Roll No. | | | | | | | |

(Write Roll Number from left side exactly as in the Admit Card)

Signature of Invigilators

1. _____

2. _____

1218

Question Booklet Series **X**

PAPER–II

Question Booklet No.

(Identical with OMR Answer Sheet Number)

Subject Code : 12

CHEMICAL SCIENCES

Time : 2 *Hours* *Maximum Marks:* 200

Instructions for the Candidates

1. Write your Roll Number in the space provided on the top of this page as well as on the OMR Sheet provided.
2. At the commencement of the examination, the question booklet will be given to you. In the first 5 minutes, you are requested to open the booklet and verify it:
   (i) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page.
   (ii) Faulty booklet, if detected, should be got replaced immediately by a correct booklet from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given.
   (iii) Verify whether the Question Booklet No. is identical with OMR Answer Sheet No.; if not, the full set is to be replaced.
   (iv) After this verification is over, the Question Booklet Series and Question Booklet Number should be entered on the OMR Sheet.
3. This paper consists of One hundred (100) multiple-choice type questions. All the questions are compulsory. Each question carries *two* marks.
4. Each Question has four alternative responses marked: (A) (B) (C) (D). You have to darken the circle as indicated below on the correct response against each question.

   Example: (A) (B) ● (D), where (C) is the correct response.
5. Your responses to the questions are to be indicated correctly in the OMR Sheet. If you mark your response at any place other than in the circle in the OMR Sheet, it will not be evaluated.
6. Rough work is to be done at the end of this booklet.
7. If you write your Name, Roll Number, Phone Number or put any mark on any part of the OMR Sheet, except in the space allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, such as change of response by scratching or using white fluid, you will render yourself liable to disqualification.
8. Do not tamper or fold the OMR Sheet in any way. If you do so, your OMR Sheet will not be evaluated.
9. You have to return the Original OMR Sheet to the invigilator at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. You are, however, allowed to carry question booklet and duplicate copy of OMR Sheet after completion of examination.
10. **Use only Black Ball point pen.**
11. **Use of any calculator or mobile phone etc. is strictly prohibited.**
12. **There are no negative marks for incorrect answers.**

[Please Turn Over]

CHEMICAL SCIENCES

PAPER II

1. The low detection limits obtained in stripping methods are a result of

(A) faster measurements, which increase flux of the analyte to the electrode surface.

(B) preconcentration of the analyte at the working electrode.

(C) lower charging current compared to Pulse Polarography.

(D) increased concentration of analyte in the bulk solution.

2. $(CH_3)_3N$ is a distorted tetrahedron with bond angle of 107.9° while $(SiH_3)_3N$ is a planar molecule with bond angle of 120°. With reference to the later, which statement is NOT true?

(A) N is sp^2 hybridized in $(SiH_3)_3N$

(B) $(SiH_3)_3N$ has σ as well as π bonds.

(C) There is $p\pi - d\pi$ bonding between N and Si.

(D) $(SiH_3)_3N$ is more basic than $(CH_3)_3N$.

3. Find the correct statement.

(A) Magnetic moment of tetrahedral Co(II) complexes is generally higher than the high-spin Co(II) octahedral complexes.

(B) Magnetic moment of tetrahedral Ni(II) complexes is generally higher than octahedral Ni(II) complexes.

(C) Magnetic moment of square planar Ni(II) complexes is generally higher than tetrahedral Ni(II) complexes.

(D) Magnetic moment of tetrahedral Cu(II) complexes is always higher than the square planar Cu(II) complexes.

4. The coordination compounds, $[Ni(CN)_4]^{2-}$ and $[Pt(NH_3)_4]^{2+}$ are expected to possess

(A) square planar geometry.

(B) square planar and tetrahedral geometry, respectively.

(C) tetrahedral geometry.

(D) tetrahedral and square planar geometry, respectively.

5. Which one of the following statements is INCORRECT for aide ion (N_3^-)?

(A) It is isoelectronic with CO_2.

(B) The formal charge on nitrogen atoms from left to right is –1, +1, –1.

(C) It has two σ bonds and three π bonds.

(D) It has linear geometry.

6. The number of isomeric structures possible for disubstituted borazine $(B_3N_3H_4X_2)$ would be

(A) One

(B) Two

(C) Three

(D) Four

7. Which one of the following elements is used as photoreceptor in Xeroxing?

(A) Selenium

(B) Titanium

(C) Germanium

(D) Magnesium

8. Figure out the correct IUPAC name of given coordination compound;

$[Pt\ Br(NO_2)\ (NH_3)_4]\ [Pt\ Cl_4]$

(A) Bromonitrotetrammineplatinum(IV) tetrachloroplatinate (II)

(B) Tetramminebromonitroplatinum(IV) tetrachloroplatinate (II)

(C) Bromonitro-N tetrammineplatinum(IV) tetrachloroplatinate (II)

(D) Tetramminebromonitro-N platinum(IV) tetrachloroplatinate (II)

9. The coordination compound $[RhCl(PPh_3)]$ has an important role in the hydrogenation of alkenes as a catalyst. What is INCORRECT for this catalyst?

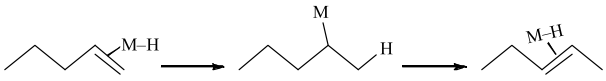
(A) Its geometry is a regular tetrahedron.

(B) It does not follow 18e rule.

(C) The oxidation state of Rh is +1.

(D) It is known as Wilkinson's catalyst.

10. Observe the following reaction:



The reaction is an example of

(A) 1,2-insertion and β-hydride elimination

(B) alkene isomerization

(C) α-hydride elimination

(D) Both (A) and (B)

11. Which one of the following comes within determinate error?

(A) Instrument error

(B) Method error

(C) Personal error

(D) All of the above

12. The compounds, MgF_2, CaF_2, ZnO and NaCl are arranged in order of their increasing lattice energy. Select the correct order.

(A) $NaCl < CaF_2 = MgF_2 < ZnO$

(B) $ZnO < CaF_2 < MgF_2 < NaCl$

(C) $CaF_2 < MgF_2 < ZnO < NaCl$

(D) $NaCl < CaF_2 < MgF_2 < ZnO$

13. The correct structural types of the following compounds $B_{10}H_{14}$, B_9H_{15} and $B_{12}H_{12}^{2-}$

are

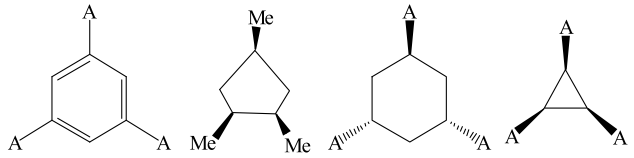
(A) nido, arachano and closo, respectively

(B) closo, arachano and nido, respectively

(C) closo, nido and arachano, respectively

(D) arachano, closo and nido, respectively

14. The compound(s) possessing C_3-axis of symmetry is/are



I II III IV

(A) I and IV

(B) I, II and IV

(C) II and IV

(D) IV only

15. The formula of a metal carbonyl is $M_2(CO)_{10}$. M is

(A) Fe

(B) Co

(C) Mn

(D) Ni

16. Silica gel contains $[CoCl_4]^{2-}$ as an indicator. When activated silica gel is blue and on absorption of moisture, it becomes pale pink. This is because

(A) oxidation state of Co changes from +2 to +3.

(B) water changes the high-spin cobalt complex to low-spin cobalt complex.

(C) water replaces the Cl^- ion to form tetrahedral $[Co(H_2O)_4]^{2+}$ complex.

(D) water changes the geometry of Co(II) from tetrahedral to octahedral.

17. The CFSE (Δ_0) of *d*-orbital for the given metal ions in an octahedral field increases in the order:

(A) $Co^{2+} < Co^{3+} = Rh^{3+}$

(B) $Co^{2+} < Co^{3+} < Rh^{3+}$

(C) $Rh^{3+} < Co^{3+} < Co^{2+}$

(D) $Co^{3+} < Co^{2+} < Rh^{3+}$

18. For which of the following metal ions, strongest Jahn-Teller effect is observed in an octahedral complex?

(A) Ti^{3+}

(B) V^{3+}

(C) Mn^{3+} (high-spin)

(D) Co^{3+} (high-spin)

19. The number of isomers for $[Ma_3b_2c]$ is:

(A) 2

(B) 3

(C) 4

(D) 6

20. Which of the following co-ordination compounds/ ions should be achiral?

(A) $[Cr(EDTA)]^-$

(B) $[Ru(bipyridyl)_3]^+$

(C) *trans*-$[CrCl_2(ox)_2]^{3-}$

(D) *cis*-$[CrCl_2(ox)_2]^{3-}$

21. The pair having similar shape is

(A) BF_3 and NH_3

(B) $SiCl_4$ and SCl_4

(C) XeF_4 and $[Ni(CN)_4]^{2-}$

(D) $POCl_3$ and $[XeOF_3]^+$

22. An isotope ${}^{b}_{a}X$ undergoes a series of *n* alpha (α) and *m* beta (β) disintegration to form a stable isotope ${}_{a-10}Y^{b-32}$. What are the values of *n* and *m*?

(A) 8, 6

(B) 6, 8

(C) 5, 8

(D) 8, 8

23. On heating a mixture of Cu_2O and Cu_2S, we get

(A) $Cu + SO_2$

(B) $Cu + SO_3$

(C) $CuO + S$

(D) $CuSO_4$

24. Mössbauer spectra of $Fe_3(Co)_{12}$ indicate that

(A) environment around all three Fe-atoms are the same

(B) environment around all three Fe-atoms are different

(C) environment around two Fe-atoms are the same and that of the other Fe-atom is different

(D) environment of the Fe-atoms is in dynamic equilibrium, hence indistinguishable.

25. Which one of the following reactions does not occur?

(A) $XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$

(B) $Xe + PtF_4 \rightarrow XeF_4 + Pt$

(C) $XeF_2 + SbF_5 \rightarrow [XeF]^+ [SbF_6]^-$

(D) $(C_6H_5)_3B + XeF_2 \rightarrow [C_6H_5Xe]^+[(C_6H_5)_2BF_2]^-$

26. Which one of the following compounds is an oxidizing agent?

(A) BCl_3

(B) $AlCl_3$

(C) $TiCl_3$

(D) $TlCl_3$

27. Among the following the strongest conjugate base is

(A) NO_3^-

(B) $C_2H_5O^-$

(C) SO_4^{2-}

(D) $C_6H_5COO^-$

28. The electronegativity difference is highest for the pair

(A) Na, F

(B) Li, Cl

(C) K, F

(D) K, Br

29. Which of the following species possess a lone pair, four bonded pairs and see-saw shaped geometry?

XeF_4, SF_4, ClF_4^-, ClF_4^+

(A) SF_4 and ClF_4^-

(B) SF_4 and ClF_4^+

(C) XeF_4

(D) SF_4 and XeF_4

30. For which of the following pairs bond angle of the first compound is greater than the second one?

(A) NO_2 and CO_2

(B) NH_3 and NF_3

(C) OF_2 and XeF_2

(D) H_2S and H_2O

31. The correct 'bond order' for the following species is

(A) $N_2 > O_2 > NO^+$

(B) $N_2 > O_2^+ > NO^+$

(C) $N_2 > NO > O_2$

(D) $O_2^+ > NO^+ > N_2$

32. The ground state terms for Ce^{3+} is

(A) $^2F_{5/2}$

(B) $^2F_{7/2}$

(C) $^1S_0$

(D) $^7F_6$

33. Which one of the following should possess maximum effective nuclear charge (Z_{eff}) for an outer most electron?

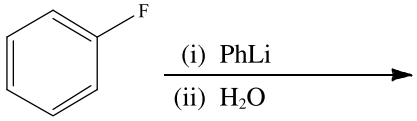
(A) F

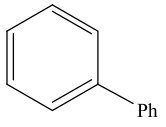
(B) Li

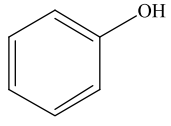
(C) B

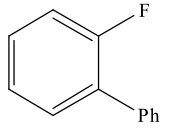
(D) Na

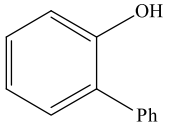
34. The major product of the following reaction is



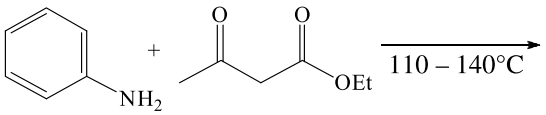
(A) 

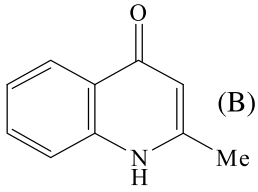
(B) 

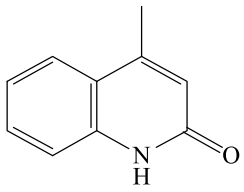
(C) 

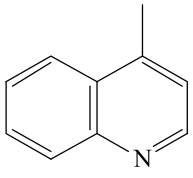
(D) 

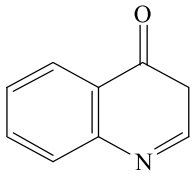
35. The major product formed in the following reaction is:



(A) 

(B) 

(C) 

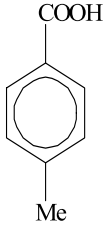
(D) 

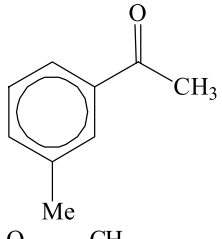
36. An organic compound $C_9H_{10}O$ exhibited the following spectral data:

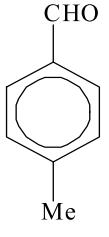
IR = 1680 cm^{-1}

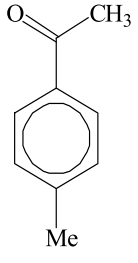
^1H – NMR = 7·8 (2H, d, J = 7·5Hz), 7·2 (2H, d, J = 7·5Hz), 2·7 (3H, s) and 2·4 (3H, s)

Identify the compound:

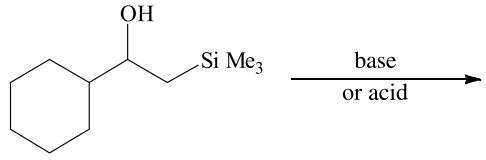
(A) 

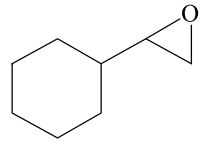
(B) 

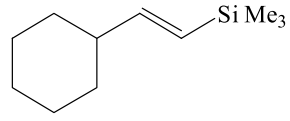
(C) 

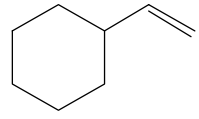
(D) 

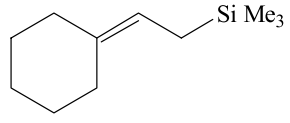
37. The major product of the following reaction is:



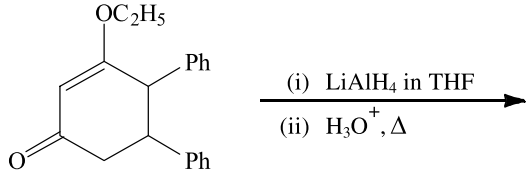
(A) 

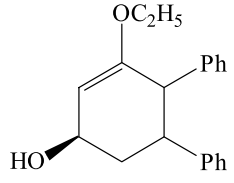
(B) 

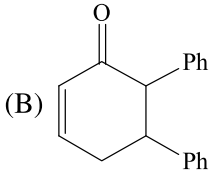
(C) 

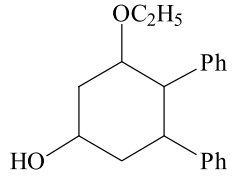
(D) 

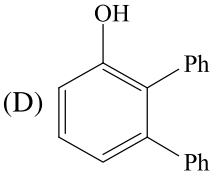
38. Predict the major product of the following reaction:



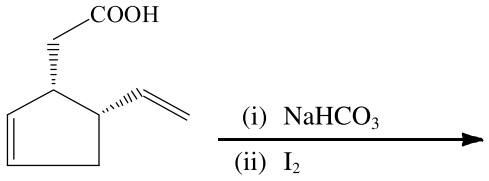
(A) 

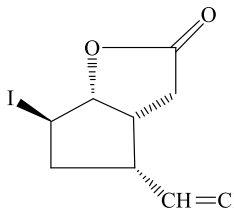
(B) 

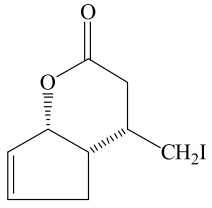
(C) 

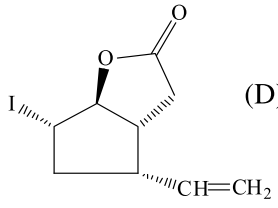
(D) 

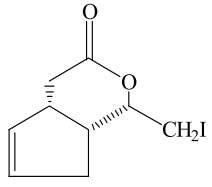
39. The major product of the following reactions is:

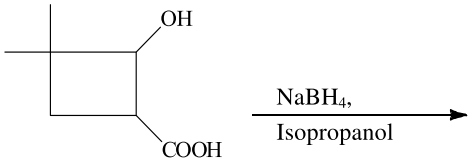


(A) 

(B) 

(C) 

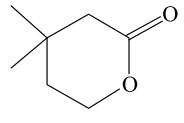
(D) 

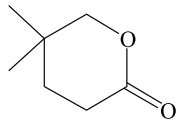
40. 

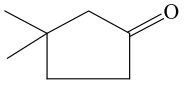
Suggest the structure of the product in the above reaction from the following spectral data:

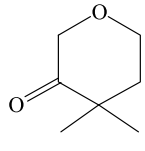
IR : 1725 cm^{-1}

PMR : δ (ppm) 1·02 (6H, s), 1·66 (2H, t, J = 7Hz), 2·51 (2H, t, J = 7Hz) and 3·9 (2H, s).

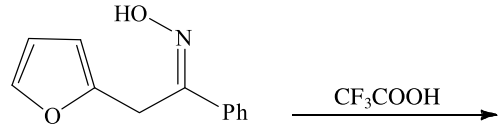
(A) 

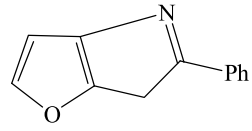
(B) 

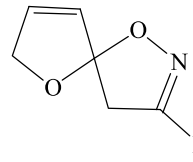
(C) 

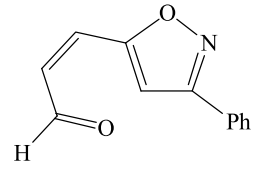
(D) 

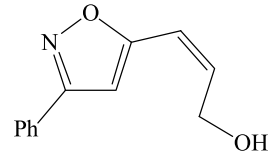
41. The major product of the following reaction is:



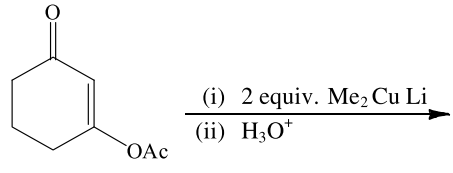
(A) 

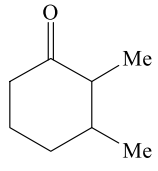
(B) 

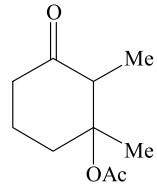
(C) 

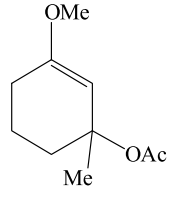
(D) 

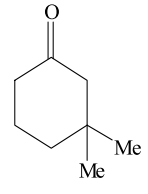
42. The major product of the following reaction is:



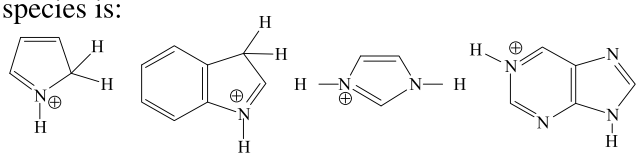
(A) 

(B) 

(C) 

(D) 

43. The decreasing order of acidity of the following species is:



I II III IV

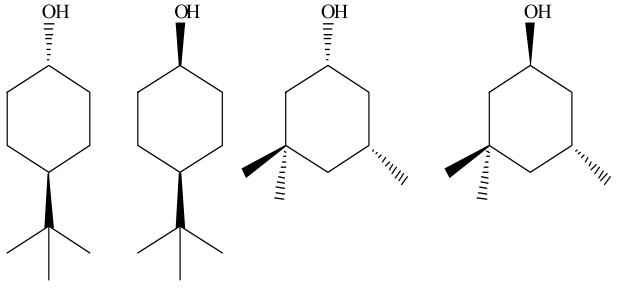
(A) I > III > II > IV

(B) II > I > IV > III

(C) I > III > IV > II

(D) I > II > IV > III

44. The correct order of chromic acid oxidation of the following alcohols is:



I II III IV

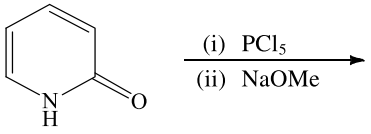
(A) I > II > III > IV

(B) III > II > IV > I

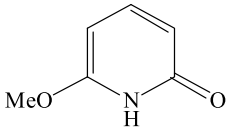
(C) IV > III > I > II

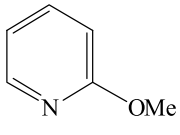
(D) IV > II > III > I

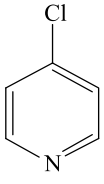
45. What is the major product of the following reaction?

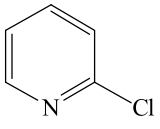


(i) PCl_5
(ii) NaOMe

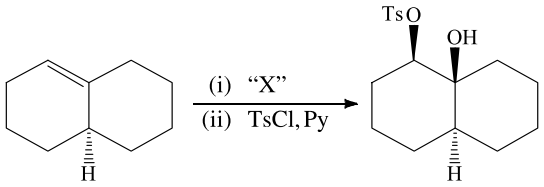
(A) 

(B) 

(C) 

(D) 

46. The oxidant "X" used in the following reaction is:



(i) "X"
(ii) TsCl, Py

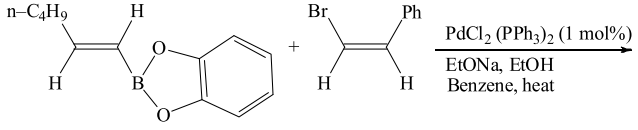
(A) CrO_3

(B) OsO_4

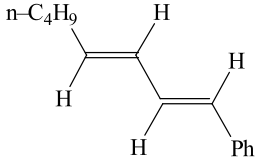
(C) $NaIO_4$

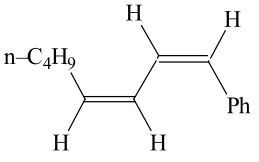
(D) *m*CPBA/NaOH

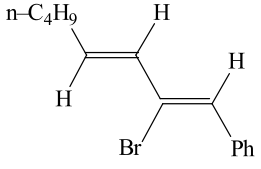
47. The major product of the following reaction is

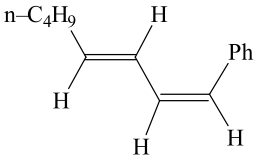


$PdCl_2(PPh_3)_2$ (1 mol%)
EtONa, EtOH
Benzene, heat

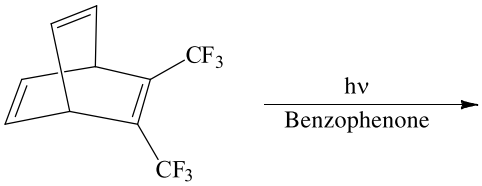
(A) 

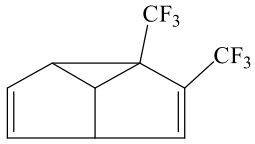
(B) 

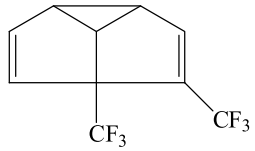
(C) 

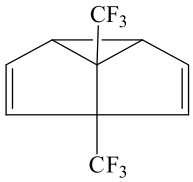
(D) 

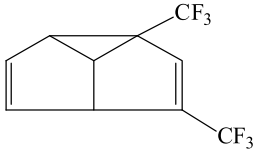
48. The major product of the following photochemical reaction is:



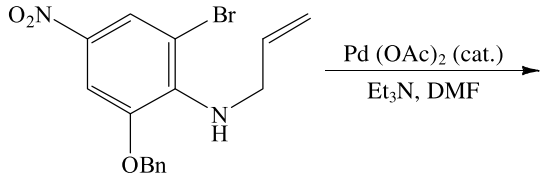
(A) 

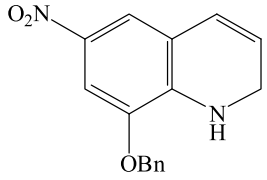
(B) 

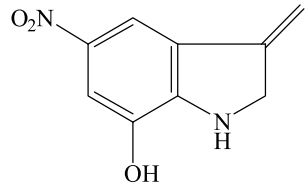
(C) 

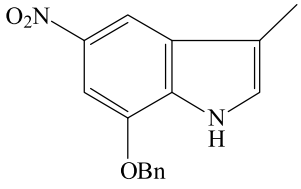
(D) 

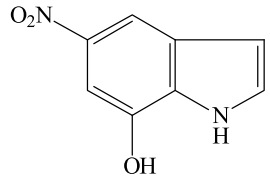
49. The major product of the following reaction is:



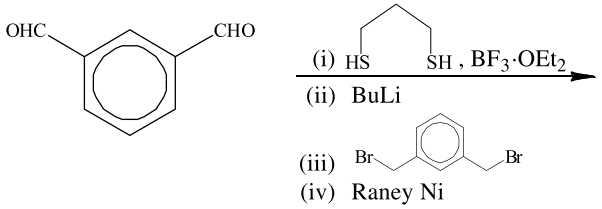
(A) 

(B) 

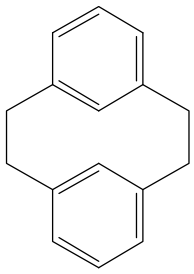
(C) 

(D) 

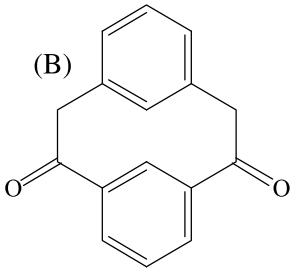
50. The major product of the following reaction is:



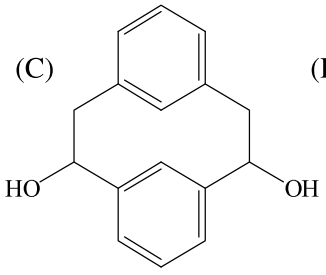
(A)



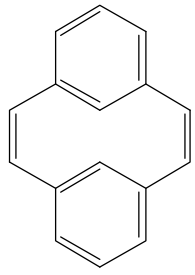
(B)



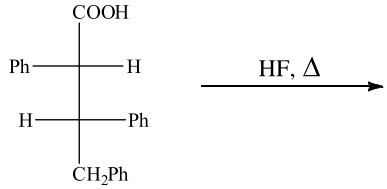
(C)



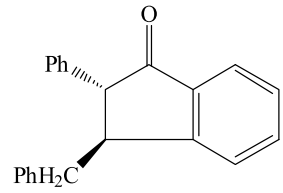
(D)



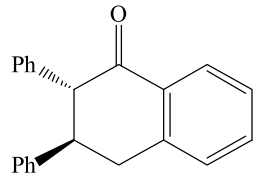
51. Identify the major product of the following reaction:



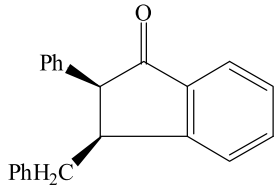
(A)



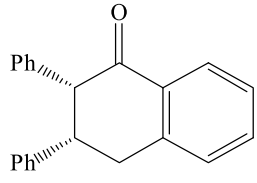
(B)



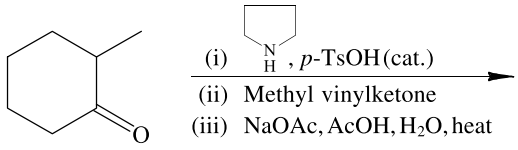
(C)

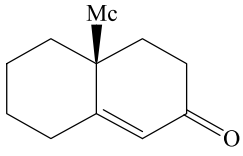


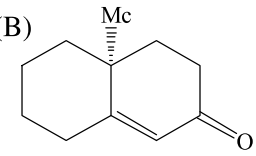
(D)

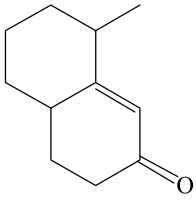


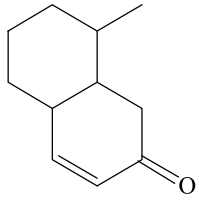
52. The major product of the following reaction is:



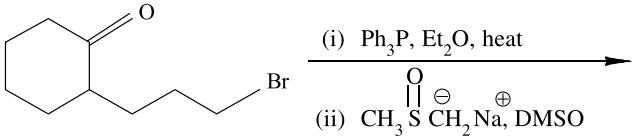
(A) 

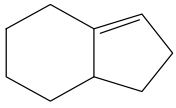
(B) 

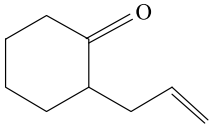
(C) 

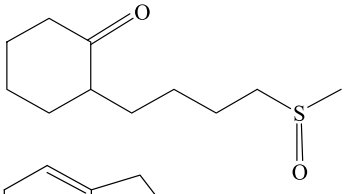
(D) 

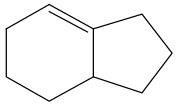
53. The major product of the following reaction is:



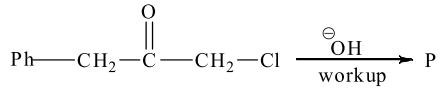
(A) 

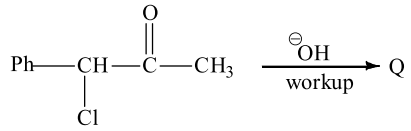
(B) 

(C) 

(D) 

54. Identify the products P and Q in the following reactions:

1. 

2. 

(A) P = Ph CH_2 CH_2 COOH

Q = Ph–CH(–CH_3)–COOH

(B) P = Ph – CH(–CH_3)–COOH

Q = Ph CH_2 CH_2 COOH

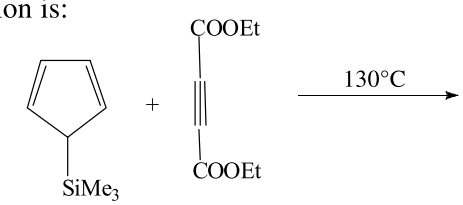
(C) P = Ph CH_2 CH_2 COOH

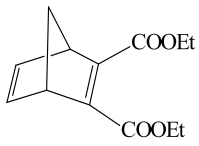
Q = Ph CH_2 CH_2 COOH

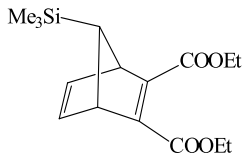
(D) P = Ph CH(–CH_3)–COOH

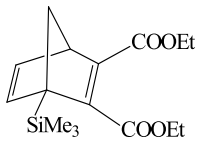
Q = Ph–CH(–CH_3)–COOH

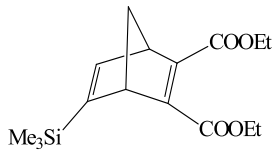
55. The major product formed in the following reaction is:



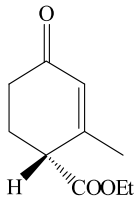
(A) 

(B) 

(C) 

(D) 

56. The IUPAC name of the following compound is



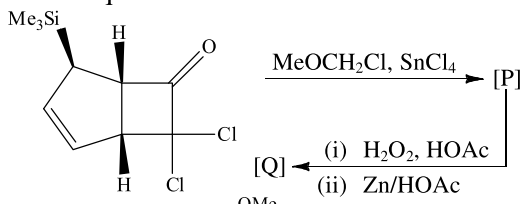
(A) ethyl (*S*)-2-methyl-4-oxocyclohex-2-enecarboxylate

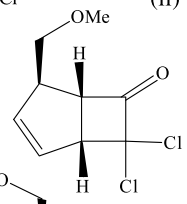
(B) ethyl (*R*)-2-methyl-4-oxocyclohex-2-enecarboxylate

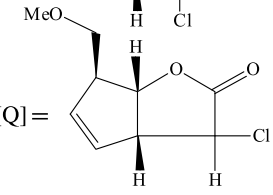
(C) (*R*)-4-ethoxycarbonyl-3-methylcyclohex-2-enone

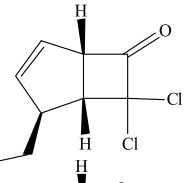
(D) (*S*)-4-ethoxycarbonyl-3-methylcyclohex-2-enone

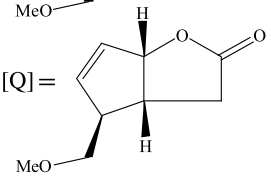
57. The major products [P] and [Q] in the following reaction sequence are:

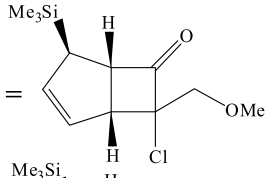


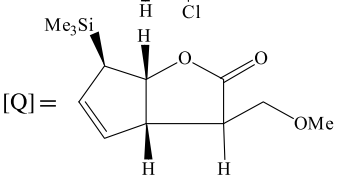
(A) [P] = 

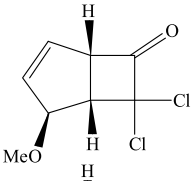
[Q] = 

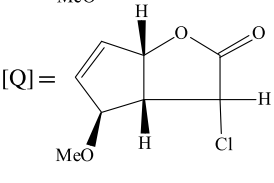
(B) [P] = 

[Q] = 

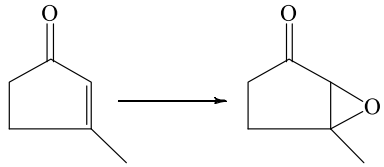
(C) [P] = 

[Q] = 

(D) [P] = 

[Q] = 

58. The most suitable reagent for the following conversion is:



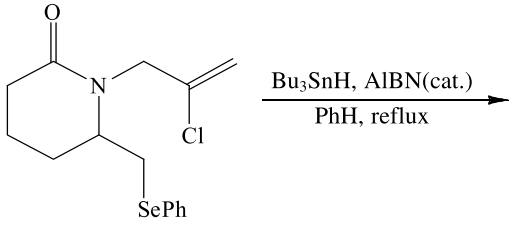
(A) *m*CPBA

(B) H_2O_2/AcOH

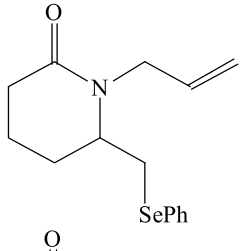
(C) *t*-BuOOH/HCl

(D) H_2O_2/NaOH

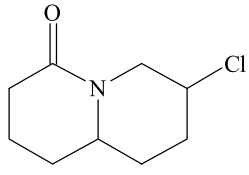
59. The major product formed in the following reaction is:



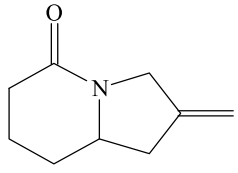
(A)



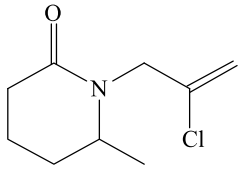
(B)



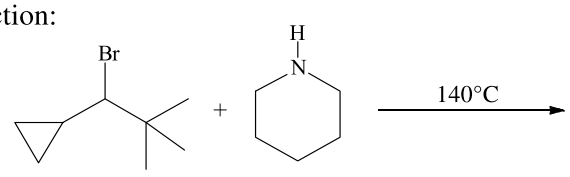
(C)



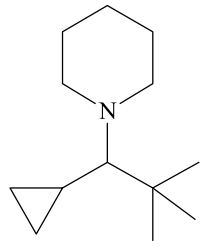
(D)



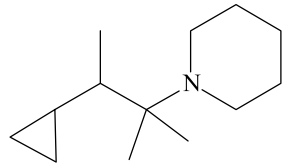
60. Identify the major product in the following reaction:



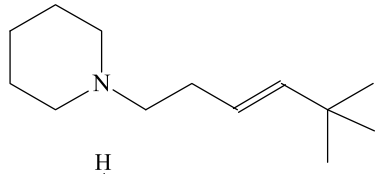
(A)



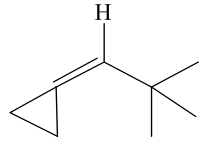
(B)



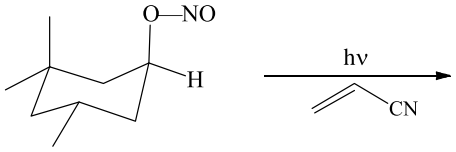
(C)

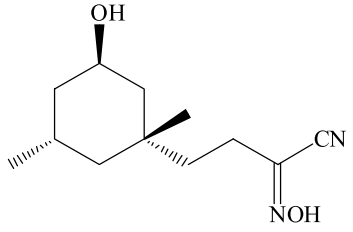


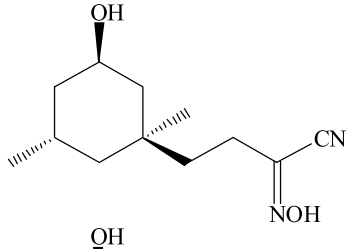
(D)

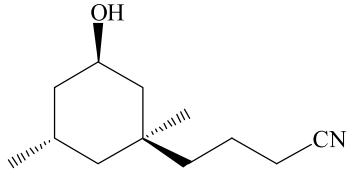


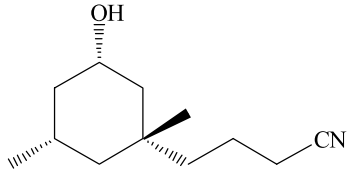
61. The major product of the following photochemical reaction is:



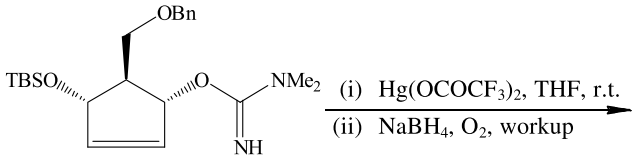
(A)


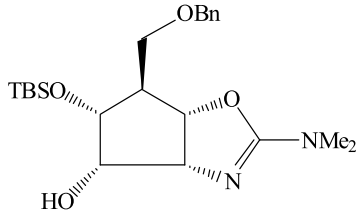
(B)


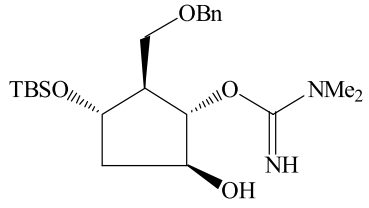
(C)


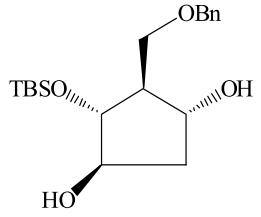
(D)


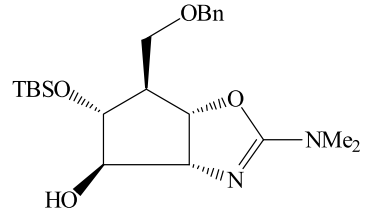
62. The major product formed in the following reaction sequence is:



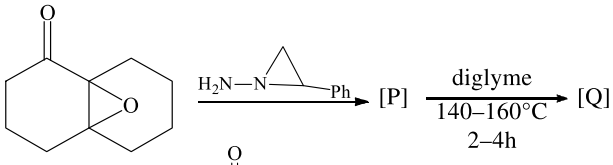
(A)


(B)


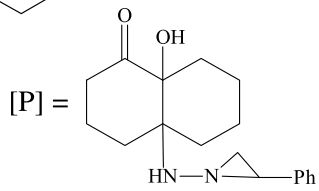
(C)


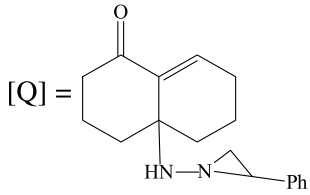
(D)


63. The major products [P] and [Q] formed in the following reaction sequence are:

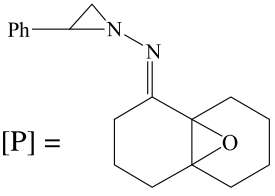


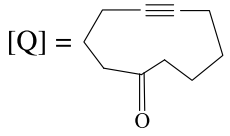
(A)



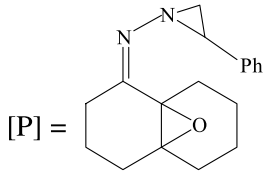


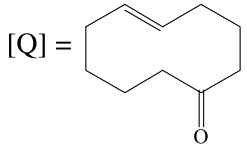
(B)



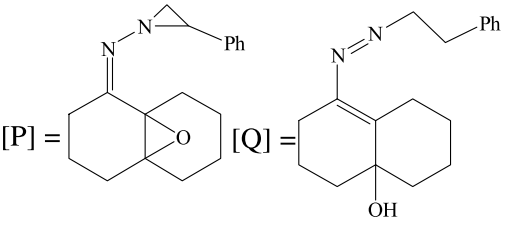


(C)

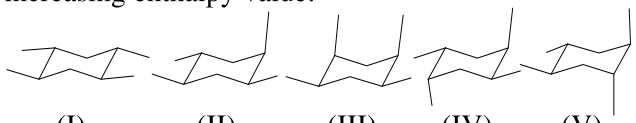




(D)



64. Arrange the following chair conformations of 1,2,4,5-tetramethylcyclohexane according to their increasing enthalpy value:



(I) (II) (III) (IV) (V)

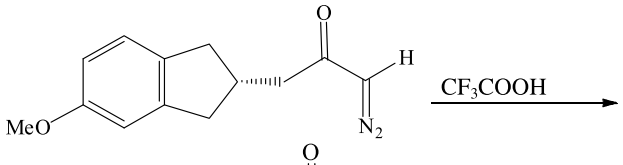
(A) (I) < (II) < (V) < (IV) < (III)

(B) (I) < (III) < (II) < (IV) < (V)

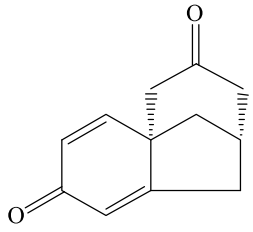
(C) (I) < (II) < (IV) < (V) < (III)

(D) (I) < (II) < (V) < (III) < (IV)

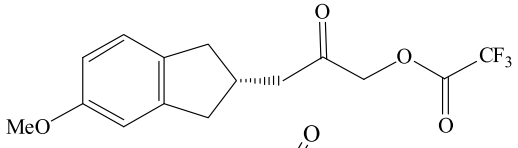
65. The major product formed in the following transformation is:



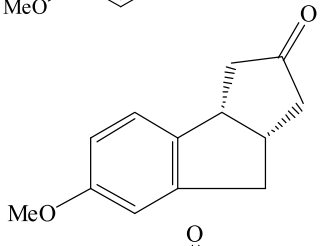
(A)



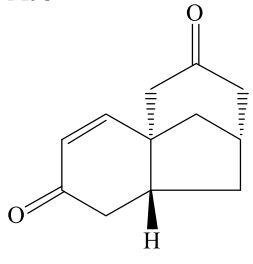
(B)



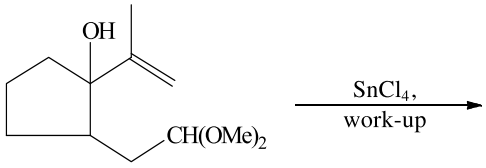
(C)

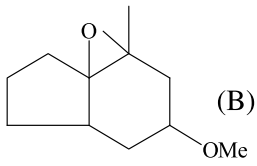


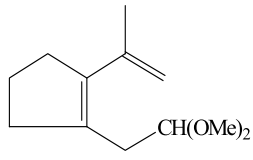
(D)

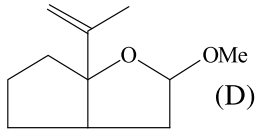


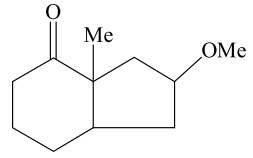
66. Predict the product of the following reaction:



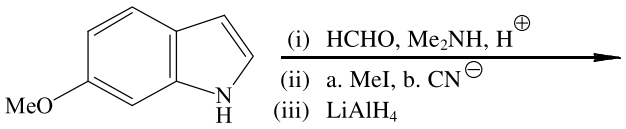
(A) 

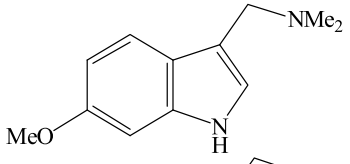
(B) 

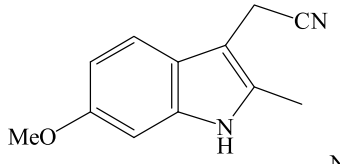
(C) 

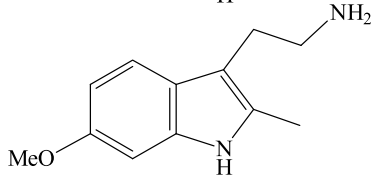
(D) 

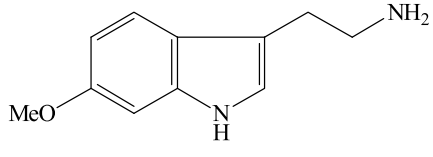
67. The final product of the following reactions is:



(A) 

(B) 

(C) 

(D) 

68. The degree of degeneracy for an energy level $\frac{17h^2}{8mL^2}$ of a particle in a cubical box of side 'L' is

(A) 5
(B) 3
(C) 4
(D) 2

69. A particle of mass 'm' moving in one-dimension between $x = a$ and $x = b$ is described by a wavefunction $\psi = \frac{N}{x}$ where N is normalization constant. The average value of x is

(A) $\frac{b}{a}$

(B) $\frac{ab}{b-a} e^{b/a}$

(C) $\frac{ab}{b-a} ln\frac{a}{b}$

(D) $\frac{ab}{b-a}[ln\, b - ln\, a]$

70. ψ_1 and ψ_2 are normalized and are mutually orthogonal to each other. The normalization constant for the function $\psi_1 + \sqrt{3}\,\psi_2$ is

(A) $\frac{\sqrt{3}}{2}$
(B) 1
(C) $\frac{1}{2}$
(D) $\frac{3}{2}$

71. A system undergoes change from macrostate I to macrostate II, where six distinguishable particles are distributed in three different energy levels (0, ε and 2ε)

Energy	0	ε	2ε
Macrostate I	3	3	0
Macrostate II	2	2	2

The change in entropy would be

(A) RT $ln\frac{3}{2}$

(B) K ln 4·5

(C) K $ln\frac{3}{2}$

(D) 0

72. Which of the following is correct wavefunction for helium atom?

(A) $1s(1)\ 2s(2)\ (\alpha_1\beta_2 - \beta_1\alpha_2)$

(B) $[1s(1)\ 2s(2) - 2s(1)\ 1s(2)]\ (\alpha_1\beta_2 - \beta_1\alpha_2)$

(C) $1s(1)2s(2)\ \alpha_1\beta_2 - 2s(1)1s(2)\ \beta_1\alpha_2 + 1s(1)\ 2s\ (2)\ \beta_1\alpha_2 - 2s(1)\ 1s(2)\ \alpha_1\beta_2$

(D) $[1s(1)2s(2) - 2s(1)1s(2)]\ (\alpha_1\beta_2 - \beta_1\alpha_2)$

73. The degeneracy of the most probable energy level for an atom of mass 'm' of one mole of an ideal gas at T K and pressure P atm, assuming that the atom can be treated as a particle in a three-dimensional cubical box is

(A) $\frac{2\sqrt{3mKT}}{h}\left(\frac{RT}{P}\right)^{\frac{1}{3}}$

(B) $\frac{2L\sqrt{3mKT}}{h}$

(C) $\frac{\sqrt{3mKT}}{h}\left(\frac{RT}{P}\right)^{\frac{1}{2}}$

(D) $\frac{2L\sqrt{mKT}}{h}$

74. A normalized trial function for a particle in a one-dimensional box of length 'L' is $\psi = Nx\ (L - x)$ where N is normalization constant. The upper bound to the ground state energy of the system

(A) $\frac{N\hbar^2}{8mL^2}$

(B) $\frac{N^2\hbar^2}{8mL^2}$

(C) $\frac{N^2\hbar^2L^3}{6m}$

(D) $\frac{N^2\hbar^2L^3}{8m}$

75. The partition function for a two-level system for which lower state (at energy 0) being non-degenerate and the upper state (at an energy ε) triply degenerate is

(A) $e^{-\varepsilon/KT}$

(B) $3e^{-\varepsilon/KT}$

(C) $1+2e^{-\varepsilon/KT}$

(D) $1+3e^{-\varepsilon/KT}$

76. The energy transfer efficiency between a donor (D) and an acceptor (A) molecule decreases when the

(A) distance between the donor (D) and the acceptor (A) decreases.

(B) distance between the donor (D) and the acceptor (A) increases.

(C) the emission spectrum of the donor (D) strongly overlaps with the absorption spectrum of the acceptor (A).

(D) fluorescence quantum yield of donor (D) becomes equal to that of the acceptor (A).

77. Match Column A with Column B

Column A	Column B
(a) CdSeS/ZnS	(i) Surface Plasmon Resonance
(b) Zinc-Phthalocyanine	(ii) Forbidden Singlet-Singlet transition
(c) Gold nanoparticles	(iii) Electronic transition between conduction and valence band
(d) Fullerene C_{70}	(iv) Appearence of Soret and Q absorption bands

(A) (a) → (i), (b) → (ii), (c) → (iii), (d) → (iv)

(B) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)

(C) (a) → (iii), (b) → (iv), (c) → (i), (d) → (ii)

(D) (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)

78. Which of the following molecules would generate triplet excited state upon irradiation by 532nm laser source during transient absorption experiment?

(A) Calix [4] pyrrole

(B) Tetracyanoethylene

(C) C_{60}

(D) Allene

79. Three roots of van der Waals equation for real gas correspond to ($p < p_c$) the volumes of

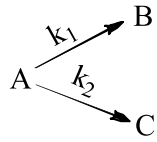
(A) (i) liquid phase (ii) gaseous phase and (iii) solid phase, respectively.

(B) (i) ideal gas phase (ii) real gas phase and (iii) liquid phase, respectively.

(C) (i) liquid phase (ii) gaseous phase and (iii) super saturated metastable phase, respectively.

(D) (i) liquid phase (ii) gaseous phase and (iii) physically unreal phase, respectively.

80. For a parallel reaction,



the activation energy for the disappearance of A in terms of activation energies E_1 and E_2 of two parts is given by

(A) $\frac{k_1E_1 + k_2E_2}{k_1 + k_2}$

(B) $\frac{E_1 + E_2}{2}$

(C) $\frac{k_1E_1 + k_2E_2}{E_1 + E_2}$

(D) $\sqrt{E_1 \cdot E_2}$

81. If heat flows from a colder body to a hotter body (without any other change), the entropy of the system will be

(A) unchanged

(B) decreased

(C) increased

(D) decreased initially then increased passing through a minimum

82. Organic molecules X and Y give coloured solutions while Z give colourless solution in water. In a photochemical experiment, X and Y are found to give well defined λ_{max} at 550 nm and 710 nm, respectively, and Z at 240 nm. Which of the following orders refers to the life times of the corresponding excited states?

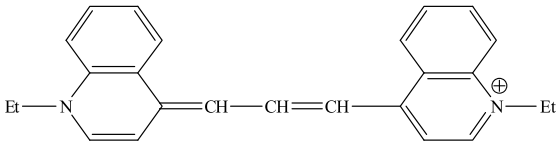
(A) X > Y > Z

(B) Y > X > Z

(C) X > Z > Y

(D) Z > Y > X

83. The cryptocyanine dye molecule,



, has a distance of 4·637 Å between two nitrogen atoms. The electronic spectra of cryptocyanine follow the model of a particle in one dimensional box. At which wavelength does it expected to absorb?

(Given 8mc/h = 3297).

(A) 707 nm

(B) 840 nm

(C) 727 nm

(D) 2706 nm

84. Characters of a few symmetry operations are given below. Identify the characters of the irreducible representation E_u.

	E	C_3	C_2	i	S_6	σ_d
(A)	1	1	–1	1	1	–1
(B)	2	–1	0	2	–1	0
(C)	1	1	1	–1	–1	–1
(D)	2	–1	0	–2	1	0

85. $X + Y \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} Z$ is a millisecond reaction. Which of the following expressions corresponds to the time of relaxation τ [suffix *e* refers to equilibrium]?

(A) $\frac{1}{\tau} = k_1 + k_{-1}$

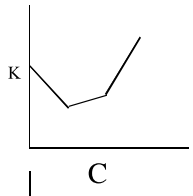
(B) $\frac{1}{\tau} = k_1([X]_e + [Y]_e) + k_{-1}$

(C) $\frac{1}{\tau} = 4k_1[X]_e + k_{-1}[Y]_e$

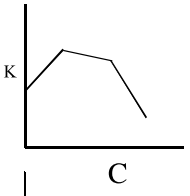
(D) $\frac{1}{\tau} = k_1\left(4[X]_e[Y]_e + [X]_e^2\right)k_{-1}$

86. In a conductivity experiment, sodium hydroxide solution is titrated with oxalic acid solution. Select the correct graph for K Vs. concentration of oxalic acid plot (K = specific conductance)

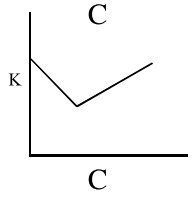
(A)



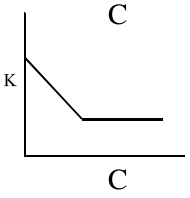
(B)



(C)



(D)



87. Following are the electronic transitions of a diatomic molecule:

(i) $^1\sum_g^+ \longrightarrow {}^3\sum_g^+$ (ii) $^1\sum_u^+ \longrightarrow {}^1\sum_g^+$

(i) $^1\Delta_g \longrightarrow {}^1\sum_g^+$ (ii) $^1\Pi_g \longrightarrow {}^1\sum_u^+$

The allowed transitions are

(A) (i) and (iii) only

(B) (ii) and (iv) only

(C) (i), (ii) and (iii) only

(D) (i), (iii) and (iv) only

88. The ClO_2 molecule (C_{2v}) is trapped in a solid. Its ground state is known to be B_1. Light polarised parallel to the y axis (parallel to 00 separation) excites this molecule to a upper state. What is the symmetry of that state?

Character Table

C_{2v}	E	$C_2(z)$	σ (x z)	σ (y z)	
A_1	1	1	1	1	Z
A_2	1	1	–1	–1	R_Z
B_1	1	–1	1	–1	x, R_y
B_2	1	–1	–1	1	y, R_x

(A) A_1 because $A_2 \times B_1 \times B_2 = A_1$

(B) A_2 because $A_2 \times A_2 = A_1$

(C) B_1 because $A_2 \times B_2 = B_1$

(D) B_2 because $A_2 \times B_1 = B_2$

89. For the reaction, $P + 2Q \longrightarrow R + S$, $\Delta H = -25 kcal.mol^{-1}$ and $\Delta S = 90$ cal deg^{-1} mol^{-1} at 27°C.

Among the following, the correct statement is:

(A) The reaction is not feasible at 27°C.

(B) The reaction is irreversible at 27°C.

(C) The reaction is at equilibrium state at 27°C.

(D) The reaction can occur only at temperatures higher than 27°C.

90. The Vapour pressure of solid and liquid ammonia near the triple point are given by:

$$\log\left(p^s / torr\right) = 10{\cdot}0 - \frac{1630K}{T} \text{ and } \log\left(p^l / torr\right) = 8{\cdot}46 - \frac{1330K}{T}$$

What is the value of the ratio of slope of the solid-gas curve and liquid-gas curve at the triple point?

(A) 0·815

(B) 1·815

(C) 0·225

(D) 1·225

91. In simultaneous static and dynamic quenching reaction the ratio of fluorescence intensity of uncomplexed fluorophore to that of complexed fluorophore Vs. concentration of quencher should give rise

(A) a straight line passing through origin.

(B) an upward curvature.

(C) downward curvature.

(D) parabolic shape.

92. The character table of C_{3v} point group is given as follows:

C_{3v}	E	$2C_3$	$3\sigma_v$	
A_1	1	1	1	Z
A_2	1	1	–1	R_Z
E	2	–1	0	(x, y) (R_x,R_y)

Let us consider the reducible representation (Γ_1) of the C_{3v} point group as follows:

C_{3v}	E	$2C_3$	$3\sigma_v$
Γ_1	4	1	–2

The sum of the irreducible representation is

(A) $2A_1 + A_2 + E$

(B) $A_1 + 2A_2 + E$

(C) $A_1 + A_2 + 2E$

(D) $A_1 + A_2 + E$

93. What fraction of the volume of the unit cell is occupied by a Copper atom? Assume each atom has a hard-sphere in contact with its neighbour and Copper crystallizes in a face-centred cubic lattice.

(A) 0·140

(B) 0·340

(C) 0·540

(D) 0·740

94. A polydisperse protein has 10% of molecules having molecular weight 10,000, 80% of 20,000 and 10% of 40,000. Calculate the mass-average molecular weight of the protein sample.

(A) 23,333

(B) 21,000

(C) 23,300

(D) 20,000

95. Aüger electron spectroscopy is useful only for elements having atomic number

(A) above 100

(B) above 50

(C) below 30

(D) below 50

96. The molar volume of Isobutane at 300·0K and one bar is 24·31 $dm^3 \cdot mol^{-1}$. What is the value of 2_{nd} virial co-efficient at 300·0K?

(A) 0 $cm^3 \cdot mol^{-1}$

(B) 630 $cm^3 \cdot mol^{-1}$

(C) –630 $cm^3 \cdot mol^{-1}$

(D) – 63·0 $cm^3 \cdot mol^{-1}$

97. The strongest infrared band of $^{12}C\ ^{16}O$ occurs at 2143cm^{-1}. Find the force constant of $^{12}C^{16}O$ if the reduced mass of $^{12}C\ ^{16}O$ is given as $1{\cdot}1385 \times 10^{-23}$g.

(A) 185·5 N/m

(B) 1855 N/m

(C) 1050 N/m

(D) 105 N/m

98. Predict the number of spectral lines resulted as a splitting up of an energy level in a weak magnetic field for $J = \frac{5}{2}$.

(A) Five

(B) Six

(C) Seven

(D) Eight

99. $\exp(-\alpha x^2)$ is an eigenfunction of $-\frac{d^2}{dx^2} + x^2$ provided

(A) $\alpha = \frac{1}{2}$

(B) $\alpha = 1$

(C) $\alpha = \frac{1}{\sqrt{2}}$

(D) $\alpha = 2$

100. Pick the correct relation between vibrational temperature (θ_{vib}) and rotational temperature (θ_{rot}) from the following:

(A) $\theta_{rot} = \frac{\text{vibrational frequency}}{\text{rotational Constant}} \times \theta_{vib}$

(B) $\theta_{vib} = \frac{\text{vibrational frequency}}{\text{rotational Constant}} \times \theta_{rot}$

(C) $\theta_{vib} \times \theta_{rot} = \frac{\text{rotational Constant}}{\text{vibrational frequency}}$

(D) $\theta_{vib} = \frac{\text{rotational Constant}}{\text{vibrational frequency}} \times \theta_{rot}$

ROUGH WORK

ROUGH WORK