

CSIR UGC – NET JRF: June 2015

Chemical Science

❖ Question Paper

Section-A

Q.1 Each of the following pairs of words hides a number, based on which you can arrange them in ascending order. Pick the correct answer:

I. Cloth reel

J. Silent wonder

K. Good tone

L. Bronze rod

- (a) L,K,J,I (b) I,J,K,L (c) K,L,J,I (d) K,J,I,L

Q.2 Which of the following values is same as $2^{2^{2^2}}$?

- (a) 2^6 (b) 2^8 (c) 2^{16} (d) 2^{222}

Q.3 A 12×4 m rectangular roof is resting on four 4 m tall thin poles. Sunlight falls on the roof at an angle of 45° from east, creating a shadow on the ground. What will be the area of the shadow?

- (a) 24m^2 (b) 36m^2 (c) 48m^2 (d) 60m^2

Q.4 If

$$\begin{array}{r} 2a \\ \times \quad b2 \\ \hline c6 \\ 84 \\ \hline 8d6 \end{array}$$

Here a,b,c and d are digits. Then $a + b =$

- (a) 4 (b) 9 (c) 11 (d) 16

Q.5 The maximum number of points formed by intersection of all pairs of diagonals of convex octagon is

- (a) 70 (b) 400 (c) 120 (d) 190

Q.6 Find the height of a box of base area $24 \text{ cm} \times 48 \text{ cm}$, in which the longest stick that can be kept is 56 cm long.

- (a) 8 cm (b) 32 cm (c) 37.5 cm (d) 16 cm

Q.7 The product of the perimeter of a triangle, the radius of its in-circle, and a number gives the area of the triangle. The number is

- (a) $\frac{1}{4}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) 1

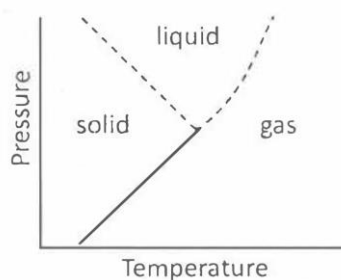
Q.8 An infinite row of boxes is arranged. Each box has half the volume of the previous box. If the largest box has a volume of 20 cc, what is the total volume of all the boxes?

- (a) Infinite (b) 400 cc (c) 40 cc (d) 80 cc

Q.9 Find the missing element based on the given pattern.

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

Q.10 By reading the accompanying graph, determine the INCORRECT statement out of the following.



- (a) Melting point increases with pressure.

- (b) Melting point decreases with pressure.
- (c) Boiling point increases with pressure.
- (d) Solid, liquid and gas can co-exist at the same pressure and temperature.

Q.11 If you change only one observation from a set of 10 observations, which of the following will definitely change?

- (a) Mean
- (b) Median
- (c) Mode
- (d) Standard deviation

Q.12 A man starts his journey at 0100 hrs. local time to reach another country at 0900 hrs. local time on the same date. He starts a return journey on the same night at 2100 hrs. local time to his original place, taking the same time to travel back. If the time zone of his country of visit lags by 10 hours, the duration for which the man was away from his place is

- (a) 48 hours
- (b) 20 hours
- (c) 25 hours
- (d) 36 hours

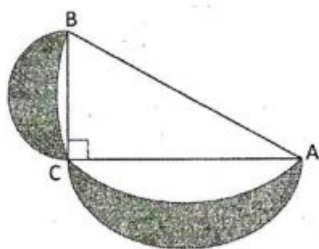
Q.13 Let r be a positive number satisfying $r^{(1/1234)} + r^{(-1/1234)} = 2$. Then $r^{4321} + r^{-4321} = ?$

- (a) 2
- (b) $2^{(4321/1234)}$
- (c) 2^{3087}
- (d) 2^{1234}

Q.14 A boat is drifting in a river, 10 m downstream of a boat that can be rowed at a speed of 10 m/minute in still water. If the boat is rowed downstream, the time taken to catch up with the float

- (a) Will be 1 minute.
- (b) Will be more than 1 min.
- (c) Will be less than 1 min.
- (d) Can be determined only if the speed of the river is known.

Q.15 ABC is a right angled triangle inscribed in a semicircle. Smaller semicircles are drawn on sides BC and AC. If the area of the triangle is a , what is the total area of the shaded lunes?



- (a) a (b) πa (c) a/π (d) $a/2\pi$

Q.16 An ant can lift another ant of its size whereas an elephant can not lift another elephant of its size because

- (a) Ant muscle fibers are stronger than elephant muscle fibers.
 (b) Ant has proportionately thicker legs than elephant.
 (c) Strength scales as the square of size while weight scales as cube of size.
 (d) Ant work cooperatively, whereas elephant work as individuals.

Q.17 Consider a series of letters placed in the following way:

U G C C S I R

Each letter moves one step to its right and the extreme right letter takes the first position, completing one operation. After which of the following numbers of operations do the Cs not sit side by side?

- (a) 3 (b) 10 (c) 19 (d) 25

Q.18 An inclined plane rests against a horizontal cylinder of radius R . If the plane makes an angle of 30° with the ground, the point of contact of the plane with the cylinder is at a height of

- (a) $1.500 R$ (b) $1.866 R$ (c) $1.414 R$ (d) $1.000 R$

Q.19 What is the maximum number of parallel, non-overlapping cricket pitches (length 24 m, width 3 m) that can be laid in a field of diameter 140 m, if the boundary is required to be at least 60 m from the center of any pitch?

- (a) 6 (b) 7 (c) 12 (d) 4

Q.20 In a fast-moving car with open windows, the driver feels a continuous incoming breeze. The pressure inside the car, however, does not keep increasing because,

- (a) Air coming in from the front window goes out from the rear.
- (b) Air comes in as well as goes out through every window but the driver only feels the incoming one.
- (c) No air actually comes in and the feeling of breeze is an illusion.
- (d) Cool air reduces the temperature therefore the pressure does not increase.

Section-B

Q.21 The biological functions of carbonic anhydrase and carboxypeptidase A, respectively, are

- (a) Interconversion of CO_2 and carbonates, and hydrolysis of peptide bond.
- (b) Gene regulation and interconversion of CO_2 and carbonates.
- (c) Gene regulation and hydrolysis of peptide bond.
- (d) Interconversion of CO_2 and carbonates and gene regulation.

Q.22 The Fe–N_{porphyrin} bond distances in the deoxy and oxy-hemoglobin, respectively, are

- (a) ~ 2.1 and 2.0 \AA
- (b) ~ 2.0 and 2.0 \AA
- (c) ~ 2.2 and 2.3 \AA
- (d) ~ 2.3 and 2.5 \AA

Q.23 The binding modes of NO in 18 electron compounds $[\text{Co}(\text{CO})_3(\text{NO})]$ and $[\text{Ni}(\eta^5\text{-Cp})(\text{NO})]$, respectively, are

- (a) Linear and bent
- (b) Bent and linear
- (c) Linear and linear
- (d) Bent and bent

Q.24 The role of copper salt as co-catalyst in Wacker process is

- (a) Oxidation of Pd(0) by Cu(II)
- (b) Oxidation of Pd(0) by Cu(I)
- (c) Oxidation of Pd(II) by Cu(I)
- (d) Oxidation of Pd(II) by Cu(II)

Q.25 For typical Fischer and Schrock carbenes, consider the following statements

A. Oxidation state of metal is low in Fischer carbene and high in Schrock carbene

B. Auxilliary ligands are π -acceptor in Fischer carbene and non- π -acceptor in Schrock carbene

C. Substituents on carbene carbon are non- π -donor in Fischer carbene and π -donor in Schrock carbene carbene

D. Carbene carbon is electrophilic in Fischer carbene and nucleophilic in Schrock carbene

The correct statements are

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

Q.26 The species having the strongest gas phase proton affinity among the following,

- (a) N^{3-} (b) NF_3 (c) NH_3 (d) $\text{N}(\text{CH}_3)_3$

Q.27 Consider the following statements regarding the diffusion current at dropping mercury electrode

A. It does not depend on mercury flow rate.

B. It depends on drop time.

C. It depends on temperature.

Correct statements is/are:

- (a) A only (b) B only (c) A and B (d) B and C

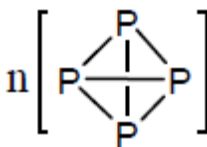
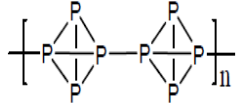
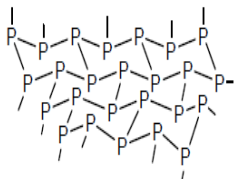
Q.28 Q value for the reaction $^{13}\text{N}(n, p)^{13}\text{C}$ is 3.236 MeV. The threshold energy (in MeV) for the reaction $^{13}\text{C}(p, n)^{13}\text{N}$ is

- (a) -3.236 (b) -3.485 (c) 3.485 (d) 3.845

Q.29 The ^{119}Sn NMR chemical shift (approximately in ppm) corresponding to $(\eta^5\text{-Cp})_2\text{Sn}$ (relative to Me_4Sn) is

- (a) -4 (b) +137 (c) +346 (d) -2200

Q.30 All forms of phosphorus upon melting, exist as

- (a)  (b)  (c) P_2 (d) 

Q.31 For the oxidation state(s) of sulphur atoms in S_2O , consider the following

A. -2 and +4 B. 0 and +2 C. +4 and 0

The correct answer(s) is/(are)

- (a) A and B (b) A and C (c) B and C (d) C only

Q.32 The correct set of pseudohalide anions is

- (a) CN^- , ClO_4^- , BF_4^- , PF_6^- (b) N_3^- , NO_3^- , HSO_4^- , AsF_6^-
 (c) SCN^- , PO_4^{3-} , $H_2PO_4^-$, N_3^- (d) CN^- , N_3^- , SCN^- , NCN^{2-}

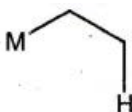
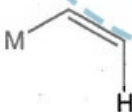


Q.33 In transition metal phosphine ($M-PR_3$) complexes, the back-bonding involves donation of electrons from

- (a) $M(t_{2g}) \rightarrow PR_3(\sigma^*)$ (b) $M(t_{2g}) \rightarrow PR_3(\pi^*)$ (c) $M(e_g) \rightarrow P(d)$ (d) $PR_3(\pi) \rightarrow M(t_{2g})$

Q.34 The refluxing of $RhCl_3 \cdot 3H_2O$ with an excess of PPh_3 in ethanol gives a complex A. Complex A and the valence electron count on rhodium are, respectively,

- (a) $[RhCl(PPh_3)_3]$, 16 (b) $[RhCl(PPh_3)_5]$, 16 (c) $[RhCl(PPh_3)_3]$, 18 (d) $[RhCl(PPh_3)_5]$, 18

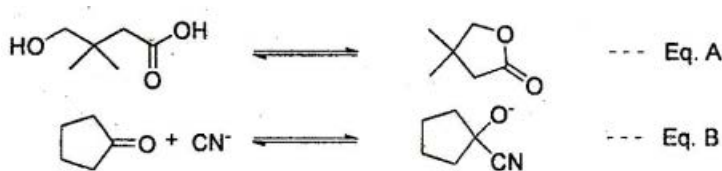
Q.35 The β -hydrogen elimination will be facile in

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

Q.36 The reaction $[Co(CN)_5H_2O]^{2-} + X^- \rightarrow [Co(CN)_5X]^{2-} + H_2O$ follows :

- (a) Interchange dissociative (I_d) mechanism (b) Dissociative (D) mechanism
 (c) Associative (A) mechanism (d) Interchange Associative (I_a) mechanism

Q.37 Correct statement on the effect of addition of aq. HCl on the equilibrium is



- (a) Equilibrium will shift towards right in case of both A and B.
 (b) Equilibrium will shift towards left in case of both A and B.
 (c) Equilibrium will shift towards right in A and left in case of B
 (d) Equilibrium will shift towards right in B and left in case of A

Q.38 The compound that exhibits sharp bands at 3300 and 2150 cm^{-1} in the IR spectrum is

- (a) 1-butyne (b) 2-butyne (c) butyronitrile (d) butylamine

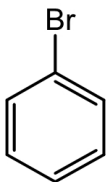
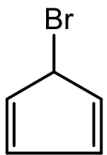
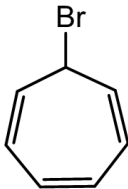
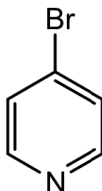
Q.39 The ^1H NMR spectrum of a dilute solution of a mixture of acetone and dichloromethane in CDCl_3 exhibits two singlet of 1 : 1 intensity. Molar ratio of acetone to dichloromethane in the solution is

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

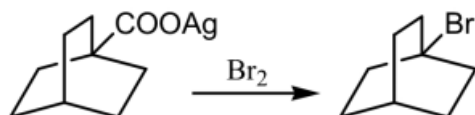
Q.40 Intense band generally observed for a carbonyl group in the IR spectrum is due to

- (a) The force constant of CO bond is large.
 (b) The force constant of CO bond is small.
 (c) There is no change in dipole moment for CO bond stretching.
 (d) The dipole moment change due to CO bond stretching is large.

Q.41 The compound that gives precipitate on warming with aqueous AgNO_3 is

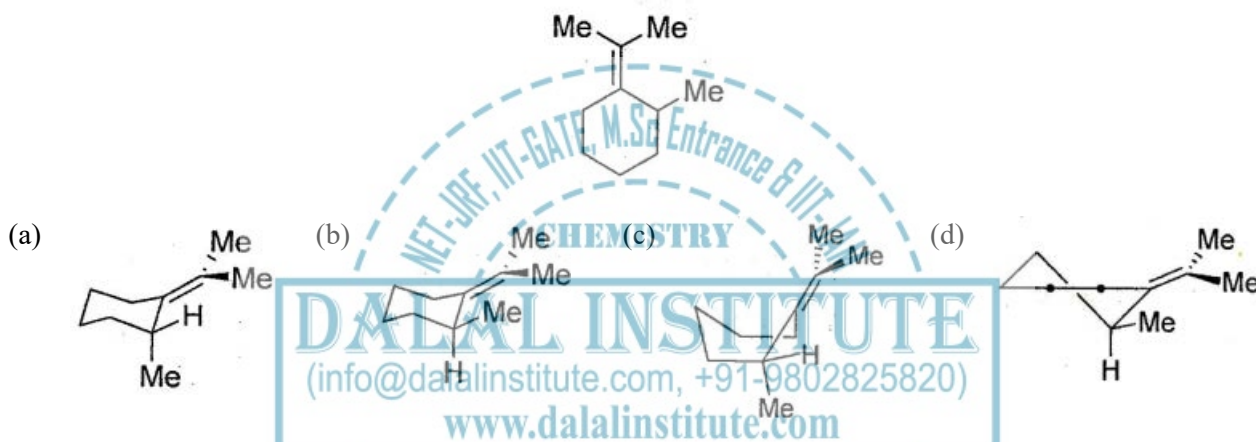
- (a)  (b)  (c)  (d) 

Q.42 Following reaction goes through

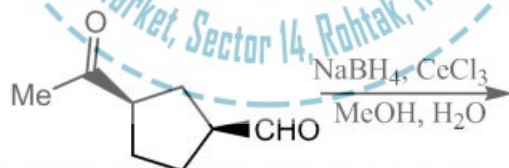


- (a) Free radical intermediate (b) Carbanion intermediate
(c) Carbocation intermediate (d) Carbene intermediate

Q.43 The most stable conformation for the following compound is

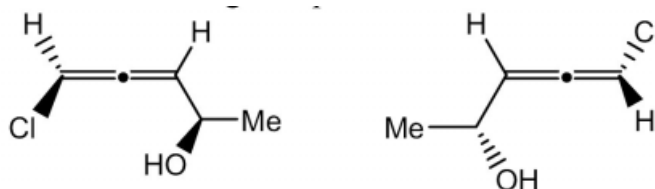


Q.44 The major product formed in the following reaction is



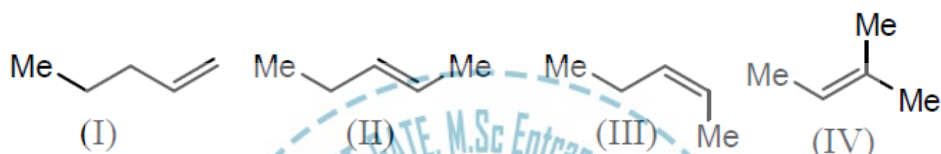
- (a) (b) (c) (d)

Q.45 The correct relation between the following compounds is



- (a) Enantiomers (b) Diastereomers
(c) Homomers (identical) (d) Constitutional isomers

Q.46 The correct order of heat of hydrogenation for the following compounds is

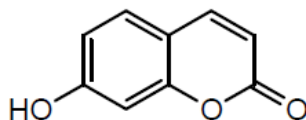


- (a) I > II > III > IV (b) I > III > II > IV (c) IV > I > III > II (d) IV > II > I > III

Q.47 Among the following, the correct statement(s) about ribose is (are)

- (A) On reduction with NaBH_4 it gives optically inactive product.
(B) On reaction with methanolic HCl it gives a furanoside.
(C) On reaction with $\text{Br}_2\text{-CaCO}_3\text{-water}$ it gives optically inactive product.
(D) It gives positive Tollen's test.
- (a) A, B and D (b) A, B and C (c) B and C (d) D only

Q.48 Biogenetic precursors for the natural product umbelliferone among the following are



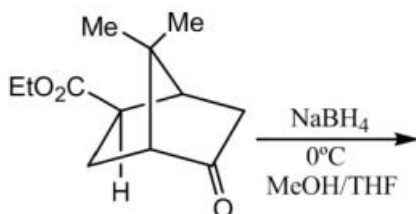
umbelliferone

- (a) L-tryptophan (b) Cinnamic acid (c) L-methionine (d) L-phenylalanine

Q.49 Number of signals in the $^{13}\text{C}\{^1\text{H}\}$ NMR spectrum of (R)-4-methylpentan-2-ol are

- (a) 3 (b) 4 (c) 5 (d) 6

Q.50 The major product formed in the following reaction is



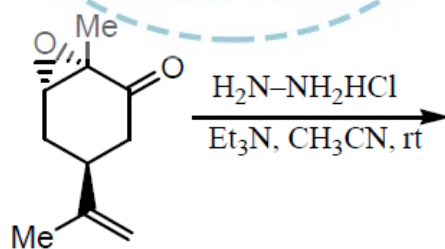
- (a)
- (b)
- (c)
- (d)

Q.51 The major product formed in the following reaction is



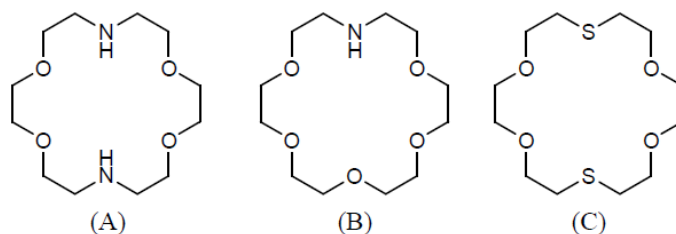
- (a)
- (b)
- (c)
- (d)

Q.52 The major product formed in the following reaction is



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

Q.53 The magnitude of the stability constants for K^+ ion complexes of the following supra-molecular hosts follows the order,



- (a) $B > A > C$ (b) $C > A > B$ (c) $A > B > C$ (d) $C > B > A$

Q.54 Antitubercular drug(s) among the following is (are)

(A) Salbutamol (B) Ethambutanol (C) Isoniazid (D) Diazepam

- (a) A and B (b) B and C (c) C and D (d) D alone

Q.55 A particle is in a one-dimensional box with a potential V_0 inside the box and infinite outside. An energy state corresponding to $n = 0$ (n : quantum number) is not allowed because

- (a) The total energy becomes zero
 (b) The average momentum becomes zero
 (c) The wave function becomes zero everywhere
 (d) The potential $V_0 \neq 0$

Q.56 An eigenstate of energy satisfies $H\Psi_n = E_n\Psi_n$. In the presence of an extra constant potential V_0

- (a) Both E_n and Ψ_n will change.
 (b) Both E_n and average kinetic energy will change.
 (c) Only E_n will change, but not Ψ_n will change, but not $E_n \cdot \Psi_n$.
 (d)

Q.57 The intensity of a light beam decreases by 50% when it passes through a sample of 1.0 cm path length. The percentage of transmission of the light passing through the same sample, but of 3.0 cm path length, would be

- (a) 50.0 (b) 25.0 (c) 16.67 (d) 12.5

Q.58 The electric-dipole allowed transition among the following is

- (a) $^3S \rightarrow ^3D$ (b) $^3S \rightarrow ^3P$ (c) $^3S \rightarrow ^1D$ (d) $^3S \rightarrow ^1F$

Q.59 The product $C_2^x \sigma_{xy}$ (C_2^x is the two-fold rotation axis around the x-axis and σ_{xy} is the xy mirror plane) is

- (a) σ_{xz} (b) σ_{yz} (c) C_2^y (d) C_2^z

Q.60 The simplest ground-state VB wave function of a diatomic molecule like HCl is written as

$\Psi = \Psi_H(1s, 1)\Psi_{Cl}(3p_z, 2) + B$, where B stands for

- (a) $\Psi_H(3p_z, 2)\Psi_{Cl}(1s, 1)$ (b) $\Psi_H(1s, 2)\Psi_{Cl}(3p_z, 1)$
 (c) $\Psi_{Cl}(1s, 2)\Psi_{Cl}(3p_z, 1)$ (d) $\Psi_{Cl}(1s, 2)\Psi_H(3p_z, 1)$

Q.61 Heat capacity of a species is independent of temperature if it is

- (a) Tetratomic (b) Triatomic (c) Diatomic (d) Monatomic

Q.62 In a chemical reaction : $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, xenon gas is added at constant volume.

The equilibrium

- (a) Will shift towards the reactant.
 (b) Will shift towards the products.
 (c) Will not change the amount of reactant and products.
 (d) Will increase both reactant and products.

Q.63 The temperature-dependence of a reaction is given by $k = AT^2 \exp(-E_0/RT)$. The activation energy (E_a) of the reaction is given by

- (a) $E_0 + \frac{1}{2}RT$ (b) E_0 (c) $E_0 + 2RT$ (d) $2E_0 + RT$

Q.64 For a reaction, $2A + B \rightarrow 3Z$, if the rate of consumption of A is $2 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$ the rate of formation of Z (in $\text{mol dm}^{-3} \text{ s}^{-1}$) will be

- (a) 3×10^{-4} (b) 2×10^{-4} (c) $\frac{4}{3} \times 10^{-4}$ (d) 4×10^{-4}

Q.65 Dominant contribution to the escaping tendency of a charged particle with uniform concentration in a phase, depends on

- (a) Chemical potential of that phase (b) Electric potential of the phase
(c) Thermal energy of that phase (d) Gravitational potential of that phase

Q.66 The intrinsic viscosity depends on the molar mass as $[\eta] = KM^a$. The empirical constants K and a are dependent on

- (a) Solvent only (b) Polymer only
(c) Polymer solvent pair (d) Polymer-polymer interaction

Q.67 The correct ΔG for the cell reaction involving steps



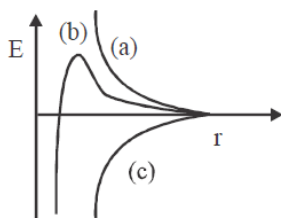
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu(s)}$ is

- (a) $\Delta G^0 - RT \ln \frac{a_{\text{Zn}^{2+}}}{a_{\text{Cu}^{2+}}}$ (b) $\Delta G^0 + RT \ln \frac{a_{\text{Zn}^{2+}}}{a_{\text{Cu(s)}}}$
(c) $\Delta G^0 - RT \ln \frac{a_{\text{Zn(s)}}}{a_{\text{Cu}^{2+}}}$ (d) $\Delta G^0 + RT \ln \frac{a_{\text{Zn}^{2+}}}{a_{\text{Cu}^{2+}}}$

Q.68 The lowest energy-state of an atom with electronic configuration $ns^1 np^1$ has the term symbol

- (a) 3P_1 (b) 1P_1 (c) 3P_2 (d) 3P_0

Q.69 Energy of interaction of colloidal particles as a function of distance of separation can be identified as (1) vander Waals, (2) double layer, (3) vander Waals and double layer. The correct order of interactions in the figure corresponding to curves (a), (b) and (c), respectively, is



- (a) 1, 2, 3 (b) 2, 3, 1 (c) 3, 1, 2 (d) 1, 3, 2

Q.70 The packing factor (PF) and number of atomic sites per unit cell (N) of an FCC crystal system are

- (a) PF = 0.52 and N = 3 (b) PF = 0.74 and N = 3
 (c) PF = 0.52 and N = 4 (d) PF = 0.74 and N = 4

Section-C

Q.71 Differential pulse polarography (DPP) is more sensitive than D.C. Polarography (DCP). Consider following reasons for it

- (A) Non-faradic current is less in DPP in comparison to DCP
 (B) Non-faradic current is more in DPP in comparison to DCP
 (C) Polarogram of DPP is of different shape than that of DCP

Correct reason(s) is/are

- (a) A and C (b) B and C (c) B only (d) A only

Q.72 Considering the following parameters with reference to the fluorescence of a solution:

- (A) Molar absorptivity of fluorescent molecule
 (B) Intensity of light source used excitation
 (C) Dissolved oxygen

The correct answer for the enhancement of fluorescence with the increase in these parameters is/are

- (a) A and B (b) B and C (c) A and C (d) C only

Q.73 The geometric cross section of ^{125}Sn (in barn) is nearly

- (a) 1.33 (b) 1.53 (c) 1.73 (d) 1.93

Q.74 Match column A (coupling reactions) with column B (reagents)

Column A	Column B
1. Suzuki coupling	I. $\text{H}_2\text{C}=\text{CHCO}_2\text{CH}_3$
2. Heck coupling	II. $\text{RB}(\text{OH})_2$
3. Sonagashira coupling	III. $\text{PhCO}(\text{CH}_2)_3\text{Znl}$
4. Negeshi coupling	IV. $\text{CH}\equiv\text{CR}$
	V. SnR_4

The correct match is

- (a) 1-II, 2-I, 3-IV, 4-III (b) 1-I, 2-V, 3-III, 4-IV
 (c) 1-IV, 2-III, 3-II, 4-I (d) 1-II, 2-III, 3-IV, 4-V

Q.75 The oxoacid of phosphorus having P atoms in +4, +3, and +4 oxidation states respectively, is

- (a) $\text{H}_3\text{P}_3\text{O}_{10}$ (b) $\text{H}_5\text{P}_3\text{O}_7$ (c) $\text{H}_5\text{P}_3\text{O}_8$ (d) $\text{H}_5\text{P}_3\text{O}_9$

Q.76 The geometries of $[\text{Br}_3]^+$ and $[\text{I}_5]^+$, respectively, are

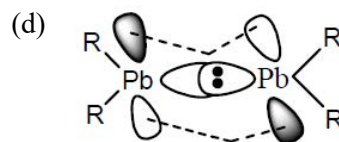
- (a) Trigonal and tetrahedral (b) Tetrahedral and trigonal bipyramidal
 (c) Tetrahedral and tetrahedral (d) Linear and trigonal pyramidal

Q.77 According to Wade's theory the anion $[\text{B}_{12}\text{H}_{12}]^{2-}$ adopts

- (a) Closo-structure (b) Arachno-structure (c) Hypo-structure (d) Nido-structure

Q.78 Considering the inert pair effect on lead, the most probable structure of $\text{PbR}_2[\text{R} = 2, 6\text{-C}_6\text{H}_3(2, 6\text{-Pr}_2\text{C}_6\text{H}_3)_2]$ is





Q.79 The reaction of SbCl_3 with 3 equivalents of EtMgBr yields compound X. Two equivalents of SbI_3 react with one equivalent of X to give Y. In the solid state, Y has a 1D-polymeric structure in which each Sb is in a square pyramidal environment. Compounds X and Y respectively, are

- (a) SbEt_3 and $[\text{Sb}(\text{Et})\text{I}_2]_n$ (b) $\text{Sb}(\text{Et}_2)\text{Cl}$ and $[\text{Sb}(\text{Et}_2)\text{Cl}]_n$
 (c) SbEt_3 and $[\text{SbEt}_2\text{Br}_2]_n$ (d) $\text{Sb}(\text{Et})\text{Br}_2$ and $[\text{SbEt}(\text{I})(\text{Br})]_n$

Q.80 Match the complexes given in column I with the electronic transitions (mainly responsible for their colours) listed in column II

Column I	Column II
(I) $\text{Fe}(\text{II})$ -protoporphyrin IX	(A) $\pi \rightarrow \pi^*$
(II) $[\text{Mn}(\text{H}_2\text{O})_6]\text{Cl}_2$	(B) spin allowed $d \rightarrow d$
(III) $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_2$	(C) spin forbidden $d \rightarrow d$
	(D) $\text{M} \rightarrow \text{L}$ charge transfer

The correct answer is

- (a) I-A, II-C and III-B (b) I-D, II-B and III-C (c) I-A, II-C and III-D (d) I-A, II-B and III-C

Q.81 The following statements are given regarding the agostic interaction $\text{C-H} \cdots \text{Ir}$ observed in $[\text{Ir}(\text{Ph}_3\text{P})_3\text{Cl}]$.

- (A) Upfield shift of C-H proton in ^1H NMR spectrum
 (B) Increased acid character of C-H
 (C) $\text{C}_{\text{C-H}}$ in IR spectrum shifts to higher wavenumber

The correct answer is

- (a) A and C (b) B and C (c) A and C (d) Conly

Q.82 Amongst the following

(A) $[\text{Mn}(\eta^5\text{-Cp})(\text{CO})_3]$, (B) $[\text{Os}(\eta^5\text{-Cp})_2]$, (C) $[\text{Ru}(\eta^5\text{-Cp})_2]$ and (D) $[\text{Fe}(\eta^5\text{-Cp})_2]$

The compounds with most shielded and deshielded Cp protons respectively, are

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

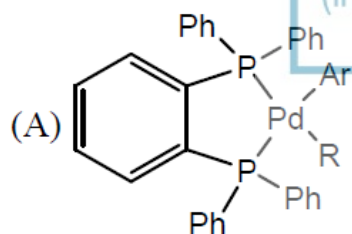
Q.83 Total number of vertices in metal clusters $[\text{Ru}_6(\text{C})(\text{CO})_{17}]$, $[\text{Os}_5(\text{C})(\text{CO})_{15}]$ and $[\text{Ru}_5(\text{C})(\text{CO})_{16}]$ are 6, 5 and 5, respectively. The predicted structures of these complexes, respectively are

- (a) Closo, nido and nido (b) Closo, nido and arachno
(c) Arachno, closo and nido (d) Arachno, nido and closo

Q.84 Among the complexes, (A) $\text{K}_4[\text{Cr}(\text{CN})_6]$, (B) $\text{K}_4[\text{Fe}(\text{CN})_6]$, (C) $\text{K}_4[\text{Co}(\text{CN})_6]$, and (D) $\text{K}_4[\text{Mn}(\text{CN})_6]$, John-Teller distortion is expected in

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

Q.85 The reductive elimination of Ar-R (coupled product) from A is facile when



- (a) $\text{R} = \text{CH}_3$ (b) $\text{R} = \text{CH}_2\text{Ph}$ (c) $\text{R} = \text{CH}_2\text{COPh}$ (d) $\text{R} = \text{CH}_2\text{CF}_3$

Q.86 The total number of metal ions and the number of coordinated imidazole units of histidine in the active site of oxy-hemocyanin, respectively, are

- (a) 2Cu^{2+} and 6 (b) 2Fe^{2+} and 5 (c) 2Cu^+ and 6 (d) Fe^{2+} and 3

Q.87 Match the action of H_2O_2 in aqueous medium given in column A with the oxidation/reduction listed in column B

A : action of H_2O_2	B : type of reaction
--------------------------------------	----------------------

(I) Oxidation in acid	(A) $[\text{Fe}(\text{CN})_6]^{3-} \rightarrow [\text{Fe}(\text{CN})_6]^{4-}$
(II) Oxidation in base	(B) $[\text{Fe}(\text{CN})_6]^{4-} \rightarrow [\text{Fe}(\text{CN})_6]^{3-}$
(III) Reduction in acid	(C) $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$
(IV) Reduction in base	(D) $\text{Mn}^{2+} \rightarrow \text{Mn}^{4+}$

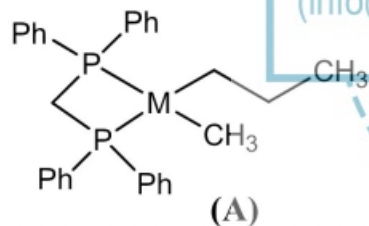
The correct answer is

- (a) I-A, II-B, III-C, IV-D (b) I-B, II-D, III-C, IV-A
 (c) I-C, II-D, III-B, IV-A (d) I-D, II-A, III-C, IV-B

Q.88 The reduced form of a metal ion M in a complex is NMR active. On oxidation, the complex gives an EPR signal with $g_{\parallel} \approx 2.2$ and $g_{\perp} \approx 2.0$. Mossbauer spectroscopy cannot characterize the metal complex. The M is

- (a) Zn (b) Sn (c) Cu (d) Fe

Q.89 The least probable product from A on reductive elimination is



- (a) (b) CH_4 (c) (d)

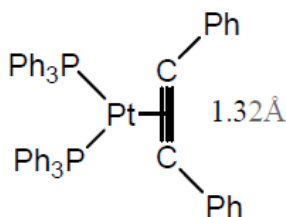
Q.90 Water plays different roles in the following reactions.

- (i) $2\text{H}_2\text{O} + \text{Ca} \rightarrow \text{Ca}^{2+} + 2\text{OH}^- + \text{H}_2$
 (ii) $n\text{H}_2\text{O} + \text{Cl} \rightarrow [\text{Cl}(\text{H}_2\text{O})_n]^-$
 (iii) $6\text{H}_2\text{O} + \text{Mg}^{2+} \rightarrow [\text{Mg}(\text{H}_2\text{O})_6]^{2+}$
 (iv) $2\text{H}_2\text{O} + 2\text{F}_2 \rightarrow 4\text{HF} + \text{O}_2$

The correct role of water in each reaction is

- (a) (i) oxidant, (ii) acid, (iii) base and (iv) reductant.
 (b) (i) oxidant, (ii) base, (iii) acid and (iv) reductant.
 (c) (i) acid, (ii) oxidant, (iii) reductant and (iv) base.
 (d) (i) base, (ii) reductant, (iii) oxidant and (iv) base

Q.91 With respect to σ and π bonding in Pt–III in the structure given below, which of the following represent the correct bonding.



- (a) $M(\sigma) \rightarrow L(\sigma)$ and $M(\pi) \rightarrow L(\pi^*)$ (b) $L(\sigma) \rightarrow M(\pi)$ and $L(\pi) \rightarrow M(\pi)$
 (c) $L(\pi) \rightarrow M(\pi)$ and $L(\sigma) \rightarrow M(\pi)$ (d) $L(\pi) \rightarrow M(\sigma)$ and $M(\pi) \rightarrow L(\pi^*)$

Q.92 The complex $[\text{Fe}(\text{phen})_2(\text{NCS})_2]$ (phen = 1,10-phenanthroline) shows spin cross-over behavior CFSE and μ_{eff} at 250 and 150K, respectively are

- (a) $0.4\Delta_0$, 4.90 BM and 0 $2.4\Delta_0$, 0.00 BM (b) $2.4\Delta_0$, 2.90 BM and 0 $0.4\Delta_0$, 1.77 BM
 (c) $2.4\Delta_0$, 0.00 BM and 0 $0.4\Delta_0$, 4.90 BM (d) $1.2\Delta_0$, 4.90 BM and 0 $2.4\Delta_0$, 0.00 BM

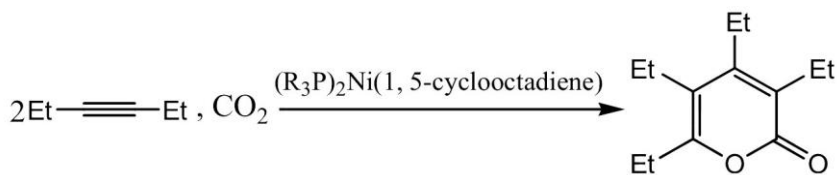
Q.93 Consider the following statements with respect to uranium

- (A) UO_2^+ disproportionate more easily than UO_2^{2+} .
 (B) U_3O_8 is its most stable oxide of U.
 (C) Coordination number of U in $[\text{UO}_2(\text{NO}_3)_2(\text{H}_2\text{O})_2] \cdot 4\text{H}_2\text{O}$ is six.
 (D) UO_2^{2+} is linear.

The correct set of statements is

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

Q.94



For the above conversion, which of the following statements are correct?

- (A) CO₂ combines with Ni(PR₃)₂(1, 5-cyclooctadiene)
 (B) Insertion of CO₂ occurs
 (C) Insertion of Et-C≡C-Et takes place.

The correct answer is

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

Q.95 Consider the following statements for

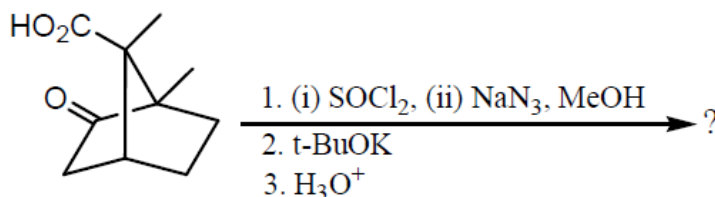


- (A) Coordination number of Ce is 12
 (B) Z is paramagnetic
 (C) Z is an oxidizing agent
 (D) Reaction of Ph₃PO with Z gives a complex having coordination number 10 for Ce.

The correct statements are

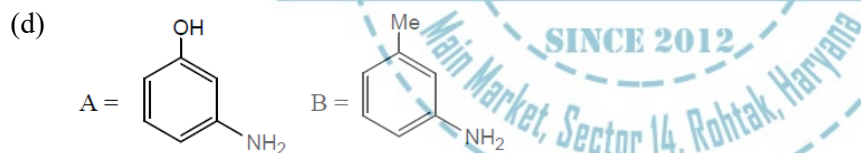
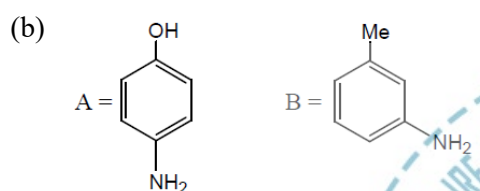
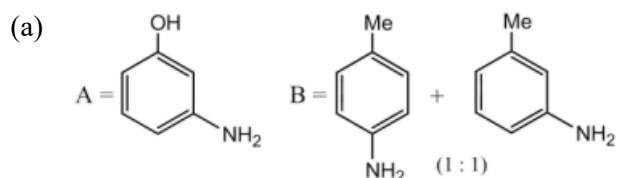
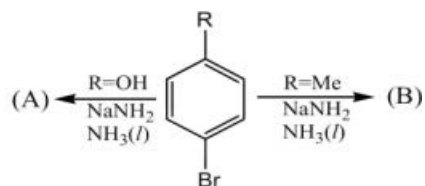
- (a) A, B and C (b) B, A and D (c) B, C and D (d) A, C and D

Q. 96 The major product formed in the following reaction sequence is

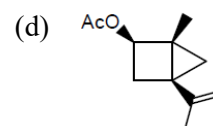
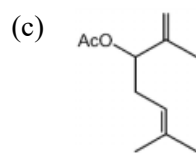
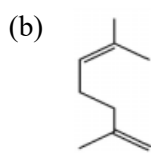
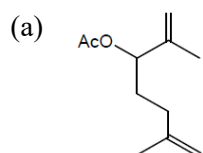
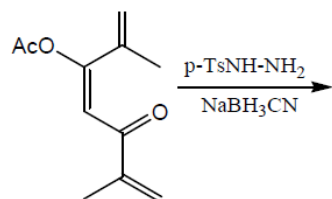


- (a)
- (b)
- (c)
- (d)

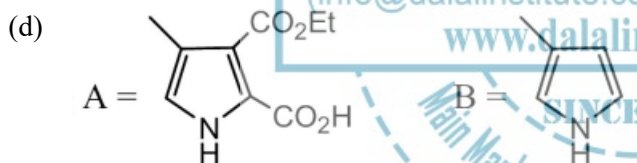
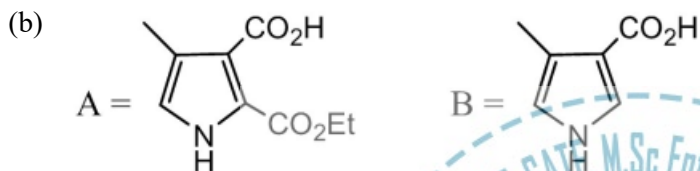
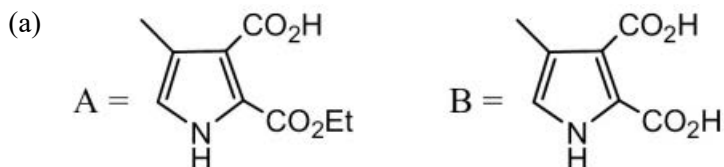
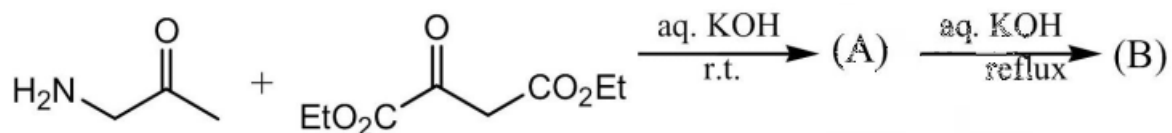
Q.97 The major products A and B in the following reaction sequence are



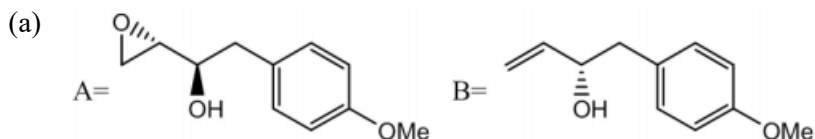
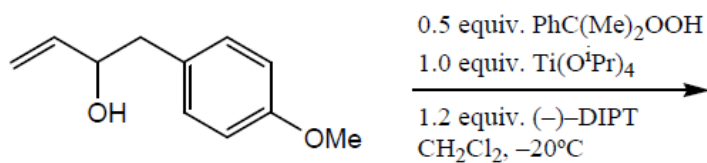
Q.98 The major product formed in the following reaction is

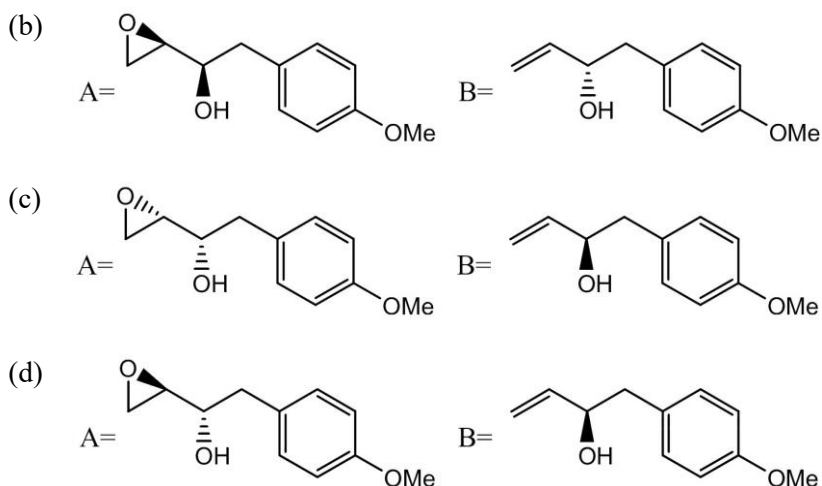


Q.99 The major products A and B in the reactions sequence are

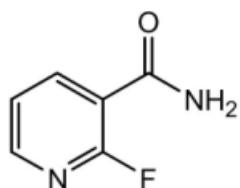


Q.100 The major products formed in the following reaction are



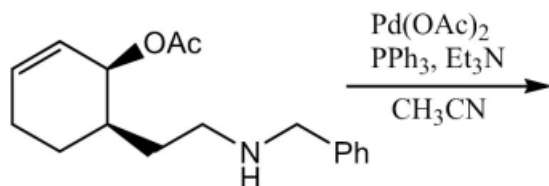


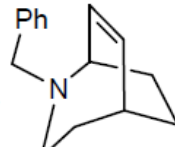
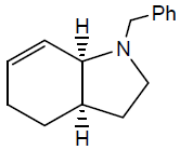
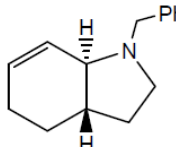
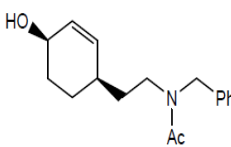
Q.101 The correct statement about the following reaction is



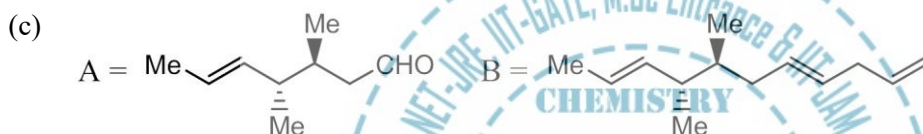
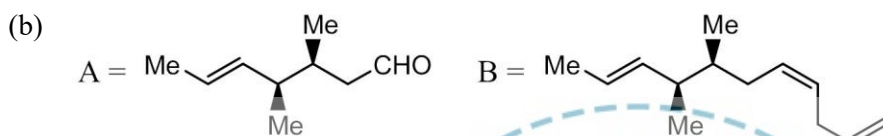
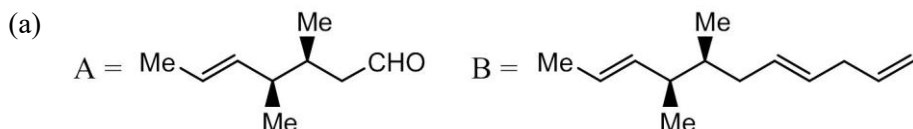
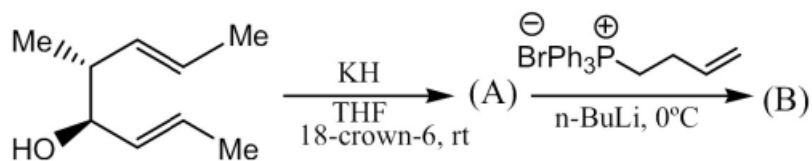
- (a) The product is 2-fluoropyridin-3-amine and reaction involves nitrene intermediate.
- (b) The product is 2-fluoropyridin-3-amine and reaction involves radical intermediate.
- (c) The product is 2-hydroxynicotinamide and reaction involves benzene-like intermediate.
- (d) The product is 2-hydroxynicotinamide and reaction involves addition-elimination mechanism.

Q.102 The major product formed in the following reaction is

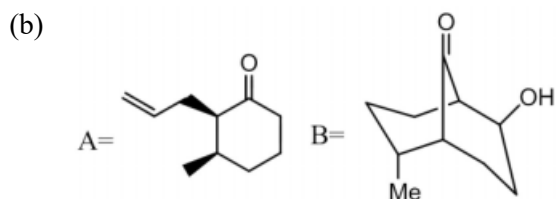
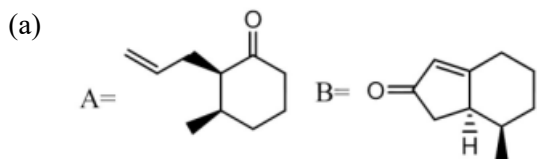
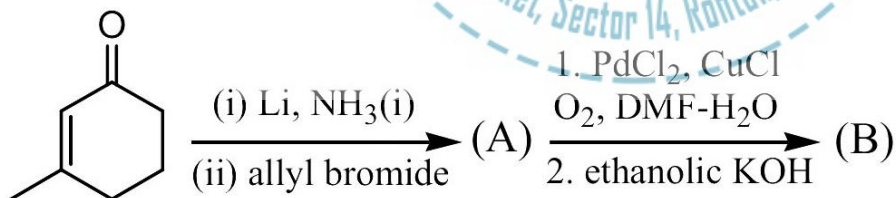


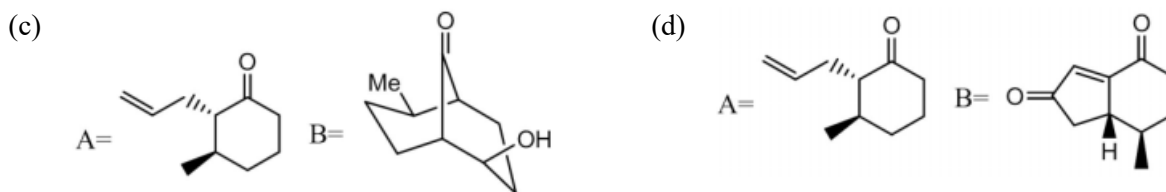
- (a) 
- (b) 
- (c) 
- (d) 

Q.103 The major products A and B formed in the following reactions are



Q.104 The major products A and B formed in the following reactions are





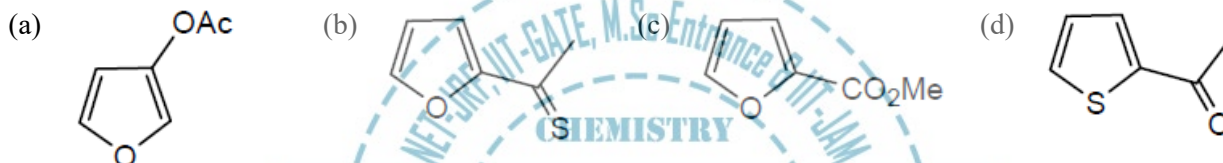
Q.105 An organic compounds shows following spectral data:

IR (cm^{-1}): 1680

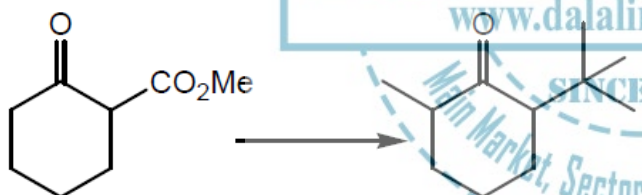
$^1\text{H NMR}(\text{CDCl}_3)$: δ 7.66(m,1H), 7.60 (m,1H), 7.10 (m,1H) , 2.50 (s,3H)

$^{13}\text{C NMR}$: δ 190,144,134,132,128, 28 m/z (EI) : 126 (M^+ , 100%), 128 (M^++2 , 4.9%)

The structure of the compound is

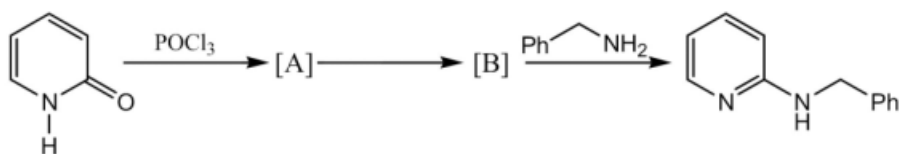


Q.106 The correct set of reagents to effect the following transformation is



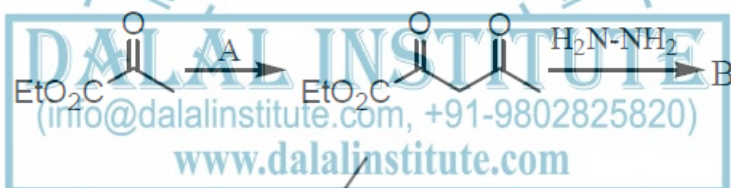
- (a) . (I) (i) NaOMe, MeI; (ii) NaCl, wet DMSO, 160°C ; (II) (i) LDA, -78°C , TMSCl; (ii) t-BuCl, TiCl_4 , 50°C .
- (b) (I) (i) NaOMe, MeI; (ii) aq. NaOH then HCl, heat; (II) (i) Et_3N , TMSCl, rt; (ii) t-BuCl, TiCl_4 , 50°C .
- (c) (i) LDA, t-BuCl, (ii) LDA, MeI; (iii) aq. NaOH then HCl, heat.
- (d) (I) (i) NaCl, wet DMSO, 160°C ; (ii) NaH, t-BuCl; (II) (i) morpholine, H^+ ; (ii) MeI then H_3O^+ .

Q.107 The correct structures of the intermediates [A] and [B] in the following reactions are



- (a) $A = \text{2-pyridone-2-yl } \text{OP(O)Cl}_2^{\ominus}$ $B = \text{2-pyridone-2-yl } \text{P(O)Cl}_2^{\ominus}$
- (b) $A = \text{2-pyridone}$ $B = \text{2-pyridone-2-yl } \text{P(O)Cl}_2^{\ominus}$
- (c) $A = \text{2-pyridone-2-yl } \text{OP(O)Cl}_2^{\ominus}$ $B = \text{2-chloropyridine}$
- (d) $A = \text{2-pyridone}$ $B = \text{2-pyridone-2-yl } \text{P(O)Cl}_2^{\ominus}$

Q.108 The correct reagent combination A and the major product B in the following reaction sequence are



(a)

A : LiHMDS, AcCl B =

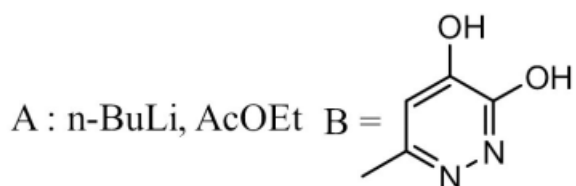
(b)

A : n-BuLi, AcCl B =

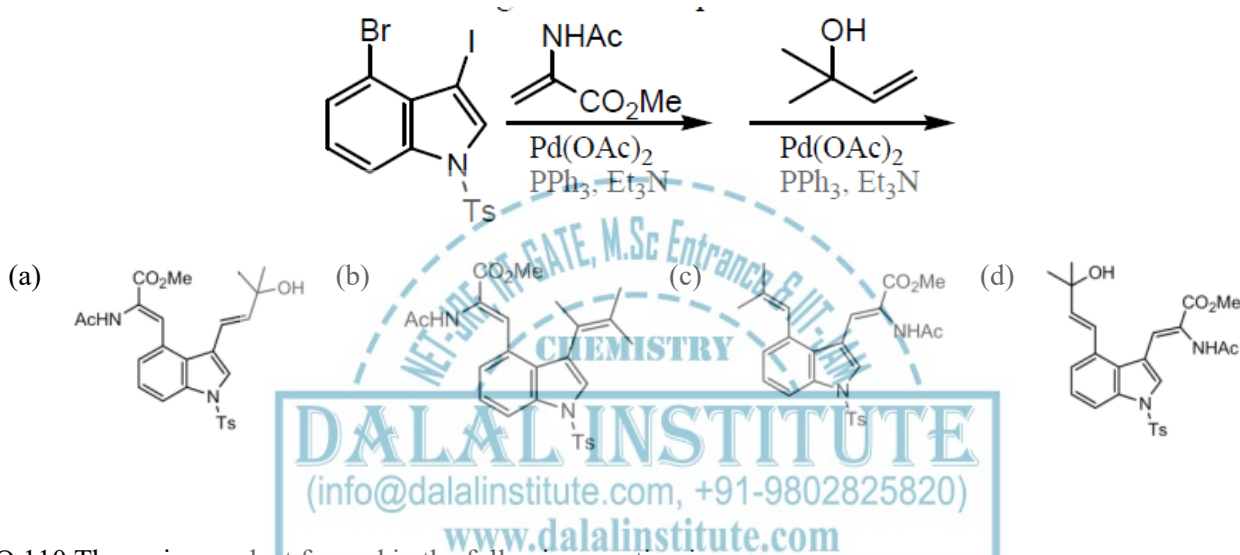
(c)

A : LiHMDS, AcOEt B =

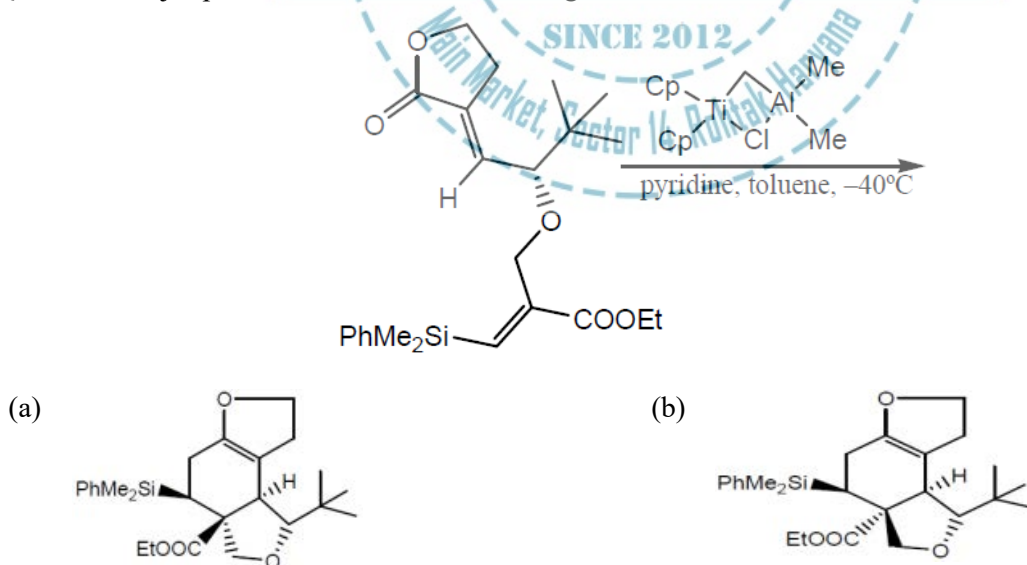
(d)

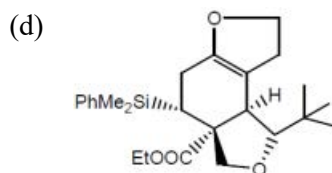
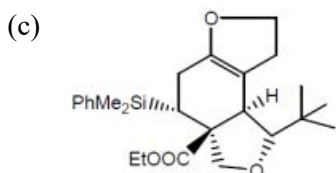


Q.109 The major product of the following reaction sequence is

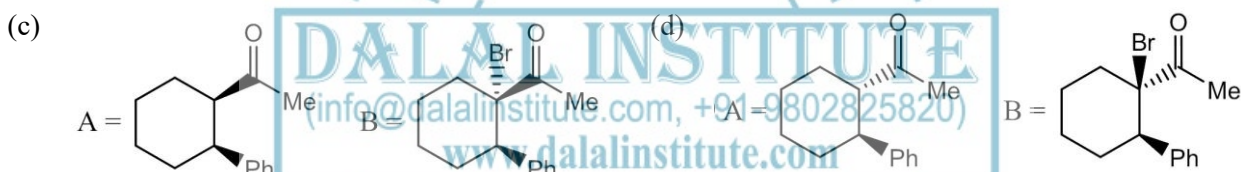
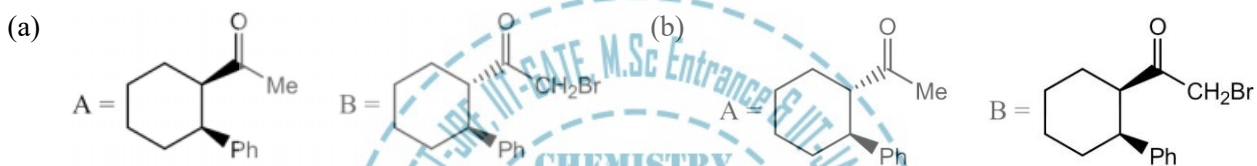
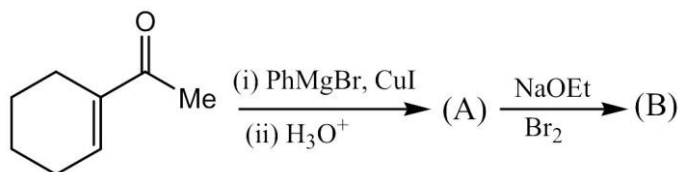


Q.110 The major product formed in the following reaction is

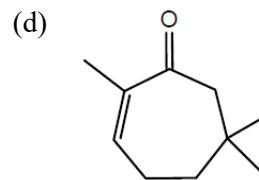
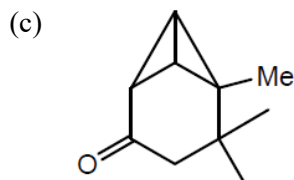
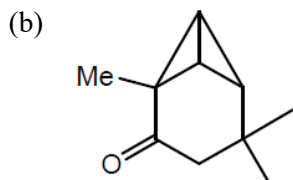
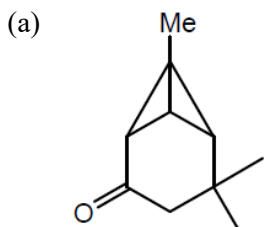
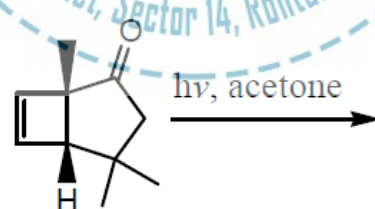




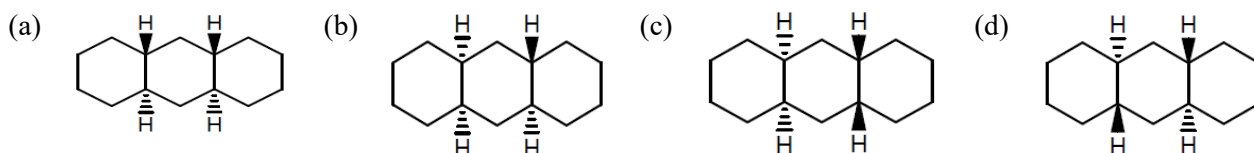
Q.111 The major products A and B in the following synthetic sequence are



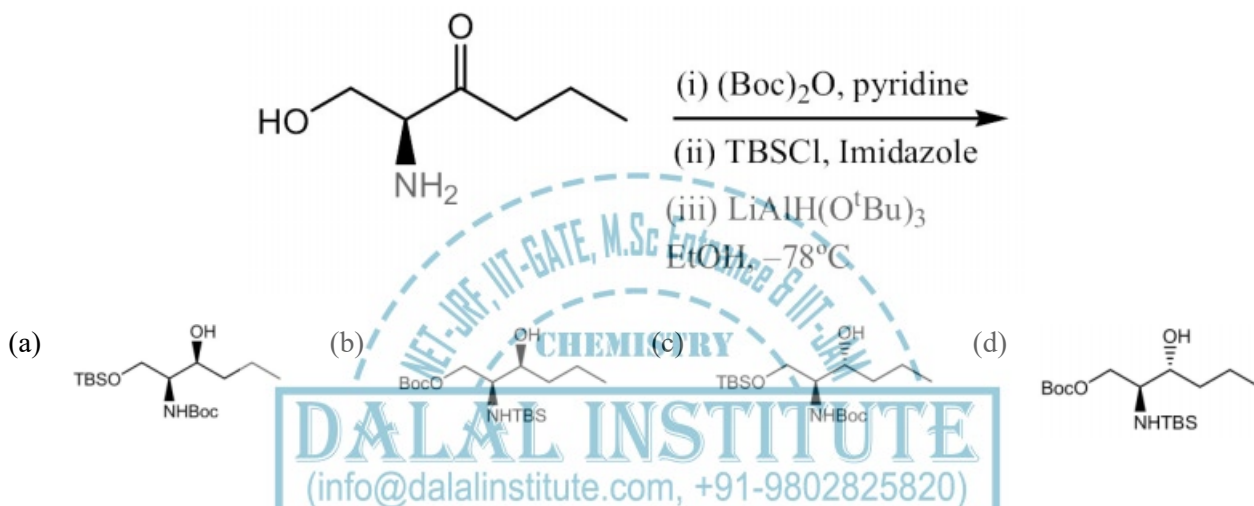
Q.112 The major product formed in the following reaction is



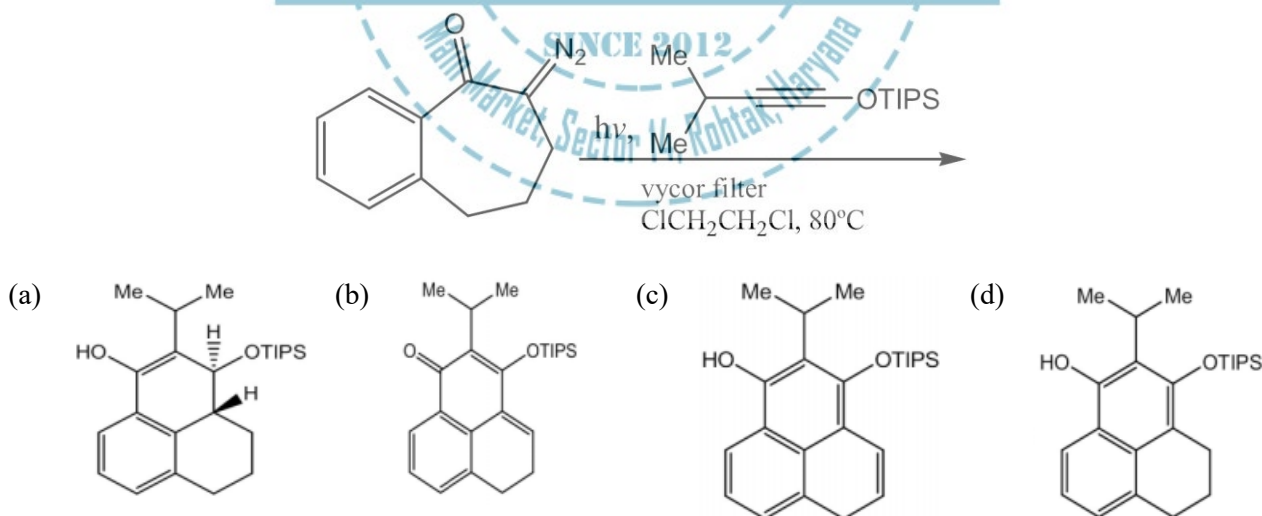
Q.113 The hydrocarbon among the following having conformationally locked chair-boat-chair form is



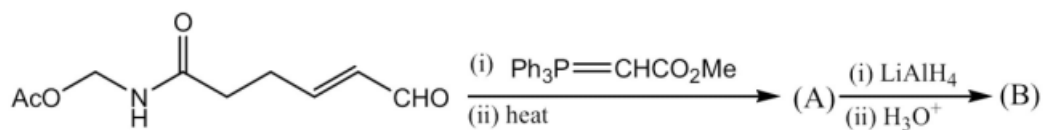
Q.114 The major product formed in the following reaction sequence is



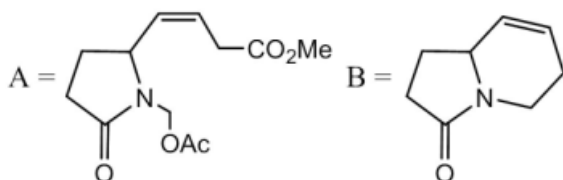
Q.115 The major product in the following reaction sequence is



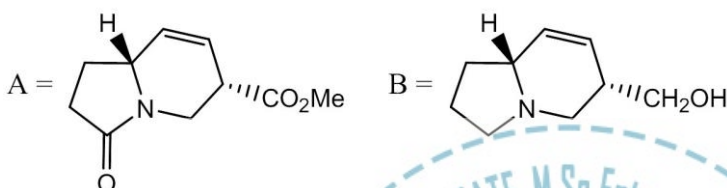
Q.116 Structures of A and B in the following synthetic sequence are



(a)



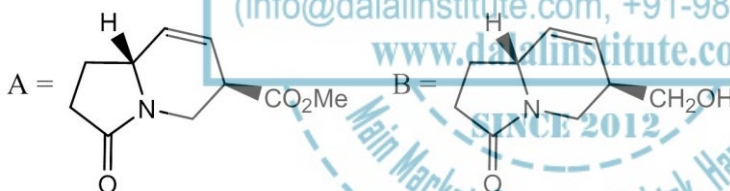
(b)



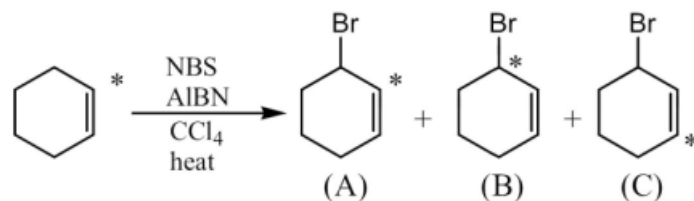
(c)



(d)



Q.117 In the following reaction, the ratio of A : B : C is (*indicates labelled carbon)



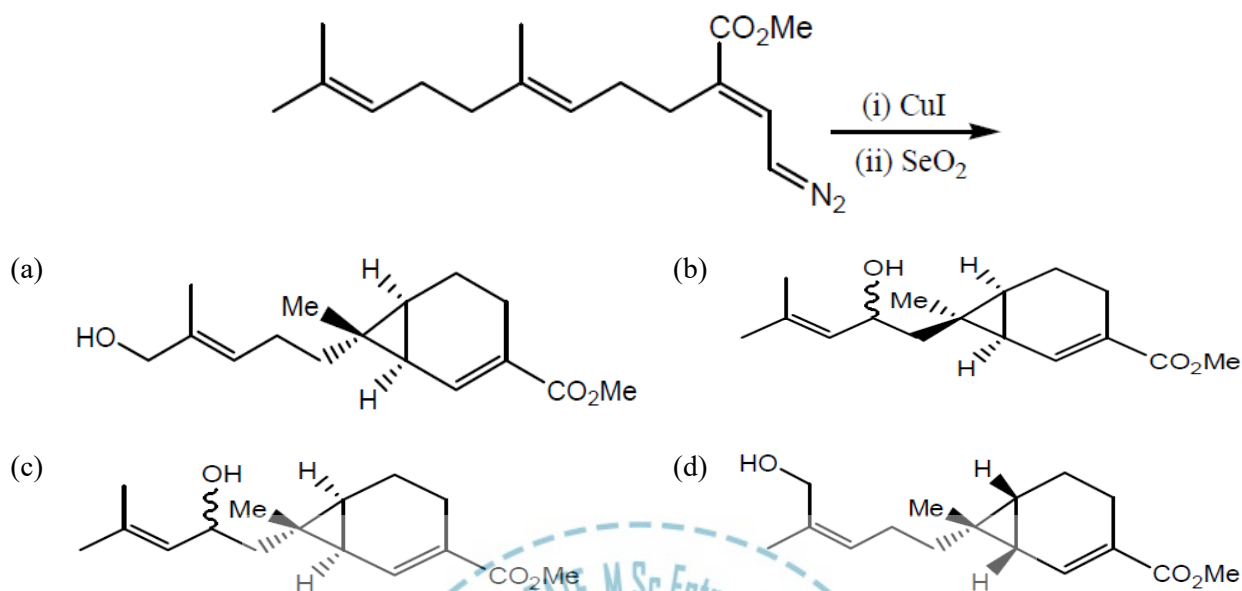
(a) 1 : 1 : 1

(b) 1 : 2 : 1

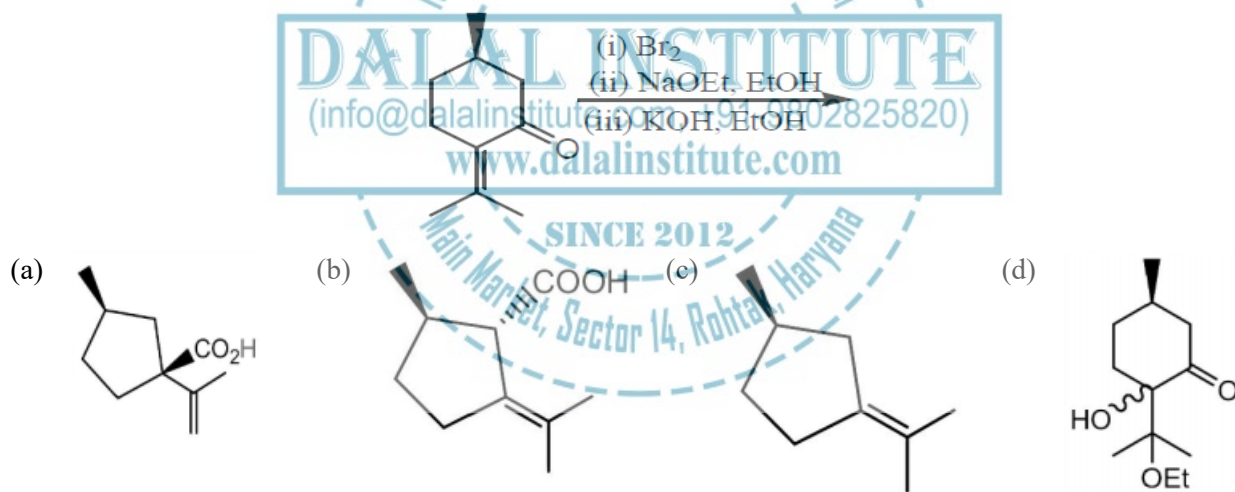
(c) 2 : 1 : 1

(d) 3 : 2 : 1

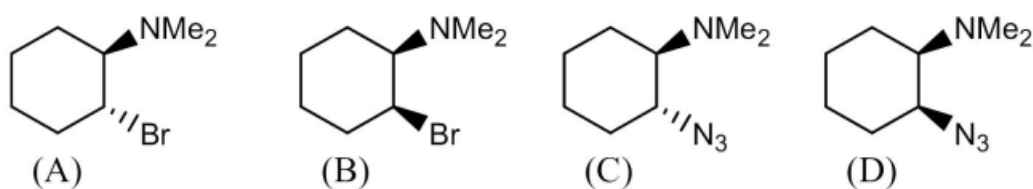
Q.118 Structure of the major product in the following synthetic sequence is



Q.119 Major product formed in the following synthetic sequence on the monoterpene pulegone is



Q.120 Optically pure isomers A and B were heated with NaN_3 in DMF. The correct statement from the following is



- (a) A gives optically pure D and B gives optically pure C.
 (b) A gives racemic mixture of C and B gives optically pure C.
 (c) A gives optically pure C and B gives racemic C.
 (d) A gives optically pure D and B gives racemic D.

Q.121 A molecular orbital of a diatomic molecule changes sign when it is rotated by 180° around the molecular axis. This orbital is

- (a) σ (b) π (c) δ (d) ϕ

Q. 122 IR active normal modes of methane belong to the irreducible representation:

T_d	E	$8C_3$	$3C_2$	$6S_6$	$6\sigma_d$	
A_1	1	1	1	1	1	$x^2+y^2+z^2$
A_2	1	1	1	-1	-1	
E	2	-1	2	0	0	$2z^2-x^2-y^2, x^2-y^2$
T_1	3	0	-1	1	-1	R_x, R_y, R_z
T_2	3	0	-1	-1	1	x, y, z, xy, yz, zx

- (a) $E + A_1$ (b) $E + A_2$ (c) T_1 (d) T_2

Q.123 The symmetric rotor among the following is

- (a) CH_4 (b) CH_3Cl (c) CH_2Cl_2 (d) CCl_4

Q.124 The nuclear g-factors of 1H and ^{14}N are 5.6 and 0.40 respectively. If the magnetic field in an NMR spectrometer is set such that the proton resonates at 700 MHz, the ^{14}N nucleus would resonate at

- (a) 1750 MHz (b) 700 MHz (c) 125 MHz (d) 50 MHz

Q.125 The spectroscopic technique, by which the ground state dissociation energies of diatomic molecules can be estimated, is

- (a) Microwave spectroscopy (b) Infrared spectroscopy
(c) UV-visible absorption spectroscopy (d) X-ray spectroscopy

Q.126 The term symbol for the first excited state of Be with the electronic configuration $1s^2 2s^1 3s^1$ is

- (a) 3S_1 (b) 3S_0 (c) 1S_0 (d) $^2S_{1/2}$

Q.127 Which of the following statement is INCORRECT?

- (a) A Slater determinant is an antisymmetrized wavefunction.
(b) Electronic wavefunction should be represented by Slater determinants.
(c) A Slater determinant always corresponds to a particular spin state.
(d) A Slater determinant obeys the Pauli exclusion principle.

Q.128 Compare the difference of energies of the first excited and ground states of a particle confined in (i) a 1-d box (Δ_1), (ii) a 2-d square box (Δ_2) and (iii) a 3-d cubic box (Δ_3). Assume the length of each of the boxes is the same. The correct relation between the energy differences Δ_1 , Δ_2 and Δ_3 for the three states is

- (a) $\Delta_1 > \Delta_2 > \Delta_3$ (b) $\Delta_1 = \Delta_2 = \Delta_3$ (c) $\Delta_3 > \Delta_2 > \Delta_1$ (d) $\Delta_3 > \Delta_1 > \Delta_2$

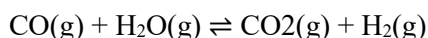
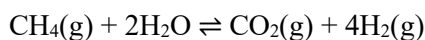
Q.129 The correct statement about both the average value of position ($\langle x \rangle$) and momentum ($\langle p \rangle$) of a 1-d harmonic oscillator wavefunction is

- (a) $\langle x \rangle \neq 0$ and $\langle p \rangle \neq 0$ (b) $\langle x \rangle = 0$ but $\langle p \rangle \neq 0$
(c) $\langle x \rangle = 0$ and $\langle p \rangle = 0$ (d) $\langle x \rangle \neq 0$ but $\langle p \rangle = 0$

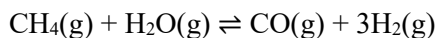
Q.130 The value of the commutator $[x, [x, p_x]]$ is

- (a) $i\hbar x$ (b) $-i\hbar$ (c) $i\hbar$ (d) 0

Q.131 The equilibrium constants for the reactions

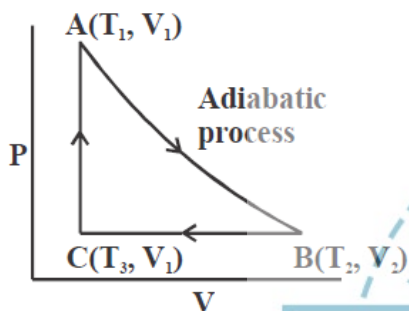


Are K_1 and K_2 , respectively. The equilibrium constant for the reaction



- (a) $K_1 \cdot K_2$ (b) $K_1 - K_2$ (c) K_1/K_2 (d) $K_2 - K_1$

Q.132 Consider the progress of a system along the path shown in the figure $\Delta S(B \rightarrow C)$ for one mole of an ideal gas is then given by



- (a) $R \ln \frac{T_1}{T_3}$ (b) $R \ln \frac{T_3}{T_1}$ (c) $R \ln \frac{V_2}{V_1}$ (d) $R \ln \frac{V_1}{V_2}$

Q.133 A thermodynamic equation that relates the chemical potential to the composition of a mixture is known as

- (a) Gibb's-Helmholtz equation (b) Gibbs-Duhem equation
(c) Joule-Thomson equation (d) Debye-Huckel equation

Q.134 According to transition state theory, the temperature-dependence of pre-exponential factor (A) for a reaction between a linear and a non-linear molecule, that forms products through a non-linear transition state, is given by

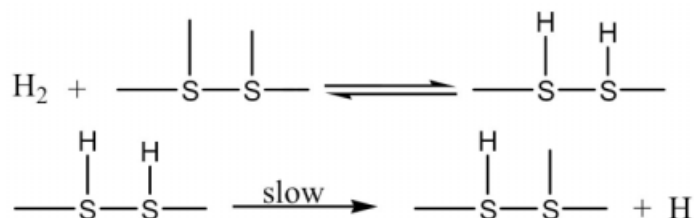
- (a) T (b) T^2 (c) T^{-2} (d) $T^{-1.5}$

Q.135 For a given ionic strength, (I) rate of reaction is given by

$\log \frac{K}{K_0} = -4 \times 0.51(I)^{1/2}$. Which of the following reactions follows the above equation?

- (a) $\text{S}_2\text{O}_8^{2-} + \text{I}^-$ (b) $\text{Co}(\text{NH}_3)_5\text{Br}^{2+} + \text{OH}^-$
 (c) $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{OH}^-$ (d) $\text{H}^+ + \text{Br}^- + \text{H}_2\text{O}_2$

Q.136 For a reaction on a surface



At low pressure of H_2 , the rate is proportional to

- (a) $[\text{H}_2]$ (b) $1/[\text{H}_2]$ (c) $[\text{H}_2]^{1/2}$ (d) $1/[\text{H}_2]^{1/2}$

Q.137 The temperature-dependence of an electrochemical cell potential is

- (a) $\frac{\Delta G}{nFT}$ (b) $\frac{\Delta H}{nF}$ (c) $\frac{\Delta S}{nF}$ (d) $\frac{\Delta S}{nFT}$

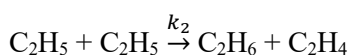
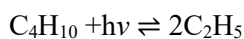
Q.138 The single-particle partition function (f) for a certain system has the form $f = AVe^{BT}$. The average energy per particle will then be (k is the Boltzmann constant)

- (a) BkT (b) BkT^2 (c) kT/B (d) kT/B^2

Q.139 The indistinguishability correction in the Boltzmann formulation is incorporated in the following way : (N = total number of particles, f = single-particle partition function)

- (a) Replace by $f/N!$ (b) Replace f^N by $f^N/N!$
 (c) Replace f by $f/\ln(N!)$ (d) Replace f^N by $f^N/\ln(N!)$

Q.140 In a photochemical reaction, radicals are formed according to the equation



If I is the intensity of light absorbed, the rate of the overall reaction is proportional to

- (a) I (b) $I^{1/2}$ (c) $I[C_4H_{10}]$ (d) $I^{1/2}[C_4H_{10}]^{1/2}$

Q.141 Conductometric titration of a strong acid with a strong alkali (MOH) shows linear fall of conductance up to neutralization point because of

- (a) Formation of water.
(b) Increase in alkali concentration.
(c) Faster moving H^+ being replaced by slower moving M^+ .
(d) Neutralization of acid.

Q.142 Find the probability of the link in polymers where average values of links are (A) 10, (B) 50 and (C) 100.

- (a) (A) 0.99, (B) 0.98, (C) 0.90 (b) (A) 0.98, (B) 0.90, (C) 0.99
(c) (A) 0.90, (B) 0.98, (C) 0.99 (d) (A) 0.90, (B) 0.99, (C) 0.98

Q.143 The stability of lyophobic colloid is the consequence of

- (a) Van der waals attraction among the solute-solvent adducts.
(b) Brownian motion of the colloidal particles.
(c) Insolubility of colloidal particles in solvent.
(d) Electrostatic repulsion among double-layered colloidal particles.

Q.144 In a conductometric experiment for estimation of acid dissociation constant of acetic acid, the following values were obtained in four sets of measurements.

1.71×10^{-5} , 1.77×10^{-5} , 1.79×10^{-5} and 1.73×10^{-5}

The standard deviation of the data would be in the range of

- (a) $0.010 \times 10^{-5} - 0.019 \times 10^{-5}$ (b) $0.020 \times 10^{-5} - 0.029 \times 10^{-5}$
(c) $0.030 \times 10^{-5} - 0.039 \times 10^{-5}$ (d) $0.040 \times 10^{-5} - 0.049 \times 10^{-5}$

Q.145 Silver crystallizes in face-centered cubic structure. The 2nd order diffraction angle of a beam of X-ray ($\lambda = 1\text{\AA}$) of (111) plane of the crystal is 30° . Therefore, the unit cell length of the crystal would be

- (a) $a = 3.151 \text{ \AA}$ (b) $a = 3.273 \text{ \AA}$ (c) $a = 3.034 \text{ \AA}$ (d) $a = 3.464 \text{ \AA}$



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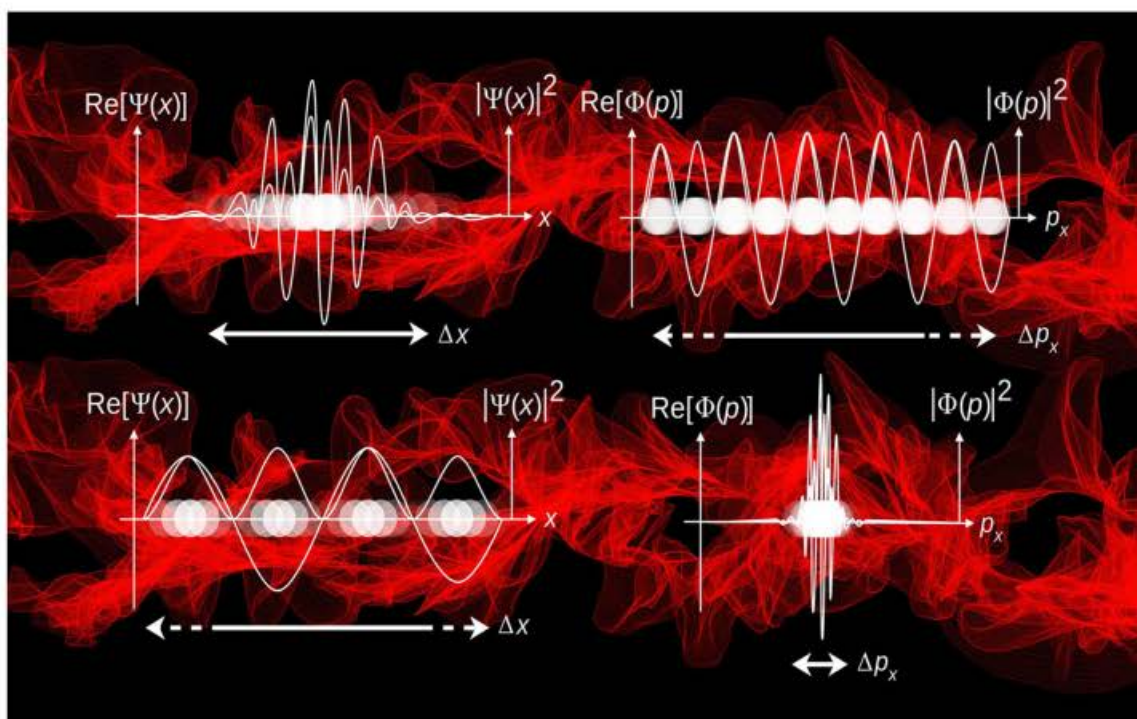
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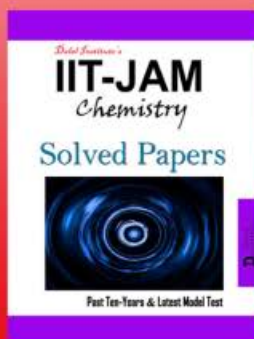
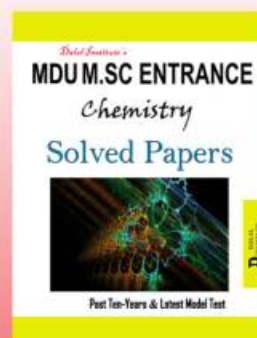
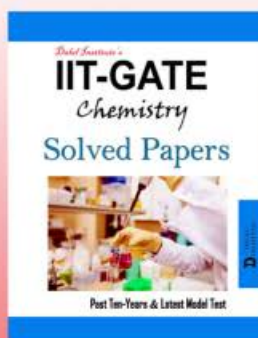
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