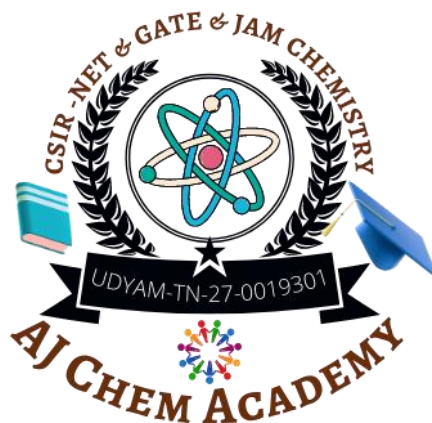


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Q.21 – Q.60 MCQ, carry TWO marks each (for each wrong answer: -0.5).

You are required to Answer Maximum 35 Questions.

21. Which one of the following pairs has two **magic numbers** for closed nuclear shells?
 (a) 8, 10 (b) 10, 20 (c) 50, 82 (d) 82, 130
22. Identify the correct statement(s) for **phosphorimetric measurement** from the following:
[P] It is done after a time delay when fluorescence, if present becomes Negligible
[Q] Immobilization of analyte increases phosphorescence
[R] Phosphorescence decreases in the presence of heavy atoms
 Answer(s) is/are
 (a) P only (b) P and Q (c) P and R (d) Q and R
23. Choose the **isoelectronic pair** among the following:
- | P | Q | R | S |
|---------------------------|---|------------------------------|--|
| $[\text{V}(\text{CO})_6]$ | $[\text{Cu}(\eta^5\text{-C}_5\text{H}_5)(\text{CO})]$ | $[\text{Co}(\text{CO})_4]^-$ | $[\text{IrCl}(\text{CO})(\text{PPh}_3)_2]$ |
- (a) P and Q (b) Q and R (c) R and S (d) P and S
24. An **organometallic fragment** that is **isolobal** to CH_3^+ is
 (a) $[\text{Fe}(\text{CO})_5]$ (b) $[\text{Mn}(\text{CO})_5]$ (c) $[\text{Cr}(\text{CO})_5]$ (d) $[\text{Ni}(\text{CO})_3]^+$
25. The **calculated and observed magnetic moments (in B.M.)** of aqua complex of a lanthanide ion are **0** and **~3.5**, respectively, the lanthanide ion is
 (a) Pm^{3+} (b) Pr^{3+} (c) Eu^{3+} (d) Sm^{3+}
26. The compound that gives a **basic solution in HF** is;
 (a) AsF_5 (b) PF_5 (c) BF_3 (d) BrF_3
27. Based on **VSEPR theory**, the predicted shapes of $[\text{XeF}_5]^-$ and BrF_5 , respectively, are
 (a) pentagonal planar and square pyramidal
 (b) square pyramidal and trigonal bipyramidal
 (c) trigonal bipyramidal and square pyramidal
 (d) square pyramidal and pentagonal planar
28. Both potassium and sulfuric acid form **intercalation compounds** with **graphite**. The graphite layers are
 (a) reduced in both the cases
 (b) oxidized in both the cases
 (c) oxidized in the case of potassium and reduced in the case of sulphuric acid



(d) reduced in the case of potassium and oxidized in the case of Sulfuric acid

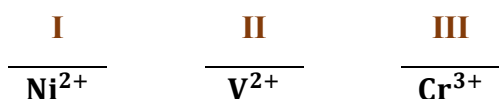
29. The resonance Raman stretching frequencies (in cm^{-1}) of the bound O_2 species in oxy-hemerythrin and oxy-hemoglobin, respectively, are

(a) ~ 850 and 1100 (b) ~ 750 and 850 (c) ~ 850 and 850 (d) ~ 1100 and 850

30. CdS , HgS and BiI_3 are coloured due to

(a) $\text{L} \rightarrow \text{M}$ charge transfer transitions
 (b) $\text{d} \rightarrow \text{d}$ electronic transitions
 (c) $\text{M} \rightarrow \text{L}$ charge transfer transitions
 (d) combination of $\text{L} \rightarrow \text{M}$ charge transfer and $\text{d} \rightarrow \text{d}$ electronic transitions

31. The relative rates of water exchange for the hydrated complexes of the given ions follow the trend



(a) $(\text{I}) > (\text{II}) > (\text{III})$
 (b) $(\text{I}) < (\text{II}) < (\text{III})$
 (c) $(\text{I}) > (\text{II}) < (\text{III})$
 (d) $(\text{I}) < (\text{II}) > (\text{III})$

32. Consider the following sulfur donor atom bearing bidentate ligand where X and name of ligands are given in following columns:



	X		Ligand Name	P	Q	R	S	
P.	NR ₂	I.	Dithiocarbonate	(a)	II	III	I	IV
Q.	OR	II.	Dithiocarbamate	(b)	III	II	IV	I
R.	O ⁻	III.	Xanthate	(c)	I	II	III	IV
S.	SR	IV.	Thioxanthate	(d)	IV	I	II	III

33. In vitro reaction of an excess of O_2 with free heme-B in aqueous medium the end product is

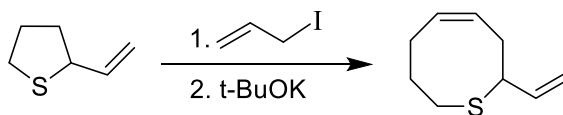
(a) hematin (b) $[\text{O}_2^- - \text{Fe}(\text{III})\text{-protoporphyrin-IX}]$
 (c) heme-B(O_2) (d) oxoferrylprotoporphyrin-IX cation radical

34. ^{13}C -NMR spectrum of DMSO-d_6 gives a signal at $\delta 39.7$ ppm as a

(a) singlet (b) triplet (c) quintet (d) septet

35. Following reaction is an example of



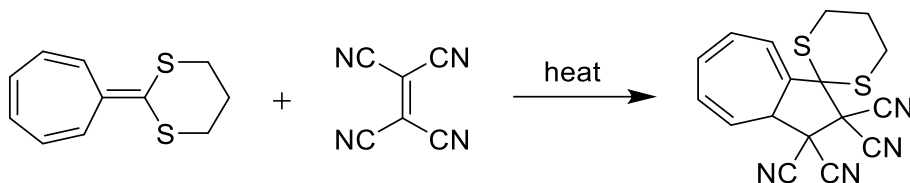


- (a) Ramberg-Bäcklund reaction
 (b) [2,3]-sigmatropic shift
 (c) [3,3]-sigmatropic shift
 (d) Pummerer rearrangement

36. Among the following, the **synthetic equivalent of acetyl anion** is

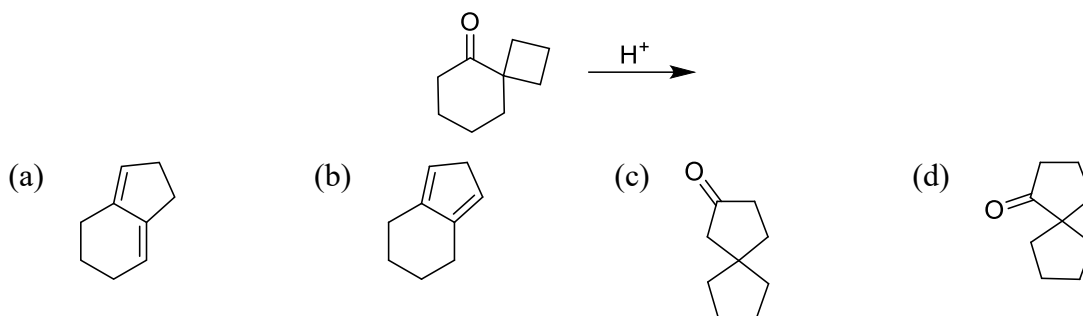
- (a) (b) CH_3CN (c) (d) $\text{CH}_3\text{CH}_2\text{NO}_2$

37. Following reaction is an **example of** _____ cycloaddition



- (a) [3 + 2] (b) [4 + 2] (c) [6 + 2] (d) [8 + 2]

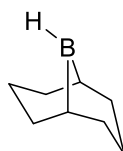
38. The **major product** of the following reaction is



39. The **most stable conformation** of **2-fluoroethanol** is

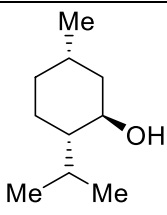
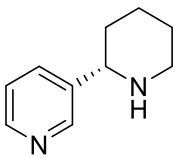
- (a) (b) (c) (d)

40. The **IUPAC** name of the following compound is



- (a) 9-borabicyclo[3.3.1]nonane (b) 1-borabicyclo[3.3.1]nonane
 (c) 9-borabicyclo[3.3.0]octane (d) 1-borabicyclo[3.3.0]octane

41. The **correct match** of **natural products** is **Column-I** with their **biosynthetic precursors** in **Column-II** is

	Column I	Column II
P.		I. L-Lysine
Q.		II. L-Ornithine
		III. Farnesyl pyrophosphate
		IV. Geranyl pyrophosphate

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

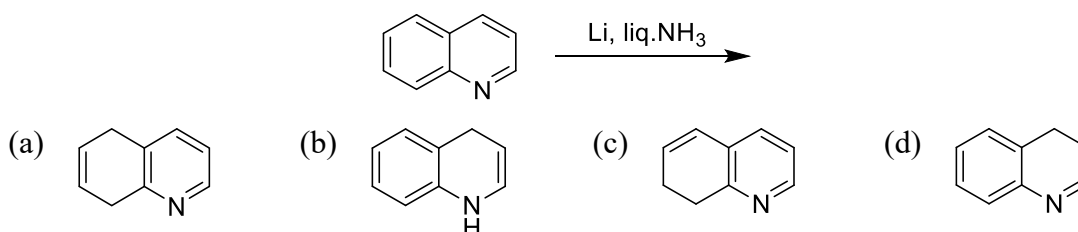
42. The correct order of pK_a values for the following species is

- (a) $\text{PhNH}_3^+ < \text{i-Pr}_2\text{NH}_2^+ < \text{Ph}_2\text{NH}_2^+$
 (b) $\text{Ph}_2\text{NH}_2^+ < \text{PhNH}_3^+ < \text{i-Pr}_2\text{NH}_2^+$
 (c) $\text{i-Pr}_2\text{NH}_2^+ < \text{Ph}_2\text{NH}_2^+ < \text{PhNH}_3^+$
 (d) $\text{PhNH}_3^+ < \text{Ph}_2\text{NH}_2^+ < \text{i-Pr}_2\text{NH}_2^+$

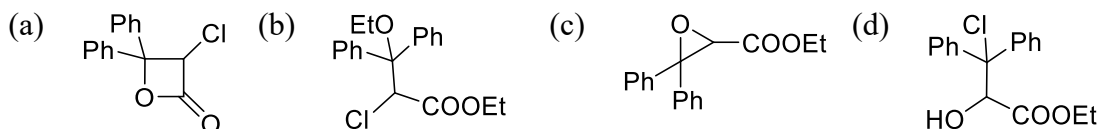
43. Among the following, the natural product that is a steroid and contains an α, β -unsaturated ketone is

- (a) estrone (b) prostaglandin (c) cortisone (d) morphine

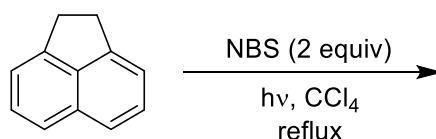
44. The major product formed in the following reaction is

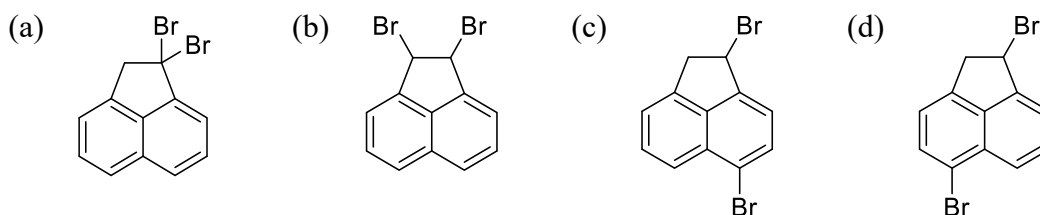


45. The major product formed in the sodium ethoxide mediated reaction between benzophenone and ethyl chloroacetate is



46. The major product formed in the following reaction is





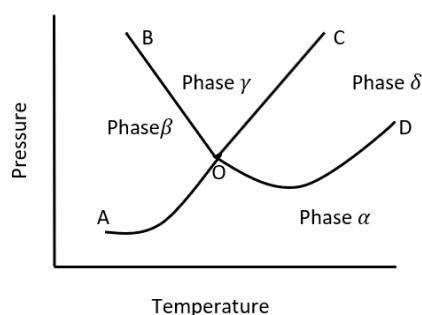
47. Consider a particle in its ground state confined to a **one-dimensional box** in the interval $(0, 8)$. The **probability** of finding it between $4.0 - \frac{\delta}{2}$ and $4.0 + \frac{\delta}{2}$ is close to (δ is sufficiently small so that the wavefunction can be taken as a constant in this interval)

(a) $\frac{\delta}{4}$ (b) $\frac{\delta}{3}$ (c) $\frac{\delta}{2}$ (d) δ

48. Which of the functions below is a **common eigenfunction** of $\frac{d}{dx}$ and $\frac{d^2}{dx^2}$ operators?

(a) $\cos x$ (b) kx (c) e^{ix} (d) $e - x^2$

49. A **one-component system** with the associated phase diagram (see the figure) is **not possible** because



- (a) OB has a negative slope (b) OC has a positive slope
(c) Both OB and OC are linear (d) OB, OC and OD cannot all coexist, given OA
50. A **phase transition process** is always
(a) isothermal – isentropic (b) isochoric – isothermal
(c) isobaric – isochoric (d) isothermal – isobaric
51. The correct statement for any **cyclic thermodynamic process** is
(a) $\oint dq = 0$ (b) $\oint dw = 0$ (c) $\oint dU = 0$ (d) $\oint Vdq = 0$
52. Metallic silver crystallizes in **face-centred-cubic lattice structure** with a unit cell of length **40 nm**. The **first order diffraction angle** of **X-ray beam** from **(2, 1, 0)** plane of silver is **30°**. The **wavelength of X-ray** used is close to
(a) 11 nm (b) 18 nm (c) 25 nm (d) 32 nm
53. If the **pre-exponential factor** in **Arrhenius equation** is **$1.6 \times 10^{12} \text{ s}^{-1}$** the value of the rate constant at extremely high temperature will be close to



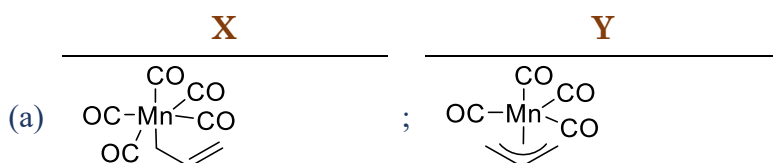
- (a) $1.6 \times 10^{12} \text{ s}^{-1}$ (b) $4.2 \times 10^{12} \text{ s}^{-1}$ (c) $2.4 \times 10^9 \text{ s}^{-1}$ (d) $1.2 \times 10^6 \text{ s}^{-1}$
54. In kinetic study of a chemical reaction, slopes are drawn at different times in the plot of concentration of reactants versus time. The magnitude of slopes with increase of time
- (a) remains unchanged (b) increases
(c) decreases (d) increases and decreases periodically
55. The electrochemical cell potential (E), after the reactants and products reach equilibrium, is (E° is the standard cell potential and n is the number of electrons involved)
- (a) $E = E^\circ + nF/RT$ (b) $E = E^\circ - RT/nF$ (c) $E = E^\circ$ (d) $E = 0$
56. For the electronic configuration $1s^2 2s^2 2p^4$, two of the possible term symbols are 1S and 3P . The remaining term is
- (a) 1D (b) 1F (c) 3D (d) 3F
57. The $v = 0$ to 1 vibration-rotation spectrum of a diatomic molecule exhibits transitions for $R(0), R(1), P(1)$ and $P(2)$ lines at $2242, 2254, 2216$ and 2203 cm^{-1} , respectively. From this data, we can conclude that the molecule
- (a) has rigid rotation and harmonic vibration (b) has anharmonic vibration
(c) has rotational-vibrational interaction (d) is affected by nuclear spin-statistics
58. Consider aqueous solutions of two compounds X and Y of identical concentrations. The surface tension of the solution of X is smaller than that of pure water while for Y it is greater than that of pure water under identical conditions. From this one infers that
- (a) surface concentration of X is smaller than its bulk concentration
(b) surface concentration of Y is larger than its bulk concentration
(c) surface concentration of X is larger than that of Y
(d) surface concentration of X is smaller than that of Y
59. For a monodisperse polymer, the number-average molar mass ($\bar{M}_n$) and weight-average molar mass ($\bar{M}_w$) are related according to
- (a) $\bar{M}_w < \bar{M}_n$ (b) $\bar{M}_w = \bar{M}_n$ (c) $\bar{M}_w > \bar{M}_n$ (d) $\bar{M}_w < \log \bar{M}_n$
60. An intense purple colour (Plasmon band) is exhibited by a colloid consisting of spherical
- (a) silver particles of 10 nm diameter (b) silicon particles of 5 nm diameter
(c) gold particles of 5 nm diameter (d) iron particles of 3 nm diameter

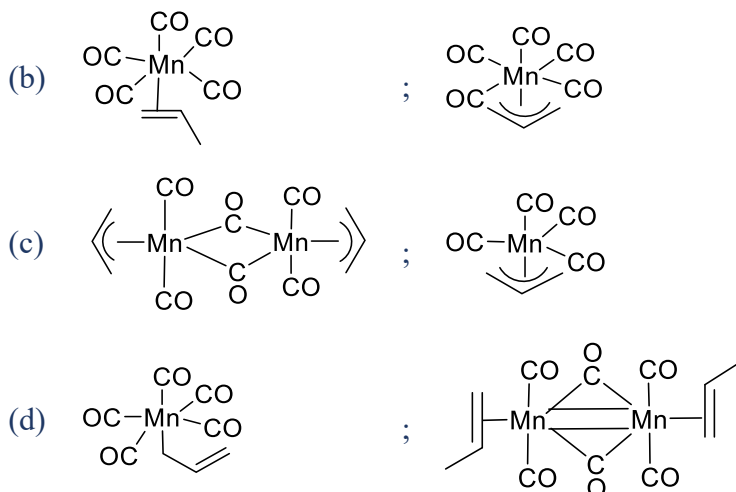


Q.61 – Q.120 MCQ, carry FOUR marks each (for each wrong answer: –1).

You are required to Answer Maximum 25 Questions.

61. Choose the correct statement for magnitude of **threshold energy** of an **endoergic nuclear reaction** between stationary nucleus and a moving projectile,
- It is greater than $|Q|$ of nuclear reaction
 - It has to be more than kinetic energy of a projectile
 - It is less than $|Q|$ of nuclear reaction
 - It has to be equal to kinetic energy of a projectile
62. Identify correct statements from the following:
- P.** Area of differential thermal analysis peak is proportional to amount of sample
- Q.** Area of differential thermogravimetric analysis curve is proportional to mass loss
- R.** Phase transition cannot be studied with differential scanning calorimetry
- S.** Simultaneous determination of two metal ions is possible with thermogravimetric analysis
- P, Q and R
 - P, Q and S
 - Q, R and S
 - P, R and S
63. Consider following statements for fission of ^{235}U with thermal neutrons,
- [P]** The % of nuclei undergoing unsymmetrical fission is maximum
- [Q]** In each fission, one thermal neutron is produced
- [R]** Magnitude of energy released per fission is of the order 200 MeV
- Correct statement(s) is/are
- P and Q
 - P and R
 - Q and R
 - R only
64. Addition of two electrons to the bismuth cluster Bi_5^{3+} results in change of structure type from
- closo to nido
 - nido to arachno
 - closo to arachno
 - arachno to hypho
65. Reaction of $\text{Na}[\text{Mn}(\text{CO})_5]$ with $\text{H}_2\text{C}=\text{CHCH}_2\text{Cl}$ gives **X** along with **NaCl**. Photolysis of compound **X** results in compound **Y** together with elimination of CO. The correct structural formulations of compounds **X** and **Y** are respectively,





66. A copper(II) complex having distorted octahedral geometry shows an absorption band at 625 nm. Given spin-orbit coupling of complexes as -625 cm^{-1} , the μ_{eff} (in B.M.) is

- (a) 1.73 (b) 1.86 (c) 1.63 (d) 1.93

67. Match items in column-I with items in column-II

	Column-I		Column-II
i	$\text{SbF}_5 + \text{BrF}_3 \rightarrow [\text{BrF}_2]^+ + [\text{SbF}_6]^-$	P.	Lewis acid behaviour of BrF_3
ii	$[\text{BrF}_2][\text{SbF}_6] + \text{Ag}[\text{BrF}_4] \rightarrow \text{Ag}[\text{SbF}_6] + 2\text{BrF}_3$	Q.	Lewis base behaviour of BrF_3
iii	$\text{KF} + \text{BrF}_3 \rightarrow \text{K}^+ + [\text{BrF}_4]^-$	R.	Self ionisation
iv	$2\text{BrF}_3 \rightarrow [\text{BrF}_2]^+ + [\text{BrF}_4]^-$	S.	Neutralisation

The correct answer is

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

(b)	Q	;	S	;	R	;	P		
(d)	Q	;	S	;	P	;	R		

68. Mossbauer spectrum of complex $[\text{Fe}(\text{1,10-phenanthroline})_2(\text{NCS})_2]$ shows two lines at 300 K, four lines at 186 K, and again two lines at 77 K. This can be attributed to

[P] change in the coordination mode of NCS

[Q] change in the spin-state of iron

[R] cis-trans isomerisation

[S] change in metal-ligand bond distances

The correct statements are

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



69. $(\text{R}_3\text{Ge})_2$ on photolysis gives a radical which shows ESR spectrum. The ESR signals carrying the signature of ^{73}Ge ($I = 9/2$) are in terms of
 (a) Nine lines (b) Ten lines (c) Two lines (d) One line
70. Mass fragment of $[\text{IrCl}]^+$ in mass spectrometry shows three mass peaks at $m/z = 226, 228$ and 230 . Given that natural abundances of ^{191}Ir , ^{193}Ir , ^{35}Cl and ^{37}Cl are 37%, 63%, 76% and 24% respectively, the intensities of the mass peaks are in the order
 (a) 49.5 : 100 : 26.6 (b) 100 : 49.5 : 26.6
 (c) 26.6 : 100 : 49.5 (d) 26.6 : 49.5 : 100
71. The $^{31}\text{P}\{^1\text{H}\}$ -NMR spectrum of $2, 2, 6, 6 - \text{N}_4\text{P}_4\text{Cl}_4(\text{NMe}_2)_4$ is expected to show
 (a) two triplets (b) two doublets
 (c) one doublet and one triplet (d) one quartet and one doublet
72. The number of bonding molecular orbitals and the number of available skeletal electrons in $[\text{B}_6\text{H}_6]^{2-}$, respectively, are
 (a) 7 and 14 (b) 6 and 12 (c) 18 and 12 (d) 11 and 14
73. The compound N_2F_2 has two isomers. Choose the correct option from the following:
 (a) both isomers possess σ_v plane
 (b) both isomers possess σ_h plane
 (c) one isomer has a σ_h plane while the other has a σ_v plane
 (d) none of them have a σ_h plane
74. Consider the following statements for metallothioneins:
[P] they contain about 30% cysteine residues
[Q] they prefer to bind soft metal ions such as Cd(II) , Hg(II) and Zn(II)
[R] they are involved in electron transfer reactions
[S] they are low molecular weight proteins
 Correct statements are
 (a) P, Q and R (b) P, Q and S (c) P, R and S (d) Q and R
75. Consider the following statements for deoxy-hemerythrin and deoxy-hemocyanin:
[P] they are involved in O_2 transport in biological systems
[Q] they contain two metal ions in their active site
[R] active site metal centres are bridged by amino acid residues
[S] they prefer to bind only one O_2 per active site



The correct statements are

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

76. Consider the following statements for octahedral complexes,

I	II	III
$[\text{CrF}_6]^{3-}$	$[\text{Cr}(\text{ox})_3]^{3-}$	$[\text{Cr}(\text{en})_3]^{3+}$
[P] their $d \rightarrow d$ transitions are at 14900, 17500 and 21800 cm^{-1} , respectively		
[Q] their spin-only magnetic moments are same		
[R] two of them have optical isomers		
[S] all of them show Jahn-Teller distortion		

Correct statements are

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

77. Addition of NaBH_4 to $[(\eta^5\text{-Cp})\text{Fe}(\eta^6\text{-C}_6\text{H}_6)]^+$ will give

- (a) $[(\eta^5\text{-Cp})\text{Fe}(\text{H})_2]^-$ (b) $[(\eta^5\text{-Cp})\text{Fe}(\text{H})(\eta^6\text{-C}_6\text{H}_6)]$
 (c) $[(\eta^5\text{-Cp})\text{Fe}(\eta^6\text{-C}_6\text{H}_6)]$ (d) $[(\eta^5\text{-Cp})\text{Fe}(\eta^5\text{-C}_6\text{H}_7)]$

78. The μ_{eff} of $[\text{Fe}(\text{S}_2\text{CNET}_2)_3]$ changes with temperature with the involvement of two electronic states. The states are

- (a) low spin $^2T_{2g}$ and high-spin $^6A_{1g}$ (b) low spin $^1A_{1g}$ and high-spin $^3T_{2g}$
 (c) low spin 2E_g and high-spin $^6A_{1g}$ (d) low spin $^2T_{2g}$ and high-spin $^4T_{1g}$

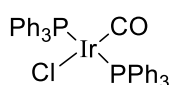
79. Match the items in the three columns.

Complex	Colour	Absorption max (λ_{max} nm)
P. $[\text{Ni}(\text{H}_2\text{O})_6](\text{NO}_3)_2$	I. Blue	X. 675
Q. $[\text{Ni}(\text{NH}_3)_6](\text{NO}_3)_2$	II. Green	Y. 565
R. $[\text{Ni}(\text{en})_3](\text{NO}_3)_2$	III. Violet	Z. 615

The correct answer is

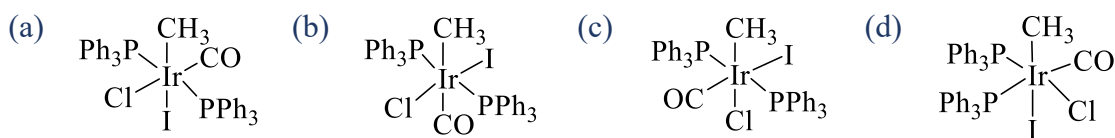
- (a) P - II - X ; Q - I - Z ; R - III - Y
 (b) P - I - X ; Q - II - Y ; R - III - Z
 (c) P - III - Y ; Q - I - Z ; R - II - X
 (d) P - I - X ; Q - II - Z ; R - III - Y

80. Identify the product in the reaction between

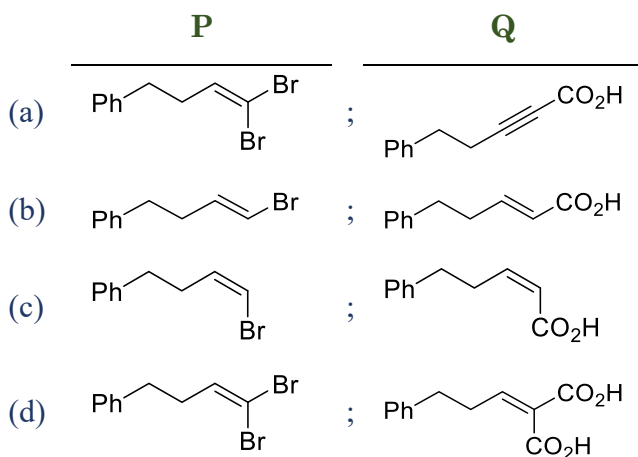
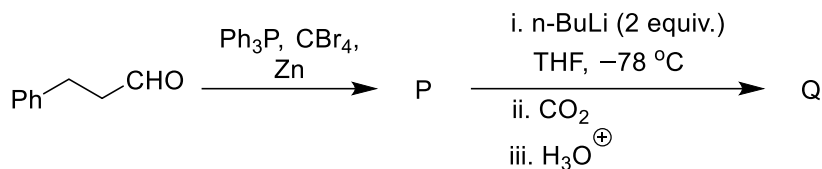


and CH_3I going at room temperature via $\text{S}_{\text{N}}2$ mechanism

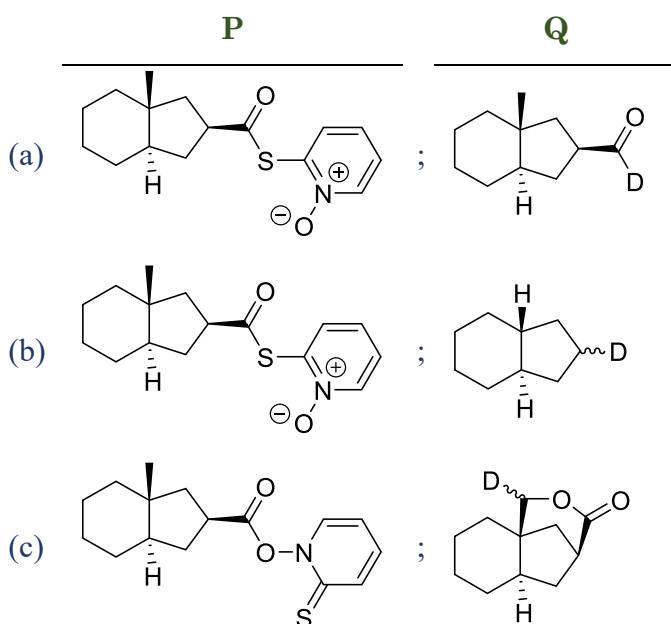
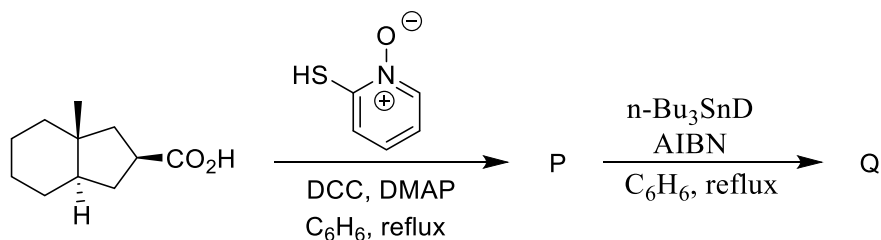


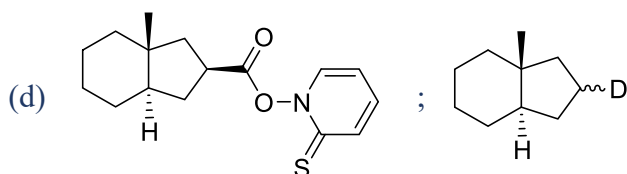


81. The Major product **P** and **Q** formed in the following reaction sequence are

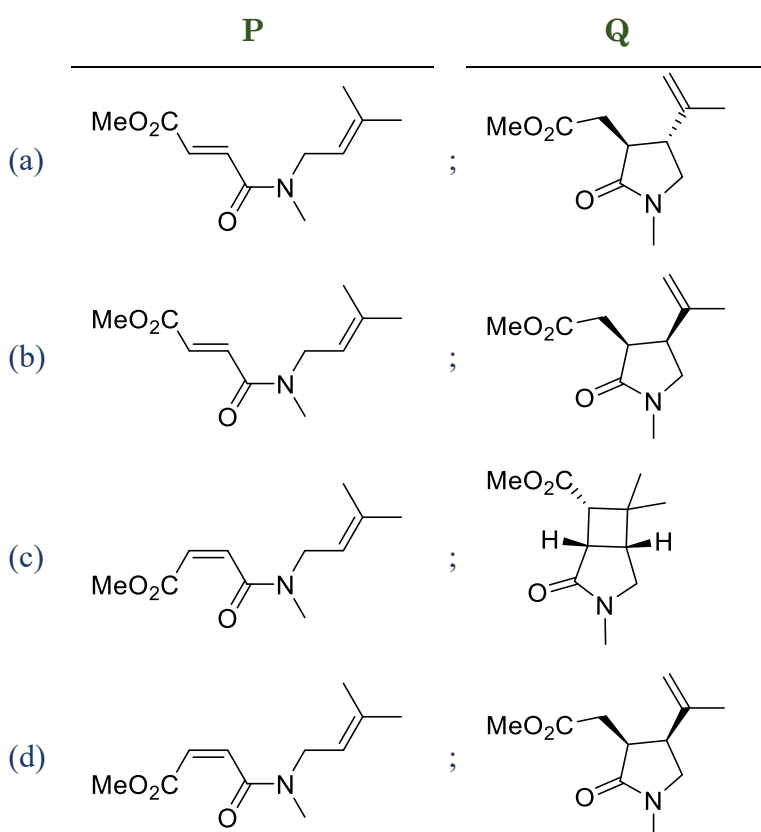
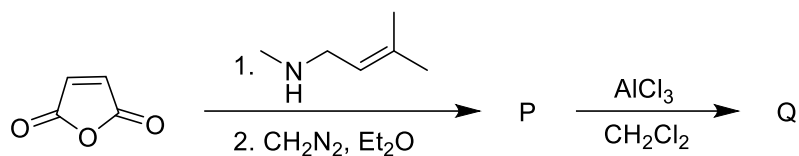


82. The intermediate **P** and product **Q** formed in the following reaction sequence are

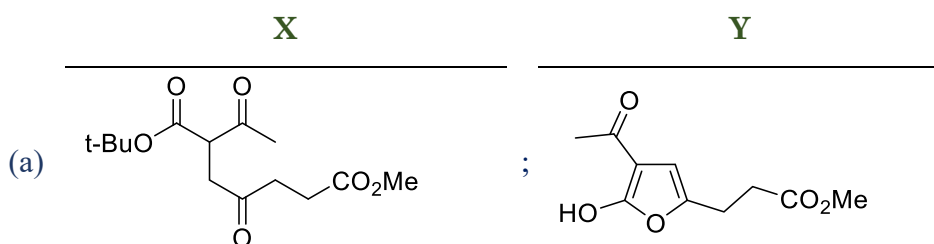
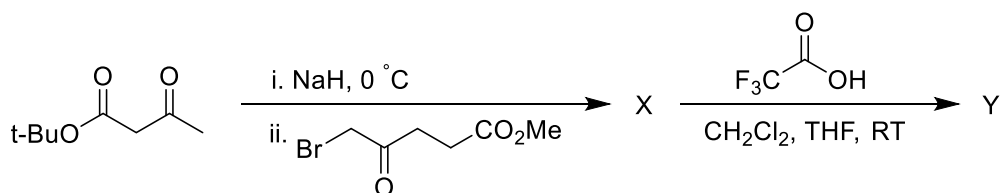


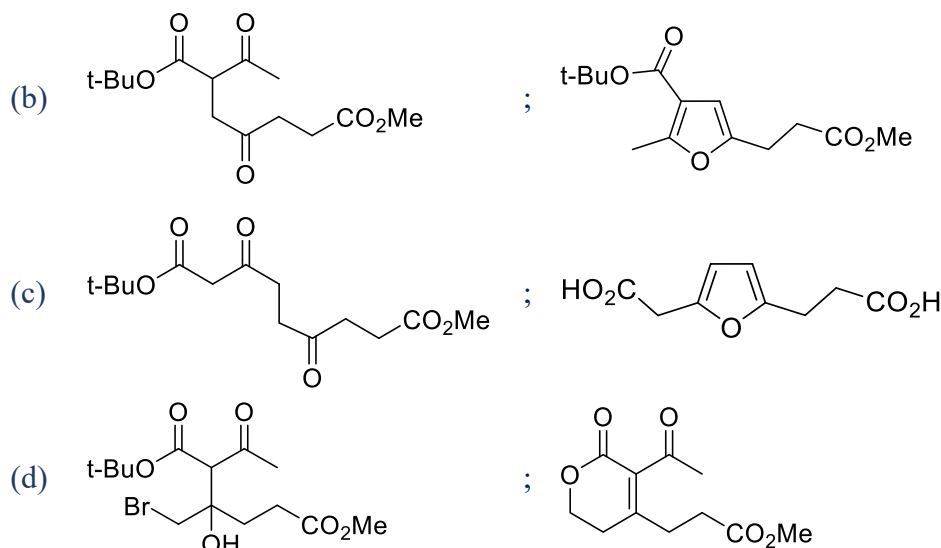


83. The Major products **P** and **Q** formed in the following reaction sequence are

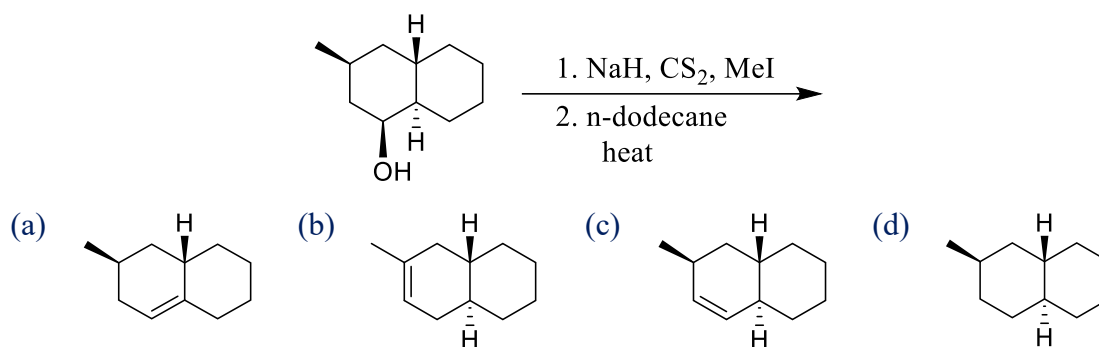


84. The major products **X** and **Y** formed in the following reaction sequence are

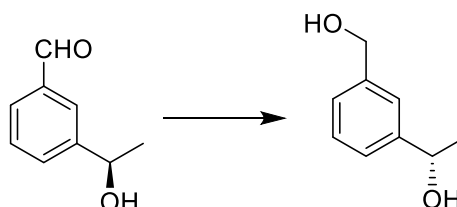




85. The major products formed in the following reaction is

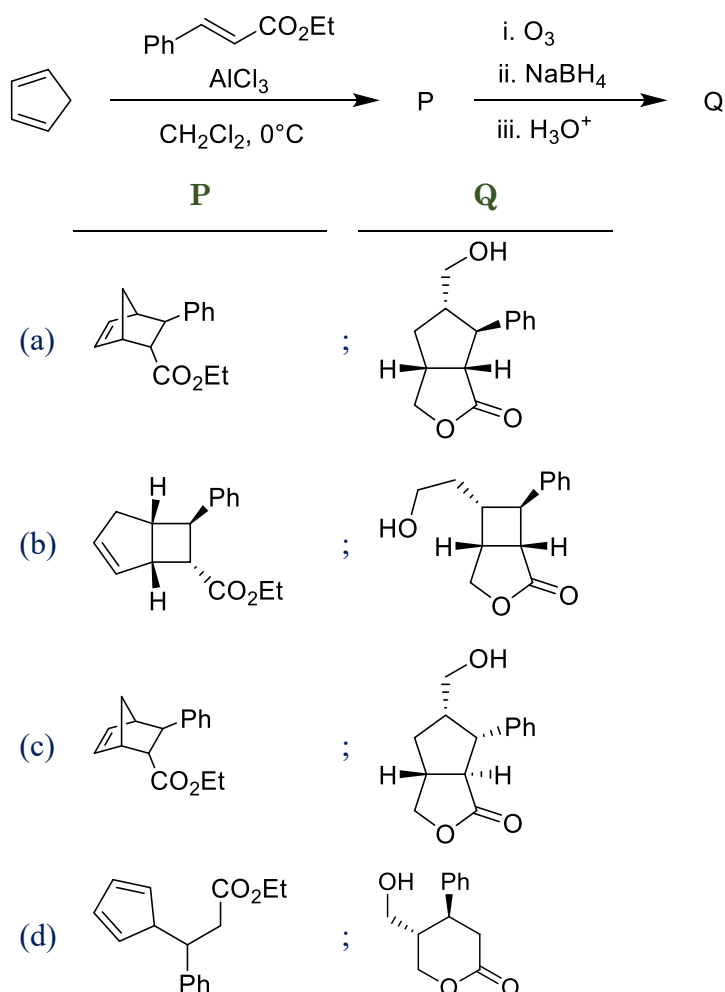


86. The correct combination of reagents to effect the following reaction is

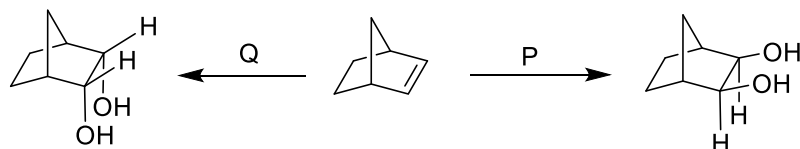


- | | | | | | | | |
|-----|-----|---|---|-----|----|---|---|
| (a) | i | = | POCl_3 , pyridine | (b) | i | = | NaBH_4 |
| | ii | = | AgOAc | | ii | = | Ph_3P , DEAD, PhCO_2H |
| | iii | = | LiAlH_4 | | | | |
| | | | | | | | |
| (c) | i | = | Ph_3P , DEAD, PhCO_2H | (d) | i | = | PCC |
| | ii | = | LiAlH_4 | | ii | = | L-selectride |

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



88. The correct combination of reagents **P** and **Q** to effect following transformations are



(a) P = (i) Cat.OsO₄, NMO

(b) P = (i) Alkaline KMnO₄

Q = (i) I₂, PhCO₂Ag

Q = (i) I₂, PhCO₂Ag, H₂O

(ii) aq.NaOH

(ii) aq.NaOH

(c) P = (i) I₂, PhCO₂Ag

(d) P = (i) m-CPBA

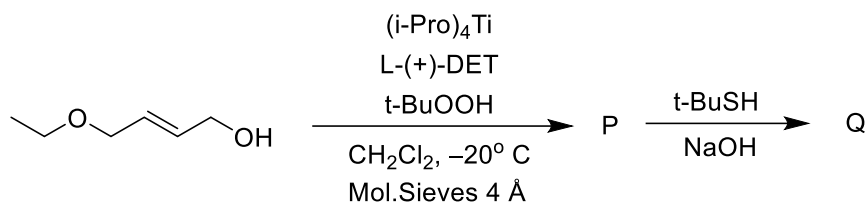
(ii) aq.NaOH

(ii) aq.NaOH

Q = (i) Cat.OsO₄, TMEDA, NMO

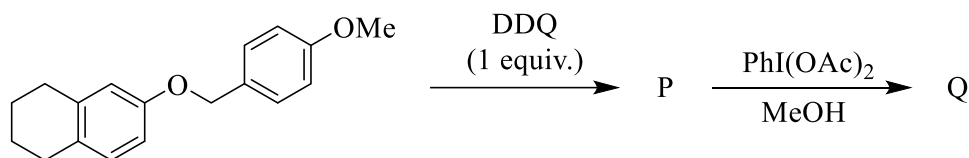
Q = (i) Alkaline KMnO₄

89. The major products **P** and **Q** formed in the following reaction sequence are



- | P | Q |
|---|---------------------------------|
| <p>(a) </p> <p>(b) </p> <p>(c) </p> <p>(d) </p> | <p></p> <p></p> <p></p> <p></p> |

90. The major products **P** and **Q** formed in the following reaction sequence are

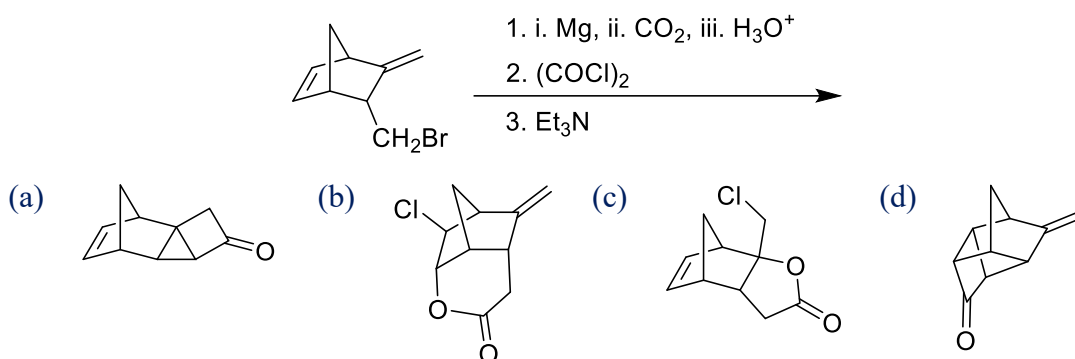


- | P | Q |
|---|---------------------------------|
| <p>(a) </p> <p>(b) </p> <p>(c) </p> <p>(d) </p> | <p></p> <p></p> <p></p> <p></p> |

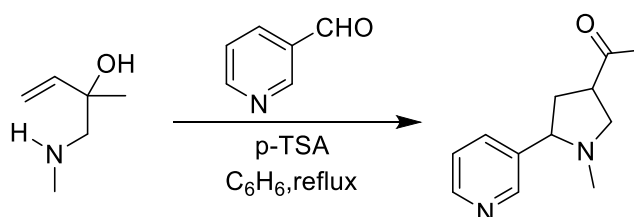
91. The specific rotation $[\alpha]_D$ for (S)-(+)-2-butanol is 10° mL/g dm . The observed optical rotation (α_{obs}) of a sample composed of a mixture of (R)- and (S)-2-butanol is -0.45° . If the cell path length is 0.6 dm and the concentration of 2-butanol in the sample is 0.15 g/mL , the percentages of (R) and (S) enantiomers in the sample are

- (a) (R) = 25% , (S) = 75% (b) (R) = 40% , (S) = 60%
(c) (R) = 60% , (S) = 40% (d) (R) = 75% , (S) = 25%

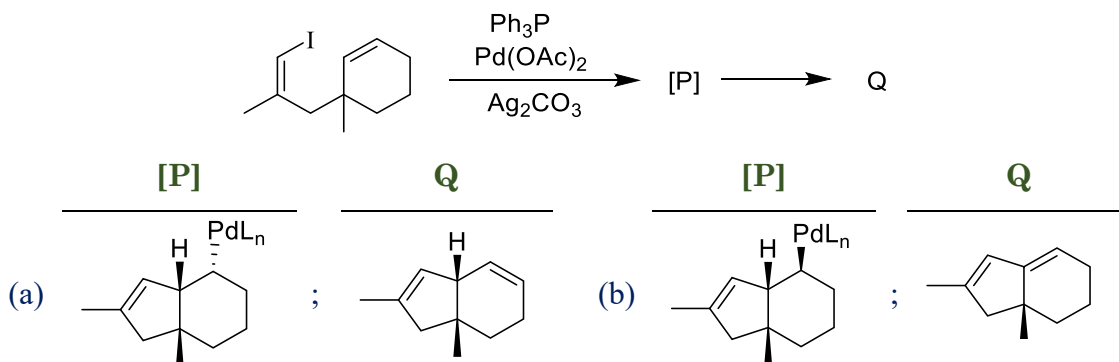
92. The major products formed in the following reaction is

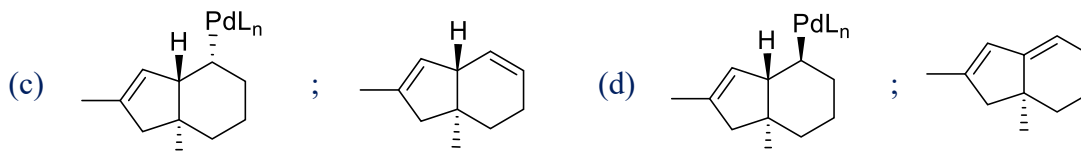


93. Following reaction involves

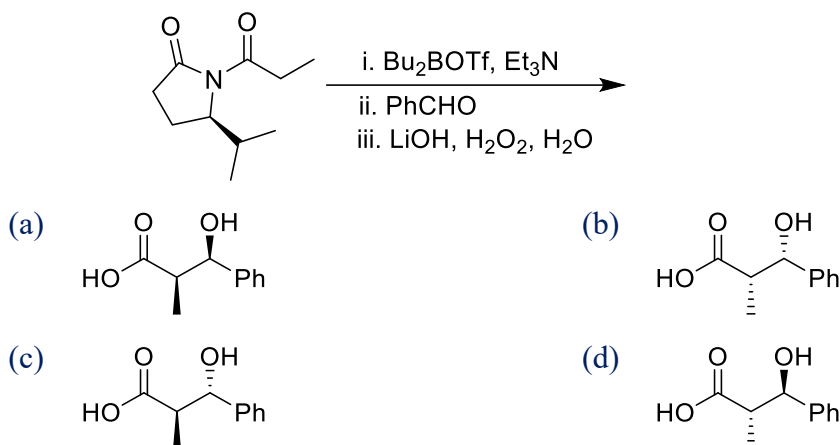


- (a) Claisen followed by Mannich reaction (b) aza-Cope followed by Mannich reaction
(c) Claisen followed by aza-aldol reaction (d) aza-Cope followed by aza-aldol reaction
94. The intermediate P and the major product Q formed in the following reaction is (here L = Ligand)

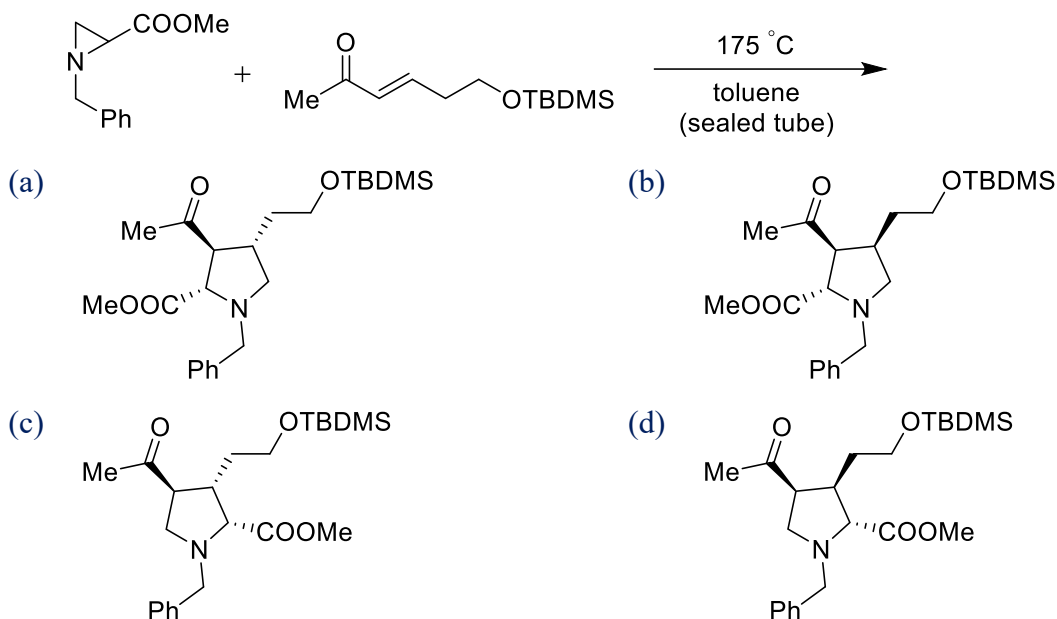




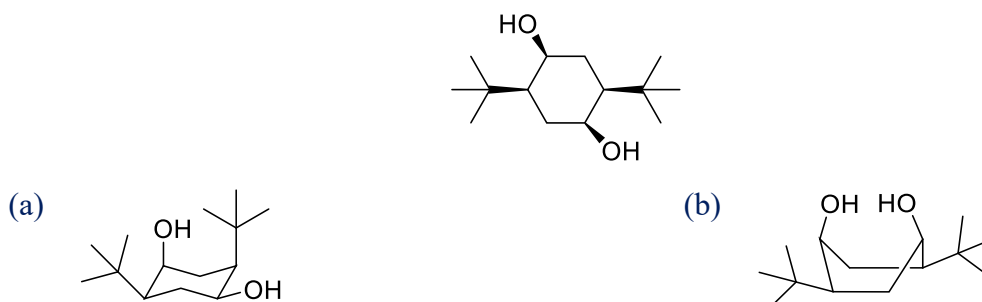
95. The major products formed in the following reaction is

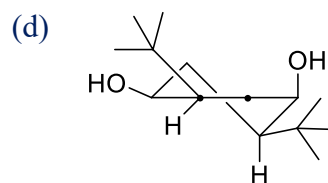
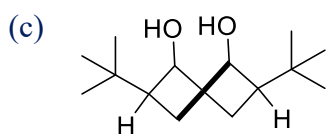


96. The major product formed in the following reaction is



97. The most stable conformation for the following compound is



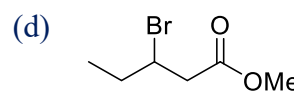
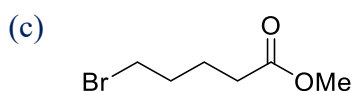
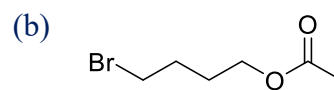
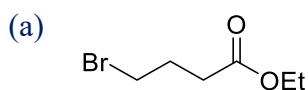


98. The correct structure of the compound based on the following characteristic spectral data is

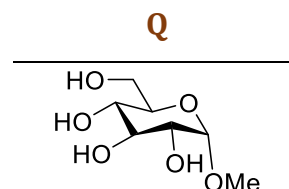
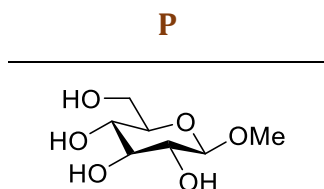
IR : 1736 cm^{-1}

$^1\text{H-NMR}$: δ 3.59 (s, 3H), 3.32 (t, 2H), 2.25 (t, 2H), 1.85 - 1.75 (m, 2H),
1.73 - 1.62 (m, 2H)

$^{13}\text{C-NMR}$: δ 174.0, 51.0, 32.9, 32.8, 31.0, 23.0



99. The major product formed in the reaction of **D-glucose** with **ZnCl₂** in **MeOH** is a methyl glucopyranoside (**P** or **Q**). The structure of this product and the molecular orbital interaction present between ring-oxygen and the anomeric **C-O** bond responsible for its stability, respectively, are

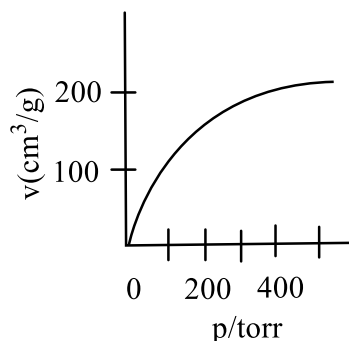


- (a) P and $n \rightarrow \sigma^*$ (b) P and $n \rightarrow \sigma$ (c) Q and $n \rightarrow \sigma^*$ (d) Q and $n \rightarrow \sigma$

100. Among the following correct statement for **nucleic acids** is

- (a) Uracil is present in DNA
(b) Uracil is present in RNA
(c) Phosphorylation in RNA is at 2' and 5' positions
(d) Normally three hydrogen bonds stabilize A-T base pair

101. The figure below depicts an **adsorption isotherm** of **O₂** on charcoal at **90 K**.



At a pressure **25 torr**, only **10 %** of charcoal sites are occupied by **O₂**. Therefore, the ratio of adsorption to desorption rate constants (in **torr⁻¹**) is close to

- (a) 0.003 (b) 0.004 (c) 0.006 (d) 0.015

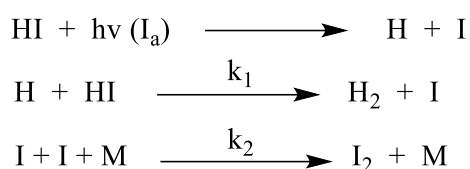
102. Polonium is the only metal known to exist in a simple cubic lattice form. The density of polonium at **0 °C** is measured to be **10.00 g/cm³**. The atomic radius of polonium would then be (assume the mass of a polonium atom = **2.7×10^{-22} g**)

- (a) 1.1 Å (b) 1.9 Å (c) 1.5 Å (d) 2.3 Å

103. The specific conductance of a solution is **$0.176 \Omega^{-1} \text{ cm}^{-1}$** . If the cell constant is **0.255 cm^{-1}** , the conductance (**Ω^{-1}**) of that solution is

- (a) 1.449 (b) 0.690 (c) 0.045 (d) 0.431

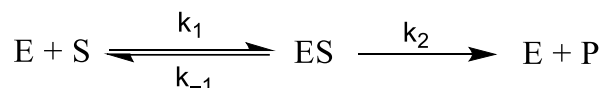
104. Photochemical decomposition of **HI** takes place with the following mechanism



Considering hydrogen(H) and iodine(I) atoms as intermediates, the rate of removal of **HI** is

- (a) $I_a/2$ (b) I_a (c) $2I_a$ (d) I_a^2

105. In an enzyme-catalysed reaction



$k_2 = 3.42 \times 10^4 \text{ s}^{-1}$. If **$[\text{E}]_0 = 1 \times 10^{-2} \text{ mol dm}^{-3}$** , the magnitude of maximum velocity and turn over number using Michaelis-Menten Kinetics are

- (a) $3.42 \times 10^2 \text{ mol dm}^{-3} \text{ s}^{-1}$; $3.42 \times 10^4 \text{ s}^{-1}$
 (b) $3.42 \times 10^6 \text{ mol dm}^{-3} \text{ s}^{-1}$; $3.42 \times 10^4 \text{ s}^{-1}$
 (c) $3.42 \times 10^4 \text{ mol dm}^{-3} \text{ s}^{-1}$; $3.42 \times 10^6 \text{ s}^{-1}$



- (d) $3.42 \times 10^4 \text{ mol dm}^{-3} \text{ s}^{-1}$; $3.42 \times 10^2 \text{ s}^{-1}$
106. Arrhenius equations for two chemical reactions are: $k_1 = A_1 e^{-E_1/RT}$, $k_2 = A_2 e^{-E_2/RT}$. If $E_1 > E_2$, then at a given temperature T,
- (a) $\frac{k_1}{k_2} < \frac{A_1}{A_2}$ (b) $\frac{k_2}{k_1} < \frac{A_2}{A_1}$ (c) $k_1 k_2 > A_1 A_2$ (d) $k_1 + k_2 > A_1 + A_2$
107. The fugacity of a real gas is less than the pressure(P) of an ideal gas at the same temperature (T) only when (T_b is the Boyle temperature of the real gas)
- (a) high P, $T < T_b$ (b) low, P, $T < T_b$ (c) high P, $T > T_b$ (d) low P, $T > T_b$
108. For the reaction $\text{H}_2\text{O}_{(g)} \rightleftharpoons \text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)}$, the equilibrium constant K_p depends on the degree of dissociation α ($\alpha \ll 1$) and total pressure P as
- (a) $K_p \propto \alpha^2 P$ (b) $K_p \propto \alpha^{3/2} P^{1/2}$ (c) $K_p \propto \alpha^{1/2} P^{3/2}$ (d) $K_p \propto \alpha P^2$
109. The minimum work required by an engine to transfer 5 J of heat from a reservoir at 100 K to one at 300 K is
- (a) 5 J (b) 10 J (c) 15 J (d) 20 J
110. The correct relation involving symmetry operations
- (a) $S_4^2 = S_2$ (b) $\sigma_{(xz)}\sigma_{(yz)} = C_{2(x)}$ (c) $S_4^3 = C_4^3$ (d) $S_6^3 = S_2$
111. A polydisperse polymer sample has ten molecules of molar mass $20,000 \text{ g mol}^{-1}$ and fifteen molecules of molar mass $10,000 \text{ g mol}^{-1}$. The number-average molar mass (g mol^{-1}) ($\bar{M}_n$) of the sample is
- (a) 13,000 (b) 14,000 (c) 15,000 (d) 16,000
112. Consider a system of three particles which can occupy energy levels with energy $0, \epsilon$ and 2ϵ such that the total energy (E) = 4ϵ . Cases P, Q and R correspond to spin $\frac{1}{2}$ fermions, spin 0 bosons, and classically distinguishable particles, respectively. The correct ordering of entropy is
- (a) $S_P > S_Q > S_R$ (b) $S_Q > S_P > S_R$ (c) $S_R > S_Q > S_P$ (d) $S_R > S_P > S_Q$
113. For a point group, an incomplete character table is given below with one irreducible representation missing

	E	$2C_3$	$3\sigma_v$
A_1	1	1	1
-	-	-	-
E	2	-1	0

The Mulliken symbol and characters of the missing representation are



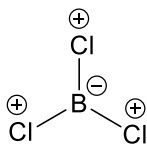
(a) $A'_1 \quad 1 \quad -1 \quad 1$

(b) $B_1 \quad 1 \quad -1 \quad -1$

(b) $A_2 \quad 1 \quad 1 \quad -1$

(d) $B_2 \quad 1 \quad -1 \quad 1$

114. Given below is a specific vibrational mode of BCl_3 with $\oplus$ and $\ominus$ denoting movements of the respective atoms above and below the plane of the molecule respectively. The irreducible representation of the vibrational mode and its IR/Raman activity are

	D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$		
	A_1	1	1	1	1	1	1		$x^2 + y^2, z^2$
	A_2	1	1	-1	1	1	-1	R_z	
	E'	2	-1	0	2	-1	0	(x, y)	$(x^2 - y^2, xy)$
	A_1''	1	1	1	-1	-1	-1		
	A_2''	1	1	-1	-1	-1	1	z	
	E''	2	-1	0	-2	1	0	(R_x, R_y)	(xz, yz)

(a) A'_2 ; neither IR nor Raman active(b) E' ; both IR and Raman active(c) A'_1 ; Raman active(d) A''_2 ; IR active

115. The first excited state ($^2P_{1/2}$) of fluorine lies at an energy of 400 cm^{-1} above the ground state ($^2P_{3/2}$). The fraction of Fluorine atoms in the first excited state at $k_B T = 420 \text{ cm}^{-1}$ is close to

(a) $\frac{1}{1+e}$

(b) $\frac{1}{2+e}$

(c) $\frac{1}{1+4e}$

(d) $\frac{1}{1+2e}$

116. The two limiting wavefunctions of the ground state of H_2^+ molecular ion, as the internuclear separation R goes to (i) ∞ (infinity) and (ii) 0 (zero) are ($1s_a$, $1s_b$ are $1s$ -orbital wave functions of hydrogen atoms a and b in H_2^+ and $1s_{\text{He}}$ is the wave function of the $1s$ orbital of He^+)

(a) (i) $1s_a(r)$;

(b) (i) $1s_b(r)$;

(ii) $1s_b(r)$

(ii) $1s_a(r)$

(c) (i) $1s_a(r_1) 1s_b(r_2)$;

(d) (i) $1s_a(r) + 1s_b(r)$;

(ii) $1s_{\text{He}}(r_1) 1s_{\text{He}}(r_2)$

(ii) $1s_{\text{He}}(r)$

117. For a certain magnetic field strength, a free proton spin transition occurs at **700 MHz**. Keeping the magnetic field strength constant, the ^{14}N nucleus will resonate at

$(g(p) \approx 5.6 \text{ and } g(^{14}\text{N}) \approx 0.4)$

(a) 700 MHz

(b) 400 MHz

(c) 200 MHz

(d) 50 MHz

118. The first electronic absorption band maximum of a polar and relatively rigid aromatic molecule appears at **310 nm** but its fluorescence maximum in acetonitrile solution appears with a large Stokes shift at **450 nm**. The most likely reason for the Stokes shift is
- (a) large change in molecular geometry in the excited state
 (b) increase in dipole moment of the molecule in the excited state
 (c) decrease in polarizability of the molecule in the excited state
 (d) lowered interaction of the excited molecule with polar solvent
119. The un-normalized radial wave function of a certain hydrogen atom eigenstate is $(6r - r^2)\exp(-r/3)$. A possible angular part of the eigenstate is
- (a) $5\cos^3\theta - 3\cos\theta$ (b) $3\cos^2\theta - 1$ (c) $\cos\theta$ (d) 1
120. Given a trial wave function $\psi_t = C_1\phi_1 + C_2\phi_2$, and the Hamiltonian matrix elements, $\int \phi_1^* H \phi_1 dv = 0$, $\int \phi_1^* H \phi_2 dv = 2.5$, $\int \phi_2^* H \phi_2 dv = 12.0$ the variationally determined ground state energy is
- (a) -0.52 (b) -0.50 (c) 12.50 (d) 12.52

Answer Key

PART - B

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

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

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

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

PART - C



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

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

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

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

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