CSIR UGC – NET JRF: December 2016

Chemical Science

❖ Question Paper

Section-A

Q.1 The houses of three sisters lie in the same row, but the middle sister does not live in the middle house .In the morning, the shadow of the eldest sister's house falls on the youngest sister's house .What can be concluded for sure?

(a) The youngest sister lives in the middle.

(b) The eldest sister lives in the middle.

(c) Either the youngest or the eldest sister lives in the middle.

(d) The youngest sister's house lies on the east of the middle sister's house.

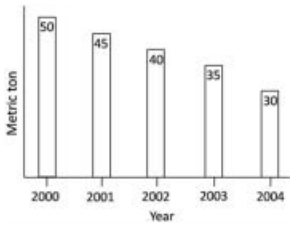
Q.2 A woman starts shopping with Rs .X and Y paise, spends Rs .3.50 and is left with Rs .2Y and 2 X paise .The amount she started with is

(a) Rs .48.24 (b) Rs .28.64 (c) Rs .32.14 (d) Rs .23.42

Q.3 A mine supplies 10000 tons of copper ore, containing an average of 1.5 wt %copper, to a smelter every day .The smelter extracts 80 %of the copper from the ore on the same day .What is the production of copper in tons/day ?

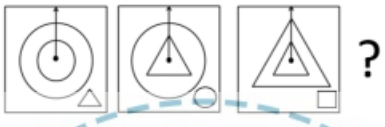
(a) 80 (b) 12 (c) 120 (d) 150

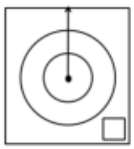
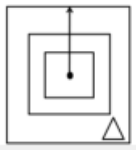
Q.4 Wheat production of a country over a number of years is shown .Which year recorded highest percent reduction in production over the previous year ?



(a) 2001 (b) 2002 (c) 2003 (d) 2004

Q.5 What is the next pattern in the given sequence ?



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

Q.6 A person completely under sea water tracks the Sun .Compared to an observer above water, which of the following observations would be made by the underwater observer?

(a) Neither the time of sunrise or sunset nor the angular span of the horizon changes.

(b) Sunrise is delayed, sunset is advanced, but there is no change in the angular span of the horizon.

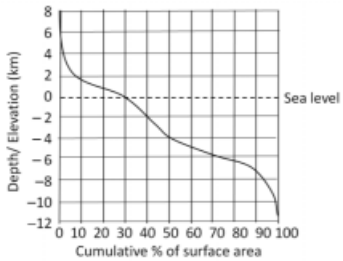
(c) Sunrise and sunset times remain unchanged, but the angular span of the horizon shrinks.

(d) The duration of the day and the angular span of the horizon, both decrease.

Q.7 A man sells three articles A, B, C and gains 10 %on A, 20 %on B and loses 10 %on C .He breaks even when combined selling prices of A and C are considered, whereas he gains 5 %when combined selling prices of B and C are considered .What is his net loss or gain on the sale of all the articles ?

(a) 10 %gain (b) 20 %gain (c) 10.66 %gain (d) 6.66 %gain

Q.8 Based on the distribution of surface area of the Earth at different elevations and depths)with reference to sea-level (shown in the figure, which of the following is FALSE ?



(a) Larger proportion of the surface of the Earth is below sea-level.

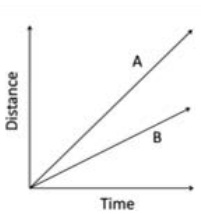
(b) Of the surface area above sea-level, larger proportion lies below 2 km elevation.

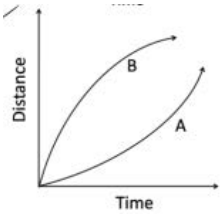
(c) Of the surface area below sea-level, smaller proportion lies below 4 km depth.

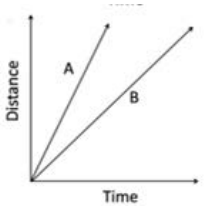
(d) Distance from sea level to the maximum depth is greater than that to the maximum elevation.

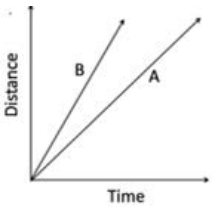
Q.9 Time-distance graph of two objects A and B are shown.

If the axes are interchanged, then the same information is shown by

(a) 

(b) 

(c) 

(d) 

Q.10 A chocolate salesman is travelling with 3 boxes with 30 chocolates in each box .During his journey he encounters 30 toll booths .Each toll booth inspector takes one chocolate per box that contains chocolate)s(, as tax .What is the largest number of chocolates he can be left with after passing through all toll booths?

(a) 0 (b) 30 (c) 25 (d) 20

Q.11 A milkman adds 10 litres of water to 90 litres of milk .After selling 1/5th of the total quantity, he adds water equal to the quantity he has sold .The proportion of water to milk he sells now would be

(a) 72:28 (b) 28:72 (c) 20:80 (d) 30:70

Q.12 Two coconuts have spherical space inside their kernels, with the first having an inner diameter twice that of the other .The larger one is half filled with liquid, while the smaller is completely filled .Which of the following statements is correct?

(a) The larger coconut contains 4 times the liquid in the smaller one.

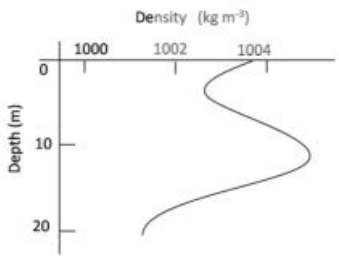
(b) The larger coconut contains twice the liquid in the smaller one.

(c) The coconuts contain equal volumes of liquid.

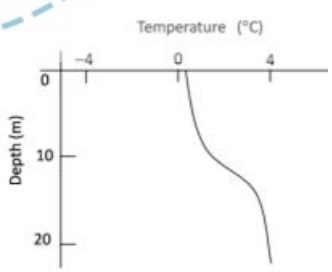
(d) The smaller coconut contains twice the liquid in the larger one.

Q.13 Which of the following graphs represents a stable fresh water lake ?)i.e., no vertical motion of water(

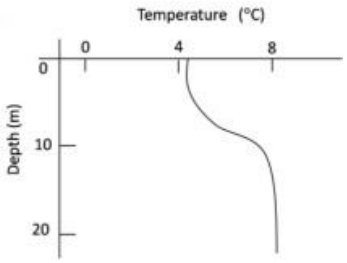
(a)



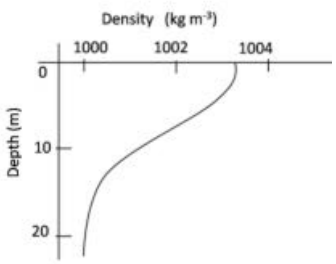
(b)



(c)



(d)



Q.14 A tiger usually stalks its prey from a direction that is upwind of the prey .The reason for this is

(a) The wind aids its final burst for killing the prey.

(b) The wind carries the scent of the prey to the tiger and helps the tiger locate the prey easily.

(c) The upwind area usually has denser vegetation and better camouflage.

(d) The upwind location aids the tiger by not letting its smell reach the prey.

Q.15 A cellphone tower radiates 1W power while the handset transmitter radiates 0.1 mW power .The correct comparison of the radiation energy received by your head from a tower 100m away)E1 (and that from a handset held to your ear)E2 (is

(a) E1 >> E2

(b) E2 >> E1

(c) E1 =E2 for communication to be established

(d) Insufficient data even for a rough comparison

Q.16 The pitch of a spring is 5 mm .The diameter of the spring is 1 cm .The spring spins about its axis with a speed of 2 rotations/s .The spring appears to be moving parallel to its axis with a speed of

(a) 1 mm/s (b) 5 mm/s (c) 6 mm/s (d) 10 mm/s

Q.17 The dimensions of a floor are 18 × 24 .What is the smallest number of identical square tiles that will pave the entire floor without the need to break any tile?

(a) 6 (b) 24 (c) 8 (d) 12

Q.18 To determine the number of parrots in a sparse population, an ecologist captures 30 parrots and puts rings around their necks and releases them .After a week he captures 40 parrots and finds that 8 of them have rings on their necks .What approximately is the parrot population?

(a) 70 (b) 150 (c) 160 (d) 100

Q.19 The mid-point of the arc of a semicircle is connected by two straight lines to the ends of the diameter as shown .What is the ratio of the shaded area to the area of the triangle?

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

Q.20 Why is there low fish population in lakes that have large hyacinth growth?

(a) Hyacinth prevents sunlight from reaching the depths of the lake.

(b) Decaying matter from hyacinth consumes dissolved oxygen in copious amounts.

(c) Hyacinth is not a suitable food for fishes.

(d) Hyacinth releases toxins in the water.

Section-B

Q.21 The HOMO)highest occupied molecular orbital (to LUMO)lowest unoccupied molecular orbital (electronic transition responsible for the observed colours of halogen molecules)gas (is

(a) $\pi \rightarrow *\sigma\ *$ (b) $\pi \rightarrow \pi\ *$ (c) $\sigma \rightarrow \sigma*$ (d) $\pi \rightarrow \sigma*$

Q.22 In the hydrolysis of trans]-Co)en(₂Cl)A⁺[(, if the leaving group is chloride, the formation of cis product is the least, when A is,

(a) NO^{2-} (b) NCS^{-} (c) Cl^{-} (d) OH^{-}

Q.23 The expected number of ^{19}F NMR spectral lines, including satellites, for]XeF_5[⁻is]Abundance of ^{129}Xe)I =½ = (26[%

(a) Two (b) Twenty one (c) Three (d) One

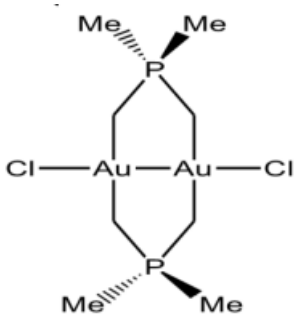
Q.24 The expected H−H−H bond angle in]H_3^+[is

(a) 180° (b) 120° (c) 60° (d) 90°

Q.25 The number of bridging ligand)s (and metal–metal bond)s (present in the complex]Ru_2)η5-Cp(₂)CO(₂)$Ph_2PCH_2PPh_2$) [(obeys 18-electron rule(, respectively, are

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

Q.26 The oxidation state of gold in the following complex is



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

Q.27 The rate of alkene coordination to $[PtCl_4]^{2-}$ is highest for

(a) Norbornene (b) Ethylene (c) Cyclohexene (d) 1-Butene

Q.28 The nephelauxetic parameter 'β' is highest for

(a) Br^- (b) Cl^- (c) CN^- (d) F^-

Q.29 The $^2E_g \leftarrow {}^4A_{2g}$ transition in the electronic spectrum of $[Cr(NH_3)_6]^{3+}$ occurs nearly at

(a) 650 nm (b) 450 nm (c) 350 nm (d) 200 nm

Q.30 In the catalytic hydration of CO_2 by carbonic anhydrase, CO_2 first interacts with

(a) OH group of the active site of the enzyme and then with zinc.

(b) H_2O of the active site of the enzyme and then with zinc.

(c) Zinc of the active site of the enzyme and then with OH group.

(d) Zinc of the active site of the enzyme and then with H_2O

Q.31 $HX_{(aq)} + (H_2O)_l \rightleftharpoons (H_3O)^+_{aq} + (X)^-_{aq}$ The highest value of $[X]^-_{aq}$, when X^- is

(a) OCl^- (b) F^- (c) Cl^- (d) NO_2^-

Q.32 The correct statement for d.c .polarography is

(a) $E_{1/2}$ is concentration dependent.

(b) Dropping mercury electrode is a macro electrode.

(c) Limiting current is equal to diffusion current.

(d) A large excess of supporting electrolyte eliminates migration current.

Q.33 Saturation factor in neutron activation analysis is)A =induced radioactivity; φ =neutron flux; σ = effective nuclear cross section; N =no of target atoms; λ =decay constant(

(a) $\frac{A}{\varphi\sigma N}$ (b) $\frac{\sigma\varphi NA}{\lambda}$ (c) $\frac{\lambda}{\sigma\varphi AN}$ (d) $\frac{\sigma\varphi N}{A}$

Q.34 The primary analytical method)not using a reference (is

(a) Inductively coupled plasma emission spectrometry.

(b) Energy dispersive X-ray fluorescence spectrometry.

(c) Anodic stripping voltammetry.

(d) Isotopic dilution mass spectrometry.

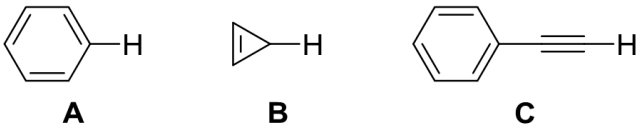
Q.35 The number of inorganic sulphur)or sulphide (atoms present in the metalloprotein active sites of rubredoxin, 2-iron ferredoxin and 4-iron ferredoxin, respectively, are

(a) 0, 2 and 4 (b) 2, 4 and 3 (c) 0, 4 and 2 (d) 0, 2 and 3

Q.36 The metal iodide with metallic lustre and high electrical conductivity is

(a) NaI (b) CdI_2 (c) LaI_2 (d) BiI_3

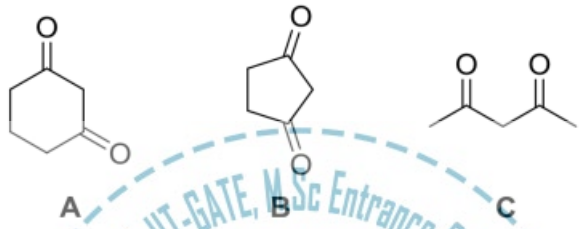
Q.37 The correct order of the bond dissociation energies for the indicated C-H bond in following compounds is



A B C

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

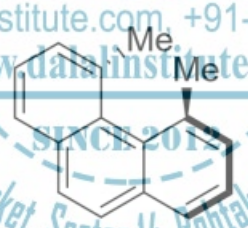
Q.38 The correct order of the acidity for the following compounds is



A B C

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

Q.39 The correct statement about the following compound is



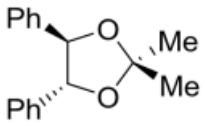
(a) Compound is chiral and has P configuration.

(b) Compound is chiral and has M configuration.

(c) Compound is achiral as it possesses C_2-axis of symmetry.

(d) Compound is achiral as it possesses plane of symmetry.

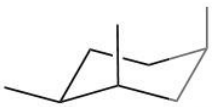
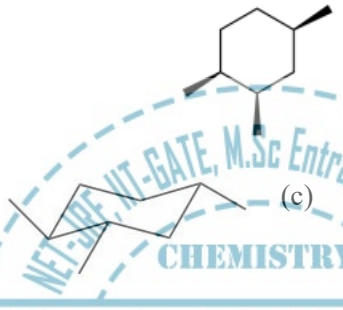
Q.40 Methyl groups in the following compound are



(a) Homotopic (b) Diasterotopic

(c) Enantiotopic (d) Constitutionally Heterotopic

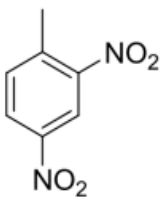
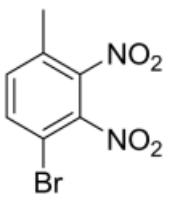
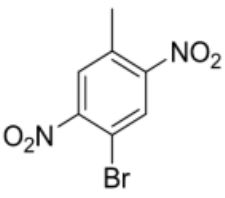
Q.41 Among the structures given below, the most stable conformation for the following compound is

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

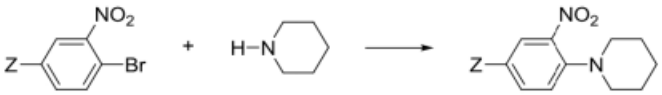
Q.42 Molecular orbital interactions involved in the first step of the following reaction is

(a) $\pi_{C=C} \rightarrow \sigma^*_{Br-Br}$ (b) nBr $\rightarrow \sigma^*_{C-C}$ (c) $\pi_{C=C} \rightarrow \sigma_{Br-Br}$ (d) nBr $\rightarrow \sigma_{C=C}$

Q.43 The major product formed in the Dinitration of 4-Bromotoluene is

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

Q.44 The correct order of the rate constants for the following series of reactions)Z =CF_3/CH_3/OCH_3 (is



(a) $CF_3 > CH_3 > OCH_3$ (b) $CF_3 > OCH_3 > CH_3$ (c) $OCH_3 > CF_3 > CH_3$ (d) $CH_3 > OCH_3 > CF_3$

Q.45 ^1H NMR spectrum of a mixture of benzene and acetonitrile shows two singlets of equal integration .The molar ratio of benzene :acetonitrile is

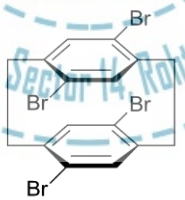
(a) 1:1 (b) 2:1 (c) 1:2 (d) 6:1

Q.46 The compound which shows IR frequencies at both 3314 and 2126 cm^{-1} is

(a) $CH_3)CH_2(_4CH_2SH$ (b) $CH_3)CH_2(_4CH_2C{\equiv}N$

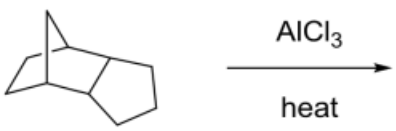
(c) $CH_3)CH_2(_4CH_2C{\equiv}C\text{-}H$ (d) $CH_3)CH_2(_2C{\equiv}C)CH_2(_2CH_3$

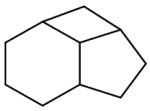
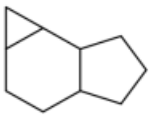
Q.47 Number of signals present in the proton decoupled ^{13}C NMR spectrum of the following compound is



(a) 4 (b) 6 (c) 8 (d) 10

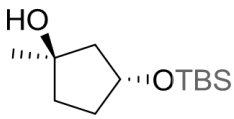
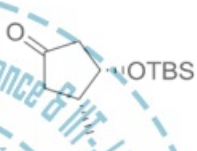
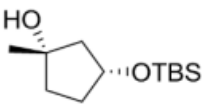
Q.48 The most stable product formed in the following reaction is



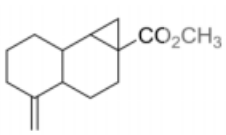
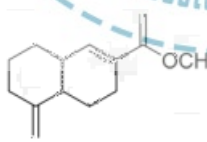
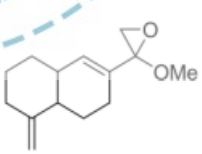
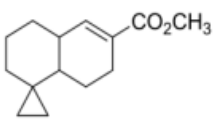
(a)  (b)  (c)  (d) 

Q.49 The major product in the following reaction is

TBS = $Si(CH_3)_2t\text{-}C_4H_9$

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

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

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

Q.51 Correct characteristics of the functional groups of adenine in DNA base pair are

(a) N)3 (is a hydrogen bond acceptor and C)6(NH$_2$ is a hydrogen bond donor.

(b) N)1 (is a hydrogen bond acceptor and C)6(NH$_2$ is a hydrogen bond donor.

(c) Both N)3 (and C)6(NH$_2$ are hydrogen bond acceptors.

(d) Both N)1 (and C)6(NH_2 are hydrogen bond acceptors

Q.52 1H NMR spectrum of an organic compound recorded on a 500 MHz spectrometer showed a quartet with line positions at 1759, 1753, 1747, 1741 Hz .Chemical shift)δ (and coupling constant)Hz (of the quartet are

(a) 3.5 ppm, 6 Hz (b) 3.5 ppm, 12 Hz (c) 3.6 ppm, 6 Hz (d) 3.6 ppm, 12 Hz

Q.53 The weight of the configuration with two up and three down spins in a system with five spin $\frac{1}{2}$ particles is

(a) 120 (b) 60 (c) 20 (d) 10

Q.54 For a reaction with an activation energy of 49.8 kJ mol^{-1}, the ratio of the rate constants at 600 K and 300 K,)k_{600}/k_{300}(, is approximately)R =8.3 J mol^{-1} K^{-1}(

(a) ln)10((b) 10 (c) 10 + e (d) e^{10}

Q.55 Covariance is defined by the relation Cov)x,y = (<xy> − <x><y> .Given the arbitrary constants A B and C, Cov)x,y(will be zero only when

(a) y =Ax^2 (b) y =Ax^2 + B (c) y =Ax + B (d) Ax^2 + Bx +C

Q.56 Each void in a two dimensional hexagonal close-packed layer of circles is surrounded by

(a) Six circles (b) Three Circles (c) Four Circles (d) Twelve Circles

Q.57 The ionic mobilities of NH_4^+ and HCO_3^- are 6×10^{-4} $V^{-1}s^{-1}$ and 5×10^{-4} $V^{-1}s^{-1}$, respectively .The transport numbers of NH_4^+ and HCO_3 are, respectively

(a) 0.545 and 0.455 (b) 0.455 and 0.545 (c) 0.090 and 0.910 (d) 0.910 and 0.090

Q.58 The ionic strength of a solution containing 0.008 M $AlCl_3$ and 0.005 M KCl is

(a) 0.134 M (b) 0.053 M (c) 0.106 M (d) 0.086 M

Q.59 The correct normalized wavefunction for one of the sp^2 hybrid orbitals is

(a) $\frac{1}{3}\psi_{2s} + \frac{1}{3}\psi_{2p_x} + \frac{1}{3}\psi_{2p_y}$

(b) $\frac{1}{\sqrt{3}}\psi_{2s} + \frac{2}{\sqrt{3}}\psi_{2p_x} + \frac{1}{\sqrt{6}}\psi_{2p_y}$

(c) $\frac{1}{\sqrt{3}}\psi_{2s} + \frac{1}{\sqrt{2}}\psi_{2p_x} + \frac{1}{\sqrt{6}}\psi_{2p_y}$

(d) $\frac{1}{\sqrt{3}}\psi_{2s} + \frac{1}{2\sqrt{3}}\psi_{2p_x} + \frac{1}{\sqrt{6}}\psi_{2p_y}$

Q.60 The correct statement in the context of NMR spectroscopy is

(a) Static magnetic field is used to induce transition between the spin states.

(b) Magnetization vector is perpendicular to the applied static magnetic field.

(c) The static magnetic field is used to create population difference between the spin states.

(d) Static magnetic field induces spin-spin coupling.

Q.61 The parameter which always decreases during a spontaneous process at constant S and V, is

(a) U (b) H (c) C_p (d) q

Q.62 Triple point pressure of substances A, B, C and D are 0.2, 0.5, 0.8 and 1.2 bar, respectively .The substance which sublimes under standard conditions on increasing temperature is

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

Q.63 According to the transition state theory, the plot with slope equal to $\frac{-\Delta H^{\neq}}{R}$ is

(a) ln k vs .T (b) ln)$\frac{k}{T}$ (vs .T (c) ln)$\frac{k}{T}$ (vs .$\frac{1}{T}$ (d) ln k vs .$\frac{1}{T}$

Q.64 The transition that belongs to the Lyman series in the Hydrogen-atom spectrum is

(a) 1s ←4s (b) 1s ←4p (c) 2s ←4s (d) 2s ←4p

Q.65 The molecule that possesses S_4 symmetry element is

(a) Ethylene (b) Allene (c) Benzene (d) 1,3B-utadiene

Q.66 Vibrations of diatomic molecules are usually modelled by a harmonic potential .If the potential is given by x^2, the correct statement is

(a) force is $2x$ and force constant is 2. (b) force is− $2x$ and force constant is 2.

(c) force is $2x$ and force constant is −1. (d) force is −$2x$ and force constant is −1.

Q.67 When 1×10^{-5}g of a fatty acid)M =602.3 g/mol (was placed on water as a surface film, a monomolecular layer of area 100 cm^2 was formed on compression .The cross sectional area) in $Å^2$ (of the acid molecule is

(a) 50 (b) 100 (c) 150 (d) 200

Q.68 Mark-Houwink equation])η = [KM^a (is used for the determination of

(a) Number-average molar mass. (b) Weight-average molar mass.

(c) Viscosity-average molar mass. (d) Z-average molar mass.

Q.69 Many properties of nanoparticles are significantly different than the corresponding bulk material due to

(a) Smaller band gap of nanoparticles compared to bulk.

(b) Higher heterogeneity of the nanoparticle solutions.

(c) Larger ratio of surface area to volume of the nanoparticles compared to the bulk.

(d) Smaller ratio of surface area to volume of the nanoparticles compared to the bulk.

Q.70 The correct match for the following is

Column A	Column B
i .Camphor	a .Structural Protein
ii .Insulin	bH .ormone
iii .Keratin	cE .nzyme
	dS .teroid
	e .Terpene

(a) i – a; ii -c; iii – (b) i –e; ii -b; iii -a (c) i –d; ii -c; iii –a (d) i –e; ii -b; iii -d e

Section-C

Q.71 Consider the following statements for KC_8): A (It is paramagnetic,)B (It has eclipsed layer structure,)C (Its electrical conductivity is greater than that of graphite .The correct answer is

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

Q.72 Among the following, choose the correct products that are formed in the reaction of S_2Cl_2 with ammonia in CCl_4 :NH_4Cl)A(, S_4N_4) B(, S_8) C(, and $S_3N_3Cl_3$) D.(

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

Q.73 For]Ce)NO_3(4)$OPPh_3$(2[, from the following

A .Its aqueous solution is yellow-orange in colour.

B .Coordination number of Ce is ten.

C .It shows metal to ligand charge transfer.

D .It is diamagnetic in nature.

The correct answer is

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

Q.74 Consider the following statements, I and II:

I] :Rh)CO(2I_2^-[catalytically converts CH_3I and CO to CH_3COI

II] :Rh)CO(2I_2^-[is diamagnetic in nature

the correct from the following is

(a) I and II are correct and II is an explanation of I.

(b) I and II are correct and II is not an explanation of I.

(c) I is correct and II is incorrect.

(d) I and II are incorrect.

Q.75 In a direct isotopic dilution method for determination of phosphate, 2 mg of $^{32}PO_4^{3}$) $^-$specific activity 3100 disintegration $s^{-1}mg^{-1}$ (was added to 1 g of a sample solution .The 30 mg of phosphate isolated from it has an overall activity of 3000 disintegration s^{-1} .The %mass of PO_4^{3-} in the sample is

(a) 30 (b) 6 (c) 9 (d) 15

Q.76 Consider the following statements for]FeO_4^-[^{4}.

A .It is paramagnetic

B .It has T_d symmetry

C .Adopts distorted square planar geometry

D .Shows approximately D_{2d} symmetry

The correct answer is

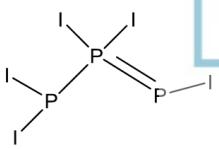
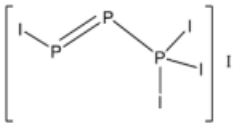
(a) A, B and C (b) A, C and D (c) A and D (d) A and B

Q.77 The geometry of $]ReH_9[^{2-}$ is

(a) Monocapped square antiprism. (b) Monocapped cube.

(c) Tricapped trigonal prism. (d) Heptagonal bipyramid.

Q.78 The reaction between PI_3, $PSCl_3$ and zinc powder gives P_3I_5 as one of the products. The solution state ^{31}P NMR spectrum of P_3I_5 shows a doublet (δ 98) and a triplet (δ 102). The correct structure of P_3I_5 is

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

Q.79 Some molecules and their properties in liquid ammonia are given in columns A and B respectively. Match column A with column B

Column A	Column B
(a) Cl_2	(i) Weak acid
(b) S_8	(ii) Strong acid
(c) CH_3CO2H	(iii)Disproportionation
(d) Urea	(iv) Solvolysis and disproportionation

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

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

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

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

Q.80 The spectroscopic ground state term symbols for the octahedral aqua complexes of Mn(II), Cr(III) and Cu(II), respectively, are

(a) ^{2}H, 4F and ^{2}D (b) ^{6}S, ^{4}F and ^{2}D (c) ^{2}H, 2H and ^{2}D (d) ^{6}S, ^{4}F and ^{2}P

Q.81 From the following transformations,

A. Epoxidation of alkene.

B. Diol dehydrase reaction.

C. Conversion of ribonucleotide-todeoxyribonucleotide.

D. 1,2-carbon shift in organic substrates.

those promoted by coenzyme B_{12} are

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

Q.82 Match the items in column A with the appropriate items in column B

Column A	Column B
(a) Metallothioneins	(i) cis-[Pd(NH3)2Cl2]
(b) Plastocyanin	(ii) Cysteine rich protein
(c) Ferritin	(iii) Electron transfer
(d) Chemotherapy	(iv) Iron transport
	(v) Iron storage
	(vi) Carboplatin

The correct answer is

(a) (a)-(ii), (b)-(iii), (c)-(v), (d)-(iv)

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

(c) (a)-(ii), (b)-(iii), (c)-(v), (d)-(vi)

(d) (a)-(iii), (b)-(v), (c)-(vi), (d)-(ii)

Q.83 For OH^- catalysed SN_1 conjugate base mechanism of $[Co(NH_3)_5Cl]^{2+}$, the species obtained in the first step of the reaction is/are

(a) $[Co(NH_3)_5(OH)]^{2+} + Cl^-$ (b) $[Co(NH_3)_4(NH_2)Cl]^+ + H_2O$

(c) $[Co(NH_3)_4(NH_2)]^{2+} + Cl^-$ (d) $[Co(NH_3)_5Cl(OH)]^+$ only

Q.84 Match the species in column X with their properties in column Y

Column X	Column Y
(1) Heme A	(i) Oxo-bridged Mn_4 cluster
(2) water splitting enzyme	(ii) Tetragonal elongation
(3) $[Mn(H_2O)_6]^{2+}$	(iii) Predominantly $\pi \rightarrow \pi^*$ electronic transitions
(4) $[Cr(H_2O)_6]^{2+}$	(iv) d→d spin forbidden transitions
	(v) tetragonal compression

Q.85 According to isolobal analogy, the right set of fragments that might replace $Co(CO)_3$ in $[Co_4(CO)_{12}]$ is

(a) CH, BH and $Mn(CO)_5$ (b) P, CH and $Ni(\eta^5\text{-}C_5H_5)$

(c) $Fe(CO)_4$, CH_2 and $SiCH_3$ (d) BH, $SiCH_3$ and P

Q.86 According to Wade's rules, the correct structural types of $[Co(\eta^5\text{-}C_5H_5)B_4H_8]$ and $[Mn(\eta^2\text{-}B_3H_8)(CO)_4]$ are

(a) Closo and nido (b) Nido and arachno (c) Closo and arachno (d) Nido and nido

Q.87 The correct geometry of $[Rh_6C(CO)_{15}]^{2-}$ is

(a) Octahedron (b) Pentagonal pyramid

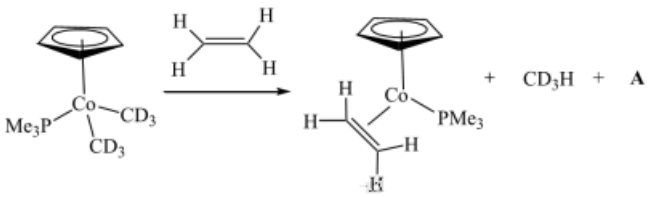
(c) Trigonal prism (d) Monocapped square pyramid

Q.88 The final product(s) of the reaction of arachno borane, B_4H_{10} with NMe_3 is/are

(a) $[BH_3.NMe_3]$ and $[B_3H_7.NMe_3]$ (b) $[BH_2(NMe_3)_2]^+[B_3H_8]^-$

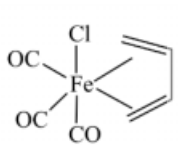
(c) $[B_4H_{10}.NMe_3]$ (d) $[B4H_{10}.NMe_3]$ and $[BH_2(NMe_3)_2]^+[B_3H_8]^-$

Q.89 Product A in the following reaction is



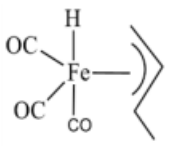
(a) $D_2C{=}CD_2$ (b) $D_3C{-}CD_3$ (c) (d) $H_2C{=}CD_2$

Q.90 Treatment of $Fe(CO)_5$ with 1,3-butadiene gives B that shows two signals in its ^1H NMR spectrum. B on treatment with HCl yields C which shows four signals in its ^1H NMR spectrum. The compound C is

(a) 

(b) 

(c) 

(d) 

Q.91 In the following redox reaction with an equilibrium constant $K = 2.0 \times 10^8$,

$$[Ru(NH_3)_6]^{2+} + [Fe(H_2O)_6]^{3+} \rightleftharpoons [Ru(NH_3)_6]^{3+} + [Fe(H_2O)_6]^{2+}$$

the self exchange rates for oxidant and reductant are 5.0 $M^{-1}s^{-1}$ and 4.0×10^3 $M^{-1}s^{-1}$, respectively. The approximate rate constant ($M^{-1}s^{-1}$) for the reaction is

(a) 3.16×10^6 (b) 2.0×10^6 (c) 6.32×10^6 (d) 3.16×10^4

Q.92 The correct statement for a Fischer carbine complex is

(a) The carbene carbon is electrophilic in nature.

(b) Metal exists in high oxidation state.

(c) Metal fragment and carbene are in the triplet states.

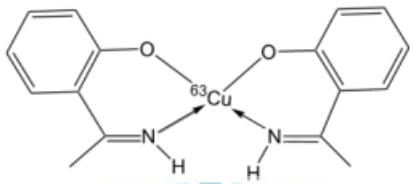
(d) CO ligands destabilize the complex.

Q.93 The acidic solution containing trimethylamine (**A**), dimethylamine (**B**) and methyl amine (**C**)

(pk_a of cations 9.8, 10.8 and 10.6, respectively) was loaded on a cation exchange column. The order of their elution with a gradient of increasing pH >7 is

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

Q.94 For complex A, deuteration of NH protons does not alter the EPR spectrum. The number of hyperfine lines expected in the EPR [I(^{63}Cu) = 3/2] spectrum of A is



(a) 20 (b) 12 (c) 60 (d) 36

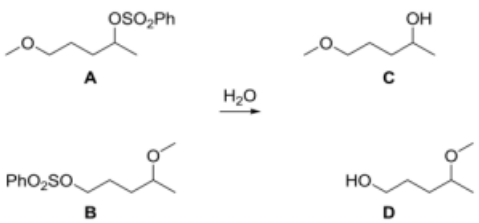
Q.95 The numbers of triangular faces in square antiprism, icosahedron and tricapped trigonal prism (capped on square faces), respectively, are

(a) 8, 20 and 14 (b) 8, 20 and 12 (c) 10, 12 and 14 (d) 10, 12 and 12

Q.96 Number of lines in the ^{19}F NMR spectrum of $F_2C(Br)\text{-}C(Br)Cl_2$ at -120°C assuming it a mixture of static conformations given below, are

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

Q.97 The correct statement for the reactants A, B to give products C, D is



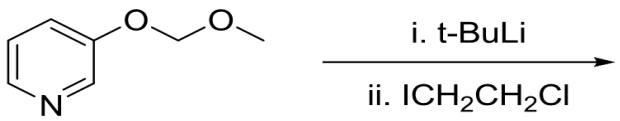
(a) A gives C and B gives D

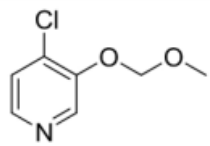
(b) A gives D and B gives C

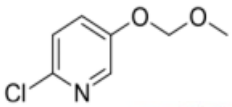
(c) A and B give identical amounts of C and D

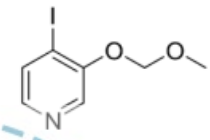
(d) A and B give D

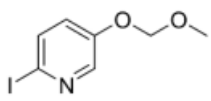
Q.98 The major product formed in the following reaction is



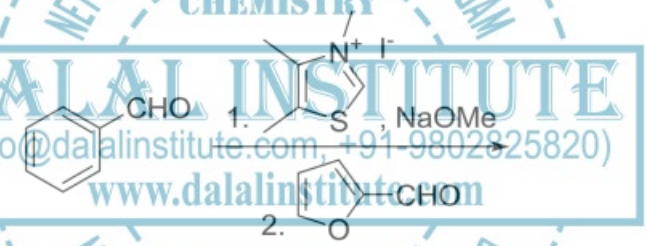
(a) 

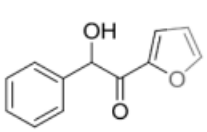
(b) 

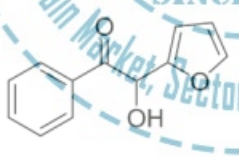
(c) 

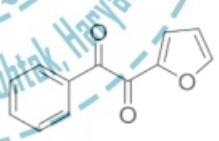
(d) 

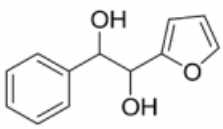
Q.99 The major product formed in the following reaction is



(a) 

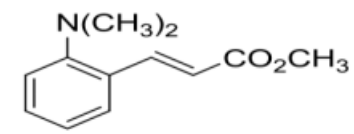
(b) 

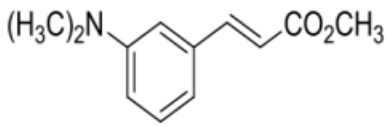
(c) 

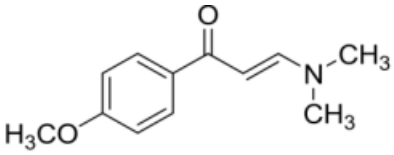
(d) 

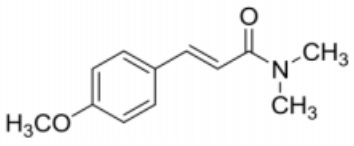
Q.100 The compound that exhibits following spectral data is

^{1}H NMR: δ 8.0 (d, J = 12.3 Hz, 1H), 7.7 (d, J =8.0 Hz, 2H), 6.8 (d, J = 8.0 Hz, 2H), 5.8 (d, J =12.3 Hz, 1H), 3.8 (s, 3H), 3.0 (s, 6H) ppm

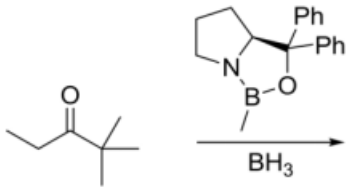
(a) 

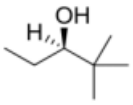
(b) 

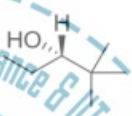
(c) 

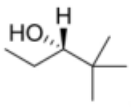
(d) 

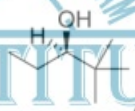
Q.101 The major product in the following reaction is



(a)  , by Re face attack

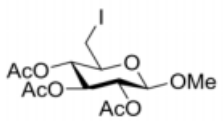
(b)  , by Re face attack

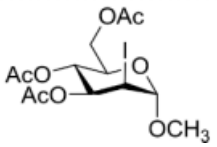
(c)  , by Si face attack

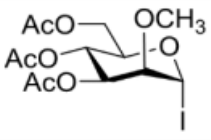
(d)  , by Si face attack

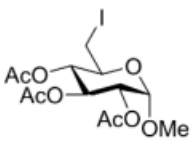
Q.102 The major product formed in the following reaction is

NIS: *N*-iodosuccinimide

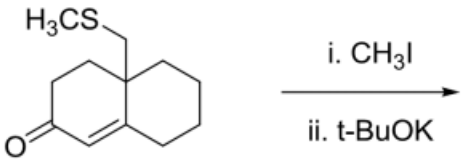
(a) 

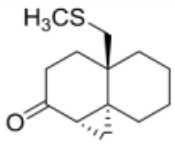
(b) 

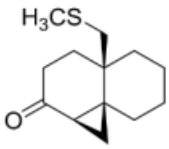
(c) 

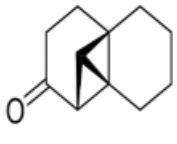
(d) 

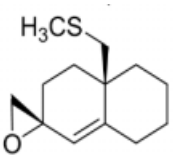
Q.103 The major product formed in the following reaction is



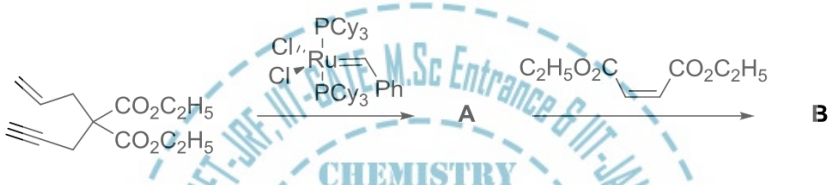
(a) 

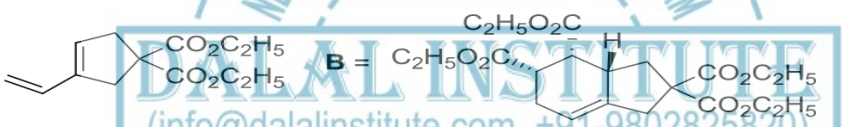
(b) 

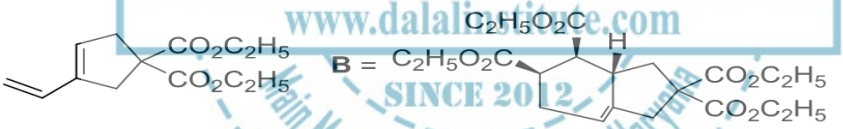
(c) 

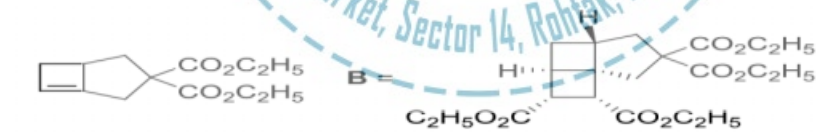
(d) 

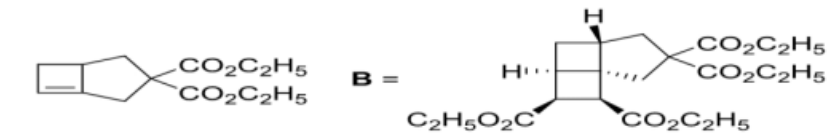
Q.104 The major product formed in the following reaction is



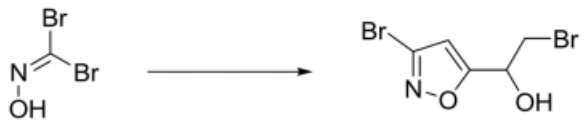
(a) 

(b) 

(c) 

(d) 

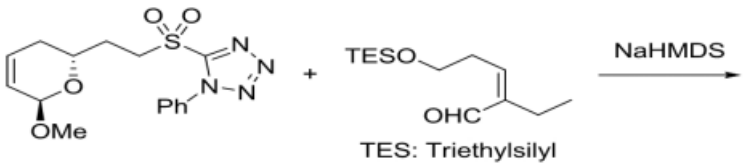
Q.105 Correct sequence of reagents for the following conversion is

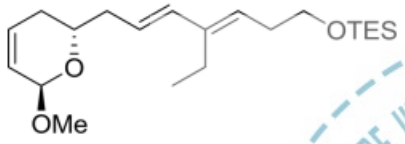


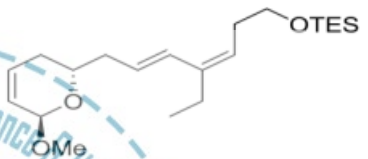
(a) i. K_2CO_3, ii. $HC{\equiv}CCOCH_3$, iii. Br_2, iv. $NaBH_4$ (b) i. $NaBH_4$, ii. $HC{\equiv}CCOCH_3$, iii. Br_2, iv. K_2CO_3

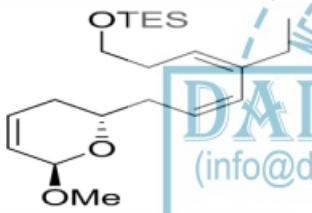
(c) i. $HC{\equiv}CCOCH_3$, ii. K_2CO_3, iii. Br_2, iv. $NaBH_4$ (d) i. Br_2, ii. $HC{\equiv}CCOCH_3$, iii. K_2CO_3, iv. $NaBH_4$

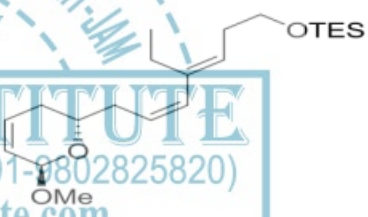
Q.106 The major product in the following reaction is



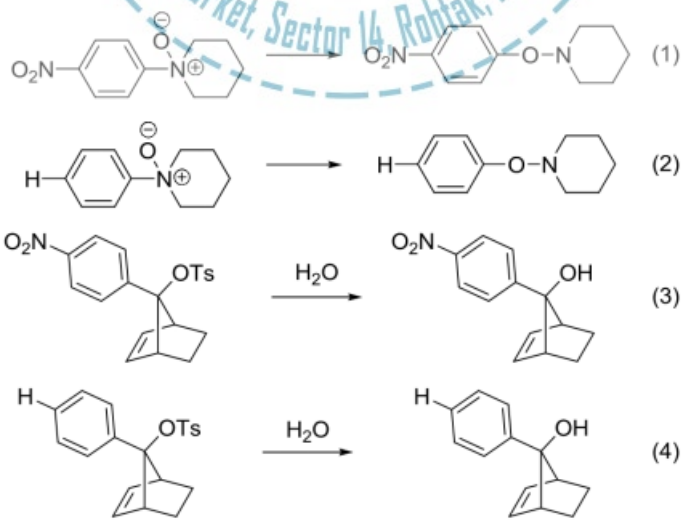
(a)


(b)


(c)


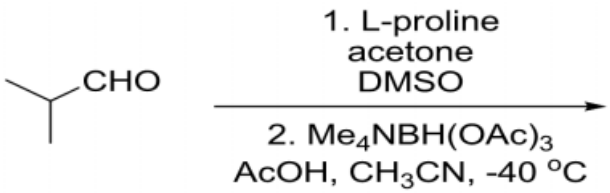
(d)


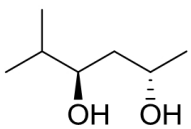
Q.107 For the four reactions given below, the rates of the reactions will vary as

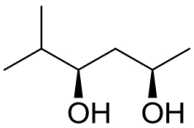


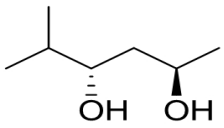
(a) 1 > 2 and 3 > 4 (b) 2 > 1 and 3 > 4 (c) 2 > 1 and 4 > 3 (d) 1 > 2 and 4 > 3

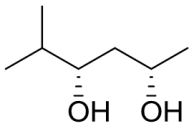
Q.108 The major product formed in the following reaction is



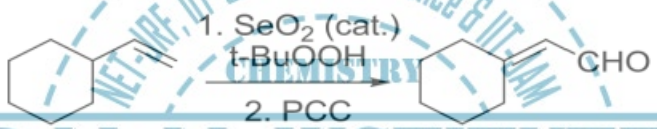
(a) 

(b) 

(c) 

(d) 

Q.109 The correct sequence of pericyclic reactions involved in the following transformation is



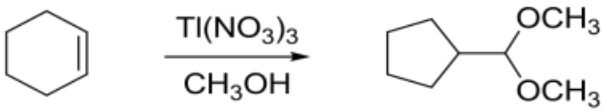
(a) (i) ene reaction, (ii) [2,3]-sigmatropic shift, (iii) [3,3]-sigmatropic shift.

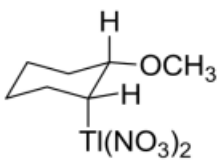
(b) (i) ene reaction, (ii) [3,3]-sigmatropic shift, (iii) [1,3]-sigmatropic shift.

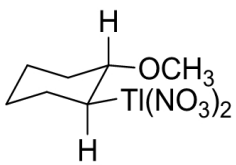
(c) (i) [2,3]-sigmatropic shift, (ii) ene reaction, (iii) [1,3]-sigmatropic shift.

(d) (i) [1,3]-sigmatropic shift, (ii) [2,3]- sigmatropic shift, (iii) [3,3]-sigmatropic shift.

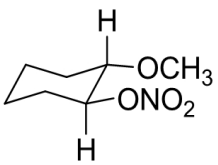
Q.110 The intermediate that leads to the product in the following transformation is



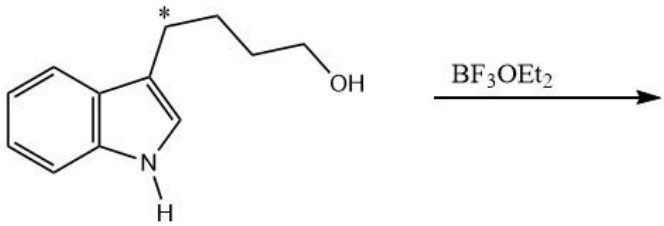
(a) 

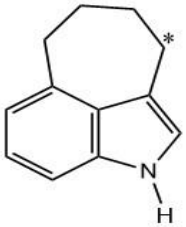
(b) 

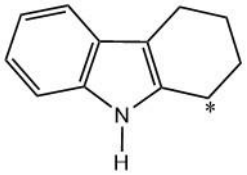
(c) 

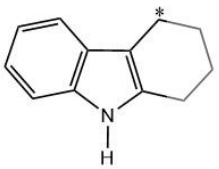
(d) 

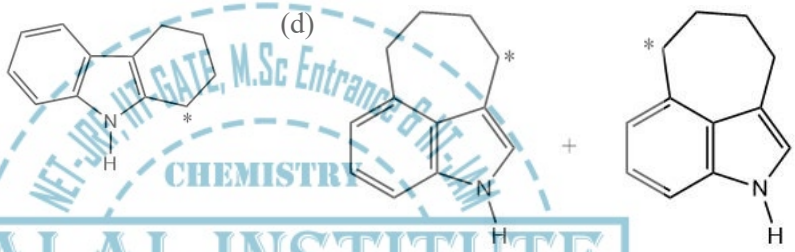
Q.111 Product(s) of the following reaction is (are) [*- indicates isotopically labelled carbon]



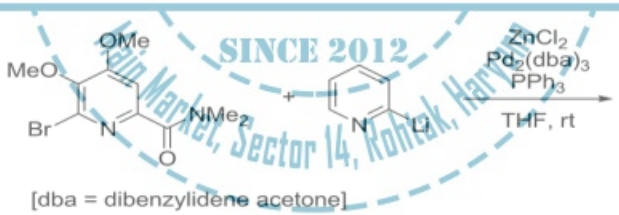
(a) 

(b) 

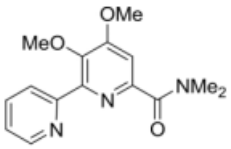
(c) 

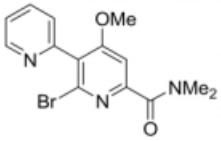
(d) 

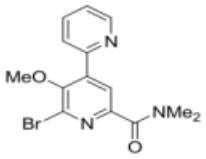
Q.112 The major product formed in the following reaction is

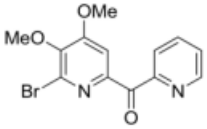


[dba = dibenzylidene acetone]

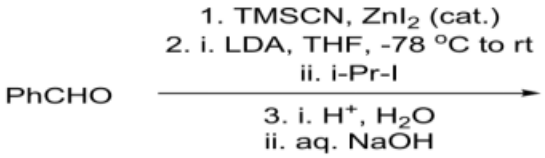
(a) 

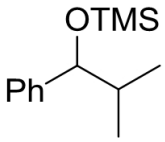
(b) 

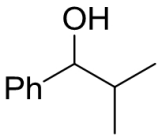
(c) 

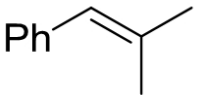
(d) 

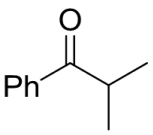
Q.113 The major product formed in the following reaction is



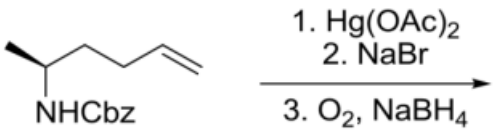
(a) 

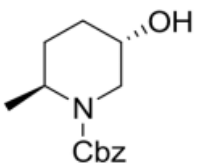
(b) 

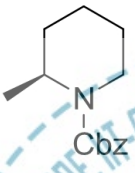
(c) 

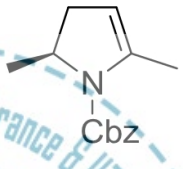
(d) 

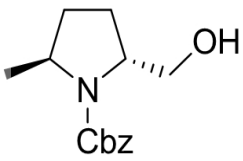
Q.114 The major product formed in the following reaction is



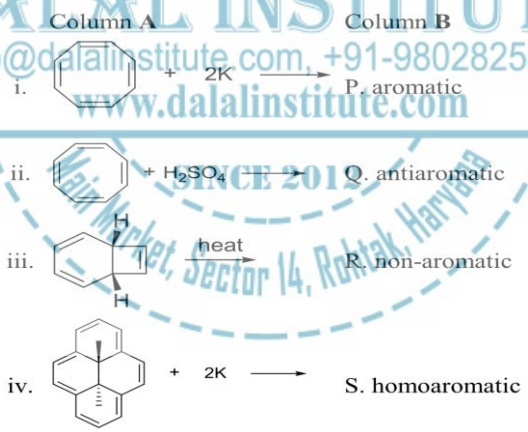
(a) 

(b) 

(c) 

(d) 

Q.115 Correct match for the products of the reactions in Column A with the properties in Column B is



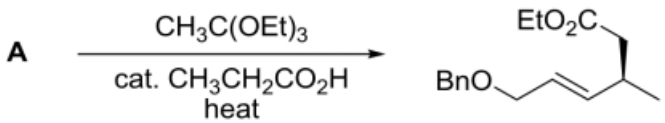
(a) i – P, ii – S, iii – R, iv – Q

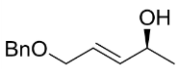
(b) i – P, ii – R, iii – Q, iv – S

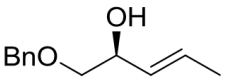
(c) i – Q, ii – R, iii – S, iv – P

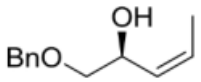
(d) i – S, ii – Q, iii – R, iv – P

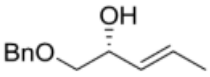
Q.116 The correct starting compound A in the following reaction is



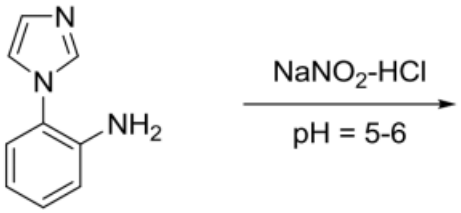
(a) 

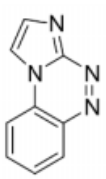
(b) 

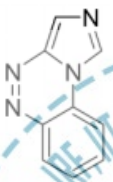
(c) 

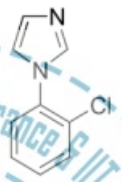
(d) 

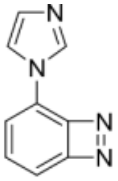
Q.117 The major product formed in the following reaction is



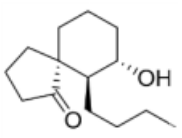
(a) 

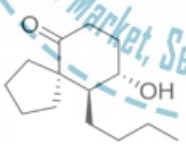
(b) 

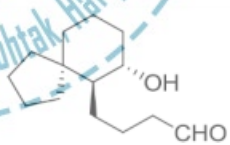
(c) 

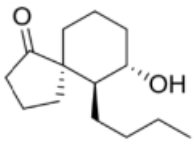
(d) 

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

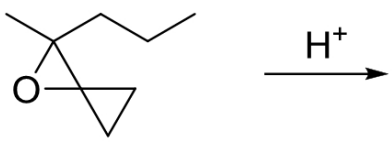
(a) 

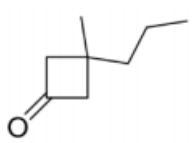
(b) 

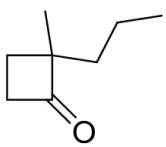
(c) 

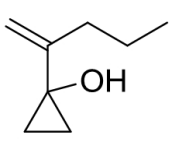
(d) 

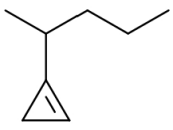
Q.119 The major product formed in the following reaction is



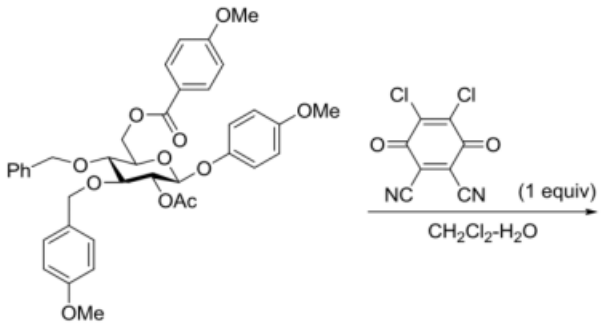
(a) 

(b) 

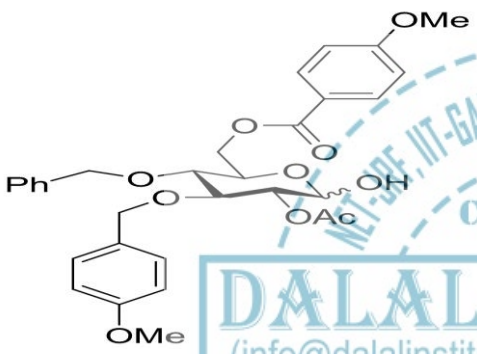
(c) 

(d) 

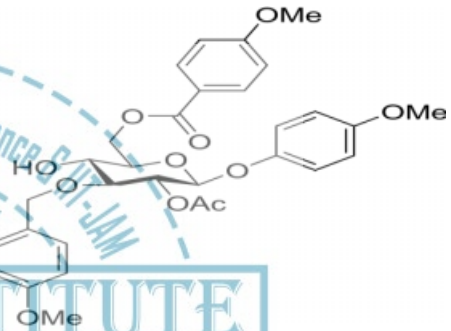
Q.120 The major product formed in the following reaction is



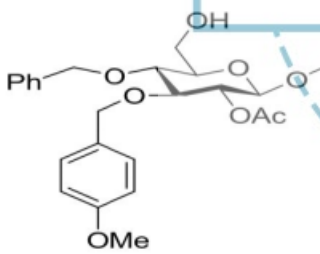
(a)



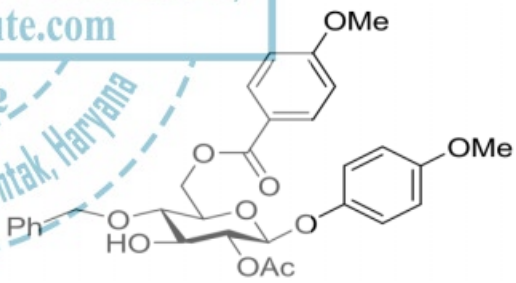
(b)



(c)



(d)



Q.121A constant of motion of hydrogen atom in the presence of spin-orbit coupling is

(a) l (b) s (c) l + s (d) l – s

Q.122 The orbital degeneracy of the level of a one electron atomic system with Z = 5 and energy ≈ –13.6 eV, is

(a) 1 (b) 5 (c) 25 (d) 36

Q.123 If we write a normalized wavefuntion ψ as $\psi = \hat{A}\phi$, then ϕ is also normalized when

(a) $\hat{A}$ is hermitian (b) $\hat{A}$ is anti-hermitian (c) $\hat{A}$ is unitary (d) $\hat{A}$ is any linear oprator

Q.124 The ground state of a certain system with energy ϵ_0 is subjected to a perturbation V, yielding a first-order correction ϵ_1. If E_0 is the true ground-state energy of the perturbed system, the inequality that always holds is

(a) $\epsilon_1 \geq 0$ (b) $\epsilon_0 \geq E_0$ (c) $\epsilon_0 + \epsilon_1 \leq E_0$ (d) $\epsilon_0 + \epsilon_1 \geq E_0$

Q.125 The spatial part of an excited state $b\ ^3\sum_u^+$ of hydrogen molecule is proportional to $[1\sigma_g(1)1\sigma_u(2) - 1\sigma_g(2)1\sigma_u(1)]$. Using LACO – MO expansion of $1\sigma_g$ and $1\sigma_u$ in terms of 1s-atomic orbitals, one can infer that this wavefunction has

(a) only ionic parts (b) only covalent parts

(c) both ionic and covalent parts (d) neither ionic nor covalent parts

Q.126 The highest molecular orbitals for an excited electronic configuration of the oxygen molecule are $[1\pi_g]^1[3\sigma_u]^1$. A possible molecular term symbol for oxygen with this electronic configuration is

(a) $^1\Pi$ (b) $^3\sum$ (c) $^1\Delta$ (d) $^1\sum$

Q.127 For H_2O molecule, the electronic transition from the ground state to an excited state of B_1 symmetry is

C_{2v}	E	C_2	σ_v	σ_v'	
A_1	1	1	1	1	z,z^2,x^2,y^2
A_2	1	1	–1	–1	xy
B_1	1	–1	1	–1	x,xz
B_2	1	–1	–1	1	y,yz

(a) Not allowed (b) Allowed with *x* polarization.

(c) Allowed with y polarization. (d) Allowed with z polarization.

Q.128 The pair of symmetry point groups that are associated with only polar molecules is

(a) C_{2v}, $D_{\infty h}$ (b) C_{3v}, C_{2h} (c) D_{2h}, T_d (d) C_{2v}, $C_{\infty v}$

Q.129 The rotational constant and the fundamental vibrational frequency of HBr are, respectively, 10 cm^{-1} and 2000 cm^{-1}. The corresponding values for DBr approx. are

(a) 20 cm^{-1} and 2000 cm^{-1} (b) 10 cm^{-1} and 1410 cm^{-1}

(c) 5 cm^{-1} and 2000 cm^{-1} (d) 5 cm^{-1} and 1410 cm^{-1}

Q.130 Among the following, both microwave and rotational Raman active molecule is

(a) CH_4 (b) N_2O (c) C_2H_4 (d) CO_2

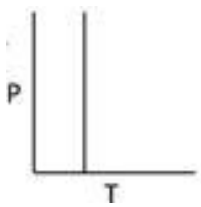
Q.131 In a 200 MHz NMR spectrometer, a molecule shows two doublets separated by 2 ppm. The observed coupling constant is 10 Hz. The separation between these two signals and the coupling constant in a 600 MHz spectrometer will be, respectively

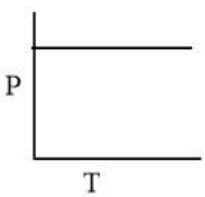
(a) 600 Hz and 30 Hz (b) 1200 Hz and 30 Hz (c) 600 Hz and 10 Hz (d) 1200 Hz and 10 Hz

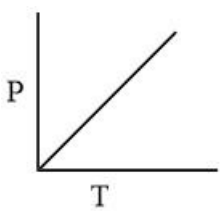
Q.132 The equation of state for one mole of a gas is given by P(V – b) = RT, Where b and R are constants. The value of $\left(\frac{\partial H}{\partial P}\right)_T$ is

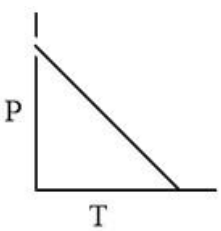
(a) V – b (b) b (c) 0 (d) $\frac{RT}{P} + b$

Q.133 The volume change in a phase transition is zero. From this, we may infer that the phase boundary is represented by

(a) 

(b) 

(c) 

(d) 

Q.134 The partial derivative $\left(\frac{\partial T}{\partial V}\right)_P$ is equal to

(a) $-\left(\frac{\partial P}{\partial S}\right)_T$ (b) $-\left(\frac{\partial P}{\partial S}\right)_V$ (c) $-\left(\frac{\partial P}{\partial S}\right)_n$ (d) $-\left(\frac{\partial P}{\partial S}\right)_H$

Q.135 If the energies of a bare proton aligned alond and against an external field (B_z) are $-\hbar\gamma B_z/2$, respectively, then ration of probabilities of finding the proton along and against the magnetic field is

(a) $e^{-\hbar\gamma B_z/4k_BT}$ (b) $e^{-\hbar\gamma B_z/2k_BT}$ (c) $e^{\hbar\gamma B_z/2k_BT}$ (d) $e^{\hbar\gamma B_z/k_BT}$

Q.136 Partition function of a one-dimensional oscillator having equispaced energy levels with energy spacing equal to k_BT and zero ground state energy is

(a) e (b) $1/(e-1)$ (c) $e/(e-1)$ (d) $1/(e+1)$

Q.137 A reaction goes through the following elementary steps

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2C \quad \text{(fast)}$$

$$A + B \xrightarrow{k_2} D \quad \text{(slow)}$$

Assuming that steady state approximation can be applied to C, on doubling the concentration of A, the rate of production of will increase by (assume $k_2[A] << k_{-1}[C]$)

(a) 2 times (b) 4 times (c) 8 times (d) $2\sqrt{2}$ times

Q.138 The rate of an acid catalysed reaction in aqueous solution follows the rate equation $r[X^+][Y^{2-}][H^+]$ if k_{16} and k_4 are the rate constants for the reaction at ionic strength of 16 mol L^{-1} and 4 mol L^{-1}, respectively, $\ln\frac{k_4}{k_{16}}$, in terms of Debye-Huckel constant (B = 0.51), is

(a) 4B (b) 8B (c) 10B (d) 12B

Q.139 For two reactions

$$X_{(g)} + Y_{(g)} \rightarrow Z_{(g)} \quad (1)$$

$$M_{(g)} + N_{(g)} \rightarrow P_{(g)} \quad (2)$$

According to the collision theory, the ratio of squares of pre-exponential factors of the reactions 2 (A_2) and 1 (A_1) at the same temperature, $\left(\frac{A_2}{A_1}\right)^2$, is

Spcies	Mass(g/mol)	Diameter(nm)
X	5	0.3
Y	20	0.5
M	10	0.4
N	10	0.4

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

Q.140 If the specific conductances of a sparingly soluble (1:1) salt (MW = 200 g mol^{-1}) in its saturated aqueous solution at 25˚C and that of water are 1.5×10^{-3} ohm^{-1} dm^{-1} and 1.5×10^{-5} ohm^{-1} dm^{-1}, respectively, and the ionic conductances for its cation and anion at infinite dilution are 0.485 and 1.0 ohm^{-1} dm2 mol^{-1}, respectively, the solubility (in g L^{-1}) of the salt in water at 25˚C is

(a) 1×10^{-6} (b) 1×10^{-3} (c) 2×10^{-1} (d) 2×10^{-4}

Q.141 Given

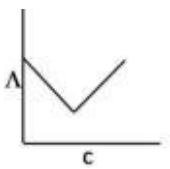
(i) $Zn + 4NH_3 \rightarrow Zn(NH_3)_4^{2+} + 2e$, $E^0 = 1.03$ V

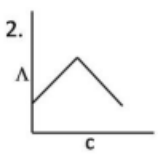
(ii) $Zn \rightarrow Zn^{2+} + 2e$, $E^0 = 0.763$ V

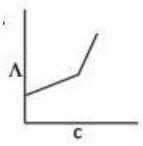
The formation constant of the complex $Zn(NH_3)_4^{2+}$ is approx.. $\left(\frac{2.303RT}{F} = 0.0591\right)$

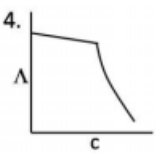
(a) 1×10^5 (b) 1×10^7 (c) 1×10^9 (d) 1×10^{12}

Q.142The molar conductivity (Λ) vs. concentration (c) plot of sodium dodecylsulfate in water is expected to look like

(a) 

(b) 

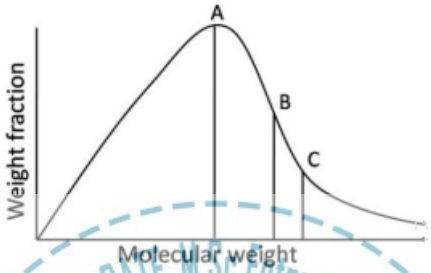
(c) 

(d) 

Q.143 The $\sin^2\theta$ values obtained from X-ray powder diffraction pattern of a solid are 2x,4x,6x,8x where x is equal to 0.06. The wavelength of X ray used to obtain this pattern is 1.54 Å. The unit cell and the unit cell length, respectively, are

(a) BCC, 3.146 Å (b) FCC, 3.146 Å (c) SCC, 6.281 Å (d) BCC, 1.544 Å

Q.144 Distribution of molar masses in a typical polymer sample is shown below



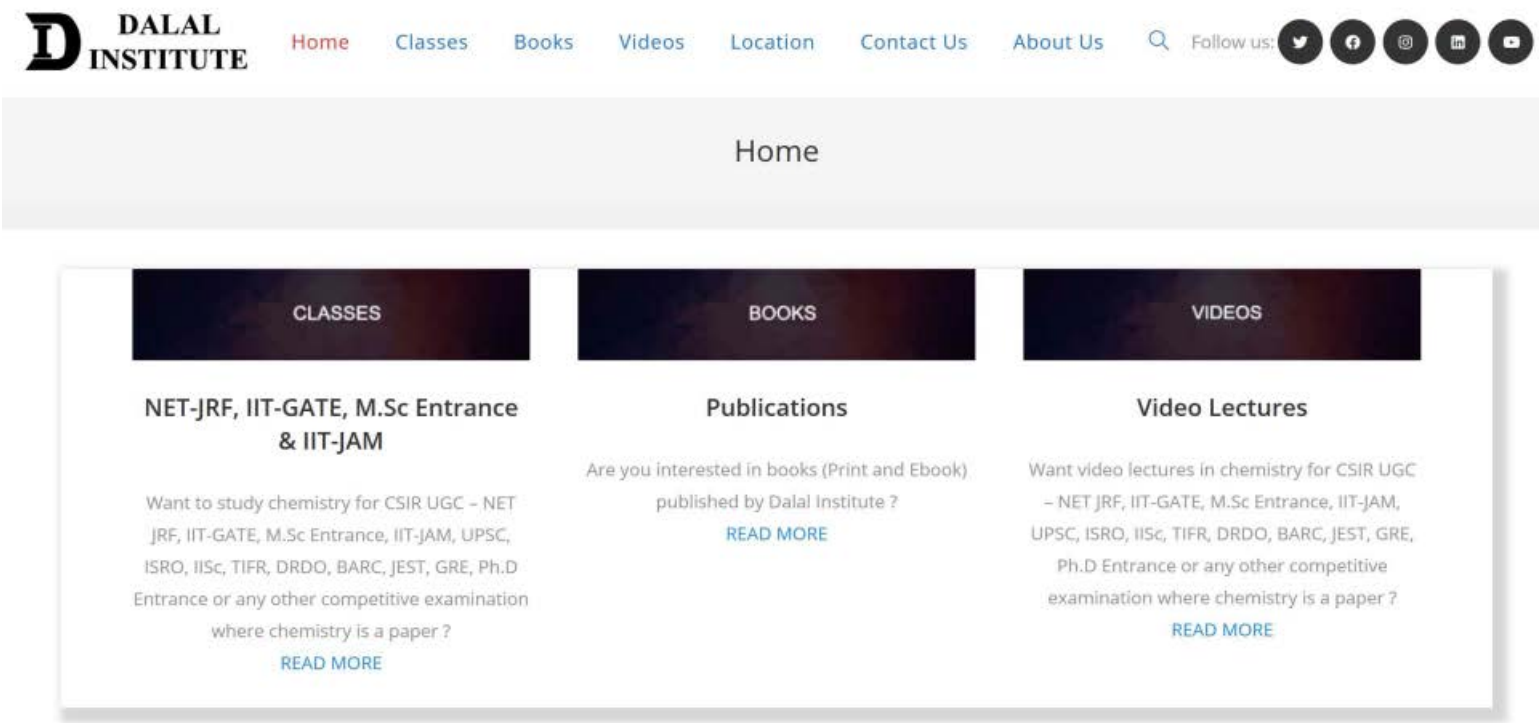
The A, B and C represent

(a) $\bar{M}_w, \bar{M}_v$ *and* $\bar{M}_n$, *respectively* (b) $\bar{M}_n, \bar{M}_v$ *and* $\bar{M}_w$, *respectively*

(c) $\bar{M}_v, \bar{M}_w$ *and* $\bar{M}_n$, *respectively* (d) $\bar{M}_n, \bar{M}_w$ *and* $\bar{M}_v$, *respectively*

Q.145 Two bound stationary states, 1 and 2, of a one-electron atom, with $E_2 > E_1$ (E is the total energy) obey the following statement about their kinetic energy (T) and potential energy (V)

(a) $T_2 > T_1$; $V_2 > V_1$ (b) $T_2 > T_1$; $V_2 < V_1$ (c) $T_2 < T_1$; $V_2 > V_1$ (d) $T_2 = T_1$; $V_2 > V_1$



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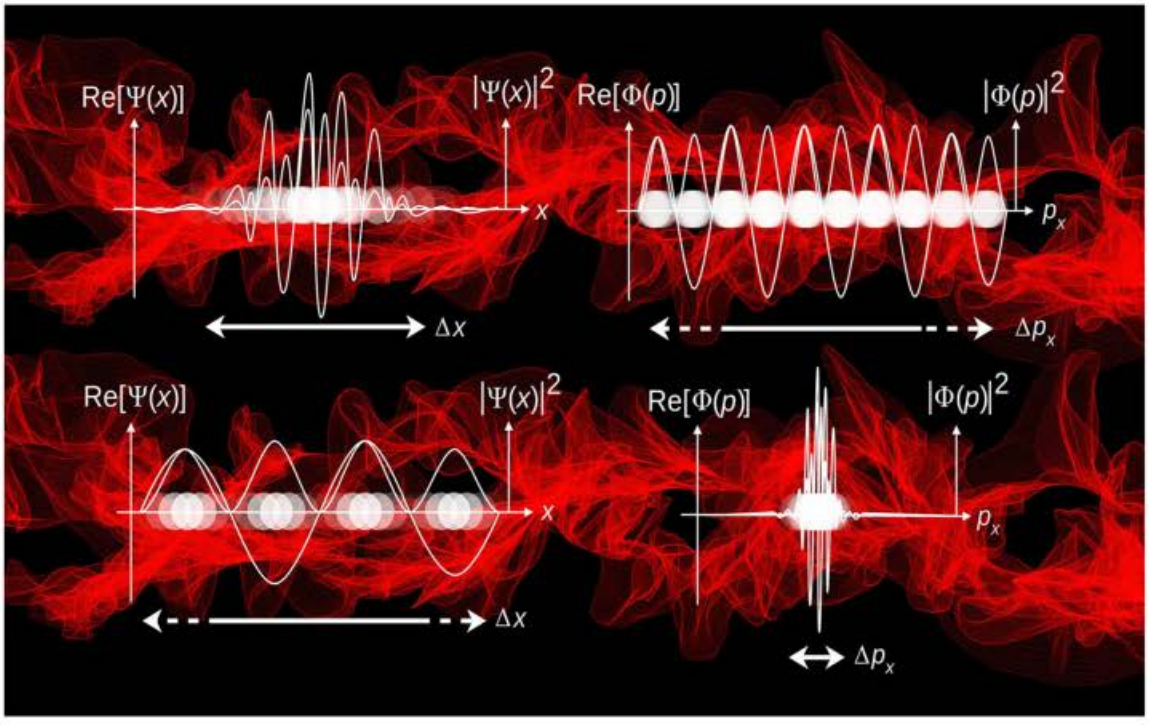

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