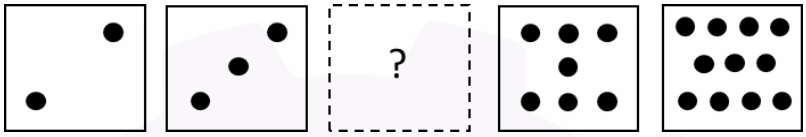
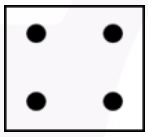
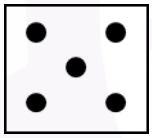
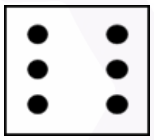
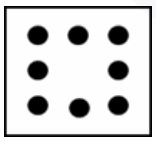
General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	"He often _____ the numbers. False claims are not going to help. Honesty _____ trust", said the manager. Choose the option with the correct order of words to fill the blanks.
(A)	exaggerates; engenders
(B)	excels; encourages
(C)	aggravates; alleviates
(D)	diminishes; eliminates

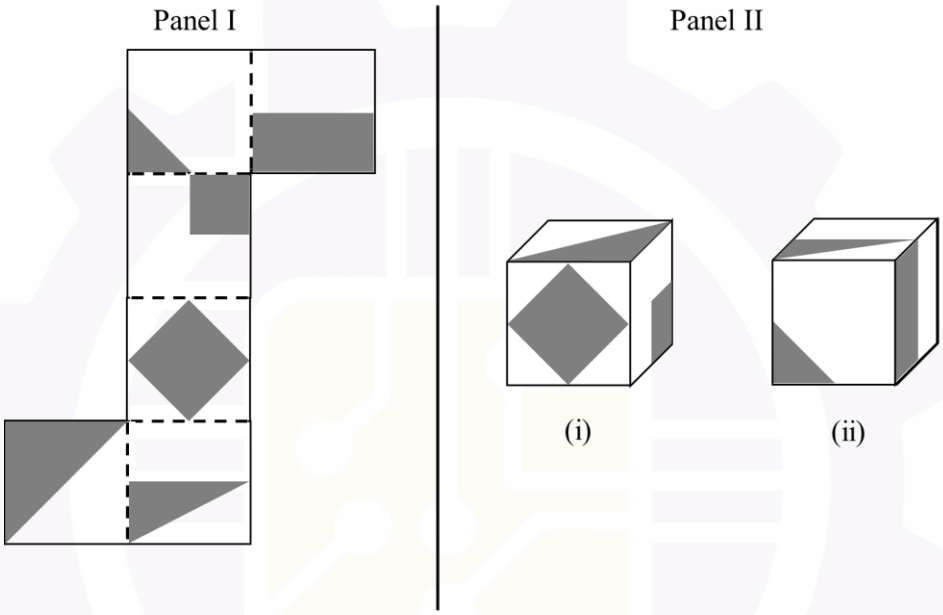
Q.2	In the sequence of tiles shown below, the missing tile indicated by the question mark should be 
(A)	
(B)	
(C)	
(D)	

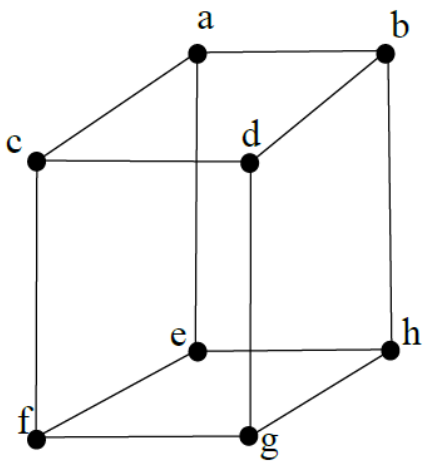
Q.3	A school has 100 students distributed among 1^{st} to 10^{th} standards. Based on this, which one of the following statements is always correct?
(A)	There are at least 10 students who belong to the same standard.
(B)	There is at least one student in each standard.
(C)	There are at most 10 students in 10^{th} standard.
(D)	The total number of students from 1^{st} to 5^{th} standards is at least 50.
Q.4	How many 3-digit numbers can be formed using three distinct single digit prime numbers?
(A)	64
(B)	24
(C)	12
(D)	4

Q.5	In a group of students, 10 students like Mathematics, 12 students like English, 4 students like both Mathematics and English, and 6 students like neither Mathematics nor English. The number of students in the group is ____
(A)	18
(B)	20
(C)	24
(D)	32

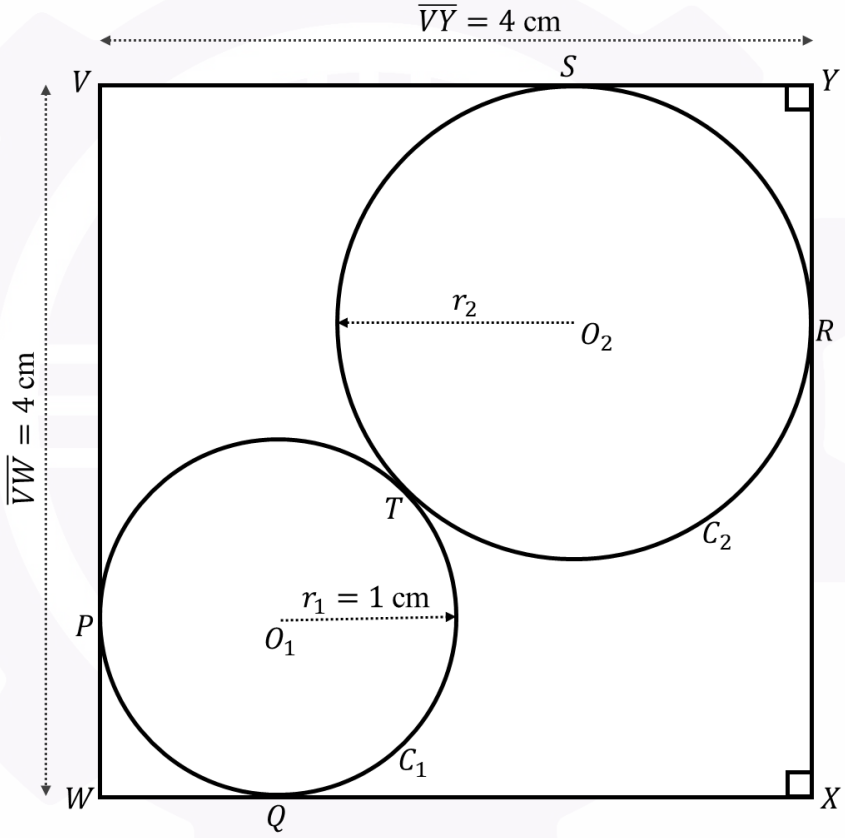
Q.6 – Q.10 Carry TWO marks Each

Q.6	Charity : P :: Retaliation : Q Choose the appropriate pair of words P and Q that fit the analogy.
(A)	P = Parsimonious; Q = Vengeful
(B)	P = Altruistic; Q = Amicable
(C)	P = Resentful; Q = Spiteful
(D)	P = Magnanimous; Q = Vindictive

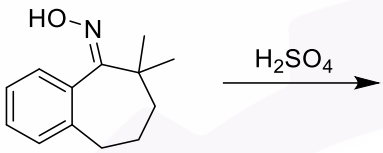
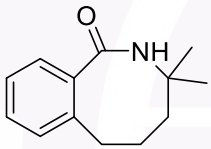
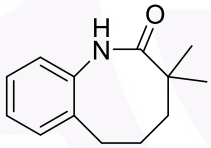
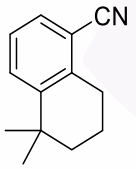
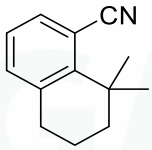
Q.7	A paper shown in Panel I is folded along the dashed lines (- - -) to construct a cube. The shaded regions shown in Panel I appear on the outer surface of the cube. Referring to cubes shown in Panel II, which one of the options is correct? 
(A)	Only (i) can correspond to the unfolded cube in Panel I.
(B)	Only (ii) can correspond to the unfolded cube in Panel I.
(C)	Both (i) and (ii) can correspond to the unfolded cube in Panel I.
(D)	Neither (i) nor (ii) can correspond to the unfolded cube in Panel I.

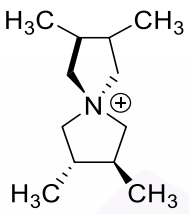
Q.8	Consider the cube shown below with its 8 corners labelled a, b, c, d, e, f, g, and h. The figure is representative. All corners are to be colored such that any two corners that are connected by an edge must be of different colors. The minimum number of colors required to achieve this is _____ 
(A)	8
(B)	4
(C)	3
(D)	2

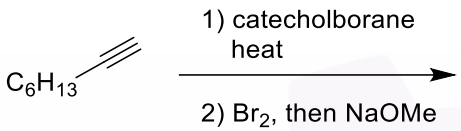
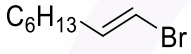
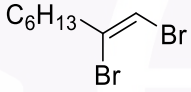
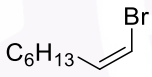
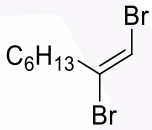
Q.9	Four hills H1, H2, H3, and H4 are present in an area. The following observations are made about them: i. Neither H2 nor H3 is the easternmost hill. ii. Neither H2 nor H3 is the westernmost hill. iii. Neither the easternmost hill nor the westernmost hill is the southernmost hill. iv. Two hills are located to the west of H2. v. The southernmost hill has at least two hills to its east. The southernmost hill is _____.
(A)	H1
(B)	H2
(C)	H3
(D)	H4

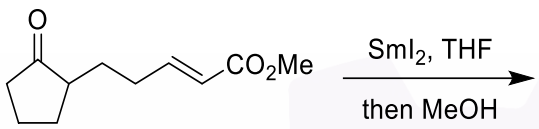
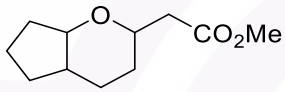
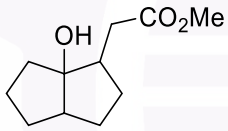
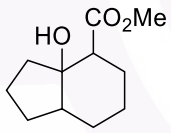
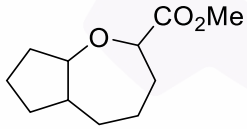
Q.10	As shown in the figure, circle C_1 with center O_1 and radius r_1 touches the square $VWXY$ at points P and Q while circle C_2 with center O_2 and radius r_2 touches the square $VWXY$ at points R and S. The two circles touch each other at T. Given $r_1 = 1$ cm and $\overline{VY} = \overline{VW} = 4$ cm, r_2 = _____ cm. 
(A)	$4 - 3\sqrt{2}$
(B)	$1 + 2\sqrt{2}$
(C)	$7 - 4\sqrt{2}$
(D)	$5 + 3\sqrt{2}$

Q.11 – Q.35 Carry ONE mark Each

Q.11	The major product formed in the following reaction is 
(A)	
(B)	
(C)	
(D)	

Q.12	The correct statement about the following quaternary ammonium ion is 
(A)	It has only C_2-symmetry, hence chiral
(B)	It has S_4-symmetry, hence achiral
(C)	It has no symmetry, hence chiral
(D)	It has a centre of symmetry, hence achiral

Q.13	The major product formed in the following reaction sequence is 
(A)	
(B)	
(C)	
(D)	

Q.14	The major product formed in the following reaction is 
(A)	
(B)	
(C)	
(D)	

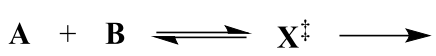
Q.15	The species that undergoes β-elimination is
(A)	$[Rh(C_5H_5)(P(CH_3)_3)(C_2H_5)]^+$
(B)	$[Rh(NH_3)_5(C_2H_5)]^{2+}$
(C)	$[Pt(P(C_6H_5)_3)_2(C_6H_5)I]$
(D)	$[Cr(CH_2Si(CH_3)_3)_4]$

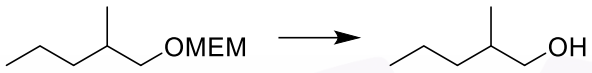
Q.16	According to molecular orbital theory, the correct ground state electronic configuration for $[Co(NH_3)_6]^{3+}$ ion is
(A)	$a_{1g}^2 \ t_{1u}^6 \ e_g^4 \ t_{2g}^6 \ e_g^{*0}$
(B)	$a_{1g}^2 \ t_{1u}^6 \ t_{2g}^6 \ e_g^4 \ e_g^{*0}$
(C)	$t_{1u}^6 \ a_{1g}^2 \ e_g^4 \ t_{2g}^6 \ e_g^{*0}$
(D)	$a_{1g}^2 \ t_{1u}^6 \ e_g^4 \ t_{2g}^4 \ e_g^{*2}$

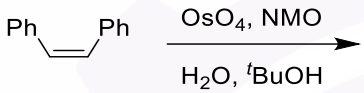
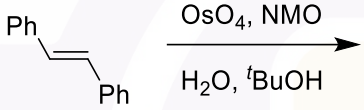
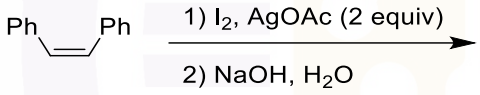
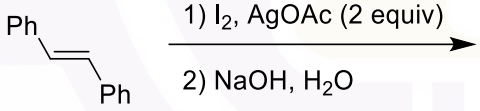
Q.17	The species which follows 18-electron rule is (en = ethylenediamine)
(A)	$[Rh(PPh_3)_3Cl]$
(B)	$[Co(NH_3)_6]^{2+}$
(C)	$[V(CO)_6]^-$
(D)	$[Ni(en)_3]^{2+}$

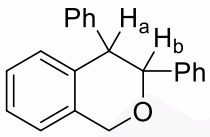
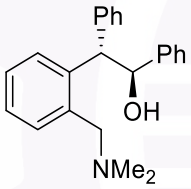
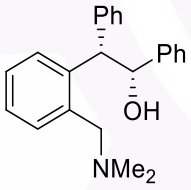
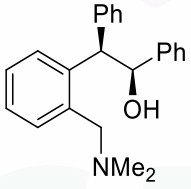
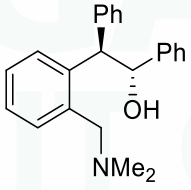
Q.18	The point group of $CH_2=C=CH_2$ is
(A)	D_{2h}
(B)	C_{2h}
(C)	C_{2v}
(D)	D_{2d}

Q.19	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

Q.20	For the following reaction,  If the value of $\Delta^{\ddagger}U^{o} = \frac{5}{2}RT$, then the value of $\Delta^{\ddagger}H^{o}$ is ($\mathbf{X}^{\ddagger}$ is an activated complex; $\Delta^{\ddagger}U^{o}$ is standard change in internal energy; $\Delta^{\ddagger}H^{o}$ 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)	$\frac{5}{2}RT$

Q.21	The reagent(s) that will effect the following transformation is(are)  MEM = methoxyethoxymethyl
(A)	Pd/C, H_2
(B)	$ZnBr_2$
(C)	Pyridinium *p*-toluenesulfonate (PPTS), ^{t}BuOH
(D)	$^{n}Bu_4NF$

Q.22	The reaction(s) that give(s) *meso*-1,2-diphenylethane-1,2-diol as the major product is(are)
(A)	
(B)	
(C)	
(D)	

Q.23	In the ^{1}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)  **X**
(A)	
(B)	
(C)	
(D)	

Q.24	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

Q.25	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)	$K_2[Fe(CN)_5NO]$ shows large quadrupole splitting
(D)	Isomer shift of $FeSO_4 \cdot 7H_2O$ is smaller than that of $K_3[Fe(CN)_6]$

Q.26	The interconversion of oxidation states of metal(s) observed in Wacker process is(are)
(A)	Pd(II) / Pd(0)
(B)	Cu(II) / Cu(I)
(C)	Pd(IV) / Pd(II)
(D)	Cu(II) / Cu(0)

Q.27	For the wavefunction $\Phi = x(a - x)$, where a is a constant, the correct statement(s) 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

Q.28	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

Q.29	The difference in the number of gauche interactions present in diaxial and diequatorial chair conformations of *trans*-1,2-dimethylcyclohexane is _____ (*in integer*).

Q.30	The total number of symmetry operations (order, *h*) present in the point group of $[PdCl_6]^{2-}$ is ***x*** and that in *trans*-$[PdBr_2Cl_4]^{2-}$ is ***y***. The value of ***x*** – ***y*** is _____ (*in integer*).

Q.31	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)

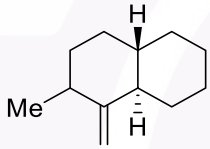
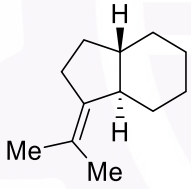
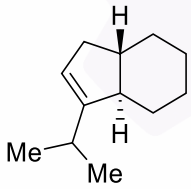
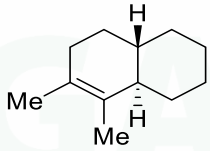
Q.32	The microwave spectrum of gaseous HF consists of a series of lines separated by 41.11 cm^{-1}. The bond length (in Å) of HF is _____ (*rounded off to two decimal places*). (Given: Atomic mass (in amu): H = 1.008, F = 18.998; 1 amu = 1.661×10^{-27} kg; $h = 6.626 \times 10^{-34}$ J s; $c = 2.998 \times 10^{8}$ m s^{-1})

Q.33	In a ^{1}H 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 = 2.675×10^{8} T^{-1} s^{-1})

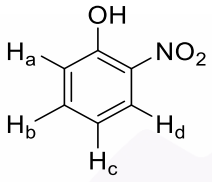
Q.34	The maximum work ($\lvert W_{max} \rvert$, in kJ) that can be obtained by complete combustion of 1.0 mol of CH_4 at constant pressure and 25 °C is _____ (*rounded off to one decimal place*). (Given: $\Delta S = -241.60$ J K^{-1} mol^{-1}; $\Delta H = -890.01$ kJ mol^{-1}; $R = 8.314$ J mol^{-1} K^{-1})

Q.35	If the ionic mobility of Ag^{+} ion in a very dilute aqueous solution of $AgNO_3$ at 298 K is $\boldsymbol{y} \times 10^{-8}$ m^2 V^{-1} s^{-1}, then the value of $\boldsymbol{y}$ is _____ (*rounded off to two decimal places*). (Given: viscosity of water at 298 K = 8.94×10^{-4} kg m^{-1} s^{-1}; $k = 1.38 \times 10^{-23}$ J K^{-1}; $F = 96500$ C mol^{-1}; $R = 8.314$ J mol^{-1} K^{-1}; Stokes radius of Ag^{+} = 0.15 nm)

Q.36 – Q.65 Carry TWO marks Each

Q.36	The major product formed in the following reaction is 
(A)	
(B)	
(C)	
(D)	

Q.37 The correct match for the protons labeled in compound **X** in **Column M** with the corresponding chemical shifts (δ, ppm) in **Column N** is



X

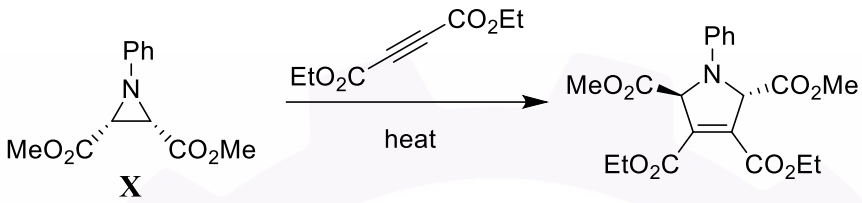
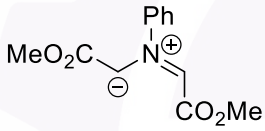
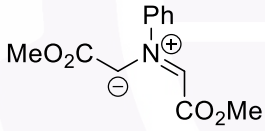
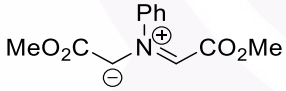
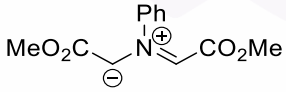
Column M		**Column N**	
P	H_a	**I**	7.00 (ddd, J = 8.4, 7.3, 1.4 Hz, 1H)
Q	H_b	**II**	7.17 (dd, J = 8.4, 1.4 Hz, 1H)
R	H_c	**III**	7.59 (ddd, J = 8.4, 7.3, 1.4 Hz, 1H)
S	H_d	**IV**	8.12 (dd, J = 8.4, 1.4 Hz, 1H)

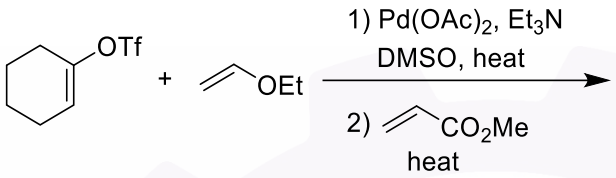
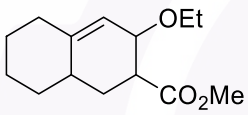
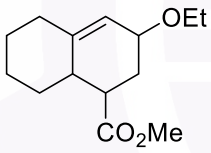
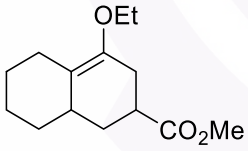
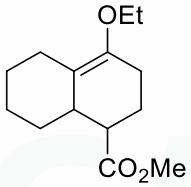
(A) **P → II; Q → III; R → I; S → IV**

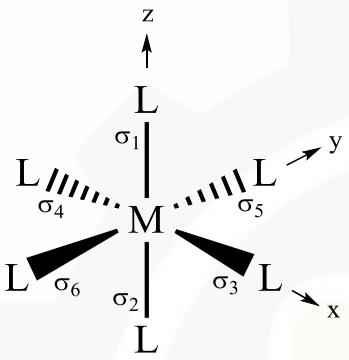
(B) **P → I; Q → IV; R → II; S → III**

(C) **P → II; Q → IV; R → I; S → III**

(D) **P → I; Q → III; R → II; S → IV**

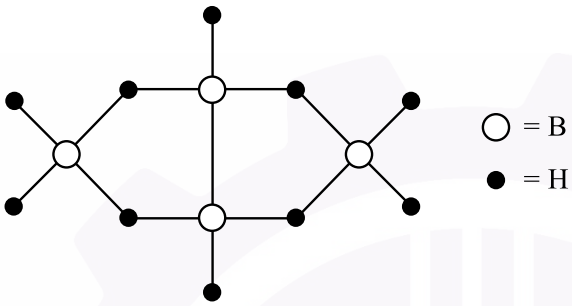
Q.38	The correct statement about the intermediate formed in the following reaction is 
(A)	 is formed through conrotatory opening of **X**
(B)	 is formed through disrotatory opening of **X**
(C)	 is formed through conrotatory opening of **X**
(D)	 is formed through disrotatory opening of **X**

Q.39	The major product formed in the following reaction sequence is 
(A)	
(B)	
(C)	
(D)	

Q.40	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 d_{z^2} orbital of M in the octahedral coordination geometry is 
(A)	$\frac{1}{\sqrt{12}}(2\sigma_1 + 2\sigma_2 - \sigma_3 - \sigma_4 - \sigma_5 - \sigma_6)$
(B)	$\frac{1}{\sqrt{12}}(2\sigma_1 - 2\sigma_2 + \sigma_3 - \sigma_4 + \sigma_5 - \sigma_6)$
(C)	$\frac{1}{\sqrt{6}}(\sigma_1 + \sigma_2 - \sigma_3 - \sigma_4 - \sigma_5 - \sigma_6)$
(D)	$\frac{1}{\sqrt{6}}(\sigma_1 + \sigma_2 + \sigma_3 + \sigma_4 + \sigma_5 + \sigma_6)$

Q.41	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)	$d_{xy}^2 < d_{xz}^2 = d_{yz}^2 < d_{x^2-y^2}^0 < d_{z^2}^0$

Q.42	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 $[Mn(CN)_6]^{4-}$

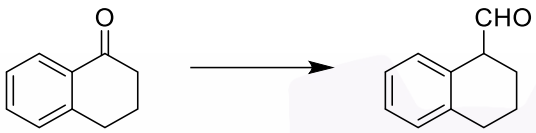
Q.43	The structure of B_4H_{10} is given below. Its *styx* number is 
(A)	4012
(B)	4102
(C)	2104
(D)	2014

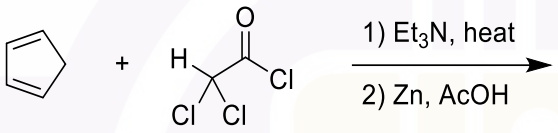
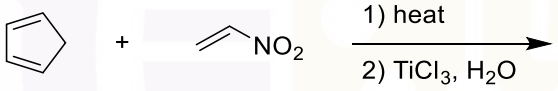
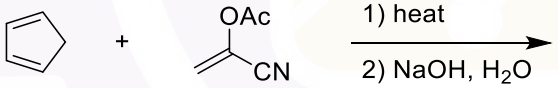
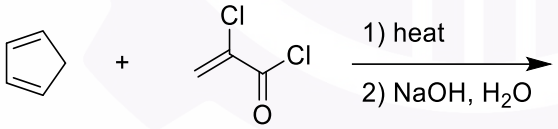
Q.44	For the following reaction, $2\ Pb_3O_4(s) \rightleftharpoons 6\ PbO(s) + O_2(g)$ The correct option showing the number of phases (P), number of components (C) and degrees of freedom (F) is
(A)	P = 3, C = 2, F = 1
(B)	P = 3, C = 3, F = 2
(C)	P = 2, C = 3, F = 3
(D)	P = 2, C = 2, F = 2

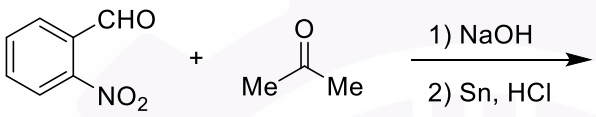
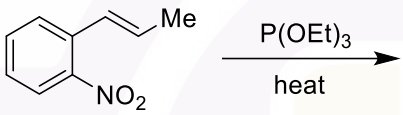
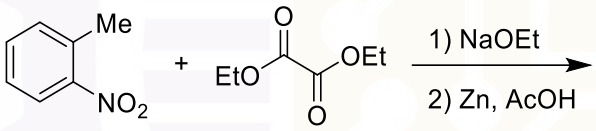
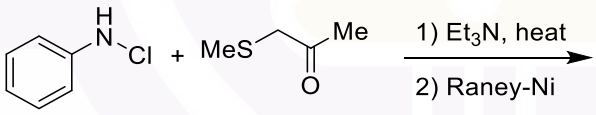
Q.45	The correct option for the average value of kinetic energy and the average value of potential energy of a one-dimensional harmonic oscillator with frequency ν in its ground state is
(A)	$\frac{h\nu}{2}$ and $\frac{h\nu}{4}$, respectively
(B)	$\frac{h\nu}{2}$ and $\frac{h\nu}{2}$, respectively
(C)	$\frac{h\nu}{4}$ and $\frac{h\nu}{4}$, respectively
(D)	$\frac{h\nu}{4}$ and $\frac{h\nu}{2}$, respectively

Q.46	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)	$15kT/4\eta$

Q.47	For the following electrochemical cells, liquid junction potentials affect the cell potential (E_{cell}). I. Electrode-1 $\vert$ 0.1 M KCl $\Vert$ 0.1 M NaCl $\vert$ Electrode-2 II. Electrode-1 $\vert$ 0.1 M HCl $\Vert$ 0.01 M HCl $\vert$ Electrode-2 III. Electrode-1 $\vert$ 0.01 M KCl $\Vert$ 0.01 M HCl $\vert$ Electrode-2 The correct order of their E_{cell} at 25 °C is
(A)	I > II > III
(B)	II > I > III
(C)	III = I > II
(D)	II > I = III

Q.48	The set(s) of reagents that will effect the following conversion is(are) 
(A)	i) $Ph_3P{=}CHOMe$; ii) H_3O^+
(B)	i) $TsNHNH_2$; ii) ^nBuLi (2 equiv) then DMF
(C)	i) 1,3-dithane, ^nBuLi; ii) $HgSO_4$, dil. H_2SO_4
(D)	i) Me_3SI, NaH; ii) $BF_3{\cdot}OEt_2$

Q.49	The reaction(s) that produce(s) the following compound is(are) 
(A)	
(B)	
(C)	
(D)	

Q.50	The reaction(s) that produce(s) 2-methylindole as the major product is(are)
(A)	
(B)	
(C)	
(D)	

Q.51	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

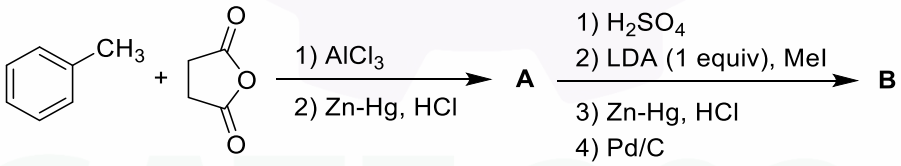
Q.52	Consider the given pairs of complex ions. The correct pair(s) in which each complex ion exhibits three spin-allowed *d-d* transitions (excluding those arising due to distortions) is(are)
(A)	$[V(H_2O)_6]^{3+}$ and $[Ni(H_2O)_6]^{2+}$
(B)	$[Cr(H_2O)_6]^{3+}$ and $[NiCl_4]^{2-}$
(C)	$[Ti(H_2O)_6]^{3+}$ and $[Mn(H_2O)_6]^{2+}$
(D)	$[FeF_6]^{3-}$ and $[FeCl_4]^{2-}$

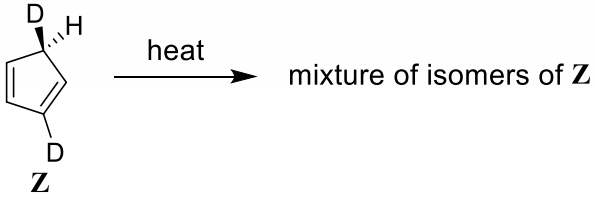
Q.53	The correct statement(s) about the structure of metal oxides is(are)
(A)	Spinel has 8 tetrahedral sites and 4 octahedral sites per formula unit
(B)	$BaTiO_3$ has a perovskite structure
(C)	In Fe_3O_4, Fe^{2+} occupies both tetrahedral and octahedral sites in the unit cell
(D)	γ-Al_2O_3 is a defect spinel

Q.54	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) (Given: Atomic number: Nd = 60; Pm = 61; Ho = 67; Er = 68)
(A)	Pm^{3+} and Ho^{3+}
(B)	Nd^{3+} and Er^{3+}
(C)	Pm^{3+} and Nd^{3+}
(D)	Ho^{3+} and Er^{3+}

Q.55	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 $[Fe(\textbf{ent})]^{3-}$ ion
(D)	It has three hydroxamic acid groups

Q.56	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

Q.57	Consider the following reaction sequence, where **A** and **B** are the major products. In proton-decoupled ^{13}C NMR spectra, the total number of carbon signals observed for **A** and **B** is _____ (*in integer*). 

Q.58	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*). 

Q.59	The sum of bond orders of metal–metal bonds in $[Os_2Cl_8]^{2-}$, $[Re_2Cl_8]^{2-}$, $[W_2(NMe_2)_6]$ and $[Mo(C_5H_5)(CO)_2]_2$ is _____ (*in integer*).

Q.60	The sum of the number of α-particles and β-particles emitted in the nuclear decay process, ${}^{238}_{92}U \rightarrow {}^{206}_{82}Pb$, is _____ (*in integer*).

Q.61	The positions of two atoms in spherical polar coordinates (r, θ, Φ) are $(1, \frac{\pi}{2}, \frac{\pi}{2})$ and $(1, \frac{\pi}{4}, \frac{3\pi}{2})$, where the distance is in Å and the angles are in radian. The interatomic distance (in Å) is _____ (*rounded off to two decimal places*).

Q.62	If the translational partition function for H_2 confined in a 1 L vessel at 300 K is $\boldsymbol{y} \times 10^{27}$, then the value of $\boldsymbol{y}$ is _____ (*rounded off to one decimal place*). (Given: Atomic mass (in amu): H = 1.008; 1 amu = 1.661×10^{-27} kg; $h = 6.626 \times 10^{-34}$ J s; $k = 1.381 \times 10^{-23}$ J K^{-1})

Q.63	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 4.0×10^{-3} M solution of acetic acid, the measured potential (in V) is _____ (*rounded off to three decimal places*). (Given: K_a of acetic acid at 25 °C = 1.75×10^{-5}; $2.303RT/F = 0.059$; Assume: $a_{H^+} = [H^+]$)

Q.64	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 6×10^{-4} mm^{-3} and 4×10^{-6} mm^{-3}, respectively. The surface area (in $m^2\ g^{-1}$) 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_o, where p is the pressure of the N_2 gas and p_o is equilibrium vapour pressure of liquid N_2)

Q.65	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*).