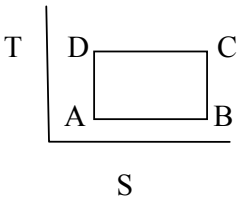
87. Overtones are observed in the vibrational spectra of diatomic molecules when

1. anharmonicity is large
2. anharmonicity is absent
3. vibration and rotational modes are coupled
4. an alternating electric field is applied

88. Which of the following electronic transitions is disallowed?

1. $\pi \rightarrow \pi^*$
2. $\sigma \rightarrow \sigma^*$
3. $n \rightarrow \pi^*$
4. $\delta \rightarrow \delta^*$

89. If the Carnot cycle in entropy-temperature diagram looks as below,



then the system rejects heat to the surroundings in going from

1. $B \rightarrow A$
2. $A \rightarrow B$
3. $D \rightarrow C$
4. $C \rightarrow D$

90. The correlation coefficient $\rho(x, y)$ for two variables x and y satisfies

1. $-1 \leq \rho(x, y) \leq 1$
2. $-1 < \rho(x, y) < 1$
3. $0 \leq \rho(x, y) \leq 1$
4. $0 < \rho(x, y) < 1$

91. When we introduce anharmonicity in the harmonic vibrator model of a diatomic molecule, the energy-level spacing changes from

1. equal to gradually decreasing
2. gradually decreasing to equal
3. equal to gradually increasing
4. gradually increasing to equal

92. For a one-electron atom with nuclear charge Z, the speed v_n of the electron in some n-th stationary orbit satisfies

1. $v_n \propto Z$
2. $v_n \propto Z^2$
3. $v_n \propto Z^{-1}$
4. $v_n \propto Z^{-2}$

93. The optimized variational wavefunction gives

1. all properties and energy of same quality
2. properties better than the energy
3. energy better than properties
4. equal kinetic and potential energy values

94. The commutator [Ly, Lx] has a value equal to

1. zero
2. $-iL_Z$
3. $-i\eta L_Z$
4. $-\eta L_Z$

95. The following statement is true for *any* hermitian operator:

1. All eigenvalues are real and non-degenerate
2. All eigenfunctions are real
3. All eigenfunctions are complex
4. All eigenvalues are real

96. A δ molecular orbital of a diatomic molecule is defined by

1. $n = 3$
2. $\ell = 2$
3. $\lambda = 2$
4. $m_\ell = 2$

97. The $2p_x$ hydrogenic orbital has the ϕ-part in its wavefunction of the form

1. $e^{-i\varphi}$
2. $e^{+i\varphi}$
3. $\sin \varphi$
4. $\cos \varphi$

98. Which of the following statements about valence bond (VB) and molecular orbital (MO) theory is false?

1. The VB uses non-orthogonal basis.
2. The simple MO theory does not include any ionic terms.
3. The VB theory views molecules as composed of atomic cores and bonding valence electrons.
4. The MOs can be delocalized over all the atoms.

99. If $\hat{A}$ an operator and $\hat{A}\psi = i\eta\frac{d\psi}{dx}$, then $\hat{A}^2\psi$ is given by

1. $-\eta^2\left(\frac{d\psi}{dx}\right)^2$
2. $-\eta^2\frac{d^2\psi}{dx^2}$
3. $\eta^2\left(\frac{d\psi}{dx}\right)^2$
4. $\eta^2\frac{d^2\psi}{dx^2}$

100. If all the energy-levels of a system are given a constant shift by an amount α, the entropy of the system

1. does not change at all
2. changes by the amount of α
3. decreases
4. increases, but irregularly

101. An equimolar mixture of two macromolecules of molar masses 10,000 and 30,000 will have the number average molar mass equal to:

1. $\overline{M}_n$ = 10,000
2. $\overline{M}_n$ = 15,000
3. $\overline{M}_n$ = 20,000
4. $\overline{M}_n$ = 25,000

102. Addition of a positive catalyst to an exothermic reaction

1. increases exothermicity and activation barrier
2. decreases exothermicity, but increases barrier
3. increases exothermicity only
4. decreases activation barrier, but does not change the exothermicity.

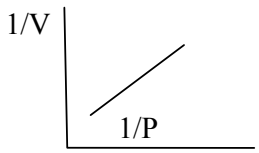
103. The electrical conductivity of a crystalline solid increases with temperature. The solid is a

1. superconductor
2. metal
3. semiconductor
4. semimetal

104. K_{sp} values for CuS, FeS, PbS and ZnS are 8.5×10^{-45}, 6.3×10^{-18}, 3.4×10^{-28} and 1.6×10^{-24}, respectively. If H_2S gas is passed through a solution containing these ions with same molar concentration, the ion that will precipitate first is

1. Pb^{2+}
2. Zn^{2+}
3. Fe^{2+}
4. Cu^{2+}

105. The experimental adsorption data of a gas on a solid surface at temperature T exhibits the following variation with pressure. V is the volume of gas adsorbed.



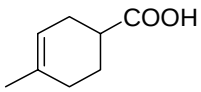
Which of the following statements is true?

1. Heat of coverage varies linearly with temperature
2. Adsorption is multilayer
3. Heat of adsorption is independent of coverage
4. Complete coverage cannot be determined

106. The second order Bragg diffraction from the 100 planes of a cubic crystal is equivalent to

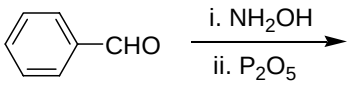
1. the second order diffraction from the 200 planes
2. first order diffraction from the 200 planes
3. first order diffraction from the 400 planes
4. first order diffraction from the 100 planes

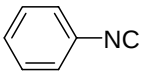
107. IUPAC name of the compound given below is

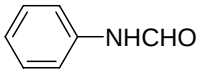


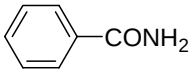
1. 4-methylcyclohex-4-enecarboxylic acid
2. 4-methylcyclohex-3-enecarboxylic acid
3. 1-methylcyclohexene-4-carboxylic acid
4. 2-methylcyclohexene-5-carboxylic acid

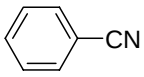
108. The major product formed in the reaction given below is



1. 

2. 

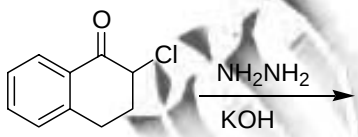
3. 

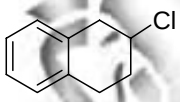
4. 

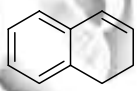
109. Cope rearrangement involves

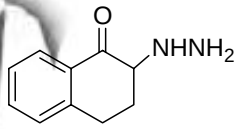
1. [1,5]-sigmatropic rearrangement
2. [4+2]-cycloaddition reaction
3. [3,3]-sigmatropic rearrangement
4. 6π-electrocyclisation reaction

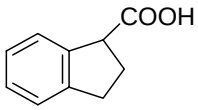
110. The major product formed in the reaction given below is



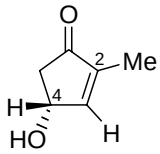
1. 

2. 

3. 

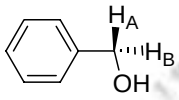
4. 

111. The stereochemical descriptors for the chiral centre and olefin in the compound given below, are



1. 4*R*, 2*Z*
2. 4*S*, 2*Z*
3. 4*R*, 2*E*
4. 4*S*, 2*E*

112. In the compound given below, the hydrogens H_A and H_B are

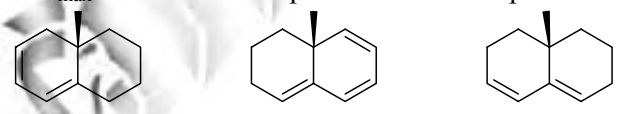


1. homotopic
2. enantiotopic
3. diastereotopic
4. isotopic

113. An organic compound with molecular formula $C_3H_6Cl_2$ exhibits only one signal in the ^1H NMR spectrum. The compound is

1. 2,2-dichloropropane
2. 1,2-dichloropropane
3. 1,3-dichloropropane
4. 1,1-dichloropropane

114. The order of λ_{max} in the UV-Vis spectra for the compounds **A-C** is



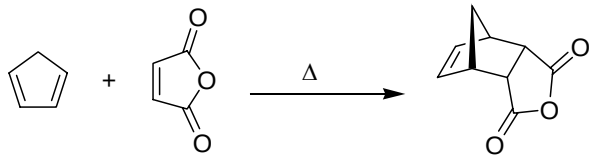
A **B** **C**

1. A > B > C
2. B > A > C
3. B > C > A
4. C > B > A

115. The photochemical Paterno-Büchi reaction is a cycloaddition between

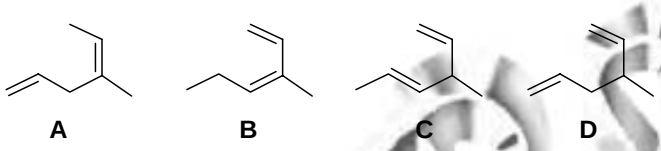
1. two >C=C< groups
2. a >C=O and >C=C< groups
3. a >C=N-R and >C=C< groups
4. a >C=S and >C=C< groups

116. The reaction given below is an example of



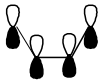
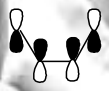
1. $_{\pi}4_{s} + _{\pi}2_{s}$ cycloaddition
2. $_{\pi}4_{s} + _{\pi}2_{a}$ cycloaddition
3. $_{\pi}4_{a} + _{\pi}2_{s}$ cycloaddition
4. $_{\pi}4_{a} + _{\pi}2_{a}$ cycloaddition

117. Which one among the dienes **A-D** will undergo [3,3]-sigmatropic shift upon heating

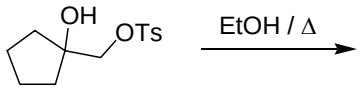


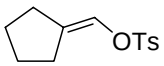
1. A
2. B
3. C
4. D

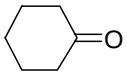
118. The LUMO of the ground state buta-1,3-diene is

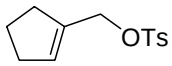
1. 
2. 
3. 
4. 

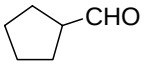
119. The major product formed in the reaction given below is



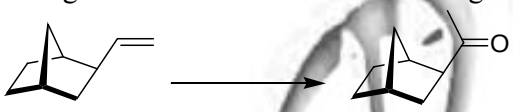
1. 

2. 

3. 

4. 

120. The transformation given below can be achieved using

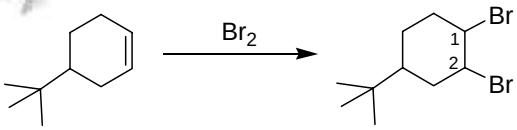


1. BH_3.THF followed by H_2O_2 / NaOH
2. alkaline $KMnO_4$ / $NaIO_4$
3. pyridinium chlorochromate
4. $PdCl_2$ / $CuCl_2$ / O_2 / H_2O

121. The base peak in the electron impact mass spectrum (EI MS) of acetophenone is

1. 120
2. 105
3. 77
4. 65

122. In the reaction given below, the orientation of two bromine substituents in the product is

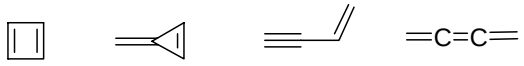


1. equatorial at both C-1 and C-2
2. equatorial at C-1 and axial at C-2
3. axial at C-1 and equatorial at C-2
4. axial at both C-1 and C-2

123. Cyclohexyl benzyl ether is converted to cyclohexanol using

1. 5% aq. KOH
2. hydrazine hydrate
3. H_2-Pd/C
4. tetrabutylammonium fluoride

124. Which one among the compounds **A**-**D** will have highest dipole moment?



A **B** **C** **D**

1. A
2. B
3. C
4. D

125. The major products formed in the nitration (HNO_3 / H_2SO_4) of aniline and acetanilide are

1. *o*-nitroaniline and *o*-nitroacetanilide
2. *m*-nitroaniline and *p*-nitroacetanilide
3. *p*-nitroaniline and *m*-nitroacetanilide
4. *m*-nitroaniline and *m*-nitroacetanilide

126. Which one of the following name reactions is an example of *atom economy reaction*?

1. Wittig reaction
2. Grignard reaction
3. Dieckmann condensation
4. Diels-Alder reaction

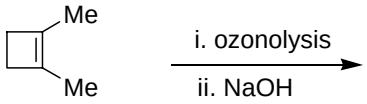
127. The order of nucleophilicity among $PhNH_2$, $EtNH_2$ and $PhNHNH_2$ is

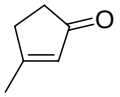
1. $PhNHNH_2 > PhNH_2 > EtNH_2$
2. $EtNH_2 > PhNH_2 > PhNHNH_2$
3. $PhNHNH_2 > EtNH_2 > PhNH_2$
4. $EtNH_2 > PhNHNH_2 > PhNH_2$

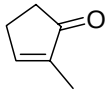
128. The order of acid strengths of CH_3COOH, CF_3COOH and CCl_3COOH is

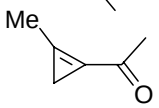
1. $CCl_3COOH > CF_3COOH > CH_3COOH$
2. $CCl_3COOH > CH_3COOH > CF_3COOH$
3. $CF_3COOH > CCl_3COOH > CH_3COOH$
4. $CF_3COOH > CH_3COOH > CCl_3COOH$

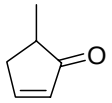
129. The major product formed in the reaction given below is



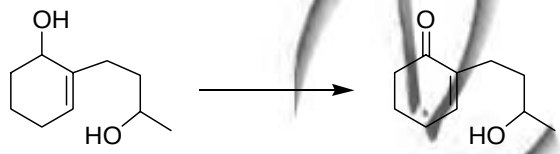
1. 

2. 

3. 

4. 

130. The most suitable reagent to achieve the transformation, given below, is



1. CrO_3 / H_2SO_4
2. MnO_2
3. $KMnO_4$ / H^+
4. $RuCl_3$ / $NaIO_4$

131. An *optically active* compound **A** having molecular formula C_6H_{12} on catalytic hydrogenation gives an *optically inactive* compound (C_6H_{14}). The compound **A** is

1. 2-methylpentene
2. 3-methylpentene
3. 3,3-dimethylbutene
4. 4-methylpentene

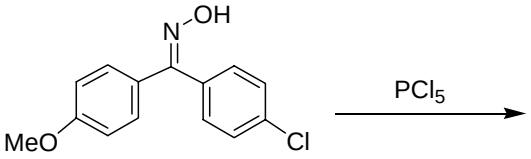
132. The reagent suitable for converting oct-4-yne to *trans*-oct-4-ene is

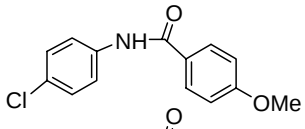
1. H_2 – Pd/C
2. Pd / $CaCO_3$ / H_2
3. $NaBH_4$
4. Na / liq. NH_3

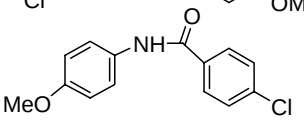
133. Which one of the following is a polar aprotic solvent?

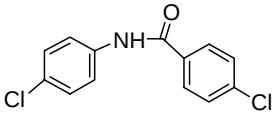
1. toluene
2. carbon tetrachloride
3. *N*,*N*-dimethylformamide
4. acetic acid

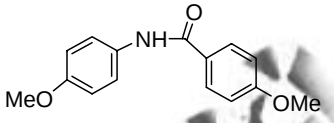
134. The major product formed in the reaction, given below, is



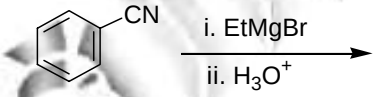
1. 

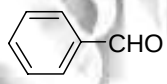
2. 

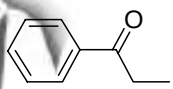
3. 

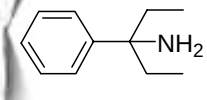
4. 

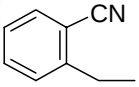
135. The major product formed in the reaction, given below, is



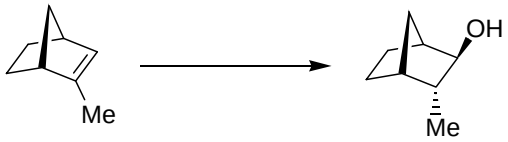
1. 

2. 

3. 

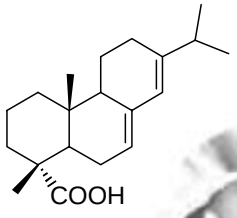
4. 

136. The most suitable reagent for carrying out the transformation given below, is



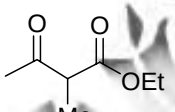
1. aq. H_2SO_4
2. $Hg(OAc)_2$ followed by reaction with $NaBH_4$ / NaOH
3. B_2H_6 followed by reaction with H_2O_2 / NaOH
4. *m*-CPBA followed by reaction with dil H_2SO_4

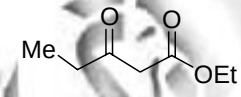
137. Natural product abietic acid, given below, is a

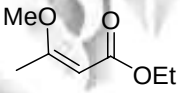


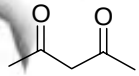
1. monoterpene
2. sesquiterpene
3. diterpene
4. triterpene

138. The major product formed in the reaction of ethyl acetoacetate with sodium hydride (1 equivalent) and methyl iodide (1 equivalent) is

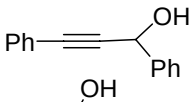
1. 

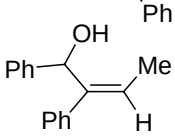
2. 

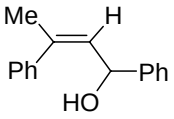
3. 

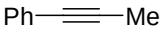
4. 

139. The reaction of phenylacetylene with one equivalent of methylmagnesium bromide followed by reaction with benzaldehyde provides

1. 

2. 

3. 

4. 

140. Sucrose is a disaccharide consisting of

1. glucose and glucose
2. glucose and galactose
3. glucose and fructose
4. glucose and mannose