B-6

ENTRANCE EXAMINATIONS – 2022

Ph.D. Chemistry

TIME: 2 HOURS **MAXIMUM MARKS: 70**

HALL TICKET NUMBER:

1. Write your **HALL TICKET NUMBER** in the space provided above and also on the **OMR** ANSWER SHEET given to you.
2. Make sure that pages numbered from **1 - 26** are present (excluding **4** pages assigned for rough work).
3. There are eighty (80) multiple-choice questions in this paper (**20 in Part-A** and **60 in Part-B**). You are required to answer all **questions of Part-A** and a **maximum of 20 questions of Part-B**. If more than the required number of questions are answered in Part-B, **only the first 20 questions** will be evaluated.
4. Each question in Part-A and Part-B carries **1.75 marks**.
5. **There is no negative marking** for both Part-A and Part-B.
6. Answers are to be marked on the OMR answer sheet following the instructions provided on it.
7. Handover the OMR answer sheet to the invigilator at the end of the examination.
8. In case of a tie, the marks obtained in the first 20 questions (**Part-A**) will be used to determine the order of merit.
9. No additional sheets will be provided. Rough work can be done in the space provided at the end of the booklet.
10. Calculators are allowed. Cell phones are not allowed.
11. Useful constants are provided just above Part-A in the question paper.
12. OMR without hall ticket number will not be evaluated and University shall not be held responsible.

Useful Constants:

Rydberg constant = 109737 cm^{-1}; Faraday constant = 96500 C; Planck constant = 6.625×10^{-34} J s; Speed of light = 2.998×10^{8} m s^{-1}; Boltzmann constant = 1.380×10^{-23} J K^{-1}; Gas constant = 8.314 J K^{-1} mol^{-1} = 0.082 L atm K^{-1} mol^{-1} = 1.987 cal K^{-1} mol^{-1}; Mass of electron = 9.109×10^{-31} kg; Mass of proton = 1.672×10^{-27} kg; Charge of electron = 1.6×10^{-19} C; 1 bar = 10^{5} N m^{-2}; RT/F (at 298.15 K) = 0.0257 V; Avogadro number = 6.022×10^{23}; amu = 1.674×10^{-27} kg.

PART-A

1. Identify the most appropriate name reactions for conversion of (i) benzaldehyde into styrene and (ii) phenol into salicylaldehyde

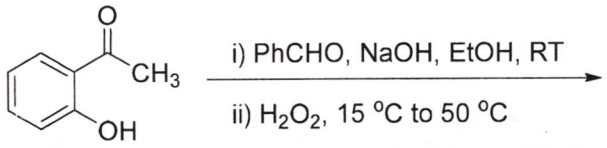
[A] (i) Wittig reaction
(ii) Prins reaction

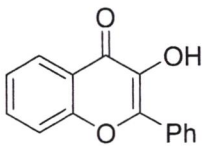
[B] (i) Wittig reaction
(ii) Reimer-Tiemann reaction

[C] (i) Reimer-Tiemann reactioin
(ii) Wittig reaction

[D] (i) Reimer-Tiemann reaction
(ii) Prins reaction

2. The major product obtained in the following reaction is:



[A]


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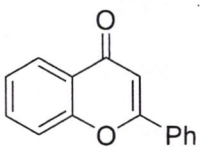

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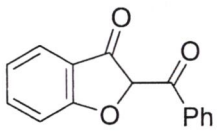
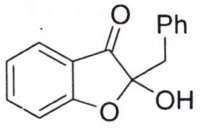
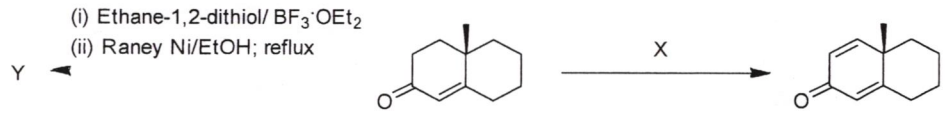
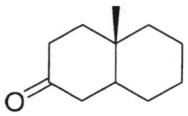
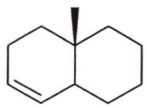


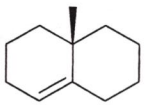
[D]


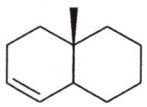
3. Identify the most appropriate reagent (X) and the product (Y) in the following reactions:



[A] X = Pd/C; Y = 

[B] X = *m*CPBA; Y = 

[C] X = DDQ; Y = 

[D] X = DDQ; Y = 

4. Identify the species that can act as a 1,3-dipole in cycloadditions:

(i) $H_2C{=}N_2$ (ii) $H_2C{=}C{=}O$ (iii) O_3 (iv) $H_2C{=}\underset{H}{C}{-}OMe$

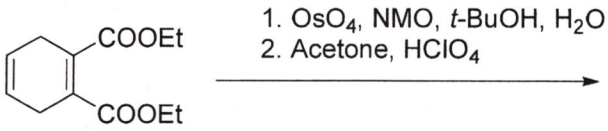
[A] (ii) and (iii)

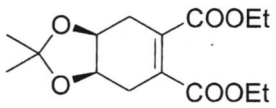
[B] (ii)

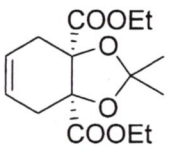
[C] (i), (ii) and (iv)

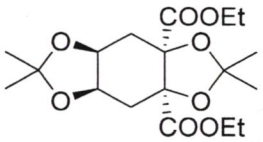
[D] (i) and (iii)

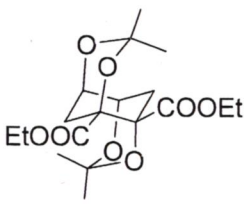
5. The major product formed in the following reaction is:



[A] 

[B] 

[C] 

[D] 

6. In Kiliani-Fischer synthesis of monosaccharides, the products are generally:

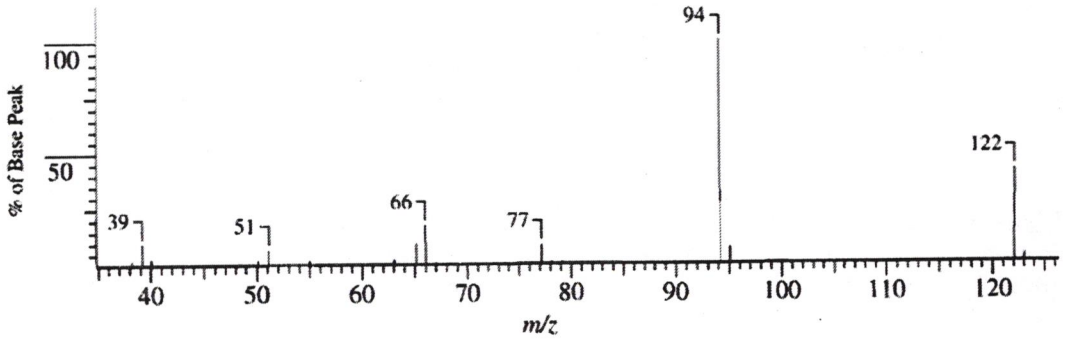
[A] Enantiomers

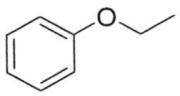
[B] Diastereomers

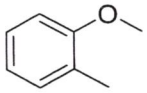
[C] Anomers

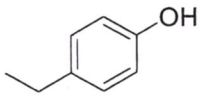
[D] Rotamers

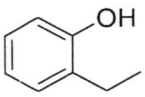
7. The compound that shows the following mass spectrum is



[A] 

[B] 

[C] 

[D] 

8. The most significant observation of Watson and Crick that led to the proposal of the double helical model for DNA is:

[A] Hydrogen bonding between the nucleobases

[B] Base stacking in the double helix

[C] van der Waals attraction between nucleobases

[D] Electrostatic attraction between nucleobases

9. Hypophosphorous acid molecule has

[A] 4 lone pairs, 1 π bond and 5 σ bonds.
[B] 5 lone pairs and 5 σ bonds.
[C] 6 lone pairs, 1 π bond and 6 σ bonds.
[D] 7 lone pairs and 6 σ bonds.

10. The compound *isolobal* to $Ni(CO)_2$ is:

[A] $[Co(CO)_4]^+$ [B] $Fe(CO)_4$

[C] $[Ni(CO)_3]^+$ [D] $[Cu(CO)_2]^+$

11. The lowest formal oxidation state of iron is found in

[A] $[CpFe(CO)_2]_2$ [B] $K_4[Fe(CN)_6]$

[C] $Na_2[Fe(CO)_4]$ [D] $Fe(CO)_5$

12. Coulometry refers to:

[A] Determination of quantity of analyte using Faraday's law when the reaction proceeds at 100% current efficiency.
[B] Determination of quantity of analyte using half-wave potential.
[C] Qualitative determination of elements using half-wave potential.
[D] Quantitative determination of metals deposited on electrodes in a electrolytic process.

13. The metalloprotein oxyhemocyanin contains

[A] Co(II) and O_2^{2-} [B] Cu(II) and O_2^{2-}

[C] Co(IV) and O_2^- [D] Fe(III) and O_2^{2-}

14. The most appropriate statement about valinomycin is:

[A] It is an acyclic oligopeptide capable of binding K^+
[B] It is a cyclic oligopeptide capable of binding K^+
[C] It is an acyclic oligopeptide capable of binding Cl^-
[D] It is a cyclic oligopeptide capable of binding Cl^-

15. Among N_2, H_2O, CH_3CH_3 and CH_2Cl_2, pure vibrational spectrum will be shown by

[A] N_2, H_2O and CH_2Cl_2
[B] H_2O and CH_2Cl_2
[C] H_2O, CH_3CH_3 and CH_2Cl_2
[D] H_2O

16. The commutator $2\pi[x, p_x]$ equals to

[A] $i\hbar$
[B] $-i\hbar$
[C] ih
[D] $-\hbar$

17. For a first-order reaction, $2A \rightarrow$ Products, the expression for [A] is:

(Here, k: rate constant, t: time, $[A]_0$: initial concentration)

[A] $[A] = [A]_0 \exp(-kt/2)$
[B] $[A] = 2[A]_0 \exp(-kt)$
[C] $[A] = 2[A]_0 \exp(-2kt)$
[D] $[A] = [A]_0 \exp(-2kt)$

18. The value of the rotational partition function for a structureless particle is:

[A] 0
[B] 1
[C] ln 2
[D] Infinite

19. The single equivalent symmetry operation for S_6^3 is:

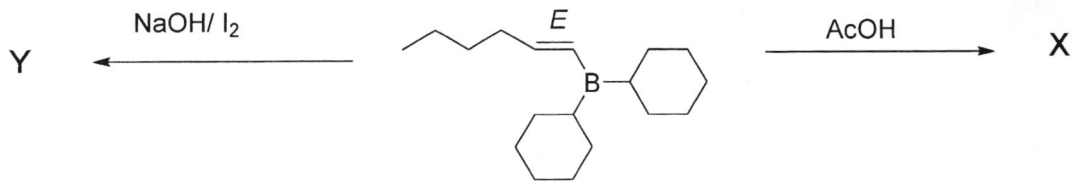
[A] C_3 [B] σ_h
[C] E [D] i

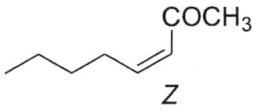
20. The rotational symmetry number for water is:

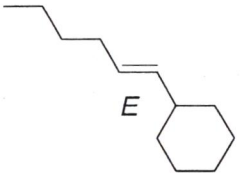
[A] 0 [B] 1
[C] 2 [D] 3

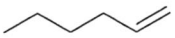
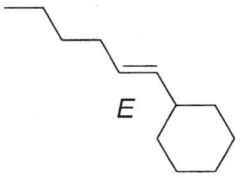
PART - B

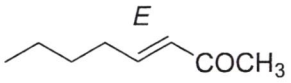
21. Identify X and Y in the following reactions

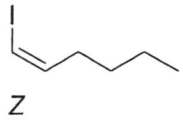


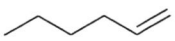
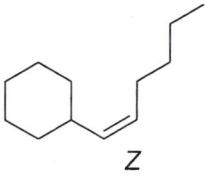
[A] X = 

Y = 

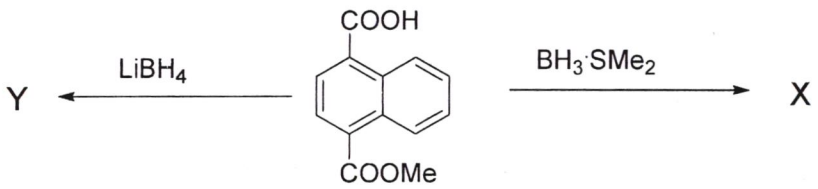
[B] X = 
Y = 

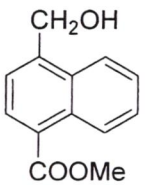
[C] X = 

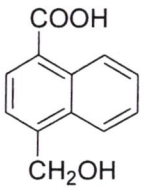
Y = 

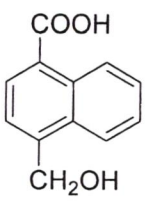
[D] X = 
Y = 

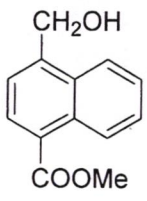
22. Identify X and Y in the following reactions

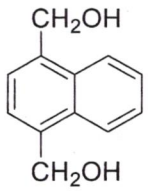
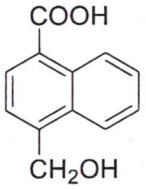


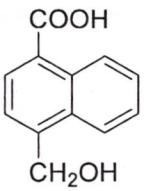
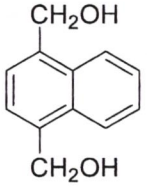
[A] X = 

Y = 

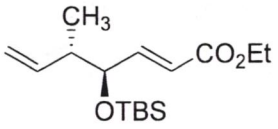
[B] X = 

Y = 

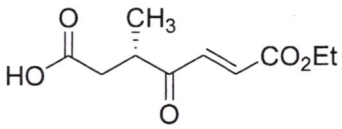
[C] X =  Y = 

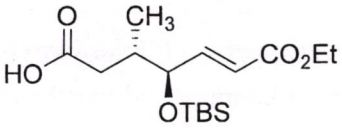
[D] X =  Y = 

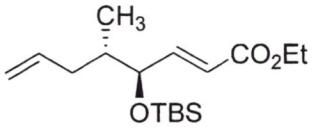
23. The major product formed in the following reaction is:

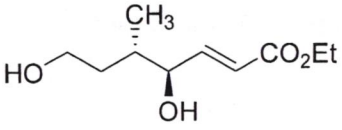


i) Disiamylborane
THF, 0°C, 4 hrs,
then, $NaOH/H_2O_2$
ii) Dess-Martin, DCM
4 hrs
iii) $NaClO_2$, NaH_2PO_4
2-methyl-2-butene

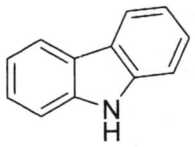
[A] 

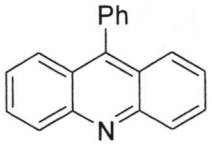
[B] 

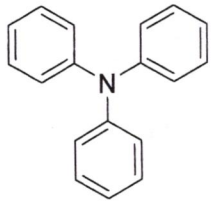
[C] 

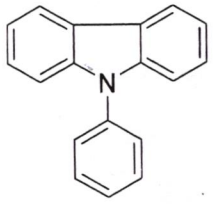
[D] 

24. The major product obtained by the reaction of diphenylamine with benzoic acid in the presence of $ZnCl_2$ at 230 °C is:

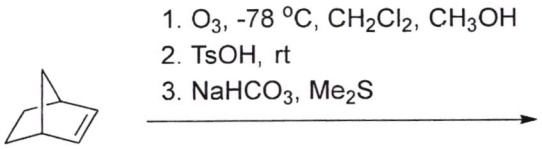
[A] 

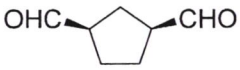
[B] 

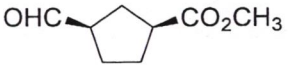
[C] 

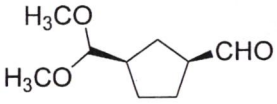
[D] 

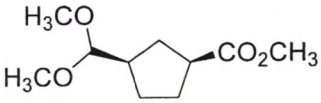
25. The major product formed in the following reaction is:



[A] 

[B] 

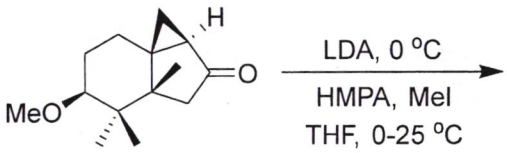
[C] 

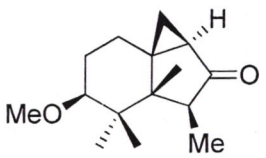
[D] 

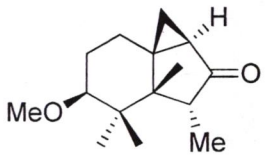
26. The biosynthetic precursor for the hormone serotonin and natural camphor respectively are:

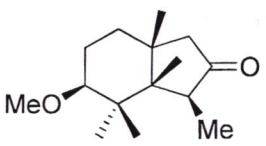
[A] tryptophan and linaloyl pyrophosphate
[B] phenylalanine and neryl pyrophosphate
[C] glycine and chrysanthemyl pyrophosphate
[D] dopamine and farnesyl pyrophosphate

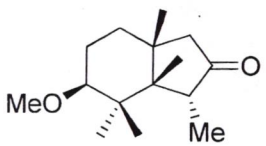
27. The major product formed in the following reaction is:



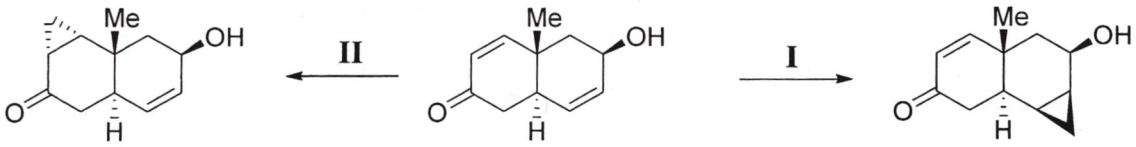
[A] 

[B] 

[C] 

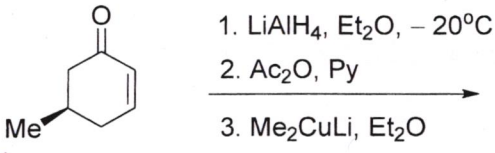
[D] 

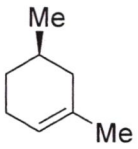
28. The reagents I and II in the following reactions are

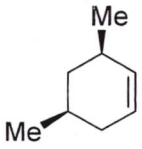


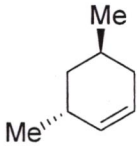
[A] I = CH_2I_2, Zn-Cu; II = $Me_3S^+I^-$, NaH
[B] I = CH_2I_2, Zn-Cu; II = $Me_3S^+(O)I^-$, NaH
[C] I = $Me_3S^+(O)I^-$, NaH; II = $Me_3S^+I^-$, NaH
[D] I = $Me_3S^+(O)I^-$, NaH; II = CH_2I_2, Zn-Cu

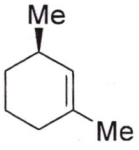
29. The major product formed in the following reaction is:



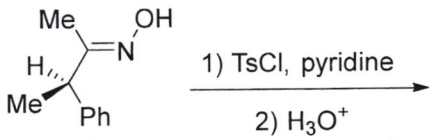
[A] 

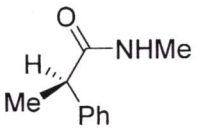
[B] 

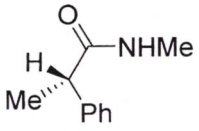
[C] 

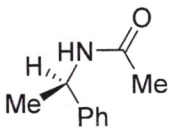
[D] 

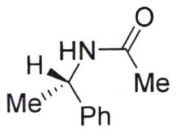
30. The major product formed in the following reaction is:



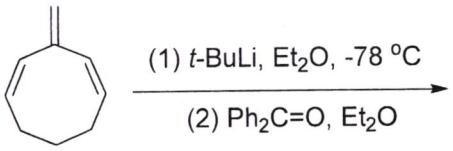
[A] 

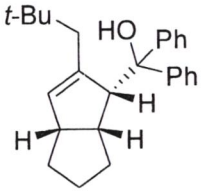
[B] 

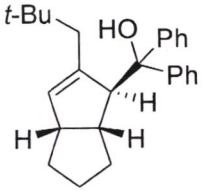
[C] 

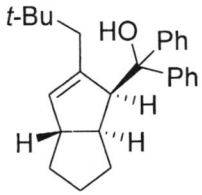
[D] 

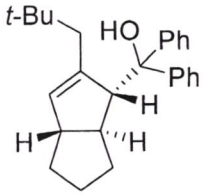
31. The major product formed in the following reaction is:



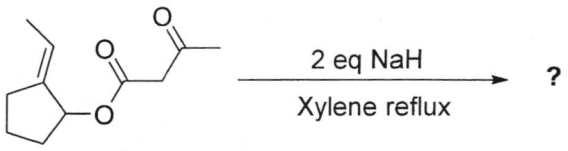
[A] 

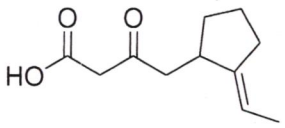
[B] 

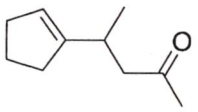
[C] 

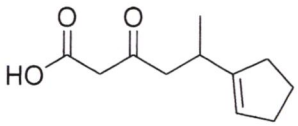
[D] 

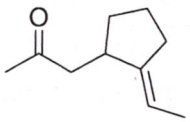
32. The major product formed in the following reaction is:



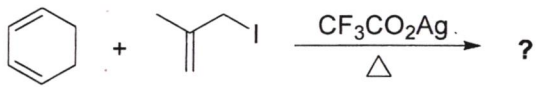
[A] 

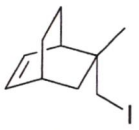
[B] 

[C] 

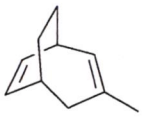
[D] 

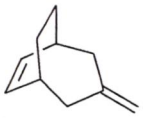
33. The major product formed in the following reaction is:



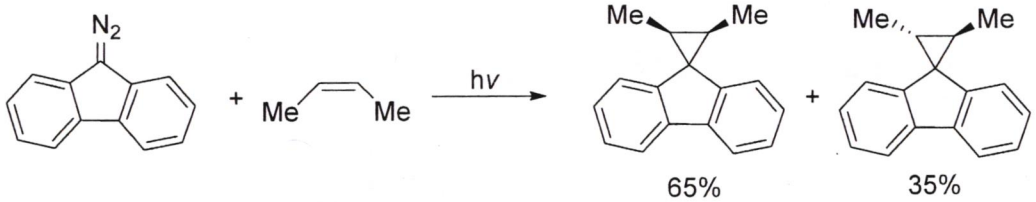
[A] 

[B] 

[C] 

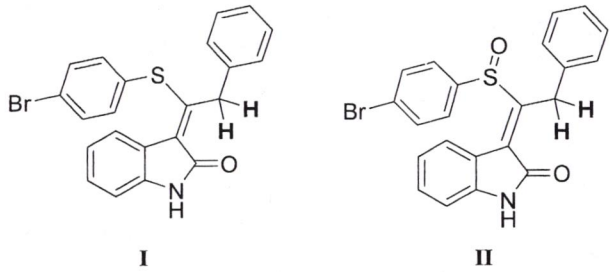
[D] 

34. The reaction intermediate involved in the following reaction is a



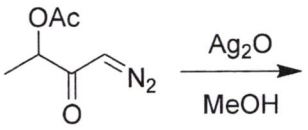
[A] singlet carbene
[B] radical
[C] carbanion
[D] triplet carbene

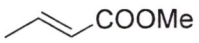
35. The relation between the benzylic protons (marked bold) in the following compounds I and II are respectively:

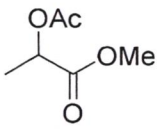


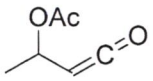
[A] homotopic and enantiotopic
[B] enantiotopic and enantiotopic
[C] enantiotopic and diastereotopic
[D] diastereotopic and enantiotopic

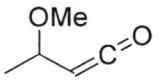
36. The major product formed in the following reaction is:



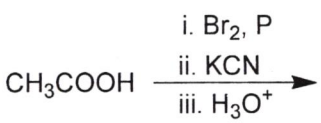
[A] 

[B] 

[C] 

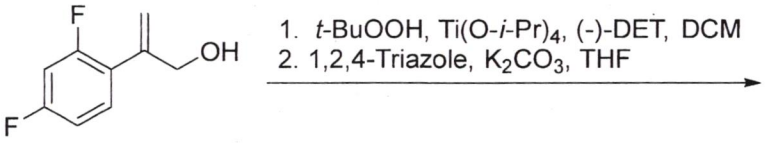
[D] 

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



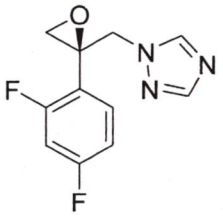
[A] Succinic acid
[B] Malonic acid
[C] Glycolic acid
[D] α-Hydroxypropionic acid

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

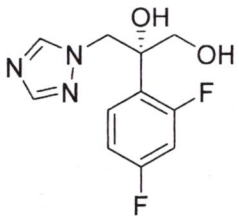


[A]

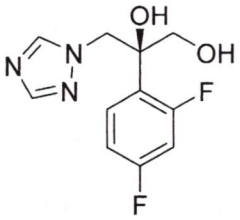
[B]



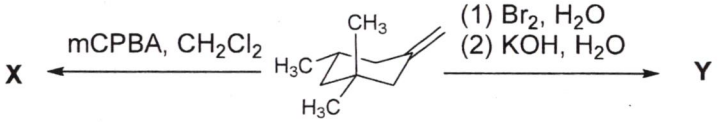
[C]



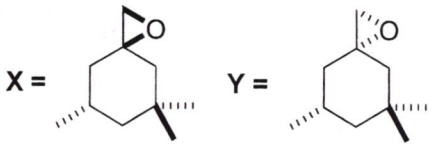
[D]



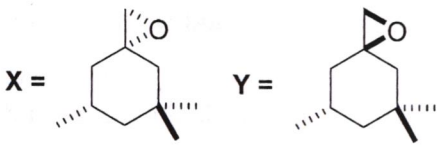
39. The major products **X** and **Y** formed in the following reactions are:



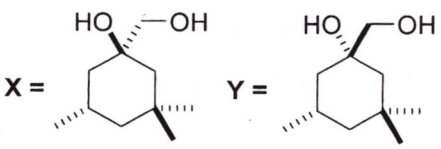
[A]



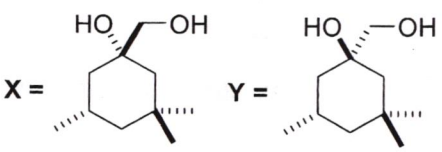
[B]



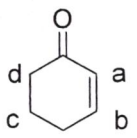
[C]



[D]



40. Identify the most appropriate chemical shifts (i to iv) to the labelled carbons (a to d) of the given compound from the following list:



(i) δ 25.7

(ii) δ 38.1

(iii) δ 129.8

(iv) δ 150.9

[A] a – (iv); b – (iii); c – (ii); d – (i)
[B] a – (iii); b – (iv); c – (ii); d – (i)
[C] a – (iv); b – (iii); c – (i); d – (ii)
[D] a – (iii); b – (iv); c – (i); d – (ii)

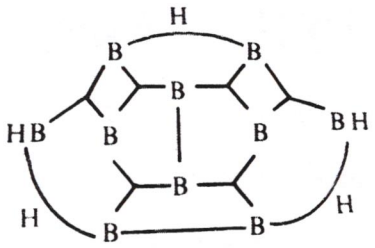
41. The experimental hydration energies of Ca^{2+}, Mn^{2+} and Zn^{2+} were plotted against atomic numbers. A straight line passing through these points gave a value of −716 kcal/mol as the hydration energy of Ni^{2+}. If the $^3A_{2g} \rightarrow {}^3T_{2g}$ transition for $[Ni(H_2O)_6]^{2+}$ occurs at 8650 cm^{-1}, calculate the expected hydration energy of Ni^{2+} [1 kcal/mol = 350 cm^{-1}].

[A] −666 kcal/mol
[B] −686 kcal/mol
[C] −746 kcal/mol
[D] −766 kcal/mol

42. Trigonal-bipyramidal complex of formula $[M(A–A)B_2X]$ (A–A represents a symmetrical bidentate ligand and B and C represent two different monodentate ligands) can have

[A] 3 geometrical isomers and one of them will be optically active.
[B] 4 geometrical isomers and 2 of them will be optically active.
[C] 3 geometrical isomers and 2 of them will be optically active.
[D] 4 geometrical isomers and one of them will be optically active.

43. The correct *styx* number of $[B_{10}H_{15}]^-$ structure given below is (B in the given structure represents BH):



[A] 3412 [B] 4012

[C] 3422 [D] 3622

44. Identify the correct order by using ^{1}H-NMR chemical shift values of compounds.

[A] $W(Me)_6 = Mn(CO)_5H < (\eta^2\text{-}C_2H_4)_2Ni < (\eta^5\text{-}C_5H_5)_2Fe$

[B] $Mn(CO)_5H < (\eta^5\text{-}C_5H_5)_2Fe < (\eta^2\text{-}C_2H_4)_2Ni < W(Me)_6$

[C] $(\eta^5\text{-}C_5H_5)_2Fe < (\eta^2\text{-}C_2H_4)_2Ni < W(Me)_6 < Mn(CO)_5H$

[D] $W(Me)_6 < Mn(CO)_5H < (\eta^5\text{-}C_5H_5)_2Fe < (\eta^2\text{-}C_2H_4)_2Ni$

45. Match the following terms:

a	$(\eta^1\text{-}C_5H_5)(\eta^5\text{-}C_5H_5)(CO)_2Fe$	i	Butterfly framework
b	$HCo(CO)_4$	ii	Hemocyanin
c	$Os_4(CO)_{15}$	iii	Ring Whizzer
d	Cyanide poisoning	iv	Carboxypeptidase
e	Arthropoda	v	Amyl nitrite
f	Entactic	vi	Acidic

[A] a=iii; b=vi; c=i; d=v; e=ii; f=iv

[B] a=vi; b=i; c=iii; d=v; e=iv; f=ii

[C] a=vi; b=v; c=i; d=ii; e=iv; f=iii

[D] a=iii; b=v; c=i; d=ii; e=iv; f=vi

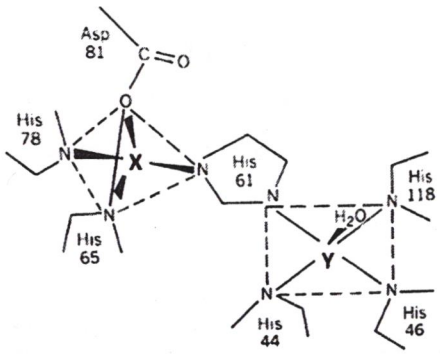
46. The following diagrams are the pictorial representations of hemoglobin synthetic model systems.

I II III

The correct names of the models are:

[A] I) Roofed, II) Strapped and III) Picket fence
[B] I) Picket fence, II) Strapped and III) Roofed
[C] I) Picket fence, II) Roofed and III) Strapped
[D] I) Picket fence, II) Hemisphere and III) Roofed

47. The schematic drawing shown below represents active sites of bovin *Superoxide Dismutase*. X and Y are the metal centres.



Identify a combination of X and Y centres which can deactivate the enzyme.

[A] X = Zn and Y = Cu [B] X = Cu and Y = Cu
[C] X = Co and Y = Cd [D] X = Cd and Y = Cu

48. The rate of a substitution reaction is given by rate = $(k_1 + k_2[I^-])$ $[PtCl(dien)^+]$, with k_1 and k_2 being the first and second order rate constants. The observed rate in the presence of excess of I^- ions is given by

[A] $k_{obs} = k_1 + k_2[I^-]$ [B] $k_{obs} = k_2[I^-][PtCl(dien)^+]$

[C] $k_{obs} = k_1$ [D] $k_{obs} = k_1[PtCl(dien)^+]$

49. Consider Bailar twist and Ray-Dutt twist for the racemization of octahedral complexes with bidentate ligands and choose the correct statement/s among the following.

(i) Ray-Dutt twist takes place intermolecularly.

(ii) The C_3 axis is the twist axis for Bailar twist.

(iii) Both the processes take place *via* a trigonal prismatic intermediate/transition state.

[A] (i) and (ii) [B] (i) and (iii)

[C] (ii) and (iii) [D] (ii) only

50. For the molecule MX_7 with capped (capping on the square face) trigonal prismatic structure, how many environments are theoretically possible for X?

[A] Two [B] Three

[C] Four [D] One

51. Given that $p[H_2] = 1$, pH = 7, $[Fe]^{2+} = 1M$, and $E^{o}_{Fe^{2+}/Fe} = 0.47$ V, the potential E for the oxidation of Fe to Fe^{2+} is closest to

[A] + 0.05V [B] - 0.05 V

[C] - 0.36 V [D] + 0.36 V

52. Sulfur dioxide forms 1:1 coordination complexes with both SbF_5 and $Ir(PPh_3)_2(CO)Cl$. Choose the correct statement about the donor atom (from SO_2) among the following.

[A] Oxygen is the donor atom in both the complexes.

[B] Sulfur is the donor atom in both the complexes.

[C] Sulfur is the donor atom in the iridium complex and the oxygen is the donor atom in SbF_5 complex.

[D] Oxygen is the donor atom in the iridium complex and sulfur is the donor atom in the SbF_5 complex.

53. Consider a metal ion having a S = 3/2 spin system. Predict the possible number of fine structures in an EPR spectrum if you consider a zero field splitting ZFS (D) and Kramer's degeneracy to be present in the system and in case if the ZFS (D) value is too large compared to applied magnetic field.

[A] 3 and 1, respectively. [B] 4 and 2, respectively.

[C] 1 and 2, respectively. [D] 3 and 2, respectively.

54. For Sm^{3+} and Eu^{3+}, the calculated values of μ_J (BM) are far lesser than the experimentally obtained values of 1.6 and 3.6 BM respectively. The reason for this anamoly is

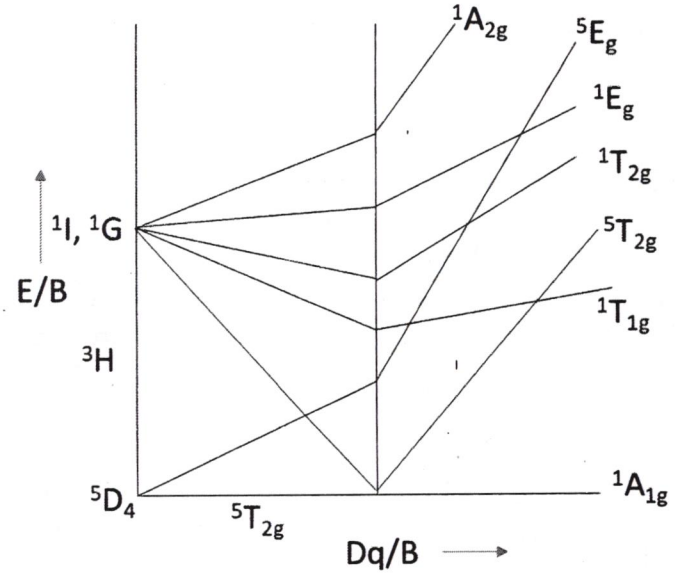
[A] multiplet width approximately being equal to k_BT.

[B] multiplet width much lesser than k_BT.

[C] multiplet width greater than k_BT.

[D] multiplet width infinitely larger than k_BT.

55. Identify the d^n system corresponding to the Tanabe-Sugano configuration given below. Also identify the number of spin allowed transitions in the weak and strong field part of the diagram.



[A] d^4: 2 and 1, respectively. [B] d^5: 3 and 3, respectively.

[C] d^6: 1 and 4, respectively. [D] d^7: 3 and 1, respectively.

56. Calculate the cell potential for

Ag | AgCl (saturated) , HCl (0.0200 M) | H_2(0.800 atm),Pt

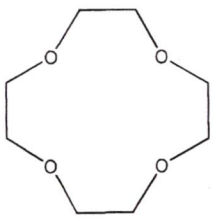
and comment whether it is a spontaneous (galvanic cell) or non-spontaneous (electrolytic cell) reaction (Use $E^o_{AgCl/Ag}$ = 0.222 V)

[A] 0.00 V and no reaction will occur
[B] –0.420 and non-spontaneous electrolytic cell
[C] +0.420 and spontaneous galvanic cell
[D] +0.222 V and non-spontaneous electrolytic cell

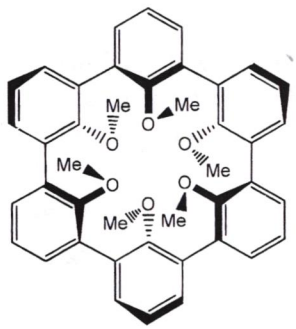
57. For the electron transfer process $[Co(NH_3)_5X]^{2+} + [Cr(H_2O)_6]^{2+} + 5H_3O^+ \rightarrow [Cr(H_2O)_5X]^{2+} + [Co(H_2O)_6]^{2+} + 5NH_4^+$, identify the correct pair of inert complexes:

[A] $[Co(NH_3)_5X]^{2+}$ and $[Co(H_2O)_6]^{2+}$
[B] $[Co(NH_3)_5X]^{2+}$ and $[Cr(H_2O)_6]^{2+}$
[C] $[Cr(H_2O)_5X]^{2+}$ and $[Co(H_2O)_6]^{2+}$
[D] $[Co(NH_3)_5X]^{2+}$ and $[Cr(H_2O)_5X]^{2+}$

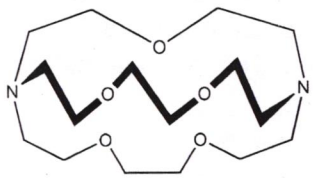
58. Among macrocycles A, B and C, the order of affinity towards lithium ion is



A



B



C

[A] C = B = A
[B] A < B < C
[C] C < B < A
[D] C < A < B

59. Truncated icosahedron (e.g., C_{60}) has

[A] 12 pentagons and 20 hexagons
[B] 12 pentagons and 20 squares
[C] 20 equilateral triangular faces and 20 hexagons
[D] 20 equilateral triangular faces and 12 pentagons

60. Which statement among the following about a Verkade's superbase is correct?

[A] Protonation occurs on the phosphorus atom with additional intramolecular N–P bond formation
[B] Protonation occurs on the phosphorus atom without any additional intramolecular N–P bond formation
[C] Protonation occurs on the nitrogen atom without any additional intramolecular N–P bond formation
[D] Protonation occurs on the nitrogen atom with the additional intramolecular N–P bond formation

61. The packing efficiency of a 2-dimensional square lattice is:

[A] 0.820 [B] 0.785
[C] 0.682 [D] 0.750

62. The bond dissociation energy of H_2 molecule is 431.6 $kJ\ mol^{-1}$. If the zero-point energy of H_2 molecule is 26.0 $kJ\ mol^{-1}$, the bond dissociation energy of D_2 molecule in $kJ\ mol^{-1}$is: (assume identical force constant for the H-H and D-D bonds)

[A] 457.6 [B] 405.6
[C] 439.2 [D] 444.1

63. The reaction $2NO + O_2 \rightarrow 2NO_2$ proceeds through the following steps:

$$2NO \rightleftharpoons N_2O_2 \quad \text{(fast)}$$
$$N_2O_2 + O_2 \longrightarrow 2NO_2$$

If ΔG for the first step is $-15\ kcal\ mol^{-1}$ and E_a for the second step is $9\ kcal\ mol^{-1}$, the rate constant of the reaction at 35°C (k_2) is related to the rate constant at 25 °C (k_1) as

[A] $k_2 = 8.2\ k_1$ [B] $k_2 = 0.6\ k_1$
[C] $k_2 = 7.2\ k_1$ [D] $k_2 = 6.3\ k_1$

64. The characters of the irreducible representations of C_{3h} point group are given below. The correct Mulliken symbols for the IR_1 and IR_2 are:

C_{3h}	E	$2C_3$	σ_h	$2S_3$
IR_1	2	−1	2	−1
IR_2	1	1	−1	−1

[A] E and A
[B] $E'$and A''
[C] $E''$and A'
[D] E_2 and A_1

65. The separation between the energy levels in a two-level system is $1.38 \times 10^{-20} J$. The temperature (in K) at which the population of the ground state would be 4 times greater than that of the excited state is closest to:

[A] 475
[B] 530
[C] 721
[D] 1220

66. The rotational temperature for H_2 with a rotational constant 60.6 cm^{-1} is nearly equal to:

[A] 67.3
[B] 77.3
[C] 87.3
[D] 97.3

67. The work done (in kJ) when 3 moles of an ideal monatomic gas at 298 K undergo irreversible isothermal expansion from pressure of 60.0 kPa to 30.0 kPa until the volume is doubled is:

[A] 0.37
[B] 3.7
[C] −0.37
[D] −3.7

68. The bond length in $^{12}C^{14}N$ is 117 pm, and its force constant is 1630 Nm^{-1}, the fundamental vibrational frequency (in cm^{-1}) is:

[A] 2.07×10^3
[B] 2.07×10^2
[C] 3.07×10^3
[D] 2.07×10^2

69. The zero-point energy (in J) of an electron confined in a box of length 1.0 nm is close to:

[A] 1.060×10^{-20}
[B] 4.025×10^{-20}
[C] 6.025×10^{-20}
[D] 3.025×10^{-20}

70. The correct expression for the Langmuir adsorption isotherm which is required to plot the experimental data set of pressure and volume is (where V_∞ is the volume corresponding to complete coverage and K is the ratio of adsorption and desorption rate constants):

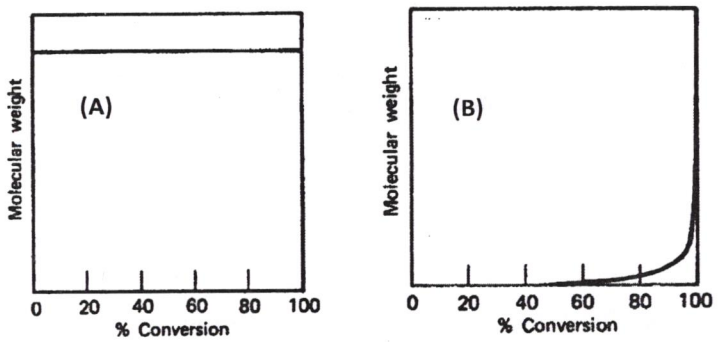
[A] $\frac{p}{V} = \frac{p}{V_\infty} - \frac{1}{KV_\infty}$

[B] $\frac{p}{V} = \frac{p}{V_\infty} + \frac{1}{K}$

[C] $\frac{p}{V} = \frac{p}{V_\infty} + \frac{1}{KV_\infty}$

[D] $\frac{p}{V} = \frac{p}{V_\infty} - \frac{1}{K}$

71. The polymer molecular weight vs. conversation plots of two different polymerization mechanisms are shown below. Plots (A) and (B) represent:



[A] step and chain polymerizations, respectively
[B] chain polymerization of different types
[C] chain and step polymerizations, respectively
[D] step polymerization of different types

72. The reduced form of the van der Waals equation is:

[A] $p_r = \frac{8T_r}{3V_r - 1} - \frac{3}{T_r V_r^2}$

[B] $p_r = \frac{8T_r}{3V_r - 1} - \frac{3}{V_r^2}$

[C] $p_r = \frac{3T_r}{8V_r - 1} - \frac{8}{3T_r V_r^2}$

[D] $p_r = \frac{3V_r}{8T_r - 1} - \frac{3}{V_r^2}$

73. Which of the following is equal to zero:

[A] $[\hbar L_z, L^2]$ [B] $[L_z, \hbar L]$

[C] $[L_x, iL_y]$ [D] $[L_y, iL_z]$

74. The energy eigenvalue of the ground electronic state of a hydrogen atom is -13.6 eV. If the atom stays in this state for 2 ns, the uncertainty in its energy (in eV) will be close to

[A] 1.64×10^{-7} [B] 5.23×10^{-7}

[C] 8.23×10^{-7} [D] 6.14×10^{-7}

75. The spatial part of the ground electronic wave function of H_2 molecule is given by Ψ = N $[1s_A(1) + 1s_B(1)]$ $[1s_A(2) + 1s_B(2)]$, where the two hydrogen atoms are designated by A and B, 1 and 2 are the two electrons, and N is the normalization constant. The term symbol of the corresponding electronic state is:

[A] ${}^1\Sigma_g^+$ [B] ${}^1\Sigma_u^-$

[C] ${}^3\Sigma_g^+$ [D] ${}^3\Sigma_u^+$

76. Butadiene has an absorption at 4.54×10^4 cm^{-1} for an electron on a transition from $n = 2$ state to $n = 3$ state. Assuming that butadiene can be modeled as a particle in a 1-dimensional box, the approximate total length of the molecule (in Å) is:

[A] 5.78 [B] 4.78

[C] 6.78 [D] 7.78

77. If 4% of the K^+ ions in a KCl crystal are replaced by Ca^{2+} ions, the % decrease in the density of the crystal [atomic weight (g mol^{-1}): K = 39.10; Ca = 40.08; Cl = 35.45] is:

[A] 0.00 [B] 0.50

[C] 1.02 [D] 2.05

78. In the X-ray diffraction pattern of a crystal with a cubic lattice, peaks are observed at 2θ values of 21.00° and 29.87°. If the first peak is assigned to the (1 0 0) plane, the second peak can be assigned to the plane:

[A] (1 1 0) [B] (1 1 1)

[C] $(\bar{1}\ 0\ 0)$ [D] (2 0 0)

79. The ionic mobility of Na^+ ion (in $m^2V^{-1}s^{-1}$) in 0.1 M aqueous solution of NaCl at 25°C, (given the diffusion coefficient of Na^+ ion is $1.30 \times 10^{-9} m^2 s^{-1}$) is:

[A] 5.92×10^{-7} [B] 0.59×10^{-7}

[C] 5.06×10^{-8} [D] 50.6×10^{-8}

80. A zinc rod is placed in 0.1 M solution of zinc sulphate at 25°C. Assume that the salt is dissociated to the extent of 95% at this dilution. Given, $E^0_{Zn^{2+},\ Zn} = -0.76$ V, the electrode potential (in V) at 25°C is:

[A] -0.79 [B] 0.79

[C] -0.76 [D] 0.76

University of Hyderabad

Ph.D. Entrance Examinations - 2022

School/Department/Centre : Chemistry
Course : Ph.D. Subject : Chemistry

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1	B	26	A	51	A
2	A	27	A	52	C
3	C	28	B	53	A
4	D	29	C	54	A
5	A	30	C	55	C
6	B	31	B	56	B
7	D	32	B	57	D
8	A	33	C	58	D
9	A	34	D	59	A
10	D	35	C	60	A
11	C	36	A	61	B
12	A	37	B	62	C
13	B	38	D	63	B
14	B	39	B	64	B
15	C	40	D	65	C
16	C	41	C	66	C
17	D	42	D	67	D
18	B	43	D	68	A
19	D	44	C	69	C
20	C	45	A	70	C
21	D	46	B	71	C
22	A	47	C	72	B
23	B	48	A	73	A
24	B	49	C	74	A
25	C	50	B	75	A
				76	A
				77	C
				78	A
				79	C
				80	A

Note/Remarks :

M. Satyanarayana

Signature 22-11-22
School/Department/Centre