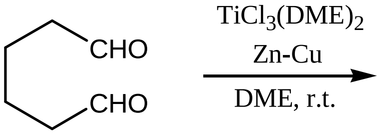
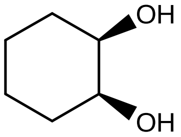
CHEMISTRY

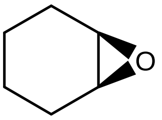
Q.11 – Q.35 : Carry ONE mark each.

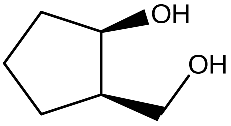
11. The major product formed in the given reaction is

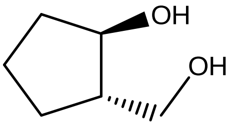


DME: 1, 2-Dimethoxyethane

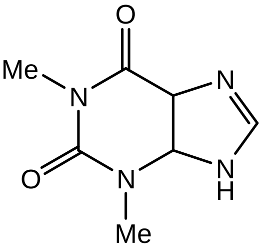
(a) 

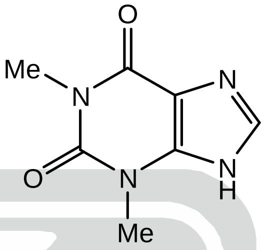
(b) 

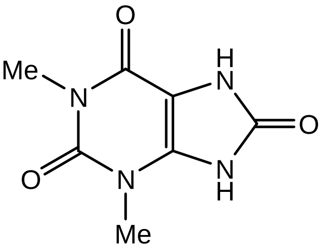
(c) 

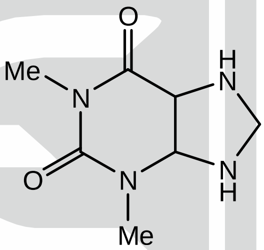
(d) 

12. The compound which gives a fragment at *m*/*z* = 124$[M + H]^+$ is

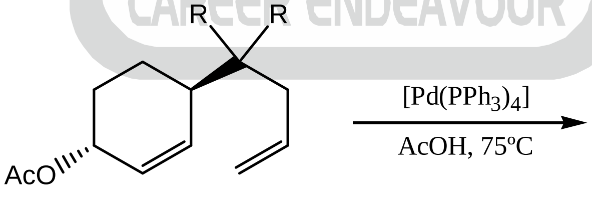
(a) 

(b) 

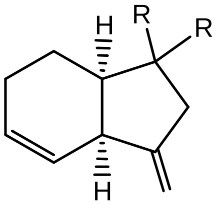
(c) 

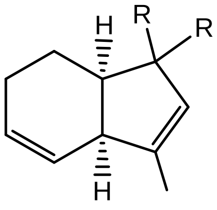
(d) 

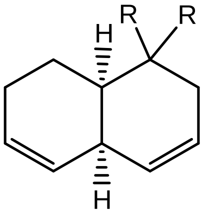
13. The major product formed in the given reaction is

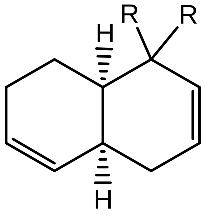


R = CO_2Me

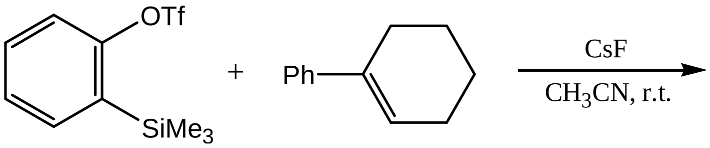
(a) 

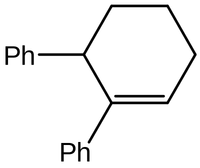
(b) 

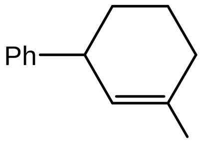
(c) 

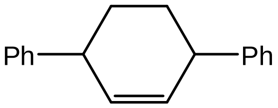
(d) 

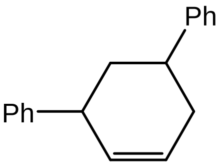
14. The major product formed in the given reaction is



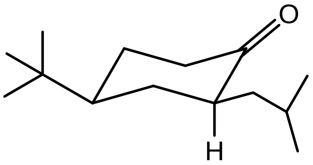
(a) 

(b) 

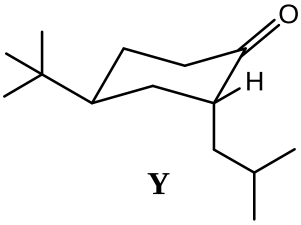
(c) 

(d) 

15. On irradiation using UV light (>300 nm), compounds **X** and **Y**, predominantly, undergo



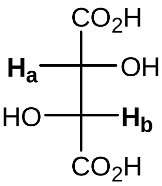
X



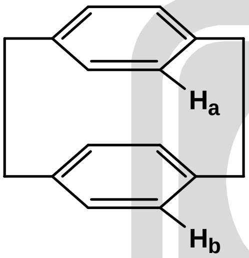
Y

- (a) **X**: Norrish type I reaction and **Y**: Norrish type II reaction
- (b) **X**: Norrish type II reaction and **Y**: Norrish type I reaction
- (c) Both **X** and **Y**: Norrish type I reaction
- (d) Both **X** and **Y**: Norrish type II reaction

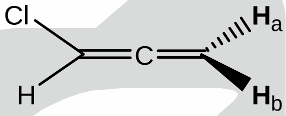
16. The *topicity relationship* of $\mathbf{H_a}$ and $\mathbf{H_b}$ in X, Y and Z are, respectively,



X



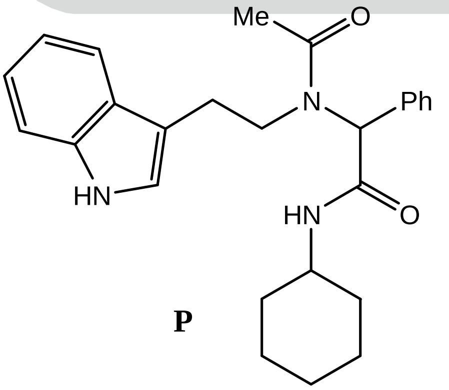
Y



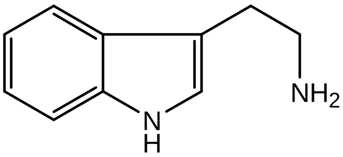
Z

- (a) Diastereotopic, Homotopic and Enantiotopic
- (b) Homotopic, Enantiotopic and Enantiotopic
- (c) Homotopic, Homotopic and Enantiotopic
- (d) Diastereotopic, Enantiotopic and Homotopic

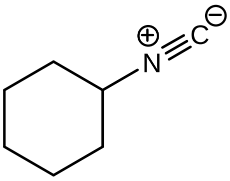
17. Compound **P** was prepared based on a four-component reaction at room temperature in methanol. The required starting materials for the synthesis are



P

(a) 

; PhCHO ; $MeCO_2H$;



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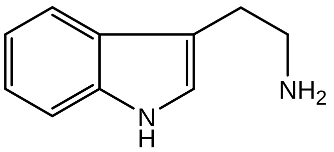
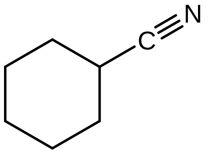


; PhCHO ; $MeCO_2H$;


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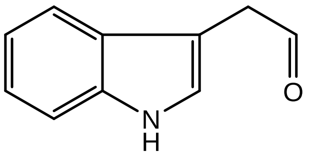
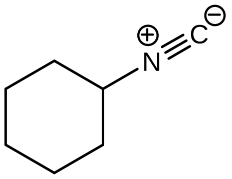


; $PhCH_2NH_2$; $MeCO_2H$;


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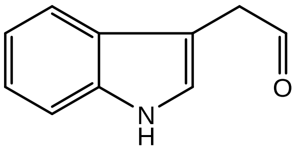
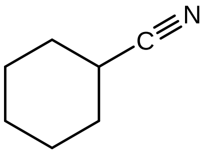
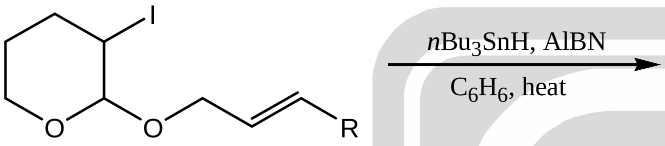
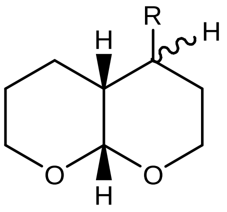


; $PhCH_2NH_2$; $MeCO_2H$;


18. The major product formed in the following reaction is



(a)


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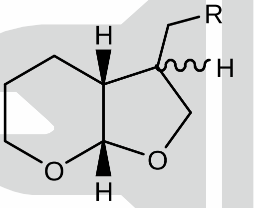

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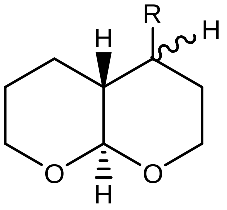

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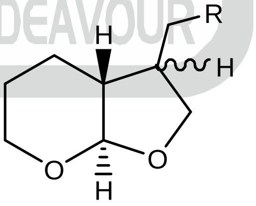


19. The reaction of Ph_3PCl_2 with $PhNH_2$ primarily produces

(a) $Ph_3P = NPh$ (b) $PhP = NPh$ (c) $PhCl_2P = NPh$ (d) $Ph_2ClP = NPh$

20. Formation of $[M(en)_3]^{2+}$ from $[M(H_2O)_6]^{2+}$ and three equivalents of ethylenediamine (en) is **LEAST** favored when M is

(a) Co (b) Ni (c) Cu (d) Fe

21. Wacker oxidation of alkenes is catalyzed by a combination of

(a) Pd(II) and Cu(II) (b) Co(II) and Cu(II)

(c) Pd(II) and Ni(II) (d) Pd(II) and Co(II)

22. For the conversion of $[Pt(L)Cl_3]^-$ to *trans*-$[Pt(L)Cl_2(H_2O)]$, the *trans*-effect is **LEAST** when the ligand L is

(a) H_2O (b) NH_3 (c) DMSO (d) C_2H_4

23. The tetracoordinated copper center in the oxidized and reduced forms of plastocyanin exhibits longest bond with

(a) cysteine-S and methionine-S, respectively
(b) methionine-S and cysteine-S, respectively
(c) cysteine-S and cysteine-S, respectively
(d) methionine-S and methionine-S, respectively

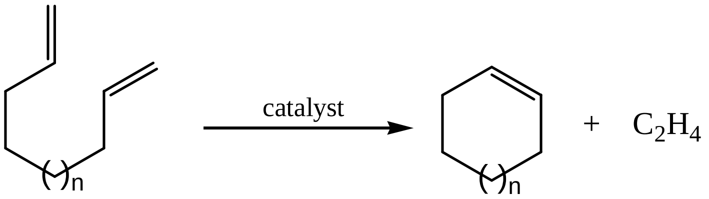
24. The packing efficiency (in %) of spheres for a body-centered cubic (*bcc*) lattice is approximately

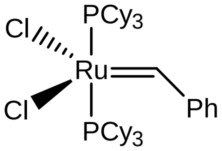
(a) 74
(b) 68
(c) 60
(d) 52

25. The magnitudes of CFSE in $[M(H_2O)_6]^{n+}$ for Mn and Fe ions satisfy the relations

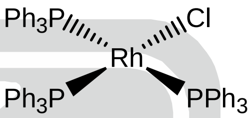
(a) $Mn^{2+} < Mn^{3+}$ and $Fe^{2+} < Fe^{3+}$
(b) $Mn^{2+} > Mn^{3+}$ and $Fe^{2+} > Fe^{3+}$
(c) $Mn^{2+} < Mn^{3+}$ and $Fe^{2+} > Fe^{3+}$
(d) $Mn^{2+} > Mn^{3+}$ and $Fe^{2+} < Fe^{3+}$

26. The organometallic catalyst for the following transformation is



(a)


Cy : cyclohexyl

(b)


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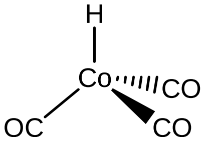

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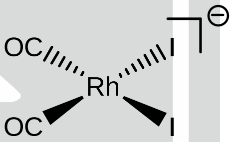


27. Point group of naphthalene ($C_{10}H_8$) is

(a) D_{2d}
(b) D_{2h}
(c) D_{3d}
(d) D_{3h}

28. The **INCORRECT** statement is

(a) Zero-point energy of a quantum mechanical harmonic oscillator of frequency ν is $\frac{h\nu}{2}$

(b) Energy level of a quantum mechanical rigid rotor is inversely proportional to its moment of inertia

(c) The time independent Schrödinger equation for Li^{2+} **cannot** be solved exactly

(d) Total angular momentum of an atomic system is equal to the sum of orbital angular momentum and spin angular momentum

29. For an ideal gas, the molecular partition function in the canonical ensemble, that is proportional to the system volume (V), is the

(a) vibrational partition function
(b) rotational partition function
(c) electronic partition function
(d) translational partition function

30. Assertion (**S**): The total angular momentum for light atoms (low atomic number) is obtained by Russell-Saunders coupling, whereas *jj*-coupling is used for heavy atoms (high atomic number).

Reasoning (**R**): The spin-orbit interactions are weak in light atoms (low atomic number) and strong in heavy atoms (high atomic number).

The ***correct*** option is

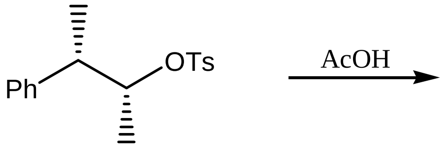
(a) **S** and **R** are true; and **R** is the correct reason for **S**

(b) **S** and **R** are true; but **R** is NOT the correct reason for **S**

(c) **S** is true but **R** is false

(d) **S** is false but **R** is true

31. The acetolysis product(s) of the given reaction is(are)



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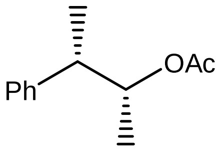

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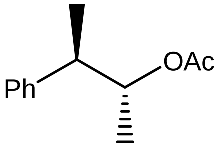

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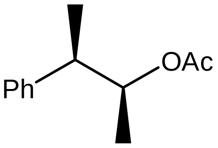

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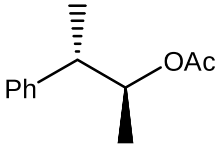
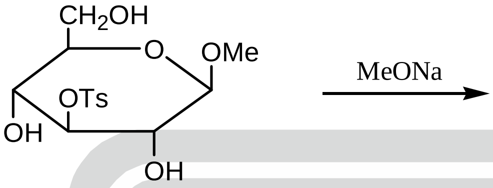
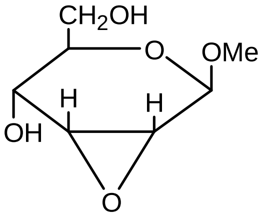


32. Product(s) formed in the given reaction is(are)



(a)


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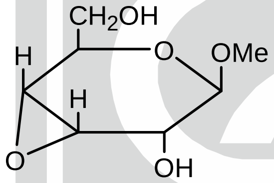

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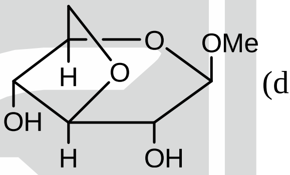

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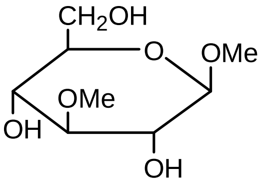


33. The choice(s) that correctly identify radioisotopes (P, Q, R, S) shown in the following nuclear reaction is(are)

$$\begin{tikzcd}
 & & n + Q \\
{}^{60}_{28}\mathrm{Ni} + \alpha \arrow[r] & \underset{\text{(unstable)}}{P} \arrow[ru] \arrow[r] \arrow[rd] & 2n + R \\
 & & p + n + S
\end{tikzcd}$$

(a) $P = {}^{64}_{30}\mathrm{Zn}$ (b) $Q = {}^{63}_{30}\mathrm{Zn}$ (c) $R = {}^{62}_{29}\mathrm{Cu}$ (d) $S = {}^{62}_{29}\mathrm{Cu}$

34. For the Lindemann-Hinshelwood mechanism of gas phase unimolecular reactions, the ***true*** statement(s) is(are)

(a) Only molecules with three or more atoms can follow the Lindemann-Hinshelwood mechanism

(b) Lindemann-Hinshelwood mechanism involves bimolecular elementary steps

(c) The overall reaction is of second order at low pressure

(d) The overall reaction is of second order at high pressure

35. The calculated magnetic moment of $[\mathrm{Ce(NO_3)_5}]^{2-}$ is _______ BM. (rounded off to two decimal places)
(Given: Atomic number of Ce is 58)

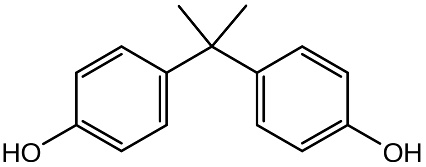
Q.26 – Q.55 : Carry TWO marks each.

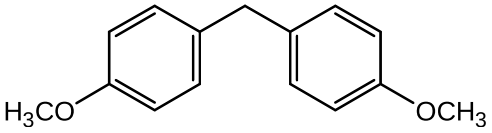
26. A compound, $C_{15}H_{16}O_2$, has the following spectral data;

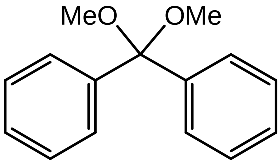
^{1}H NMR (ppm): 9.16 (s), 6.89 (d, J = 8 Hz), 6.64 (d, J = 8 Hz), 1.53 (s)

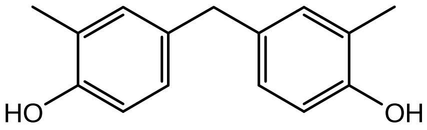
^{13}C NMR (ppm): 154.7, 140.9, 127.1, 114.4, 40.7, 30.7

The structure of the compound is

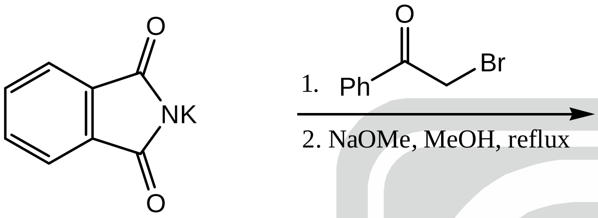
(a) 

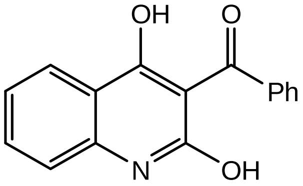
(b) 

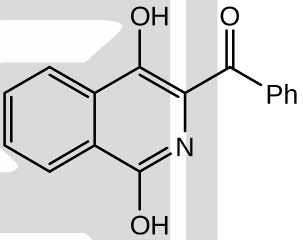
(c) 

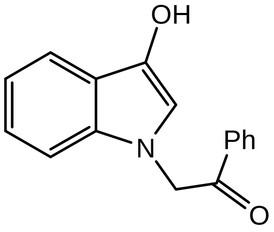
(d) 

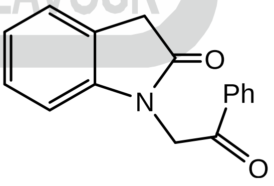
37. The major product formed in the given reaction sequence is



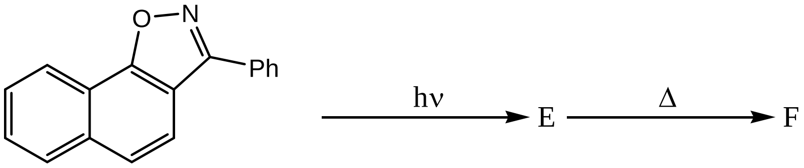
(a) 

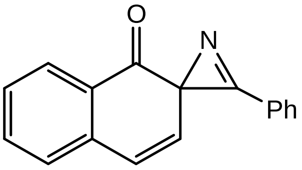
(b) 

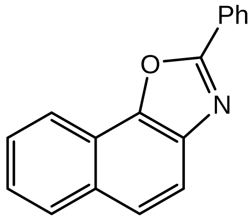
(c) 

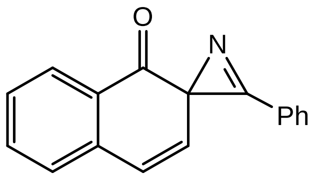
(d) 

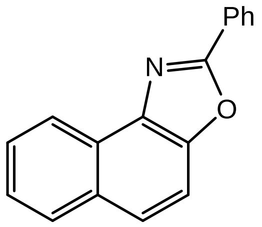
38. **E** and **F** in the given reaction scheme are

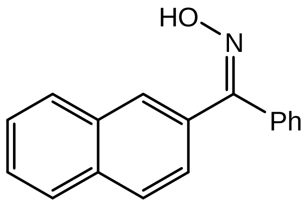


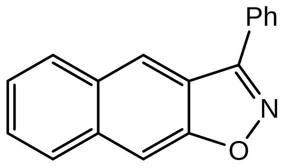
(a) **E :** 

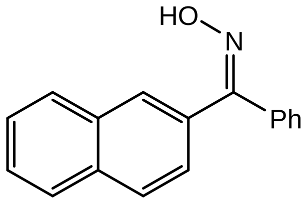
and **F :** 

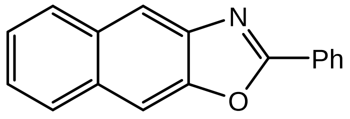
(b) **E :** 

and **F :** 

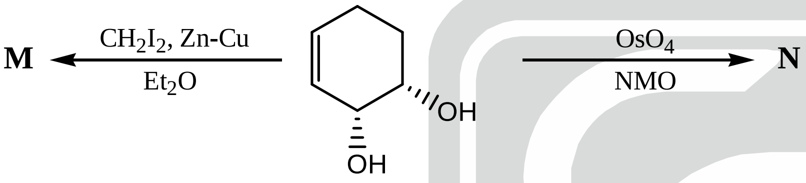
(c) **E :** 

and **F :** 

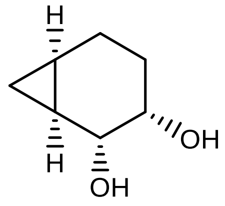
(d) **E :** 

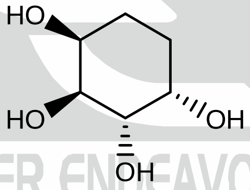
and **F :** 

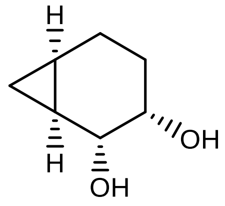
39. **M** and **N** in the given reaction scheme are

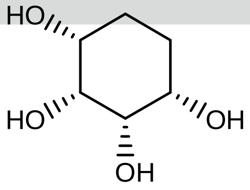


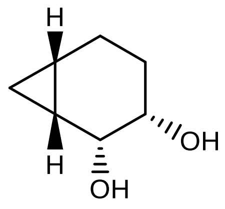
NMO : *N*-Methylmorpholine-*N*-oxide

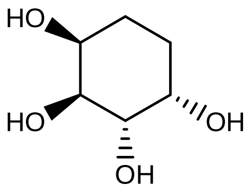
(a) **M :** 

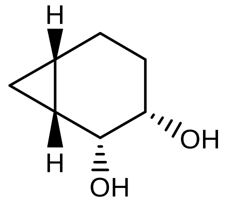
and **N :** 

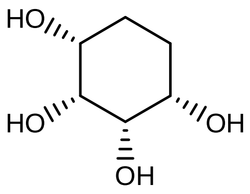
(b) **M :** 

and **N :** 

(c) **M :** 

and **N :** 

(d) **M :** 

and **N :** 

40. In the ^{1}H NMR spectrum, multiplicity of the signal (bold and underlined H atom) in the following species is

(I) $[\underline{\mathbf{H}}\text{Ni(OPEt}_3)_4]^+$ (II) $\text{Ph}_2\text{Si(Me)}\underline{\mathbf{H}}$ (III) $\text{P}\underline{\mathbf{H}}_3$

(IV) $(\text{Cp*})_2\text{Zr}\underline{\mathbf{H}}_2$ (Cp* = pentamethylcyclopentadienyl)

(a) I-pentet, II-quartet, III-doublet and IV-singlet
(b) I-pentet, II-singlet, III-singlet and IV-doublet
(c) I-triplet, II-triplet, III-doublet and IV-doublet
(d) I-singlet, II-quartet, III-singlet and IV-singlet

41. The major product obtained by the treatment of $(\eta^5\text{-C}_5\text{H}_5)_2\text{Ni}$ with Na/Hg in ethanol is

(a) $(\eta^5\text{-C}_5\text{H}_5)(\eta^3\text{-C}_5\text{H}_5)\text{Ni}$ (b) $(\eta^3\text{-C}_5\text{H}_5)_2\text{Ni}$

(c) $(\eta^5\text{-C}_5\text{H}_5)(\eta^3\text{-C}_5\text{H}_7)\text{Ni}$ (d) $(\eta^3\text{-C}_5\text{H}_7)_2\text{Ni}$

42. The number of shared corners of the constituent SiO_4 units in orthosilicate, pyrosilicate, cyclic silicate and sheet silicate, respectively, are

(a) 0, 1, 2 and 3 (b) 2, 3, 0 and 1 (c) 0, 3, 1 and 2 (d) 1, 2, 3 and 0

43. Concentration of Q in a consecutive reaction $P \xrightarrow{k_1} Q \xrightarrow{k_2} R$ is given by

$[Q] = \dfrac{k_1[P]_0}{k_2 - k_1}[e^{-k_1 t} - e^{-k_2 t}]$, where $[P]_0$ is the initial concentration of P.

If the value of $k_2 = 25\ \text{s}^{-1}$, the value of k_1 that leads to the longest waiting time for Q to reach its maximum is

(a) $k_1 = 20\ \text{s}^{-1}$ (b) $k_1 = 25\ \text{s}^{-1}$ (c) $k_1 = 30\ \text{s}^{-1}$ (d) $k_1 = 35\ \text{s}^{-1}$

44. The wavefunction for Be^{3+} in a certain state is given by $\psi = N e^{-\left(\frac{4}{a_0}r\right)}$, where N is the normalization constant, r is the distance of electron from the nucleus and a_0 is the Bohr radius. The most probable distance of the electron from the nucleus in this state is

(a) $4a_0$ (b) $\dfrac{a_0}{4}$ (c) $8a_0$ (d) $\dfrac{a_0}{8}$

45. Match the following

Column-I	**Column-II**
(P) Associated Legendre polynomials	(I) Harmonic oscillator
(Q) Hermite polynomials	(II) Particle in a box model
(R) Associated Laguerre polynomials	(III) Angular part of H atom
(S) Trigonometric functions	(IV) Radial part of H atom

(a) P → III, Q → I, R → IV, S → II (b) P → III, Q → IV, R → II, S → I
(c) P → IV, Q → I, R → III, S → II (d) P → II, Q → III, R → IV, S → I

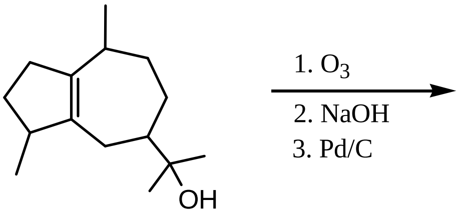
46. In the scheme below,

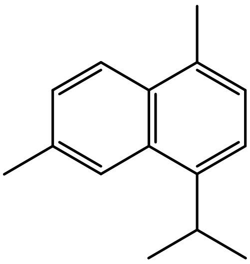
$$\text{P}_2 \underset{k_1}{\overset{I_a}{\rightleftharpoons}} 2\text{Q} \xrightarrow{k_2} \text{R}$$

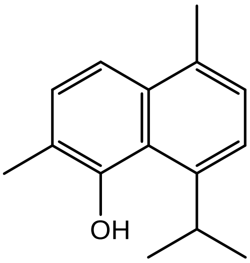
I_a represents the intensity of the light absorbed. Assuming that the quantum yield of the first step is one, the steady state concentration of Q is given by

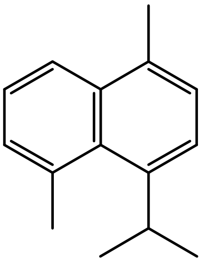
(a) $\sqrt{\dfrac{I_a}{k_1 + k_2}}$ (b) $\sqrt{\dfrac{I_a[P_2]}{k_1 + k_2}}$ (c) $\dfrac{I_a}{k_1 + k_2}$ (d) $\dfrac{I_a[P_2]}{k_1 + k_2}$

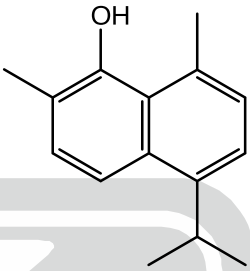
47. Product(s) formed in the given reaction sequence is(are)



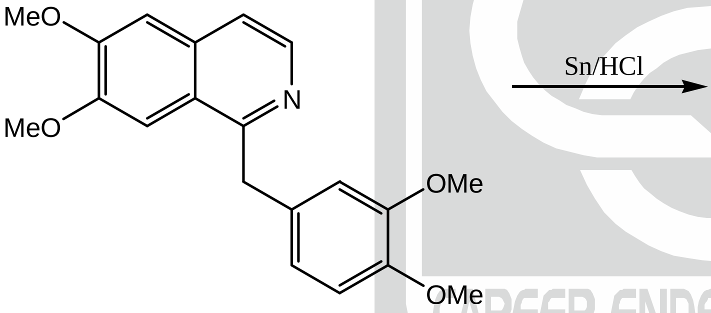
(a)


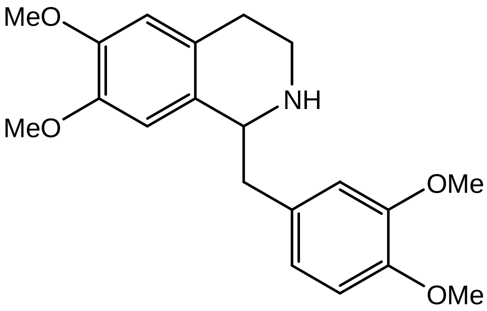
(b)


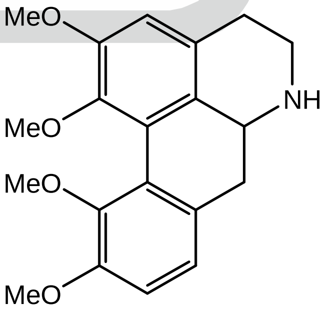
(c)


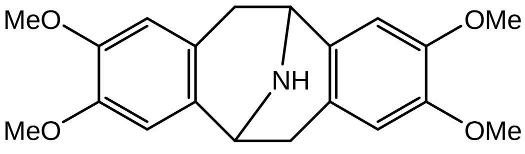
(d)


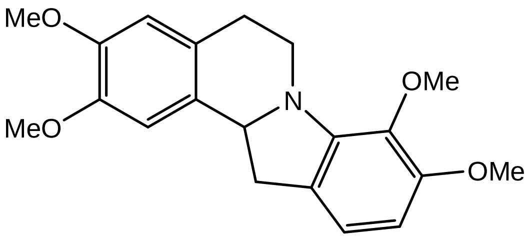
48. Product(s) formed in the reaction below is(are)



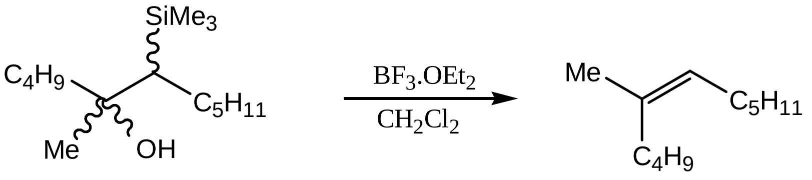
(a)


(b)


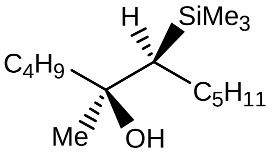
(c)


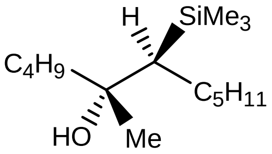
(d)


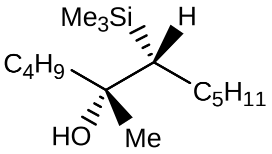
49. The stereoisomer(s) of **G** giving the depicted product is(are)

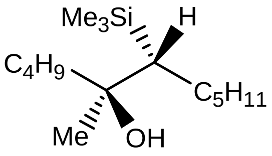


G

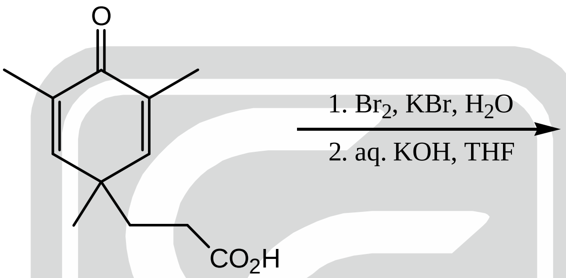
(a) 

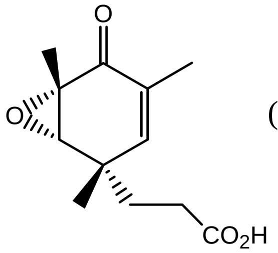
(b) 

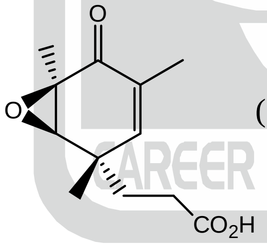
(c) 

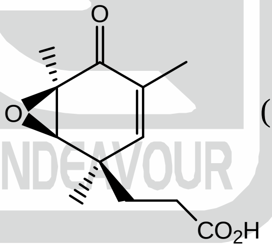
(d) 

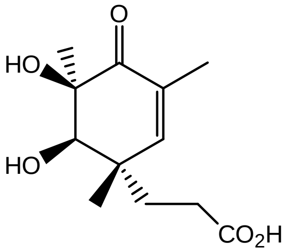
50. Product(s) formed in the given reaction sequence is(are)



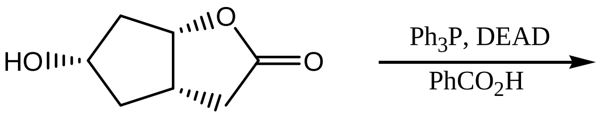
(a) 

(b) 

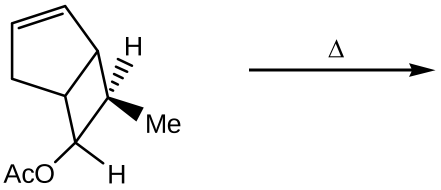
(c) 

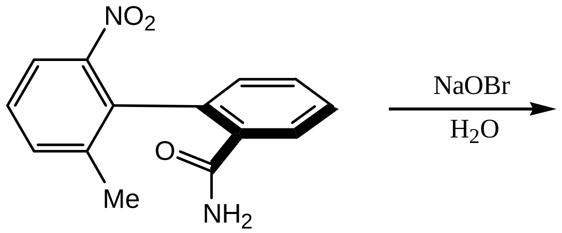
(d) 

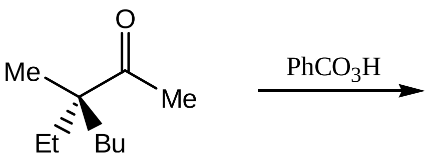
51. The reaction(s) in which *inversion of configuration* occur(s) is(are)

(a) 

DEAD : Diethyl azodicarboxylate

(b) 

(c) 

(d) 

52. The ***correct*** statement(s) regarding myoglobin (Mb) and haemoglobin (Hb) is(are)

(a) At low partial pressure of O_2 (e.g., 5 kPa), the O_2 affinity of Hb lowers upon lowering the pH

(b) Binding of the first O_2 molecule to Hb results in lower affinity for the binding of second O_2 molecule

(c) Metal center in deoxy-Mb is low-spin whereas it is high-spin in the case of oxy-Mb

(d) One end of O_2 binds to the metal center in oxy-Mb and the other end of the bound O_2 is H-bonded with imidazole-NH of a distal histidine

53. The ***correct*** statement(s) regarding $Co_2(CO)_8$ is(are)

(a) It reacts with Na to give $Na[Co(CO)_4]$

(b) It contains three bridging carbonyls

(c) It can be prepared by reductive carbonylation of $Co(OAc)_2 \cdot 4H_2O$

(d) Two isomers exist in hexane solution

54. The compound(s) having $[Xe]4f^{\,1}$ configuration is(are)

(Given the atomic numbers Ce:58, Lu:71, Pr:59 and Nd:60)

(a) $Na_3[Ce(NO_3)_6]$

(b) $Na_3[LuCl_6]$

(c) PrO_2

(d) $Nd(NR_2)_3$ (R = $SiMe_3$)

55. The ***correct*** statement(s) for XeF_2 is(are)

(a) Its bonding is best explained by classical 2-centered-2-electron bonds

(b) Its bonding is best explained by a non-classical 3-centered-4-electron bond

(c) It contains nine lone pairs of electrons

(d) Its point group is $D_{\infty h}$

56. For the non-dissociative adsorption of a gas on solid,

(i) the Freundlich isotherm is given by $\theta = kp^{1/n}$ where θ is surface coverage, *p* is pressure, *k* and *n* are empirical constants; and

(ii) the BET isotherm is given by $\dfrac{p}{p^* - p} = \dfrac{\theta}{c} + \theta(c-1)\left(\dfrac{p}{p^*}\right)$

where p^* and *c* are empirical constants, and $p < p^*$.

The ***correct*** statement(s) is(are)

(a) At low surface coverage, the Langmuir isotherm reduces to the Freundlich isotherm with $n = 1$

(b) At high surface coverage, the Langmuir isotherm reduces to the Freundlich isotherm with $n = \infty$

(c) At very low pressure $(p \ll p^*)$, the BET isotherm reduces to the Langmuir isotherm

(d) At very high pressure $(p \to p^*)$, the BET isotherm reduces to the Langmuir isotherm

57. Two different enzyme catalysis reactions I and II have identical Y-intercepts for the Lineweaver-Burke (equation given below) plots. The slope for reaction I is twice than that of reaction II.

If the initial concentrations of enzymes in I and II are same, the ***correct*** statement(s) is(are)

$$\frac{1}{v} = \frac{1}{v_{\max}} + \frac{K_M}{v_{\max}} \frac{1}{[S]}$$

where v and v_{max} are rate and maximum rate; K_M is Michaelis-Menten constant, and [S] is substrate concentration.

(a) Reactions I and II have same turn over number

(b) Michaelis-Menten constants for reactions I and II are identical

(c) Michaelis-Menten constant for reaction I is twice than that of reaction II

(d) The rates of the elementary steps for reactions I and II are identical

58. The enthalpy change for the exothermic reaction between BeI_2 and HgF_2 is _______ kJ mol^{-1}
(rounded off to the nearest integer)
(Given: Bond dissociation energy (in kJ mol^{-1}) for Be–F = 632, Be–I = 289,
Hg–F = 268 and Hg–I = 145)

59. Number of carbon atoms connected to the metal center in $[W(C_{60})(CO)_5]$ is _______
(rounded off to the nearest integer). (Given: atomic number of W is 74)

60. Two-component solid-liquid system of naphthalene-benzene forms a simple eutectic mixture. Assuming that naphthalene-benzene forms an ideal solution, the mole fraction of naphthalene in benzene at 300 K and 1 bar is _______ (rounded off to two decimal places)

(Given: Freezing point (T_{fp}) and enthalpy of fusion (ΔH_{fus}) of naphthalene are 353 K and 19.28 kJ mol^{-1}, respectively and gas constant (R) = 8.31 JK^{-1} mol^{-1})

61. The intrinsic viscosity of a sample of polystyrene in toluene is 84 cm^3 g^{-1} at 30ºC. It follows Mark-Houwink equation with empirical constant values of $K = 1.05 \times 10^{-2}$ cm^3 g^{-1} and $a = 0.75$. The molecular weight of the polymer is ________ × 10^3 g mol^{-1} (rounded off to the nearest integer)

62. According to Debye-Hückel limiting law, the mean molal activity coefficient for 0.87 g K_2SO_4 (molar mass = 174 g mol^{-1}) in 1 kg of water at 25ºC is _________ (rounded off to two decimal places)

63. A solution is prepared by dissolving 128 g of naphthalene ($C_{10}H_8$) in 780 g of benzene (C_6H_6). The vapor pressure of pure benzene is 12.6 kPa at 25ºC. Assuming that naphthalene in benzene is an ideal solution, the partial vapor pressure of benzene is _________kPa (rounded off to two decimal places)

64. For the galvanic cell: $H_2(g)$ | HCl (aq) | $Cl_2(g)$
the standard electromotive force (E^0) value is given by $E^0 = 1.73 - (1.25 \times 10^{-3})T + (1.00 \times 10^{-6})T^2$
where E^0 is in Volts and T is in Kelvin. For the cell reaction, the standard enthalpy change ($\Delta_r H^0$) at 300 K is ________ kJ mol^{-1} (rounded off to the nearest integer)
(Given: Faraday constant, F = 96500 C mol^{-1})

65. A solution of three non-interacting compounds P, Q, and R is taken in a cuvette of 1 cm path length. Their concentrations are [P] = 1×10^{-6} M, [Q] = 2×10^{-6} M, [R] = 3×10^{-6} M and the molar extinction coefficients at 300 nm are $\varepsilon_P = 1 \times 10^5$ M^{-1} cm^{-1}, $\varepsilon_Q = 2 \times 10^5$ M^{-1} cm^{-1} and

$\varepsilon_R = 3 \times 10^5$ M^{-1} cm^{-1}. The % transmittance at 300 nm is ___________
(rounded off to two decimal places)