CSIR UGC – NET JRF: June 2016

Chemical Science

❖ Question Paper

Section-A

Q.1 It takes 2 hours for Tiwari and Deo to do a job. Tiwari and Hari take 3 hours to do the same job. Deo and Hari take 6 hours to do the same job. Which of the following statements is incorrect?

(a) Tiwari alone can do the job in 3 hours

(b) Deo alone can do the job in 6 hours

(c) Hari does not work at all

(d) Hari is the fastest worker

Q.2 Abdul travels thrice the distance Catherine travels, which is also twice the distance that Binoy travels. Catherine's speed is 1/3 of Abdul's speed, which is also 1/2 of Binoy's speed. If they start at the same time then who reaches first?

(a) Both Abdul and Catharine

(b) Binoy

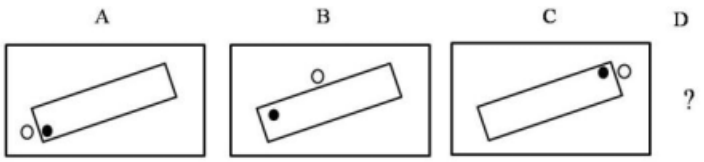
(c) Catherine

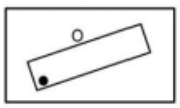
(d) All three together

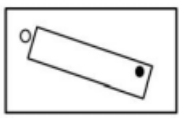
Q.3 For a certain regular solid: number of faces + number of vertices = number of edges+2. For three such distinct (not touching each other) objects, what is the total value of faces + vertices – edges?

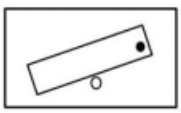
(a) 2 (b) 4 (c) 6 (d) 0

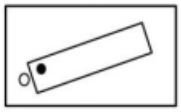
Q.4 What will be the next figure in the following sequence?



(a) 

(b) 

(c) 

(d) 

Q.5 A, B, C, D are points on a circle with AB=5 cm, BC=12 cm, AC=13 cm and AD=7cm. Then, the closest approximation of CD is

(a) 9 cm (b) 10 cm (c) 11 cm (d) 14 cm

Q.6 Choose the four digit number, in which the product of the first & fourth digits is 40 and the product of the middle digits is 28. The thousands digit is as much less than the unit digit as the hundreds digit is less than the tens digit.

(a) 5478 (b) 5748 (c) 8745 (d) 8475

Q.7 Equilateral triangles are drawn one inside the other as shown. What is the ratio of the two shaded areas?

(a) 2 : 1 (b) $\sqrt{3}$: 4 (c) 4 : 1 (d) 8 : 1

Q.8 A frog hops and lands exactly 1 meter away at a time. What is the least number of hops required to reach a point 10 cm away?

(a) 1 (b) 2 (c) 3 (d) Never reach

Q.9 A train running at 36 km/h crosses a mark on the platform in 8 sec and takes 20 sec to cross the platform. What is the length of the platform?

(a) 120 m (b) 280 m (c) 40 m (d) 160 m

Q.10 When a polynomial $f(x)$ is divided by $x - 5$ or $x - 3$ or $x - 2$. It leaves a remainder of 1. Which of the following would be the polynomial?

(a) $x^3-10x^2+31x+31$ (b) $x^3-10x^2+31x-29$ (c) $x^3-10x^2+31x-31$ (d) $x^3-10x^2+31x+29$

Q.11 Water is slowly dripping out of a tiny hole at the bottom of a hollow metallic sphere initially full of water. Ignoring the water that has flowed away, the Centre of mass of the system

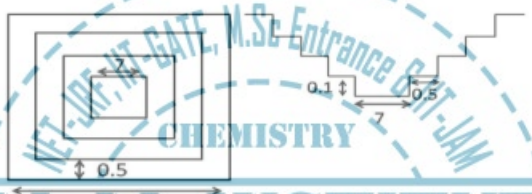
(a) remains fixed at the Centre of the sphere

(b) moves down steadily as the amount of water decreases

(c) moves down for some time but eventually returns to the Centre of the sphere

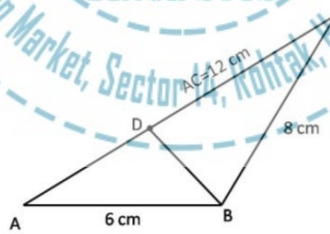
(d) moves down until half of the water is lost and then moves up

Q12 The diagram (not to scale) shows the top view and cross section of a pond having a square outline and equal sized steps of 0.5 m width and 0.1m height. What will be the volume of water (in m3) in the pond when it is completely filled?



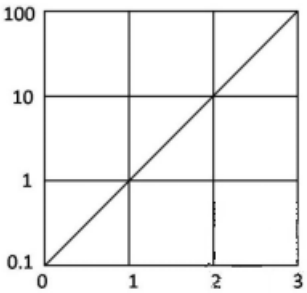
(a) 40.0 (b) 29.4 (c) 19.4 (d) 11.3

Q.13 D is a point on AC in the following triangle such that $\angle ADB = \angle ABC$. Then BD (in cm) is



(a) 8 (b) 6 (c) 3 (d) 4

Q14 The function f(x) is plotted against x as shown. Extrapolate and find the value of the function at x = –1



(a) –0.01 (b) –0.1 (c) 0.01 (d) 0.1

Q.15 A notebook contains only hundred statements as under:

1. This notebook contains 1 false statement.

2. This notebook contains 2 false statements.

99.This notebook contains 99 false statements.

100. This notebook contains 100 false statements.

Which of the statements is correct?

(a) 100^{th} (b) 1^{st} (c) 99^{th} (d) 2^{nd}

Q.16 A chocolate bar having m × n unit square tiles is given. Calculate the number of cuts needed to break it completely, without stacking, into individual tiles.

(a) (m × n) (b) (m – 1) × (n – 1) (c) (m × n) – 1 (d) (m × n) + 1

Q.17 A person paid income tax at the rate of R% for the first Rs 2 lakhs, and at the rate of (R+10)% for income exceeding Rs 2 lakhs. If the total tax paid is (R+5)% of the annual income, then what is the annual income ?

(a) Rs 2.5 lakhs (b) Rs 3.0 lakhs (c) Rs 4.0 lakhs (d) Rs 5.0 lakhs

Q.18 An experiment leads to the following set of observations of the variable 'v' at different times 't'

t	0	1	2	3	4	5	6
v	5	6.1	9.1	13.7	20.6	30.8	41.4

Allowing for experimental errors, which of the following expressions best describes the relationship between t and v?

(a) $v \propto t^2$ (b) $(v-5) \propto t^2$ (c) $v = 5t + t^2$ (d) $(v-5) = (t+5)^2$

Q.19 The difference between the squares of the ages (in complete years) of a father and his son is 899. The age of the father when his son was born

(a) cannot be ascertained due to inadequate data. (b) is 27 years.

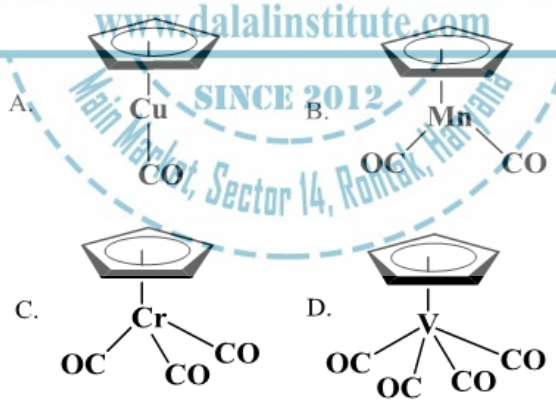
(c) is 29 years. (d) is 31 years.

Q.20 A bicycle tube has a mean circumference of 200 cm and a circular cross section of diameter 6 cm. What is the approximate volume of water (in cc) required to completely fill the tube, assuming that it does not expand

(a) 600 π (b) 1200 π (c) 3600 π (d) 1800 π

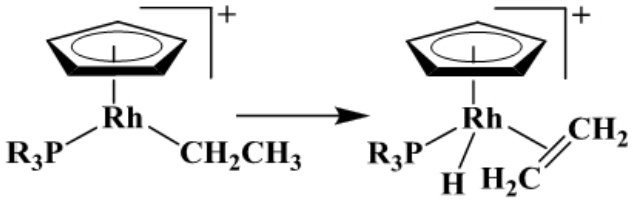
Section-B

Q.21 Identify the species, those obey the 18 electron rule, from the following:



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

Q.22 The following transformation



is an example of

(a) Oxidative addition (b) Insertion

(c) β-hydride elimination (d) Reductive elimination

Q.23 $[Ni^{II}L_6]^{n+ \text{ or } n-}$ shows absorption bands at 8500, 15400, and 26000 cm^{-1} whereas $[Ni^{II}L'_6]^{n+ \text{ or } n-}$, at 10750, 17500, and 28200 cm^{-1}. L and L′ are respectively,

(a) OH^- and N_3^- (b) Cl^- and I^- (c) NCS^- and RCO_2^- (d) H_2O and NH_3

Q.24 The number of microstates present in ^3F term is

(a) 3 (b) 21 (c) 9 (d) 28

Q.25 CpM [Cp is (η^5-C_5H_5)] fragment isolobal with a BH fragment is

(a) CpGe (b) CpMn (c) CpRu (d) CpCo

Q.26 The number of metal-metal bonds in $[Co_2Fe_2(CO)_{11}(\mu_4\text{-PPh})_2]$ is

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

Q.27 Correct combination for π and π* orbitals in B2 molecule is

	π	π*
1.	Gerade	Ungerade
2.	Ungerade	Gerade
3.	Gerade	Gerade

4.	Ungerade	Ungerade

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

Q.28 The correct shape of $[TeF_5]^-$ ion on the basis of VSEPR theory is

(a) Trigonal bipyramidal (b) Square pyramidal

(c) Pentagonal planar (d) See-saw

Q.29 The numbers of P-S and P-P bonds in the compound P_4S_3 are, respectively,

(a) 6 and 3 (b) 4 and 3 (c) 3 and 6 (d) 6 and 2

Q.30 In the iodometric titration of sodium thio-sulfate ($Na_2S_2O_3$) with acidic dichromate solution, 25 mL of 0.1 M dichromate requires 25 mL of 'x' M thiosulfate. The value of 'x' is

(a) 0.2 (b) 0.1 (c) 0.6 (d) 0.4

Q.31 Decomposition temperature of $CaCO_3$ in thermogravimetric analysis will be highest in dynamic atmosphere of

(a) Nitrogen (b) Synthesis Gas

(c) 1:1 mixture of O_2 and CO (d) Water Gas

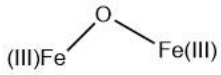
Q.32 On two sequential electron capture, $_{56}Ba^{131}$ will give

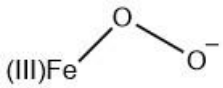
(a) $_{54}Xe^{131}$ (b) $_{54}Xe^{130}$ (c) $_{56}Ce^{131}$ (d) $_{56}Ce^{130}$

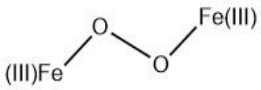
Q.33 The compound which dissolves in $POCl_3$ to give a solution with highest chloride ion concentration, is

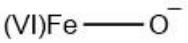
(a) Et_3N (b) KCl (c) $FeCl_3$ (d) $SbCl_5$

Q.34 In the absence of bound globin chain, heme group on exposure to O_2 gives the iron-oxygen species

(a) 

(b) 

(c) 

(d) 

Q.35 For monoionic complex $[UO_2(NO_3)_3]^-$, the correct coordination number and geometry respectively, are

(a) 8 and hexagonal bipyramidal

(b) 5 and square pyramidal

(c) 8 and square antiprism

(d) 5 and trigonal bipyramidal

Q.36 Chelate effect is

(a) predominantly due to enthalpy change

(b) predominantly due to entropy change

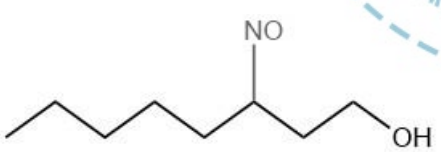
(c) independent of ring size

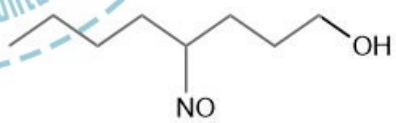
(d) due to equal contribution of entropy and enthalpy change

Q.37 The major product formed in the following reaction is

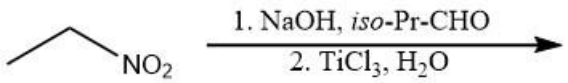
(a) 

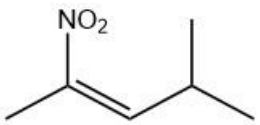
(b) 

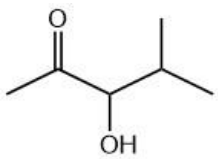
(c) 

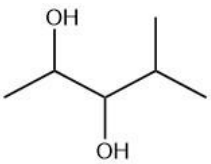
(d) 

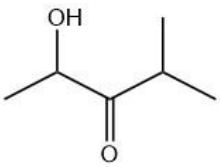
Q.38 The major product formed in the following reaction is



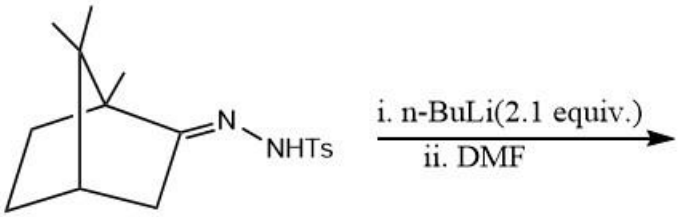
(a) 

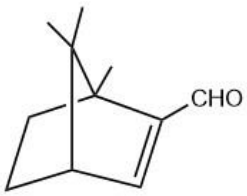
(b) 

(c) 

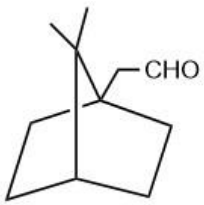
(d) 

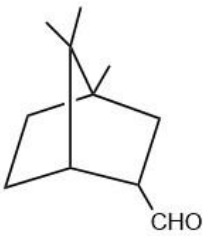
Q.39 The major product formed in the following reaction is



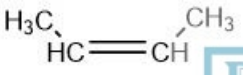
(a) 

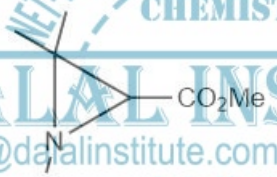
(b) 

(c) 

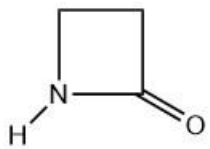
(d) 

Q.40 Among the following, the compound that displays an IR band at 2150 cm^{-1} is

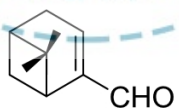
(a) 

(b) 

(c) 

(d) 

Q.41 In the ^1H NMR spectrum of myrtenal, the two methyl groups are expected to display signals at (chemical shift values (δ) in ppm)



myrtenal

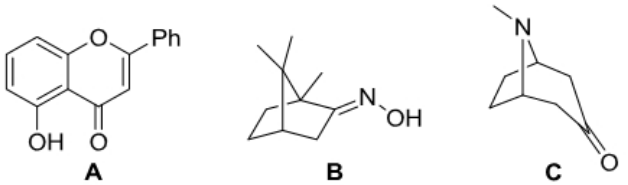
(a) 1.35 (s, 3H) and 5.0 (s, 3H)

(b) 0.74 (s, 3H) and 1.33 (s, 3H)

(c) 1.22 (s, 6H)

(d) 0.70 (s, 6H)

Q.42 Among the following, the compound(s) that can be classified as terpene derivative is(are)



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

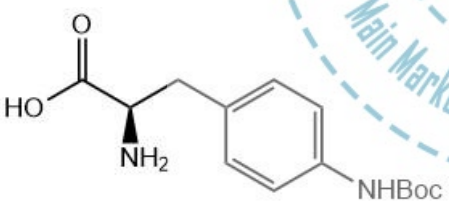
Q.43 The frontier orbital interactions involved in the formation of the carbocation intermediate in the reaction of isobutylene with HCl are

(a) π of olefin and σ* of HCl (b) π of olefin and σ of HCl

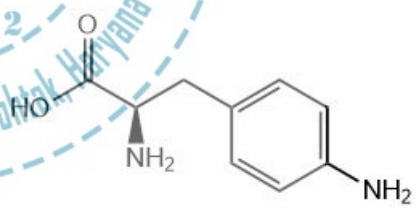
(c) π* of olefin and σ* of HCl (d) π* of olefin and σ of HCl

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

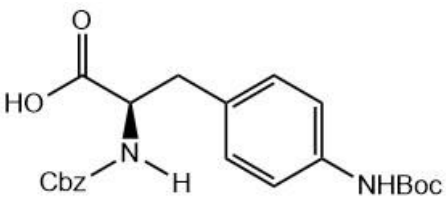
(a)



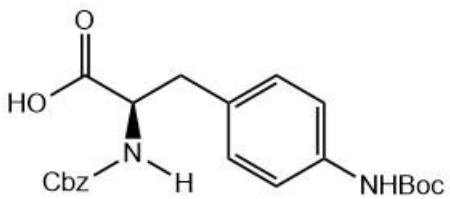
(b)



(c)



(d)



Q.45 In the UV-visible absorption spectrum of an α, β -unsaturated carbonyl compound, with increasing solvent polarity,

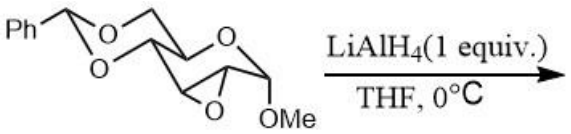
(a) n-π* transitions undergo hypsochromic shift, π-π* undergo bathochromic shift

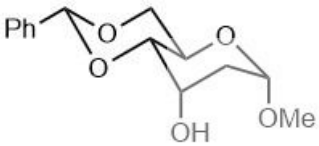
(b) n-π* transitions undergo bathochromic shift, π-π* undergo hypsochromic shift

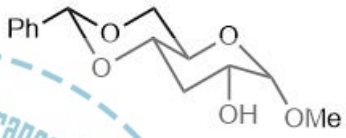
(c) both n-π* and π-π* transitions undergo bathochromic shift

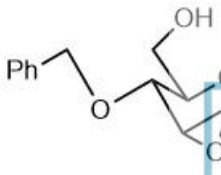
(d) both n-π* and π-π* transitions undergo hypsochromic shift

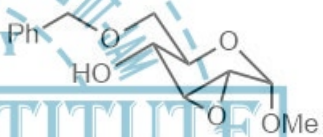
Q.46 The major product formed in the following reaction is



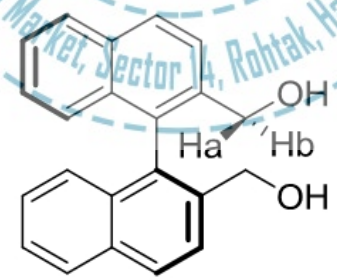
(a) 

(b) 

(c) 

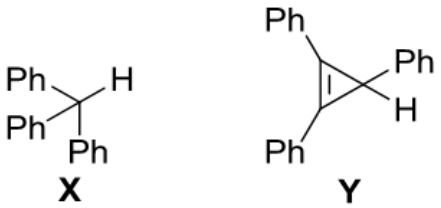
(d) 

Q.47 In the following compound, the stereochemical descriptor for Ha and Hb is



(a) Enantiotopic (b) Diasterotopic (c) Homotopic (d) Constitutionally heterotopic

Q.48 The correct statements are about the reaction of X and Y with $NaNH_2$ are



A. X reacts faster than Y

B. Y reacts faster than X

C. X and Y behave as Lewis acids

D. X is stronger Bronsted acid than Y

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

Q.49 The correct statements about conformations X and Y of 2-butanone are

A. X is more stable than Y

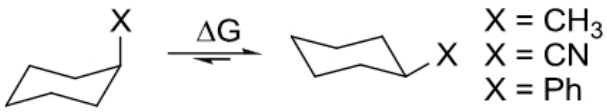
B. Y is more stable than X

C. Methyl groups in X are anti

D. Methyl groups in Y are gauche

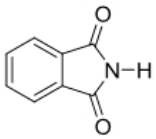
(a) A and D (b) A and C (c) B and C (d) A, C and D

Q.50 The correct order of the magnitude of 'A values' for the given substituents in cyclohexane derivatives is

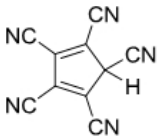


(a) Ph > CN > Me (b) Me > Ph > CN (c) CN > Me > Ph (d) Ph > Me > CN

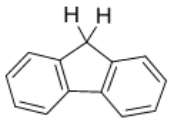
Q.51 The correct order of pKa values for the compounds X, Y and Z is



X



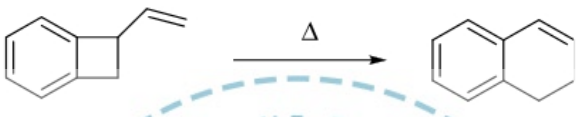
Y



Z

(a) X > Y > Z (b) Y > Z > X (c) Z > X > Y (d) Y > X > Z

Q.52 The following transformation proceeds through two consecutive electrocyclic processes, which are



(a) 4π conrotatory and 6π conrotatory (b) 4π disrotatory and 6π conrotatory

(c) 4π conrotatory and 6π disrotatory (d) 4π disrotatory and 6π disrotatory

Q.53 The simultaneous eigenfunctions of angular momentum operators L^2 and L_z are

(a) All of 2s, $2p_x$, $2p_y$ and $2p_z$ orbitals (b) Only 2s, $2p_x$ and $2p_y$ orbitals

(c) Only 2s and $2p_z$ orbitals (d) Only $2p_z$ orbitals

Q.54 An ideal gas is composed of particles of mass M in thermal equilibrium at a temperature T in one container. Another container contains ideal gas particles of mass 2M at a temperature 2T. The correct statement about the two gases is:

(a) Average kinetic energy and average speed will be same in the two cases.

(b) Both the averages will be doubled in the second case.

(c) Only the average kinetic energy will be doubled in the second case.

(d) Only the average speed will be doubled in the second case.

Q.55 The lowest energy term for the d^6 configuration is

(a) ^2D (b) ^5D (c) ^1P (d) ^1D

Q.56 If the rates of reaction are R_1 and R_2 at concentrations C_1 and C_2 of a reactant respectively, the order of reaction, 'n'(assuming that the concentrations of all other reactants and T remain constant) with respect to that reactant is given by

(a) $n = \frac{logR_1 - logR_2}{logC_1 - logC_2}$ (b) $n = \frac{logC_1 - logC_2}{logR_1 - logR_2}$ (c) $n = \frac{logC_1 - logR_1}{logC_2 - logR_2}$ (d) $n = \frac{logC_2 - logR_2}{logC_1 - logR_1}$

Q.57 Experimentally determined rate law for the chemical reaction $2NO_2F \rightarrow 2NO_2 + F_2$ is $R = k[NO_2F]$. The rate determining step consistent with the rate law is

(a) $2NO_2F \rightarrow 2NO_2 + F_2$ (b) $NO_2F + F \rightarrow NO_2 + F_2$

(c) $NO_2F \rightarrow NO_2 + F$ (d) $NO_2 + F \rightarrow NO_2F$

Q.58 The symmetry point group of the most stable geometry of the following molecule Cl(H)C=C=C(H)Cl is

(a) C_2 (b) C_1 (c) C_{2v} (d) C_{2h}

Q.59 The eigenfunctions of the Hamiltonian H(H = T + V) of a harmonic oscillator are (where T and V are kinetic energy and potential energy operators, respectively)

(a) Eigenfunctions of T as well as V (b) Eigenfunctions of T, But not of V

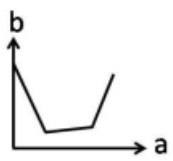
(c) Eigenfunctions of V, But not of T (d) Eigenfunctions of neither T nor V

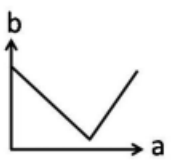
Q.60 In a potentiometric titration, the end point is characterized by

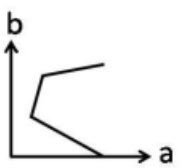
(a) $\frac{dE}{dV} = 0, \frac{d^2E}{dV^2} = 0$ (b) $\frac{dE}{dV} \neq 0, \frac{d^2E}{dV^2} = 0$ (c) $\frac{dE}{dV} = 0, \frac{d^2E}{dV^2} \neq 0$ (d) $\frac{dE}{dV} \neq 0, \frac{d^2E}{dV^2} \neq 0$

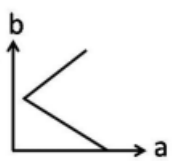
Where E is the emf of the titration cell and V is the volume of the titrant added

Q.61 On titrating conductometrically a NaOH solution with a mixture of HCl and CH_3CO_2Hsolutions, plot of the volume of mixed acid added (b) in y-axis against the conductance (a) in x-axis is expected to look like

(a) 

(b) 

(c) 

(d) 

Q.62 $\left(\frac{\partial H}{\partial P}\right)_T$ has the dimension of

(a) Pressure (b) Volume (c) Temperature (d) Heat Capacity

Q.63 In a cubic crystal, the plane [100] is equally inclined to the planes

(a) [010] and [011] (b) [010] and [110] (c) [001] and [101] (d) [110] and [011]

Q.64 The standard electrode potential E° at a fixed temperature and in a given medium is dependent on

(a) Only the electrode composition

(b) The electrode composition and the extent of the reaction

(c) The extent of the electrode reaction only

(d) The electrode reaction and the electrode composition

Q.65 In a titration, the percentage uncertainties in the measured aliquot volume and the measured titre volume are $\pm x$ and $\pm y$ respectively. The percentage error in the calculated concentration of aliquot is

(a) $x + y$ (b) xy (c) $(xy)^2$ (d) $(x^2 + y^2)^{1/2}$

Q.66 For an ideal gas at 300K

(a) $\left(\frac{\partial U}{\partial V}\right)T = 0$ (b) $\left(\frac{\partial U}{\partial T}\right)V = 0$ (c) $\left(\frac{\partial H}{\partial T}\right)P = 0$ (d) $\left(\frac{\partial G}{\partial T}\right)P = 0$

Q.67 The first excited state of hydrogen molecule is

(a) ${}^1\Sigma_g^+$ (b) ${}^1\Sigma_u^-$ (c) ${}^3\Sigma_g^-$ (d) ${}^3\Sigma_u^+$

Q.68 When river water containing colloidal clay flows into the sea, the major cause of silting is

(a) Accumulation of sand at the bottom (b) Delocculation and coagulation

(c) Decreased salinity of sea water (d) Micellization

Q.69 Match the metal given in Column A with its medicinal use as a compound in Column B.

Column A	Column B
(a) Gd	(i) Cancer
(b) Au	(ii) Maniac depression
(c) Pt	(iii) MRI contrast agent
(d) Li	(iv) Arthritis

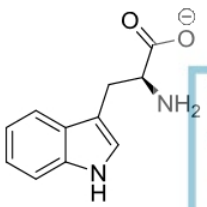
(a) (a)-(ii); (b)-(iii); (c)-(iv); (d)-(i);

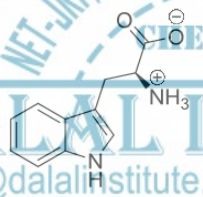
(b) (a)-(iv); (b)-(ii); (c)-(i); (d)-(iii);

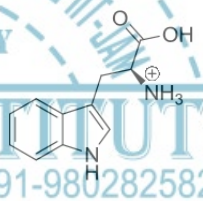
(c) (a)-(iii); (b)-(iv); (c)-(i); (d)-(ii);

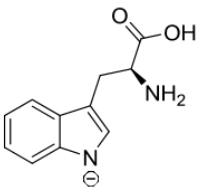
(d) (a)-(i); (b)-(ii); (c)-(iii); (d)-(iv).

Q.70 At pH 10, tryptophan exists as

(a) 

(b) 

(c) 

(d) 

Section-C

Q.71 Complex $[Cr(bipyridyl)_3]^{3+}$, shows red phosphorescence due to transition

(a) $^4T_{2g} \leftarrow {}^4A_{2g}$ (b) $^4T_{1g} \leftarrow {}^4A_{2g}$ (c) $^4A_{2g} \leftarrow {}^2E_g$ (d) $^2E_g \leftarrow {}^4A_{2g}$

Q.72 Choose the correct option for carbonyl fluoride with respect to bond angle and bond length

(a) $\angle$F-C-F > $\angle$F-C-O and C-F > C-O

(b) $\angle$F-C-F > $\angle$F-C-O and C-F < C-O

(c) $\angle$F-C-F < $\angle$F-C-O and C-F > C-O

(d) $\angle$F-C-F < $\angle$F-C-O and C-F < C-O

Q.73 Which of the following react(s) with AsF_5 in liquid BrF_3?

(a) XeF_6 only (b) XeF_6 and XeF_4 (c) XeF_6 and XeF_2 (d) XeF_4 and XeF_2

Q.74 Consider the following reactions:

A. $NOCl + Sn \xrightarrow{N_2O_4}$

B. $NOCl + AgNO_3 \rightarrow$

C. $NOCl + BrF_3 \rightarrow$

D. $NOCl + SbCl_5 \rightarrow$

Reactions which will give [NO]+ as a major product are:

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

Q.75 The complex that shows orbital contribution to the magnetic moment, is

(a) $[Cu(H_2O)_6]^{2+}$ (b) $[Ni(H_2O)_6]^{2+}$ (c) $[Co(H_2O)_6]^{2+}$ (d) $Cr(H_2O)_6]^{2+}$

Q.76 Among KF, SnF_4 and SbF_5, solute(s) that increase(s) the concentration of BrF_4^- in BrF_3, is/are

(a) KF only (b) KF and SnF_4 (c) SnF_4 and SbF_5 (d) KF, SnF_4 and SbF_5

Q.77 Paramagnetic susceptibility of the order of 10^{-6} cm^3mol^{-1} observed for $KMnO_4$ is due to

(a) Random spin alignment (b) Antiferromagnetic exchange interaction

(c) Paramagnetic impurity (d) Temperature independent paramagnetism

Q.78 Correct order of M-C bond length of metallocenes (a-c)

a. $[Fe(\eta^5\text{-}Cp)_2]$ b. $[Ni(\eta^5\text{-}Cp)_2]$ c. $[Co(\eta^5\text{-}Cp)_2]$ is

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

Q.79 A 100 mL solution of 2.5×10^{-3} M in Bi(III)and Cu(II) each, is photometrically titrated at 745 nm with 0.1 M EDTA solution. Identify correct statements for this titration.

A. Total volume of EDTA solution used is 5 mL

B. 3 mL of EDTA is required to complex Bi(III) and 2 mL for Cu(II)

C. 2.5 mL of EDTA is used for each metal ion

D. First break in titration curve is for Cu(II)

Correct statements are

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

Q.80 On continuous exposure of ^{10}B sample to a slow neutron flux of 10^{16} m^2s^{-1}, its 3 % weight fraction disappears in 3 x 10^7 s. Cross section for neutron capture (in barns) by ^{10}B is

(a) 1000 (b) 3000 (c) 10,000 (d) 30,000

Q.81 The ^1H NMR spectrum of $[Ru(\eta^4\text{- } C_8H_8)(CO)_3]$ at 23 ˚C consists of a sharp single line. The number of signals observed at low temperature (–140 ˚C) in its spectrum is

(a) 8 (b) 6 (c) 4 (d) 2

Q.82 The g values for Ce^{3+} ($4f^1$) and Pr^{3+} ($4f^2$) are, respectively

(a) 3/7 and 2/5 (b) 5/7 and 4/5 (c) 6/7 and 3/5 (d) 6/7 and 4/5

Q.83 The room temperature magnetic moment (μ_{eff} in BM) for a monomeric Cu(II) complex is greater than 1.73. This may be explained using the expression:

(a) $\mu_{eff} = \mu_s(1 - \frac{\alpha\lambda}{\Delta})$ (b) $\mu_{eff} = \sqrt{n(n+2)}$

(c) $\mu_{eff} = \sqrt{4s(s+1) + L(L+1)}$ (d) $\mu_{eff} = g\sqrt{j(j+1)}$

Q.84 The number of 3c-2e bonds present in $Al(BH_4)_3$ is

(a) Four (b) Three (c) Six (d) Zero

Q.85 The numbers of skeletal electrons present in the compounds $C_2B_3H_5$, $C_2B_4H_6$, and B_5H_9 are, respectively,

(a) 10, 12 and 12 (b) 12, 14 and 14 (c) 10, 12 and 14 (d) 12, 14 and 12

Q.86 Identify correct statements for the EPR spectrum of $VO(acac)_2$ [with square pyramidal geometry at vanadium] at 77 K [I (^{51}V) = 7/2].

A. It has two g values.

B. It has 8 lines only.

C. It has one g value.

D. It has two patterns of 8 lines each.

Correct statements are

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

Q.87 The numbers of lines shown by the BH_3 part of the molecule $Ph_3P.^{11}BH3$ in the ^1H and ^{11}B NMR spectra are, respectively [I (^{11}B) = 3/2; I (^{31}P) = ½]

(a) 8 and 8. (b) 4 and 8. (c) 3 and 6. (d) 6 and 3.

Q.88 To record Mössbauer spectrum of Fe containing samples, a source 'X' is used. X after a nuclear transformation (Y), gives γ-radiation used in Mössbauer spectroscopy. X and Y respectively, are

(a) ^{57}Fe, β-emission (b) ^{57}Co, β -emission (c) ^{57}Co, e^- capture (d) ^{57}Fe, e^- capture.

Q.89 Correct combination of number and size of rings present in a metal ion-porphine complex (including metal ion bearing chelate rings) is

(a) Four 5-membered and four 6-membered (b) Two 5-membered and six 6-membered

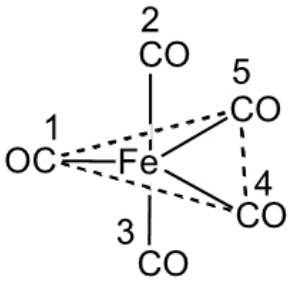
(c) Six 5-membered and two 6-membered (d) Five 5-membered and three 6-membered

Q.90 In human body cis-platin hydrolyzes to a di aqua complex and modifies the DNA structure by binding to

(a) N-atom of guanine base (b) O-atom of cytosine base

(c) N-atom of adenine base (d) O-atom of thymine base

Q.91 For fluxional $Fe(CO)_5$ (structure given below) in solution, the exchange of numbered CO groups will be between



(a) 2 and 5; 3 and 4 (b) 2 and 3; 4 and 5 (c) 2 and 3; 1 and 5 (d) 1 and 2; 4 and 5

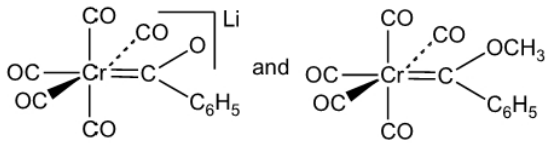
Q.92 In the following reaction sequence

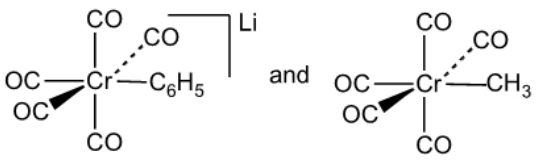
$$HNEt_2 + CS_2 \xrightarrow{KOH} P \xrightarrow[I_2]{aq\ soln} R \xrightarrow{[CpMo(CO)_3]_2} S$$

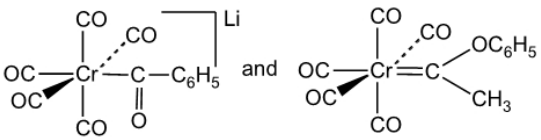
Wheren dtc = dithiocarbamate and tds = thiuramdisufide. Identify P, R and S. Cp = η^5-C_5H_5

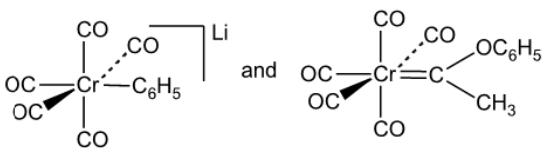
	P	Q	R
(a)	$Et_2dtc^-K^+$	Et_4tds	$CpMo(Et_2dtc)(CO)_2$
(b)	$Etdtc^-K^+$	Et_3tds	$CpMo(Et_3dtc)(CO)_2$
(c)	$Et_4dtc^-K^+$	Et_2tds	$CpMo(Et_4dtc)(CO)$
(d)	$Etdtc^-K^+$	Ettds	CpMo(Etdtc)(CO)

Q.93 Reaction of $Cr(CO)_6$ with LiC_6H_5 gives A which reacts with $[Me_3O][BF_4]$ to give B. The structures of A and B respectively, are

(a) 

(b) 

(c) 

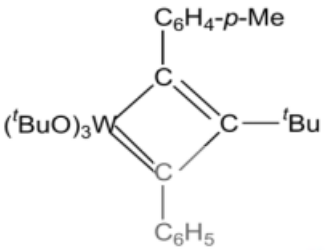
(d) 

Q.94 Heating a sample of $[(\eta^5\text{-}C_5H_5)Mo(CO)_3]_2$ results in the formation of $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ with elimination of 2 equivalents of CO. The Mo–Mo bond order in this reaction changes from

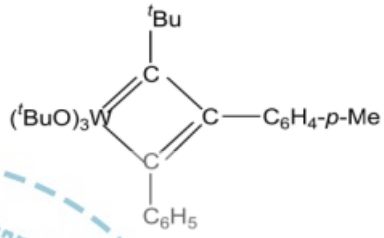
(a) 2 to 3 (b) 1 to 2 (c) 1 to 3 (d) 2 to 4

Q.95 A plausible intermediate involved in the self metathesis reaction of C_6H_5–C≡C-C_6H_4 -p-Me catalyzed by $[(^tBuO)_3W{\equiv}C{-}{}^tBu]$ is

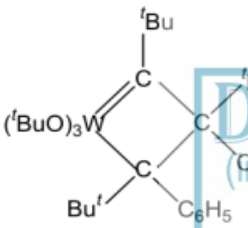
(a)



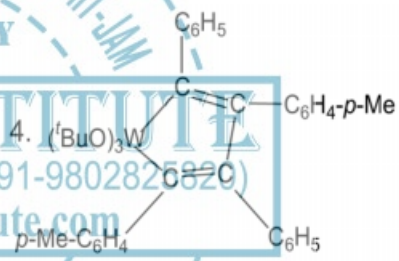
(b)



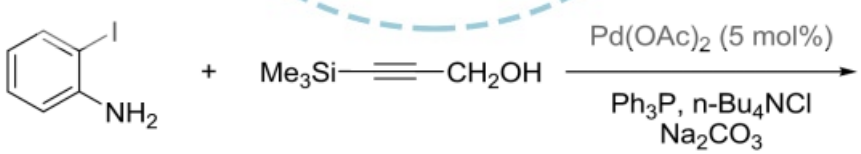
(c)



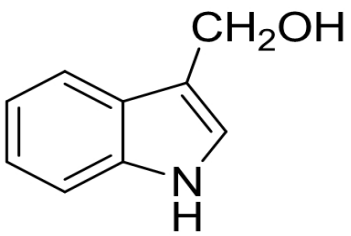
(d)



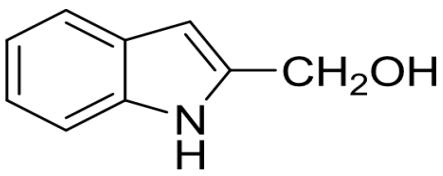
Q.96 The major product formed in the following reaction is



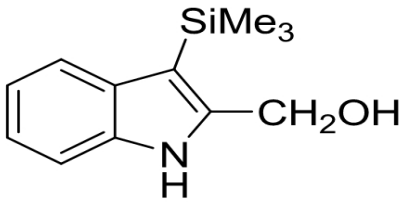
(a)



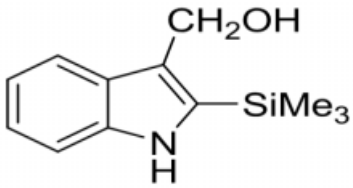
(b)



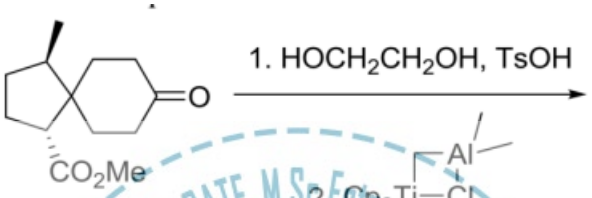
(c)



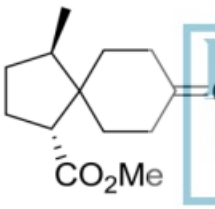
(d)



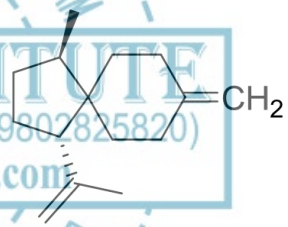
Q.97 The major product formed in the following reaction sequence is



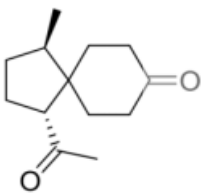
(a)



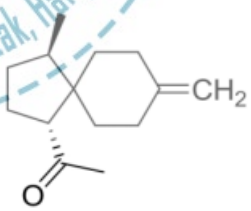
(b)



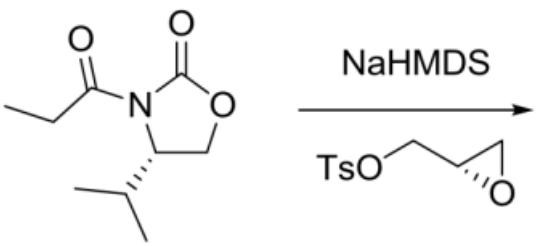
(c)

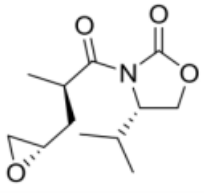
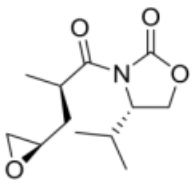
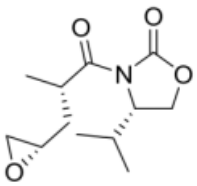
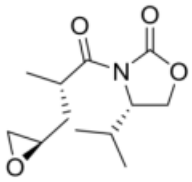


(d)

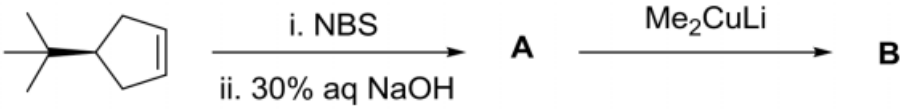


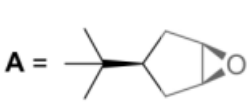
Q.98 The major product formed in the following reaction is

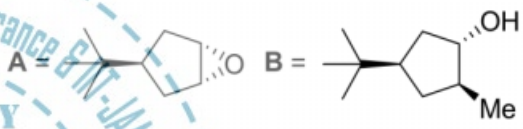


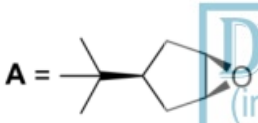
(a)  (b)  (c)  (d) 

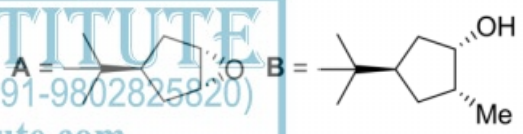
Q.99 The major products A and B in the following reaction sequence are



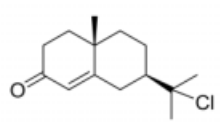
(a) 

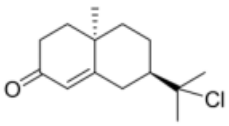
(b) 

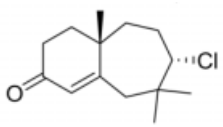
(c) 

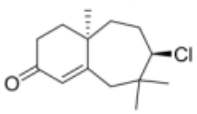
(d) 

Q.100 The major product formed in the following reaction sequence is

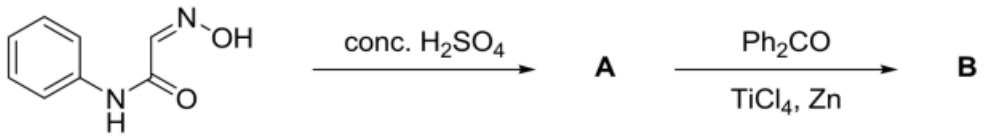
(a) 

(b) 

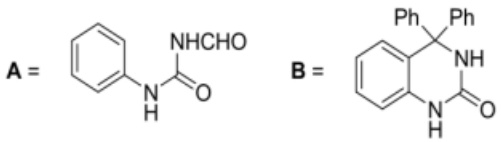
(c) 

(d) 

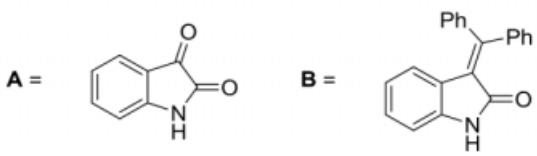
Q.101 The major products A and B in the following reaction sequence are



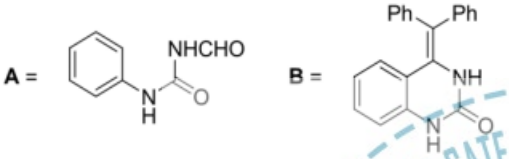
(a)



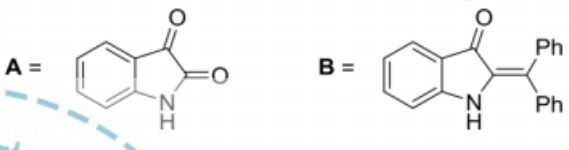
(b)



(c)

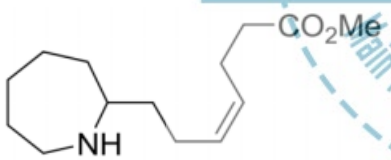


(d)

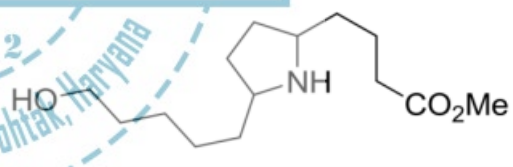


Q.102 The major product in the following reaction is

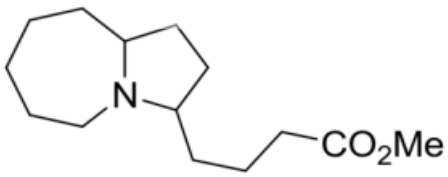
(a)



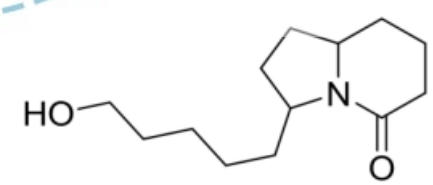
(b)



(c)



(d)



Q.103 The correct reagent combination to effect the following reaction is

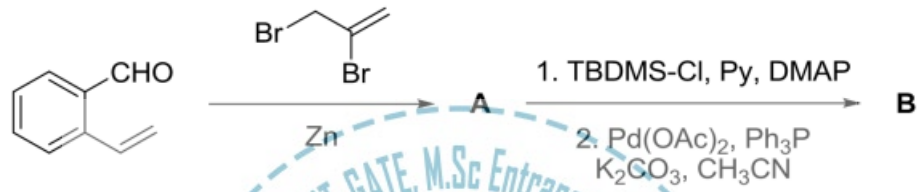
(a) i. $NaBH_4$, $CeCl_3$, MeOH, 0 ˚C;
ii. H_2, $[Ir(COD)(py)P(Cy)_3]PF_6$;
iii. Ph_3P, $PhCO_2H$, DEAD; iv. $LiAlH_4$.

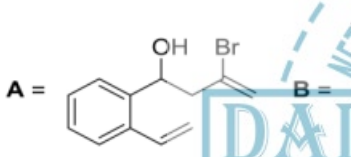
(b) i. Li, liquid NH_3;
ii. H_2, $[Ir(COD)(py)P(Cy)_3]PF_6$;
iii. Ph_3P, $PhCO_2H$, DIAD;
iv. $NaBH_4$, $CeCl_3$, MeOH, 0 ˚C.

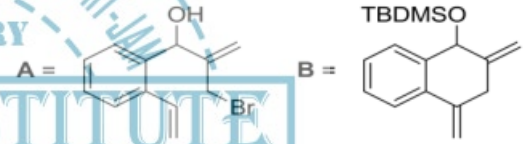
(c) i. H_2, Pd/C; ii. $LiAlH_4$, -78 ˚C.

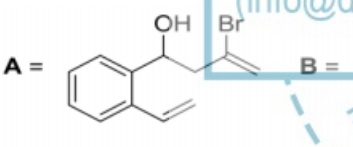
(d) i. H_2, Pd/C; ii. Li, liquid NH_3.

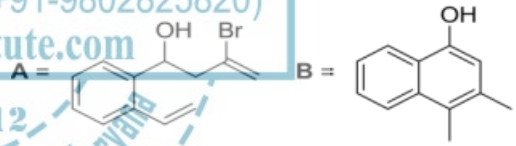
Q.104 The major products A and B in the following reaction sequence are



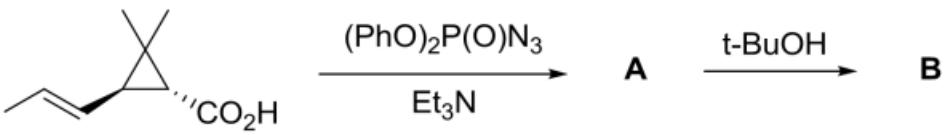
(a) 

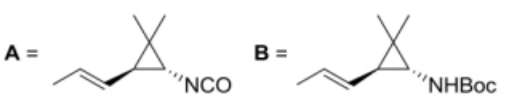
(b) 

(c) 

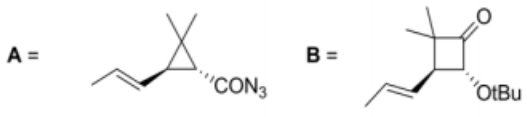
(d) 

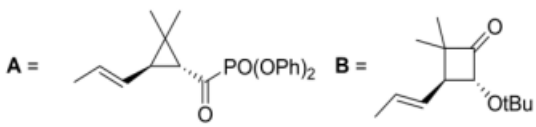
Q.105 Structures of the intermediate A and the major product B in the following reaction sequence are



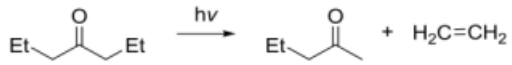
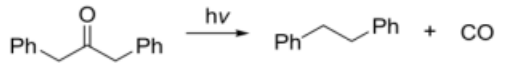
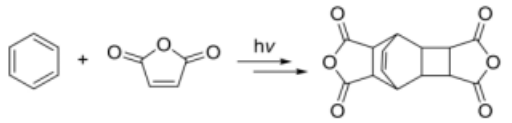
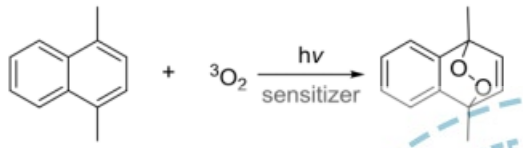
(a) 

(b) 

(c) 

(d) 

Q.106 The correct match for the following transformations P-S with the processes I-IV is

Reactions	Processes:
P 	I. Diels-Alder
Q 	II. Norrish Type I
R 	III. photocycloaddition followed by Diels-Alder
S 	IV. Norrish Type II

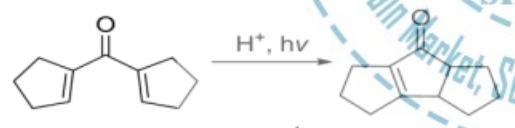
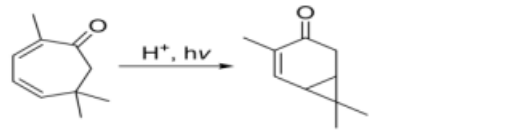
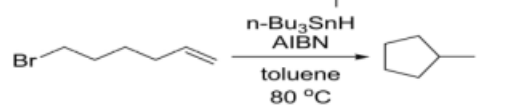
(a) P-II; Q-IV; R-III; S-I

(b) P-II; Q-IV; R-I; S-II

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

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

Q.107 The correct match for the reactions P-S with the names of cyclizations I-IV is

Reactions	Names of cyclizations:
P 	I. Halocyclization
Q 	II. Nazarov cyclization
R 	III. Radical cyclization
S 	IV. Electrocyclization

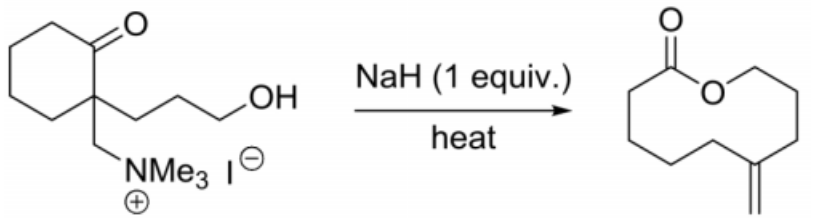
(a) P-IV; Q-I; R-II; S-III

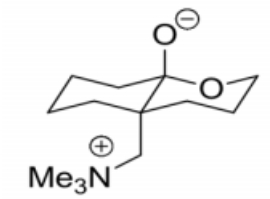
(b) P-II; Q-I; R-IV; S-III

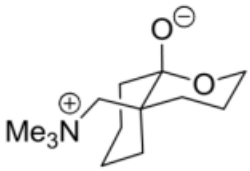
(c) P-IV; Q-II; R-III; S-I

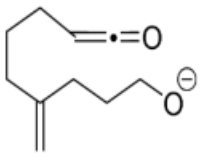
(d) P-II; Q-I; R-III; S-IV

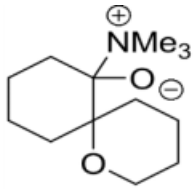
Q.108 The correct structure of the intermediate, which leads to the product in the following reaction is



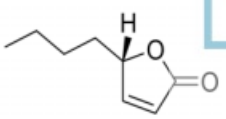
(a) 

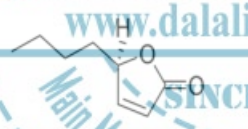
(b) 

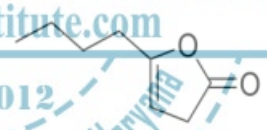
(c) 

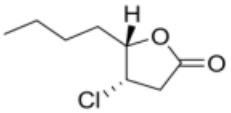
(d) 

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

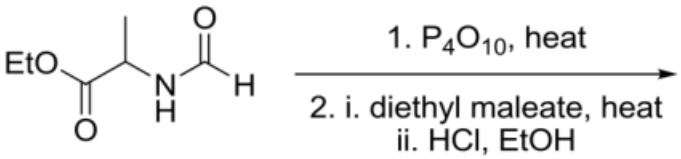
(a) 

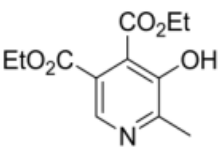
(b) 

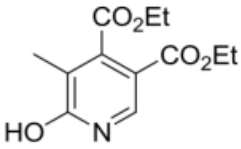
(c) 

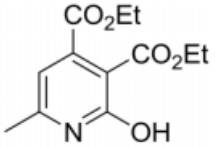
(d) 

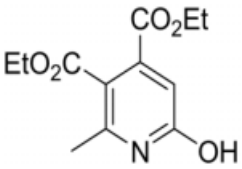
Q.110 The major product formed in the following reaction is



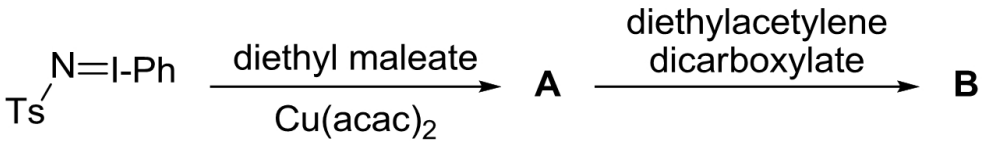
(a) 

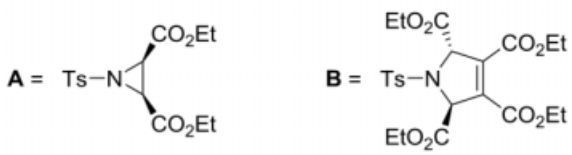
(b) 

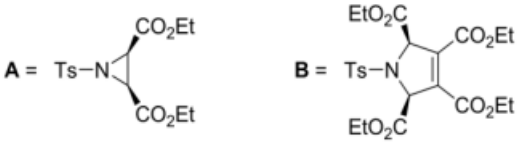
(c) 

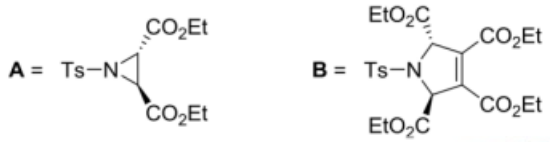
(d) 

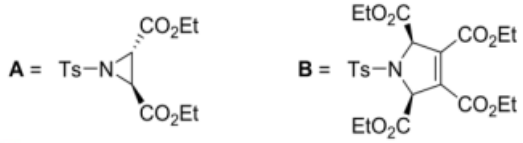
Q.111 The major products A and B formed in the following reaction sequence are



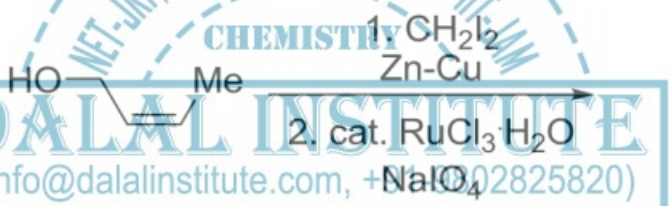
(a) 

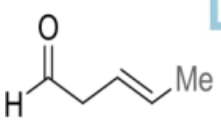
(b) 

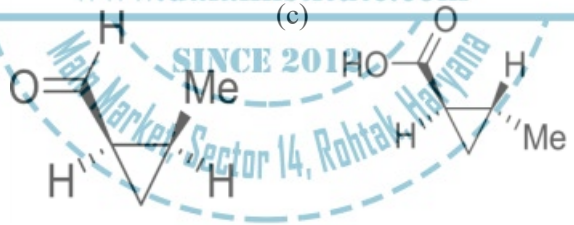
(c) 

(d) 

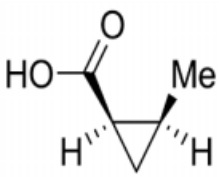
Q.112 The major product formed in the following reaction is



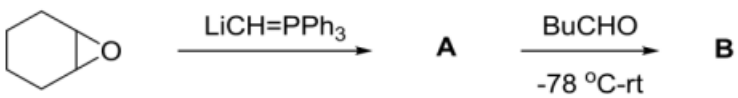
(a) 

(b) 

(c)

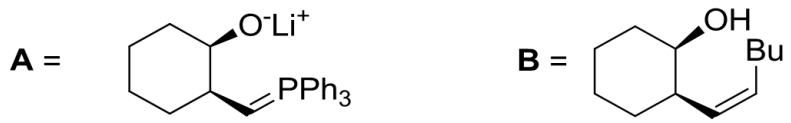
(d) 

Q.113 The intermediate A and the major product B in the following reaction sequence are

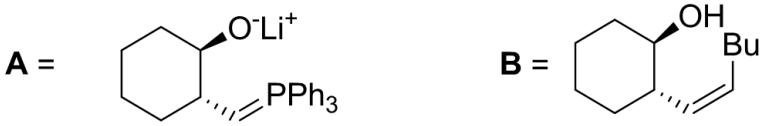


(a) 

(b)

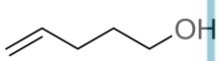


(c)



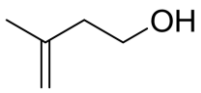
(d)

Q.114 The correct structure of the compound, which shows following ^{13}C NMR DEPT-135 data is ^{13}C NMR DEPT-135: negative peaks at δ 30.2, 31.9, 61.8, 114.7 ppm; positive peak at 130.4 ppm

(a) 

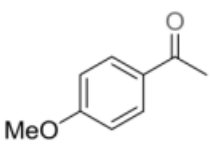
(b) 

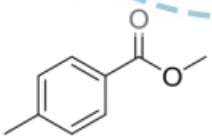
(c) 

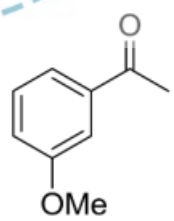
(d) 

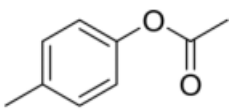
Q.115 A compound displays the following spectral data. The correct structure of the compound is

IR: 1690 cm^{-1} ^1H NMR: δ 2.5 (s, 3H), 3.8 (s, 3H), 6.9 (d, J = 8 Hz, 2H), 7.8 (d, J = 8 Hz, 2H) ppm ^{13}C NMR: δ 197, 165, 130, 129, 114, 56, 26 ppm

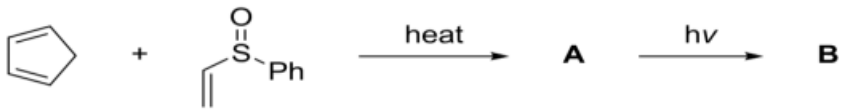
(a) 

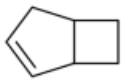
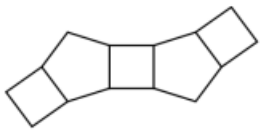
(b) 

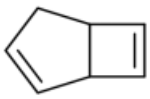
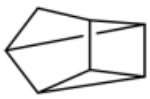
(c) 

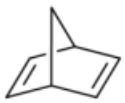
(d) 

Q.116 The major products A and B formed in the following reaction sequence are



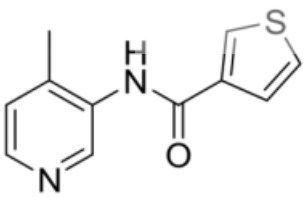
(a) A =  B = 

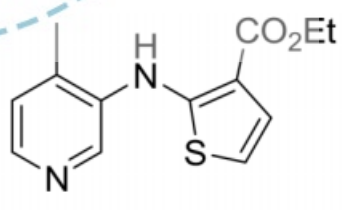
(b) A =  B = 

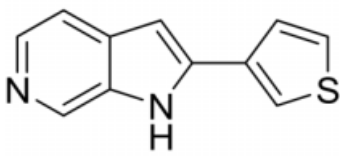
(c) A =  B = 

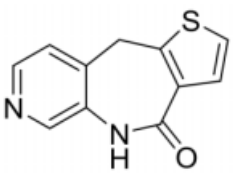
(d) A =  B = 

Q.117 The major product formed in the following reaction is

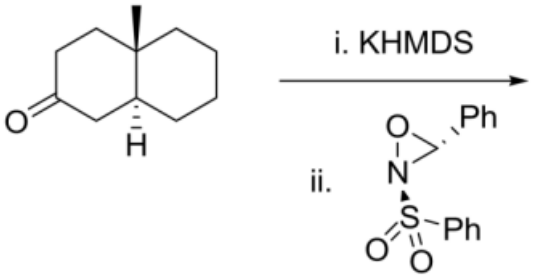
(a) 

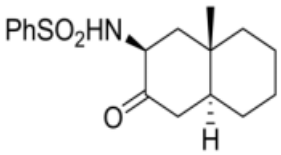
(b) 

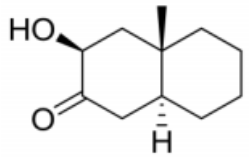
(c) 

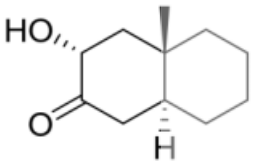
(d) 

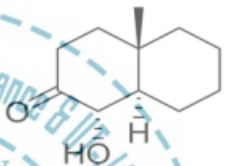
Q.118 The major product formed in the following reaction is



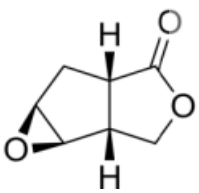
(a) 

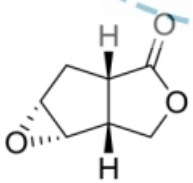
(b) 

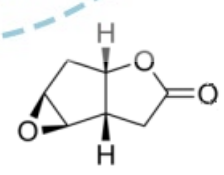
(c) 

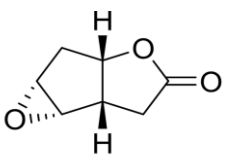
(d) 

Q.119 The major product formed in the following reaction is

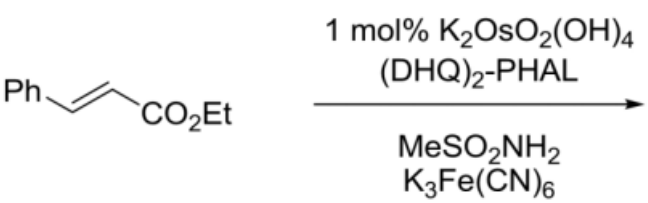
(a) 

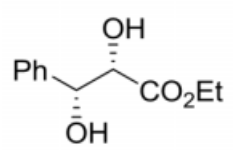
(b) 

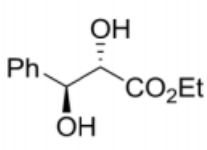
(c) 

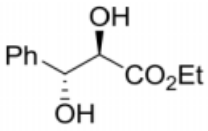
(d) 

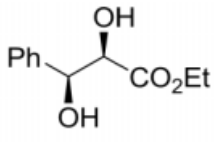
Q.120 The major product formed in the following reaction is



(a) 

(b) 

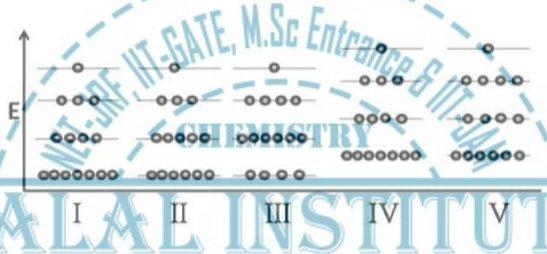
(c) 

(d) 

Q.121 The single-particle translational partition function (f) for an ideal gas in a fixed volume V depends on the thermal de Broglie wavelength λ_{th} as $f \sim (\lambda_{th})^n$ where

(a) n = 3 (b) n = 1 (c) n = – 1 (d) n = – 3

Q.122 15 particles are distributed among 4 levels as shown in state I. Heat is given to the system and no work is done. The final state could be



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

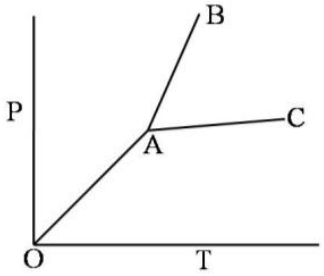
Q.123 In an NMR spectrometer containing a 2.5T magnet, Larmor precession frequency of ^1H is 100 MHz. The radio frequency used in this spectrometer has an associated magnetic field strength of 2.5×10^{-4}T. The duration of a 90° pulse in this instrument is

(a) 25×10^{-6}s (b) 50×10^{-6}s (c) 25×10^{-5}s (d) 50×10^{-5}s

Q.124 Upon application of a weak magnetic field, a line in the microwave absorption spectrum of rigid rotor splits into 3 lines. The quantum number (J) of the rotational energy level from which the transition originates is

(a) 0 (b) 1 (c) 2 (d) 3

Q. 125 Phase diagram of a compound is shown below:



The slopes of the lines OA, AC and AB are $\tan\frac{\pi}{4}$, $\tan\frac{\pi}{6}$ And $\tan\frac{\pi}{3}$, respectively. If melting point and ΔH of melting are 300 K and 3 kJ mol^{-1} respectively, the change in

(a) $10\tan\frac{\pi}{3}$ (b) $10\tan\frac{\pi}{4}$ (c) $10\cot\frac{\pi}{3}$, (d) $10\cot\frac{\pi}{4}$

Q.126 The figure below describes how a Carnot engine works. It starts from the adiabatic compression step denoted by

(a) AB (b) BC (c) DC (d) AD

Q.127 The point group obtained by adding symmetry operation σ_h to the point group C_4 is

(a) S_4 (b) C_{4h} (c) D_{2d} (d) D_4

Q.128 For a particle of mass m confined in a rectangular box with sides 2a and a, the energy and degeneracy of the first excited state, respectively, are

(a) $\frac{h^2}{8m}\left(\frac{2}{a^2}\right), 1$ (b) $\frac{h^2}{8m}\left(\frac{17}{4a^2}\right), 2$ (c) $\frac{h^2}{8m}\left(\frac{5}{4a^2}\right), 1$ (d) $\frac{h^2}{8m}\left(\frac{5}{a^2}\right), 2$

Q.129 The ionization energy of hydrogen atom in its ground state is approximately 13.6 eV. The potential energy of He^+, in its ground state is approximately

(a) –54.4 eV (b) –27.2 eV (c) –13.6 eV (d) –108.8 eV

Q.130 The character table for the D3 point group is provided below:

D_3	E	2C	3C		
A_1	1	1	1		x^2+y^2,z^2
A2	1	1	–1	z, R_z	
E	2	–1	0	(x,y) (R_x,R_y)	$x^2–y^2$,xy (xz,yz)

For this point group, the correct statement among the following is:

(a) It is possible to have a totally symmetric normal mode of vibration which is IR-active.

(b) All IR-active normal modes are necessarily Raman inactive.

(c) All Raman-active normal modes are necessarily IR-active.

(d) It is possible to have a pair of IR-active normal modes that are degenerate.

Q.131 Suppose $\psi_1, \psi_2, \psi_3, \ldots$ are wavefunctions of an anharmonic oscillator and $\phi_0, \phi_1, \phi_2, \ldots$ are wavefunctions of a harmonic oscillator with increasing order of energy. The subscripts denote vibrational quantum numbers in both the cases. Given

$\psi_0 = a_1\phi_0 + a_2\phi_2 + a_3\phi_4$

$\psi_1 = b_1\phi_0 + b_2\phi_4 + b_3\phi_6$

$\psi_2 = c_1\phi_1 + c_2\phi_4$

$\psi_3 = d_1\phi_3 + d_2\phi_5$

the FORBIDDEN electric dipole (assuming the dipole operator is linear in normal coordinates) transition among the following is

(a) $\psi_0 \rightarrow \psi_1$ (b) $\psi_0 \rightarrow \psi_2$ (c) $\psi_0 \rightarrow \psi_3$ (d) $\psi_1 \rightarrow \psi_2$

Q.132 If U is a function of V and T, $\left(\frac{\partial U}{\partial T}\right)_P$ is equal to (π and α are the internal pressure and the coefficient of thermal expansion, respectively.)

(a) C_p (b) C_v (c) $C_p - \pi V\alpha$ (d) $C_v + \pi V\alpha$

Q.133 The character table of C_{3v} point group is provided below, along with an additional reducible representation, Γ

	E	$2C_3$	$3\sigma_v$
A_1	1	1	1
A_2	1	1	–1
E	2	–1	0
Γ	6	0	2

Γ is given by

(a) $A_1 + A_2 + 2E$ (b) $2A_1 + 2E$ (c) $2A_2 + 2E$ (d) $2A_1 + 2A_2 + E$

Q.134 For the chemical reaction in aqueous solution

$$CH_2ClCOO^- + OH^- \rightarrow CH_2OHCOO^- + Cl^-$$

the correct statement is:

(a) Increase of pressure increases the rate constant.

(b) Increase of dielectric constant increases the rate constant

(c) Increase of ionic strength decreases the rate constant.

(d) The entropy of activation is positive.

Q.135 If experimentally observed rate constant is greater than the maximum value of rate constant obtained using hard-sphere model of collision theory, then relation between the impact parameter (b) and sum of the radii of two reactants is

(a) $b = r_1 + r_2$ (b) $b < r_1 + r_2$ (c) $b > r_1 + r_2$ (d) $b \leq r_1 + r_2$

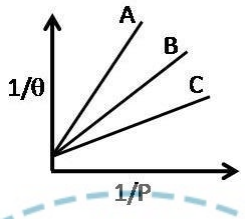
Q.136 Half-life $t_{1/2}$ for a third order reaction $3C \rightarrow$ products, where C_0 is the initial concentration of C, will be

(a) $\frac{3}{2kc_0^2}$ (b) $\frac{1}{kc_0}$ (c) $\frac{3}{2kc_0}$ (d) $\frac{2}{3kc_0^2}$

Q.137 For a simple cubic lattice, the ratio between the unit cell length and the separation of two adjacent parallel crystal planes can NOT have a value of

(a) $5^{1/2}$ (b) $7^{1/2}$ (c) $11^{1/2}$ (d) $13^{1/2}$

Q.138 Adsorption isotherm of three gases A, B and C are shown in the following figure, where θ is the percentage of surface coverage.



The correct order of the extent of adsorption of these gases is

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

Q.139 Choosing some Hamiltonian H and an orthonormal basis, a linear variation is carried out to get approximate energies $\bar{E}_j$. With 2 basis functions, one obtains $\bar{E}_1(2) \leq \bar{E}_2(2)$. Taking 3 basis functions, similarly three ordered energies $\bar{E}_1(3) \leq \bar{E}_2(3) \leq \bar{E}_3(3)$ are found. The relation which holds from the following is?

(a) $\bar{E}_1(2) \leq \bar{E}_1(3)$; $\bar{E}_2(2) \leq \bar{E}_2(3)$ (b) $\bar{E}_1(3) \leq \bar{E}_1(2)$; $\bar{E}_2(2) \leq \bar{E}_2(3)$

(c) $\bar{E}_1(2) \leq \bar{E}_1(3)$; $\bar{E}_2(3) \leq \bar{E}_2(2)$ (d) $\bar{E}_1(3) \leq \bar{E}_1(2)$; $\bar{E}_2(3) \leq \bar{E}_2(2)$

Q.140 Average value of momentum for the ground state of a particle in a 1-d box is zero because

(a) [p,H] = 0 (b) V(potential) = 0

(c) H is hermitian (d) The state is bound and stationary

Q.141 For a hermitation operator A, which does NOT commute with the Hamiltonian H, let ψ_1 be an eigenfunction of A and ψ_2 be an eigenfunction of H. The correct statement regarding the average value of the commutator of A with H ([A,H]) is

(a) Both $\langle\psi_1 |[A,H]| \psi_1\rangle$ and $\langle\psi_2 |[A,H]| \psi_2\rangle$ are non-zero.

(b) Only $\langle\psi_1|[A,H]|\psi_1\rangle$ is zero, but $\langle\psi_2|[A,H]|\psi_2\rangle$ is non zero.

(c) Only $\langle\psi_2|[A,H]|\psi_2\rangle$ is zero, but $\langle\psi_1|[A,H]|\psi_1\rangle$ is non-zero.

(d) Both $\langle\psi_1|[A,H]|\psi_1\rangle$ and $\langle\psi_2|[A,H]|\psi_2\rangle$ are zero.

Q.142 The condensation of a hydroxy acid produces a polyester with the probability of linkage at both ends being p. The mole fraction of k-mer chain formation is

(a) p^k (b) $p(1-p)^{k-1}$ (c) $p^{k-1}(1-p)$ (d) p^{k-1}

Q.143 In simple molecular orbital theory of Hydrogen molecule, bonding σ_g and antibonding σ_u molecular orbitals are constructed as linear combinations of atomic orbitals of two hydrogen atoms. The spatial part of a purely covalent singlet wavefunction is obtained by

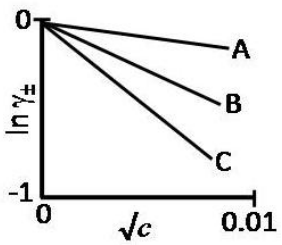
(a) $\sigma_g^2 + \sigma_u^2$ (b) σ_g^2 (c) $\sigma_g^2 - \sigma_u^2$ (d) $\sigma_g^2 + \frac{1}{2}\sigma_u^2$

Q144 Two aqueous 1:1 electrolyte systems A and B are at different temperatures T_A and T_B and C_A and C_B concentrations, respectively. Their Debye lengths will be equal if

(a) $T_A = 2T_B$ and $C_A = 2C_B$ (b) $T_A = 2T_B$ and $C_A = C_B/2$

(c) $T_A = \sqrt{2}\ T_B$ and $C_A = 2C_B$ (d) $T_A = 2T_B$ and $C_A = \sqrt{2}\ C_B$

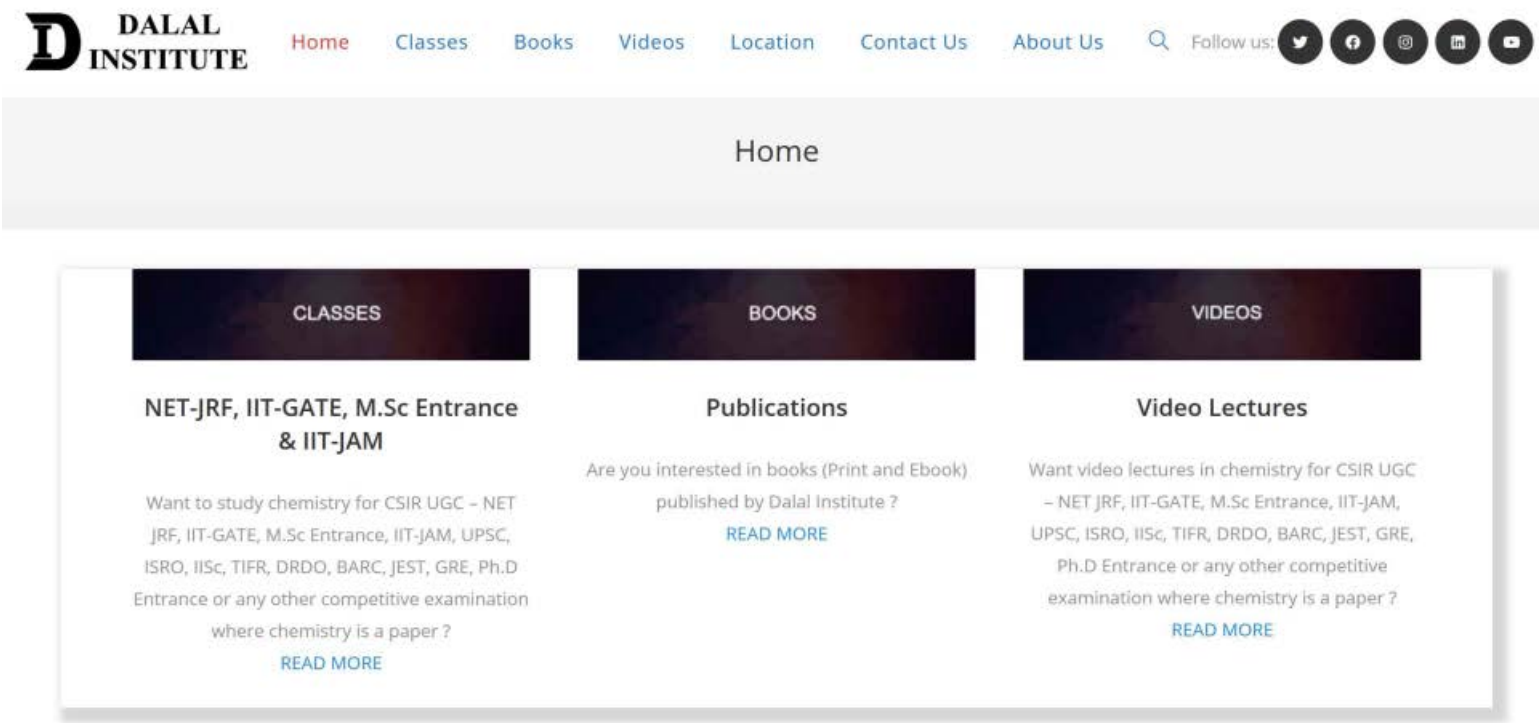
Q.145 Aqueous solutions of NaCl, $CaCl_2$ and $LaCl_3$ show the following plots of logarithms of mean ionic activity coefficient ($\ln \gamma_\pm$) vs. molar concentration (c):



The correct option is then

	NaCl	$CaCl_2$	$LaCl_3$
(a)	C	B	A

(b)	A	B	C
(c)	A	C	B
(d)	C	A	B



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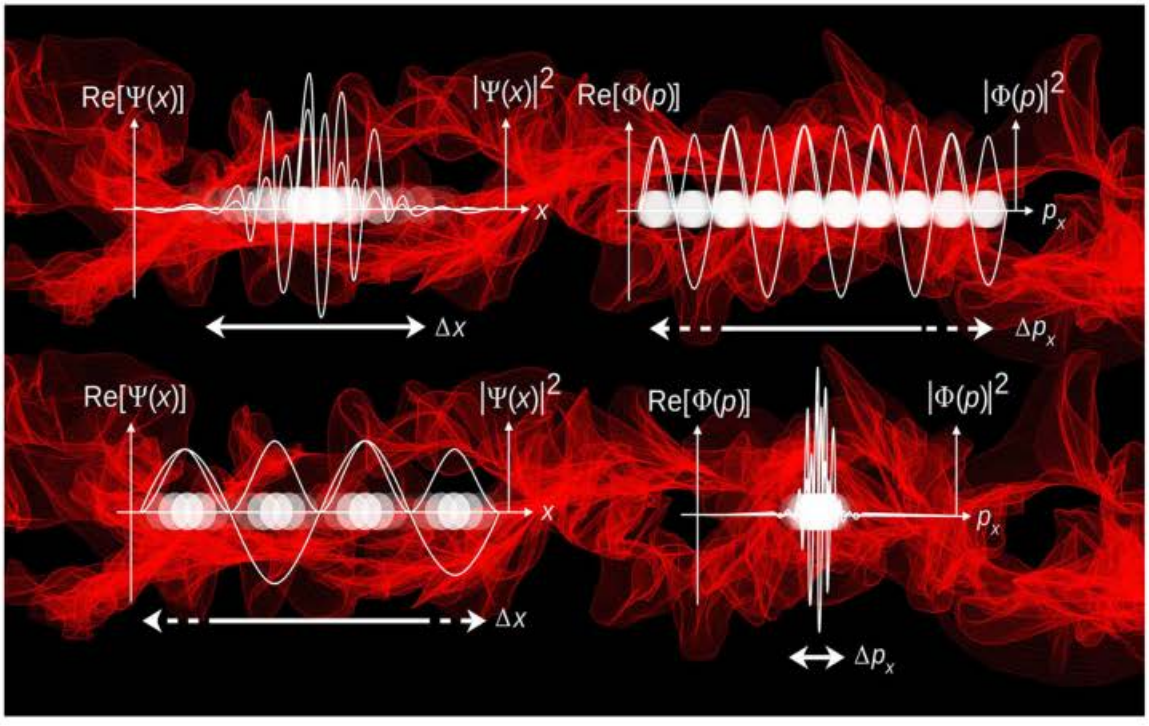

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