CSIR UGC – NET JRF: December 2015

Chemical Science

❖ Question Paper

Section-A

Q.1 "The clue is hidden in this statement", read the note handed to Sherlock by Moriarty, who hid the stolen treasure in one of the ten pillars. Which pillar is it?

(a) X (b) II (c) III (d) IX

Q.2 Suppose three meetings of a group of professors were arranged in Mumbai, Delhi and Chennai. Each professor of the group attended exactly two meetings. 21 professors attended Mumbai meeting, 27 attended Delhi meeting and 30 attended Chennai meeting. How many of them attended both the Chennai and Delhi meetings?

(a) 18 (b) 24 (c) 26 (d) No idea from data

Q.3 The probability that a ticketless traveler is caught during a trip is 0.1. If the traveler makes 4 trips, the probability that he/she will be caught during at least one of the trips is:

(a) $1-(0.9)^4$ (b) $(1-0.9)^4$ (c) $1-(1-0.9)^4$ (d) $(0.9)^4$

Q.4

The minimum number of straight lines required to connect the nine points above without lifting the pen or retracing is

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

Q.5 Let A, B be the ends of the longest diagonal of the unit cube. The length of the shortest path from A to B along the surface is

(a) $\sqrt{3}$ (b) $1+\sqrt{2}$ (c) $\sqrt{5}$ (d) 3

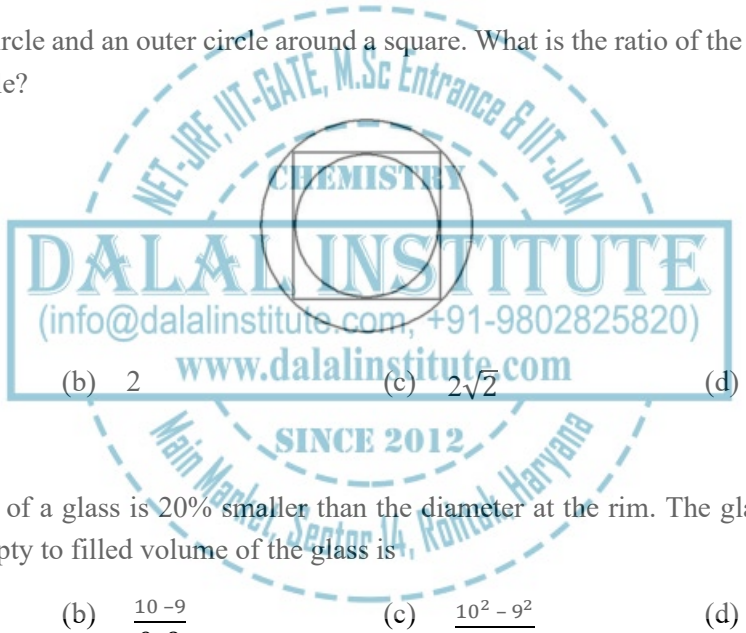
Q.6 How many digits are there in 3^{16} when it is expressed in the decimal form?

(a) Three (b) Six (c) Seven (d) Eight

Q.7 A circle drawn in the x-y coordinate plane passes through the origin and has chords of lengths 8 units and 7 units on the x and y axes, respectively. The coordinates of its centre are

(a) (8, 7) (b) (– 8, 7) (c) (– 4, 3.5) (d) (4, 3.5)

Q.8 There is an inner circle and an outer circle around a square. What is the ratio of the area of the outer circle to that of the inner circle?



(a) $\sqrt{2}$ (b) 2 (c) $2\sqrt{2}$ (d) $\sqrt{3/2}$

Q.9 The base diameter of a glass is 20% smaller than the diameter at the rim. The glass is filled to half the height. The ratio of empty to filled volume of the glass is

(a) $\frac{\sqrt{10}-\sqrt{9}}{\sqrt{9}-\sqrt{8}}$ (b) $\frac{10-9}{9-8}$ (c) $\frac{10^2-9^2}{9-8}$ (d) $\frac{10^3-9^3}{9^3-8^3}$

Q.10 A wheel barrow with unit spacing between its wheels is pushed along a semi-circular path of mean radius 10. The difference between distances covered by the inner and outer wheels i

(a) 0 (b) 10 (c) π (d) 2π

Q.11 Write d =1 degree, r = 1 radian and g = 1 grad. Then which of the following is true? (100 grad = a right angle)

(a) cos d < cos r < cos g (b) cos r < cos g < cos d

(c) $\cos r < \cos d < \cos g$ (d) $\cos g < \cos d < \cos r$

Q.12 A vendor sells articles having a cost price of Rs.100 each. He sells these articles at a premium price during first eight months, and at a sale price, which is half of the premium price, during next four months. He makes a net profit of 20% at the end of the year. Assuming that equal numbers of articles are sold each month, what is the premium price of the article?

(a) 122 (b) 144 (c) 150 (d) 160

Q.13 The statement: "The father of my son is the only child of your parents"

(a) can never be true.

(b) is true in only one type of relation.

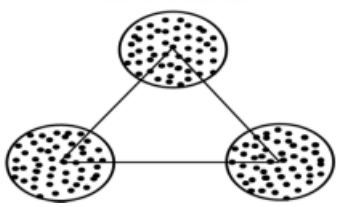
(c) can be true for more than one type of relations.

(d) can be true only in a polygamous family.

Q.14 One is required to tile a plane with congruent regular polygons. With which of the following polygons is this possible?

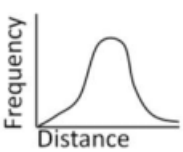
(a) 6-gon (b) 8-gon (c) 10-gon (d) 12-gon

Q.15 Three circles of equal diameters are placed such that their centres make an equilateral triangle as in the figure



Within each circle, 50 points are randomly scattered. The frequency distribution of distances between all possible pairs of points will look as

(a) 

(b) 

(c) 

(d) 

Q.16 Most Indian tropical fruit trees produce fruits in April-May. The best possible explanation for this is

(a) Optimum water availability for fruit production.

(b) The heat allows quicker ripening of fruit.

(c) Animals have no other source of food in summer.

(d) The impending monsoon provides optimum conditions for propagation.

Q.17 The number of diagonals of a convex deodecagon (12-gon) is

(a) 66 (b) 54 (c) 55 (d) 60

Q.18 Three boxes are coloured red, blue and green and so are three balls. In how many ways can one put the balls one in each box such that no ball goes into the box of its own colour?

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

Q.19 Decode

G	E	N	T	S	T	U
I	S	S	O	L	V	D
L	I	I	S	P	A	E
L	M	H	T	R	B	N
E	E	L	B	O	L	T
T	N	I	Y	B	E	S

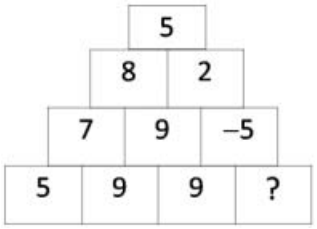
(a) GENT STUDENTS CAUSE LITTLE HEART BURNS

(b) STUDENTS ARE INTELLIGENT BUT PROBLEM IS NOT SOLVABLE

(c) THIS PROBLEM IS UNSOLVABLE BY ANY STUDENT

(d) THIS PROBLEM IS SOLVABLE BY INTELLIGENT STUDENTS

Q.20 The missing number is



(a) – 19 (b) – 5 (c) 9 (d) –9

Section-B

Q.21 The biological functions of cytochrome P_{450} and myoglobin are, respectively

(a) Oxidation of alkene and O_2 storage (b) O_2 transport and O_2 storage

(c) O_2 storage and electron carrier (d) Electron carrier and O_2 transport

Q.22 Deoxy-hemocyanin is

(a) Heme protein and paramagnetic (b) Colorless and diamagnetic

(c) O_2 transporter and paramagnetic (d) Blue colored and diamagnetic

Q.24 Using crystal field theory, identify from the following complex ions that shows same μ_{eff} (spin only) values (A) $[CoF_6]^{3-}$, (B) $[IrCl_6]^{3-}$, (C) $[Fe(H_2O)_6]^{2+}$,

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

Q.25 The W–W bond order in $[W(\eta^5\text{-}C_5H_5)(\mu\text{-}Cl)(CO)_2]_2$ is

Q.26 The correct statement for Mn–O bond lengths in $[Mn(H_2O)_6]^{2+}$ is

(a) All bonds are equal (b) Four bonds are longer than two others

(c) Two bonds are longer than four others (d) They are shorter than the Mn–O bond in $[MnO4]^-$

Q.27 For the reaction of $[Fe(\eta^5\text{-}C_5H_5)(CH_3)(CO)_2]$ with PMe_3, the main intermediate is

(a) $[Fe(\eta^5\text{-}C_5H_5)(CH_3)(CO)_2(PMe_3)]$

(b) $[Fe(\eta^5\text{-}C_5H_5)(COCH_3)(CO)]$

(c) $[Fe(\eta^3\text{-}C_5H_5)(CH_3)(CO)_2]$

(d) $[Fe(\eta^3\text{-}C_5H_5)(COCH_3)(CO)(PMe_3)]$

Q.28 Identify the complex ions in sequential order when ferroin is used as an indicator in the titration of iron(II) with potassium dichromate. (phen = 1,10-phenathroline)

(a) $[Fe(phen)_3]^{2+}$ and $[Fe(phen)_3]^{3+}$

(b) $[Fe(phen)_3]^{3+}$ and $[Fe(phen)_3]^{2+}$

(c) $[Fe(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$

(d) $[Fe(CN)_6]^{3-}$ and $[Fe(CN)_6]^{4-}$

Q.29 The structures of XeF2 and XeO2F2 respectively are

(a) Bent, tetrahedral (b) linear, square planar (c) linear, see-saw (d) Bent, see-saw

Q.30 Spin motion of which of the following gives magnetic moment

A. Electron; B. Proton; C. Neutron

Correct answer is

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

Q.31 Correct statement for coulometry is

(a) It is based on Faraday's law of electrolysis

(b) It is a type of voltammetry

(c) It is based on Ohm's law

(d) It uses ion selective electrode

Q.32 The order of increasing Brønsted acidity for Boron hydrides is

(a) $B_5H_9 < B_6H_{10} < B_{10}H_{14}$

(b) $B_{10}H_{14} < B_5H_9 < B_6H_{10}$

(c) $B_6H_{10} < B_{10}H_{14} < B_5H_9$

(d) $B_{10}H_{14} < B_6H_{10} < B_5H_9$

Q.33 Among the following, species expected to show fluxional behaviour are

A. $[NiCl_4]^{2-}$ (tetrahedral),

B. IF_7 (pentagonal bipyramidal),

C. $[CoF_6]^{3-}$ (octahedral),

D. $Fe(CO)_5$ (trigonal bipyramidal)

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

Q.34 The ring size and the number of linked tetrahedral present in $[Si_6O_{18}]^{12-}$ are, respectively,

(a) 6 and 6 (b) 12 and 6 (c) 12 and 12 (d) 6 and 12

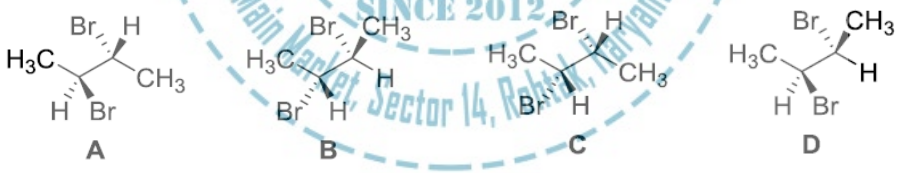
Q.35 The molecule C_3O_2 has a linear structure. This compound has

(a) 4 σ and 4 π bonds (b) 3 σ and 2 π bonds (c) 2 σ and 3 π bonds (d) 3 σ and 4 π bonds

Q.36 The metallic radii are abnormally high for which of the following pairs?

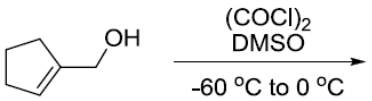
(a) Eu, Yb (b) Sm, Tm (c) Gd, Lu (d) Nd, Ho

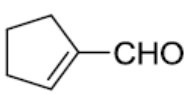
Q.37 Identify two enantiomers among the following compounds

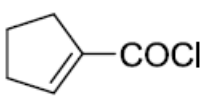


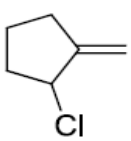
(a) A and B (b) A and C (c) B and D (d) C and D

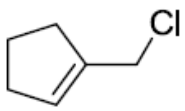
Q.38 The major product formed in the following reaction is



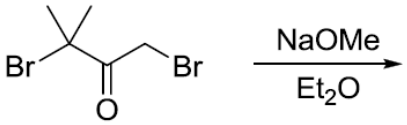
(a) 

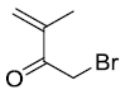
(b) 

(c) 

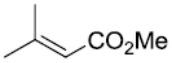
(d) 

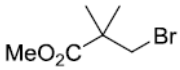
Q.39 The major product formed in the following reaction is



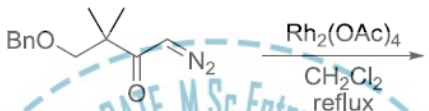
(a) 

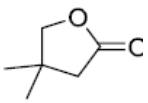
(b) 

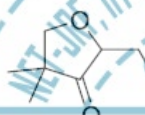
(c) 

(d) 

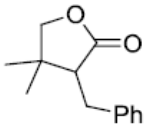
Q.40 The major product formed in the following reaction is



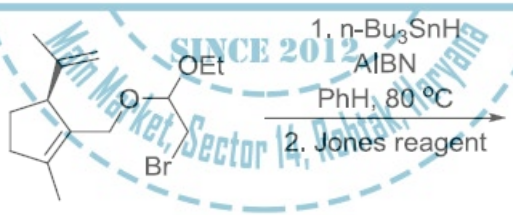
(a) 

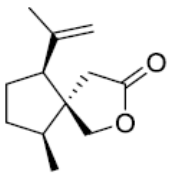
(b) 

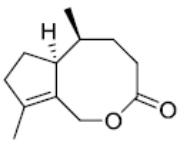
(c) 

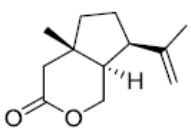
(d) 

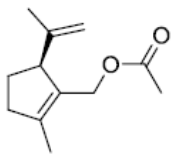
Q.41 The major product formed in the following reaction is



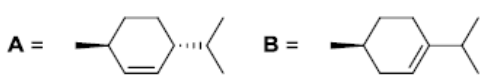
(a) 

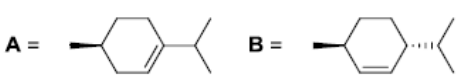
(b) 

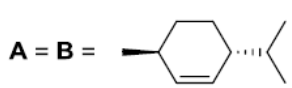
(c) 

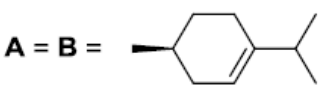
(d) 

Q.42 The major products A and B in the following reactions are

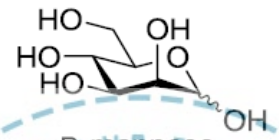
(a) 

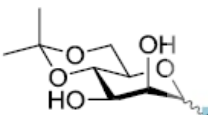
(b) 

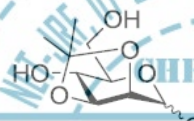
(c) 

(d) 

Q.43 D-Mannose upon refluxing in acetone with $CuSO_4$ and H_2SO_4 gives



(a) 

(b) 

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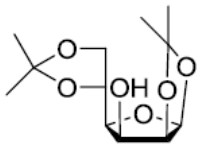
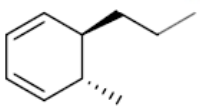
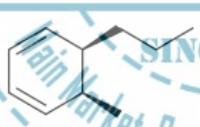
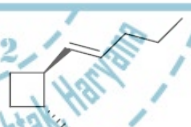
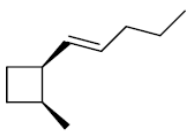
(d) 

Q.44 The major product formed by photochemical reaction of (2E,4Z,6E)-decatriene is

(a) 

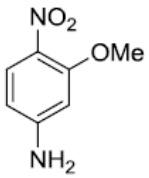
(b) 

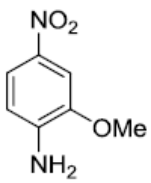
(c) 

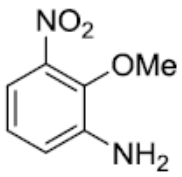
(d) 

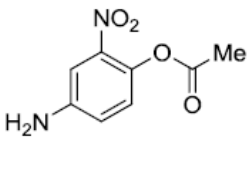
Q.46 The structure of the compound that matches the ^1H NMR data given below is

^1H NMR (DMSO-d_6): δ 7.75 (dd, J = 8.8, 2.4Hz, 1H), 7.58 (d, J = 2.4 Hz, 1H), 6.70 (d, J = 8.8 Hz, 1H), 6.50 (broad s, 2H), 3.80 (s, 3H).

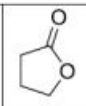
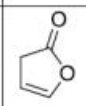
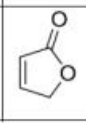
(a) 

(b) 

(c) 

(d) 

Q.47 Correctly matched structure and carbonyl stretching frequency set is

Column A		Column B	
P.		X.	1750 cm^{-1}
Q.		Y.	1770 cm^{-1}
R.		Z.	1800 cm^{-1}

(a) P-Y, Q-Z, R-X (b) P-Y, Q-X, R-Z (c) P-Z, Q-Y, R-X (d) P-X, Q-Z, R-Y

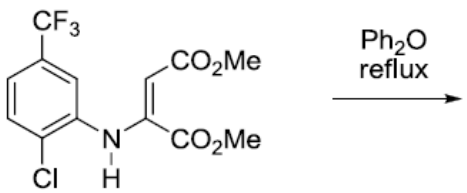
Q.48 The number of chemical shift non-equivalent protons expected in ^1H NMR spectrum of α- pinene is

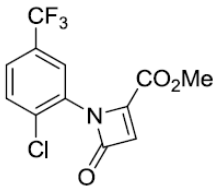
(a) 7 (b) 8 (c) 9 (d) 10

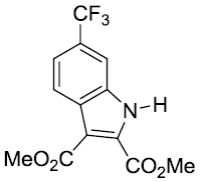
Q.49 In the mass spectrum of 1,2-dichloroethane, approximate ratio of peaks at m/z values 98,100, 102 will be

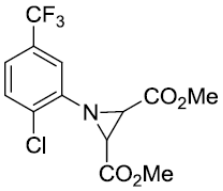
(a) 3:1:1 (b) 9:6:1 (c) 1:1:2 (d) 1:2:1

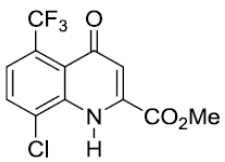
Q.50 The major product formed in the following reaction is



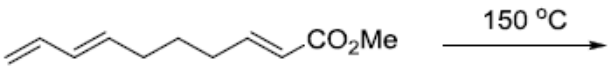
(a) 

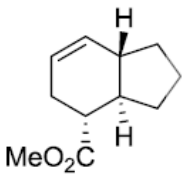
(b) 

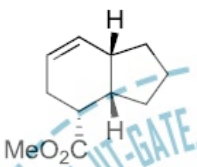
(c) 

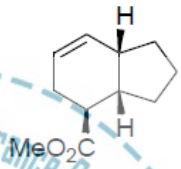
(d) 

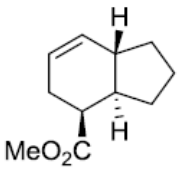
Q.51 The major product formed in the following reaction is



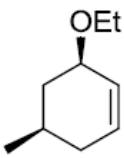
(a) 

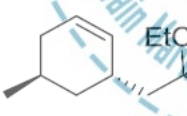
(b) 

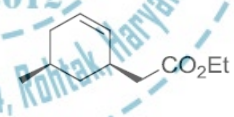
(c) 

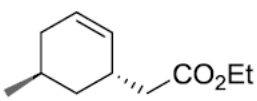
(d) 

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

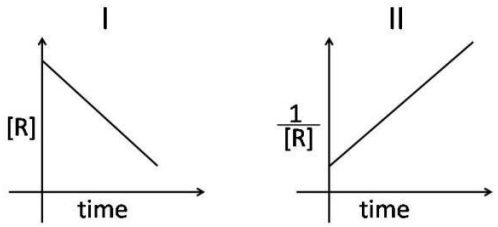
(a) 

(b) 

(c) 

(d) 

Q.53 The concentration of a reactant R varies with time for two different reactions as shown in the following plots:



The orders of these two reactions I and II, respectively, are

(a) Zero and one (b) One and zero (c) Zero and two (d) Two and zero

Q.54 For a simple cubic crystal lattice, the angle between the [2 0 1] plane and the xy plane is

(a) Less than 30° (b) Between 30° and 45° (c) Between 45° and 60° (d) Greater than 60°

Q.55 For the following reaction

$$A \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2B$$

$B \xrightarrow{k_2} C$ $\frac{d[B]}{dt}$ is given by

(a) $k_1[A] - k_{-1}[B]^2 - 2k_2[B]$ (b) $2k_1[A] - 2k_{-1}[B]^2 - k_2[B]$

(c) $\frac{1}{2}k_1[A] - \frac{1}{2}k_{-1}[B]^2 - k_2[B]$ (d) $2k_1[A] - 2k_{-1}[B]^{1/2} - k_2[B]$

Q.56 If the reduced mass of a diatomic molecule is doubled without changing its force constant, the vibrational frequency of the molecule will be

(a) $\sqrt{2}$ times the original frequency (b) $\frac{1}{\sqrt{2}}$ times the original frequency

(c) Twice the original frequency (d) Unchanged

Q.57 The standard deviation of speed (σ_c) for Maxwell's distribution satisfies the relation

(a) $\sigma_c \propto T$ (b) $\sigma_c \propto \sqrt{T}$ (c) $\sigma_c \propto 1/T$ (d) $\sigma_c \propto 1/\sqrt{T}$

Q.58 The value of $\Delta U - \Delta H$ for the reaction $Fe_2O_3(S) + 3C(s) \rightarrow 2Fe(s) + 3CO(g)$ is

(a) – 3RT (b) +3RT (c) +RT (d) –RT

Q.59 If the pressure p (system) is greater than the p (surroundings), then

(a) Work is done on the system by the surroundings.

(b) Work is done on the surroundings by the system.

(c) Work done on the system by the surroundings is equal to the work done on the surroundings by the system

(d) Internal energy of the system increases.

Q.60 Two non-zero operators Â and $\hat{B}$ $\left(\hat{A} \neq \hat{B}\right)$ satisfy the relation $\left(\hat{A}+\hat{B}\right)\left(\hat{A}-\hat{B}\right) = \hat{A}^2 - \hat{B}^2$, when

(a) $\hat{A}\hat{B} = \hat{A}^2 \; and \; \hat{B}\hat{A} = \hat{B}^2$ (b) $\hat{A}\hat{B} + \hat{B}\hat{A} = 0$

(c) Â and $\hat{B}$ are arbitrary (d) $\hat{A}\hat{B} - \hat{B}\hat{A} = 0$

Q.61 The degeneracy of an excited state of a particle in 3-dimensional cubic box with energy 3 times its ground state energy is

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

Q.62 ΔH of a reaction is equal to slope of the plot of

(a) ΔG vs. (1/T) (b) ΔG vs. T (c) (ΔG/T) vs. T (d) (ΔG/T) vs. (1/T)

Q.63 The correct form for a simple Langmuir isotherm is

(a) θ = Kp (b) $\theta = (Kp)^{1/2}$ (c) θ = Kp/(1 + Kp) (d) θ = (1 + Kp)/Kp

Q.64 In Kohlrauch Law $\Lambda_m = \Lambda_m^o - \kappa\sqrt{c}\;\Lambda_m^o \; and \; \kappa$

(a) Depend only on stoichiometry.

(b) Depend only on specific identity of the electrolyte.

(c) Are independent of specific identity of the electrolyte.

(d) Are mainly dependent on specific identity of the electrolyte and stoichiometry, respectively.

Q.65 The correct expression for the product $((\bar{M}_n).(\bar{M}_w))$ [$\bar{M}_n$ and $\bar{M}_w$ are the number average and weight average molar masses, respectively, of a polymer] is

(a) $N^{-1}\sum_i N_i M_i$ (b) $N^{-1}\sum_i N_i M_i^2$ (c) $N/\sum N_i M_i$ (d) $N/\sum N_i M_i^2$

Q.66 The concentration of a $MgSO_4$ solution having the same ionic strength as that of a 0.1M Na_2SO_4 solution is

(a) 0.05 M (b) 0.067 M (c) 0.075 M (d) 0.133 M

Q.67 sp hybrid orbitals are the form $C_1 2s + C_2 2p_z$ (2s and $2p_z$ are normalized individually). The coefficients of the normalized form of the above sp hybrid orbitals are

(a) $C_1 = \frac{1}{\sqrt{2}}, C_2 = \pm\frac{1}{\sqrt{2}}$ (b) $C_1 = \frac{1}{2}, C_2 = \pm\frac{1}{2}$ (c) $C_1 = \frac{1}{\sqrt{2}}, C_2 = \pm\frac{1}{2}$ (d) $C_1 = \frac{1}{2}, C_2 = \pm\frac{1}{\sqrt{2}}$

Q.68 The correct statement among the following is

(a) N_2 has higher bond order than N_2^+ and hence has larger bond length compared to N_2^+

(b) N_2^+ has higher bond order than N_2 and hence has larger bond length compared to N_2

(c) N_2 has higher bond order than N_2^+ and hence has higher dissociation energy compared to N_2^+

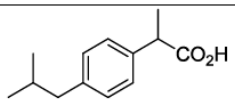
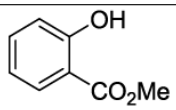
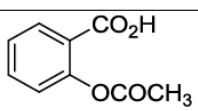
(d) N_2 has lower bond order than N_2^+ and hence has lower dissociation energy compared to N_2^+ energy

Q.69 The formation constant for the complexation of M^+ (M = Li, Na, K and Cs) with cryptand, C222 follows the order

(a) $Li^+ < Cs^+ < Na^+ < K^+$ (b) $Li^+ < Na^+ < K^+ < Cs^+$

(c) $K^+ < Cs^+ < Li^+ < Na^+$ (d) $Cs^+ < K^+ < Li^+ < Na^+$

Q.70 The correct match for compounds in column A with the description in column B is

Column A		Column B	
P.		X.	Oil of Wintergreen
Q.		Y.	Aspirin
R.		Z.	Ibuprofen

(a) P-Y, Q-Z, R-X (b) P-Z, Q-X, R-Y (c) P-Z, Q-Y, R-X (d) P-X, Q-Z, R-Y

Section-C

Q.71 The resonance Raman stretching frequency (ν_{O-O}, in cm^{-1}) of O_2 is 1580. The ν_{O-O} for O_2 in bound oxy-hemoglobin is close to

(a) 1600 (b) 1900 (c) 800 (d) 1100

Q.72 Match the metalloprotein in column A with its biological function and metal center in column B

Column A	Column B
(a) Hemoglobin	i. Electron carrier and iron
(b) Cytochrome b	ii. Electron carrier and copper
(c) Vitamin B_{12}	iii. O_2 transport and copper
(d) Hemocyanin	iv. Group transfer reactions and cobalt
	v. O_2 storage and cobalt
	vi. O_2 transport and iron

The correct match is

(a) (a)-(vi); (b)-(i); (c)-(iv) and (d)-(iii) (b) (a)-(v); (b)-(i); (c)-(iv) and (d)-(iii)

(c) (a)-(vi); (b)-(v); (c)-(i) and (d)-(ii) (d) (a)-(v); (b)-(vi); (c)-(ii) and (d)-(iv)

Q.73 Pick the correct statements about Atomic Absorption Spectrometry (AAS) from the following

A. Hg lamp is not a suitable source for AAS

B. Graphite furnace is the best atomizer for AAS

C. Non-metals cannot be determined with AAS

D. AAS is better than ICP-AES for simultaneous determination of metal ions

Correct answer is

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

Q. 74 Identify radioactive capture from the following nuclear reactions

(a) ^{9}Be (γ, n) ^{8}Be (b) ^{23}Na (n, γ) ^{24}Na (c) ^{63}Cu (p,p 3n 9α) ^{24}Na (d) ^{107}Ag (n, n) ^{107}Ag

Q.75 The calibration curve in spectrofluorimetric analysis becomes non-linear when

(a) Molecular weight of analyte is high (b) Intensity of light source is high

(c) Concentration of analyte is high (d) Molar absorptivity of analyte is high

Q.76 $[MnO_4]^-$ is deep purple in color whereas $[ReO_4]^-$ is colorless. This is due to greater energy required for

(a) d–d transitions in the Re compound compared to the Mn compound

(b) d–d transitions in the Mn compound compared to the Re compound

(c) Charge transfer from O to Re compared to O to Mn

(d) Charge transfer from O to Mn compared to O to Re

Q.77 $[(\eta^3\text{-}C_3H_5)Mn(CO)_4]$ shows fluxional behaviour. The ^1H NMR spectrum of this compound when it is in the non-fluxional state shows

(a) One signal (b) Two signals in the intensity ratio of 4:1

(c) Three signals in the intensity ratio of 2:2:1 (d) Five signals of equal intensity

Q.78 The number of lone pair(s) of electrons on the central atom in $[BrF_4]^-$ XeF_6 and $[SbCl_6]^{3-}$ are, respectively,

(a) 2, 0 and 1 (b) 1, 0 and 0 (c) 2, 1 and 1 (d) 2, 1 and 0

Q.79 Consider the following reaction:

$N_3P_3Cl_6 + 6\ HNMe_2 \rightarrow N_3P_3Cl_3(NMe_2)_3 + 3[A]Me2NH{\bullet}HCl.$

The number of possible isomers for [A] is

(a) 4 (b) 3 (c) 2 (d) 5

Q.80 Using Wade's rules predict the structure type of $[C_2B_5H_7]$.

(a) Nido (b) Closo (c) Arachno (d) Hypho

Q.81 Among the following complexes

A. $[Co(ox)_3]^{3-}$, B. trans-$[CoCl_2(en)_2]^+$, C. $[Cr(EDTA)]^-$ the chiral one(s) is/are,

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

Q.82 Mössbauer spectrum of a metal complex gives information about

A. Oxidation state and spin state of metal

B. Types of ligands coordinated to metal

C. Nuclear spin state of metal

D. Geometry of metal

Correct answer is

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

Q.83 For uranocene, the correct statement(s) is/are:

(A) oxidation state of uranium is '+4'.

(B) it has cyclooctatetraenide ligands

(C) it is a bent sandwich compound

(D) it has '–2' charge.

Correct answer is

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

Q.84 The final products of the reaction of carbonyl metalates $[V(CO)_6]^-$ and $[Co(CO)_4]^-$ with H_3PO_4, respectively, are

(a) $V(CO)_6$ and $HCo(CO)_4$ (b) $HV(CO)_6$ and $Co_2(CO)_8$

(c) $[H_2V(CO)_6]^+$ and $HCo(CO)_4$ (d) $V(CO)_6$ and $Co_2(CO)_8$

Q.85 The correct statement about the substitution reaction of $[Co(CN)_5Cl]^{3-}$ with OH^- to give $[Co(CN)_5(OH)]^{3-}$ is,

(a) It obeys first order kinetics

(b) Its rate is proportional to the concentration of both the reactants

(c) It follows the S_N1CB mechanism

(d) Its rate is dependent only on the concentration of $[OH]^-$

Q.86 Aqueous Cr^{2+} effects one electron reduction of $[Co(NH_3)_5Cl]^{2+}$ giving compound Y. Compound Y undergoes rapid hydrolysis. Y is,

(a) $[Co(NH_3)_5]^{2+}$ (b) $[Co(NH_3)_5(OH)]^+$ (c) $[Co(NH_3)_4(OH)_2]$ (d) $[Cr(H_2O)_5Cl]^{2+}$

Q.87 The reaction of BCl_3 with NH_4Cl gives product A which upon reduction by $NaBH_4$ gives product B. Product B upon reacting with HCl affords compound C, which is

(a) $Cl_3B_3N_3H_9$ (b) $[ClBNH]_3$ (c) $[HBNH]_3$ (d) $(ClH)_3B_3N_3(ClH)_3$

Q.88 The number of valence electrons provided by $[Ru(CO)_3]$ fragment towards cluster bonding is

(a) 1 (b) 14 (c) 6 (d) 2

Q.89 Choose the correct statements about Tanabe-Sugano diagrams:

A. E/B is plotted against Δ_o/B.

B. The zero energy is taken as that of the lowest term.

C. Terms of the same symmetry cross each other.

D. Two terms of the same symmetry upon increase of ligand field strength bend apart from each other. Correct answer is

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

Q.90 Which of the following statements are TRUE for the lanthanides?

(A) The observed magnetic moment of Eu^{3+} at room temperature is higher than that calculated from spin-orbit coupling

(B) Lanthanide oxides are predominantly acidic in nature

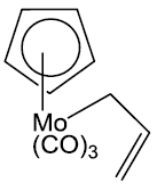
(C) The stability of Sm(II) is due to its half-filled sub-shell

(D) Lanthanide(III) ions can be separated by ion exchange chromatography

Correct answer is

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

Q.91 The intermediate and the final major product of photolysis of Z



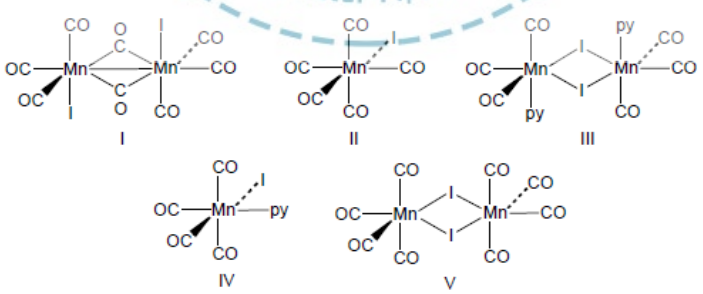
Z

From the following:

Are

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

Q.92 Reaction of $[Mn_2(CO)_{10}]$ with I_2 results in A without loss of CO. Compound A, on heating to 120 °C loses a CO ligand to give B, which does not have a Mn–Mn bond. Compound B reacts with pyridine to give 2 equivalents of C. Compounds A, B, and C from the following respectively, are



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

Q.93 The approximate positions of ν_{CO} bands (cm^{-1}) in the solid-state infrared spectrum and the Fe–Fe bond order in $[Fe(\eta^5\text{-}C_5H_5)(\mu\text{-}CO)(CO)]_2$ (non-centrosymmetric) respectively, are

(a) (2020, 1980, 1800) and one

(b) (2020, 1980, 1800) and two

(c) (2020, 1980) and one

(d) (2143) and one

Q.94 Protonated form of ZSM-5 catalyzes the reaction of ethene with benzene to produce ethylbenzene. The correct statement for this catalytic process is

(a) Alkyl carbocation is formed

(b) Carbanion is formed

(c) Benzene is converted to $(C_6H_5)^+$ group

(d) Vinyl radical is formed

Q.95 Three electronic transitions at 14900, 22700 and 34400 cm^{-1} are observed in the absorption spectrum of $[CrF_6]^{3-}$. The Δ_o value (in cm^{-1}) and the corresponding transition are

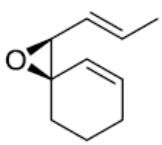
(a) 7800 and $^4A_{2g} \rightarrow {}^4T_{2g}$

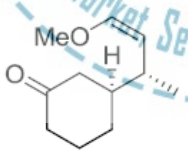
(b) 14900 and $^4A_{2g} \rightarrow {}^4T_{2g}$

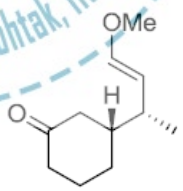
(c) 14900 and $^4T_{2g} \rightarrow {}^4T_{1g}(F)$

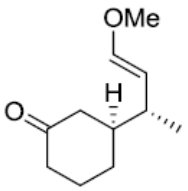
(d) 7800 and $^4T_{2g} \rightarrow {}^4T_{1g}(F)$

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

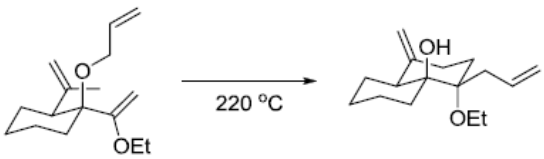
(a) 

(b) 

(c) 

(d) 

Q.97 The following transformation involves sequential



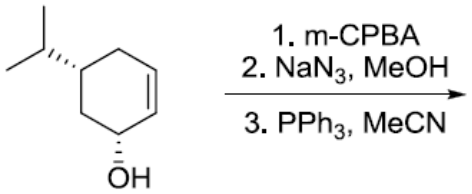
(a) Claisen rearrangement – Cope rearrangement – ene reaction

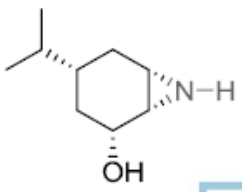
(b) Cope rearrangement – Claisen rearrangement – ene reaction

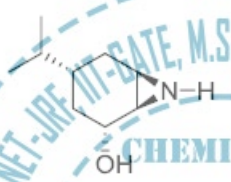
(c) Cope rearrangement – ene reaction – Claisen rearrangement

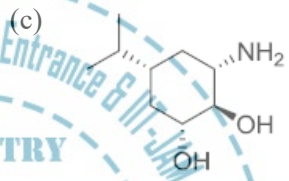
(d) ene reaction – Claisen rearrangement – Cope rearrangement

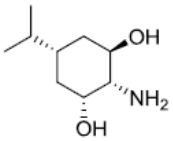
Q.98 The major product formed in the following reaction sequence is



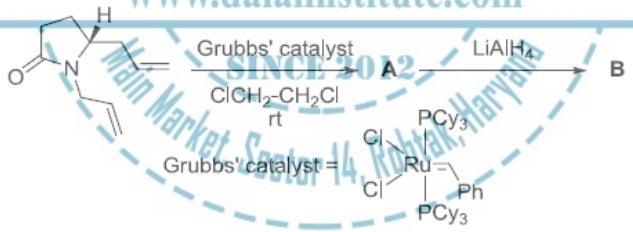
(a) 

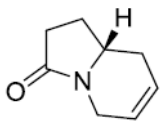
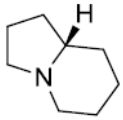
(b) 

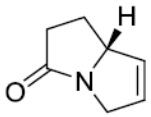
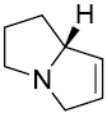
(c) 

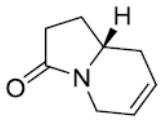
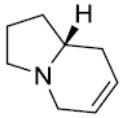
(d) 

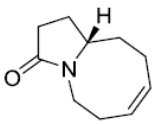
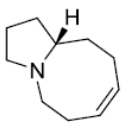
Q.99 The major products A and B in the following reaction sequence are



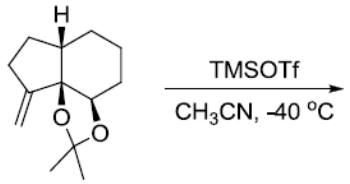
(a) **A** =  **B** = 

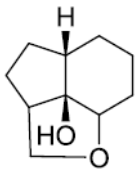
(b) **A** =  **B** = 

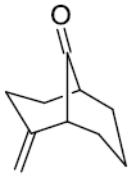
(c) **A** =  **B** = 

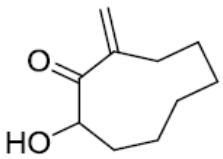
(d) **A** =  **B** = 

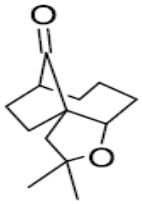
Q.100 The major product formed in the following reaction is



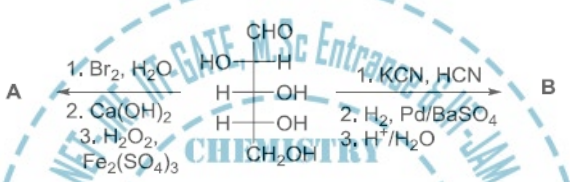
(a) 

(b) 

(c) 

(d) 

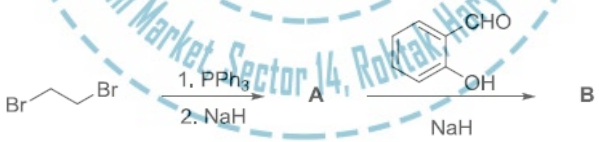
Q.101 The major products A and B in the following reaction sequences are

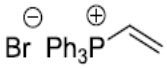


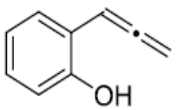
(a) A = D-threose; B = D-glucose (b) A = D-erythrose; B = D-glucose + D-mannose

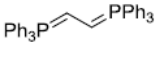
(c) A = D-threose; B = D-glucose + D-mannose (d) A = D-tartaric acid; B = D-glucose

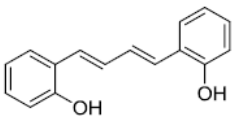
Q.102 The major products A and B in the following reaction sequence are

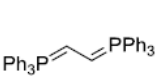


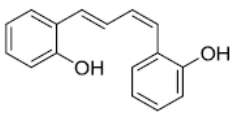
(a) A = 

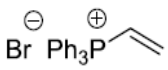
B = 

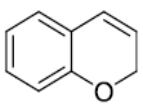
(b) A = 

B = 

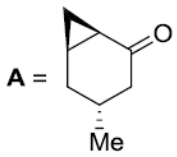
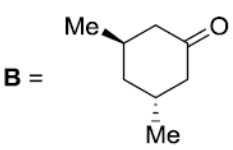
(c) A = 

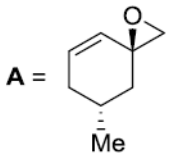
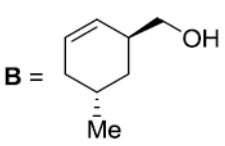
B = 

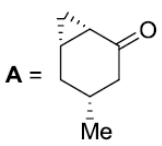
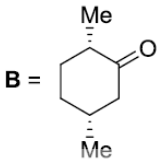
(d) A = 

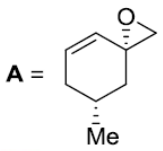
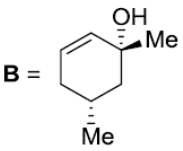
B = 

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

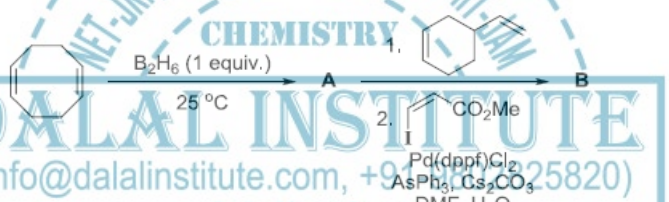
(a) A =  B = 

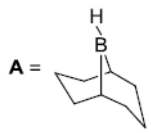
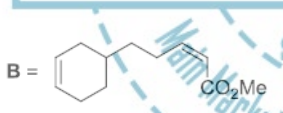
(b) A =  B = 

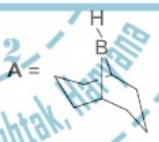
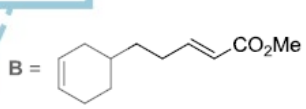
(c) A =  B = 

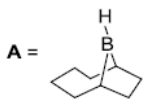
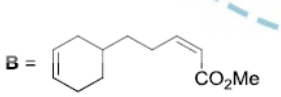
(d) A =  B = 

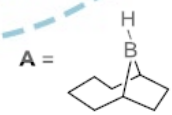
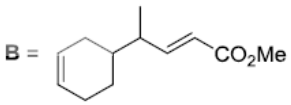
Q.104 The major products A and B in the following reaction sequence are



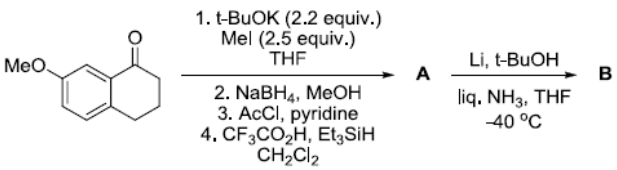
(a) A =  B = 

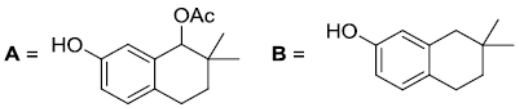
(b) A =  B = 

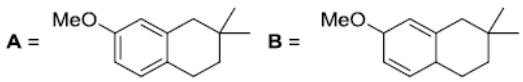
(c) A =  B = 

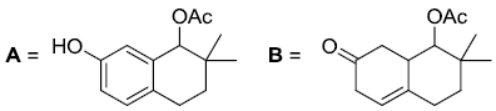
(d) A =  B = 

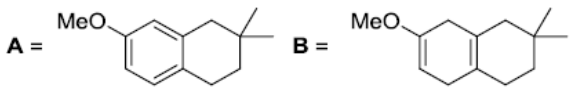
Q.105 The major products A and B in the following reaction sequence are



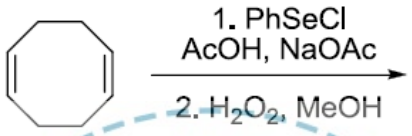
(a) 

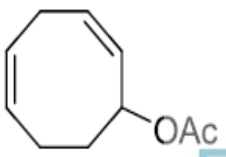
(b) 

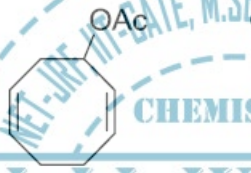
(c) 

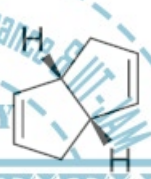
(d) 

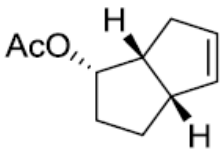
Q.106 The major product formed in the following reaction is



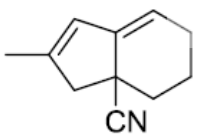
(a) 

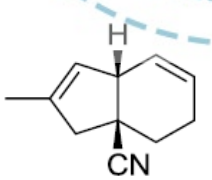
(b) 

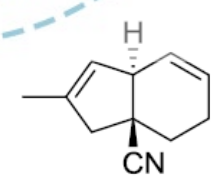
(c) 

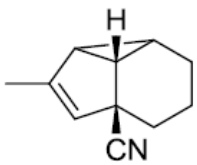
(d) 

Q.107 The major product formed in the following reaction is

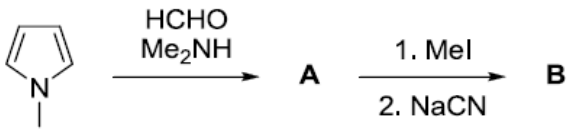
(a) 

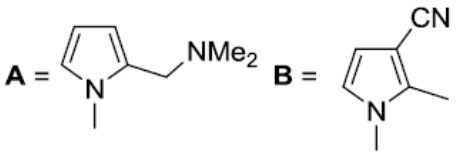
(b) 

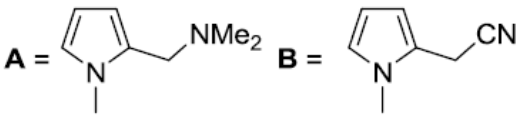
(c) 

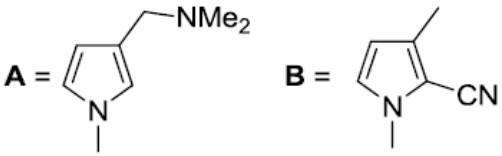
(d) 

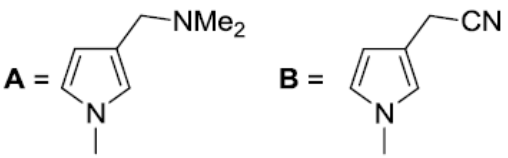
Q.108 The major products A and B in the following reaction sequence are



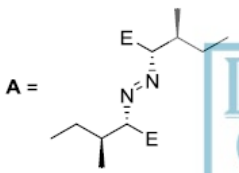
(a) 

(b) 

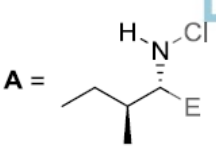
(c) 

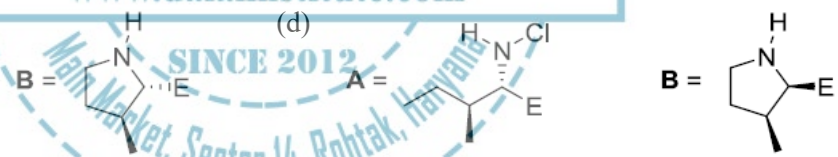
(d) 

Q.109 The major products A and B in the following reaction sequence are

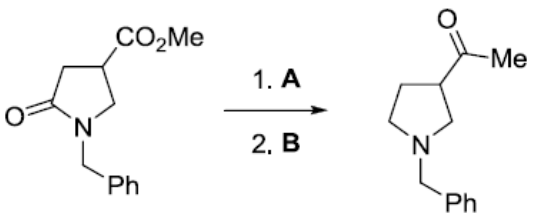
(a) 

(b) 

(c) 

(d) 

Q.110 The correct reagent combination to effect the following transformation is



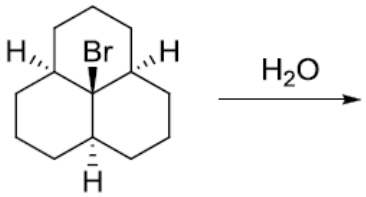
(a) A = $NaBH_4$, $BF_3{\cdot}OEt_2$; B = MeMgBr (2.5 equiv.), THF then H_3O^+

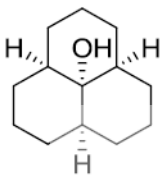
(b) A = $BH_3{\cdot}THF$; B = MeLi (2.5 equiv.), THF then H_3O^+

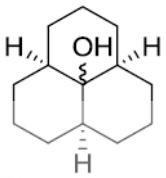
(c) A = $BH_3{\cdot}THF$; B = (i) aq. NaOH then H_3O^+, (ii) MeLi (2.5 equiv.), THF then H_3O^+

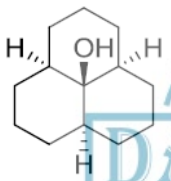
(d) A = (i) Me_3Al, MeNHOMe, (ii) MeMgBr, THF then H_3O^+; B = $LiAlH_4$, THF

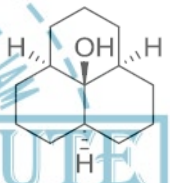
Q.111 The mechanism and the product formed in the following reaction, respectively, are



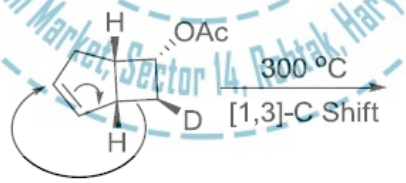
(a) S_N2 

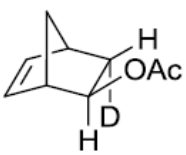
(b) S_N1 

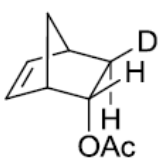
(c) S_N2 

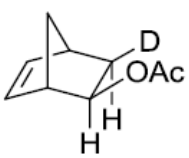
(d) S_N1 

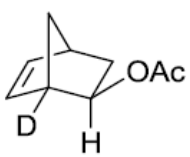
Q.112 A concerted [1,3]-sigmatropic rearrangement took place in the reaction shown below. The structure of the resulting product is



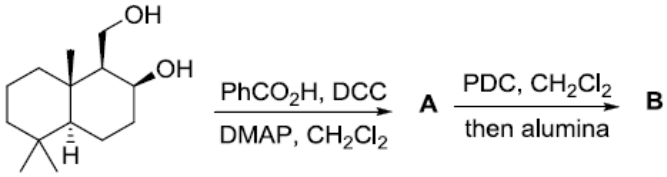
(a) 

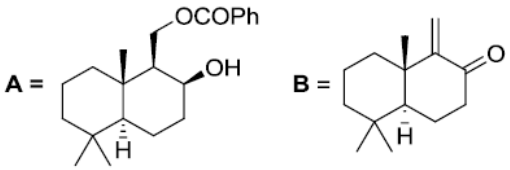
(b) 

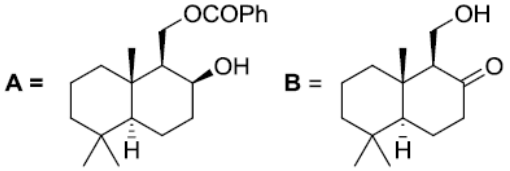
(c) 

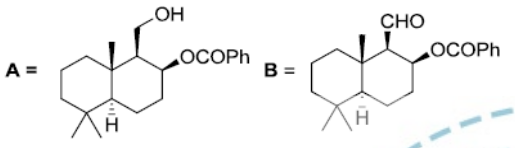
(d) 

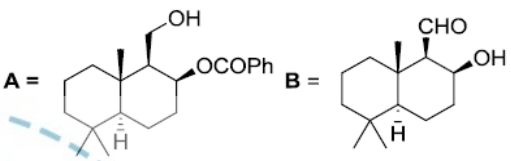
Q.113 The major products A and B in the following reaction sequence are



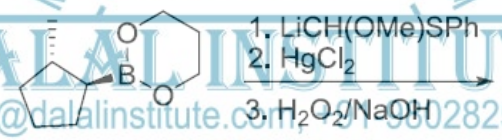
(a) 

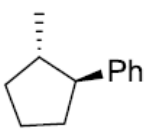
(b) 

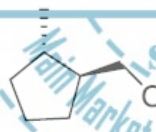
(c) 

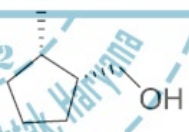
(d) 

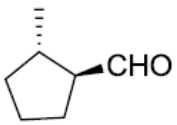
Q.114 The major product formed in the following reaction sequence is



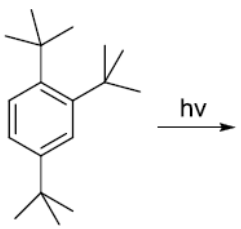
(a) 

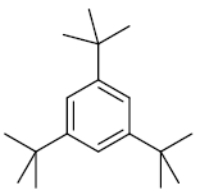
(b) 

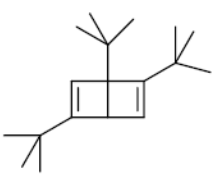
(c) 

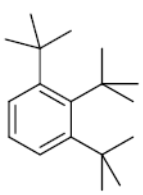
(d) 

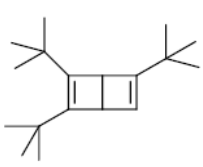
Q.115 The major product formed in the following reaction is



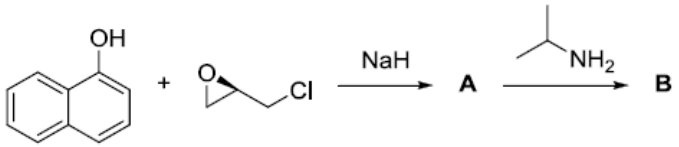
(a) 

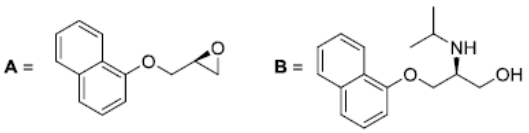
(b) 

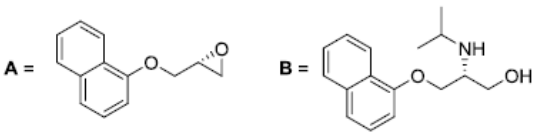
(c) 

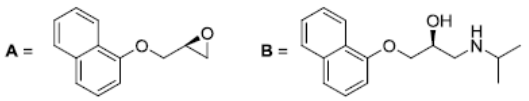
(d) 

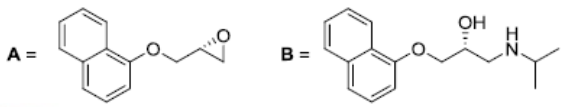
Q.116 The major products A and B in the following reaction sequence are



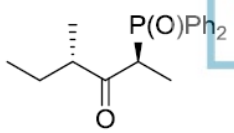
(a) 

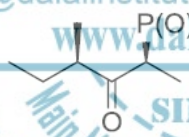
(b) 

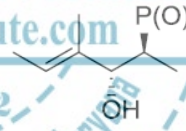
(c) 

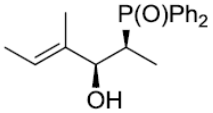
(d) 

Q.117 The major product of the following reaction is

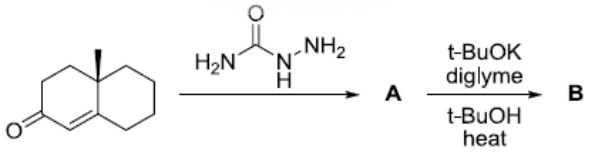
(a) 

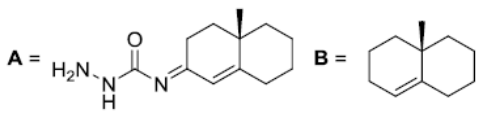
(b) 

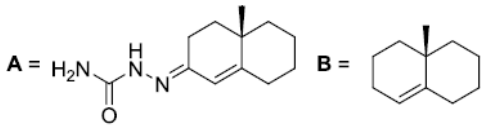
(c) 

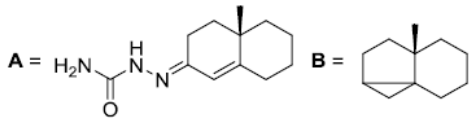
(d) 

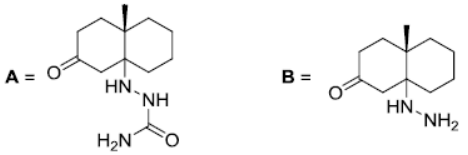
Q.118 The major products A and B in the following reaction sequence are



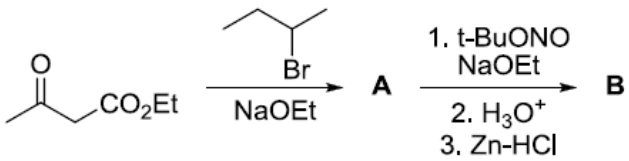
(a) 

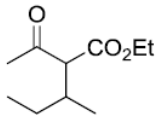
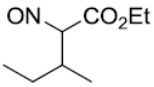
(b) 

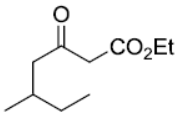
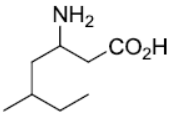
(c) 

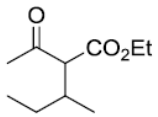
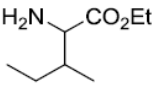
(d) 

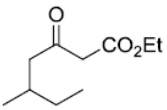
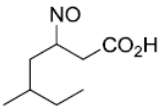
Q.119 The major products A and B in the following reaction sequence are



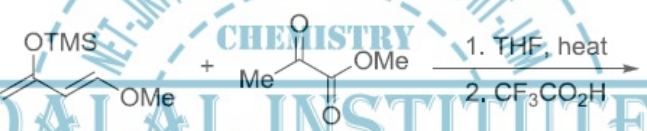
(a) A =  B = 

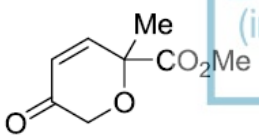
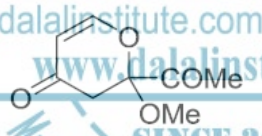
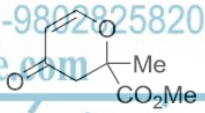
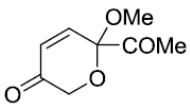
(b) A =  B = 

(c) A =  B = 

(d) A =  B = 

Q.120 The major product of the following reaction is



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

Q.121 According to the transition state theory, one of the vibrations in the activated complex is a loose vibration. The partition function for this loose vibration is equal to (k_B is the Boltzmann's constant and h is the Planck's constant)

(a) $\frac{k_B T}{h}$ (b) $\frac{h\nu}{k_B T}$ (c) $k_B T$ (d) $\frac{k_B T}{h\nu}$

Q.122 Possible term symbol(s) of the excited states of Na atom with the electronic configuration $[1s^2 2s^2 2p^6 3p^1]$ is/are

(a) $^2S_{1/2}$ (b) $^2P_{3/2}$ and $^2P_{1/2}$ (c) $^1S_0$ and $^1P_1$ (d) $^3P_0$ and $^3P_1$

Q.123 For a simple cubic crystal, X-ray diffraction shows intense reflections for θ_1 angles θ_2 and which are assigned to [1 0 1] and [1 1 1] planes, respectively. The ratio $\sin\theta_1/\sin\theta_2$ is

(a) 1.5 (b) 1.22 (c) 0.82 (d) 0.67

Q.124 Stability of lyophobic dispersions is determined by

(a) Inter-particle electric double layer repulsion and intra-particle van der Waals attraction.

(b) Inter-particle electric double layer attraction and intra-particle van der Waals repulsion.

(c) Inter-particle excluded volume repulsion and intra-particle van der Waals attraction.

(d) Inter-particle excluded volume attraction and intra-particle van der Waals repulsion.

Q.125 A certain 2-level system has stationary state energies E_1 and E_2 ($E_1 < E_2$) with normalized wave function φ_1 *and* φ_2 respectively. In the presence of a perturbation V, the second-order correction to the energy for the first state (φ_1) will be

(a) $\frac{\langle\varphi_1|V|\varphi_2\rangle}{E_1 - E_2}$ (b) $\frac{\langle\varphi_1|V|\varphi_2\rangle}{E_2 - E_1}$ (c) $\frac{|\langle\varphi_1|V|\varphi_2\rangle|^2}{E_1 - E_2}$ (d) $\frac{|\langle\varphi_1|V|\varphi_2\rangle|^2}{(E_1 - E_2)^2}$

Q.126 The ^1H NMR frequency at 1.0 T ia 42.4 MHz. If the gyromagnetic ratios of ^1H and ^{13}C are 27×10^7 and 6.75×10^7 $T^{-1}s^{-1}$, respectively, what will be the ^{13}C frequency at 1.0 T?

(a) 10.6 MHz (b) 169.6 MHz (c) 42.6 MHz (d) 21.3 MHz

Q.127 10 mL aliquots of a mixture of and HCl are HNO_3 titrated conductometrically using a 0.1M NaOH and a 0.1M $AgNO_3$ separately. The titre volumes are V_1 are V_2 mL and respectively. The concentration of HNO_3 in the mixture is obtained from the combination

(a) $V_1 - V_2$ (b) $2V_1 - V_2$ (c) $V_2 - V_1$ (d) $2V_2 - V_1$

Q.128 agiven that $E^0(Cl_2/Cl^-) = 1.35$ V and $K_{sp}(AgCl) = 10^{-10}$ at 25°C, E^0 corresponding to the electrode reaction

$\frac{1}{2}Cl_2(g) + Ag^+(soln.) + e^- \rightarrow AgCl(s)$ is

(a) 0.75 V (b) 1.05 V (c) 1.65 V (d) 1.95 V

$\left[\frac{2.303RT}{F} = 0.06V\right]$

Q.129 The standard EMF of the cell

$Pt,H_2|HCl(soln.)|AgCl(s),Ag(s)$

(a) Increases with T (b) Decreases with T

(c) Remains unchanged with T (d) Decreases with [HCl]

Q.130 The molecule with the smallest rotational constant (in the microwave spectrum) among the following is.

(a) $N \equiv CH$ (b) $HC \equiv CCl$ (c) $ClC \equiv CF$ (d) $B \equiv CCl$

Q.131 The spectroscopic technique that can distinguish unambiguously between trans-1,2- dichloroethylene and cis-1,2-dichloroethylene without any numerical calculation is

(a) Microwave spectroscopy (b) UV-Visible spectroscopy

(c) X-ray photoelectron spectroscopy (d) γ-ray spectroscopy

Q.132 The ground state electronic configuration of C_2 using all electrons is

(a) $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p}^2\pi_{2p}^2$ (b) $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p}^2\sigma_{2p}^{*2}$

(c) $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p}^2\sigma_{2p}^1\sigma_{2p}^{*1}$ (d) $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p}^4$

Q.133 v_{max} and K_m for as enzyme catalyzed reaction are 2.0×10^{-3} Ms^{-1} and 1.0×10^{-6} M, respectively. The rate of reaction when the substrate concentration is 1.0×10^{-6} M is

(a) 3.0×10^{-3} s^{-1} (b) 1.0×10^{-3} s^{-1} (c) 2.0×10^{-3} s^{-1} (d) 0.5 s^{-1}

Q.134 The first order rate constant for a unimolecular gas phase reaction A → products that follows Lindemann mechanism is 2.0 $s^{-}1$ at p_A = 1 atm and 4.0 s^{-1} at p_A atm. The rate constant for the activation step is

(a) 1.0 $atm^{-}1s^{-1}$ (b) 2.0 $atm^{-}1s^{-1}$ (c) 4.0 $atm^{-}1s^{-1}$ (d) 8.0 $atm^{-}1s^{-1}$

Q.135 The molecule diborane belongs to the symmetry point group

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

Q.136 Though a constant shift of energy levels of a system changes the partition function, the properties that do not change are

(a) Average energy, entropy and heat capacity.

(b) Average energy and entropy.

(c) Average energy and heat capacity.

(d) Entropy and heat capacity.

Q.137 The vibrational frequency of a homonuclear diatomic molecule is v. The temperature at which the population of the first excited state will be half that of the ground state is given by

(a) $h\nu.\ln 2/k_B$ (b) $h\nu/(\ln 2.k_B)$ (c) $\ln 2/(h\nu.k_B)$ (d) $h\nu.\log 2/k_B$

Q.138 The irreducible representations of C_{2h} are A_g,B_g,A_u and B_u. The Raman active modes of trans-1,3-butadiene belong to the irreducible representations

(a) A_g and B_g (b) A_g and A_u (c) A_u and B_g (d) B_g and B_u

Q.139 The symmetry-allowed atomic transition among the following is

(a) $^3F \rightarrow {}^1D$ (b) $^3F \rightarrow {}^3D$ (c) $^3F \rightarrow {}^1P$ (d) $^3F \rightarrow {}^3P$

Q.140 The average end-to-end distance of a random coil polymer of 10^6 monomers (in units of segment length) is

(a) 10^6 (b) 10^5 (c) 10^4 (d) 10^3

Q.141 A reversible expansion of 1.0 mol of an ideal gas is carried out from 1.0 L to 4.0 L under isothermal condition at 300 K. ΔG for this process is

(a) 300 R.ln2 (b) 600 R.ln2 (c) –600 R.ln2 (d) –300 R.ln2

Q.142 The temperature-dependence of the vapour pressure of solid A can be represented by $\log p = 10.0 - \frac{1800}{T}$, and that of liquid by $\log p = 8.0 - \frac{1400}{T}$. The temperature of the triple point of A is

(a) 200 K (b) 300 K (c) 400 K (d) 500 K

Q.143 The non-spontaneous process among the following is

(a) Vapourisation of superheated water at 105 ˚C and 1 atm pressure.

(b) Expansion of a gas into vacuum.

(c) Freezing of supercooled water at –10 ˚C and 1 atm pressure.

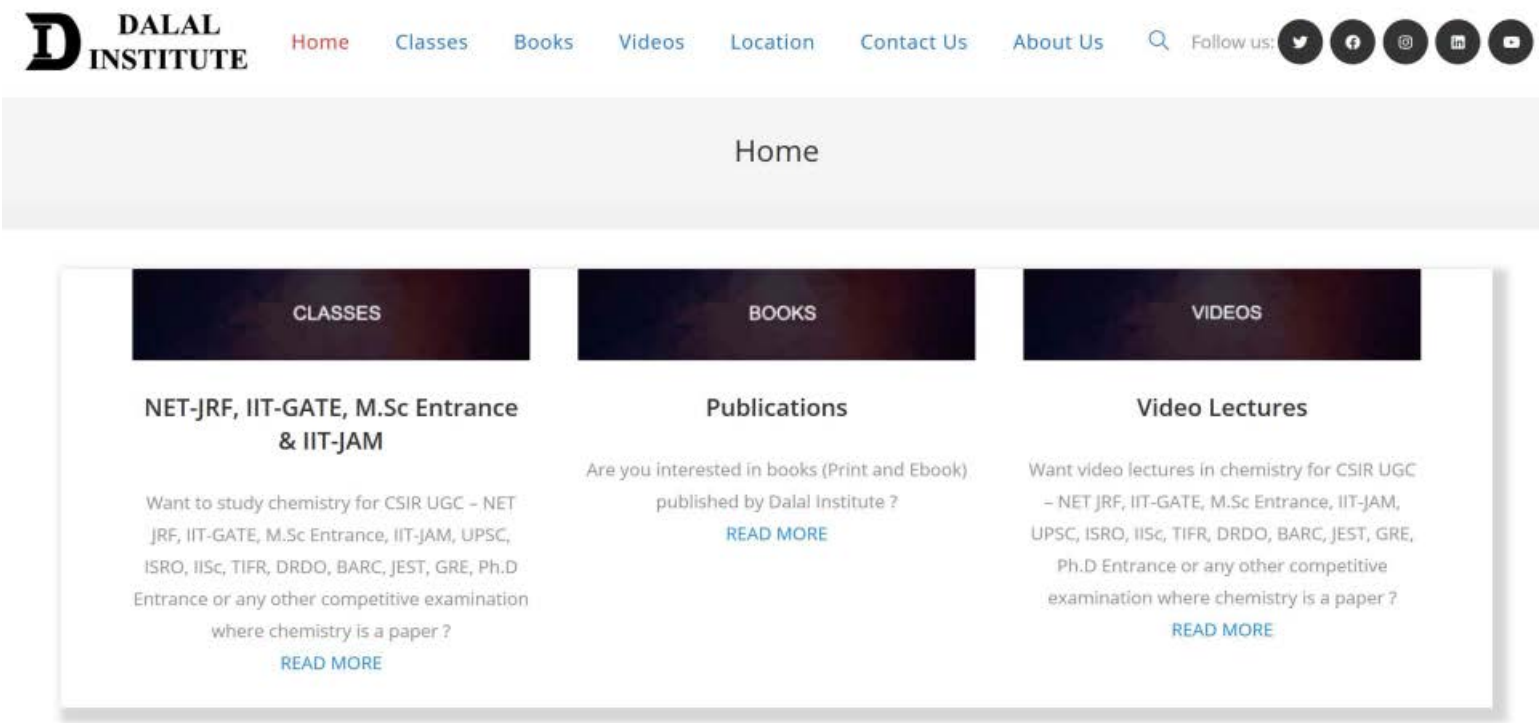
(d) Freezing of water at 0 ˚C and 1 atm pressure.

Q.144 The radial part of a hydrogenic wave function is given as $r(\alpha - r)^{-\beta r}(\alpha, \beta$ are constants). This function is then identifiable as

(a) 2s (b) 3p (c) 4d (d) 5f

Q.145 A normalized state ϕ is constructed as a linear combination of the ground state (ψ_0) and the first excited state (ψ_1) of some harmonic oscillator with energies 1/2 and 3/2 units, respectively. If the average energy of the state ϕ is 7/6, the probability of finding ψ_0 in ϕ will be

(a) ½ (b) 1/3 (c) 1/4 (d) 1/5



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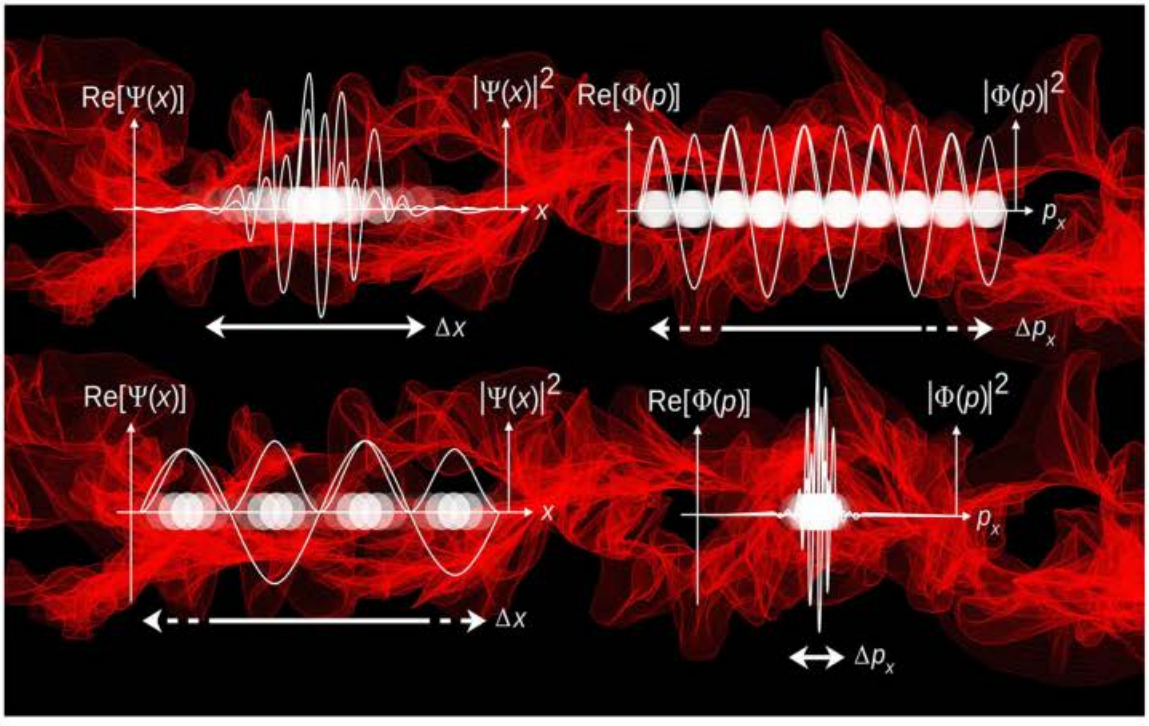

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