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Q.21 – Q.60 MCQ, carry TWO marks each (for each wrong answer: –0.5).
You are required to Answer Maximum 35 Questions.

21. **The correct order of acceptor ability of the phosphorus ligands is**

(a) $PMe_3 > PPh_3 > P(OPh)_3 > PF_3$ (b) $PF_3 > P(OPh)_3 > PPh_3 > PMe_3$

(c) $PF_3 > PMe_3 > PPh_3 > P(OPh)_3$ (d) $P(OPh)_3 > PF_3 > PMe_3 > PPh_3$

22. **In the $^{31}P\{^1H\}$-NMR spectrum of a diamagnetic complex mer-$[M(PR_3)_3Cl_3]$ expected number of resonance(s) is, (M = Transition metal, $I = 0$)**

(a) Three (b) One (c) Two (d) Six

23. **Consider the species NO, I_2, I_2^-, Cu^{2+} and VO^{2+}. The number of paramagnetic species among them and the EPR inactive species, respectively are**

(a) 4 and I_2^- (b) 4 and I_2 (c) 3 and VO^{2+}, Cu^{2+} (d) 3 and NO, Cu^{2+}

24. **Identify the correct statement(s) for $H_3B.CO$**

[P] sp^2 hybridized orbital of B accepts the lone pair of CO

[Q] Its ν_{CO} value is more than that for free CO

[R] Formal oxidation state of C is +4 in the compound

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

25. **Match the items of Column I with those of Column II**

	Column I		Column II
P.	Laser source	i	Electron capture detector
Q.	Thermometric titration	ii	Polarography
R.	Gelatin	iii	Heat of reaction
S.	Gas-liquid chromatography	iv	spectrofluorimetry

Correct answer is

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

26. **Consider compounds PF_5, SbF_5, PH_3 and SbH_3. The strongest acid and the strongest base among these are, respectively.**

(a) PF_5 and PH_3 (b) SbF_5 and PH_3 (c) SbF_5 and SbH_3 (d) PF_5 and SbH_3

27. **Among $SiCl_4, P(O)Cl_3, NF_3$, trans-$[SnCl_4(py)_2]$, those with zero dipole moment are (py = pyridine)**

(a) $SiCl_4$ and NF_3 (b) $SiCl_4$, $P(O)Cl_3$ and trans-$[SnCl_4(py)_2]$

(c) $SiCl_4$ and trans-$[SnCl_4(py)_2]$ (d) NF_3 and trans-$[SnCl_4(py)_2]$

28. The standard reduction potentials in acid medium for F_2, Cl_2, Na and Zn are in the order

(a) $F_2 > Cl_2 > Na > Zn$ (b) $F_2 > Cl_2 > Zn > Na$

(c) $Na > Zn > Cl_2 > F_2$ (d) $Cl_2 > F_2 > Zn > Na$

29. The characters of LUMO of CN^- and O_2 respectively, are

(a) σ_g and π_u (b) π_u and σ_u (c) π_g and σ_u (d) σ_u and π_g

30. The intermediate $[Fe(SCN)(H_2O)_5]^{2+}$ is detected in the reaction of $[Co(NCS)(NH_3)_5]^{2+}$ with $[Fe(H_2O)_6]^{2+}$ in aqueous medium to produce $[Co(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{3+}$. The mechanism of the reaction is

(a) Interchange dissociative (b) Interchange associative

(c) Inner sphere electron transfer (d) Outer sphere electron transfer

31. The chelate rings made by macrocyclic ligand in vitamin B_{12} are

(a) One five-membered and three six-membered

(b) Two five-membered and two six-membered

(c) Three five-membered and one six-membered

(d) Four six-membered

32. For magnesium complex of $EDTA^{2-}$, the number of N-donor and O-donor centers, are respectively,

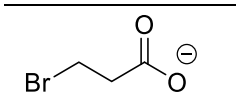
(a) two and four (b) two and two (c) two and six (d) two and eight

33. The correct set of electronic configurations for metal ions in octahedral coordination geometry for strong Jahn-Teller distortion is

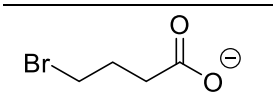
(a) $t_{2g}^6e_g^1, t_{2g}^3e_g^1, t_{2g}^6e_g^3$ (b) $t_{2g}^1, t_{2g}^3e_g^2, t_{2g}^6e_g^1$ (c) $t_{2g}^3, t_{2g}^3e_g^1, t_{2g}^3e_g^2$ (d) $t_{2g}^3e_g^2, t_{2g}^6e_g^2, t_{2g}^6e_g^3$

34. The order of relative rate of cyclization of following bromocarboxylates to generate corresponding lactones is

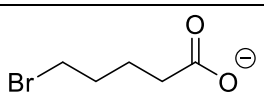
P



Q

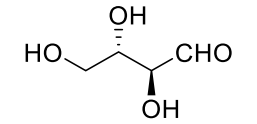


R



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

35. Oxidation of X with HNO_3/H_2O provides the product(s), which is (are)



X

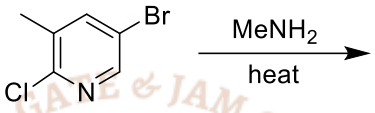
(a) Optically inactive as it racemic mixture

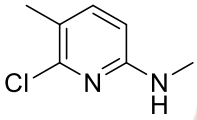
(b) Optically inactive as it is meso

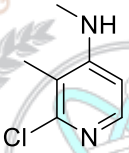
(c) Optically active as it is a single diastereomer

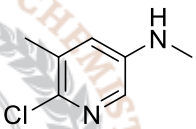
(d) Optically active as it is a single enantiomer

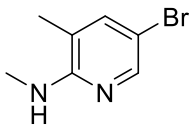
36. The major product formed in the following reaction is



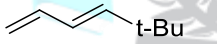
(a) 

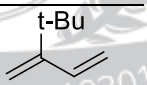
(b) 

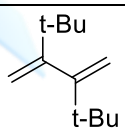
(c) 

(d) 

37. The order of reactivity of the following dienes towards Diels-Alder reaction is

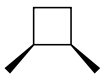
P 

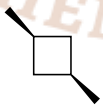
Q 

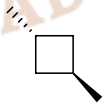
R 

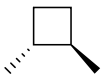
(a) Q > P > R (b) P > R > Q (c) Q > R > P (d) R > Q > P

38. Among the following, the optically active compound is

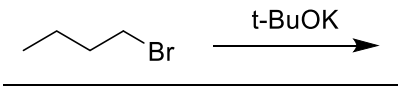
(a) 

(b) 

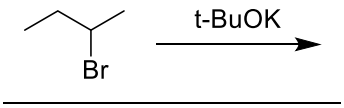
(c) 

(d) 

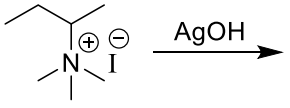
39. Among the following, reaction(s) which provide(s) 1-butene as the major product is (are)



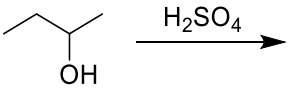
P



Q



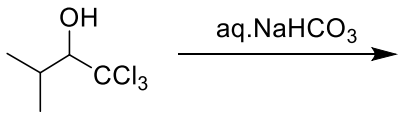
R

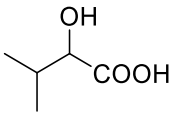


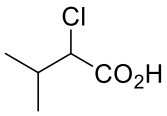
S

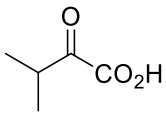
(a) P alone (b) P and Q (c) P and R (d) R and S

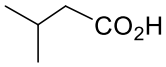
40. The major product formed in the following reaction is



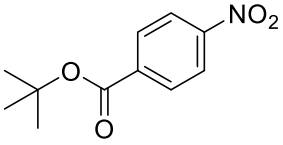
(a) 

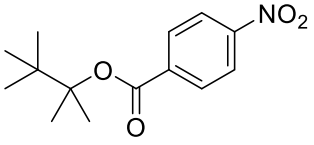
(b) 

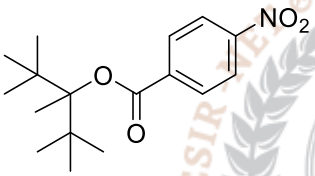
(c) 

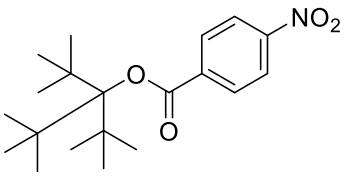
(d) 

41. Among the following, the compound that will have highest rate for nucleophilic substitution through S_N1 mechanism is

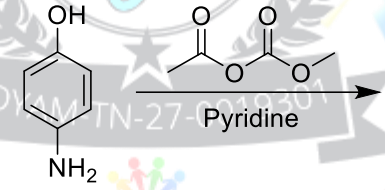
(a) 

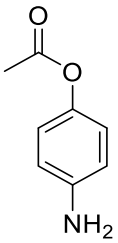
(b) 

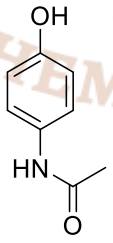
(c) 

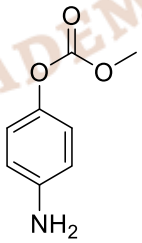
(d) 

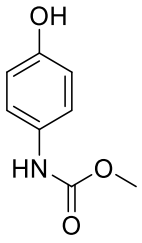
42. The major product formed in the following reaction is



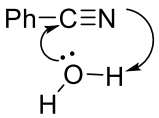
(a) 

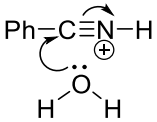
(b) 

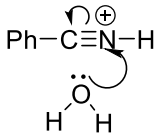
(c) 

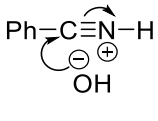
(d) 

43. The mechanism of acid catalysed hydrolysis of benzonitrile involves

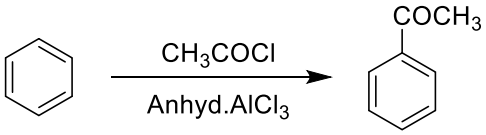
(a) 

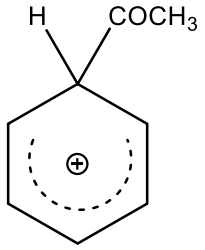
(b) 

(c) 

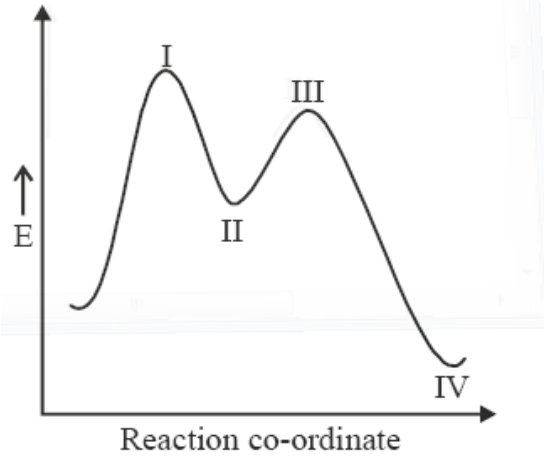
(d) 

44. In the energy profile diagram of the reaction given below, the species X would correspond to the position



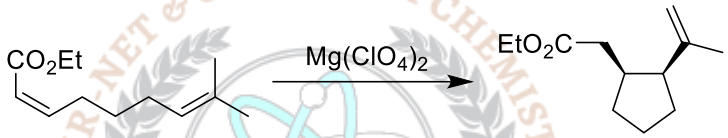


(X)



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

45. Following reaction is an example of

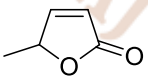


(a) Alder-Ene reaction (b) Michael addition

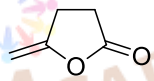
(c) Sigmatropic Rearrangement (d) Wagner-Meerwein Rearrangement

46. In IR spectra, the stretching frequency (in cm^{-1}) of the carbonyl group of the following compounds is in the order

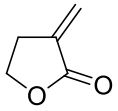
P



Q



R



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

47. The uncertainty in the position of a moving electron is 100 pm. The uncertainty in its speed is closest to $(m_e = 9.11 \times 10^{-31} kg; h = 6.63 \times 10^{-34} J\ s)$

(a) $6.0 \times 10^{2}\ m\ s^{-1}$ (b) $6.0 \times 10^{5}\ m\ s^{-1}$ (c) $6.0 \times 10^{8}\ m\ s^{-1}$ (d) $6.0 \times 10^{11}\ m\ s^{-1}$

48. The spectrum of sodium atom has a closely separated doublet at 16956.2 and 16973.4 cm^{-1}. The higher energy transition is due to

(a) $^2P_{3/2} \rightarrow {}^2S_{1/2}$ (b) $^2P_{1/2} \rightarrow {}^2S_{1/2}$ (c) $^2P_{3/2} \rightarrow {}^2P_{1/2}$ (d) $^2S_{1/2} \rightarrow {}^2P_{3/2}$

49. N_2O molecule belongs to the point group

(a) $D_{\infty h}$ (b) $C_{\infty v}$ (c) C_{2v} (d) S_2

50. For a closed system in the absence of non-PV work, the correct statement is

(a) $dU = TdS - PdV$ (b) $dG = VdP + SdT$

(c) $dU = TdS + PdV$ (d) $dU = VdP - SdT$

51. **The volume change in a certain phase transition is $2.0\ mL\ mol^{-1}$ at the transition point. From this, we may conclude that the transition is most likely a**

(a) first order phase transition (b) second order phase transition

(c) third order phase transition (d) λ phase transition

52. **Root mean square speed of the molecules of a perfect gas is proportional to**

(a) $1/T^{1/2}$ (b) T (c) $T^{1/2}$ (d) $1/T$

53. **For a second-order reaction, the straight line among the following plots is**

(a) [X] versus time (b) 1/[X] versus time

(c) log[X] versus 1/time (d) log[X] versus time

54. **The activation energy of a reaction reduces by $12\ kcal\ mol^{-1}$ in the presence of an enzyme at 300 K. Assuming pseudo-first order kinetics, calculate the factor by which the reaction rate is increased, $[Given: R = 2cal\ K^{-1}\ mol^{-1}]$**

(a) 2×10^{-9} (b) 1.02 (c) 8.7×10^{6} (d) 5×10^{8}

55. **The correct statement among the following is**

(a) Salt bridge is required for the mixing of the solutions in the two half cells

(b) Salt bridge allows current to flow between the half cells without mixing the solutions

(c) Salt bridge enhances the rate of the reaction

(d) Salt bridge consists of a non-electrolyte in a gel

56. **The standard free energy of the reaction, $AgBr_{(s)} \longrightarrow Ag^{+}{}_{(aq)} + Br^{-}{}_{(aq)}$, is closest to**

$$\left(E^{0}{}_{(AgBr/Ag,Br^{-})} = +0.07\ V, E^{0}{}_{(Ag/Ag^{+})} = 0.80\ V; F = 96500\ C\ mol^{-1}\right)$$

(a) 7 kJ mol^{-1} (b) 70 J mol^{-1} (c) 70 kJ mol^{-1} (d) 7 J mol^{-1}

57. **The internal pressure of a liquid drop $(radius = 10^{-6}\ m)$ is greater than the external pressure by $1.5 \times 10^{5}\ N\ m^{-2}$. The surface tension $(mN\ m^{-1})$ of the liquid is closest to**

(a) 150 (b) 125 (c) 100 (d) 75

58. **In a cubic crystal, the (111) and (222) reflections are observed, but not the (001) reflection. The Bravais lattice is**

(a) body centred cubic (b) face centred cubic (c) simple cubic (d) side centred cubic

59. **The dispersity of a polymeric sample is**

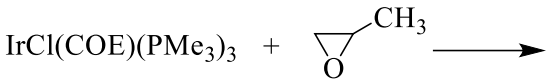
(a) $\langle M^2\rangle/\langle M\rangle^2$ (b) $\langle M\rangle^2/\langle M^2\rangle$ (c) $\langle M^2\rangle/\langle M\rangle$ (d) $\langle M\rangle/\langle M\rangle^2$

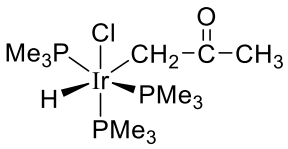
60. **The keto-hexose among the following is**

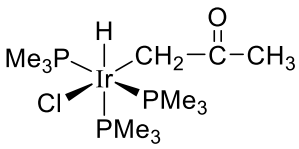
(a) Xylose (b) Galactose (c) Fructose (d) Mannose

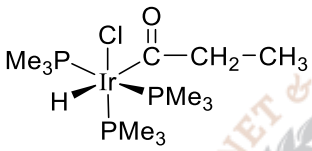
Q.61 – Q.120 MCQ, carry FOUR marks each (for each wrong answer: –1).
You are required to Answer Maximum 25 Questions.

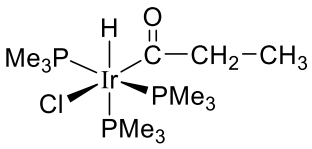
61. The product for the reaction given below is



(a) 

(b) 

(c) 

(d) 

62. The $^{31}P\{^{1}H\}$-NMR spectrum of cis-$[Pt(PEt_3)_2Cl_2]$ is comprised with satellite peaks of a
(^{195}Pt (33.8% abundance) I = ½; its other isotopes are NMR inactive; ^{31}P:I = ½)

(a) triplet (b) singlet (c) doublet (d) quartlet

63. The correct order of intensity of the d-d transitions in the complexes of a 3d-transition metal ion M^{2+} is

(a) $[\text{cis-}[M(H_2O)_4Cl_2] > [\text{trans-}M(H_2O)_4Cl_2] > [M(H_2O)_6]^{2+}$

(b) $[M(H_2O)_6]^{2+} > [\text{cis-}[M(H_2O)_4Cl_2] > [\text{trans-}M(H_2O)_4Cl_2]$

(c) $[\text{trans-}M(H_2O)_4Cl_2] > [\text{cis-}[M(H_2O)_4Cl_2] > [M(H_2O)_6]^{2+}$

(d) $[M(H_2O)_6]^{2+} > [\text{cis-}[M(H_2O)_4Cl_2] \approx [\text{trans-}M(H_2O)_4Cl_2]$

64. The reaction of decaborane ($B_{10}H_{14}$) with acetylene in the presence of Et_2S gives

(a) $C_2B_{10}H_{12}$ (b) $C_2B_8H_{10}$ (c) $C_2B_{10}H_{14}$ (d) $C_2B_9H_{11}$

65. In compound $N_3P_3F_6$, the geometry around nitrogen and phosphorus, respectively, are

(a) pyramidal and tetrahedral (b) planar and tetrahedral
(c) pyramidal and planar (d) planar and trigonal bipyramidal

66. The number of 2c-2e bonds ('x') of a molecule is related to 'N' (valence electrons) and 'n' (skeletal atoms) by $x = (8n - N)/2$. for P_4S_3, the values of x, N and n, respectively, are

(a) 7, 38, 9 (b) 7, 24, 9 (c) 9, 38, 7 (d) 9, 24, 7

67. **Match the following complexes with their ν_{CO} stretching frequency**

	Complex		$\nu_{CO}(cm^{-1})$
I.	$Mo(PF_3)_3(CO)_3$	P	1835, 1934
II.	$Mo\{P(OMe)_3\}_3(CO)_3$	Q	1888, 1977
III.	$Mo(PPh_3)_3(CO)_3$	R	2055, 2090
IV.	$Mo(pyridine)_3(CO)_3$	S	1746, 1888

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

68 **The ν_{CN} in P and Q as well as ν_{CO} in R and S are compared below. The pair with correct order is**

P	Q	R	S
$[Fe(CN)_6]^{3-}$	$[Fe(CN)_6]^{4-}$	$[Cr(CO)_3(NH_3)_3]$	$[Cr(CO)_6]$

(a) P > Q ; R > S (b) P > Q ; R < S

(c) P < Q ; R > S (d) P < Q ; R < S

69. **Consider the following statements for $[FeO_4]^{2-}$**

[P] It is stable in the pH range from 0 to 14

[Q] It is stable in strongly basic medium only

[R] It is a very strong oxidizing agent

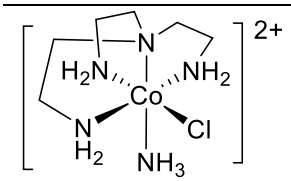
[S] The isomer shift in its Mossbauer spectrum is more negative compared to that of $FeCl_3$

The correct statements are

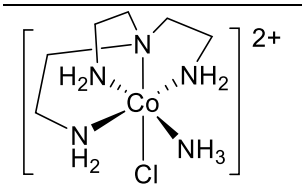
(a) P, R and S (b) Q, R and S (c) Q and R (d) R and S

70. **The isomers I and II undergo base hydrolysis by forming a trigonal bipyramidal intermediate. The correct statement is**

I



II



(a) I reacts faster than II and both results in a mixture of products

(b) II reacts faster than I and both results in a mixture of products

(c) I reacts faster than II and II results in a mixture of products

(d) II reacts faster than I and I results in a mixture of products

71. **B_2H_6 reacts with**

[P] water to give boric acid and H_2

[Q] oxygen to give B_2O_3 and H_2

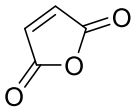
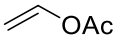
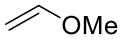
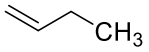
[R] water to give boric acid and H_2O

[S] oxygen to give B_2O_3 and H_2O

Correct statements from the above are

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

72. **The ligand that binds strongly to the nickel center in 2,2′-(bipyridine)Ni(0) complex is**

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

73. **Match the items given in Column-I with those given in Column-II**

	Column-I		Column-II
(P)	Magic number	I.	Nuclear fission
(Q)	Liquid drop model of nucleus	II.	Q-value
(R)	Actinides	III.	Radioactivity
(S)	Threshold energy	IV.	Shell model of nucleus

The correct match is

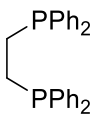
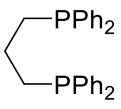
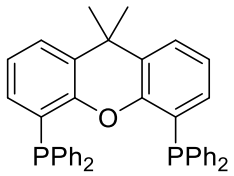
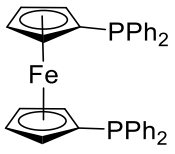
	P	Q	R	S
(a)	IV	I	III	II
(b)	II	I	III	IV
(c)	III	IV	I	II
(d)	IV	III	I	II

74. **The cluster type and geometry of the species $[Rh_9P(CO)_{21}]^{2-}$ are**

(a) closo, tricapped trigonal prism (b) arachno, trigonal prism

(c) nido, capped square antiprism (d) nido, bicapped trigonal prism

75. **Hydroformylation of 1-propene with $[HRh(CO)L_2]$ leads to linear and branched formylated products. The linear hydroformylated product is formed with highest selectivity when 'L' in the rhodium complex is**

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

76. **The hydrocarbon having an analogous structure to that of P_4O_6 is**

(a) $[(CH)_4(\mu\text{-}CH_2)_6]$ (b) $[(CH)_6(\mu\text{-}CH_2)_4]$

(c) $[(CH_2)_4(\mu\text{-}CH)_6]$ (d) $[(CH_2)_4(\mu\text{-}CH)_4]$

77. Match the items given below in the three columns:

	Metalloprotein		Species coordinated to metal centre(s)		Resonance Raman O-O stretching frequency (cm^{-1})
P.	Oxymyoglobin	I.	$\eta^2:\eta^2\text{-}O_2^{2-}$	X	844
Q.	Oxyhemocyanin	II.	HO_2^-	Y	803
R.	Oxyhemerythrin	III.	O_2^-	Z	1105

correct matches:

(a) P - III - Z ; Q - I - Y ; R - II - X

(b) P - II - Y ; Q - I - X ; R - III - Z

(c) P - III - Y ; Q - I - Z ; R - II - X

(d) P - I - X ; Q - II - Y ; R - III - Z

78. A solid sample of $Na[Fe(EDTA)(H_2O)_n]$ (X) showed 5.6 % weight loss at 120 ℃ in a thermogravimetric experiment. Identify the complex left after this weight loss,

(a) $Na[Fe(EDTA)(H_2O)]$ (b) $Na[Fe(EDTA)]$

(c) $Na[Fe(EDTA)(H_2O)_2]$ (d) $Na[Fe(EDTA)(H_2O)_3]$

79. Consider the two sets of molecules.

Set I: $[AlF_6]^{3-}$, $[PF_6]^-$, $[SF_6]$ and $[SiF_6]^{2-}$

Set II: $[Ba(H_2O)_6]^{2+}$, $[Ca(H_2O)_6]^{2+}$, $[Mg(H_2O)_6]^{2+}$ and $[Sr(H_2O)_6]^{2+}$

The slowest ligand exchange rate in Set-I and Set-II are, respectively

(a) $[AlF_6]^{3-}$ and $[Sr(H_2O)_6]^{2+}$ (b) $[SF_6]$ and $[Mg(H_2O)_6]^{2+}$

(c) $[SiF_6]^{2-}$ and $[Ca(H_2O)_6]^{2+}$ (d) $[PF_6]^-$ and $[Ca(H_2O)_6]^{2+}$

80. Consider following statements for Eu^{3+}

[P] The positions of sharp bands in UV-vis spectra of its complexes depend heavily on the ligand environment

[Q] Its ground state term symbol is $^7F_0$

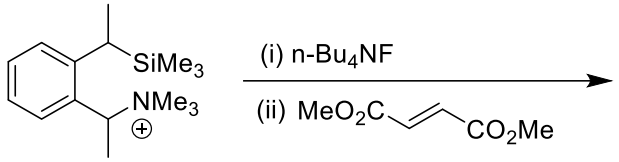
[R] The observed magnetic moment is due to populated higher J level

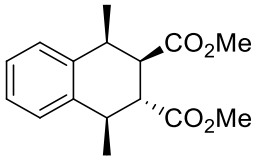
[S] At 2K its magnetic moment approaches to zero

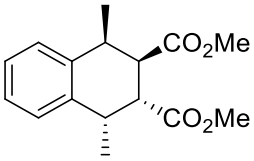
The set of correct statements is

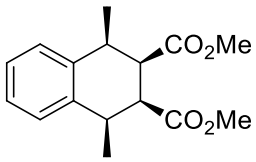
(a) P, R and S (b) Q, R and S (c) P, Q and S (d) P, Q and R

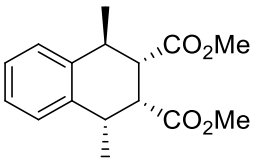
81. The major product formed in the following reaction is



(a) 

(b) 

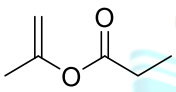
(c) 

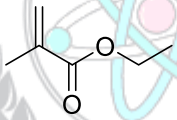
(d) 

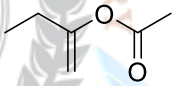
82. Structure of the compound displaying following characteristics spectral data is

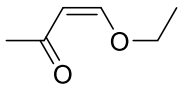
IR : $1720\ cm^{-1}$

^{1}H-NMR : $6.2(br\ s, 1H), 5.5(br\ s, 1H), 4.2(q, 2H), 2.0(s, 3H), 1.1(t, 3H)$

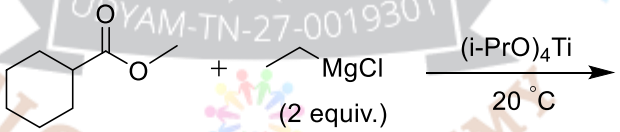
(a) 

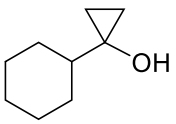
(b) 

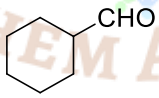
(c) 

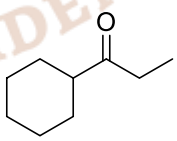
(d) 

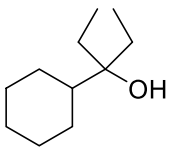
83. The major product formed in the following reaction is



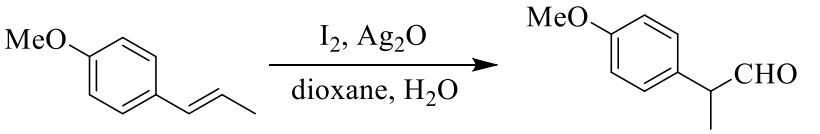
(a) 

(b) 

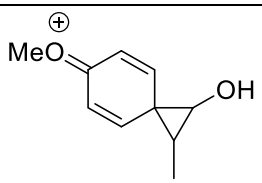
(c) 

(d) 

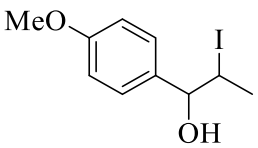
84. The intermediate(s) involved in the following reaction is (are)



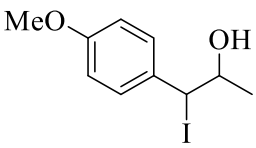
I



II

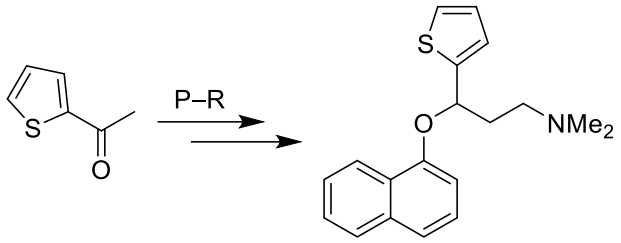


III



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

85. Correct sequence of reagents (P-R) to be used for the following conversion is



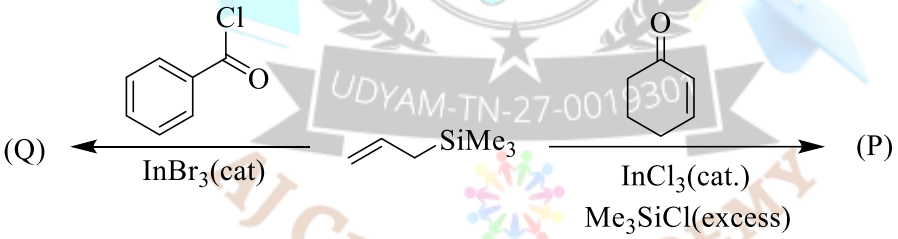
(a) P = NaH,1-fluoronaphthalene
Q = $NaBH_4$
R = (i) $(CH_2O)_n$, $Me_2NH.HCl$;
(ii) 5N NaOH

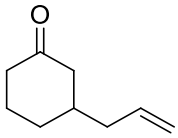
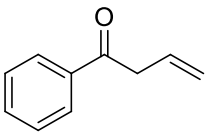
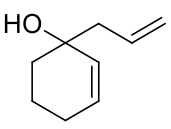
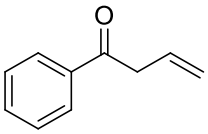
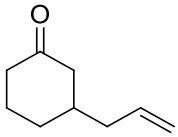
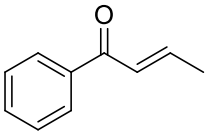
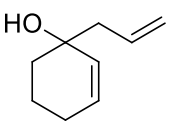
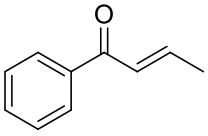
(b) P = $NaBH_4$
Q = NaH,1-fluoronaphthalene
R = (i) $(CH_2O)_n$, $Me_2NH.HCl$;
(ii) 5N NaOH

(c) P = (i) $(CH_2O)_n$, $Me_2NH.HCl$;
(ii) 5N NaOH
Q = $NaBH_4$
R = NaH, 1-fluoronaphthalene

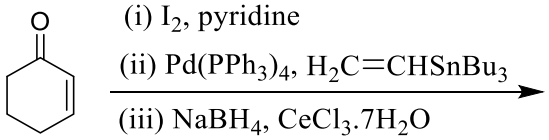
(d) P = (i) $(CH_2O)_n$, $Me_2NH.HCl$;
(ii) 5N NaOH
Q = NaH,1-fluoronaphthalene
R = $NaBH_4$

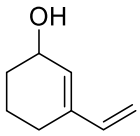
86. The major products (P) and (Q) formed in the following reactions are

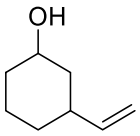


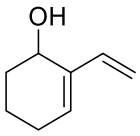
	P	Q
(a)		
(b)		
(c)		
(d)		

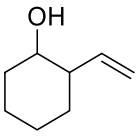
87. The major product formed in the following reaction is



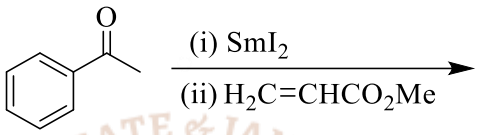
(a) 

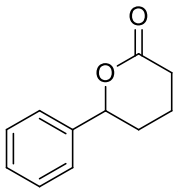
(b) 

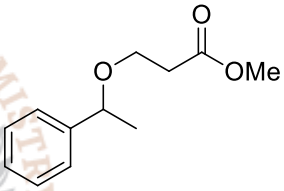
(c) 

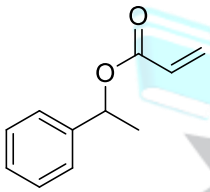
(d) 

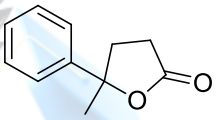
88. The major product formed in the following reaction is



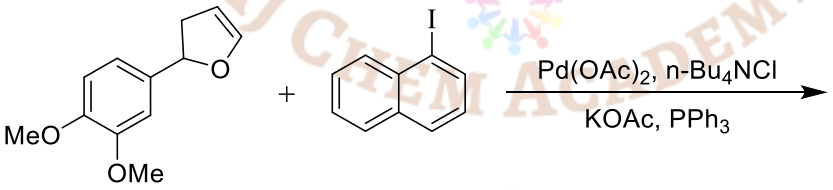
(a) 

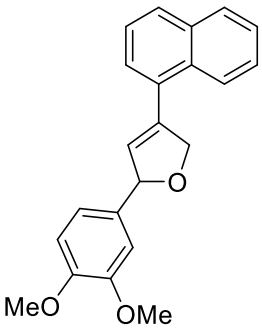
(b) 

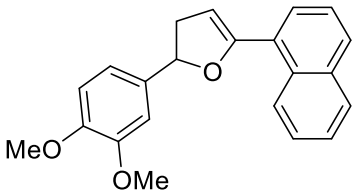
(c) 

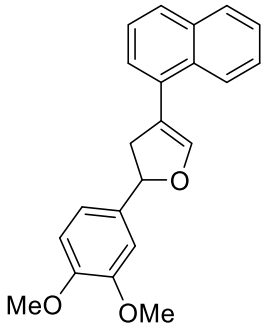
(d) 

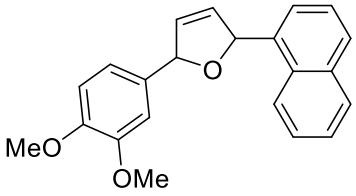
89. The major product formed in the following reaction is



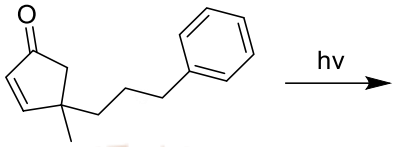
(a) 

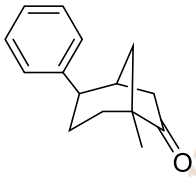
(b) 

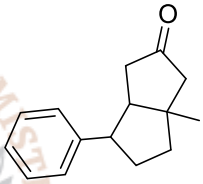
(c) 

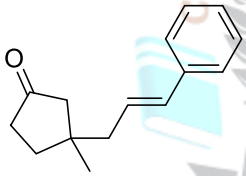
(d) 

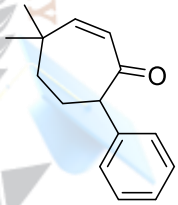
90. The major product formed in the following photochemical reaction is



(a) 

(b) 

(c) 

(d) 

91. Correct sequence of reagents (I - III) to be used for the following conversion is

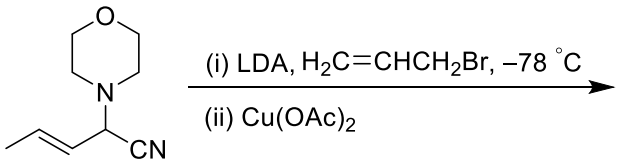
	I		II		III
(a)	LDA, EtBr	;	EtLi	;	H_3O^+
(b)	EtLi	;	LDA, EtBr	;	H_3O^+
(c)	H_3O^+	;	EtLi	;	LDA, EtBr
(d)	EtLi	;	H_3O^+	;	LDA, EtBr

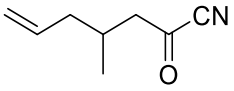
92. Both, 1-chloro-1-phenylpropan-2-one and 1-chloro-3-phenylpropan-2-one give same product (X) when heated in presence of NaOMe. The product (X) is

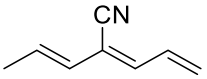
(a) methyl-3-phenylpropanoate (b) methyl-2-phenylpropanoate

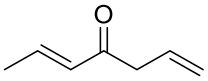
(c) methyl-2-methoxy-2-phenylacetate (d) 1-methoxy-3-phenylpropan-2-one

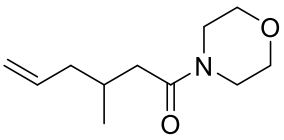
93. The major product formed in the following reaction sequence is



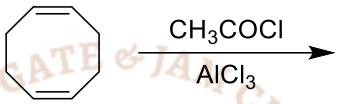
(a) 

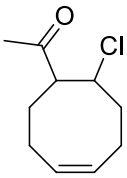
(b) 

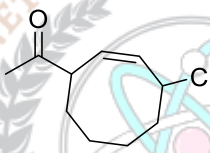
(c) 

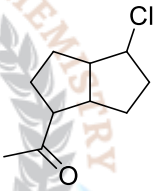
(d) 

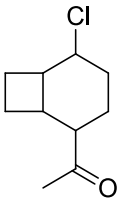
94. The major product formed in the following reaction is



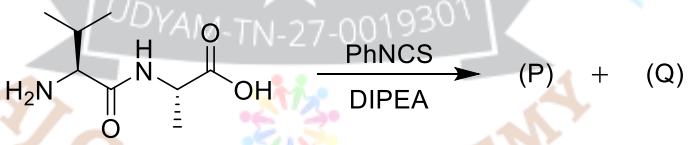
(a) 

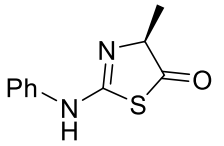
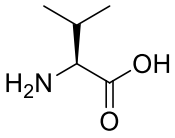
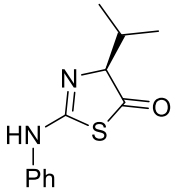
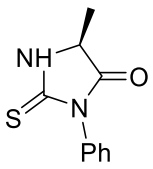
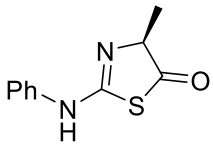
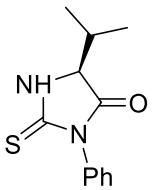
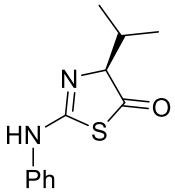
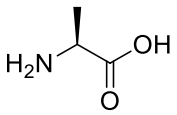
(b) 

(c) 

(d) 

95. The structures of products (P) and (Q) formed in the Edman degradation of the dipeptide are



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

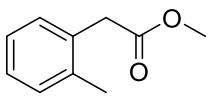
96. Partial spectroscopic data is given below for an organic compound

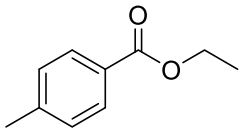
[P] 4 signals between δ 120 – 150 ppm in ^{13}C-NMR spectrum

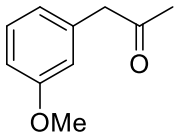
[Q] 2 doublets between δ 6.8 – 8.5 ppm in ^{1}H-NMR spectrum

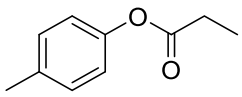
[R] An absorption band at 1724 cm^{-1} in IR spectrum

The structure of the compound is

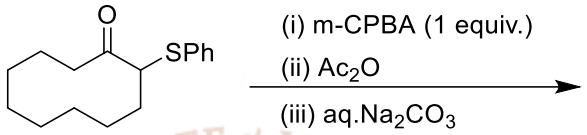
(a) 

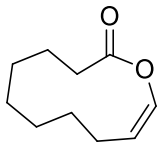
(b) 

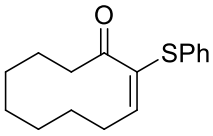
(c) 

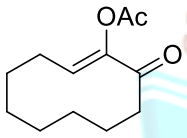
(d) 

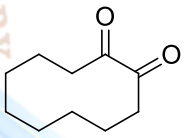
97. The major product formed in the following reaction is



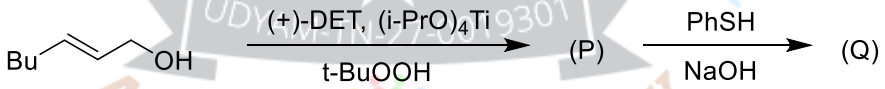
(a) 

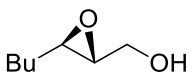
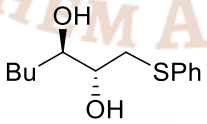
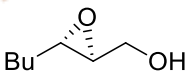
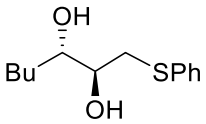
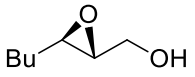
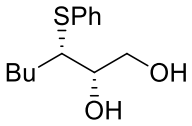
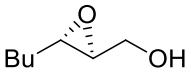
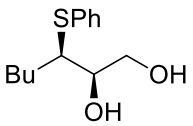
(b) 

(c) 

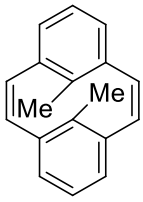
(d) 

98. The major product (P) and (Q) in the following reaction sequence are



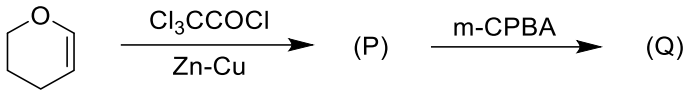
	P	Q		P	Q
(a)			(b)		
(c)			(d)		

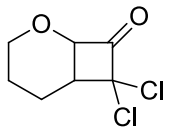
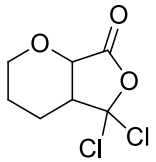
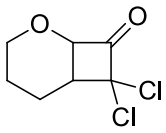
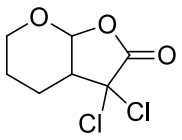
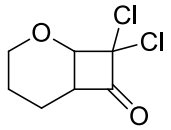
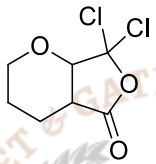
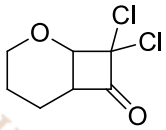
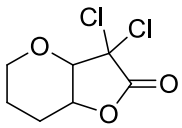
99. The compound-P undergoes a pericyclic reaction under photochemical conditions to give compound-Q. In compound-Q, the relative stereochemistry and ^{1}H-NMR chemical shift values of methyl groups (in δ ppm), respectively, are



(a) cis; −5 (b) trans; 17 (c) cis; 17 (d) trans; −5

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



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

101. Arrange the following molecules in order of increasing fundamental vibrational frequencies

(a) $O_2^{2-} < O_2^- < O_2 < O_2^+$ (b) $O_2 < O_2^+ < O_2^- < O_2^{2-}$

(c) $O_2^{2-} < O_2^- < O_2^+ < O_2$ (d) $O_2^+ < O_2 < O_2^- < O_2^{2-}$

102. One of the Huckel molecular orbitals of 1, 3-butadiene is

$$\varphi = 0.60\chi_1 + 0.37\chi_2 - 0.37\chi_3 - 0.60\chi_4$$

The energy of this orbital in terms of the coulomb (α) and resonance (β) integrals are

(a) $\alpha + 1.62\beta$ (b) $\alpha + 0.62\beta$ (c) $\alpha - 0.62\beta$ (d) $\alpha - 1.62\beta$

103. A molecule AB_2 shows the following IR and Raman spectra

$\bar{\upsilon}(cm^{-1})$	IR	Raman
2215	vs, PR	s, depol.
1250	vs, PR	vs, pol.
560	s, PQR	-

The structure of the molecule is

(a) Linear symmetrical ($D_{\infty h}$) (b) Bent symmetrical (C_{2v})

(c) Linear asymmetrical ($C_{\infty v}$) (d) Bent asymmetrical (C_s)

104. For a one-dimensional (x) harmonic oscillator perturbed by an x^3 potential, the sum of the first order and second order corrections to the ground state energy is

(a) < 0 (b) 0 (c) > 0 (d) ≥ 0

105. Difference of average values of position $< x >$ for states $n = 1$ and $n = 2$ of a particles confined in a one-dimensional (x) box of length L is

(a) $L/4$ (b) $L/2$ (c) $L/3$ (d) 0

106. The hermitian operator among the following is

(a) $i\hbar \frac{d^2}{dx^2}$ (b) $-i\hbar \frac{d}{dx}$ (c) $i\hbar x$ (d) $i\hbar$

107. The translational partition function for Ar confined to a volume of 1L at 300 K, having thermal wavelength of 1.60×10^{-11} m, is closest to

(a) 24.4×10^{29} (b) 2.44×10^{29} (c) 0.244×10^{29} (d) 244×10^{29}

108. Consider a phase transition between two incompressible phases. The correct statement among the following is

(a) The transition is independent of pressure

(b) The transition is independent of temperature

(c) The entropy of such transition is always zero

(d) The enthalpy of such transition is always non-zero

109. The third and fourth lines in the rotational Raman spectrum of CO are separated by $8\ cm^{-1}$. The CO bond length is given by

(a) $\sqrt{\frac{h}{16\pi^2 \mu c}}$ (b) $\sqrt{\frac{3h}{32\pi^2 \mu c}}$ (c) $\sqrt{\frac{h}{32\pi^2 \mu c}}$ (d) $\sqrt{\frac{5h}{32\pi^2 \mu c}}$

110. Conductivities of water and a saturated solution of a sparingly soluble salt AB_2 are 7 and 21 $\mu S\ m^{-1}$, respectively. the solubility of AB_2, in $mol\ m^{-3}$, is

[Given, $\lambda^0_{A^{2+}} = 12.72\ mS\ m^2 mol^{-1}$ and $\lambda^0_{B^-} = 7.64\ mS\ m^2 mol^{-1}$]

(a) 5.0×10^{-4} (b) 5.0×10^{-3} (c) 5.0×10^{-5} (d) 5.0×10^{-6}

111. The equilibrium constant of the following reaction:

$$Sn_{(s)} + Sn^{4+}{}_{(aq)} \rightleftharpoons 2\ Sn^{2+}{}_{(aq)}$$

at 300 K is close to_____. $E^0_{Sn^{4+}/Sn^{2+}} = +0.15\ V$ and $E^0_{Sn^{2+}/Sn} = -0.15\ V$, $R = 8.314\ JK^{-1}mol^{-1}$; $F = 96485\ C\ mol^{-1}$

(a) $10^{6.08}$ (b) $10^{8.08}$ (c) $10^{10.08}$ (d) $10^{12.08}$

112. Langmuir adsorption isotherm for the dissociative adsorption of D_2 is

(p = partial pressure of D_2 and k = ratio of rate constants for adsorption and desorption)

(a) $\theta = \frac{kp}{1+kp}$ (b) $\theta = \frac{k}{1+kp}$ (c) $\theta = \frac{(kp)^{1/2}}{1+(kp)^{1/2}}$ (d) $\theta = \left[\frac{p}{1+kp}\right]^{1/2}$

113. **Entropy of a perfect gas is**

(a) independent of V (b) proportional to V

(c) proportional to lnV (d) proportional to V^2

114. **The contour and root mean square length (in nm) of a polymer chain modelled as a random coil, with $N = 1000$ and $l = 150$ pm, are closest to**

(a) 1.50 and 47.4 (b) 15.0 and 4.74 (c) 150 and 47.4 (d) 150 and 4.74

115. **The free energy $[A - A(0)]$ of a system with 10 non-interacting spins ($S = 1$) is**

(a) $-k_B T \ln(3)$ (b) $-10k_B T \ln(3)$ (c) $-k_B T \ln(0.3)$ (d) $-10k_B T \ln(0.3)$

116. **Table-1:**

D_{2h}	E	$C_2(z)$	$C_2(y)$	$C_2(x)$	i	$\sigma(xy)$	$\sigma(xz)$	$\sigma(yz)$	
A_g	1	1	1	1	1	1	1	1	x^2, y^2, z^2
B_{1g}	1	1	−1	−1	1	1	−1	−1	$R_z, xy,$
B_{2g}	1	−1	1	−1	1	−1	1	−1	R_Y, xz
B_{3g}	1	−1	−1	1	1	−1	−1	1	R_X, yz
A_u	1	1	1	1	−1	−1	−1	−1	
B_{1u}	1	1	−1	−1	−1	−1	1	1	x
B_{2u}	1	−1	1	−1	−1	1	−1	1	y
B_{3u}	1	−1	−1	1	−1	1	1	−1	z

The π_u-orbital of ethylene, when placed in the xy-plane with the C=C bond aligned to the x-axis, transforms according to the irreducible representation (Use Table-1)

(a) a_u (b) b_{1u} (c) b_{2u} (d) b_{3u}

117. **The $b_{1u} \rightarrow b_{2g}$ transition in ethylene is (Use table-1)**

(a) not allowed (b) allowed by to x-polarized light

(c) allowed by y-polarized light (d) allowed by z-polarized light

118. **A metal crystallizes with cubic close-packed structure. The $\sin^2\theta$ values of Bragg reflections of Miller Planes (200) and (111) are 0.18 and 0.14, respectively. The unit cell length is**

(a) $\frac{\lambda}{2}$ (b) $\frac{\lambda}{0.2}$ (c) $\frac{\lambda}{0.4}$ (d) $0.4\,\lambda$

119. **k_{uni} is the effective first-order rate constant of the following unimolecular reaction**

$$A + M \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} A^* + M$$

$$A^* \xrightarrow{k_2} P$$

The slope and intercept of the plot of $1/k_{uni}$ vs. $1/[M]$ are 4×10^6 and 8×10^{11}, respectively. The value of k_{-1}/k_2 is

(a) 2×10^5 (b) 0.5×10^5 (c) 32×10^5 (d) 2×10^{-5}

120. The decomposition mechanism of ozone is

$$O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O$$

$$O_3 + O \xrightarrow{k_2} 2O_2$$

If $k_{-1}[O_2] << k_2[O_3]$, then the order of the reaction with respect to ozone is

(a) zero (b) one (c) two (d) complex

Answer Key

PART - B

Q.No	Ans
21.	b
22.	c
23.	b
24.	b
25.	a
26.	b
27.	c
28.	b
29.	c
30.	c

Q.No	Ans
31.	a
32.	a
33.	a
34.	c
35.	b
36.	d
37.	a
38.	d
39.	c
40.	a

Q.No	Ans
41.	d
42.	b
43.	b
44.	b
45.	a
46.	c
47.	b
48.	a
49.	b
50.	a

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

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PART - C

Q.No	Ans
61.	b
62.	b
63.	a
64.	a
65.	b
66.	c
67.	b
68.	b
69.	b
70.	c
71.	b
72.	a
73.	a
74.	c
75.	c

Q.No	Ans
76.	a
77.	a
78.	b
79.	b
80.	b
81.	a
82.	b
83.	a
84.	c
85.	c
86.	a
87.	c
88.	d
89.	d
90.	c

Q.No	Ans
91.	a
92.	a
93.	c
94.	c
95.	d
96.	b
97.	d
98.	b
99.	d
100.	d
101.	a
102.	b
103.	c
104.	a
105.	d

Q.No	Ans
106.	b
107.	b
108.	a
109.	a
110.	a
111.	c
112.	c
113.	c
114.	d
115.	b
116.	c
117.	d
118.	c
119.	a
120.	b