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CSIR-UGC-NET (Chemical Science) June - 2015

Q.21 – Q.70 Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: −0.5). You are required to Answer Maximum 35 Questions.

21. **The biological functions of carbonic anhydrase and carboxypeptidase-A, respectively, are**

(a) interconversion of CO_2 and carbonates and hydrolysis of peptide bond

(b) gene regulation and interconversion of CO_2 and carbonates

(c) gene regulation and hydrolysis of peptide bond

(d) interconversion of CO_2 and carbonates and gene regulation

22. **The $Fe–N_{porphyrin}$ bond distances in the deoxy- and oxy-haemoglobin, respectively are**

(a) ~ 2.1 and 2.0 Å (b) ~2.0 and 2.0 Å (c) ~2.2 and 2.3 Å (d) ~2.3 and 2.5 Å

23. **The binding modes of NO in 18-electron compounds $[Co(CO)_3(NO)]$ and $[Ni(\eta^5\text{-}Cp)(NO)]$, respectively are**

(a) linear and bent (b) bent and linear (c) linear and linear (d) bent and bent

24. **The role of copper salt as co-catalyst in Wacker Process is**

(a) oxidation of Pd(0) by Cu(II) (b) oxidation of Pd(0) by Cu(I)

(c) oxidation of Pd(II) by Cu(I) (d) oxidation of Pd(II) by Cu(II)

25. **For typical Fischer and Schrock carbenes, consider the following statements**

[P] **Oxidation state of metal is low in Fischer carbene and high in Schrock carbene**

[Q] **Auxiliary ligands are π-acceptor in Fischer carbene and non-π-acceptor in Schrock carbene**

[R] **Substituents on carbene carbon are non-π-donor in Fischer carbene and π-donor in Schrock carbene**

[S] **Carbene carbon is electrophilic in Fischer carbene and nucleophilic in Schrock carbene**

The correct statements are

(a) P, Q and R (b) P, Q and S (c) Q, R and S (d) P, R and S

26. **The species having the strongest gas phase proton affinity among the following**

(a) N^{3-} (b) NF_3 (c) NH_3 (d) $N(CH_3)_3$

27. **Consider the following statements regarding the diffusion current at dropping mercury electrode,**

[P] It does not depend on mercury flow rate

[Q] It depends on drop time

[R] It depends on temperature

Correct statement(s) is/are

(a) P only (b) Q only (c) P and Q (d) Q and R

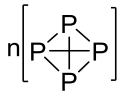
28. **Q value for the reaction $^{13}N(n,p)\,^{13}C$ is 3.236 MeV. The threshold energy (in MeV) for the reaction $^{13}C(p,n)^{13}N$ is**

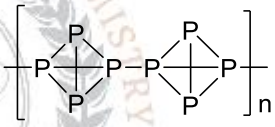
(a) -3.236 (b) -3.485 (c) 3.485 (d) 3.845

29. **The ^{119}Sn-NMR chemical shift (approximately in ppm) corresponding to $(\eta^5\text{-}Cp)_2$ Sn (relative to Me_4Sn) is**

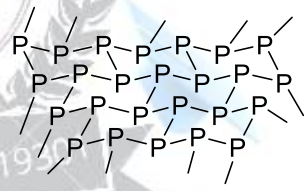
(a) -4 (b) $+137$ (c) $+346$ (d) -2200

30. **All forms of phosphorus upon melting, exist as**

(a) 

(b) 

(c) n(P≡P)

(d) 

31. **For the oxidation state(s) of sulphur atoms in S_2O, consider the following**

P	Q	R
-2 and $+4$	0 and $+2$	$+4$ and 0

The correct answer(s) is/are

(a) P and Q (b) P and R (c) Q and R (d) R only

32. **The correct set of pseudohalide anions is**

(a) CN^-, ClO_4^-, BF_4^-, PF_6^- (b) N_3^-, NO_3^-, HSO_4^-, AsF_6^-

(c) SCN^-, PO_4^{3-}, $H_2PO_4^-$, N_3^- (d) CN^-, N_3^-, SCN^-, NCN^{2-}

33. **In transition metal phosphine(M-Pr_3) complexes, the back-bonding involves donation of electrons from**

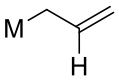
(a) $M_{(t_{2g})} \rightarrow PR_{3(\sigma^*)}$ (b) $M_{(t_{2g})} \rightarrow PR_{3(\pi^*)}$ (c) $M_{(e_g)} \rightarrow P_{(d)}$ (d) $PR_{3(\pi)} \rightarrow M_{(t_{2g})}$

34. **The refluxing of $RhCl_3.3H_2O$ with an excess of PPh_3 in ethanol gives a complex-X. Complex-X and the valence electron count on rhodium are, respectively**

(a) $[RhCl(PPh_3)_3]$, 16 (b) $[RhCl(PPh_3)_5]$, 16

(c) $[RhCl(PPh_3)_3]$, 18 (d) $[RhCl(PPh_3)_5]$, 18

35. The β-hydrogen elimination will be facile in

(a)  (b)  (c)  (d) 

36. The reaction $[Co(CN_5)H_2O]^{2-} + X^- \longrightarrow [Co(CN)_5X]^{2-} + H_2O$ follows a/an

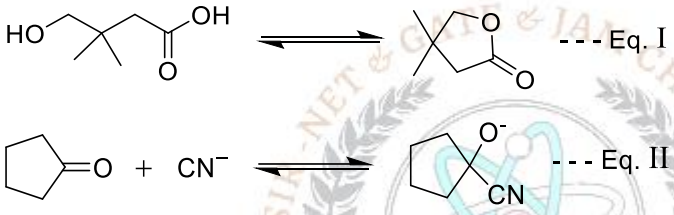
(a) Interchange dissociative (I_d) mechanism

(b) Dissociative (D) mechanism

(c) Associative (A) mechanism

(d) Interchange Associative (I_a) mechanism

37. Correct statement on the effect of addition of aq. HCl on the equilibrium is



(a) Equilibrium will shift towards right in case of both I and II

(b) Equilibrium will shift towards left in case of both I and II

(c) Equilibrium will shift towards right in I and left in case of II

(d) Equilibrium will shift towards right in II and left in case of I

38. The compound that exhibits sharp bands at 3300 and 2150 cm^{-1} in the IR spectrum is

(a) 1-butyne (b) 2-butyne (c) butyronitrile (d) butylamine

39. The ^{1}H-NMR spectrum of a dilute solution of a mixture of acetone and dichloromethane in $CDCl_3$ exhibits two singlets of 1 : 1 intensity. Molar ratio of acetone to dichloromethane in the solution is

(a) 3 : 1 (b) 1 : 3 (c) 1 : 1 (d) 1 : 2

40. Intense band generally observed for a carbonyl group in the IR spectrum is due to

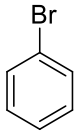
(a) The force constant of CO bond is large

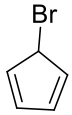
(b) The force constant of CO bond is small

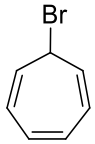
(c) There is no change in dipole moment for CO bond stretching

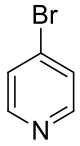
(d) The dipole moment change due to CO bond stretching is large

41. The compound that gives precipitate on warming with aqueous $AgNO_3$ is

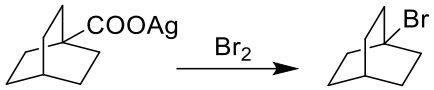
(a) 

(b) 

(c) 

(d) 

42. Following reaction goes through



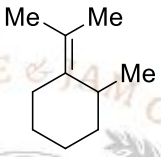
(a) Free radical intermediate

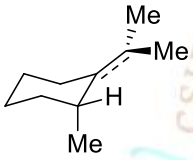
(b) carbanion intermediate

(c) carbocation intermediate

(d) carbene intermediate

43. The most stable conformation for the following compound is



(a) 

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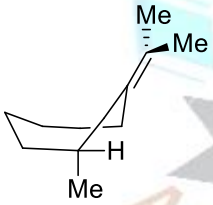
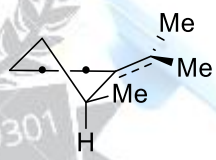
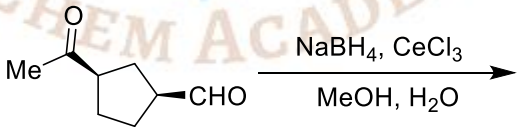
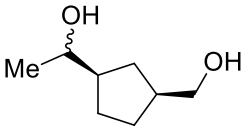
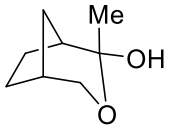
(c) 

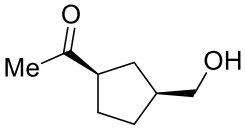
(d) 

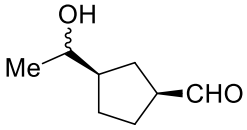
44. The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

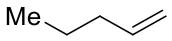
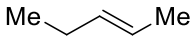
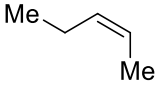
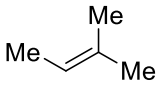
45. The correct relation between the following compounds is

(a) enantiomers

(b) diastereomers

(c) homomers (identical) (d) constitutional isomers

46. **The correct order of heat of hydrogenation for the following compounds is**

I	II	III	IV
			

(a) I > II > III > IV (b) I > III > II > IV

(c) IV > I > III > II (d) IV > II > I > III

47. **Among the following, the correct statement(s) about ribose is (are)**

[P] On reduction with $NaBH_4$ it gives optically inactive product

[Q] On reaction with methanolic HCl it gives a furanoside

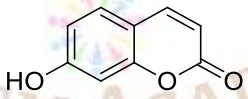
[R] On reaction with Br_2–$CaCO_3$–water it gives optically inactive product

[S] It gives positive Tollen's test

(a) P, Q and S (b) P, Q and R (c) Q and R (d) S only

48. **Biogenetic precursors for the natural product umbelliferone among the following are,**

P	Q	R	S
L-tryptophan	cinnamic acid	L-methionine	L-phenylalanine



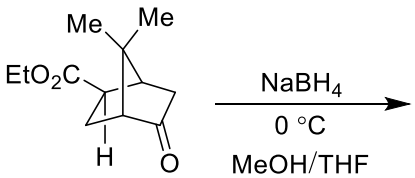
umbelliferone

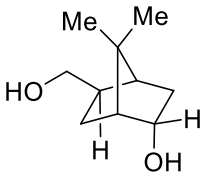
(a) P and Q (b) Q and S (c) Q and R (d) R and S

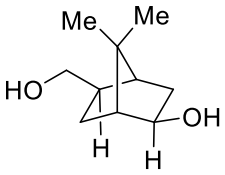
49. **Number of signals in the $^{13}C\{^1H\}$-NMR spectrum of (R)–4-methylpentan-2-ol are**

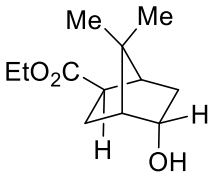
(a) 3 (b) 4 (c) 5 (d) 6

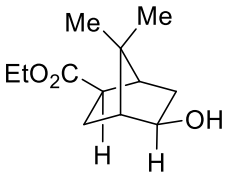
50. **The major product formed in the following reaction is**



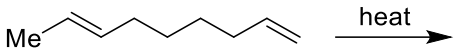
(a) 

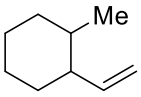
(b) 

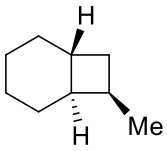
(c) 

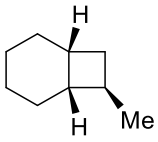
(d) 

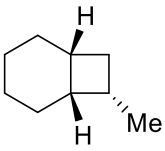
51. **The major product formed in the following reaction is**



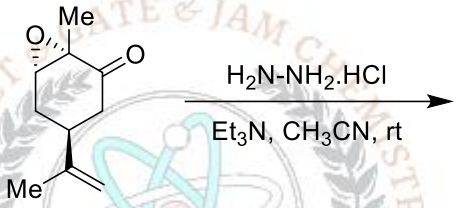
(a) 

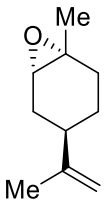
(b) 

(c) 

(d) 

52. **The major product formed in the following reaction is**



(a) 

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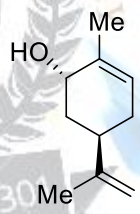
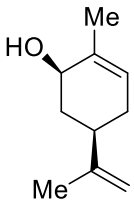
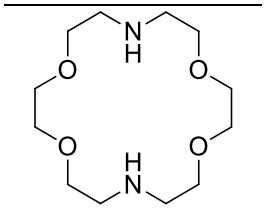
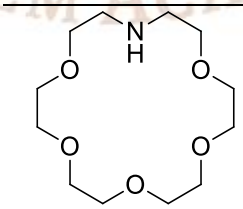
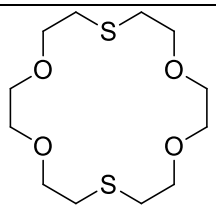
(c) 

(d) 

53. **The magnitude of the stability constants for K^+ ion complexes of the following supra-molecular hosts follows the order**

I 

II 

III 

(a) II > I > III (b) III > I > II

(c) I > II > III (d) III > II > I

54. **Antitubercular drug(s) among the following is(are)**

I	II	III	IV
Salbutamol	Ethambutanol	Isoniazid	Diazepam

(a) I and II (b) II and III (c) III and IV (d) IV Only

55. **A particle is in a one-dimensional box with a potential V_0 inside the box and infinite**

outside. An energy state corresponding to $n = 0$ (n : quantum number) is not allowed because

(a) the total energy becomes zero

(b) the average momentum becomes zero

(c) the wave function becomes zero everywhere

(d) the potential $V_0 \neq 0$

56. An eigen state of energy satisfies $H\Psi_n = E_n\Psi_n$. In the presence of an extra constant potential V_0

(a) both E_n and Ψ_n will change

(b) both E_n and the average kinetic energy will change

(c) only E_n will change, but not Ψ_n

(d) only Ψ_n will change, but not E_n

57. The intensity of a light beam decreases by 50% when it passes through a sample of 1.0 cm path length. The percentage of transmission of the light passing through the same sample, but of 3.0 cm path length, would be

(a) 50.0 (b) 25.0 (c) 16.67 (d) 12.5

58. The electric-dipole allowed transition among the following is

(a) $^3S \rightarrow {}^3D$ (b) $^3S \rightarrow {}^3P$ (c) $^3S \rightarrow {}^1D$ (d) $^3S \rightarrow {}^1F$

59. The product $C_2^x \times \sigma_{xy}$ (C_2^x is the two-fold rotational axis around the x-axis and σ_{xy} is the xy mirror plane) is

(a) σ_{xz} (b) σ_{yz} (c) C_2^y (d) C_2^z

60. The simplest ground-state VB wave function of a diatomic molecule like HCl is written as $\Psi = \Psi_H\,(1s, 1)\,\Psi_{Cl}\,(3p_z, 2) + B$ where B stands for

(a) $\Psi_H\,(3p_z, 2)\,\Psi_{Cl}\,(1s, 1)$ (b) $\Psi_H\,(1s, 2)\,\Psi_{Cl}\,(3p_z, 1)$

(c) $\Psi_{Cl}\,(1s, 2)\,\Psi_{Cl}(\,(3p_z, 1)$ (d) $\Psi_{Cl}\,(1s, 2)\,\Psi_H\,(3p_z, 1)$

61. Heat capacity of a species is independent of temperature if it is

(a) tetratomic (b) triatomic (c) diatomic (d) monoatomic

62. In a chemical reaction: $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$, xenon gas is added at constant volume. The equilibrium

(a) will shift towards the reactant

(b) will shift towards the products

(c) will not change the amount of reactant and products

(d) will increase both reactant and products

63. **The temperature-dependence of a reaction is given by, $k = AT^2 \exp(-E_0/RT)$. The activation energy (E_a) of the reaction is given by**

(a) $E_0 + ½ RT$ (b) E_0 (c) $E_0 + 2RT$ (d) $2E_0 + RT$

64. **For a reaction, $2A + B \longrightarrow 3Z$, if the rate of consumption of A is 2×10^{-4} mol dm^{-3}s^{-1}. the rate of formation of Z (in mol dm^{-3}s^{-1}) will be**

(a) 3×10^{-4} (b) 2×10^{-4} (c) $4/3 \times 10^{-4}$ (d) 4×10^{-4}

65. **Dominant contribution to the escaping tendency of a charged particle with uniform concentration in a phase, depends On**

(a) chemical potential of that phase (b) electric potential of the phase

(c) thermal energy of that phase (d) gravitational potential of that phase

66. **The intrinsic viscosity depends on the molar mass as $[\eta] = KM^a$. The empirical constants K and a are dependent on**

(a) solvent only (b) polymer only

(c) polymer-solvent pair (d) polymer-polymer interaction

67. **The correct ΔG for the cell reaction involving steps $Zn_{(s)} \longrightarrow Zn^{2+}{}_{(aq)} + 2e^-$ and $Cu^{2+}{}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ is**

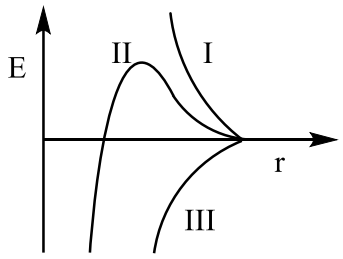
(a) $\Delta G^\circ - RT \ln \frac{a_{Zn^{2+}}}{a_{Cu^{2+}}}$ (b) $\Delta G^\circ + RT \ln \frac{a_{Zn^{2+}}}{a_{Cu(s)}}$

(c) $\Delta G^\circ - RT \ln \frac{a_{Zn(s)}}{a_{Cu^{2+}}}$ (d) $\Delta G^\circ + RT \ln \frac{a_{Zn^{2+}}}{a_{Cu^{2+}}}$

68. **The lowest energy-state of an atom with electronic configuration ns^1np^1 has the term symbol**

(a) $^3P_1$ (b) $^1P_1$ (c) $^3P_2$ (d) $^3P_0$

69. **Energy of interaction of colloidal particles as a function of distance of separation can be identified as (P) van der Waals, (Q) double layer, (R) van der Waals and double layer. The correct order of interactions in the figure corresponding to curves (I), (II) and (III) respectively, is**



(a) P, Q, R (b) Q, R, P (c) R, P, Q (d) P, R, Q

70. **The packing factor (PF) and number of atomic sites per unit cell (N) of an FCC crystal system are**

(a) PF = 0.52 and N = 3 (b) PF = 0.74 and N = 3

(c) PF = 0.52 and N = 4 (d) PF = 0.74 and N = 4

Q.71 – Q.145 Multiple Choice Question (MCQ), carry FOUR marks each (for each wrong answer: –1). You are required to Answer Maximum 25 Questions.

71. **Differential pulse polarography(DPP) is more sensitive than D.C. Polarography (DCP). Consider following reasons for it**

[P] Non-faradic current is less in DPP in comparison to DCP

[Q] Non-faradic current is more in DPP in comparison to DCP

[R] Polarogram of DPP is of different shape than that of DCP

Correct reason(s) is/are

(a) P and R (b) Q and R (c) Q only (d) P only

72. **Considering the following parameters with reference to the fluorescence of a solution:**

[P] Molar absorptivity of fluorescent molecule

[Q] Intensity of light source used for excitation

[R] Dissolved oxygen

The correct answer for the enhancement of fluorescence with the increase in these parameters is/are

(a) P and Q (b) Q and R (c) P and R (d) R only

73. **The geometric cross section of ^{125}Sn (in barn) is nearly**

(a) 1.33 (b) 1.53 (c) 1.73 (d) 1.93

74. **Match column-I (coupling reactions) with column-II (reagents)**

	Column-I		Column-II
P.	Suzuki coupling	i.	$H_2C{=}CHCO_2CH_3$
Q.	Heck coupling	ii	$RB(OH)_2$
R.	Sonogashira coupling	iii.	$PhCO(CH_2)_3ZnI$
S.	Negeshi Coupling	iv.	$HC{\equiv}CR$
		v.	SnR_4

The correct match is

P	Q	R	S

P	Q	R	S

(a) ii ; i ; iv ; iii (b) i ; v ; iii ; iv

(c) iv ; iii ; ii ; i (d) ii ; iii ; iv ; v

75. **The oxoacid of phosphorus having P atoms in $+4, +3$ and $+4$ oxidation states respectively, is**

(a) $H_5P_3O_{10}$ (b) $H_5P_3O_7$ (c) $H_5P_3O_8$ (d) $H_5P_3O_9$

76. **The geometries of $[Br_3]^+$ and $[I_5]^+$ respectively, are**

(a) trigonal and tetrahedral (b) tetrahedral and trigonal bipyramidal

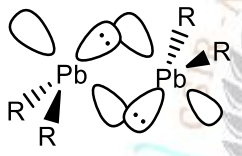
(c) tetrahedral and tetrahedral (d) linear and trigonal pyramidal

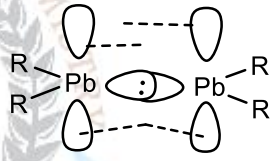
77. **According to Wade's theory the anion $[B_{12}H_{12}]^{2-}$ adopts_____ structure**

(a) closo (b) arachno (c) hypo (d) nido

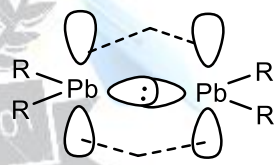
78. **Considering the inert pair effect on lead, the most probable structure of PbR_2 is,**

$[R = 2,6\text{-}C_6H_3(2,6\text{-}{}^iPr_2C_6H_3)_2]$

(a) 

(b) 

(c) 

(d) 

79. **The reaction of $SbCl_3$ with 3 equivalents of EtMgBr yields compound X. Two equivalents of SbI_3 react with one equivalent of X to give Y. In the solid state, Y has a 1D-polymeric structure in which each Sb is in a square pyramidal environment. Compounds X and Y respectively, are**

(a) $SbEt_3$ and $[Sb(Et)I_2]_n$ (b) $Sb(Et_2)Cl$ and $[Sb(Et_2)Cl]_n$

(c) $SbEt_3$ and $[SbEt_2Br_2]_n$ (d) $Sb(Et)Br_2$ and $[SbEt(I)(Br)]_n$

80. **Match the complexes given in column-I with the electronic transitions (mainly responsible for their colours) listed in column II**

Column-I		Column-II	
(P)	**Fe(II)-protoporphyrin IX**	**(i)**	**$\pi \rightarrow \pi^*$**
(Q)	**$[Mn(H_2O)_6]Cl_2$**	**(ii)**	**spin allowed d → d**
(R)	**$[Co(H_2O)_6]Cl_2$**	**(iii)**	**spin forbidden d → d**
		(iv)	**M → L charge transfer**

The correct answer is

	P		Q		R
(a)	i	;	iii	;	ii
(c)	i	;	iii	;	iv

	P		Q		R
(b)	iv	;	ii	;	iii
(d)	i	;	ii	;	iii

81. **The following statements are given regarding the agostic interaction C—H…Ir observed in $[Ir(Ph_3P)_3Cl]$.**

[P] Upfield shift of C-H proton in ^{1}H-NMR spectrum

[Q] Increased acid character of C-H

[R] ν_{C-H} in IR spectrum shifts to higher wavenumber

The correct answer is/are

(a) P and R (b) Q and R (c) P and Q (d) R only

82. **Amongst the following :**

P	Q	R	S
$[Mn(\eta^5\text{-}Cp)\ (CO)_3]$	$[Os(\eta^5\text{-}Cp)_2]$	$[Ru(\eta^5\text{-}Cp)_2]$	$[Fe(\eta^5\text{-}Cp)_2]$

the compounds with most shielded and deshielded Cp protons respectively, are

(a) S and P (b) S and Q (c) R and P (d) R and Q

83. **Total number of vertices in metal clusters $[Ru_6(C)(CO)_{17}]$, $[Os_5(C)(CO)_{15}]$ and $[Ru_5(C)(CO)_{16}]$ are $6, 5$ and 5 respectively. The predicted structures of these complexes, respectively, are**

(a) closo, nido and nido (b) closo, nido and arachno

(c) arachno, closo and nido (d) arachno, nido and closo

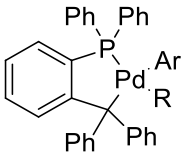
84. **Among the complexes,**

P	Q	R	S
$K_4[Cr(CN)_6]$	$K_4[Fe(CN)_6]$	$K_3[Co(CN)_6]$	$K_4[Mn(CN)_6]$

Jahn-Teller distortion is expected in

(a) P, Q and R (b) Q, R and S (c) P and S (d) Q and R

85. **The reductive elimination of Ar-R (coupled product) from X is facile when,**



X

(a) $R = CH_3$ (b) $R = CH_2Ph$ (c) $R = CH_2COPh$ (d) $R = CH_2CF_3$

86. **The total number of metal ions and the number of coordinated imidazole units of histidine in the active site of oxy-hemocyanin, respectively, are**

(a) $2Cu^{2+}$ and 6 (b) $2Fe^{2+}$ and 5 (c) $2Cu^{+}$ and 6 (d) Fe^{2+} and 3

87. Match the action of H_2O_2 in aqueous medium given in column-I with the oxidation/ reduction listed in column-II

	Action of H_2O_2		Type of reaction
P.	Oxidation in acid	(i)	$[Fe(CN)_6]^{3-} \longrightarrow [Fe(CN)_6]^{4-}$
Q.	Oxidation in base	(ii)	$[Fe(CN)_6]^{4} \longrightarrow [Fe(CN)_6]^{3}$
R.	Reduction in acid	(iii)	$MnO_4 \longrightarrow Mn^{2+}$
S.	Reduction in base	(iv)	$Mn^{2+} \longrightarrow Mn^{4+}$

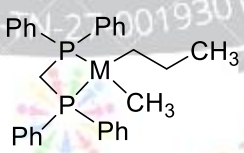
The correct answer is

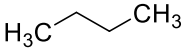
	P		Q		R		S		P		Q		R		S
(a)	i	;	ii	;	iii	;	iv	(b)	ii	;	iv	;	iii	;	i
(c)	iii	;	iv	;	ii	;	i	(d)	iv	;	i	;	iii	;	ii

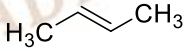
88. The reduced form of a metal ion M in a complex is NMR active. On oxidation, the complex gives an EPR signal with $g_{\parallel} \approx 2.2$ and $g_{\perp} \approx 2.0$. Mossbauer spectroscopy cannot characterise the metal complex. The M is,

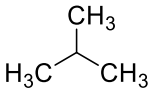
(a) Zn (b) Sn (c) Cu (d) Fe

89. The least probable product from given compound on reductive elimination is



(a) 

(b) CH_4 (c) 

(d) 

90. Water plays different roles in the following reactions

[P] $2H_2O + Ca \longrightarrow Ca^{2+} + 2OH^{-} + H_2$

[Q] $nH_2O + Cl \longrightarrow [Cl(H_2O)_n]^{-}$

[R] $6H_2O + Mg^{2+} \longrightarrow [Mg(H_2O)_6]^{2-}$

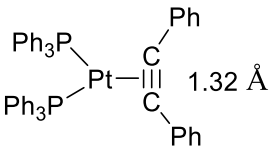
[S] $2H_2O + 2F_2 \longrightarrow 4HF + O_2$

The correct role of water in each reaction is

	P		Q		R		S
(a)	oxidant	;	acid	;	base	;	reductant
(b)	oxidant	;	base	;	acid	;	reductant
(c)	acid	;	oxidant	;	reductant	;	base

(d) base ; reductant ; oxidant ; base

91. **With respect to σ and π bonding in Pt—||| in the structure given below, which of the following represent the correct bonding?**



(a) $M(\sigma) \rightarrow L(\sigma)$ and $M(\pi) \rightarrow L(\pi*)$ (b) $L(\sigma) \rightarrow M(\pi)$ and $L(\pi) \rightarrow M(\pi)$

(c) $L(\pi) \rightarrow M(\pi)$ and $L(\sigma) \rightarrow M(\pi)$ (d) $L(\pi) \rightarrow M(\sigma)$ and $M(\pi) \rightarrow L(\pi*)$

92. **The complex $[Fe(Phen)_2(NCS)_2]$, (phen = 1, 10-phenanthroline) shows spin cross-over behaviour. CFSE and μ_{eff} at 250 and 150 K respectively, are:**

(a) 0.4 Δ_o, 4.90 BM and 2.4 Δ_o, 0.00 BM

(b) 2.4 Δ_o, 2.90 BM and 0.4 Δ_o, 1.77 BM

(c) 2.4 Δ_o, 0.00 BM and 0.4 Δ_o, 4.90 BM

(d) 1.2 Δ_o, 4.90 BM and 2.4 Δ_o, 0.00 BM

93. **Consider the following statements with respect to uranium**

[P] UO_2^+ disproportionates more easily than UO_2^{2+}

[Q] U_3O_8 is its most stable oxide of U

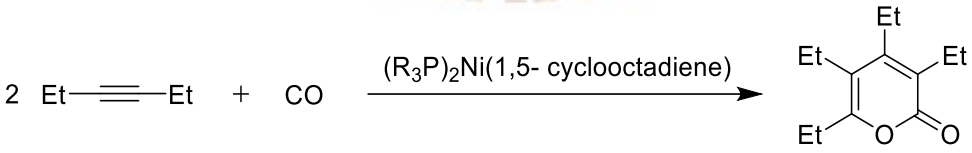
[R] Coordination number of U in $[UO_2(NO_3)_2(H_2O)_2].4H_2O$ is six

[S] UO_2^{2+} is linear

The correct set of statements is

(a) P, Q and S (b) P, R and S (c) Q, R and S (d) P, Q and R

94.



For the above conversion, which of the following statements are correct?

[P] CO_2 combines with $Ni(PR_3)_2$ (1, 5-cyclo- octadiene)

[Q] Insertion of CO_2 occurs

[R] Insertion of Et—≡—Et takes place

The correct answer is

(a) P and Q (b) Q and R (c) P and R (d) P, Q and R

95. **Consider the following statements for $Z = (NH_4)_2[Ce(NO_3)_6]$**

[P] Coordination number of Ce is 12

[Q] Z is paramagnetic

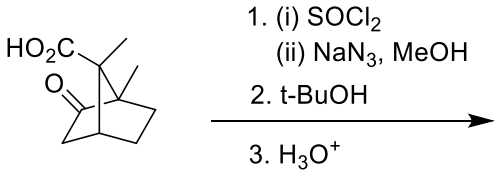
[R] Z is an oxidising agent

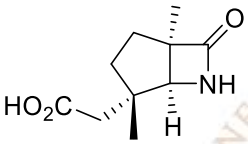
[S] Reaction with Ph_3PO gives a complex having coordination number 10 for Ce

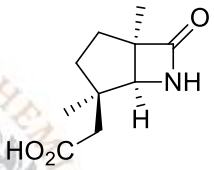
The correct statements are

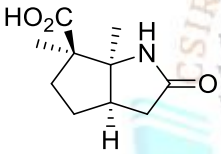
(a) P, Q and R (b) P, Q and S (c) Q, R and S (d) P, R and S

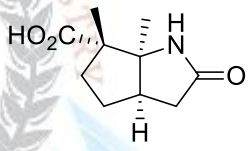
96. The major product formed in the following reaction sequence is



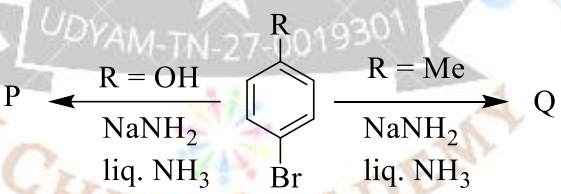
(a) 

(b) 

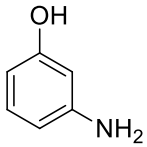
(c) 

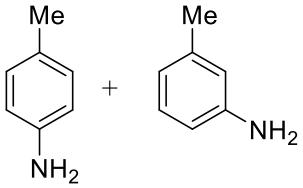
(d) 

97. The major products P and Q in the following reaction sequence are

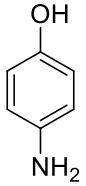


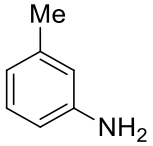
P **Q**

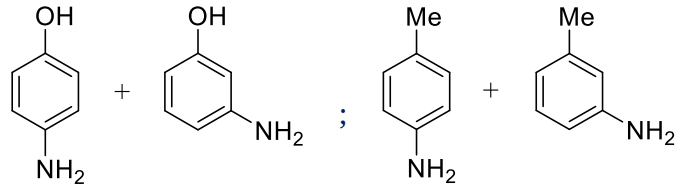
(a) 

; 

(1 : 1)

(b) 

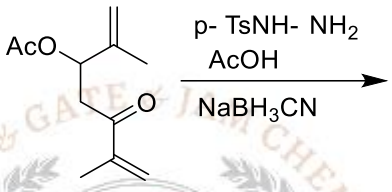
; 

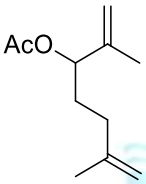
(c) 

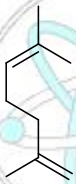
(1 : 1) (1 : 1)

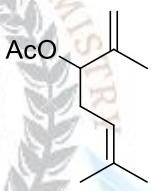
(d) 

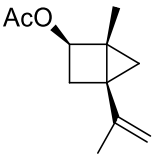
98. The major product formed in the following reaction is



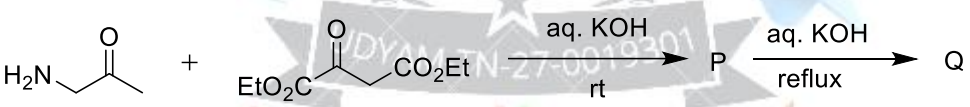
(a) 

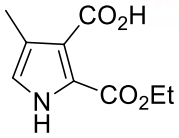
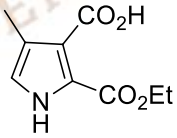
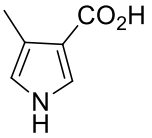
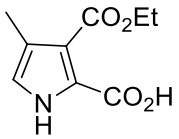
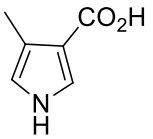
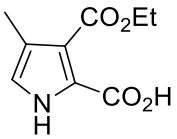
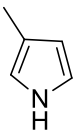
(b) 

(c) 

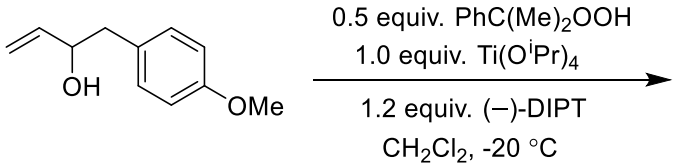
(d) 

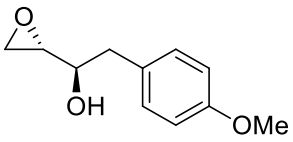
99. The major products P and Q in the following reaction sequence are

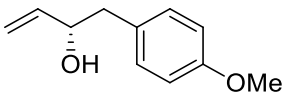


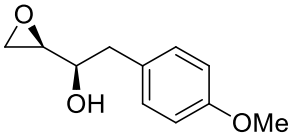
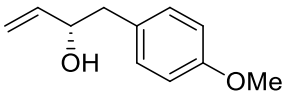
	P	Q		P	Q
(a)			(b)		
(c)			(d)		

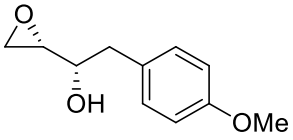
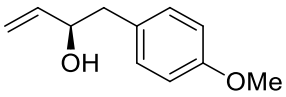
100. The major products formed in the following reaction are

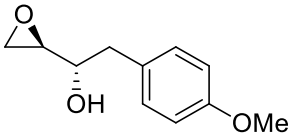
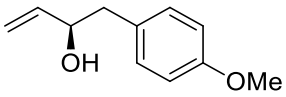


(a) 

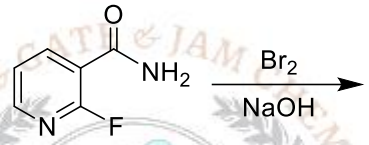
and 

(b)  and 

(c)  and 

(d)  and 

101. The correct statement about the following reaction is



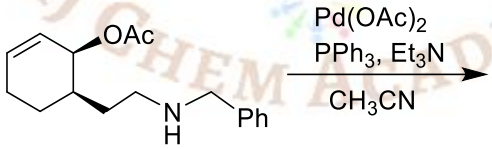
(a) The product is 2-fluoropyridin-3-amine and reaction involves nitrene intermediate

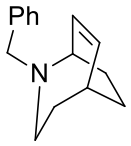
(b) The product is 2-fluoropyridin-3-amine and reaction involves radical intermediate

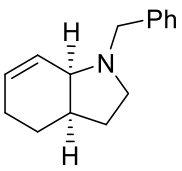
(c) The product is 2-hydroxynicotinamide and reaction involves benzyne-like intermediate

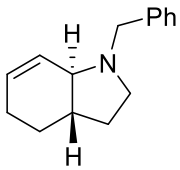
(d) The product is 2-hydroxynicotinamide and reaction involves addition-elimination mechanism

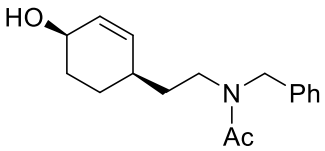
102. The major product formed in the following reaction is



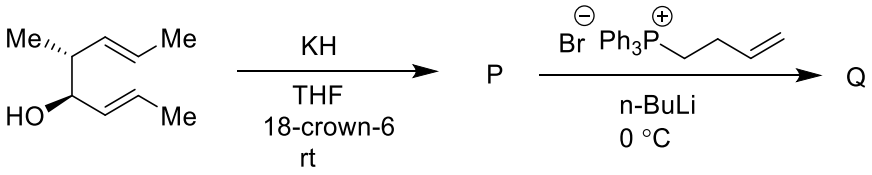
(a) 

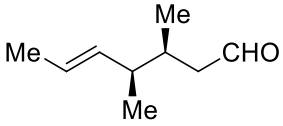
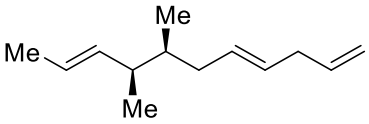
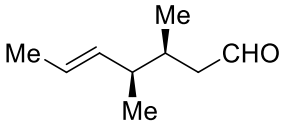
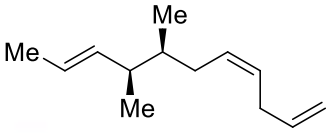
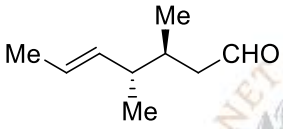
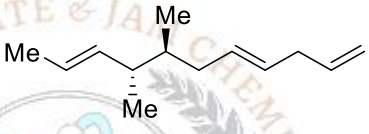
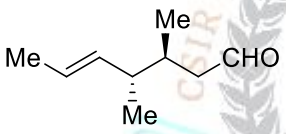
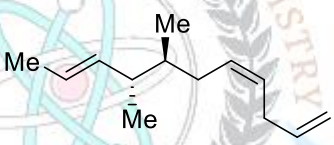
(b) 

(c) 

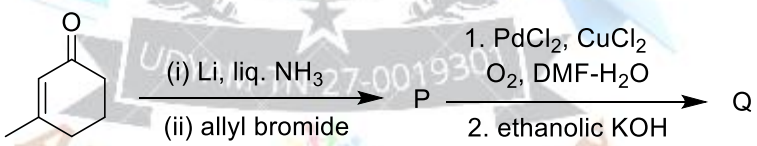
(d) 

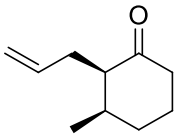
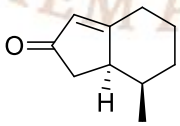
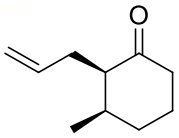
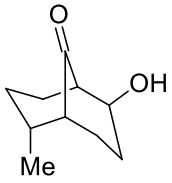
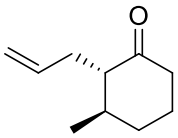
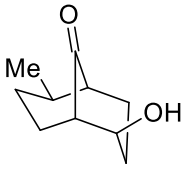
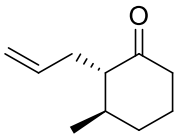
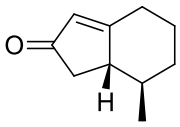
103. The major products P and Q formed in the following reactions are



	P	Q
(a)		
(b)		
(c)		
(d)		

104. The major products P and Q formed in the following reactions are



	P	Q	P	Q
(a)			(b)		
(c)			(d)		

105. An organic compound shows following spectral data :

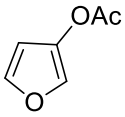
IR (cm^{-1}) : 1680

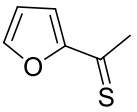
^{1}H-NMR : 7.66 (m, 1H), 7.60 (m, 1H), 7.10 (m, 1H), 2.50 (s, 3H)

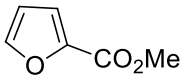
^{13}C-NMR : 190, 144, 134, 132, 128, 28

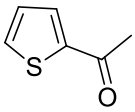
m/z (EI) : 126 (M^+, 100%), 128 ([M^+ + 2], 4.9%)

The structure of the compound is

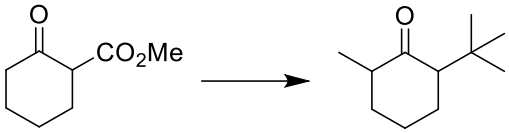
(a) 

(b) 

(c) 

(d) 

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



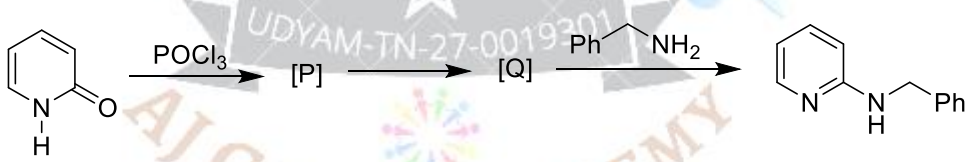
(a)
(i) NaOMe, MeI
(ii) NaCl, wet DMSO, 160 °C
(iii) LDA, −78 °C, TMSCl
(iv) t-BuCl, $TiCl_4$, 50 °C

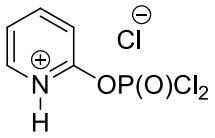
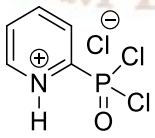
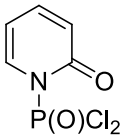
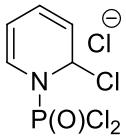
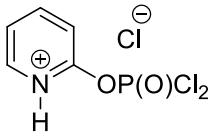
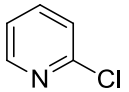
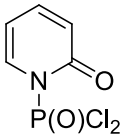
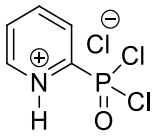
(b)
(i) NaOMe, MeI
(ii) aq. NaOH then HCl, heat
(iii) Et_3N, TMSCl, rt
(iv) t-BuCl, $TiCl_4$, 50 °C

(c)
(i) LDA, t-BuCl
(ii) LDA, MeI
(iii) aq. NaOH then HCl, heat

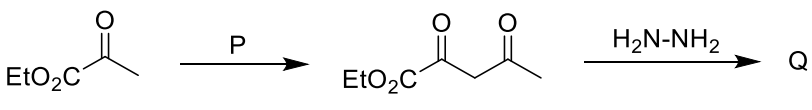
(d)
(i) NaCl, wet DMSO, 160 °C
(ii) NaH, t-BuCl
(iii) morpholine, H^+
(iv) MeI then H_3O^+

107. The correct structures of the intermediates [P] and [Q] in the following reaction are

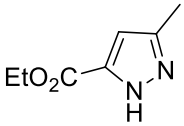


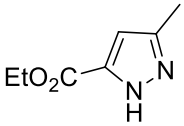
	P	Q		P	Q
(a)			(b)		
(c)			(d)		

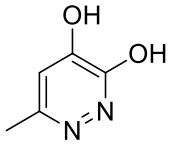
108. The correct reagent combination-X and the major product-Y in the following reaction sequence are

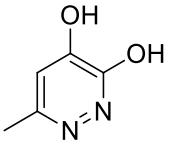


P	Q	P	Q

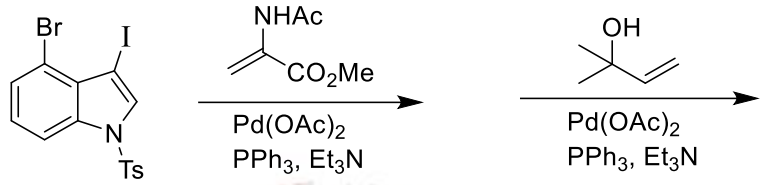
(a) LiHMDS, AcCl ; 

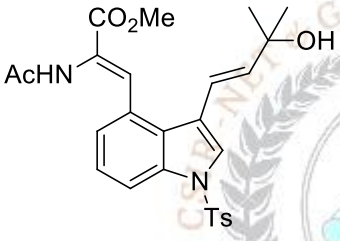
(b) n-BuLi, AcCl ; 

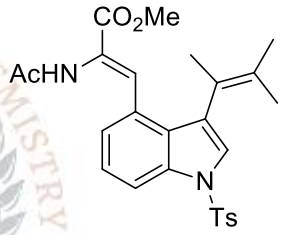
(c) LiHMDS, AcOEt ; 

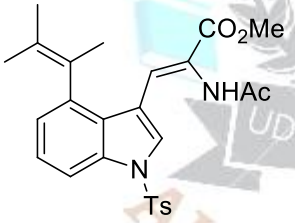
(d) n-BuLi, AcOEt ; 

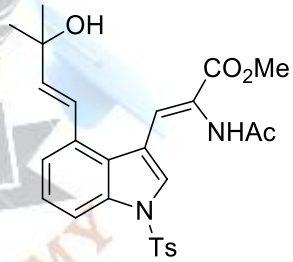
109. The major product of the following reaction sequence is



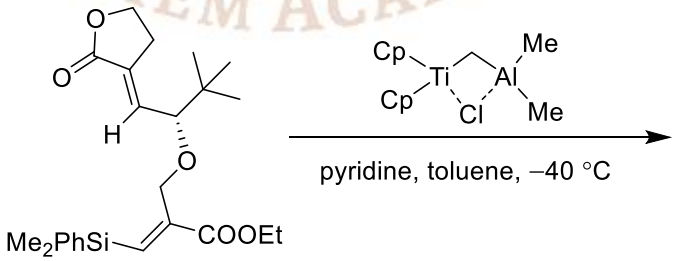
(a) 

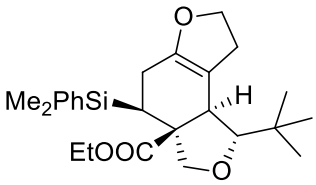
(b) 

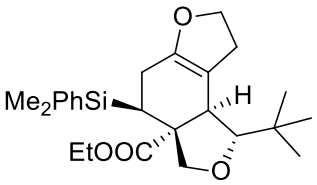
(c) 

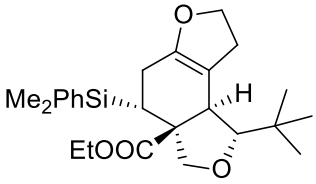
(d) 

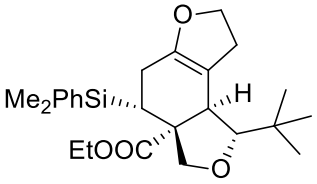
110. The major product formed in the following reaction is



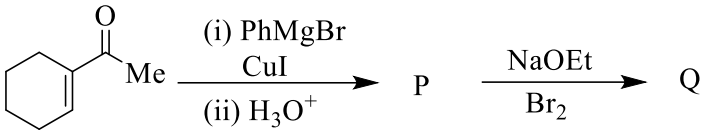
(a) 

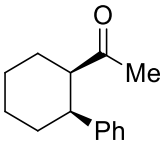
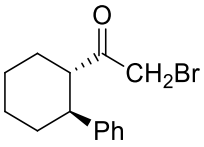
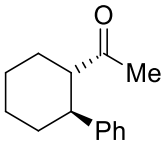
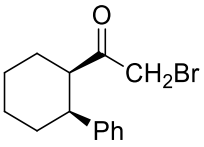
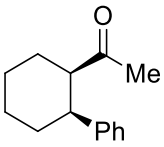
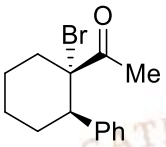
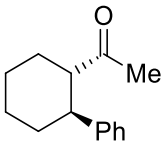
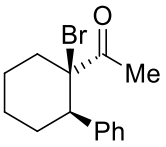
(b) 

(c) 

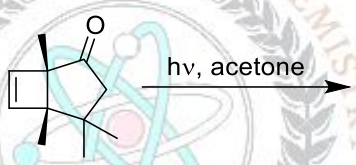
(d) 

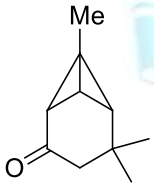
111. The major products P and Q in the following synthetic sequence are

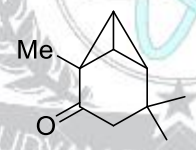


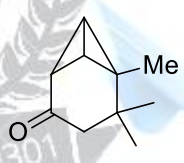
	P	Q
(a)		
(b)		
(c)		
(d)		

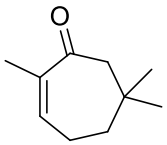
112. The major product formed in the following reaction is



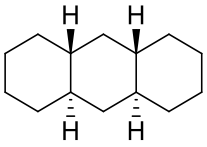
(a) 

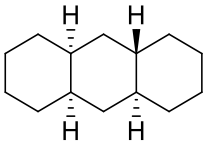
(b) 

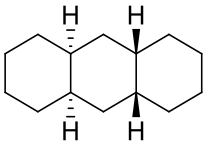
(c) 

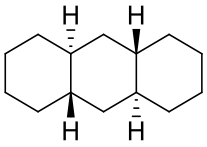
(d) 

113. The hydrocarbon among the following having conformationally locked chair-boat-chair form is,

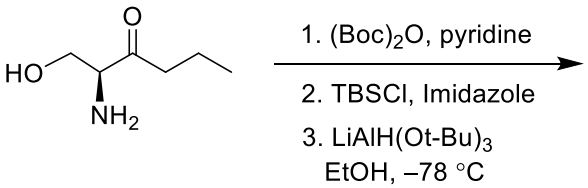
(a) 

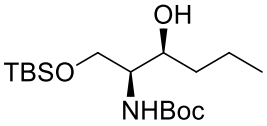
(b) 

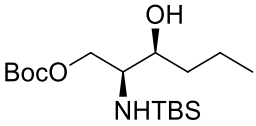
(c) 

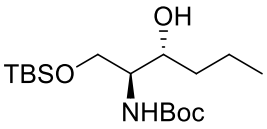
(d) 

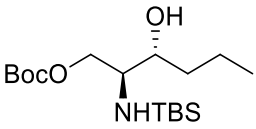
114. The major product formed in the following reaction sequence is



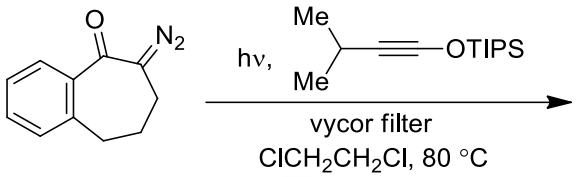
(a) 

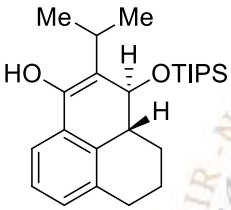
(b) 

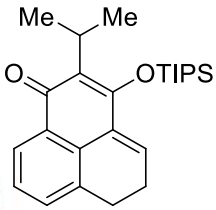
(c) 

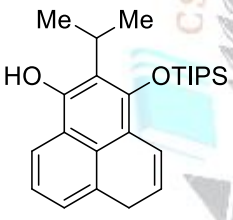
(d) 

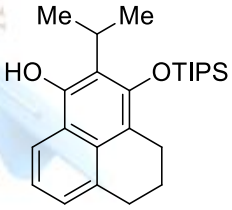
115. The major product in the following reaction sequence is



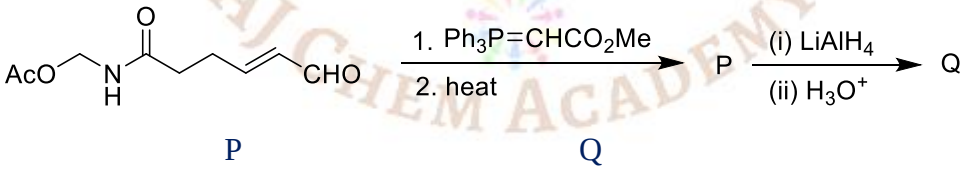
(a) 

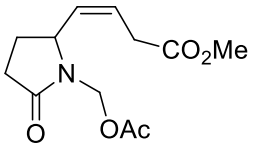
(b) 

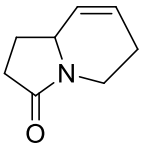
(c) 

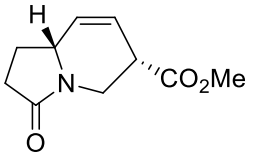
(d) 

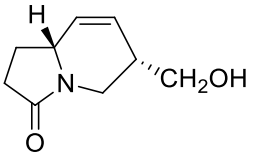
116. Structures of P and Q in the following synthetic sequence are

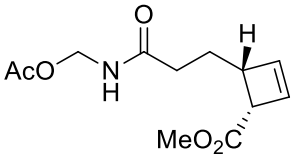


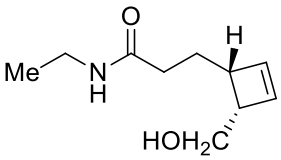
(a) 

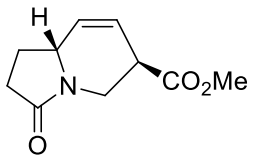
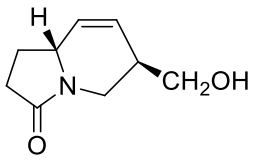
; 

(b) 

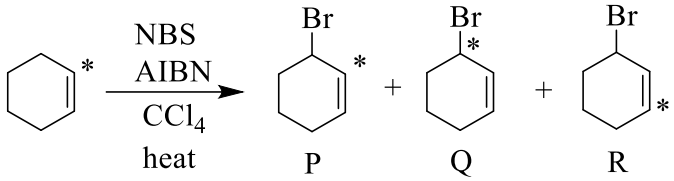
; 

(c) 

; 

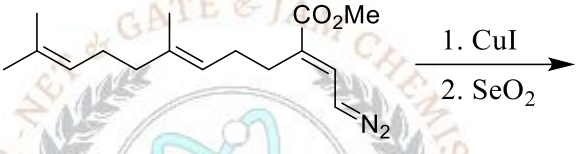
(d)  ; 

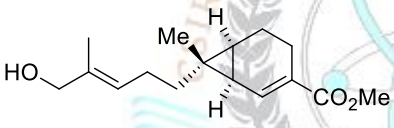
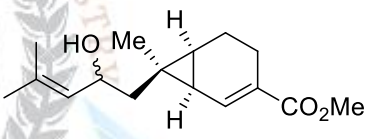
117. In the following reaction, the ratio of P : Q : R is (* indicates labelled carbon)

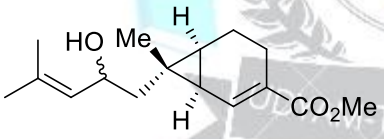
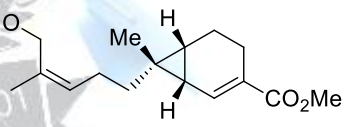


(a) 1 : 1 : 1 (b) 1 : 2 : 1 (c) 2 : 1 : 1 (d) 3 : 2 : 1

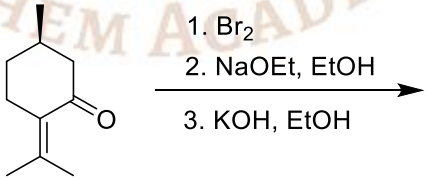
118. Structure of the major product in the following synthetic sequence is

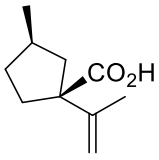
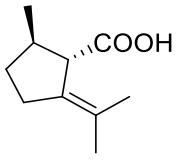
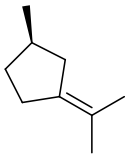
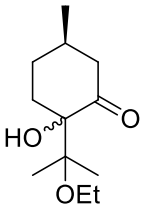


(a)  (b) 

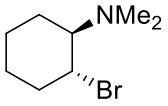
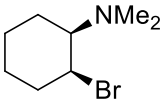
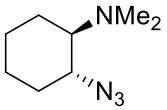
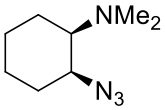
(c)  (d) 

119. Major product formed in the following synthetic sequence on the monoterpene pulegone is



(a)  (b)  (c)  (d) 

120. Optically pure isomers P and Q were heated with NaN_3 in DMF. The correct statement from the following is

P	Q	R	S

(a) P gives optically pure S and Q gives optically pure R

(b) P gives racemic mixture of R and Q gives optically pure R

(c) P gives optically pure R and Q gives racemic R

(d) P gives optically pure S and Q gives racemic S

121. **A molecular orbital of a diatomic molecule changes sign when it is rotated by $180°$ around the molecular axis. This orbital is**

(a) σ (b) π (c) δ (d) ϕ

122. **IR active normal modes of methane belong to the irreducible representation**

T_d	E	$8C_3$	$3C_2$	$6S_4$	$6\sigma_d$	
A_1	1	1	1	1	1	$x^2 + y^2 + z^2$
A_2	1	1	1	−1	−1	
E	2	−1	2	0	0	$2z^2 - x^2 - y^2,\ x^2 - y^2$
T_1	3	0	−1	1	−1	R_x, R_y, R_z
T_2	3	0	−1	−1	1	x, y, z, xy, yz, zx

(a) $E + A_1$ (b) $E + A_2$ (c) T_1 (d) T_2

123. **The symmetric rotor among the following is**

(a) CH_4 (b) CH_3Cl (c) CH_2Cl_2 (d) CCl_4

124. **The nuclear g-factors of ^1H and ^{14}N are 5.6 and 0.40 respectively. If the magnetic field in an NMR spectrometer is set such that the proton resonates at 700 MHz, the ^{14}N nucleus would resonate at**

(a) 1750 MHz (b) 700 MHz (c) 125 MHz (d) 50 MHz

125. **The spectroscopic technique, by which the ground state dissociation energies of diatomic molecules can be estimated is**

(a) microwave spectroscopy (b) infrared spectroscopy

(c) UV-visible absorption spectroscopy (d) X-ray spectroscopy

126. **The term symbol for the first excited state of Be with the electronic configuration $1s^1 2s^1 3s^1$ is**

(a) $^3S_1$ (b) $^3S_0$ (c) $^1S_0$ (d) $^2S_{1/2}$

127. **Which of the following statements is INCORRECT?**

(a) A Slater determinant is an anti-symmetrized wavefunction

(b) Electronic wavefunction should be represented by Slater determinants

(c) A Slater determinant always corresponds to a particular spin state

(d) A Slater determinant obeys the Pauli exclusion principle

128. Compare the difference of energies of the first excited and ground states of a particle confined in

(i)	(ii)	(iii)
1-d box (Δ_1)	2-d square box (Δ_2)	3-d cubic box (Δ_3)

Assume the length of each of the boxes is the same. The correct relation between the energy differences Δ_1, Δ_2 and Δ_3 for the three cases is

(a) $\Delta_1 > \Delta_2 > \Delta_3$ (b) $\Delta_1 = \Delta_2 = \Delta_3$

(c) $\Delta_3 > \Delta_2 > \Delta_1$ (d) $\Delta_3 > \Delta_1 > \Delta_2$

129. The correct statement about both the average value of position($\langle x \rangle$) and momentum($\langle p \rangle$) of a 1-d harmonic oscillator wavefunction is

(a) $\langle x \rangle \neq 0$ and $\langle p \rangle \neq 0$ (b) $\langle x \rangle = 0$ but $\langle p \rangle \neq 0$

(c) $\langle x \rangle = 0$ and $\langle p \rangle = 0$ (d) $\langle x \rangle \neq 0$ but $\langle p \rangle = 0$

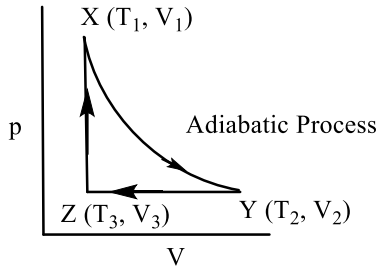
130. The value of the commutator $[x, [x, p_x]]$ is

(a) $i\hbar x$ (b) $-i\hbar$ (c) $i\hbar$ (d) 0

131. The equilibrium constants for the reactions $CH_{4(g)} + 2H_2O_{(g)} \rightleftharpoons CO_{2(g)} + 4H_{2(g)}$ and $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$ are K_1 and K_2, respectively. The equilibrium constant for the reaction $CH_{4(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + 3H_{2(g)}$ is

(a) $K_1 . K_2$ (b) $K_1 - K_2$ (c) K_1/K_2 (d) $K_2 - K_1$

132. Consider the progress of a system along the path shown in the figure. $\Delta S_{(Y \rightarrow Z)}$ for one mole of an ideal gas is then given by



(a) $R \ln \frac{T_1}{T_3}$ (b) $R \ln \frac{T_3}{T_1}$ (c) $R \ln \frac{V_2}{V_1}$ (d) $R \ln \frac{V_1}{V_2}$

133. A thermodynamic equation that relates the chemical potential to the composition of a mixture is known as

(a) Gibbs-Helmholtz equation (b) Gibbs-Duhem equation

(c) Joule-Thomson equation (d) Debye-Huckel equation

134. According to transition state theory, the temperature-dependence of pre-exponential factor (A) for a reaction between a linear and a non-linear molecule, that forms products through a non-linear transition state, is given by

(a) T (b) T^2 (c) T^{-2} (d) $T^{-1.5}$

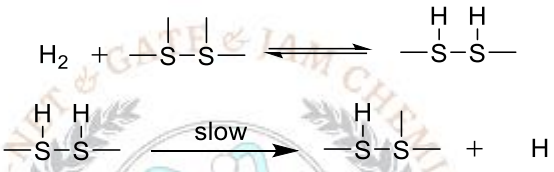
135. For a given ionic strength (I), rate of reaction is given by $\log\frac{k}{k_0} = -4 \times 0.51(I)^{1/2}$.

Which of the following reactions follows the above equation?

(a) $S_2O_8^{2} + I^-$ (b) $Co(NH_3)_5Br^{2+} + OH^-$

(c) $CH_3COOC_2H_5 + OH^-$ (d) $H^+ + Br + H_2O_2$

136. For a reaction on a surface



At low pressure of H_2, the rate is proportional to

(a) $[H_2]$ (b) $1/[H_2]$ (c) $[H_2]^{1/2}$ (d) $1/[H_2]^{1/2}$

137. The temperature-dependence of an electrochemical cell potential is

(a) $\Delta G/nFT$ (b) $\Delta H/nF$ (c) $\Delta S/nF$ (d) $\Delta S/nFT$

138. The single-particle partition function(f) for a certain system has the form $f = AVe^{BT}$. The average energy per particle will then be (k is the Boltzman constant)

(a) BkT (b) BkT^2 (c) kT/B (d) kT/B^2

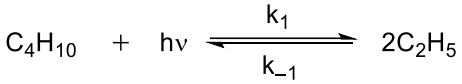
139. The indistinguishability correction in the Boltzmann formulation is incorporated in the following way:

(N = total number of particles; f = single-particle partition function)

(a) Replace f by f/N! (b) Replace f^N by $f^N/N!$

(c) Replace f by f/ln(N!) (d) Replace f^N by $f^N/\ln(N!)$

140. In a photochemical reaction, radicals are formed according to the equation



$$C_2H_5 + C_2H_5 \xrightarrow{k_2} C_2H_6 + C_2H_4$$

If I is the intensity of light absorbed, the rate of the overall reaction is proportional to

(a) I (b) $I^{1/2}$ (c) $I[C_4H_{10}]$ (d) $I^{1/2}[C_4H_{10}]^{1/2}$

141. Conductometric titration of a strong acid with a strong alkali(MOH) shows linear

fall of conductance up to neutralization point because of

(a) formation of water

(b) increase in alkali concentration

(c) faster moving H^+ being replaced by slower moving M^+

(d) neutralization of acid

142. Find the probability of the link in polymers where average values of links are

I	II	II
10	50	100

	I		II		III
(a)	0.99	;	0.98	;	0.90
(c)	0.90	;	0.98	;	0.99

	I		II		III
(b)	0.98	;	0.90	;	0.99
(d)	0.90	;	0.99	;	0.98

143. The stability of a lyophobic colloid is the consequence of

(a) van der Waals attraction among the solute-solvent adducts

(b) Brownian motion of the colloidal particles

(c) insolubility of colloidal particles in solvent

(d) electrostatic repulsion among double-layered colloidal particles

144. In a conductometric experiment for estimation of acid dissociation constant of acetic acid, the following values were obtained in four sets of measurements:

$$1.71 \times 10^{-5}, 1.77 \times 10^{-5}, 1.79 \times 10^{-5} \text{ and } 1.73 \times 10^{-5}$$

The standard deviation of the data would be in the range of

(a) $0.010 \times 10^{-5} - 0.019 \times 10^{-5}$ (b) $0.020 \times 10^{-5} - 0.029 \times 10^{-5}$

(c) $0.030 \times 10^{-5} - 0.039 \times 10^{-5}$ (d) $0.040 \times 10^{-5} - 0.049 \times 10^{-5}$

145. Silver crystallizes in face-centered cubic structure. The 2^{nd} order diffraction angle of a beam of X-ray $(\lambda = 1\text{Å})$ of (111) plane of the crystal is $30°$. Therefore, the unit cell length(a) of the crystal would be

(a) 3.151 Å (b) 3.273 Å (c) 3.034 Å (d) 3.464 Å

Answer Key

Part – B

Q.No	Ans
21.	a
22.	a
23.	c
24.	a
25.	b
26.	a
27.	d
28.	c
29.	d
30.	a
31.	a
32.	d
33.	a
34.	a
35.	a

Q.No	Ans
36.	*
37.	a
38.	a
39.	b
40.	d
41.	c
42.	a
43.	a
44.	d
45.	c
46.	b
47.	a
48.	b
49.	d
50.	d

Q.No	Ans
51.	a
52.	c
53.	a
54.	b
55.	c
56.	c
57.	d
58.	b
59.	a
60.	b

Q.No	Ans
61.	d
62.	c
63.	c
64.	a
65.	b
66.	c
67.	d
68.	d
69.	b
70.	d

Part – C

Q.No	Ans
71.	d
72.	a
73.	b
74.	a
75.	c
76.	b

Q.No	Ans
91.	d
92.	a
93.	a
94.	b
95.	d
96.	c

Q.No	Ans
111.	a
112.	a
113.	d
114.	c
115.	d
116.	b

Q.No	Ans
131.	c
132.	*
133.	b
134.	d
135.	b
136.	c

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77.	a
78.	a
79.	a
80.	a
81.	c
82.	a
83.	b
84.	c
85.	a
86.	a
87.	b
88.	c
89.	c
90.	a

97.	a
98.	c
99.	c
100.	a
101.	a
102.	b
103.	b
104.	d
105.	d
106.	a
107.	c
108.	a
109.	d
110	c

117.	c
118.	a
119.	b
120.	b
121.	b
122.	d
123.	b
124.	d
125.	b
126.	a
127.	c
128.	b
129.	c
130.	d

137.	c
138.	b
139.	b
140.	a
141.	c
142.	c
143.	d
144.	c
145	d