CSIR UGC – NET JRF: December 2014
Chemical Science

❖ **Question Paper**

Section-A

Q.1 Lunch-dinner pattern of a person for *m* days is given below. He has a choice of a VEG or a NON-VEG meal for his lunch/dinner

(a) If he takes a NON-VEG lunch, he will have only VEG for dinner.

(b) He takes NON-VEG dinner for exactly 9 days.

(c) He takes VEG lunch for exactly 15 days

(d) He takes a total of 14 NON-VEG meals

What is m?

(a)   18   (b)   24   (c)   20   (d)   38

Q.2 Two locomotives are running towards each other with speeds of 60 and 40 km/h. An object keeps on flying to and fro from the front tip of one locomotive to the front tip of the other with a speed of 70 km/h. After 30 minutes, the two locomotives collide and the object is crushed. What distance did the object cover before being crushed?

(a)   50 km   (b)   45 km   (c)   35 km   (d)   10 km

Q.3 A sphere is made up of very thin concentric shells of increasing radii (leaving no gaps). The mass of an arbitrarily chosen shell is

(a)   Equal to the mass of the preceding shell.   (b)   proportional to its volume.

(c)   proportional to its radius.   (d)   proportional to its surface area.

Q.4 Find the missing letter:

A	?	Q	E
C	M	S	C

E	K	U	A
G	I	W	Y

(a)   L   (b)   Q   (c)   N   (d)   O

Q.5 A person sells two objects at Rs. 1035/- each. On the first object he suffers a loss of 10% while on the second he gains 15%. What is his net loss/gain percentage?

(a)   5% gain   (b)   < 1% gain   (c)   < 1% loss   (d)   No loss, no gain

Q.6 A bank offers a scheme wherein deposits made for 1600 days are doubled in value, the interest being compounded daily. The interest accrued on a deposit of Rs.1000/- over the first 400 days would be Rs.

(a)   250   (b)   183   (c)   148   (d)   190

Q.7 The least significant bit of an 8-bit binary number is zero. A binary number whose value is 8 times the previous number has

(a)   12 bits ending with three zeros.   (b)   11 bits ending with four zeros.

(c)   11 bits ending with three zeros.   (d)   12 bits ending with four zeros.

Q.8 What is the next number of the following sequence?

2, 3, 4, 7, 6, 11, 8, 15, 10 .. .

(a)   12   (b)   13   (c)   17   (d)   19

Q.9 20% of students of a particular course get jobs within one year of passing. 20% of the remaining students get jobs 'by the end of second year of passing. If 16 students are still jobless, how many students had passed the course?

(a)   32   (b)   64   (c)   25   (d)   100

Q.10 A rectangle of length d and breadth d/2 is revolved once completely around its length and once around its breadth. The ratio of volumes swept in the two cases is

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(a) 1:1 (b) 1:2 (c) 1:3 (d) 1:4

Q.11 Average yield of a product in different years is shown in the histogram. If the vertical bars indicate variability during the year, then during which year was the percent variability over the average of that year the least?
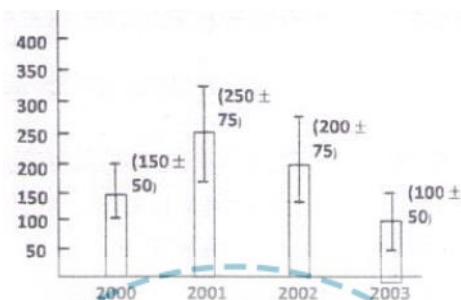

(a) 2000 (b) 2001 (c) 2002 (d) 2003

Q.12 A long ribbon is wound around a spool up to a radius R. Holding the tip of the ribbon, a boy runs away from the spool with a constant speed maintaining the unwound portion of the ribbon horizontal. In 4 minutes, the radius of the wound portion becomes $\frac{R}{\sqrt{2}}$. In what further time, it will become R/2?

(a) $\sqrt{2}$ min (b) 2 min (c) $2\sqrt{2}$ min (d) 4 min

Q.13 A ladder rests against a wall as shown. The top and the bottom ends of the ladder are marked A and B. The base B slips. The central point C of the ladder falls along
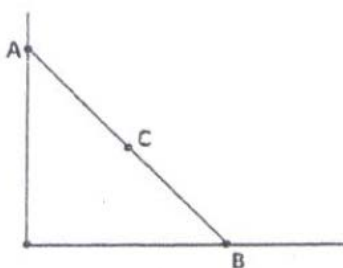
(a) A parabola (b) The arc of a circle (c) A straight line (d) A hyperbola

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Q.14 Binomial theorem in algebra gives $(1 + x)^n = a_0 + a_1x + a_2x^2 + ... + a_nx^n$, where $a_0, a_1, ..., a_n$ are constants depending on n. What is the sum $a_0 + a_1 + a_2 + ... + a_n$?

(a) 2^n (b) n (c) n^2 (d) $n^2 + n$

Q.15 Continue the sequence 2,5, 10, 17,28,41,-,-,-

(a) 58, 77, 100 (b) 64, 81, 100 (c) 43, 47, 53 (d) 55, 89, 113

Q.16 A code consists of at most two identical letters followed by at most four identical digits. The code must have at least one letter and one digit. How many distinct codes can be generated using letters A to Z and digits 1 to 9?

(a) 936 (b) 1148 (c) 1872 (d) 2574

Q.17 Two solid iron spheres are heated to 100°C and then allowed to cool. One has the size of a football; the other has the size of a pea. Which sphere will attain the room temperature (constant) first?

(a) The bigger sphere (b) The smaller sphere

(c) Both spheres will take the same time (d) It will depend on the room temperature

Q.18 Weights (in kg) of 13 persons are given below:

70, 72, 74, 76, 78 , 80 , 82, 84, 86, 88, 90, 92, 94

Two new persons having weights 100 kg and 79 kg join the group. The average weight of the group increases by

(a) 0 kg (b) 1 kg (c) 1.6 kg (d) 1.8 kg

Q.19 If n is a positive integer, then $n(n+1)(n+2)(n+3)(n+4)(n+5)(n+6)$ is divisible by

(a) 3 but not 7 (b) 3 and 7 (c) 7 but not 3 (d) Neither 3 nor 7

Q.20 The area (in m^2) of a triangular park of dimensions 50 m. 120 m and 130 m is

(a) 3000 (b) 3250 (c) 5550 (d) 7800

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Section-B

Q.21 The reaction between SbF_5 and two equivalents of HF leads to the formation of

(a) $H_2SbF_3 + 2F_2$ (b) $HSbF_2 + 3F_2$ (c) $SbF_3 + H_2 + 2F_2$ (d) $[SbF_6]^-[H_2F]^+$

Q.22 The δ-bond is formed via the overlap of

(a) $d_{x^2-y^2}$ and $d_{x^2-y^2}$ orbitals   (b) d_{xz} and d_{xz} orbitals

(c) d_{xy} and d_{xy} orbitals   (d) d_{yx} and d_{yz} orbitals

Q.23 Among F^-, Na^+, O^{2-} and Mg^{2+} ions, those having the highest and the lowest ionic radii respectively are

(a) O^{2-} and Na^+ (b) F^- and Mg^{2+} (c) O^{2-} and Mg^{2+} (d) Mg^{2+} and O^{2-}

Q.24 The extent of π-electron conjugation in macrocyclic rings of (1) heme, (2) coenzyme B_{12} and (3) chlorophyll follows the order

(a) $(1) > (3) > (2)$ (b) $(1) > (2) > (3)$ (c) $(3) > (1) > (2)$ (d) $(2) \approx (1) > (3)$

Q.25 The correct order of the retention of cations on a sulfonated cation exchange resin column is

(a) $Ag^+ > K^+ > Na^+ > Li^+$ (b) $K^+ > Na^+ > Ag^+ > Li^+$

(c) $Li^+ > Na^+ > K^+ > Ag^+$ (d) $Li^+ > Na^+ > Ag^+ > K^+$

Q.26 In a polarographic measurement, (aqueous KCl solution used as supporting electrolyte) an applied potential more than +0.4 V, results mainly in the formation of

(a) Hg^I (b) Hg^{II} (c) Cl_2 (d) O_2

Q.27 The correct order of the isomeric shift in Mossbauer spectra (^{57}Fe source) of iron compounds is

(a) $Fe(II) > Fe(III) > Fe(IV)$ (b) $Fe(III) > Fe(II) > Fe(IV)$

(c) $Fe(IV) > Fe(III) > Fe(II)$ (d) $Fe(IV) > Fe(II) > Fe(III)$

Q.28 The hapticities 'x' and 'y' of the arene moieties in the diamagnetic complex $[(\eta^x- C_6H_6)Ru(\eta^y - C_6H_6)]$ respectively are

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(a)   6 and 6   (b)   4 and 4   (c)   4 and 6   (d)   6 and 2

Q.29 The rate of the reaction $Ni(CO)_4 + PPh_3 \xrightarrow{h\nu} [Ni(CO)_3(PPh_3)] + CO$ depends on

(a)   Concentration of both the reactants   (b)   Concentration of $Ni(CO)_4$ only

(c)   Concentration of PPh_3 only   (d)   The steric bulk of PPh_3

Q.30 The product of the reaction of propene, CO and H_2 in the presence of $CO(CO)_8$ as a catalyst is

(a)   Butanoic acid   (b)   Butanal   (c)   2-butanone   (d)   Methylpropanoate

Q.31 The S and L values for ^{15}N atom respectively, are

(a)   ½ and 1   (b)   ½ and 0   (c)   1 and 0   (d)   3/2 and 0

Q.32 The point group symmetries for trans-$[Cr(en)_2F_2]^+$ and $[TiCl_6]^{3-}$, respectively, are

(a) D_{2d} and D_{3d} (b) D_{3d} and D_{4d} (c) D_{4h} and D_{3h} (d) D_{3h} and D_{4h}

Q.33 $Co_4(CO)_{12}$ adopts the

(a)   Closo-structure   (b)   Nido-structure   (c)   Arachano-structure   (d)   Hypho-sturcture

Q.34 Reductive elimination step in hydrogenation of alkenes by Wilkinson catalyst results in (neglecting solvent in coordination sphere of Rh)

(a)   T-shaped $[Rh(PPh_3)_2Cl]$ (b)   Trigonal-planar $[Rh(PPh_3)_2Cl]^{2+}$

(c)   T-shaped $[Rh(H)(PPh_3)Cl]^+$ (d)   Trigonal-planar $[Rh(H)(PPh_3)_2]$

Q.35 In the following reaction $[PtC1_4]^{2-} + NO_2^- \rightarrow A \xrightarrow{NH_3} B$, compound B is

(a)   trans-$[PtCl_2(NO_2)(NH_3)]^-$ (b)   cis-$[PtCl_2(NO_2)(NH_3)]^-$

(c)   trans-$[PtCl_2(NH_3)_2]$ (d)   cis-$[PtCl_2(NO_2)_2]^{2-}$

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Q.36 The number of histidine amino acid nitrogen atoms coordinated to bimetallic active site of oxyhemocyanin, and oxyhemerythrin, respectively, are

(a) 2, 3 and 3, 3   (b) 3, 3 and 2, 3   (c) 3, 3 and 2, 2   (d) 2, 4 and 3, 2

Q.37 Identify correct statements for mercury as an environment pollutant.

A. Carbanionic biomethylation converts it to $MeHg^+$

B. Thiol group of cysteine has strong affinity for mercury

C. Mercury containing industrial catalyst release caused Minamata disaster

The correct answer is

(a) A and B   (b) A and C   (c) B and C   (d) A, B and C

Q.38 The configurations of carbon atoms C_3 and C_4 in D-ribose, respectively, are

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

Q.39 The compound that is antiaromatic is

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

Q.40 The increasing order of pKa values of the circled hydrogens in the following compounds is
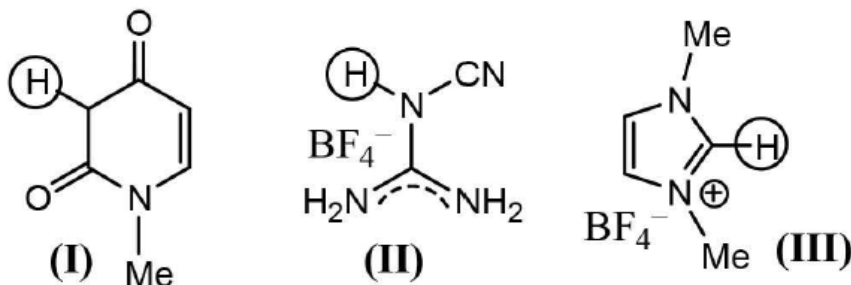
(a) I < II < III   (b) I < III < II   (c) II < I < III   (d) II < III < I

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Q.41 The decreasing order of basicity of the following compounds is
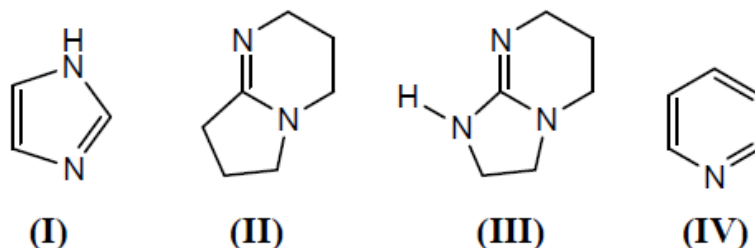
(I)   **(II)**   **(III)**   **(IV)**

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

Q.42 In the most stable conformation of neomenthol, stereochemical orientation of the three substituents on the cyclohexane ring are

(a) OH : equatorial; i-Pr : equatorial and Me : equatorial

(b) OH : axial; i-Pr : equatorial and Me : equatorial

(c) OH : equatorial; i-Pr : equatorial and Me : axial

(d) OH : equatorial; i-Pr : axial and Me : equatorial

Q.43 The absolute configurations of the chiral centres of starting ketone in the following reaction is
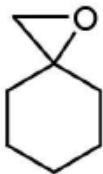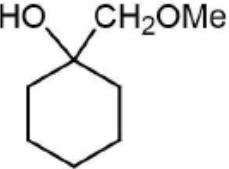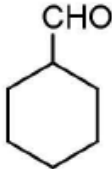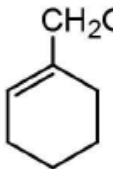
(a) 3R,6S   (b) 3S,6S   (c) 3R,6R   (d) 3S,6R

Q.44 The reaction of 1-bromo-2-fluorobenzene with furan in the presence of one equivalent of Mg gives
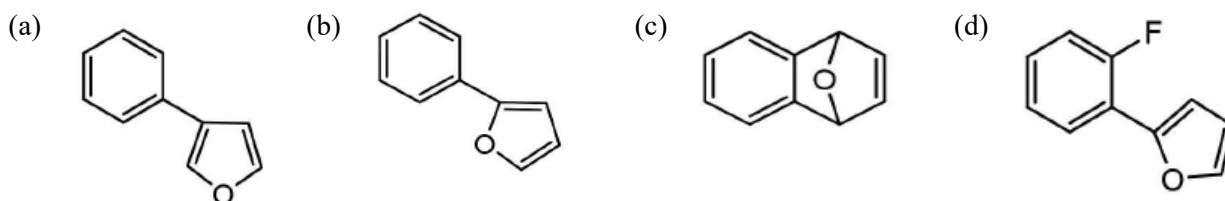
(a)   (b)   (c)   (d)

Q.45 The product for the following sequence of reactions is
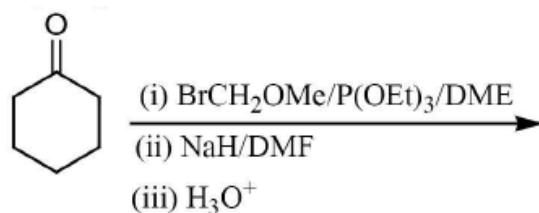
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$$
\xrightarrow[\text{(iii) } H_3O^+]{\text{(i) BrCH}_2\text{OMe/P(OEt)}_3\text{/DME} \quad \text{(ii) NaH/DMF}}
$$

(a)

(b) HO CH₂OMe

(c) CHO

(d) CH₂OH

Q.46 The major product formed in the following reaction is

$$
\xrightarrow[\substack{\text{(ii) CO}_2 \\ \text{(iii) } H_3O^+}]{\text{(i) sec-BuLi}}
$$

(a) OCH₂OCH₃
H₃C COOH

(b) OCH₂OCH₃
H₃C COOH

(c) OCH₂OCH₃
COOH
H₃C

(d) OCH₂OCH₃
HOOC
H₃C

Q.47 The major product of the following reaction is

$$
\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) Na, NH}_3\text{(i), EtOH}}
$$

(a) COOH

(b) COOH

(c) COOH

(d) COOH
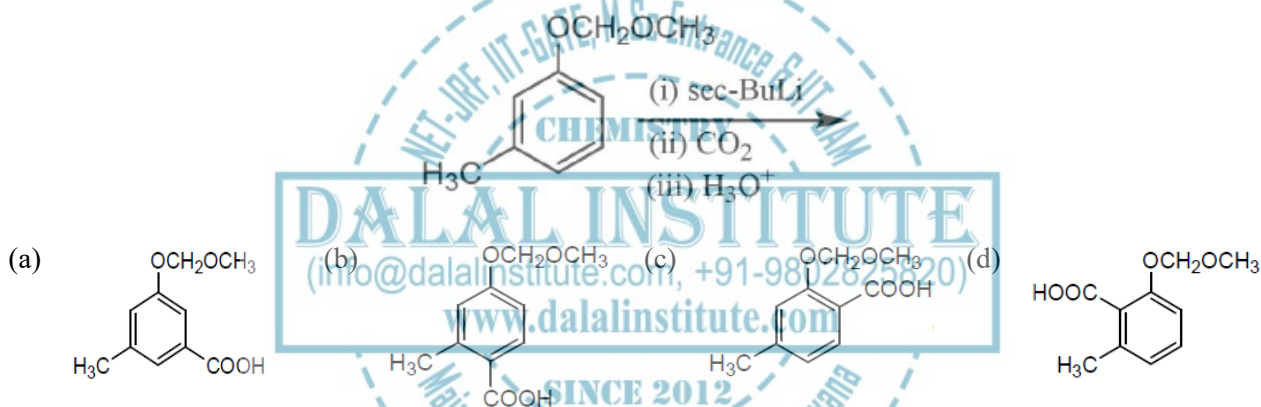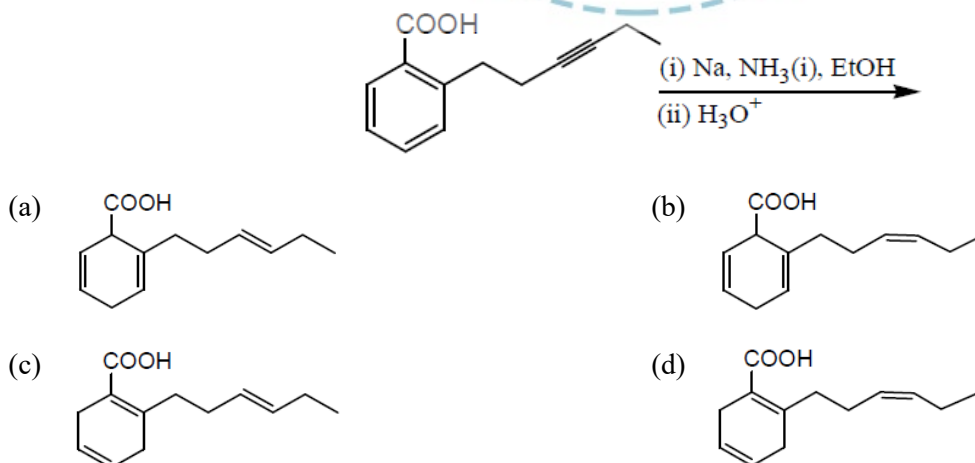
Q.48 The major product of the following reaction is

Br_2(excess), $CHCl_3$, rt
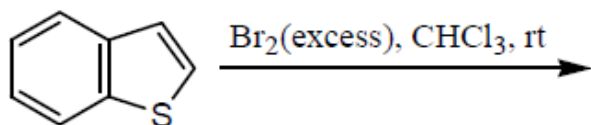
(a)
(b)
(c)
(d)

Q.49 The cyclic product(s) of the following photochemical reaction is(are)

$\dfrac{hv}{\text{vapour phase}}$
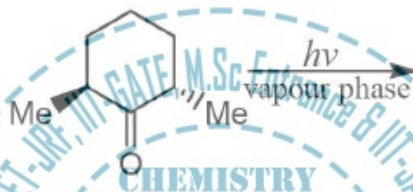
(a) Only cis- I, 2-dimethylcyclopentane

(b) Only trans- I, 2-dimethylcyclopentane

(c) A mixture of cis- and trans- I, 2-dimethylcyclopentanes

(d) Only 2, 6-dimethylcyclohexanol

Q.50 A compound with molecular formula $C_4H_6O_2$ shows band at 1770 cm^{-1} in IR spectrum and peaks at 178, 68, 28 and 22 ppm in ^{13}C NMR spectrum. The correct structure of the compound is

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

Q.51 The mass of metastable ion produced due to decomposition of F_1^+ in the following mass fragmentation sequence is

Diethyl-phthalate $\rightarrow F_1^+ \rightarrow F_2^+ + CO$
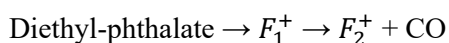
(M+, 222)   (177)

(a) 141.2   (b) 125.4   (c) 45.0   (d) 210.2

Q.52 The ratio of the relative intensities of the carbon signals in the first order ^{13}C NMR spectrum of CD_3Cl is

(a) 1:4:6:4:1   (b) 1:3:3:1   (c) 1:6:15:20:15:6:1   (d) 1:3:6:7:6:3:1

Q.53 The biosynthetic precursor of abietic acid is

(a) Shikimic acid   (b) Mevalonic acid   (c) Chorismic acid   (d) Cinnamic acid

Q.54 The amino acid constituents of artificial sweetener given below are
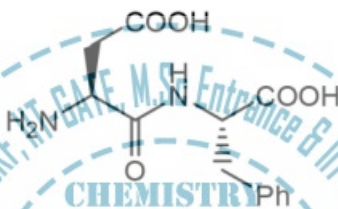
(a) D-Glutamic acid and L-phenylglycine   (b) L-Glutamic acid and L-phenylalanine

(c) L-Aspartic acid and L-phenylalanine   (d) L-Aspartic acid and L-tyrosine

Q.55 Bond lengths of homonuclear diatomic molecules can be determined with the help of both

(a) Rotational and vibrational spectroscopy.

(b) Rotational and rational Raman spectroscopy.

(c) Rotational Raman and electronic spectroscopy.

(d) Vibrational and electronic spectroscopy.

Q.56 If the component of the orbital angular momentum along the molecular axis of a heteronuclear diatomic molecule is non-zero, the rotational-vibrational spectrum will show

(a) P and R branches only.   (b) P and Q branches only.

(c) Q and R branches only.   (d) All the P, Q and R branches.

Q.57 For a particle of mass m confined in a box of length L, assume $\Delta x = L$. Assume further that $\Delta p(min) = $. Use the uncertainty principle to obtain an estimate of the energy of the particle. The value will be

(a) $\dfrac{h^2}{8mL^2}$

(b) $\dfrac{\hbar^2}{8mL^2}$
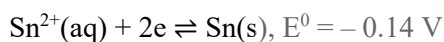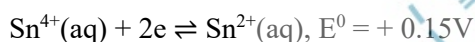
(c) $\dfrac{h^2}{32mL^2}$

(d) $\dfrac{h^2}{2mL^2}$

Q.58
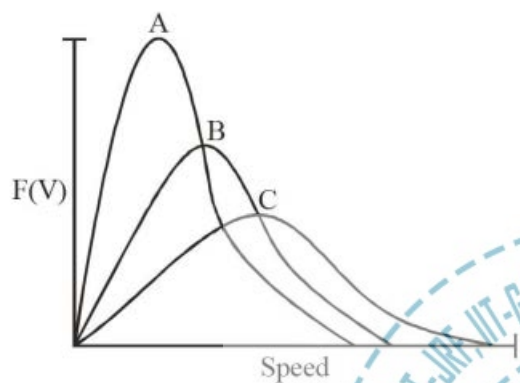
Identify the speed distribution functions of Ne, Ar, and Kr with the curves in the figure above

(a) Ne-A, Ar-B, Kr-C   (b) Ne-B, Ar-C, Kr-A   (c) Ne-C, Ar-B, Kr-A   (d) Ne-C, Ar-A, Kr-B

Q.59 For the cell reaction, $Sn(s) + Sn^{4+}(aq) \rightleftharpoons 2Sn^{2+}(aq)$, separate electrode reactions could be written with the respective standard electrode potential data at 25 °C as

$Sn^{4+}(aq) + 2e \rightleftharpoons Sn^{2+}(aq)$, $E^0 = + 0.15V$

$Sn^{2+}(aq) + 2e \rightleftharpoons Sn(s)$, $E^0 = - 0.14$ V

When RT/F is given as 25.7 mV, logarithm of the equilibrium constant (ln K) is

(a) 22.6

(b) 226

(c) 2.26

(d) 2.26×10^{-1}

Q.60 Hydrogen is adsorbed on many metal surfaces by dissociation (S represents a surface site):

$$H_2 + -S-S- \rightleftharpoons -\overset{\overset{\displaystyle H}{|}}{S}-\overset{\overset{\displaystyle H}{|}}{S}-$$
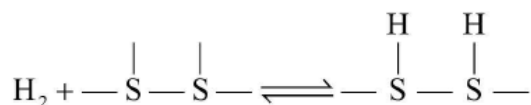
If the pressure of H_2 (p) is small, the fraction of the surface covered by hydrogen is proportional to

(a) p

(b) p^2

(c) $p^{1/2}$

(d) $p^{3/2}$

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Q.61 For a process in a closed system, temperature is equal to

(a) $\left(\frac{\partial H}{\partial P}\right)_S$

(b) $-\left(\frac{\partial A}{\partial V}\right)_T$

(c) $\left(\frac{\partial G}{\partial P}\right)_T$

(d) $\left(\frac{\partial H}{\partial S}\right)_P$

Q.62 The exact differential *df* of a state function *f(x, y)*, among the following is

(a) xdy

(b) $dx - \frac{x}{y}dy$

(c) $ydx - xdy$

(d) $\frac{1}{y}dx - \frac{x}{y^2}dy$

Q.63 The angular momentum operator $L_z = -i\hbar\frac{\partial}{\partial\phi}$ has eigen functions of the form $\exp[iA\phi]$. The condition that a full rotation leaves such an eigen function unchanged is satisfies for all the values of A.

(a) $0, \pm\frac{1}{2}, \pm\frac{2}{3}, \pm1, \pm\frac{4}{3}, ...$

(b) $0, \pm1, \pm2, \pm3, ...$

(c) $0, \pm\frac{1}{2}, \pm1, \pm\frac{3}{2}, ...$

(d) $0, \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, ...$

Q.64 X-ray diffraction does not give any structural information for

(a) Metallic solids

(b) Ionic solids

(c) Molecular solids

(d) Amorphous solids

Q.65 A reaction $A + B + C \rightarrow D$ follows the mechanism

$A + B \rightleftharpoons AB$; $AB + C \rightarrow D$
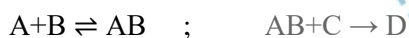
In which first step remains essentially in equilibrium. If ΔH is the enthalpy change for the first reaction and E_0 is the activation energy for the second reaction, the activation energy of the overall

reaction will be given by

(a) E_0

(b) $E_0 - \Delta H$

(c) $E_0 + \Delta H$

(d) $E_0 + 2\Delta H$

Q.66 Wavelength (λ in nm) of the Lyman series for an one-electron ion is in the range $24 \leq \lambda \leq 30$. The ionization energy of the ion will be closest to $\left(1j = \frac{10^{19}}{1.6} eV\right)$

(a) 32 eV

(b) 42 eV

(c) 52 eV

(d) 62 eV

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Q.67 A sample experiment revealed that PVC formed in the medium has $\langle M_n \rangle = 13$, and $\langle M_w \rangle = 16$, where $\langle M_n \rangle$ stands for the number average molar mass and $\langle M_w \rangle$ for the weight average molar mass. The variance of M_n will then be

(a)   39   (b)   3   (c)   1   (d)   87

Q.68 For an enzyme-substrate reaction, a plot between $\frac{1}{v}$ and $\frac{1}{[S]_0}$ yields a slope of 40s. If the enzyme concentration is 2.5 µM, then the catalytic efficiency of the enzyme is

(a) $40 \text{ L mol}^{-1} \text{s}^{-1}$ (b) $10^{-4} \text{ L mol}^{-1} \text{s}^{-1}$ (c) $10^7 \text{ L mol}^{-1} \text{s}^{-1}$ (d) $10^4 \text{ L mol}^{-1} \text{s}^{-1}$

Q.69 For a polydispersed macromolecular colloid, osmometry gives

(a)   Weight-average molecular weight.

(b)   Number-average molecular weight.

(c)   Both weight-average and number average molecular weights.

(d)   Viscosity-average molecular weight.

Q.70 10 ml of 0.02 M NaOH is added to 10 ml of 0.02 M acetic acid (pKa = 4.75). The pH of the solution will be closest to

(a)   7.0   (b)   8.4   (c)   5.6   (d)   9.6

Section-C

Q.71 Which of the following will result in deviation from Beer's law:

(A) Change in refractive index of medium

(B) Dissociation of analyte on dilution

(C) Polychromatic light

(D) Path length of cuvette

(a)   A, B and C   (b)   B, C and D   (c)   A, C and D   (d)   A, B and D

Q.72 The gas commonly used in generating plasma in Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES) is

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(a) Argon   (b) Carbon dioxide   (c) Nitrous oxide   (d) Hydrogen

Q.73 The geometric cross-section (in barn) of a nucleus A= 125, $r_0 = 1.4 \times 10^{-15}$ m approximately is

(a) 1.05   (b) 1.54   (c) 2.05   (d) 2.54

Q.74 The number of stereoisomers of trans-$[CoCl_2(triethylenetetraamine)]Br$ is

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

Q.75 Under physiological condition, oxygen is binding to deoxyhemoglobin and deoxy-myoglobin, the binding curve and its pH dependence, respectively, are

(a) Sigmoidal and pH dependent; hyperbolic and pH independent.

(b) Hyperbolic and pH independent; sigmoidal and pH dependent.

(c) Sigmoidal and pH independent; hyperbolic and pH dependent.

(d) Hyperbolic and pH dependent; sigmoidal and pH independent.

Q.76 Match the metalloproteins in column-A with their function in column-B

Column A	Column B
I. Oxyhemocyanin	A. Hydrolysis of C-terminal peptide bond
II. Carbonic anhydrase	B. Methylation
III. Cytochrome P_{450}	C. Conversion of CO_2 to H_2CO_3
IV. Carboxy-peptidase A	D. Oxdiation of alkene
	E. Oxygen stroage
	F. Oxygen transport

The correct answer is

(a) I – F; II – C; III – D; IV – A   (b) I – E; II – C; III – A; IV – F

(c) I – F; II – B; III – C; IV – A   (d) I – E; II – D; III – C; IV – A

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Q.77 $Na[(\eta^5 -C_5H_5) Fe(CO)_2]$ reacts with Br_2 to give A. Reaction of A with $LiAlH_4$ results in B. The proton NMR spectrum of B consists of two singlets of relative intensity 5:1. Compounds A and B, respectively, are

(a) $(\eta^5 – C_5H_5)Fe(CO)_2Br$ and $(\eta^5 – C_5H_5)Fe(CO)_2H$

(b) $(\eta^4 – C_5H_5)Fe(CO)_2Br_2$ and $(\eta^4 – C_5H_5)Fe(CO)_2HBr$

(c) $(\eta^5 – C_5H_5)Fe(CO)_2Br$ and $(\eta^4 – C_5H_5)Fe(CO)_2H_2$

(d) $(\eta^5 – C_5H_5)Fe(CO)_2Br$ and $(\eta^5 – C_5H_5)Fe(CO)_2HBr$

Q.78 The compound that undergoes oxidative addition reaction in presence of H_2 is

(a) $[Mn(CO)_5]^-$ (b) $[(\eta^5 -C_5H_5)Mo(CO)_3]^-$

(c) $[IrCl(CO)(PPh_3)_2]$ (d) $[(\eta^5 -C_5H_5)_2ReH]$

Q.79 ^1H NMR spectrum of free benzene shows a peak at ~ 7.2 ppm. The expected chemical shift (in ppm) of C_6H_6 ligand in ^1H NMR spectrum of $[(\eta^6 -C_6H_6)Cr(CO)_3]$ and the reason for it, if an, is/are

(a)   4.5 ; disruption of ring current.

(b)   9.0 ; inductive effect.

(c)   7.2.

(d)   2.5 ; combination of inductive effect and disruption of ring current.

Q.80 An aqueous solution of $[Mn(H_2O)_6]^{2+}$ complex is pale pink in colour. The probable reasons for it are

(A) Presence of $^6A_{1g}$ ground state

(B) Disallowed transition by spin selection rule

(C) Presence of $^2T_{2g}$ ground state

(D) Charge transfer transition

The correct answer is
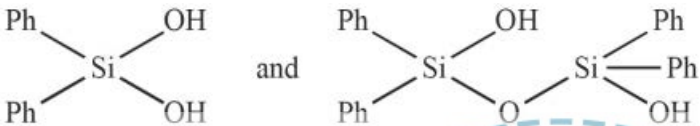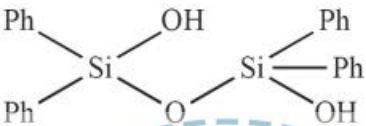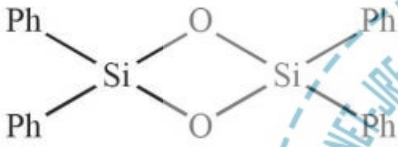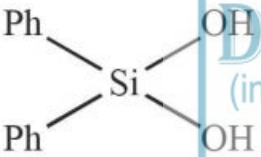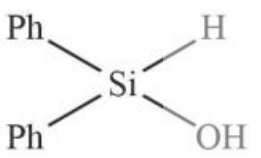
(a)   A and B   (b)   A and C   (c)   B and C   (d)   C and D

Q.81 The reaction of phosphorus trichloride with phenyllithium in 1:3 molar ratio yields product 'A',

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which on further treatment with methyl iodide produces 'B'. The reaction of B with ^nBuLi gives

product 'C'. The products A, B and C, respectively, are

(a) $[PPh_4]Cl$, $[Ph_2P=CH_2]I$, $Ph_2P(^nBu)$

(b) PPh_3, $[Ph_3PI]Me$, $Ph_2P(^nBu)_3$

(c) PPh_3, $[Ph_3PMe]I$, $Ph_3P=CH_2$

(d) $[PPh_4]Cl$, $[Ph_3P=CH_2]I$, $[Ph_3P(^nBu)]Li$
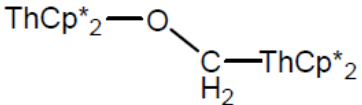
Q.82 The reaction between diphenyldichlorosilane and water in 1:2 molar ratio gives product A which on heating above 100°C yields a cyclic or polymeric product B. The products A and B respectively, are

(a)

(b)

and $(Ph_2SiO)_n$ (n = 3, 4, or ∞)

(c)

and $(Ph_2SiO)_n$ (n = 3, 4, or ∞)

(d)

Q.83 According to Wade's rule, anion $C_2B_9H_{12}^-$ adopts

(a)   Closo-structure   (b)   Nido-structure   (c)   Arachno-sturcture   (d)   Hypho-structure

Q.84 The final product in the reaction of $[Cp^*_2 ThH]$ with CO in an equimolar ratio is

(a)

(b)

(c) $ThCp^*_2$—O—CH$_2$—C(H)—ThCp$^*_2$ (epoxide with O)

(d) $ThCp^*_2$ (with O-containing three-membered ring)
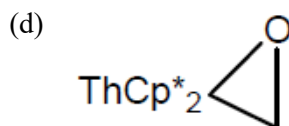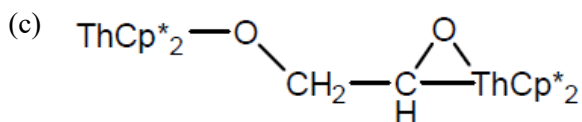
Q.85 Hindered β – diketonates like dpmH (dpmH = dipivaloylmethane) are used for the separation of lanthanides because complexes formed with dpmH can be separated by

(a) Gel permeantion chromatography

(b) Gas chromatography

(c) Gel filtration chromatography

(d) Ion exchange chromatography

Q.86 Base hydrolysis of $[CoCl(NH_3)_5]^{2+}$ is an overall second order reaction, whereas that of $[Co(CN)_6]^{3-}$ is of first order. The rates depend in both cases solely on the concentrations of the cobalt complex. This may be due to

(A) Presence of ionizable proton in $[CoCl(NH_3)_5]^{2+}$ but not in $[Co(CN)_6]^{3-}$

(B) SN^1CB mechanism in the case of $[CoCl(NH_3)_5]^{2+}$ only

(C) SN^1CB mechanism in the case of $[Co(CN)_6]^{3-}$ only

(D) SN^1CB mechanism in both the complexes

Correct explanation(s) is/are

(a) A and B

(b) A and C

(c) B only

(d) A and D

Q.87 A borane (X) is reacted with ammonia to give a salt of borohydride (Y). The ^{11}B NMR spectrum of Y consists of a triplet and a quintet. The borane X is

(a) B_2H_6

(b) B_3H_9

(c) B_4H_8

(d) B_5H_9

Q.88 The main products of the reaction of equimolar quantities of XeF_6 with $NaNO_3$ are

(a) $XeOF_4$, NaF and NO_2F

(b) XeO_2F_2 , NaF, NOF and F_2

(c) XeO_2F_2 , NaF and NOF

(d) XeF_4, $NaNO_2$ and F_2O

Q.89 The spin-only magnetic moment and the spectroscopic ground state term symbol of manganese center in $[MnF_6]^{3-}$ ion respectively, are

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(a)   4.9 BM and ^5D (b)   4.9 BM and ^4F (c)   3.9 BM and ^3D (d)   4.9 BM and ^3F

Q.90 The three dimensional structure of compound $[Co(Co(NH_3)_4(OH)_2)_3]Br_6$ has

(a)   Twelve Co-O and twelve Co-N bonds   (b)   Ten Co-O and ten Co-N bonds

(c)   Fourteen Co-O and ten Co-N bonds   (d)   Twelve Co-O and ten Co-N bonds

Q.91 The spin-only (μ_s) and spin plus orbital (μ_{S+L}) magnetic moments of $[CrCl_6]^{3-}$ are

(a)   3.87 BM and 5.20 BM   (b)   2.84 BM and 5.20 BM

(c)   3.87 BM and 6.34 BM   (d)   2.84 BM and 6.34 BM

Q.92 Complexes $HM(CO)_5$ and $[(\eta^5 - C_5H_5)M'(CO)_3]_2$ obey the 18-electron rule. Identify M and M' and their 'H NMR chemical shifts relative to TMS.

(a)   M = Mn, –7.5; M' = Cr, 4.10   (b)   M = Cr, 4.10; M' = Mn, –7.5

(c)   M = V, –7.5; M' = Cr, 4.10   (d)   M = Mn, 10.22; M' = Fe, 2.80

Q.93 12-Crown-4 binds with the alkali metal ions in the following order : $Li^+ \gg Na^+ > K^+ > Cs^+$. It is due to the

(a)   Right size of cation   (b)   Change in entropy being positive

(c)   Conformational flexibility of crown ether (d)   Hydrophobicity of crown ether

Q.94 The correct schematic molecular energy diagram for SF_6 molecule is

(a)

(b)

(c)

(d)
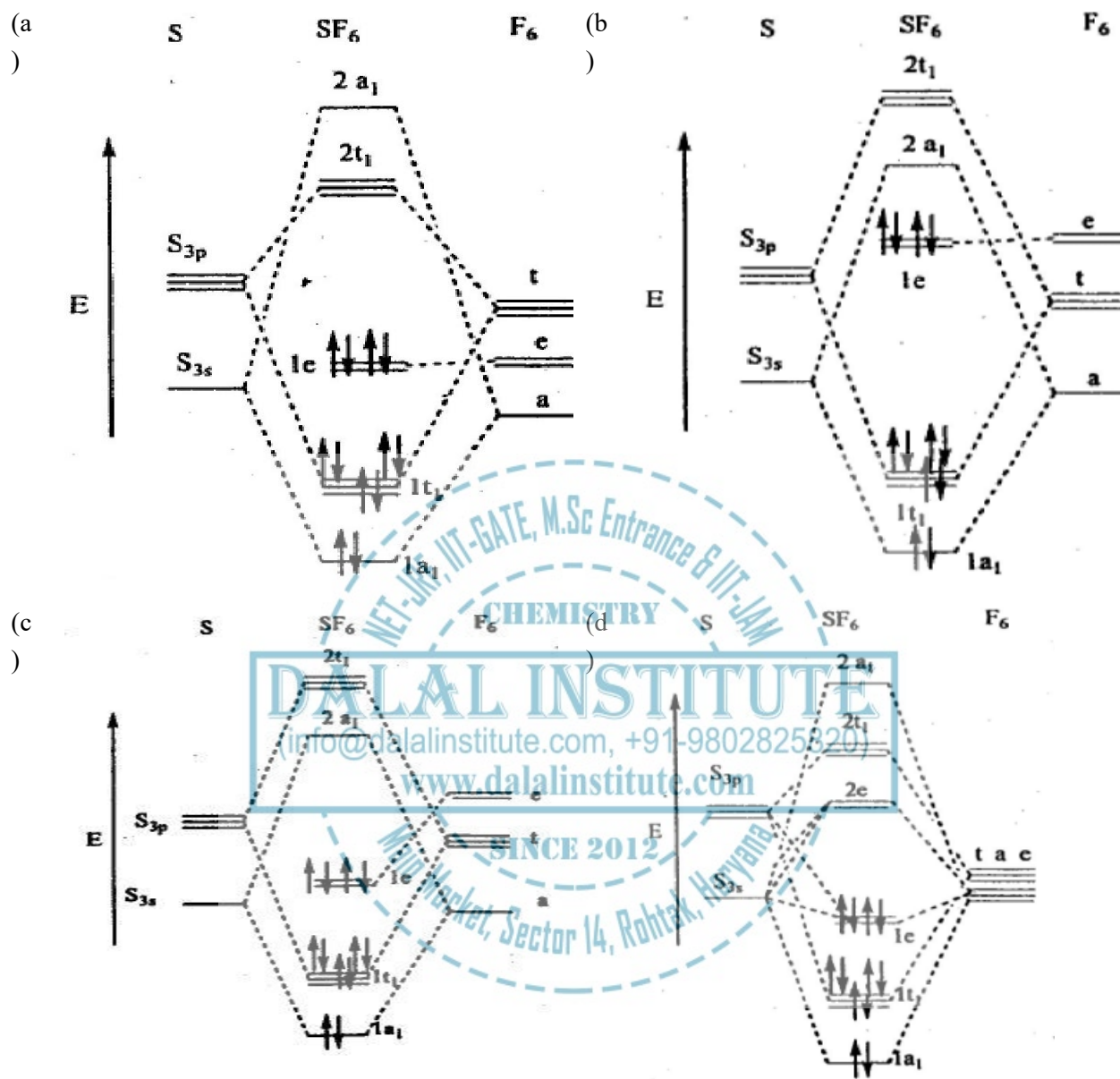
Q.95 Gel permeation chromatography can be used to separate which of the following

(A)Lanthanides (B) Alkaline earths (C) Fatty acids (D) Low molecular weight peptides

The correct answer is

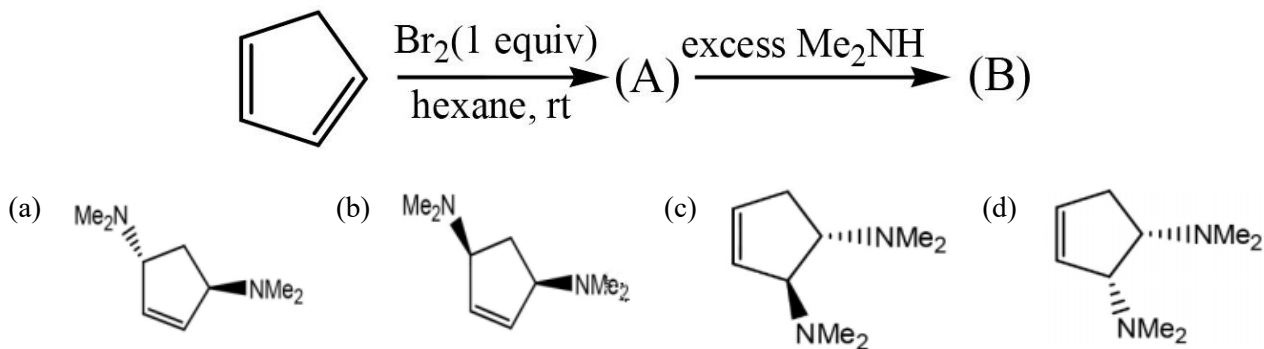 (a)   A and B   (b)   B and C   (c)   C and D   (d)   A and D
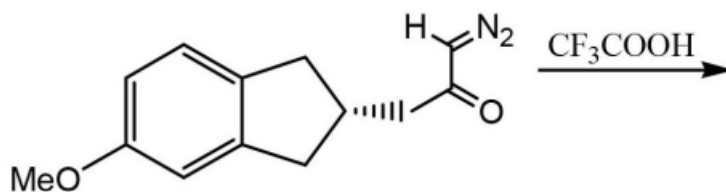
Q.96 The major product formed in the following reaction is

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(i) Me$_2$C(OMe)$_2$, TsOH(cat)

(ii) BH$_3$, THF

(iii) H$_3$O$^+$
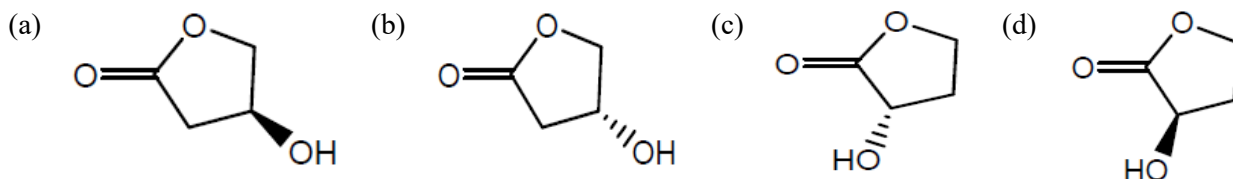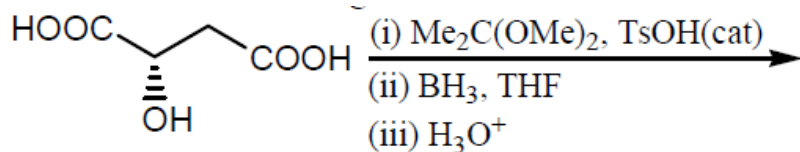
(a)   (b)   (c)   (d)

Q.97 The major product formed in the following transformation is

(i) Bu$_2$BOTf, i-Pr$_2$NEt

(ii) PhCHO
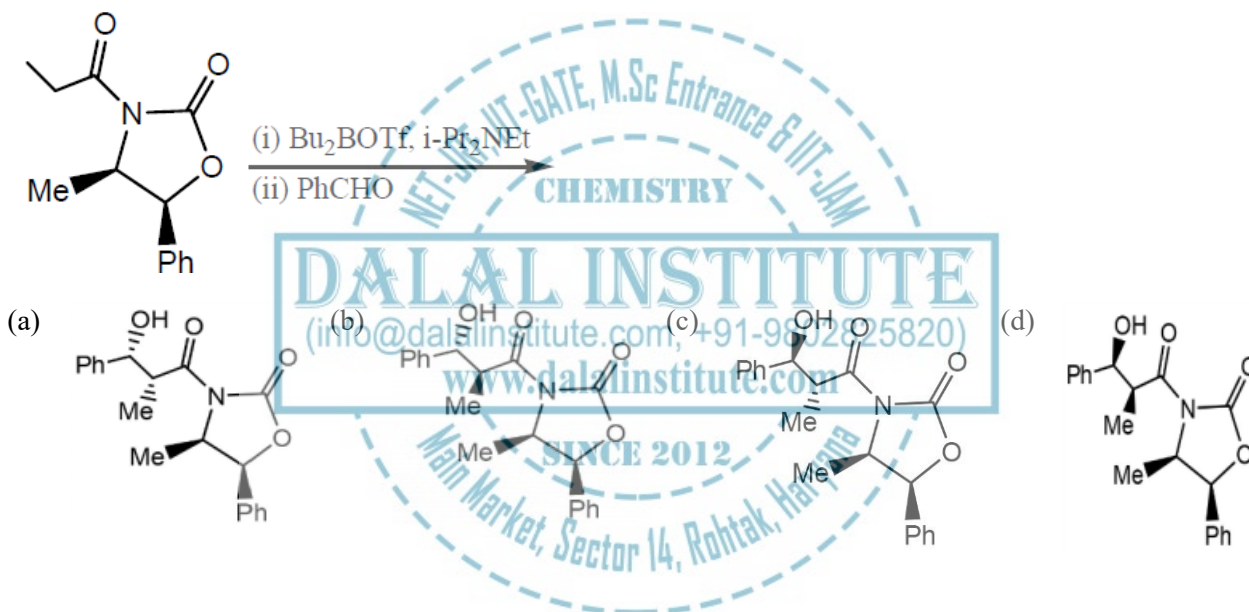
(a)   (b)   (c)   (d)

Q.98 The product of B in the following reaction sequence is

$$\xrightarrow[\text{hexane, rt}]{\text{Br}_2 (1\ \text{equiv})} (A) \xrightarrow{\text{excess Me}_2\text{NH}} (B)$$

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

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Q.99 The major product of the following reaction is

(a)

(b)

(c)

(d)

Q.100 The major product of the following reactions is

$$\text{(i) } H_3O^+, h\nu$$
$$\text{(ii) NaOH}$$

(a)

(b)

(c)

(d)

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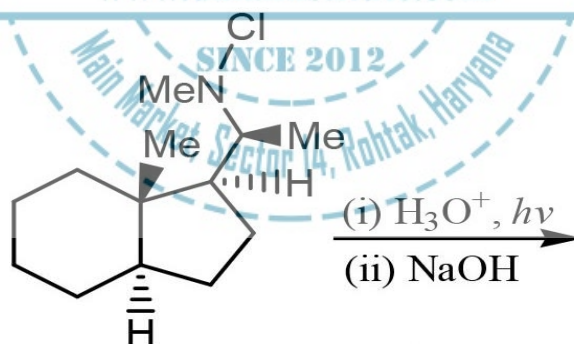
Q.101 The major product for the following reactions is

(a)

(b)

(c)

(d)
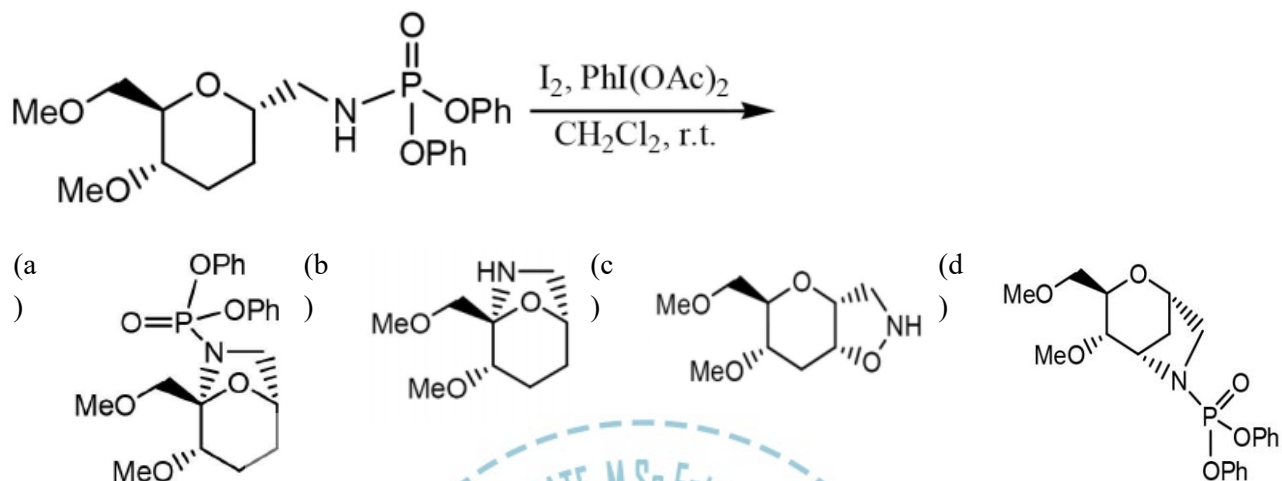
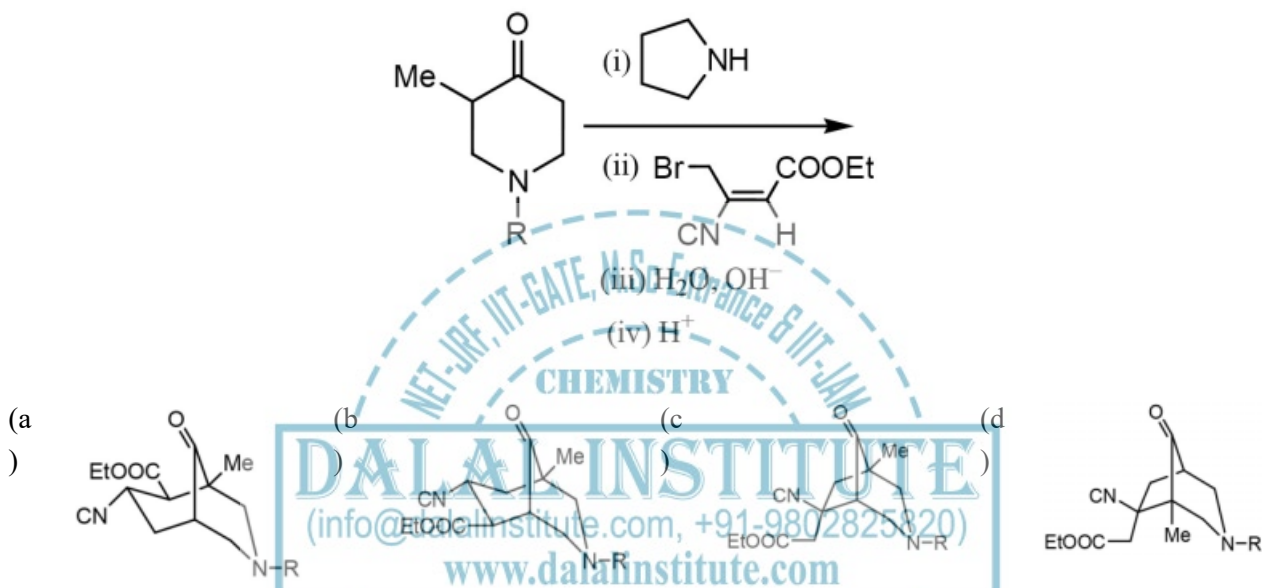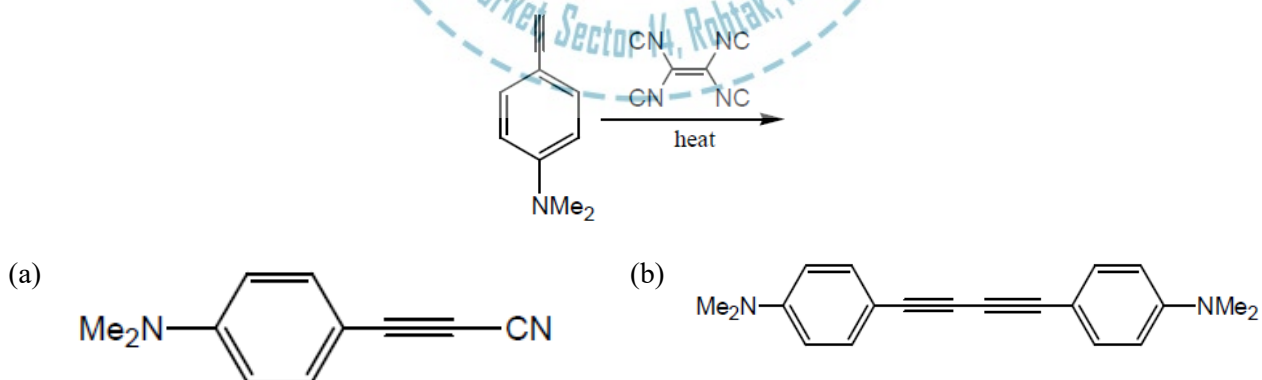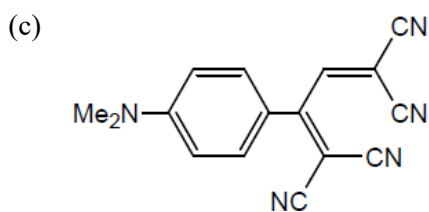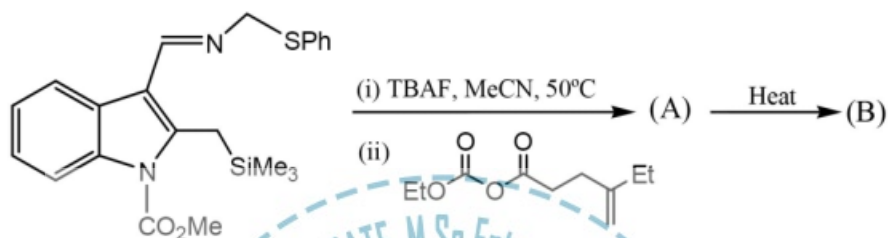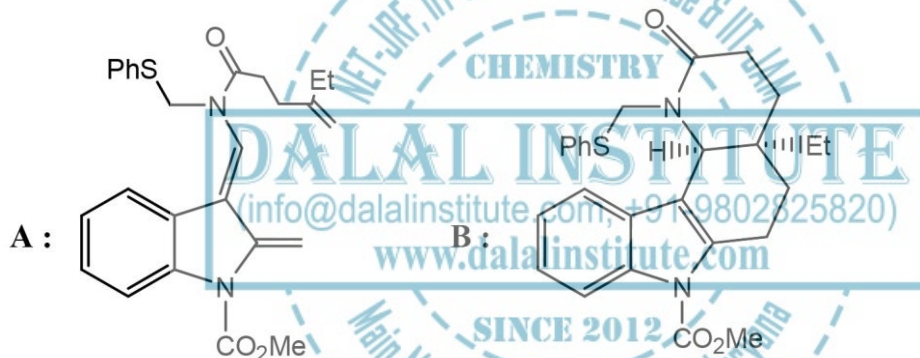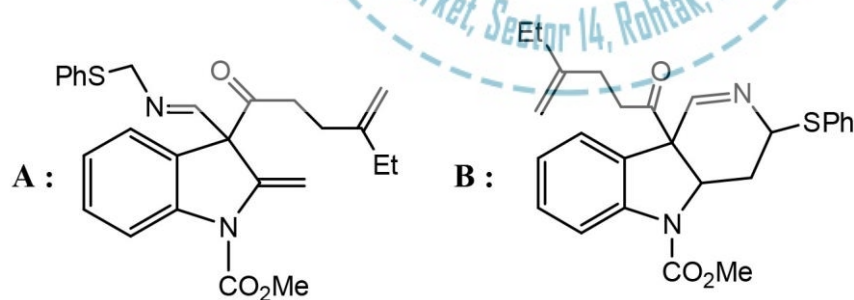Q.102 The products A and B in the following reaction sequence are

(a)

(b)

(c)

(d)

Q.103 The products A and B in the following reaction sequence are

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(a)
A : [structure with Boc, O, Me₃Si]   B : [structure BocHN, OH, SiMe₃, O]

(b)
A : [structure with Boc, O]   B : [structure BocHN, OH, O]

(c)
A : [structure with N-H, O, Me₃Si]   B : [structure H₂N, OH, SiMe₃, O]

(d)
A : [structure with N-H, O]   B : [structure H₂N, OH, O]
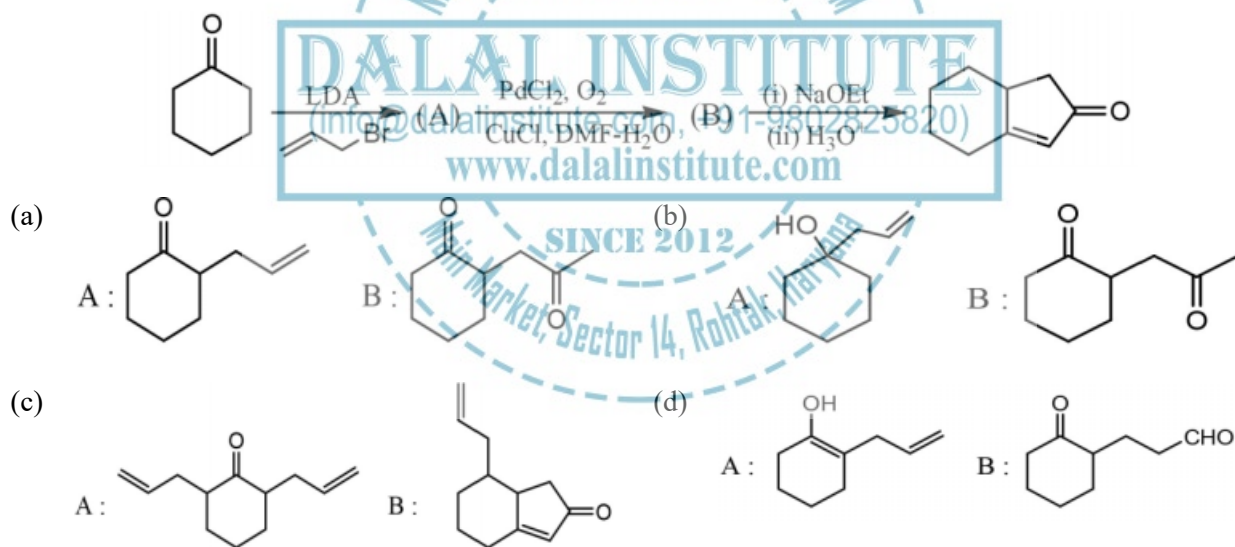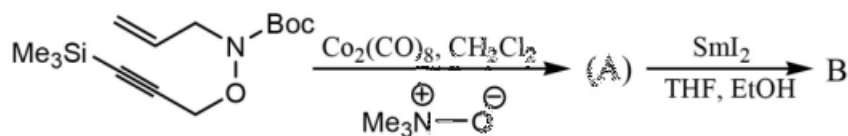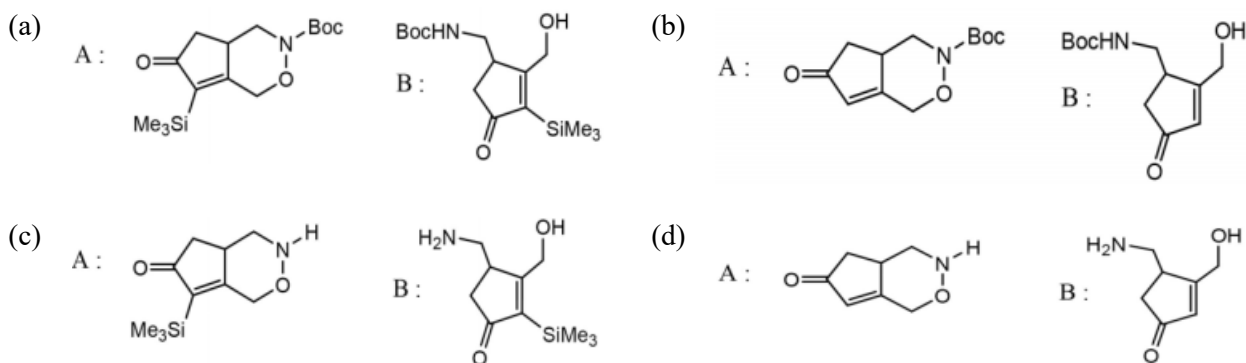
Q.104 The correct combinations of the reactions and the reagents are
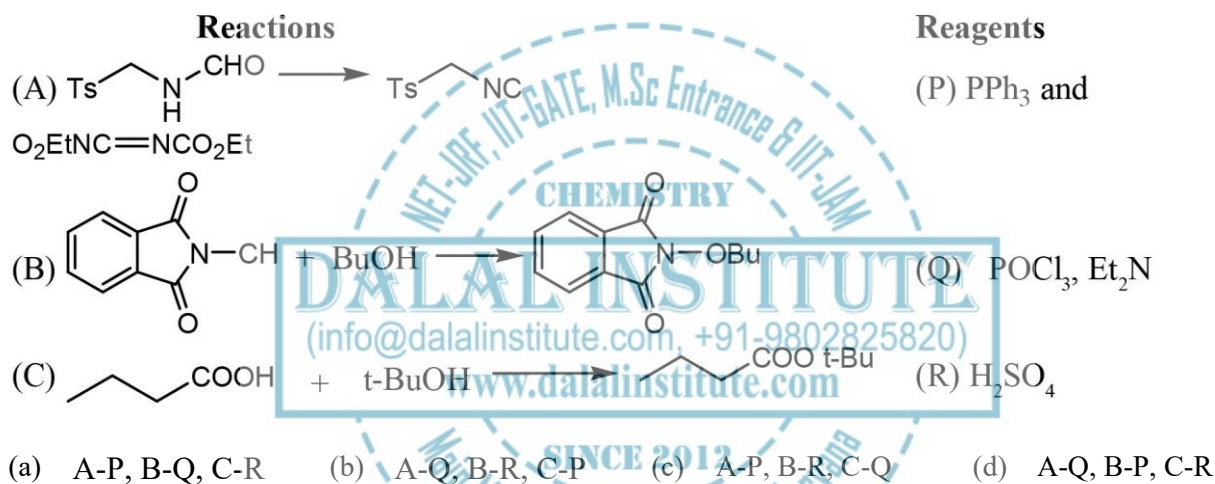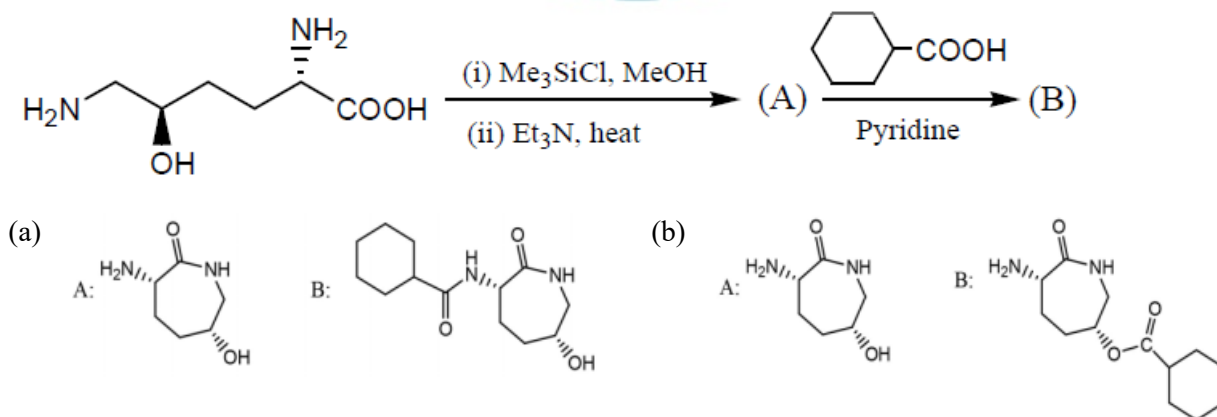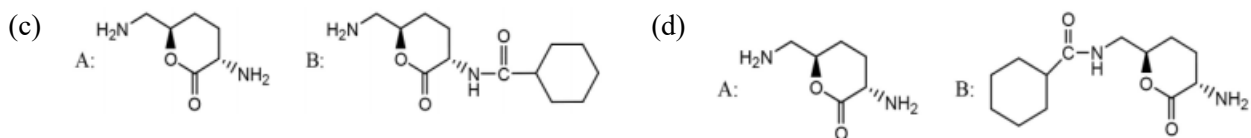
Reactions

(A) Ts-CH₂-N(H)-CHO ⟶ Ts-CH₂-NC

$O_2EtNC = NCO_2Et$

(B) [phthalimide]N-CH + BuOH ⟶ [phthalimide]N-OBu

(C) [structure]COOH + t-BuOH ⟶ [structure]COO t-Bu

Reagents

(P) PPh₃ and

(Q) POCl₃, Et₂N

(R) H₂SO₄

(a) A-P, B-Q, C-R   (b) A-Q, B-R, C-P   (c) A-P, B-R, C-Q   (d) A-Q, B-P, C-R

Q.105 The products A and B in the following reaction sequence are

[structure with NH₂, H₂N, COOH, OH]
(i) Me₃SiCl, MeOH
(ii) Et₃N, heat
⟶ (A)
[cyclohexyl-COOH]
Pyridine
⟶ (B)

(a)
A: [structure H₂N, NH, OH]   B: [cyclohexyl-C(O)-N(H), NH, OH]

(b)
A: [structure H₂N, NH, OH]   B: [structure H₂N, NH, O-C(O)-cyclohexyl]

(c) A: B: (d)   A: B:

Q.106 The major product of the following reaction is

(i) pyrrolidine NH

(ii) Br—CH=C(CN)—COOEt (H)

(iii) H_2O, OH^-

(iv) H^+

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

Q.107 The major product of the following reaction is

heat

(a) Me_2N—C₆H₄—C≡C—CN

(b) Me_2N—C₆H₄—C≡C—C≡C—C₆H₄—NMe_2

(c)

(d)
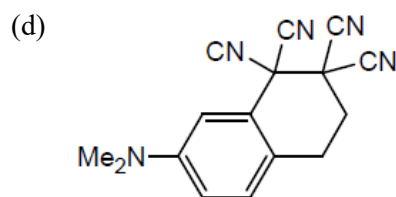
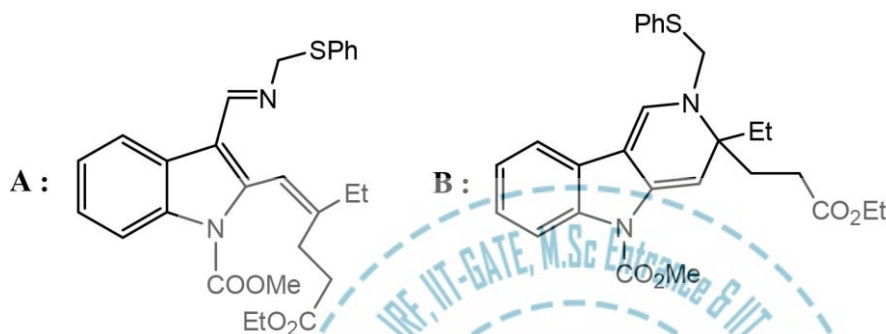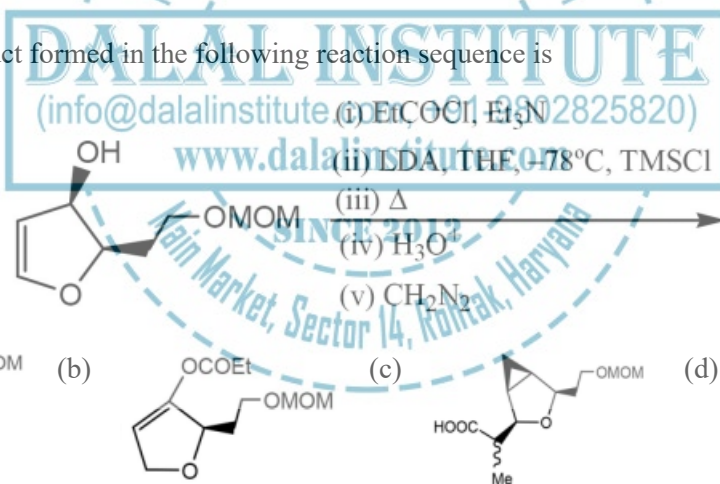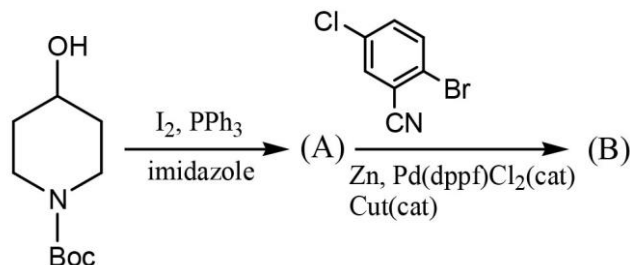Q.108 The products A and B in the following reaction sequence are

(a)

A :

B :

(b)

A :

B :

(c)

A :

B :

(d)

A :

B :

Q.109 The major product formed in the following reaction sequence is

(i) EtCOCl, Et₃N
(ii) LDA, THF, −78°C, TMSCl
(iii) Δ
(iv) H₃O⁺
(v) CH₂N₂

(a)   (b)   (c)   (d)
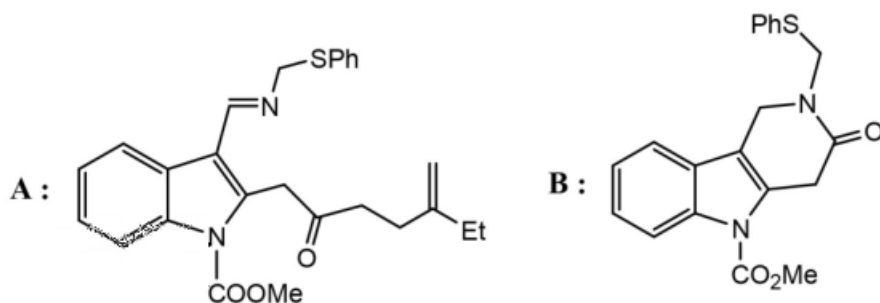
Q.110 In the following reaction sequence, the structures of A and B are, respectively,

$\xrightarrow[\text{imidazole}]{I_2, PPh_3}$ (A) $\xrightarrow[\substack{\text{Zn, Pd(dppf)Cl}_2\text{(cat)}\\\text{Cut(cat)}}]{}$ (B)

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(a)

(b)

(c)

(d)
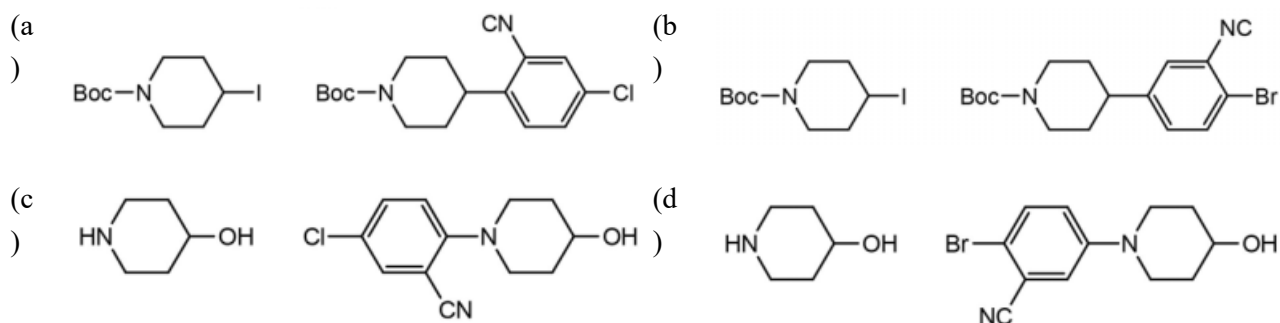
Q.111 In the following reaction sequence, the structure of the product is

(i) DIBAL-H(1, 1 equiv), hexane, −78ºC
(ii) ClCH₂COOH, diethyl azodicarboxylate PPh₃
(iii) LiAlH₄

(a)

(b)

(c)

(d)

Q.112 The correct combination of the following reactions and their ρ values is

Entry	Reaction	Entry	ρ Value
A	ArNH₂ + PhCOCl in Benzene	P	+ 2.01
B	ArO⁻ + EtI in EtOH	Q	– 0.99
C	ArCO₂Et + aq NaOH in EtOH	R	– 2.69
		S	+ 0.78

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(a)   A-P ; B-R ; C-P   (b)   A-R ; B-Q ; C-P   (c)   A-R ; B-P ; C-Q   (d)   A-Q ; B-R ; C-S

Q.113 The following reactions gives a product (racemic) which exhibits the following NMR data :

1H NMR : δ 2.67 (2H,s), 5.60 (2H,s) ppm; 13C NMR : δ 170.3, 129.0, 105.0, 25.4 ppm

The structure of the product (racemic) is
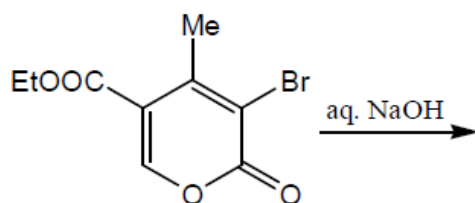
(a)   (b)   (c)   (d)

Q.114 The reactive intermediate and the product formed in the following reaction are

(a)   Free radical and 4-iodomethyloxepan-2-one   (b)   Free radical and 5-iodooxacan-2-one

(c)   Carbene and 3-oxabicyclo[5.1.0]octane-2-one   (d)   Carbene and (E)-5-iodopent-3-en-1-yl acetate

Q.115 The major product formed in the following reaction sequence is

(i) 4-Methoxybenzaldehyde, H$^+$

(ii) DIBAL-H, −78 to −40°C

(a)   (b)   (c)   (d)
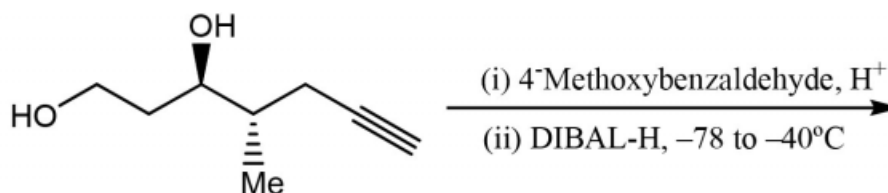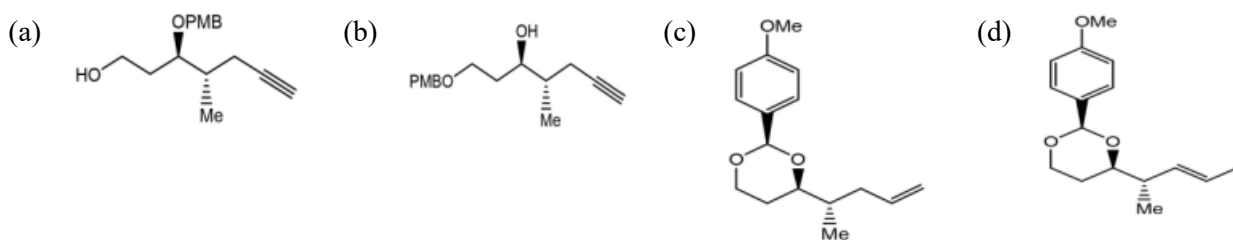
Q.116 An organic compound having molecular formula $C_{10}H_{12}O_2$ exhibits the following spectral data:
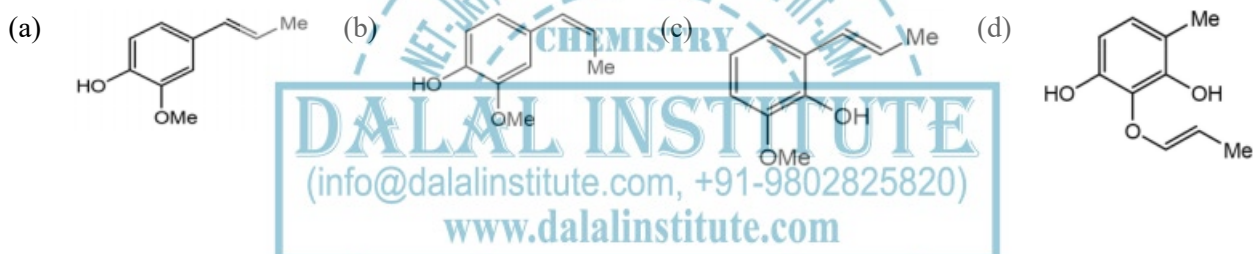
IR : 3400 (br), 1600 cm^{-1}.

^{1}H NMR: δ 1.85(3H, d, J = 6Hz), 3.8(3H,s), 5.0(1H, s, D$_2$O exchangeable), 6.0 (lH,dq,J = 18,6Hz),
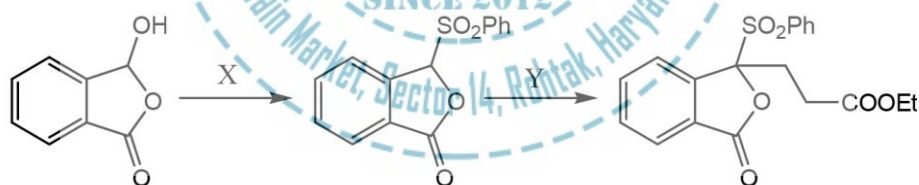
6.28 (lH, d, J = 18 Hz), 6.75 (lH, d, J = 8 Hz), 6.8 (lH, s), 6.90 (lH, d, J = 8 Hz) ppm;

^{13}C NMR: δ 146.5, 144.0, 131.0, 130.5, 123.0, 119.0, 114.0, 108.0, 55.0, 18.0 ppm.
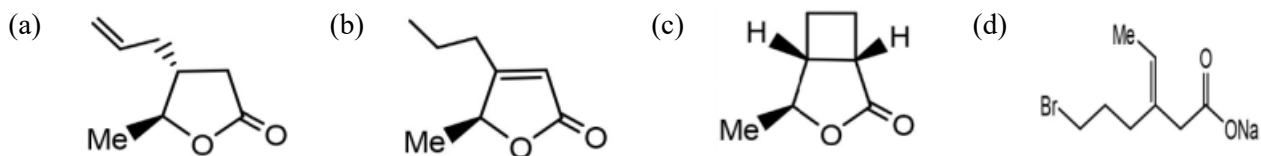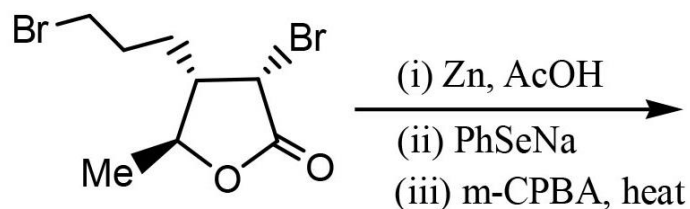
The structure of the compound is

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

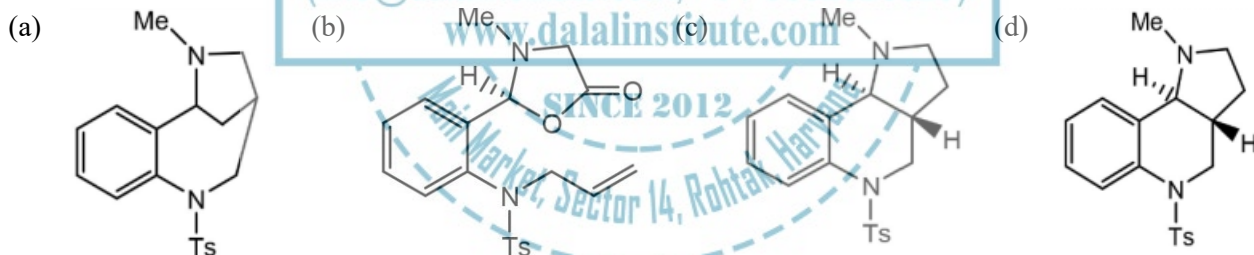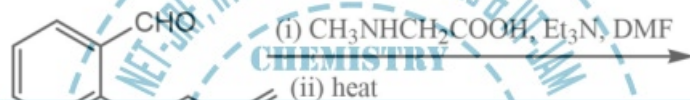Q.117 In the following reaction sequence, the reagents X and Y are, respectively,

(a) X = PhSO$_2$H, BF$_3$OEt$_2$ and Y = CH$_2$ = CHCOOEt, BF$_3$OEt$_2$

(b) X = 1. PhSH, PTSA; 2. m-CPBA and Y = CH$_2$ = CHCOOEt, BF$_3$OEt$_2$

(c) X = PhSO$_3$H, BF$_3$OEt$_2$ and Y = LDA, CH$_2$ = CHCOOEt

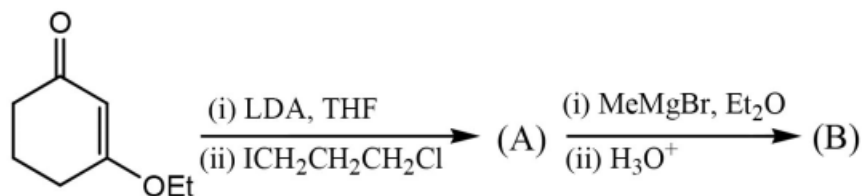(d) X = 1. PhSH, PTSA;2. m-CPBA and Y = LDA, CH$_2$ = CHCOOEt
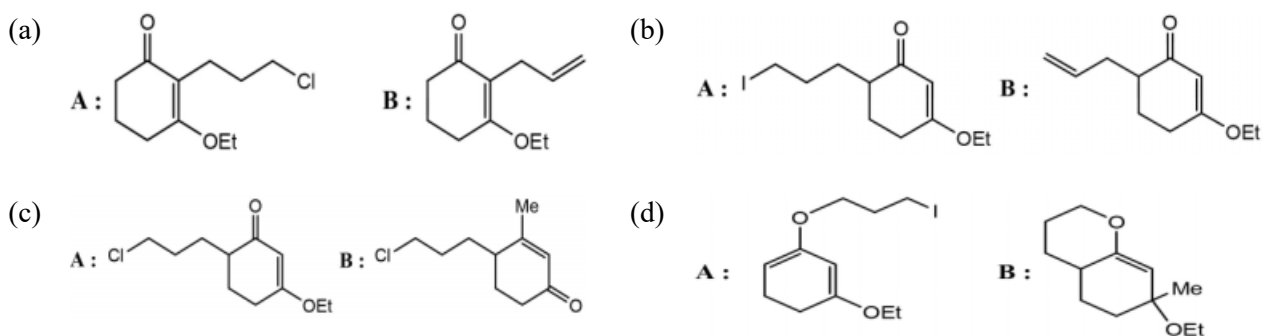
Q.118 The major product of the following reaction is

(i) Zn, AcOH

(ii) PhSeNa

(iii) m-CPBA, heat

(a)

(b)

(c)

(d)

Q.119 The major product of the following reaction is

(i) CH$_3$NHCH$_2$COOH, Et$_3$N, DMF

(ii) heat

(a)

(b)

(c)

(d)

Q.120 The major products A and B formed in the following reaction sequence are

(i) LDA, THF

(ii) ICH$_2$CH$_2$CH$_2$Cl

(A)

(i) MeMgBr, Et$_2$O

(ii) H$_3$O$^+$

(B)

(a)   (b)

A :   [structure with OEt and Cl chain]   A : I [structure]   B : [structure with OEt]

B :   [structure with OEt, allyl]

(c)   (d)

A : Cl [structure with OEt]   B : Cl [structure with Me]   A : [structure with OEt]   B : [structure with Me, OEt]

Q.121 For a gaseous reaction, $2NO(g) + Cl_2(g) \rightarrow$ Non-linear T.S. $\rightarrow 2NOCl$, the pre-exponential factor in the rate constant is proportional to

(a) $T^{1/2}$ (b) $T^{-1/2}$ (c) $T^{-5/2}$ (d) $T^{-7/2}$

Q.122 Species A undergoes a unimolecular reaction as follows:

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

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

For this reaction, the first order rate constant at high pressure is k_∞. The first order rate constant becomes $\dfrac{k_\infty}{2}$ when pressure of A is $[A]_{1/2}$
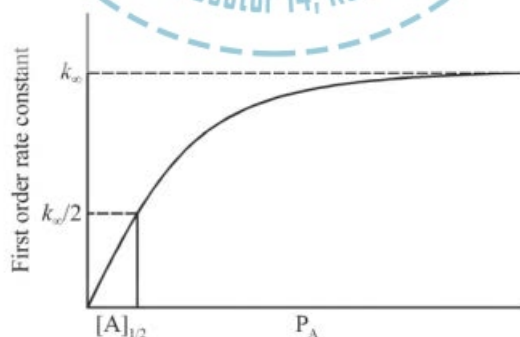
The value of k_1 will be

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

Q. 123 The low and high temperature limits of vibrational partition function are $\left(\theta = \dfrac{hv}{k}\right)$

(a)   (b)

(c)   (d)

Q.124 The probability of finding the harmonic oscillator in the energy level n = 1 is (neglect zero-point energy and assume $hv = k_BT$)

(a) e   (b) e^2 (c) $1 - e^{-2}$ (d) $e^{-2}(e-1)$

Q.125 A particle in a 1-dimensional box of length L is perturbed by a delta function potential, $\delta(x-L/2)$, in the middle of the box. The first order energy correction to the ground state will be

$$\left[Hint \int_{+\infty}^{-\infty} f(x)\delta(x-a)dx = f(a) \right]$$

(a) 0   (b) 1   (c) L/2   (d) 2/L

Q.126 The operators $S\pm$ are defined by $S\pm = S_x \pm iS_Y$, where S_x and S_y are components of the spin angular momentum operator. The commutator $[S_z, S_+]$ is

(a) $\hbar S_+$ (b) $\hbar S_-$ (c) $-\hbar S_+$ (d) $-\hbar S_-$

Q.127 A quantum particle with fixed initial energy $E_0 < V$ is allowed to strike the following four barriers separately. The transmission probability is maximum in

(a)

$0 \rightsquigarrow$ | V | 2A

(b)

$0 \rightsquigarrow$ | V | A

(c)

$0 \rightsquigarrow$ | 2V | A

(d)

$0 \rightsquigarrow$ | 2V | 2A
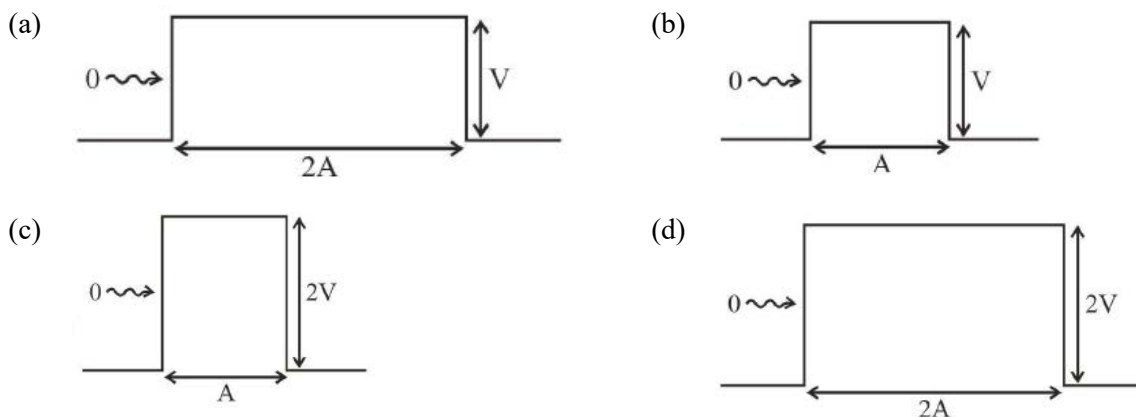
Q.128 Given the following two relations,

$x_1 d\mu_1 + x_2 d\mu_2 = 0$ (A)

$x_1 d\overline{V}_1 + x_2 d\overline{V}_2 = 0$ (B)

For a binary liquid mixture at constant temperature and pressure, the true statement is that,

(a)   Both the relations are correct.

(b)   Relation A is correct, but B is not.

(c)   Relation B is correct, but A is not.

(d)   Both the relations are incorrect, except for very dilute solutions.

Q.129 If the bond length of a heteronuclear diatomic molecule is greater in the upper vibrational state, the gap between the successive absorption lines of P-branch

(a)   Increases non-linearly.   (b)   Decreases non-linearly.

(c)   Increases linearly.   (d)   Decreases linearly.

Q.130 EPR spectrum of a free radical containing nuclei with non-zero nuclear spin is obtaining if the following selection rules are observed:

(a) $\Delta m_s = 0, \Delta m_1 = 0$ (b) $\Delta m_s = \pm 1, \Delta m_1 = \pm 0$

(c) $\Delta m_s = \pm 1, \Delta m_1 = \pm 1$ (d) $\Delta m_s = 0, \Delta m_1 = \pm 1$

Q.131 At high pressure, the fugacity coefficient of a real gas is greater than one, because

(a)   Attractive term overweighs the repulsive term.

(b)   Repulsive term overweighs the attractive term.

(c)   Repulsive term is equal to the attractive term.

(d)   The system is independent of both the attractive and repulsive terms.

Q.132 If $D_0(A)$ and $I(A)$ refer respectively to the dissociation energy and ionization potential of A (where A is either H, H_2, or H_2^+ species), the correct relation among the following is

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(a) $D_0(H_2) = D_0(H_2^+) + I(H) - I(H_2)$

(b) $D_0(H_2) = D_0(H_2^+) - I(H) + I(H_2)$

(c) $D_0(H_2^+) = D_0(H_2) + I(H) + I(H_2)$

(d) $D_0(H_2^+) = D_0(H2) - I(H) - I(H_2)$

Q.133 The character table of C_{2v} point group is given below. In cis-butadiene molecule the vibrational modes belonging to A_2 irreducible representation are IR inactive. The remaining IR active modes are

C_{2v}	E	C_2	σ_v	Σ'_v	
A_1	1	1	1	1	z, x^2, y^2, z
A_2	1	1	-1	-1	R_z, xy
B_1	1	-1	1	-1	x, R_y, xz
B_2	1	-1	-1	1	y, R_x, yz

(a) $7A_1 + 5B_1 + 8B_2$ (b) $9A_1 + 4B_1 + 7B_2$ (c) $7A_1 + 3B_1 + 7B_2$ (d) $9A_1 + 3B_1 + 8B_2$

Q.134 The product $\sigma^{xy}.S_4^z$ (S_4^z is the four fold improper axis o rotation around the z-axis, and σ^{xy} is the reflection in the xy plane) is

(a) C_4^z (b) $C_4^z.i$ (c) C_4^y (d) C_2^z

Q.135 A solid consisting of only X-atoms has a close-packed structure with X-X distance of 160 pm. Assuming it to be a closed packed structure of hard spheres with radius equal to half of the X-X bond length, the number of atoms in 1 cm^3 would be

(a) 6.023×10^{27} (b) 3.45×10^{23} (c) 6.02×10^{21} (d) 3.8×10^{21}

Q.136 Fuel cells provide clean electrical energy to a variety of applications including automobiles and stationary power sources. Normally hydrogen combines with oxygen to give electrical energy and water. If we use butane instead of hydrogen at 1.0 bar and 298 K, the following reaction occurs : $C_4H_{10}(g) + \frac{13}{2} O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$

If the change in the Gibbs free energy of this reaction is 2746.06 kJ mol^{-1}, involving 26 electrons,

its open circuit voltage is

(a)   1.55 V   (b)   1.09 V   (c)   3.15 V   (d)   2.06 V

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Q.137 The fraction of groups condensed at time t in any stepwise condensation polymerization (overall second order) reaction is

(a) $1 + kt[A]_0$

(b) $\dfrac{1}{1 + kt[A]_0}$

(c) $\dfrac{kt[A]_0}{1 + kt[A]_0}$

(d) $\dfrac{1 + kt[A]_0}{kt[A]_0}$

Q.138 The configuration [Ne] $2p^1\ 3p^1$ has a ^3D term. Its levels are

(a) $^3D_{3/2},\ ^3D_{1/2}$

(b) $^3D_{5/2},\ ^3D_{3/2},\ ^3D_{1/2}$

(c) $^3D_3,\ ^3D_2,\ ^3D_1$

(d) $^3D_3,\ ^3D_2,\ ^3D_1,\ ^3D_0$

Q.139 For some one-electron system with l = 0 and m = 0, the functions $N_0 e^{-\sigma}$ and $N_1(2 - \sigma)\ e^{-\sigma}$ refer respectively to the ground (E_0) and first excited (E_1) energy levels. If a variational wave function $N_2(3 - \sigma)\ e^{-\sigma}$ yields an average energy $\overline{E}$, it will satisfy

(a) $\overline{E} \geq 0$

(b) $0 \leq \overline{E} \leq E_0$

(c) $\overline{E} \geq E_1$

(d) $E_0 \leq \overline{E} \leq E_1$

Q.140 The number of microstates that are possible, when two particles are distributed in four states such that the resulting wave functions are antisymmetric with respect to exchange of the particles, is

(a) 16

(b) 12

(c) 8

(d) 6

Q.141 A Slater determinant corresponding to the ionic part of the ground state valence bond wave function of H_2 molecule is ($1s_a\alpha, 1s_a\beta, 1s_b\alpha, 1s_b\beta$ are atomic spin-orbitals of hydrogen atoms a and b of the hydrogen molecule)

(a) $\begin{vmatrix} 1s_a\alpha(1) & 1s_a\beta(1) \\ 1s_a\alpha(2) & 1s_a\beta(2) \end{vmatrix}$

(b) $\begin{vmatrix} 1s_a\alpha(1) & 1s_b\beta(1) \\ 1s_a\alpha(2) & 1s_b\beta(2) \end{vmatrix}$

(c) $\begin{vmatrix} 1s_a\alpha(1) & 1s_b\alpha(1) \\ 1s_a\alpha(2) & 1s_b\alpha(2) \end{vmatrix}$

(d) $\begin{vmatrix} 1s_a\alpha(1) & 1s_b\beta(1) \\ 1s_a\alpha(1) & 1s_b\beta(2) \end{vmatrix}$

Q.142 When $T \rightarrow \infty$, value of the single particle partition function will be (given : degeneracy of level j = g_i)

(a) 1

(b) g_0

(c) $\sum_j g_j$

(d) $\dfrac{1}{\sum_j g_j}$

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Q.143 The rate constant for a reaction $A^{1+} + B^{n+} \rightarrow P$ is measured in two different aqueous solutions of ionic strengths 0.01 M and 0.04 M. If $\log k \frac{k_{0.04}}{k_{0.01}} = 0.3$, the charge n on B is closest to

(a)   1   (b)   2   (c)   3   (d)   6

Q.144 According to Huckel theory, the n electron charge on the central carbon atom in propenyl cation $(CH_2CHCH_2)^+$ is (in units of electronic charge)

(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ (c)   1   (d)   2

Q.145 Among the following figures, the variations of mass adsorbs with pressure for a monolayer and a multilayer are represented by
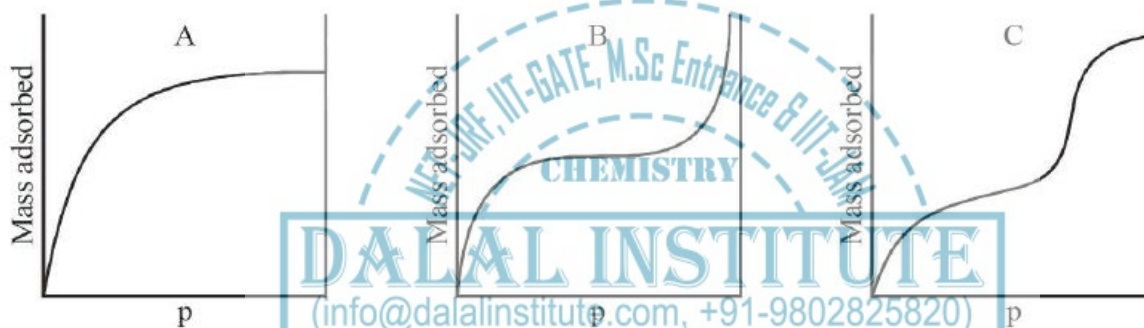
(a)   A and C respectively.   (b)   A and B respectively.

(c)   C and A respectively.   (d)   B and A respectively.

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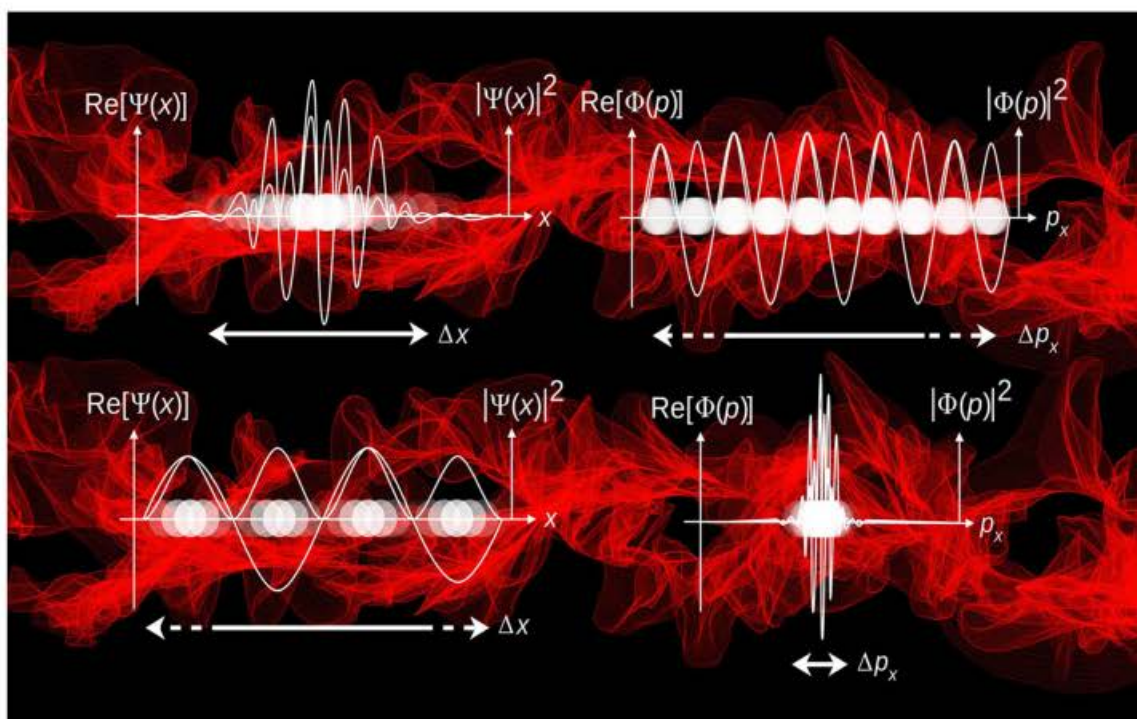
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