CSIR NET CS DEC 2025
(IFAS SOLVED PAPER)

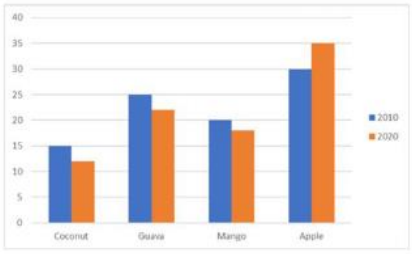
PART A

Q.1 The minimum height of a plane vertical mirror that will allow a 6-feet tall person to see himself fully in it
1. depends on the distance between the person and the mirror
2. is 3 feet
3. is 4.5 feet
4. is 6 feet

Q2. A recent survey suggests that the total fertility rate in a country has fallen below 2.1, the population replacement ratio. This necessarily implies that the
1. infant mortality rate has increased reducing the net fertility ratio.
2. total population will decline.
3. population of young people is going to increase with a faster rate in the long run if the same status continues.
4. proportion of elderly people is going to decrease in the long run if the same status continues.

Q.3 A lady bought some apples, each costing Rs. 25, and some bananas each costing Rs 6, for a total of Rs. 378. In how many ways could she have chosen the numbers of apples and bananas?
1. 1
2. 2
3. 3
4. 4

Q4. The numbers (in millions) of coconut, guava, mango and apple trees in a region in 2010 and 2020 are shown in the following figure.



The maximum relative change in numbers was for
1. coconut trees
2. guava trees
3. mango trees
4. apple trees

Q5. In an exam, questions of three difficulty levels hard, medium, and easy fetch respectively 7, 3, and 2 marks if correct and 0 if incorrect. Three students got 30 marks each but in three different ways, though the total number of questions correctly answered by each student was the same. Then what could be the total number of questions correctly answered by each of these students?
1. 12
2. 10
3. 9
4. 6

Q6.The value of $1+\left(\frac{1}{2^1}+\frac{1}{3}\right)+\left(\frac{1}{2^2}+\frac{1}{5}+\frac{1}{6}+\frac{1}{7}\right)+\cdots+\left(\frac{1}{2^9}+\cdots+\frac{1}{1023}\right)$ lies between

1. 2 and 10
2. 11 and 20
3. 21 and 30
4. 31 and 40

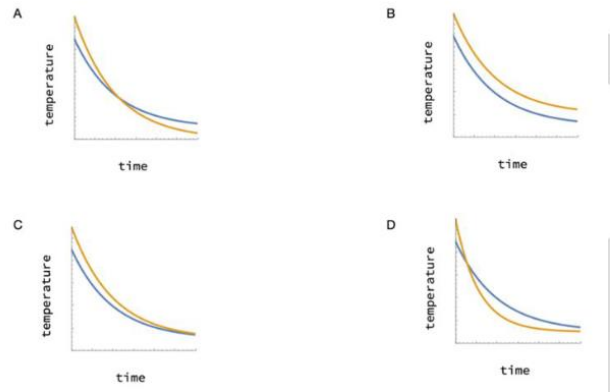
Q.7 How many 5-digit numbers can be formed from the digits 0, 2, 3, 4, 6, 7 and 9, using each at most once, which are divisible by 5?

1. 120
2. 240
3. 360
4. 720

Q.8 Three periodic events repeat every 24 seconds, 54 seconds, and 56 seconds. If they coincide at 10:20:00, when will they next coincide?

1. 10:35:12
2. 10:45:20
3. 10:45:12
4. 10:35:20

Q9. Two identical metal bars are heated to different temperatures and allowed to cool in the same surroundings. Which one of the following figures correctly shows their cooling curves?



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

Q10. Some, but not all, faces of a six-faced cubical fair die are painted red (R) and theremaining green (G); and the die is thrown until red faces come up on top 4 times. Consider the following sequences of colours listed left to right as they appear on the top.

A: GRRRR
B: GRGRRR
Which one of the following is true?

1. A is more probable than B
2. B is more probable than A
3. Both have the same probability
4. Whether A or B is more probable depends upon how many faces are painted green

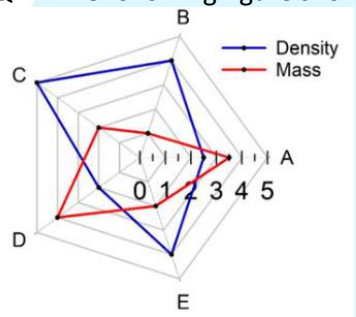
Q11. In a community, some artists are teachers, no teacher is a painter, all painters are artists, and all teachers are professionals. Then it can be definitely asserted that

1. no painter is a professional
2. all artists are professionals
3. no professionals are teachers
4. some artists are professionals

Q12. What is the minimum number of pourings required to transfer exactly 6L of water from a 12L fully filled container to an 8L empty container when a 5L empty container is also available to use?
1. 4
2. 5
3. 6
4. 7

Q13. The geometric mean of 100 observations is 25. If each observation is multiplied by 4, what will be the new geometric mean?
1. 100
2. 50
3. 25
4. $(25 \times 4)^{1/2}$

Q14. The following figure shows densities and masses of five objects (A to E).



The object with the largest volume is
1. A
2. B
3. D
4. E

Q15. Five students graduated from a college, not all in the same year, after each has studied for four years. If batchmates Jiten and Anwar were between Ramesh and Prakash but senior to Sam while Ramesh had left the college before Jiten took admission, then it is certain that
1. Anwar was the most senior
2. Ramesh was the most senior
3. Sam was the most junior
4. Prakash was the most junior

Q16. Which among the following cities can be said most appropriately to bear the same relation to Tamil Nadu that Pune bears to Maharashtra; Surat to Gujarat and Asansol to West Bengal?
1. Tirupati
2. Mysore
3. Chennai
4. Coimbatore

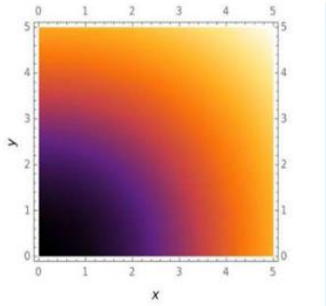
Q17. Alloy A is formed by mixing iron (Fe) and nickel (Ni) in the ratio 3:4, while alloy B is formed by mixing Fe and Ni in the ratio 9:5. If equal quantities of alloys A and B are melted together to form a new alloy C, what will be the ratio of Fe to Ni in the alloy C?

1. 4:3
2. 5:3
3. 15:13
4. 13:9

Q18. Suppose $a_1, a_2, \ldots\ldots, a_{300}$ are integers such that $a_{i-1} + a_i + a_{i+1} = 2025$ for all i = 2,3,..., 299. If $a_7 = -5, a_9 = 37$, then the value of a_{106} is

1. 1993
2. 37
3. -5
4. 2030

Q19. The following plot shows temperature as a function of x and y. Along which path is the temperature change minimum?



1. x = constant or y = constant
2. $\frac{y}{x^2}$= constant
3. $y^2 + x^2 =$ constant
4. yx = constant

Q20. In a class, 40% and 20% students passed in Mathematics and Physics, respectively, and 10% students passed in both subjects. What is the probability of a randomly selected student to have passed in Physics if the student already passed in Mathematics?

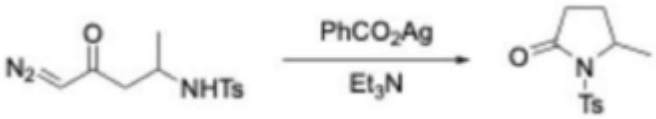
1. 1/2
2. 1/20
3. 1/4
4. 2/25

PART B

Q21. An element $^{27}_{13}A$ is bombarded with two α-particles, as a result of which B is obtained along with the emission of a neutron. The element B is –

1. $^{30}_{15}B$
2. $^{35}_{17}B$
3. $^{34}_{17}B$
4. $^{32}_{16}B$

Q.22 The intermediates involved in the following transformation are



A. carbocation; B. carbanion; C. carbene; D. ketene

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

Q.23 Consider the following statements about H_2S generation using Kipp's apparatus

A. The reagents used are FeS and dil. H_2SO_4

B. The reagents used are FeS and conc. HNO_3

C. H_2S can be prepared intermittently (on-demand)

D. Kipp's apparatus consists of three chambers

The option with the correct statements is

1. B, C and D only
2. A and D only
3. A, C and D only
4. B and C only

Q. 24 The partition function of two indistinguishable noninteracting particles, where one or both can occupy any of the two available energy levels 0 and ε is

1. $1 + e^{-\varepsilon/k_B T} + e^{-2\epsilon/k_B T}$
2. $2 + e^{-\varepsilon/k_B T} + e^{-2\epsilon/k_B T}$
3. $1 + 2e^{-5/k_B T} + e^{-2\Sigma/k_B T}$
4. $1 + e^{-\varepsilon/k_B T} + 2e^{-2E/k_B T}$

Q.25 $C_3^2 i$ is equivalent to

1. S_6
2. S_6^5
3. C_6^5
4. C_6

Q.26 For a hermitian operator $\hat{A}$, consider the following statements.

I. $\hat{A}$ has real eigenvalues

II. $< \hat{A} >$, with respect to any arbitrary state, is always ≥0

III. $< \hat{A}^2 >$, with respect to any arbitrary state, is always ≥0

IV. $\hat{A}$ always commutes with another hermitian operator

The correct complete set of options is

1. I only
2. I, II and III
3. I, II, III, IV
4. I and III only

Q.27 The peak of an absorption spectrum of a molecule is observed at: $21{,}000 cm^{-1}$. [Given: $K_B = 8.62 \times 10^{-5}\ eV\ K^{-1}$; energy corresponding to λ (nm) = (1240/%) eV]

The correct statement is

1. It is a vibrational transition and the energy required is ~ 100 times the thermal energy at 25 °C.
2. It is an electronic transition and the energy required is ~ 100 times the thermal energy at 25 °C.
3. It is a vibrational transition and the energy required is ~ 200 times the thermal energy at 25 °C.
4. It is an electronic transition and the energy required is ~ 200 times the thermal energy at 25 °C.

Q.28 The relative reactivity of alkenes for the cobalt-catalyzed hydroformylation reaction follows the order

Ans=4

1. 
2. 
3. 
4. 

Q. 29 The correct statement about the bond angles of $^{\circ}CF_3$ and $^{\circ}CH_3$ is

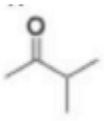
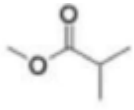
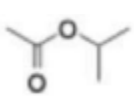
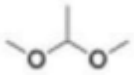
1. $^{\circ}CF_3 < {}^{\circ}CH_3$ due to $n \rightarrow \sigma^*$ interaction in $^{\circ}CF_3$
2. $^{\circ}CF_3 > {}^{\circ}CH_3$ due to $n \rightarrow \sigma^*$ interaction in $^{\circ}CF_3$
3. $^{\circ}CF_3 < {}^{\circ}CH_3$ due to bond pair-bond pair repulsion in $^{\circ}CF_3$
4. $^{\circ}CF_3 > {}^{\circ}CH_3$ due to bond pair-bond pair repulsion in $^{\circ}CF_3$

Q.30 The P-O stretching frequency of phosphoryl compounds follows the order

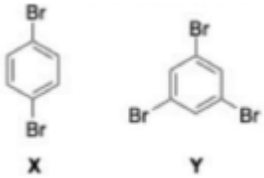
1. $F_3PO > ClaPO > Me_{3_P}O > Ph_3PO$
2. $F_3PO > Cl_3PO > Ph_3PO > Me_3PO$
3. $Me_3PO > Ph_3PO > CI_3PO > F_3PO$
4. $Ph_3PO > Me_3PO > F_3PO > CI_3PO$

Q.31 The compound that would give the following data is

^1H NMR: δ2.43 (m, 1H), 2.10 (s, 3H), 0.95 (d, J = 7 Hz, 6H) ppm.

1. 
2. 
3. 
4. 

Q.32 The relative intensity of molecular ion peaks in the mass spectra of compounds X and Y, respectively, is



1. 9:6:1 and 1:2:2:1
2. 1:2:1 and 1:2:2:1
3. 9:6:1 and 1:3:3:1
4. 1:2:1 and 1:3:3:1

Q. 33 The rate (v) of the reaction $\mathrm{A} + 2\ \mathrm{B} \rightarrow \mathrm{P}$ is given by

$v = k[A][B]$

If initial concentrations of A and B are 2 mM and 4 mM , respectively, and $k = 0.01\ \mathrm{mol}^{-1}\ \mathrm{L\ s}^{-1}$, the half-life (in s) of A is

1. 2.5×10^4
2. 5.0×10^4
3. 2.5×10^5
4. 5.0×10^5

Q. 34 The option with the correct fragments that are isolobal with "S" atom

A. $\mathrm{CpCo(CO)}$

B. $\mathrm{CpFe(CO)_2}$

C. $\mathrm{Cr(CO)_5}$

D. $\mathrm{CH_3}^+$

is

1. A, B, and C only
2. A, C, and D only
3. B, C, and D only
4. A, B, and D only

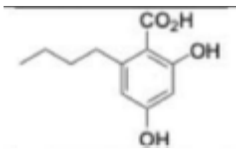
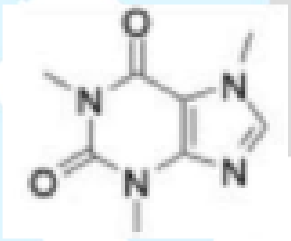
Q35. Among the following, the incorrect statement regarding ionization energy is:

1. It decreases with increase in atomic size.
2. It increases with increase in nuclear charge.
3. In the second period, it increases continuously from B to F.
4. Electrons in orbitals with greater penetration have higher ionization energy.

Q. 36 $\psi(x_1, x_2)$ represents the wavefunction for a two-particle system, where x_i is the combined space and spin coordinates of the i-th particle. The correct antisymmetric wavefunction is

1. $\psi(x_1, x_2) = (x_1^2 - x_2^2)e^{-(x_1^2 + x_2^2)}$
2. $\psi(x_1, x_2) = (x_1^2 + x_2^2)e^{-(x_1^2 - x_2^2)}$
3. $\psi(x_1, x_2) = (x_1 - x_2)^2 e^{-(x_1^2 + x_2^2)}$
4. $\psi(x_1, x_2) = (x_1 + x_2)^2 e^{-(x_1^2 - x_2^2)}$

Q. 37 The correct match of class of natural products in Column A with the compounds in Column B is

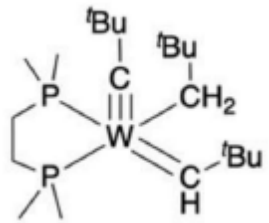
	Column A		Column B
P	alkaloid	i.	
Q	terpenoid	ii.	
R	polyketide	iii.	

1. $\mathrm{P-i; Q-iii, R-ii}$
2. $\mathrm{P-}ii\mathrm{; Q-}i\mathrm{, R-}iii$
3. $\mathrm{P-ii\ ; Q-iii,\ R-i}$
4. P - iii; Q - ii, R -i

Q. 38 The reaction NOT falling under the category of acid-base reaction is

1. $\mathrm{HClO_4 + CH_3CN \rightarrow [CH_3CNH^+[ClO_4]^-}$
2. $\mathrm{NOF + ClF_3 \rightarrow [NO^+[ClF_4]^-}$
3. $\mathrm{XeO_3 + OH^- \rightarrow [HXeO_4]^-}$
4. $\mathrm{Pt + XeF_4 \rightarrow PtF_4 + Xe}$

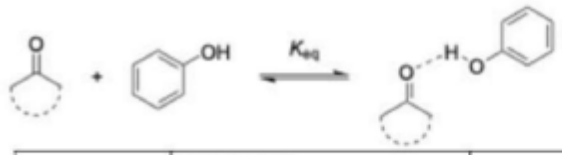
Q. 39 The correct option of bond lengths (A) of the metal-alkylidene and metalalkylidyne, respectively, and the corresponding $^{13}\mathrm{C}$ NMR chemical shifts (ppm) of the complex below

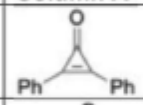
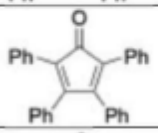


is

1. 1.78,1.94 and 296,256
2. 1.94,1.78 and 256,296
3. 1.94,1.78 and 296,256
4. 1.78,1.94 and 256,296

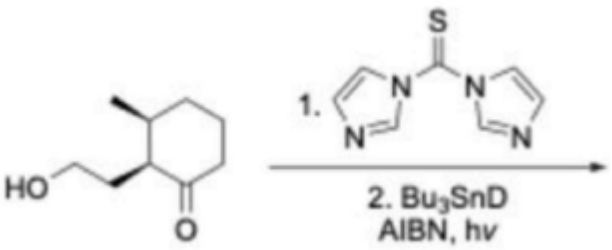
Q.40 The correct match for the ketones in Column A with the K_{eq} values in Column B for their H-bonding with phenol (as shown below) is



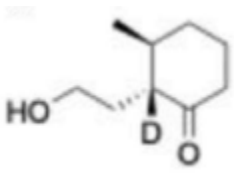
	Column A		Column B
P		i.	6.2
Q		ii.	31.2
R		iii.	83.2

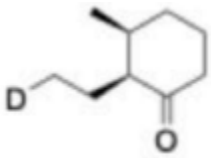
1. P-i; Q-ii, R-iii
2. P-iii; Qi, R-ii
3. P-iii; Q-ii, R-i
4. P-ii; Q-i, R-iii

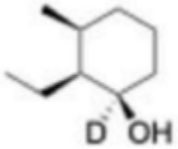
Q.41 The major product formed in the following reaction is

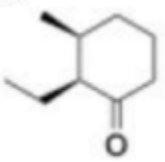


1.



2. 

3. 

4. 

Q.42 The point groups of $[Re_2Cl_8]^{2-}$ and trans-$[Co(en)_2Cl_2]^{+}$, respectively, are

1. D_{4h} and D_2
2. D_{4d} and D_2
3. D_{4h} and D_{4h}
4. $D_{4d}$and D_{4h}

Q. 43 The metals present in the active sites of particulate and soluble methane monooxygenases (abbreviated as pMMO and sMMO respectively) that are produced by methane-metabolizing bacteria, respectively, are

1. Cu and Ni
2. Fe and Ni
3. Mn and Fe
4. Cu and Fe

Q. 44 n moles of a perfect monatomic gas with volume V 1 undergoes an adiabatic free expansion to a final volume $\mathrm{V}_2 = 5\ \mathrm{V}_1$. The change in entropy (in $\mathrm{JK}^{-1}\ \mathrm{mol}^{-1}$) of the gas is
[Given $\mathrm{R} = 8.314\ \mathrm{J\ K}^{-1}\ \mathrm{mol}^{-1}$]

1. 0
2. 13.38
3. 1.61
4. 8.31

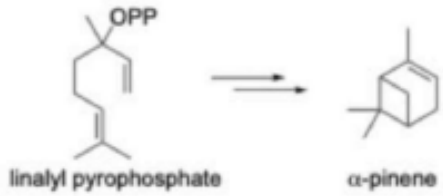
Q. 45 The expression for fractional surface coverage (θ_A) for the dissociative adsorption, $\mathrm{A}_2(\mathrm{g}) \rightarrow 2\ \mathrm{A}$ (surface), in the presence of an inhibitor $\mathrm{I}(\mathrm{I(g)} \rightarrow \mathrm{I(surface)})$ competing for the same site, is
[Given: K_A and K_l are equilibrium constants for adsorption of $\mathrm{A}_2(\mathrm{g})$ and $\mathrm{I(g)}$, respectively; p_i is the partial pressure of the i^{th} gas]

1. $\frac{K_A^{1/2} p_{A_2}^{1/2}}{\left(1+K_A^{1/2} p_{A_2}^{1/2}\right)(1+K_i pi)}$
2. $\frac{K_A^{1/2} p_{A/2}^{1/2} K_I p_I}{\left(1+K_A^{1/2} p_{A_2}^{1/2}\right)(1+K_I p_l)}$

3. $\frac{K_A^{1/2} p_A^{1/2}}{\left(1+K_A^{1/2} p_{A_2}^{1/2}+K_i p_i\right)}$

4. $\frac{K_A^{1/2} p_A^{1/2} K_i pi}{\left(1+K_A^{1/2} p_{A_2}^{1/2}+K_i p_i\right)}$

Q. 46 The correct sequence of steps involved in the biosynthesis of α-pinene from linalyl pyrophosphate is



A. six-membered ring formation with loss of pyrophosphate (OPP)

B. four-membered ring formation

C. loss of H^+

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

Q. 47 Consider the following statements:

A. Schottky defects decrease the density of the crystal

B. Schottky defects create vacancy pair(s)

C. Alkali metal halides exhibit Frenkel defect

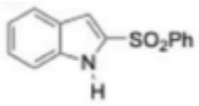
The option containing correct statement(s) is

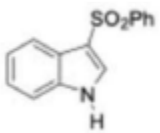
1. Only A
2. Both A and B
3. Both B and C
4. Both A and C

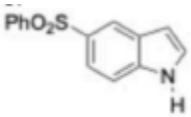
Q. 48 The correct sequence of increasing $O-O$ bond length in the following species is

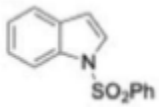
1. $[O_2]^+, O_2F_2, H_2O_2, [O_2]^{2-}$
2. $O_2F_2, [O_2]^+, H_2O_2, [O_2]^{2-}$
3. $O_2F_2, [O_2]^+, [O_2]^{2-}, H_2O_2$
4. $[O_2]^+, H_2O_2, O_2F_2, [O_2]^{2-}$

Q. 49 The major product formed in the reaction of indole with $NaNH_2$ and $PhSO_2Cl$ is

1. 

2. 

3. 

4. 

Q. 50 Among the following, the amino acid residue in histone that gets acetylated is

1. Alanine
2. Glycine
3. Phenylalanine
4. Lysine

Q. 51 For the wavefunction, $\psi(x) = A\exp\left(-\frac{x^4}{a^4} + ikx\right)$, the ratio of probability density at $x = a$ to that at $x = 2a$ is

[Given: $-\infty \leq x \leq \infty$]

1. e^6
2. e^2
3. 2
4. e^{30}

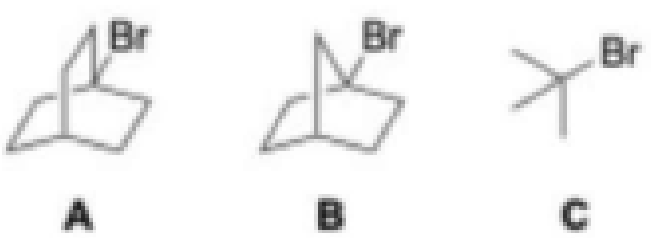
Q. 52 In the standard state at $25^\circ C$, upon reversing the electrodes of the following electrochemical cells, $Ag(s)$ will be deposited on the cathode of

Cell	Anode	Cathode
A	$AgBr/Ag, Br^-$	$AgCl/Ag, Cl^-$
B	$AgBr/Ag, Br^-$	$Agl/Ag, I^-$
C	$AgCl/Ag, Cl^-$	$Agl/Ag, I^-$

[Given, at $25^\circ C$, E^0(in V) $= +0.22(AgCl/Ag, Cl^-); +0.07(AgBr/Ag, Br^-); -0.15$ ($Agl/Ag, I^-$)]

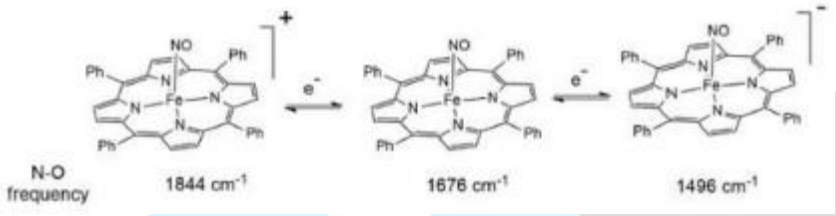
1. A
2. B and C
3. C, but not B
4. A, B and C

Q. 53 The correct order of the relative rates of solvolysis for the following compounds in 80% aqueous ethanol at $25^\circ C$ is



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

Q. 54 For the reaction sequence given below, the correct statement for the doubly reduced species (showing N-O frequency of $1496\ cm^{-1}$)



is

1. The Fe-NO bond length remains unaffected upon reduction
2. There is no back-bonding interaction between iron and NO
3. The reduction is predominantly localized on the NO ligand
4. The reduction is fully localized on the metal

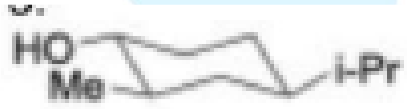
Q. 55 The degeneracy of a state with energy $\frac{27\ h^2}{8ml^2}$, for a particle confined in a 3D cubic box of length L, is

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

Q. 56 The structure that corresponds to $(1S, 2R, 4S)$-4-isopropyl-2-methylcyclohexanol is

1. 

2. 

3. 

4. 

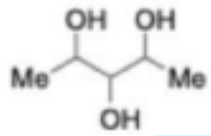
Q. 57 The correct reagent(s) to effect the following transformation is(are)



A. $Pd/C, H_2 (1\ atm)$

B. $NaBH_4, ZnCl_2$
C. $LiAlH_4$
D. $BH_3 \cdot Me_2\ S$
1. Only A
2. Only B and C
3. Only B, C and D
4. Only A, B and D

Q. 58 The number of optically active stereoisomers for the following compound is



1. 2
2. 4
3. 6
4. 8

Q. 59 Consider the following statements regarding the extraction and separation of lanthanoids from Monazite
A. Monazite is primarily $PO_4{}^{3-}$ salt of Ln
B. Monazite contains Thalong with Ln
C. Ln^{3+} ions are separated by using ion-exchange columns
D. Ln^{3+} ions are eluted from the column by using an aqueous acidic solution of H_4 EDTA
The option with all correct statements is
1. A, B, and D only
2. B, C, and D only
3. A, C, and D only
4. A, B, and C only

Q. 60 The approximate ground-state energy of He-isoelectronic series is given by $E(Z) = -Z^2 + \frac{5}{0}Z - 0.1576 + \frac{0.0087}{z}$. According to Valence Bond Theory, the expression for binding energy of H_2 from $H^-$and $H^+(H_2 \rightarrow H^- + H^+)$can be approximated to
[Given: J, K, and S represent Coulomb, exchange and overlap integrals, respectively. Energies are expressed in atomic unit]
1. $0.5239 - \frac{J+K}{1-s^2}$
2. $0.4761 + \frac{J-K}{1-s^2}$
3. $0.4761 - \frac{J+K}{1+s^2}$
4. $0.5239 + \frac{J+k}{1+s^2}$

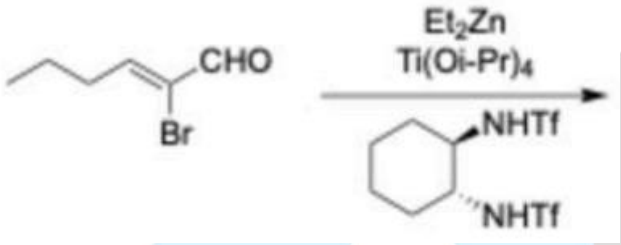
Q.61 The ^1H NMR of mixture of ethyl iodide and bromoform gives three signals at δ 6.80, 3.20 and 1.85 ppm with integration of 1, 3, 4.5, respectively. The molar ratio of ethyl iodide and bromoform is
1. 3:1

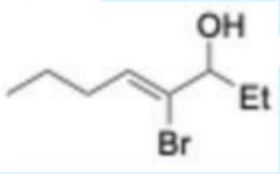
2. 1.5:1

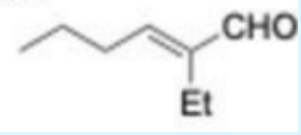
3. 1:3

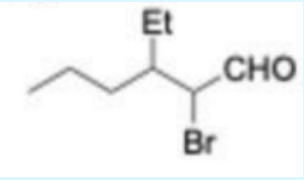
4. 1:1.5

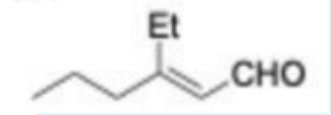
Q.62 The major product formed in the following reaction is



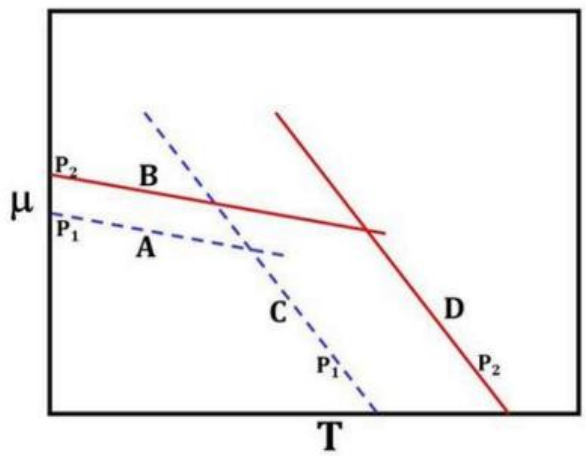
1. 

2. 

3. 

4. 

Q.63 The following figure shows the variation of chemical potential (μ) of a pure substance in its liquid or solid form with temperature, when the pressure is increased from P_1 to P_2. The lines A, B, C, D shown in the figure are at constant pressure P_1 or P_2.



The correct option about the information shown in this figure is

1. A is for ice and C is for liquid water; $S_m(C) = \left(\frac{\partial_{\mu c}}{\partial p}\right)_T$

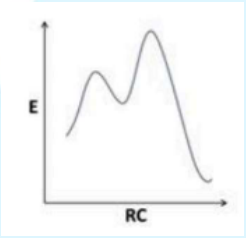
2. A and B are for an organic liquid; $V_m(B) = -\left(\frac{\partial_{\mu B}}{\partial T}\right)_P$

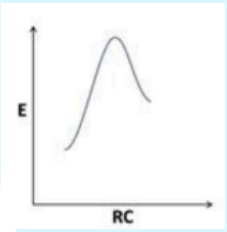
3. A and B are for ice; $S_m(C) = -\left(\frac{\partial_{\mu B}}{\partial T}\right)_P$

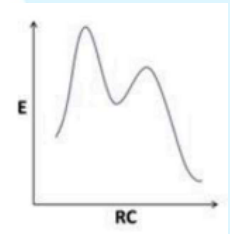
4. A is for solid and C is for liquid form of an organic substance; $S_m(A) = -\left(\frac{\partial_{\mu A}}{\partial T}\right)_P$

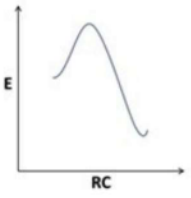
Q64. The energy profile diagram that corresponds to the following reaction is:



1. 

2. 

3. 

4. 

Q.65 The correct reagent to effect the following reaction is



1. TBAF

2. $Pd/C, H_2$

3. PTSA, MeOH

4. $Hg(CIO_4)_2, CaCO_3$

Q.66 The Hamiltonian of a two-dimensional quantum harmonic oscillator is

$H = \frac{P_x^2}{2m} + \frac{P_y^2}{2m} + \frac{1}{2}m\omega^2x^2 + 2m\omega^2y^2,$

where m and ω are positive constants. The degeneracy of the level with energy $E = \frac{25}{2}h\omega$ is

1. 5

2. 6

3. 7

4. 8

Q.67 A graph of surface tension of an aqueous solution of a surfactant as a function of concentration gives a slope $\left[\frac{dy}{d\ln(c/c^0)}\right]$ of $-4.8 \times 10^{-3} N\ m^{-1}$ at 289 K. The area $(in\ \text{Å}^2)$ occupied by each surfactant molecule at the surface is closest to $[c^\circ = 1\ mol\ L^{-1}]$

1.41

2. 62

3. 83

4. 104

Q.68 The correct order of $v_{C-S}(in\ cm^{-1})$ and $v_{C-N}(in\ cm^{-1})$ in trans$-[Pd(AsPh_3)_2(NCS)_2]$(A) and trans$-[Pd(AsPh_3)_2(SCN)_2]$ (B) is

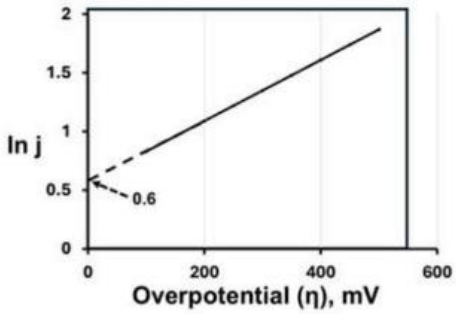
1. v_{C-S} in $A < v_{C-S}$ in B ; v_{C-N} in $A < v_{C-N}$ in B

2. v_{C-S} in $A = v_{C-S}$ in B ; v_{C-N} in $A = v_{C-N}$ in B

3. v_{C-S} in $B < v_{C-S}$ in A ; v_{C-N} in $A < v_{C-N}$ in B

4. v_{C-S} in $B < v_{C-S}$ in A ; v_{C-N} in $B < v_{C-N}$ in A

Q.69 The following figure shows a plot of ln j versus n for the platinum electrode of area $1\ cm^2$ in contact with an aqueous solution of $Fe^{3+}(10^{-3}M)$ and $Fe^{2+}(10^{-3}M)$ at 300 K. Here j and n represent current (in mA) and overpotential (in mV), respectively.



The charge transfer resistance (inΩ) for this system is closest to

1. 1.36
2. 4.91
3. 14.2
4. 49.1

Q.70 The energies, $E_{\pm}$ (in atomic units) of bonding (+) and antibonding (-) MOS of H_2^+, obtained by linear combination of 1s orbitals of H-atoms (utilizing variation principle), are

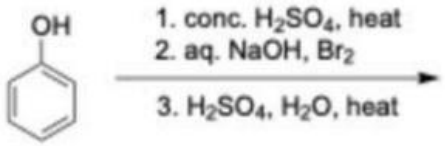
$[J = \langle 1S_A \left| -\frac{1}{r_B} \right| 1S_A\rangle + \frac{1}{R}, K = \langle 1S_A \left| -\frac{1}{r_A} \right| 1S_B\rangle + \frac{S}{R}, S = \langle 1S_A | 1S_B\rangle$ R is internuclear distance]

1. $-1 - J \pm K$
2. $-\frac{1}{2} - \frac{j \pm k}{1 \pm S}$
3. $-1 + \frac{j \pm k}{1 \pm S}$
4. $-\frac{1}{2} + \frac{j \pm k}{1 \pm S}$

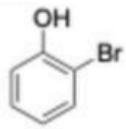
Q.71 The catalytic intermediate species involved in the Wacker process are

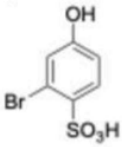
1. Pd-vinyl alcohol, Pd-β-hydroxyethyl, Pd-ethylene
2. Pd-β-hydroxyethyl, Pd-vinyl alcohol, Pd-acyl
3. Pd-dioxygen, Pd-β-hydroxyethyl, Pd-ethylene
4. Pd-β-hydroxyethyl, Pd-vinyl alcohol, Pd-dioxygen

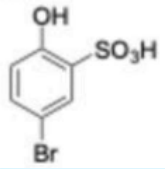
Q72. The major product formed in the following reaction sequence is



1. 

2. 

3. 

4. 

Q.73 Consider the following statements related to the glass transition temperature (T_g) of a polymer.

A. T_g of the polymer increases with its molecular weight

B. T_g of the polymer increases upon addition of a plasticizer

C. T_g of the polymer is always lower than its melting temperature (T_m)

The correct complete set of options is

1. A and B

2. A and C

3. B and C

4. A, B and C

Q.74 The maximum work available from combustion of 1.0 mol of methane gas at 298 K is $810\ kJ\ mol^{-1}$, and energy available as heat at constant pressure, at 298 K, is $890\ kJ\ mol^{-1}$.

$\Delta S°\ (in\ J\ K^{-1}\ mol^{-1})$ for this combustion process is closest to

[Assume ideal gas behaviour; Gas constant $R = 8.31\ J\ K^{-1}\ mol^{-1}$]

1. -268

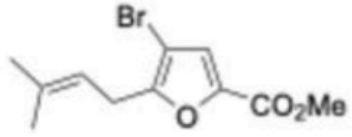
2. -252

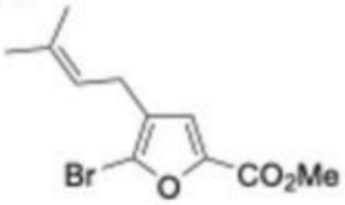
3. -204

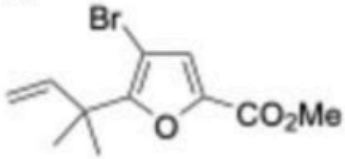
4. -2718

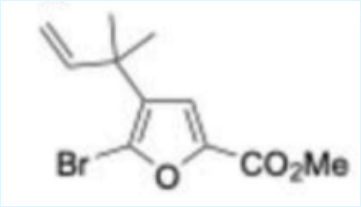
Q.75 The major product formed in the following reaction is



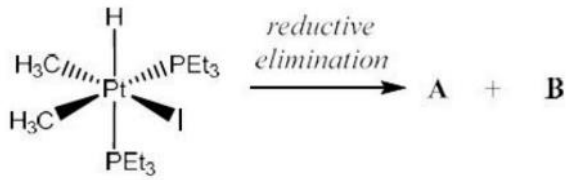
1. 

2. 

3. 

4. 

Q76. Consider the following reaction.



The most likely products A and B, respectively, are

1. 

and CH_4

2. 

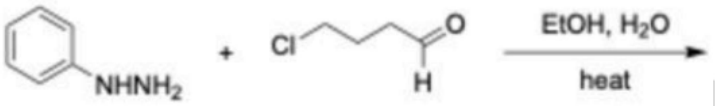
and $H_3C—CH_3$

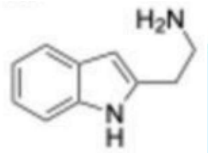
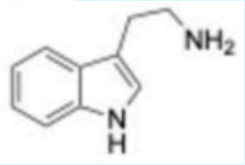
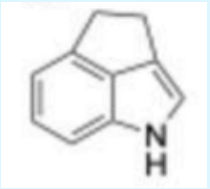
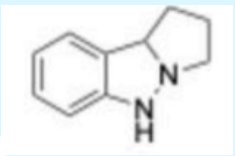
3. 

and CH_3I

4.  and HI

Q.77 The major product formed in the following reaction is



1. 
2. 
3. 
4. 

Q.78 The correct order of rate for the following isotope exchange reaction

$[M(CN)_6]^{3-} + 6\ {}^{14}CN^- \rightarrow \left[M\left({}^{14}CN\right)_6\right]^{3-} + 6\ CN^-$ (where, M = Cr, Mn, and Fe) is

1. Fe > Mn > Cr
2. Mn > Fe > Cr
3. Fe > Cr > Mn
4. Cr Mn > Fe

Q.79 The mean molar volume (V_m) of a binary solution of liquid A and liquid B is given by $V_m = a + bx + c(x - 0.5)^2$

where x is the mole fraction of liquid B and a, b and c are constants. The partial molar volume of A is given by

1. $b + 2cx - c$

2. $a + cx^2 - \frac{c}{4}$

3. $a - cx^2 + \frac{c}{4}$

4. $b + cx^2 - ax$

Q.80 Given below are the oxohalide ions (column I) and their bond lengths (column II) and bond angles (column III).

Column I Oxohalide ion	Column II X-O (pm)	Column III O-X-O angle (°)
a. ClO_3^-	p. 165	i. 100
b. BrO_3^-	q.149	ii.107
c. IO_3^-	r. 181	iii. 104

The option with the correct match is

1. (a-r-ii), (b-p-i), (c-q-iii)

2. (a-q-i), (b-r-iii), (c-p-ii)

3. (a-r-iii), (b-q-i), (c-p-ii)

4. (a-q-ii), (b-p-iii), (c-r-i)

Q. 81 The total number of isomers including pair(s) of enantiomers for the octahedral complex with the general formula Ma2-2cd is

1. 6 including 1 pair
2. 6 including 2 pairs
3. 8 including 1 pair
4. 8 including 2 pairs

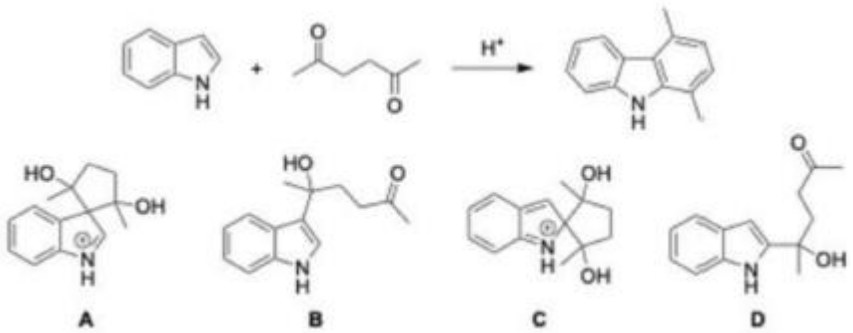
Q. 82 After 5 measurements, the length of an object is 20 ± 1 cm (mean ± standard error). The number of measurements needed to achieve a standard error of 0.25 cm is

1. 10
2. 20
3. 40
4. 80

Q. 83 A metal can exist in two different crystalline forms: face centered cubic (fcc) lattice and body centered cubic (bcc) lattice with unit cell edge lengths of 2Å and 4Å, respectively. The ratio of the density of the fcc lattice to that of the bcc lattice is

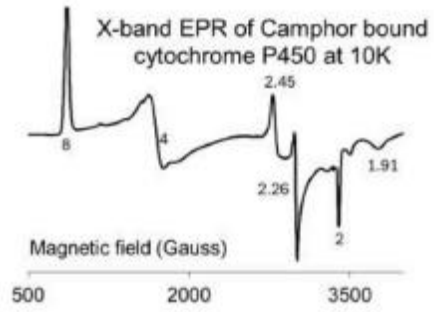
1. 2
2. 8
3. 4
4. 16

Q. 84 The intermediates involved in the following transformation are



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

Q. 85 The X-band EPR spectrum of camphor-bound cytochrome P450 at 10 K shows a mixture of high-spin and low-spin ferric species.



The correct set of g-values for the high-spin and low-spin species, respectively, are

1. High-spin: 8, 4, 2 and low-spin: 2.45, 2.26, 1.91
2. High-spin: 8, 4, 2.26 and low-spin: 2.45, 2, 1.91
3. High-spin: 8, 2.45, 2.26 and low-spin: 4, 2, 1.91
4. High-spin: 4, 2.45, 2.26 and low-spin: 8, 2, 1.91

Q86. Column I contains inner transition elements and Column II contains ore, structural property, and uses.

Column I	Column II
a. Th	i. Pitchblende
b. U	ii. BCC structure in its metallic form
c. Eu	iii. Laser
d. Nd	iv. Monazite

The correct matching option is —

1. (a–ii), (b–iv), (c–iii), (d–i)
2. (a–iv), (b–i), (c–ii), (d–iii)
3. (a–i), (b–iv), (c–ii), (d–iii)
4. (a–iv), (b–i), (c–iii), (d–ii)

Q. 87 Match the physical methods in Column I with the best suited information in Column II and III

Column I	Column II	Column III
a. Electron Resonance Paramagnetic Resonance spectroscopy	p. Radio frequency	i. nature of O_2 bound to haemoglobin
b. Nuclear Magnetic Resonance spectroscopy	q. Force constant	ii. d-block metals with odd number of unpaired electrons
c. Resonance Raman spectroscopy	r. Microwave	iii. fluxionality in organometallic compounds

1. (a-r-ii), (b-p-iii), (c-q-i)
2. (a-p-ii),(b-r-ii),(c-q-i)
3. (a-r-ii),(b-q-ii),(c-p-i)
4. (a-r-i), (b-q-iii), (c-p-ii)

Q. 88 The average energy of an ensemble of noninteracting particles is $1000k_BT$ at a temperature T. Each particle can have energy of either 0 or k_BT. The number of particles in the ensemble is closest to
[k_B : Boltzmann constant]
1. 1738
2. 3718
3. 7183
4. 8731

Q89. Consider the following statements about hemoglobin:
A. The non-heme secondary iron centers are connected by two bridging carboxylate groups.
B. Heme proteins are coordinated by internal molecular bonds.
C. Coordination of O_2 occurs on only one of the Fe atoms.
D. Myoglobin, certain phosphatases, and some ribonucleotide reductases have similar active sites.
The correct option containing all correct statements is:
1. Only A, C, and D
2. Only B and D
3. Only B, C, and D
4. Only A and C

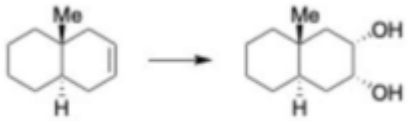
Q. 90 An enzyme (E) catalyzes the conversion of a substrate (S) to product (P) according to the following mechanism

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \overset{k_2}{\rightarrow} ES' \overset{k_3}{\rightarrow} E + P$$

Applying steady state approximation to ES and ES', the expression for the rate of reaction is [$[E]_0$ and [$S]_0$ are initial concentration of enzyme and substrate, respectively and $[S]_0 \gg [E]_0$]

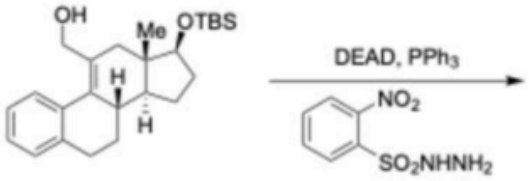
1. $k_3[E]_0[S]_0$
2. $\frac{k_1k_2[E]_0[S]_0}{(k_{-1}+k_2)+k_1[S]_0}$
3. $\frac{k_1k_2[E]_0[S]_0}{(k_{-1}+k_2)+k_1\left(1+\frac{k_2}{k_3}\right)[S]_0}$
4. $\frac{k_1k_2[E]_0[S]_0}{(k_{-1}+k_2)+k_2\left(1+\frac{k_1}{k_3}\right)[S]_0}$ sssss

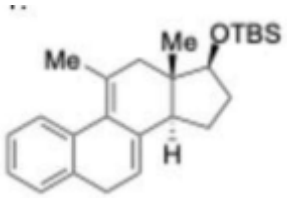
Q.91 The correct set of reagents to effect the following transformation is

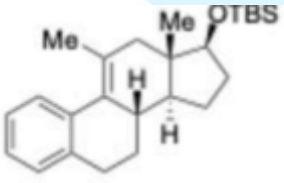


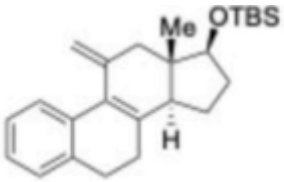
1. OsO_4, NMO
2. i. l_2, AgOAc, H_2O; ii. NaOH, H_2O
3. i. l_2, AgOBz; ii. NaOH, H_2O
4. OSO4, $NalO_4$

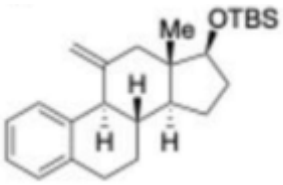
Q.92 The major product formed in the following reaction is



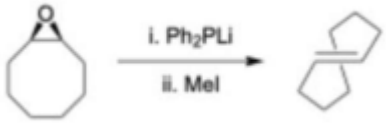
1. 

2. 

3. 

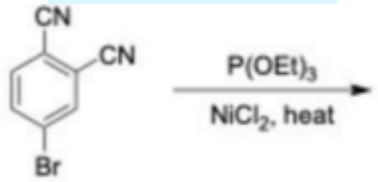
4. 

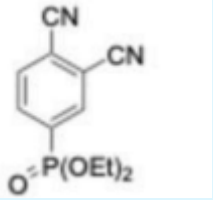
93. In the following reaction, formation of the alkene occurs through

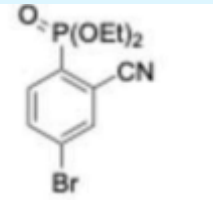


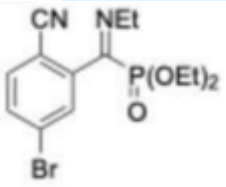
1. a c is intermediate undergoing an anti-elimination
2. a trans intermediate undergoing an anti-elimination
3. a cis intermediate undergoing a syn-elimination
4. a trans intermediate undergoing a syn-elimination

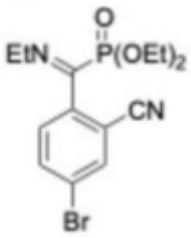
Q. 94 The major product formed in the following reaction is



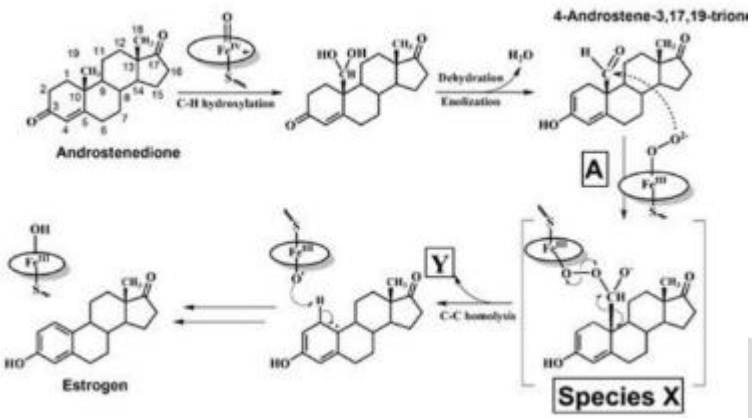
1. 

2. 

3. 

4. 

Q.95 The synthesis of Estrogen from Androstenedione in humans is catalyzed by aromatase which is a cytochrome P450 enzyme. In the reaction mechanism described below, the missing reaction step A, description of the intermediate species X, and chemical species Y, respectively, are



1. Electrophilic attack, peroxide, and CO_2
2. Nucleophilic attack, peroxyhemiacetal, and CO_2
3. Nucleophilic attack, peroxyhemiacetal, and $HCOO^-$
4. Electrophilic attack, peroxide, and $HCOO^-$

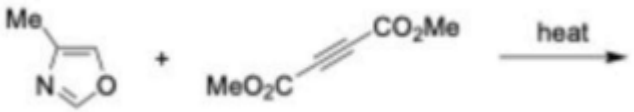
Q.96 Consider the following outer-sphere electron transfer reaction:

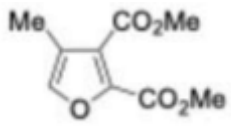
$$MnO_4{}^- + [Fe(CN)_6]^{4-} \rightarrow MnO_4{}^{2-} + [Fe(CN)_6]^{3-}$$

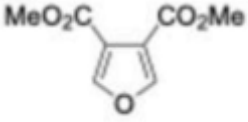
[Given at 25 °C, E° for $MnO_4{}^-$ / $MnO_4{}^{2-}$= 0.56 V. $[Fe(CN)_6]^{3-}$/$[Fe(CN)_6]^{4-}$ = 0.36 V; Self-exchange rate constant, k_{11} for Mn complex = 3600 $M^{-1}s^{-1}$,
Self-exchange rate constant, k_{22} for Fe complex = 300 $M^{-1}s^{-1}$, assume correction factor, f_{12}=1]
The cross-exchange rate constant (f_{12}, $M^{-1}s^{-1}$) for the given reaction is

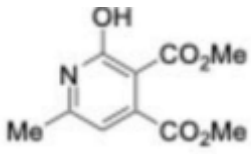
1. 1.8×10^3
2. 4.8×10^6
3. 5.1×10^4
4. 2.5×10^5

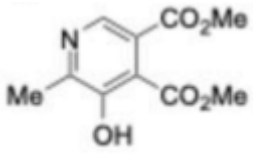
Q.97 The major product formed in the following reaction is



1. 

2. 

3. 



4.

Q.98 Consider the following gas phase reaction:

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} A^* + B$$
$$A^* \xrightarrow{k_2} C$$

Considering $[A]_o$ and $[B]_o$ to be moderate and using steady state approximation, the correct option for the overall order of the reaction is

1. 1^{st} order, when k_{-1} >> k_2
2. zero order, when k_{-1} >> k_2
3. zero order, when k_{-1}<<k_2
4. 1^{st} order, when k_{-1}<<k_2

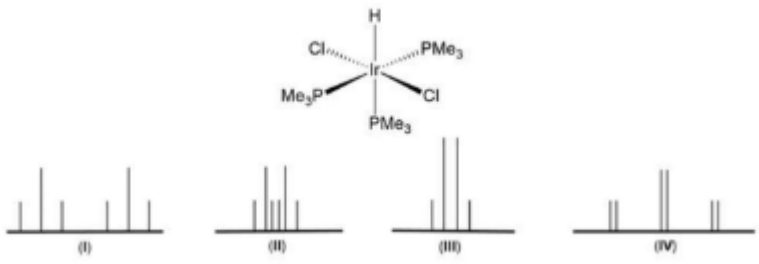
Q.99 Given below are enzymes (column I), the metal in their active sites (column II) and the class of reactions they catalyze (column III)

Column I	Column II	Column III
a. Catalase	p. Copper	i. Hydrolysis reaction
b. Urease	q. Copper and iron	ii. Decomposition reaction
c. Cytochrome c oxidase	r. Iron	iii. Phenol to quinone
d. Laccase	s. Nickel	iv. Oxygen to water

The option with the correct match is

1. (a-q-ii), (b-s-i), (c-p-iv), (d-r-iii)
2. (a-q-iii), (b-r-iv), (c-s-i), (d-p-ii)
3. (a-r-iv), (b-p-iii), (c-q-i), (d-s-ii)
4. (a-r-ii), (b-s-i), (c-q-iv), (d-p-iii)

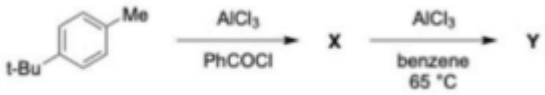
Q.100 The 1_H NMR spectral pattern in the hydride region for the given compound,
[Given, 31_P: I= ½, 100%; 1_H: I= ½, 99.98%]

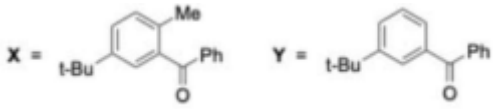


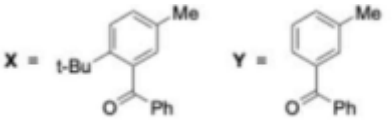
Is

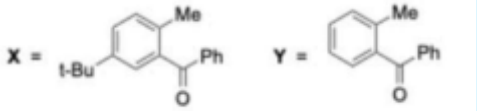
1. Iv
2. I
3. III
4. II

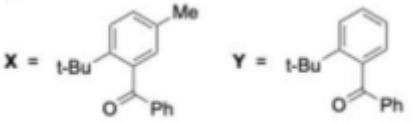
Q.101 The major products X and Y formed in the following reaction sequence are



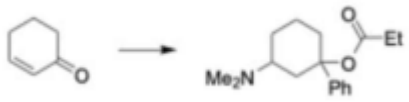
1. 

2. 

3. 

4. 

Q.102 The correct sequence of reagents to effect the following transformation is

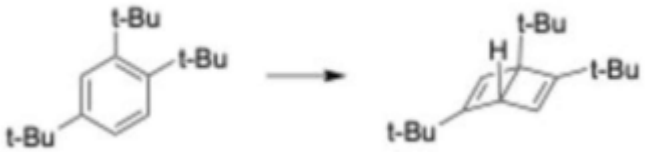


1. PhLi; Me_2NH/Et_2O; $(EtCO)_20$/pyridine
2. PhLi; $(EtCO)_20$/pyridine; Me_2NH/Et_2O
3. Me_2NH/Et_2O; PhLi; $(EtCO)_20$/pyridine
4. Me_2NH/Et_2O; $(EtCO)_200$/pyridine; PhLi

Q.103 Given the trial wavefunction $\phi(x) = ae^{-ax^2} + be^{-\beta|x|}$ for the system having potential $V(x) = \frac{1}{2}ma^2x^2$, the variationally optimized ground-state energy of the system is obtained with the parameters

1. a=1, b=0
2. a=$1/\sqrt{2}$, b=$1/\sqrt{2}$
3. a = 0, b = 1
4. a = 1, b = 1

Q.104 The following electrocyclic ring closing reaction is

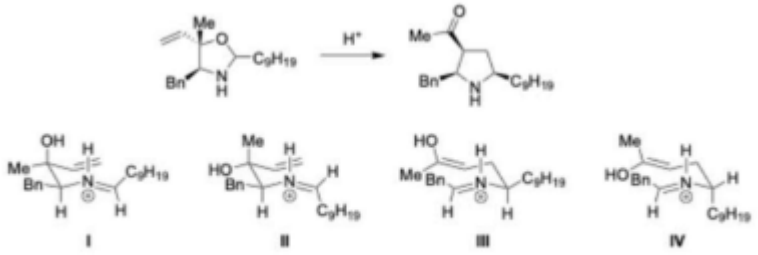


A. $4e^-$ conrotatory ring closure
B. $4e^-$ disrotatory ring closure
C. allowed under thermal conditions
D. allowed under photochemical conditions

1. A and C
2. A and D

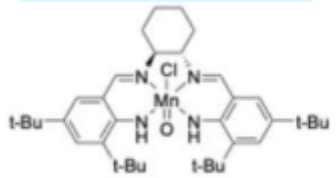
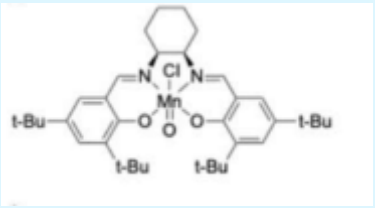
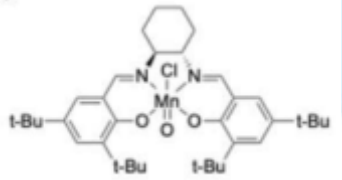
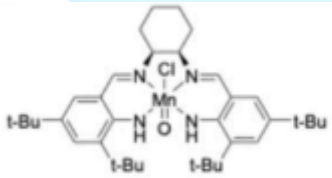
3. B and C
4. B and D

Q.105 The intermediates involved in the following reaction are

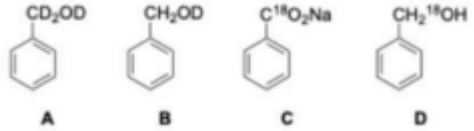


1. I and IV
2. II and III
3. I and III
4. II and IV

Q.106 The structure of active catalyst involved in Jacobsen asymmetric epoxidation is

1. 
2. 
3. 
4. 

Q.107 The Cannizzaro reaction of benzaldehyde with NaOH was carried out independently in i) D_2O and ii) $H_2{}^{18}O$. The major isotopically labelled products obtained in these reactions are



A. A, B, D only
B. B, C, D only
C. A, D only

D. 4. B, C only

Q.108 The observed frequencies of first and third overtones of a gaseous diatomic molecule are $1050\ \text{cm}^{-1}$ and $2068\ \text{cm}^{-1}$, respectively. The magnitude of (dimensionless) anharmonicity constant is closest to

1. 3.5×10^{-3}
2. 5.5×10^{-3}
3. 7.5×10^{-3}
4. 9.5×10^{-3}

Q.109 0.5 M solution (A) of a substance transmits 10% of the incident light. Another solution (B) of the same substance under identical experimental conditions transmits 1% of the incident light. The concentration (in M) of the substance in the solution B is

1. 8
2. 10
3. 1
4. 5

Q.110 Consider the following statements for ozone molecule.

A. It is Raman-active
B. It is IR-active
C. It belongs to C2h point group
D. It is a diamagnetic molecule

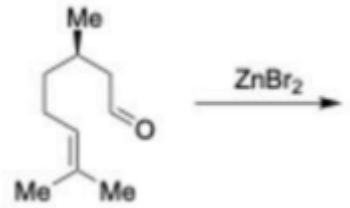
The option with the correct statements is

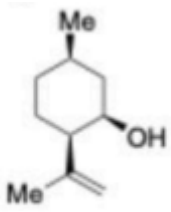
1. A, B, and C only
2. A, B, and D only
3. A, C, and D only
4. B, C, and D only

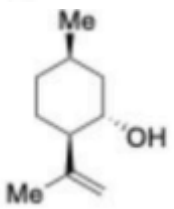
Q.111 The structures of $[B_5H_{11}]$, $[C_2B_{10}H_{12}]$ and $[B_{11}H_{14}]^-$, respectively, are

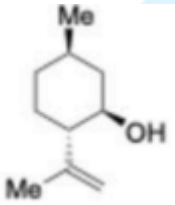
1. nido, arachno, closo
2. nido, closo, arachno
3. arachno, closo, nido
4. arachno, nido, closo

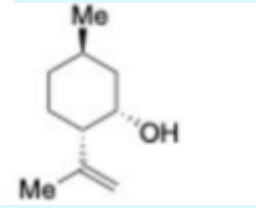
Q.112 The major product formed in the following reaction is



1. 

2. 

3. 

4. 

Q.113 The table below contains the following compounds with their characteristics

Compounds	Oxidation state of phosphorus	Number of acidic hydrogens
a. Hypophosphoric acid	P. 5	i. 2
b. Pyrophosphorous acid	q. 1	ii. 3
c. Hypophosphorous acid	r. 4	iii. 4
d. Orthophosphoric acid	s.3	iv. 1

The option with the correct match is
1. (a-r-iii), (b-s-i). (c-q-iv), (d-p-ii)
2. (a-s-ii), (b-r-iii), (c-q-iv), (d-p-i)
3. (a-p-ii), (b-r-iv), (c-q-i), (d-s-iii)
4. (a-r-iii), (b-s-ii), (c-q-iv), (d-p-i)

Q.114 The energy (in units of $\frac{h^2}{8mL^2}$) of the ground state of a system of six noninteracting electrons, confined in a 3-dimensional box with lengths L, L/2 and L/4, is
1. 74
2. 126
3. 156
4. 148

Q. 115 The calculated magnetic moment in B.M. unit of a tetrahedral transition metal complex is [Given, free ion term $4_{F_{9/2}}$, 10 Dq = 3200 cm-1 and |λ|= 200 cm-¹]

1. 2.90
2. 3.38
3. 4.35
4. 4.83

Q.116 The symmetry labels of three normal modes of water are $\Gamma_1 = A_1, \Gamma_2 = A_1$and $\Gamma_3 = B_2$. The polarization of light required for overtone $[(0,0,0)\ to\ (0,0,3)]$ and combination $[(0,0,0)\ to\ (1,0,1)]$ transitions, respectively, are

[The symmetry of the dipole moment operators μ_x, μ_y and μ_z, respectively, are $\Gamma_{ux} = B_1, \Gamma_{uy} = B_z$ and $\Gamma_{uz} = A_1\}$

1. z and z
2. y and x
3. x and y
4. y and y

Q.117 A nonlinear polyatomic molecule belongs to D2d point group. The character table of the point group is given below.

D_{2d}	E	$2S_4$	C_2	$2C_2'$	$2\sigma_d$
A_1	1	1	1	1	1
A_2	1	1	1	-1	-1
B_1	1	-1	1	1	-1
B_2	1	-1	1	-1	1
E	2	0	-2	0	0

The symmetry of one of the normal modes is E. The symmetry of the second excited state of this mode in terms of the irreducible representations of the point group of the molecule is

1. $2A_1 + 2B_2$
2. $2A_1 + B_1 + B_2$
3. $A_2 + 2B_1 + B_2$
4. $A_1 + A_2 + B_1 + B_2$

Q.118 The Raschig reaction, involving partial oxidation of NH_3 with $NaOCI$, produces P, which upon treatment with KIO_3 and HCl, forms KCl, water, compounds Q and R. The compounds P, Q, and R, respectively, are

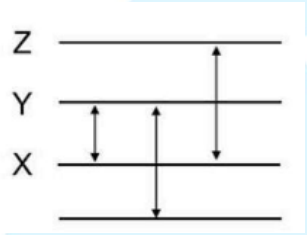
1. NCl_3, Cl_2, l_2
2. N_2H_4, N_2, ICI
3. N_2H_4, O_2, l_2

4. NCI_3, N_2, ICI

Q.119 The correct sequence of reagent addition for the qualitative analysis of $Pb^{2+}, Cd^{2+}, Sr^{2+}$ and Ni^{2+} ions in an aqueous solution of a mixture of their nitrate-containing salts, is

1. (i) HCl (aq.) (ii) $H_2S\ (acidic)$ (iii) $H_2S\ (basic)$ (iv) $(NH_4)_2CO_3\ (aq.)$
2. (i) H_2S (acidic) (ii) H_2S (basic) (iii) HCl (aq.) (iv) $(NH_4)_2CO_3(aq.)$
3. (i) $(NH_4)_2CO_3(aq.)$ (ii) H_2S (acidic) (iii) H_2S (basic) (iv) HCl (aq.)
4. (i) HCl (aq.) (ii) H_2S (basic) (iii) H_2S (acidic) (iv) $(NH_4)_2CO_3(aq.)$

Q.120 The allowed electronic transitions among four different atomic energy levels are indicated in the diagram below.



Given that the lowest energy state is a ^3P state, a possible set of correct energy levels (X, Y and Z) is

1. $X = {}^3D_1, Y = {}^3P_1$ and $Z = {}^3D_2$
2. $X = {}^3P_1, Y = {}^3D_1$ and $Z = {}^3D_2$
3. $X = {}^3P_2, Y = {}^3D_1$ and $Z = {}^3P_1$
4. $X = {}^3P_1, Y = {}^3P_2$ and $Z = {}^3D_1$