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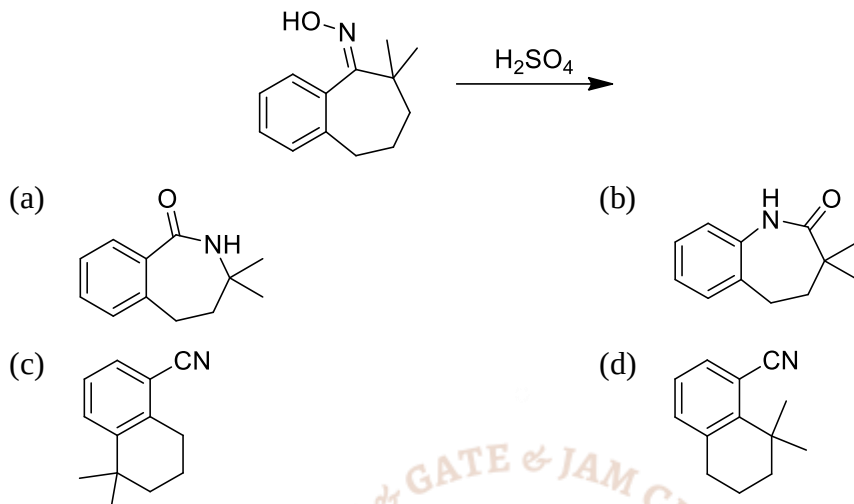
Features

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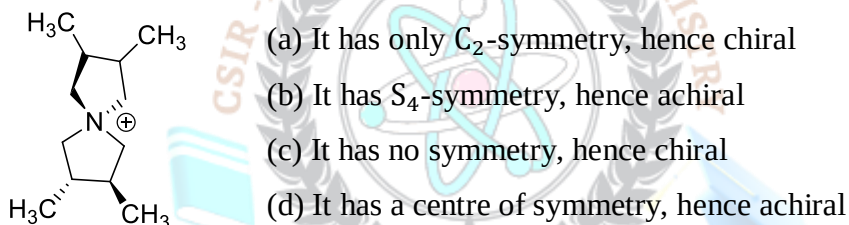


Q.1 – Q.25 carry ONE mark each (for each wrong answer: – 1/3 for MCQ).

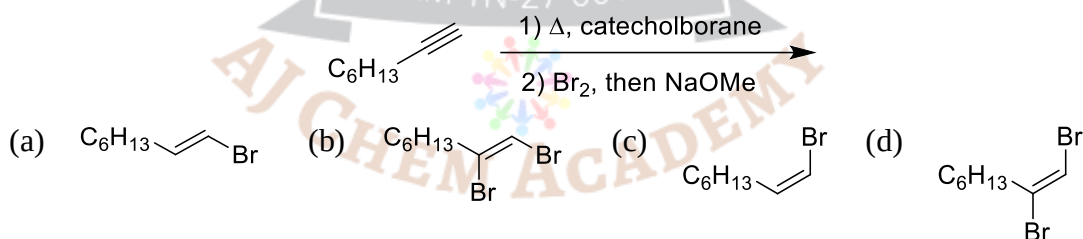
1. The **major product** formed in the following reaction is



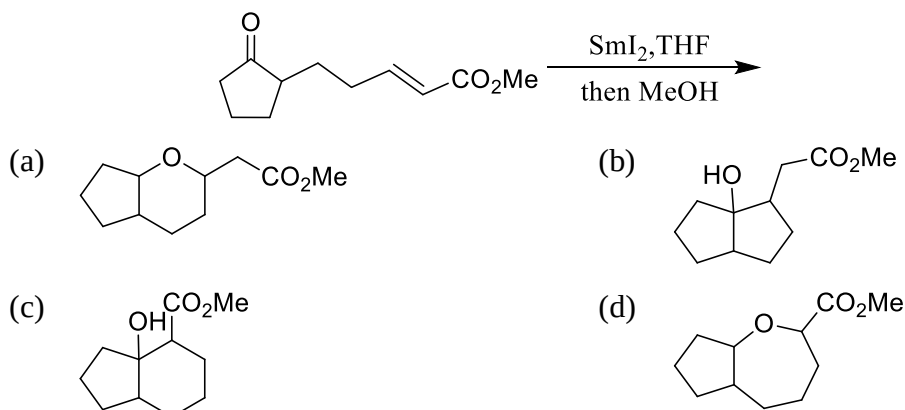
2. The **correct statement** about the following **quaternary ammonium ion** is



3. The **major product** formed in the following reaction sequence is



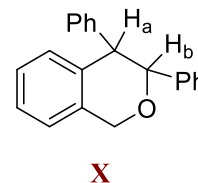
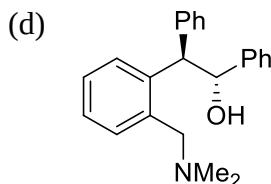
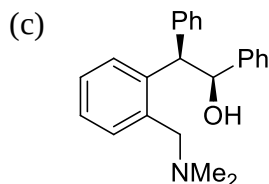
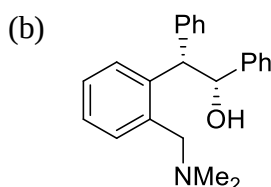
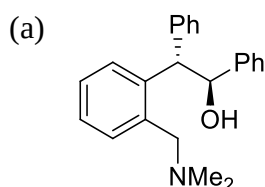
4. The **major product** formed in the following reaction is



5. The species that undergoes **β -elimination** is

- (a) $[\text{Rh}(\text{C}_5\text{H}_5)(\text{P}(\text{CH}_3)_3)(\text{C}_2\text{H}_5)]^+$ (b) $[\text{Rh}(\text{NH}_3)_5(\text{C}_2\text{H}_5)]^{2+}$
 (c) $[\text{Pt}(\text{P}(\text{C}_6\text{H}_5)_3)_2(\text{C}_6\text{H}_5)\text{I}]$ (d) $[\text{Cr}(\text{CH}_2\text{Si}(\text{CH}_3)_3)_4]$
6. According to **molecular orbital theory**, the correct ground state electronic configuration for $[\text{Co}(\text{NH}_3)_6]^{3+}$ ion is
 (a) $a_{1g}^2 t_{1u}^6 e_g^4 t_{2g}^6 e_g^{*0}$ (b) $a_{1g}^2 t_{1u}^6 t_{2g}^4 e_g^{*0}$ (c) $t_{1u}^6 a_{1g}^2 e_g^4 t_{2g}^6 e_g^{*0}$ (d) $a_{1g}^2 t_{1u}^6 e_g^4 t_{2g}^4 e_g^{*2}$
7. The species which follows **18-electron rule** is
 (a) $[\text{Rh}(\text{PPh}_3)_3\text{Cl}]$ (b) $[\text{Co}(\text{NH}_3)_6]^{2+}$ (c) $[\text{V}(\text{CO})_6]^-$ (d) $[\text{Ni}(\text{en})_3]^{2+}$
8. The **point group** of $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ is
 (a) D_{2h} (b) C_{2h} (c) C_{2v} (d) D_{2d}
9. Among the following, the one for which the **infrared active vibrational modes** are **Raman inactive and vice versa** is
 (a) H_2O (b) trans-planar conformer of H_2O_2 (c) eclipsed conformer of ethane (d) CH_4
10. For the following reaction, $\text{A} + \text{B} \rightleftharpoons \text{X}^\ddagger \rightarrow \text{Product}$
 If the value of $\Delta^\ddagger U^\circ = \frac{5}{2}RT$, then the value of $\Delta^\ddagger H^\circ$ is
($\text{X}^\ddagger$ is an activated complex; $\Delta^\ddagger U^\circ$ is standard change in internal energy; $\Delta^\ddagger H^\circ$ is standard enthalpy of activation; R is gas constant; T is temperature)
 (a) $\frac{1}{2}RT$ (b) $\frac{3}{2}RT$ (c) $\frac{7}{2}RT$ (d) $\frac{5}{2}RT$
11. The **reagent(s)** that will effect the following transformation is(are)

MEM = methoxyethoxymethyl
 (a) $\text{Pd/C}, \text{H}_2$
 (b) ZnBr_2
 (c) $\text{PPTS}, ^t\text{BuOH}$
 (d) $^n\text{Bu}_4\text{NF}$
12. The reaction(s) that give(s) **meso-1,2-diphenylethane-1,2-diol** as the major product is(are)
 (a) $\text{Ph}-\text{CH}=\text{CH}-\text{Ph} \xrightarrow[\text{H}_2\text{O}, ^t\text{BuOH}]{\text{OsO}_4, \text{NMO}}$
 (b) $\text{Ph}-\text{CH}=\text{CH}-\text{Ph} \xrightarrow[\text{H}_2\text{O}, ^t\text{BuOH}]{\text{OsO}_4, \text{NMO}}$
 (c) $\text{Ph}-\text{CH}=\text{CH}-\text{Ph} \xrightarrow[2) \text{NaOH}, \text{H}_2\text{O}]{1) \text{I}_2, \text{AgOAc} (2 \text{ equiv})}$
 (d) $\text{Ph}-\text{CH}=\text{CH}-\text{Ph} \xrightarrow[2) \text{NaOH}, \text{H}_2\text{O}]{1) \text{I}_2, \text{AgOAc} (2 \text{ equiv})}$
13. In the $^1\text{H-NMR}$ spectrum of compound X, the **coupling constant** (J_{ab}) between H_a and H_b is 3 Hz. The amino alcohol(s) that give(s) X on reaction with methyl iodide followed by heating is(are)



14. The correct statement(s) regarding **plastocyanin** is(are)

- (a) It is an electron transfer protein
- (b) It is intensely colored in its oxidised form
- (c) Its central metal ion has a distorted tetrahedral geometry
- (d) It contains S^{2-} bridged metal cluster

15. The correct statement(s) about **Mössbauer spectroscopy of iron compounds** is(are)

- (a) ^{57}Co is used as a source
- (b) Their Mössbauer spectra are obtained using γ -ray with resonance energy of 14.4 keV
- (c) $\text{K}_2[\text{Fe}(\text{CN})_5\text{NO}]$ shows large quadrupole splitting
- (d) Isomer shift of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ is smaller than that of $\text{K}_3[\text{Fe}(\text{CN})_6]$

16. The interconversion of oxidation states of metal(s) observed in **Wacker process** is(are)

- (a) $\text{Pd(II)}/\text{Pd(0)}$
- (b) $\text{Cu(II)}/\text{Cu(I)}$
- (c) $\text{Pd(IV)}/\text{Pd(II)}$
- (d) $\text{Cu(II)}/\text{Cu(0)}$

17. For the wavefunction $\Phi = x(a - x)$, where a is a constant, the correct statement(s) For the wavefunction is(are)

- (a) It represents a stationary state
- (b) It is an odd function
- (c) It represents the wavefunction of a particle moving on a circular ring of radius a
- (d) It is an eigen function of the momentum operator

18. The correct statement(s) about **spherical harmonics (Y_l^m)** is(are)

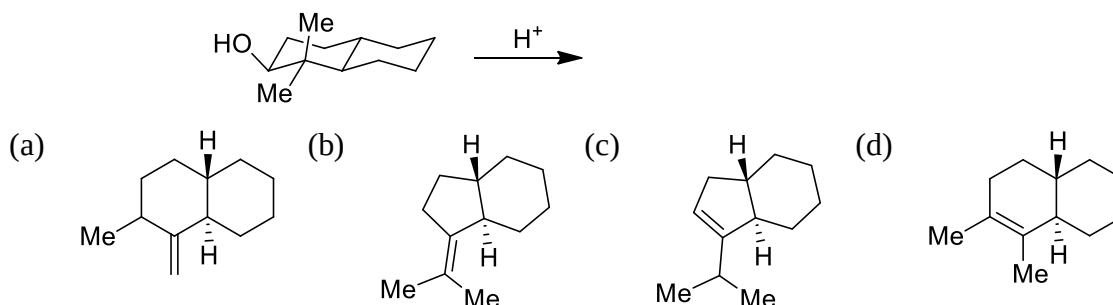
- (a) All spherical harmonics are complex functions
- (b) They are eigen functions of $\hat{L}^2$
- (c) They are eigen functions of $\hat{L}_z$
- (d) The spherical harmonics Y_1^1 and Y_1^{-1} are degenerate

19. The difference in the number of **gauche interactions** present in **diaxial** and

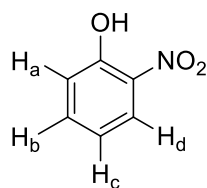
- diequatorial chair conformations of **trans-1,2-dimethylcyclohexane** is _____ (in integer).
20. The total number of symmetry operations (order, h) present in the point group of $[\text{PdCl}_6]^{2-}$ is x and that in **trans- $[\text{PdBr}_2\text{Cl}_4]^{2-}$** is y. The value of **x - y** is _____ (in integer).
21. A **0.005 M** solution of compound X transmits **80 %** of the incident light of wavelength (λ) **500 nm**. The absorbance of **0.01 M** solution of X is _____ (rounded off to three decimal places). (Given: path length = 1.0 cm)
22. The microwave spectrum of gaseous **HF** consists of a series of lines separated by **41.11 cm^{-1}** . The bond length (in $\text{\AA}$) of HF is _____ (rounded off to two decimal places). (Given: Atomic mass (in amu): H = 1.008, F = 18.998; 1 amu = 1.661×10^{-27} kg; $h = 6.626 \times 10^{-34}$ Js; $c = 2.998 \times 10^8$ m s^{-1})
23. In a ^1H -NMR spectrum obtained from a spectrometer operating at a magnetic field of **14.1 T**, two resonances are observed at **1.25 ppm** and **5.75 ppm**. The separation between the two resonances (in Hz) is _____ (rounded off to one decimal place). (Given: gyromagnetic ratio (γ) of H = $2.675 \times 10^8 \text{T}^{-1}\text{s}^{-1}$)
24. The maximum work ($|W_{\text{max}}|$, in kJ) that can be obtained by complete combustion of **1.0 mol of CH_4** at constant pressure and **25 $^\circ\text{C}$** is _____ (rounded off to one decimal place). (Given: $\Delta S = -241.60 \text{ J K}^{-1} \text{ mol}^{-1}$; $\Delta H = -890.01 \text{ kJ mol}^{-1}$; $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$)
25. If the ionic mobility of Ag^+ ion in a very dilute aqueous solution of **AgNO_3** at **298 K** is $y \times 10^{-8} \text{ m}^2 \text{V}^{-1} \text{s}^{-1}$, then the value of y is _____ (rounded off to two decimal places). (viscosity of water at 298 K = $8.94 \times 10^{-4} \text{ kg m}^{-1} \text{s}^{-1}$; $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$; $F = 96500 \text{ C mol}^{-1}$; $R = 8.314 \text{ J mol}^{-1} \text{K}^{-1}$; Stokes radius of $\text{Ag}^+ = 0.15 \text{ nm}$)

Q.26 – Q.55 carry TWO marks each (for each wrong answer: – 2/3 for MCQ).

26. The major product formed in the following reaction is



27. The correct match for the protons labeled in compound X in **Column M** with the corresponding chemical shifts (δ , ppm) in **Column N** is

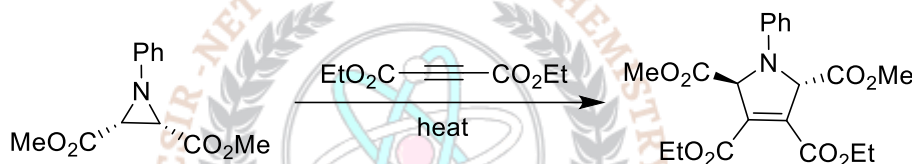


	Column M	Column N
P.	H _a	I. 7.00 (ddd, J = 8.4, 7.3, 1.4 Hz, 1H)
Q.	H _b	II. 7.17 (dd, J = 8.4, 1.4 Hz, 1H)
R.	H _c	III. 7.59 (ddd, J = 8.4, 7.3, 1.4 Hz, 1H)
S.	H _d	IV. 8.12 (dd, J = 8.4, 1.4 Hz, 1H)

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

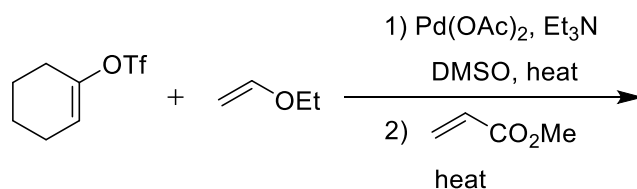
P	Q	R	S
(b) I ; IV ; II ; III			
(d) I ; III ; II ; IV			

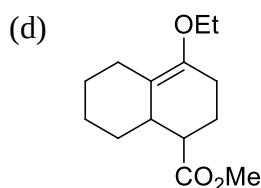
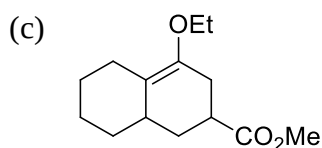
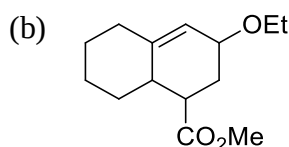
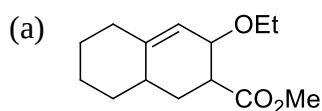
28. The correct statement about the **intermediate** formed in the following reaction is



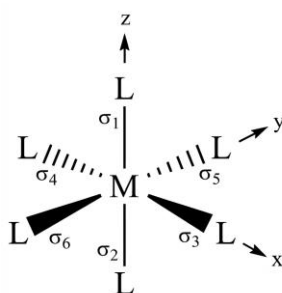
- (a) ; formed through conrotatory opening of X
- (b) ; formed through disrotatory opening of X
- (c) ; formed through conrotatory opening of X
- (d) ; formed through disrotatory opening of X

29. The **major product** formed in the following reaction sequence is





30. Consider the figure given below, where M is a metal and L is a monodentate ligand. The σ -bonding ligand group orbital (LGO) having same symmetry with The d_{z^2} orbital of M in the octahedral coordination geometry is



- (a) $1/\sqrt{12}(2\sigma_1 + \sigma_2 - \sigma_3 - \sigma_4 - \sigma_5 - \sigma_6)$
 (b) $1/\sqrt{12}(2\sigma_1 - \sigma_2 + \sigma_3 - \sigma_4 + \sigma_5 - \sigma_6)$
 (c) $1/\sqrt{6}(\sigma_1 + \sigma_2 - \sigma_3 - \sigma_4 - \sigma_5 - \sigma_6)$
 (d) $1/\sqrt{6}(\sigma_1 + \sigma_2 + \sigma_3 + \sigma_4 + \sigma_5 + \sigma_6)$

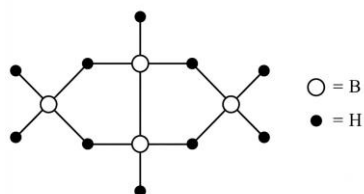
31. The correct electronic configuration of central metal ion in ferrocene with z-axis passing through the centre of two $C_5H_5^-$ rings and the metal ion is

- (a) $d_{xy}^2 = d_{x^2-y^2}^2 < d_{z^2}^2 < d_{xz}^0 = d_{yz}^0$ (b) $d_{xz}^2 = d_{yz}^2 < d_{z^2}^2 < d_{x^2-y^2}^0 = d_{xy}^0$
 (c) $d_{xy}^2 = d_{xz}^2 = d_{yz}^2 < d_{x^2-y^2}^0 = d_{z^2}^0$ (d) $d_{xy}^2 < d_{xz}^2 = d_{yz}^2 < d_{x^2-y^2}^0 < d_{z^2}^0$

32. The pair of complex ions that exhibits the slowest outer-sphere electron-exchange reaction at 25 °C is

- (a) $[Co(NH_3)_6]^{3+}$ and $[Co(NH_3)_6]^{2+}$ (b) $[Fe(H_2O)_6]^{3+}$ and $[Fe(H_2O)_6]^{2+}$
 (c) $[Ru(NH_3)_6]^{3+}$ and $[Ru(NH_3)_6]^{2+}$ (d) $[Mn(CN)_6]^{3-}$ and $[Mn(CN)_6]^{4-}$

33. The structure of B_4H_{10} is given below. Its styx number is

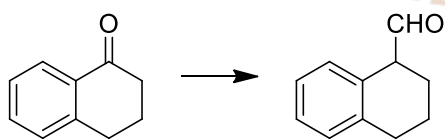


- (a) 4012 (b) 4102
 (c) 2104 (d) 2014

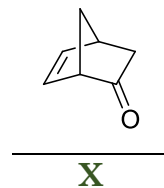
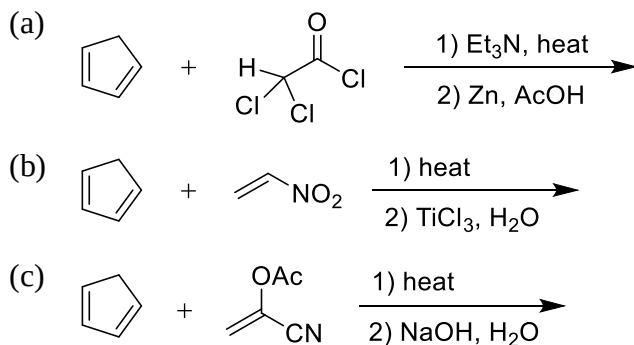
34. For the following reaction, $2Pb_3O_{4(s)} \rightleftharpoons 6PbO_{(s)} + O_{2(g)}$. The correct option showing the number of phases (P), number of components (C) and degrees of freedom (F) is

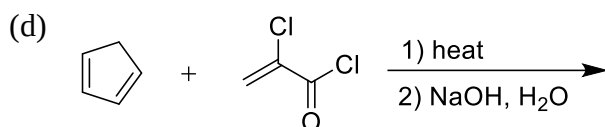
- (a) $P = 3, C = 2, F = 1$ (b) $P = 3, C = 3, F = 2$

- (c) $P = 2, C = 3, F = 3$ (d) $P = 2, C = 2, F = 2$
35. The correct option for the **average value of kinetic energy** and the **average value of potential energy** of a **one-dimensional harmonic oscillator** with **frequency ν** in its **ground state** is
- (a) $\frac{h\nu}{2}$ and $\frac{h\nu}{4}$ respectively (b) $\frac{h\nu}{2}$ and $\frac{h\nu}{2}$ respectively
 (c) $\frac{h\nu}{4}$ and $\frac{h\nu}{4}$ respectively (d) $\frac{h\nu}{4}$ and $\frac{h\nu}{2}$ respectively
36. For a reaction between neutral molecules X and Y in a solution at temperature T, the measured rate of reaction is equal to the rate of diffusion. Assume X is stationary and Y is moving. If the diameter of the molecule X is five times that of Y, then the rate constant for the reaction is (η is viscosity of the solvent; k is Boltzmann constant)
- (a) $8kT/3\eta$ (b) $4kT/\eta$ (c) $24kT/5\eta$ (d) $15kT/4\eta$
37. For the following electrochemical cells, liquid junction potentials affect the cell potential (E_{cell}).
- I. Electrode-1 | 0.1 M KCl | 0.1 M NaCl | Electrode-2**
II. Electrode-1 | 0.1 M HCl | 0.01 M HCl | Electrode-2
III. Electrode-1 | 0.01 M KCl | 0.01 M HCl | Electrode-2
- The correct order of their E_{cell} at 25°C is
- (a) $\text{I} > \text{II} > \text{III}$ (b) $\text{II} > \text{I} > \text{III}$ (c) $\text{III} = \text{I} > \text{II}$ (d) $\text{II} > \text{I} = \text{III}$
38. The set(s) of **reagents** that will effect the following conversion is(are)
- (a) (i) $\text{Ph}_3\text{P}=\text{CHOMe}$; (ii) H_3O^+
 (b) (i) TsNHNH_2 ; (ii) $^n\text{BuLi}$ (2 equiv) then DMF
 (c) (i) 1,3-dithane, $^n\text{BuLi}$; (ii) HgSO_4 , dil. H_2SO_4
 (d) (i) Me_3SiI , NaH ; (ii) $\text{BF}_3 \cdot \text{OEt}_2$

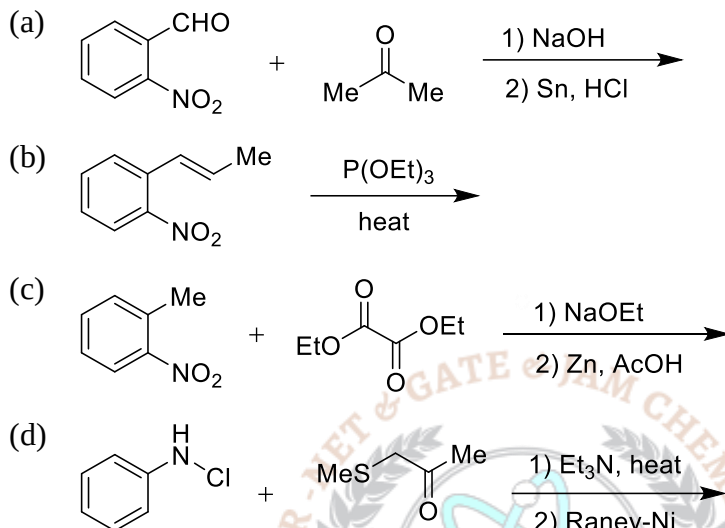


39. The reaction(s) that produce(s) the given compound-X is(are)





40. The reaction(s) that produce(s) **2-methylindole** as the major product is(are)



41. Chymotrypsin selectively cleaves a peptide at the carboxyl side of the amino acids having an aryl sidechain. The tripeptide(s) formed on hydrolysis of the peptide, **Val-Phe-Leu-Met-Tyr-Pro-Gly-Trp-Cys**, with chymotrypsin is(are)

- (a) Leu-Met-Tyr (b) Phe-Leu-Met (c) Pro-Gly-Trp (d) Tyr-Pro-Gly

42. Consider the given pairs of complex ions. The correct pair(s) in which each complex ion exhibits **three spin-allowed d-d transitions** is(are)

(excluding those arising due to distortions)

- (a) $[V(H_2O)_6]^{3+}$ and $[Ni(H_2O)_6]^{2+}$ (b) $[Cr(H_2O)_6]^{3+}$ and $[NiCl_4]^{2-}$
 (c) $[Ti(H_2O)_6]^{3+}$ and $[Mn(H_2O)_6]^{2+}$ (d) $[FeF_6]^{3-}$ and $[FeCl_4]^{2-}$

43. The correct statement(s) about the **structure of metal oxides** is(are)

- (a) Spinel has 8 tetrahedral sites and 4 octahedral sites per formula unit
 (b) $BaTiO_3$ has a perovskite structure
 (c) In Fe_3O_4 , Fe^{2+} occupies both tetrahedral and octahedral sites in the unit cell
 (d) $\gamma-Al_2O_3$ is a defect spinel

44. The pair(s) of lanthanide ions whose **ground state term symbols** have same spin multiplicity (**$2S + 1$**) and **orbital angular momentum(L)**, but different **spin-orbit coupling (J)** is(are)

- (a) Pm^{3+} and Ho^{3+} (b) Nd^{3+} and Er^{3+} (c) Pm^{3+} and Nd^{3+} (d) Ho^{3+} and Er^{3+}

45. The correct statement(s) about **enterobactin (ent)** is(are)

- (a) It has three catechol moieties
 (b) It has a serine-trilactone backbone
 (c) It binds with Fe^{3+} ion to form $[\text{Fe}(\text{ent})]^{3-}$ ion
 (d) It has three hydroxamic acid groups
46. The correct statement(s) for a surface catalyzed unimolecular gaseous reaction is(are)
 (a) It follows Freundlich adsorption isotherm
 (b) Zero order kinetics is followed at sufficiently high pressure of the reacting molecules
 (c) First order kinetics is followed at very low pressure of the reacting molecules
 (d) Rate of the reaction is proportional to the fraction of surface covered by the reacting molecules
47. Consider the following reaction sequence, where **P** and **Q** are the major products. In proton-decoupled ^{13}C -NMR spectra, the total number of carbon signals observed for **P** and **Q** is _____ (in integer).
-
48. On heating, the compound **Z** undergoes a series of 1,5-H/D shifts to give a mixture of its isomers. The total number of isomers present in the mixture (including **Z**) is _____ (in integer).
-
49. The sum of bond orders of metal-metal bonds in $[\text{Os}_2\text{Cl}_8]^{2-}$, $[\text{Re}_2\text{Cl}_8]^{2-}$, $[\text{W}_2(\text{NMe}_2)_6]$ and $[\text{Mo}(\text{C}_5\text{H}_5)(\text{CO})_2]_2$ _____ (in integer).
50. The sum of the number of α -particles and β -particles emitted in the nuclear decay process, $^{238}_{92}\text{U} \rightarrow ^{206}_{82}\text{Pb}$ is _____ (in integer).
51. The positions of two atoms in spherical polar coordinates (r, θ, ϕ) are $(1, \pi/2, \pi/2)$ and $(1, \pi/4, 3\pi/2)$, where the distance is in Å and the angles are in radian. The interatomic distance (in Å) is _____ (rounded off to two decimal places).
52. If the translational partition function for confined for H_2 in a 1 L vessel at 300 K is

$y \times 10^{27}$, then the value of y is _____ (rounded off to one decimal place).

(Given: Atomic mass (in amu): $H = 1.008$; $1 \text{ amu} = 1.661 \times 10^{-27} \text{ kg}$; $h = 6.626 \times 10^{-34} \text{ J s}$; $k = 1.381 \times 10^{-23} \text{ J K}^{-1}$)

53. In a calibrated pH meter comprising of glass electrode-standard calomel electrode, the potential for a buffer solution of pH 4.01 is measured as 0.814 V at 25 °C. For a $4.0 \times 10^{-3} \text{ M}$ solution of acetic acid, the measured potential (in V) is _____ (rounded off to three decimal places).

(K_a of acetic acid at 25°C = 1.75×10^{-5} ; $2.303 \frac{RT}{F} = 0.059$; Assume: $a_{H^+} = [H^+]$)

54. The Brunauer-Emmett-Teller (BET) surface area measurement data for adsorption of N_2 gas at 77 K on 1.0 g of an adsorbent fits into a straight line, when $\frac{z}{(1-z)V}$ is plotted against z . The slope and intercept of the straight line are $6 \times 10^{-4} \text{ mm}^{-3}$ and $4 \times 10^{-6} \text{ mm}^{-3}$, respectively. The surface area (in $\text{m}^2 \text{ g}^{-1}$) of the adsorbent is _____ (rounded off to one decimal place).

(Given: 1 mm^3 of N_2 gas corresponds to 2.7×10^{16} molecules and each molecule occupies 0.16 nm^2 . V is the volume of gas adsorbed in mm^3 , z is p/p_0 , where p is the pressure of the N_2 gas and p_0 is equilibrium vapour pressure of liquid N_2)

55. The orbital angular momentum (L) of an electron is $\sqrt{12}\hbar$. The minimum angle between L and its z -component (in degrees) is _____ (rounded off to one decimal place).

Answer Key

Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans
1.	c	16.	a,b	31.	a	46.	b,c,d
2.	b	17.	a	32.	a	47.	16 to 16
3.	c	18.	b,c,d	33.	a	48.	9 to 9
4.	b	19.	3 to 3	34.	a	49.	13 to 13
5.	a	20.	32 to 32	35.	c	50.	14 to 14
6.	a	21.	0.193 to 0.195	36.	c	51.	1.84 to 1.86
7.	c	22.	0.92 to 0.94	37.	b	52.	2.7 to 2.9
8.	d	23.	2699.0 to 2703.0	38.	a,d	53.	0.836 to 0.842

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9.	b
10.	b
11.	b,c
12.	a,d
13.	b,c
14.	a,b,c
15.	a,b,c

24.	812.8 to 813.2
25.	6.30 to 6.40
26.	b
27.	a
28.	a
29.	d
30.	a

39.	b,c
40.	b,d
41.	a,c
42.	a,b
43.	a,b,d
44.	a,b
45.	a,b,c

54.	7.1 to 7.3
55.	29.9 to 30.1

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