CSIR UGC – NET JRF: June 2019

Chemical Science

❖ Question Paper

Section-A

Q.1 Balls are being rolled out with equal initial speeds along a frictionless, undulating (wave-like) track in quick succession. There is denser clustering of balls around point B than around point A. Which of the following statements is true?

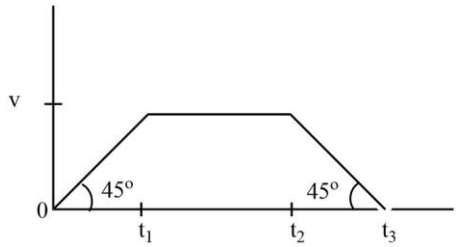
(a) Point A is higher than B

(b) Point B is higher than A

(c) Point A and B are at the same heights

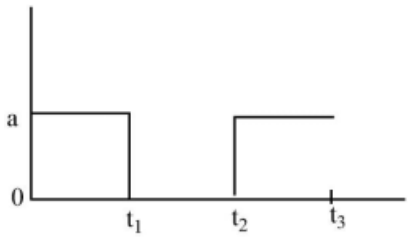
(d) Balls reached point A first and then point B

Q.2 Velocity-time curve of a body is given in the diagram below:

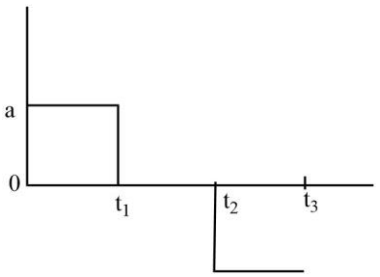


The diagram showing the acceleration of this body as a function of time is

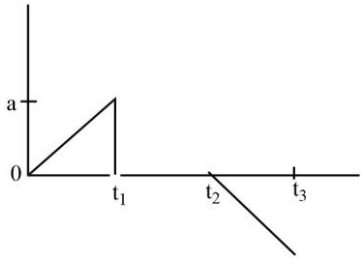
(a)



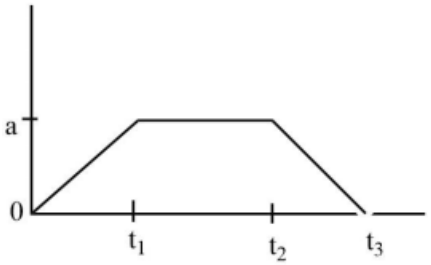
(b)



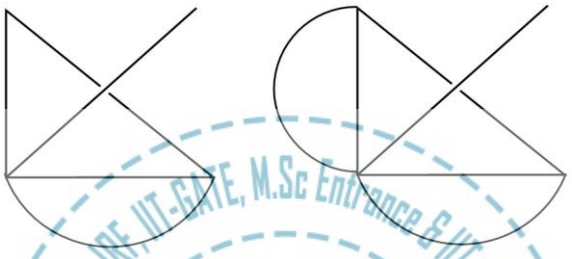
(c)



(d)



Q.3 Which of the following figures can be drawn without lifting the pen from the paper or retracing?



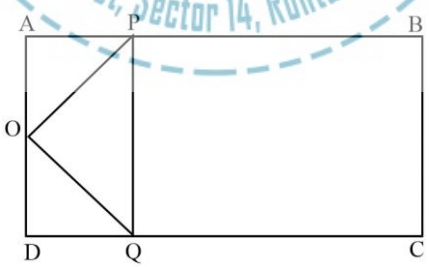
(a) figure A but not figure B

(b) figure B but not figure A

(c) both figures A and B

(d) neither figure A nor figure B

Q.4 ABCD is a rectangle and O is the midpoint of AD. P and Q are points on AB and CD, respectively such that AP = ¼ AB and DQ = ¼DC.



The ratio of area of the rectangle ABCD to that of the triangle OPQ is

(a) 4 (b) 6 (c) 8 (d) 16

Q.5 The number of digits you have to type to write all the page numbers of a book starting from 1(first page) is 2019. What is the number of pages in that book?

(a) 609 (b) 610 (c) 709 (d) 710

Q.6 A student received the following marks in the five of the six courses: 91,86,81,79 and 92. Average of this marks in six subjects is 85. How many marks did he receive in the sixth subject?

(a) 83 (b) 85 (c) 81 (d) 88

Q.7 Salesperson 'A' sells an object at a price Rs. 5 less than the marked price, receiving a commission of 5% on the selling price. The same object is sold by person 'B' at a price Rs.15 less than the marked price, receiving a commission of 15 % on the selling price. If both A and B receive the same amount in commission, then what is the marked price of the object?

(a) 10 (b) 20 (c) 22.5 (d) 30

Q.8 A ball rotates at a rate r rotations per second and simultaneously revolves around a stationary point O at a rate R revolutions per second (R < r). The rotation and revolution are in thee same sense. A certain point on the ball is in the line of the centre of the ball and point O at a certain time. This configuration repeats after a time.

(a) $\frac{1}{r-R}$ (b) $\frac{1}{R}-\frac{1}{r}$ (c) $\frac{1}{r+R}$ (d) $\frac{1}{R}+\frac{1}{r}$

Q.9 There are two examinations, A and B in a subject which are evaluated out of 30 and 70 marks, respectively. In order to pass the course the student has to get at least 40% in total and at least 40% in B. The following are the marks of the student S_1 to S_4.

Students	A	B
S_1	12	28
S_2	10	29
S_3	16	27
S_4	05	29

The only student/ to have passed is/are

(a) S_1, S_3 (b) S_1, S_2, S_4 (c) S_1, S_2 (d) S_1

Q.10 Two forest patches have, respectively, 100 and 200 teak trees of the same age. In a given season, all trees shed some of their leaves at random. The daily total collections of the leaf litter from the two patches are expected to have

(a) Nearly equal means, standard deviations and coefficients of variation

(b) Different means, nearly equal standard deviations and coefficients of variation

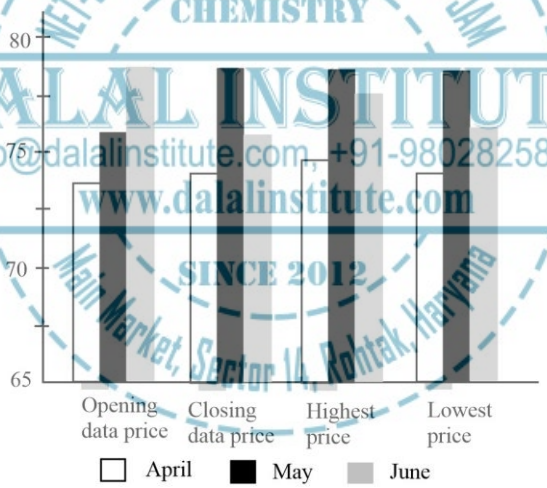
(c) Different means, nearly equal standard deviations and different coefficients of variation

(d) Different means, nearly equal standard deviations and nearly equal coefficients of variation

Q.11 Which of the following numbers is a prime number?

(a) 183 (b) 121 (c) 157 (d) 10201

Q.12 The graph depicts the petrol prices (in Rs. Per litre) for the months April, May, and June.



Pick the incorrect statement.

(a) The highest price never crossed 75

(b) The largest difference between the highest and lowest price was for the month of June

(c) Month of June showed the largest decrease of price between the opening date and closing date price

(d) All depicted prices lie between 70 and 80

Q.13 A traveller to the town reaches a crossed. Upon asking A, B and C for directions to a certain destination, he gets the following responses

A: Turn left

B: Do not turn left

C: Go straight

If only one among A, B and C is truthful, the traveller

(a) Should go left (b) Should go straight

(c) Should go right (d) Will not be able to decide between going left or right

Q.14 The value of a physical quantity is measured to be 3.4587 ± 0.0022. Which one of the appropriate representation of the result taking the errors in account?

(a) 3.4567 (b) 3.457 (c) 3.46 (d) 3.5

Q.15 The cross-section along two mutually perpendicular axes of a solid object are a circle and a square, respectively. The object is

(a) a truncated cone (b) a cylinder (c) a rhomboid (d) a cube

Q.16 In a city, each person has at least one hair on his/her head. At least two persons in this city are guaranteed to have exactly the same number of hair on their heads if the population of the city

(a) is greater than the maximum possible number of hair on the head.

(b) is less than the maximum possible number of hair on the head.

(c) has at least one pair of identical twins.

(d) is genetically homogenous.

Q.17 A metal wire is stretched along its length. Another identical wire is heated. The resultant length of the two wires is the same. What can be said about the diameters of the two wires?

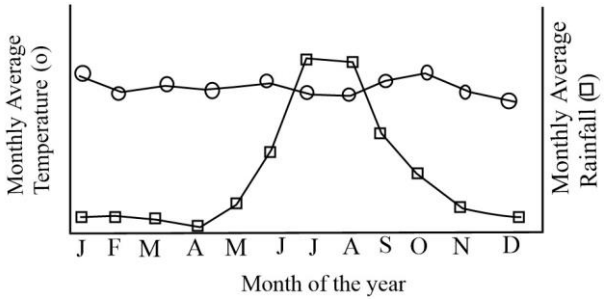
(a) Both diameters will have reduced equally

(b) Both diameters will have increased equally

(c) The hot wire has a larger diameter than the stretched wire

(d) The hot wire has a smaller diameter than the stretched wire

Q.18 The graph below shows the monthly average temperature at a certain place in India. Where is this place most likely to be located?



(a) On the west coast (b) On the east coast

(c) In the north-eastern hills (d) In the Himalayan foothills

Q.19 Graph A and B define the same relationship between y and x for $x, y > 0$. The variable on the ordinate of graph B is

(a) $\frac{1}{x}$ (b) x^2 (c) $\frac{x}{y}$ (d) xy

Q.20 Two parallel chords of length 8 cm and 6 cm of a circle are separated by a distance of 1 cm. The radius of the circle (in cm) is

(a) 4 (b) $4\sqrt{2}$ (c) 5 (d) $5\sqrt{2}$

Section-B

Q.21 In neutron analysis the radiation commonly detected is

(a) α-rays (b) β-rays (c) γ-rays (d) X-rays

Q.22 The metal transferred by bacteria and fungi using siderophores/siderochromes is

(a) Mo (b) Cu (c) Fe (d) Zn

Q.23 Self-exchange electron transfer is fastest in

(a) $[Ru(NH_3)_6]^{2+/3+}$ (b) $[Co(NH_3)_6]^{2+/3+}$ (c) $[Cr(OH_2)_6]^{2+/3+}$ (d) $[Fe(OH_2)_6]^{2+/3+}$

Q.24 The reaction of IO_3^- with I^- in aqueous acidic medium results in

(a) I_2 and H_2O (b) I_2 and H_2O_2 (c) IO^- and H_2O (d) IO^- and H_2O_2

Q.25 The organic species isolobal to

(a) CH_2^+ (b) CH^- (c) CH_3 (d) CH

Q.26 The oxidation state of sulphur in the dithionous and dithionic acids, respectively, are:

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

Q.27 Consider the following reaction:

$$Hg^{2+}(aq) + X^-(aq) = [HgX]^+(aq)$$

The solubility constants for $[HgX]^+(aq)$ for X = F, Cl and Br follow the order

(a) F < Cl < Br (b) Br < Cl < F (c) Cl < Br < F (d) Br < F < Cl

Q.28 The coordination number of Gd in $GdCl_3.6H_2O$ of

(a) 3 (b) 6 (c) 8 (d) 9

Q.29 The role of H_3PO_4 in the estimation of Fe(II) with $K_2Cr_2O_7$ using diphenylamine sulphonate as indicator is to

(a) avoid aerial oxidation of Fe(II) (b) reduce the electrode potential of $Fe^{3+} \rightarrow Fe^{2+}$

(c) stabilize the indicator (d) stabilize $K_2Cr_2O_7$

Q.30 $O_2^{\cdot-}$ is

(a) having a shorter O–O bond length than that in O_2 (b) a strong oxidising agent than O_2

(c) IR active (d) unable to abstract proton from weak acids

Q.31 The species that results by replacing one quarter of Si(IV) in pyrophyllite $[Al_2(OH)_2Si_4O_{10}]$ with Al(III) [charge balance by K(I)] is

(a) Muscovite (b) phlogopite (c) montmorillonite (d) Talc

Q.32 The number of Ni–Ni bonds in $[CpNi(\mu\text{-}PPh_2)]_2$ complex obeying the 18-electron rule is

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

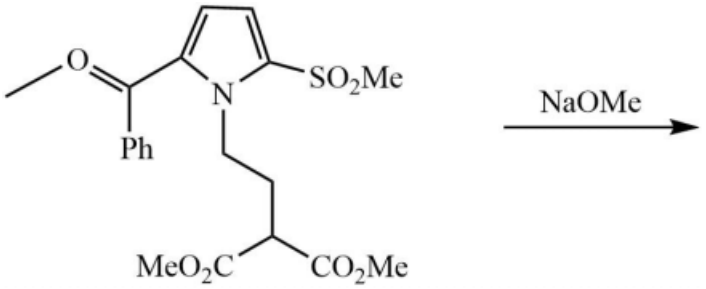
Q.33 For the reaction of *trans*-$[IrX(CO)(PPh_3)_2]$ (X = F, Cl, Br, I) with O_2, correct order of variation of rate with X is

(a) Br > I > F > Cl (b) F > Cl > Br > I (c) F ≈ Cl ≈ Br ≈ I (d) I > Br > Cl > F

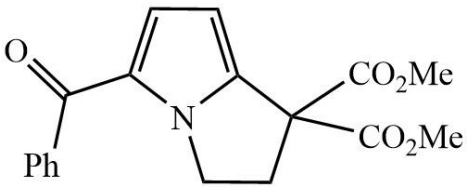
Q.34 In the following equilibrium, conformer B is more stable than A when R is

(a) Me (b) F (c) Cl (d) OMe

Q.35 The major product formed in the following reaction is



(a)



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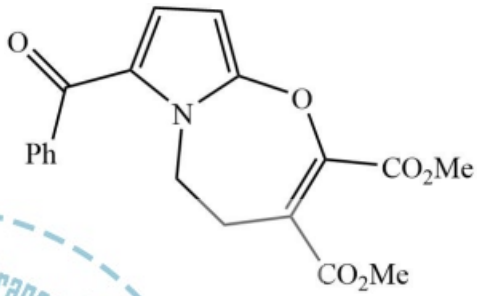

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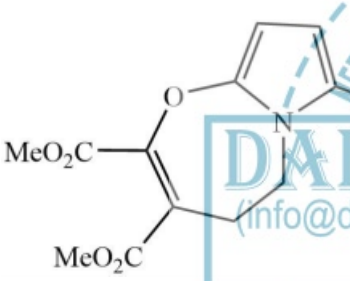
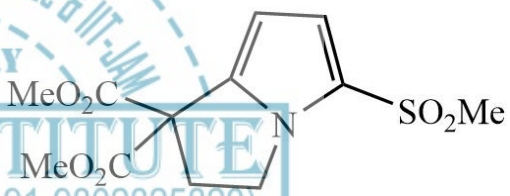
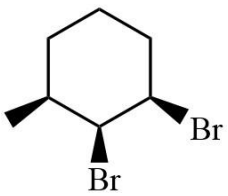


(d)

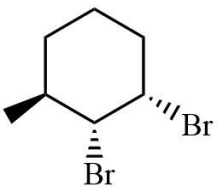


Q.36 The major product formed in the following reaction is

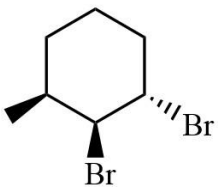
(a)



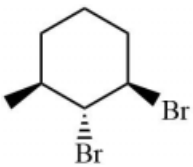
(b)



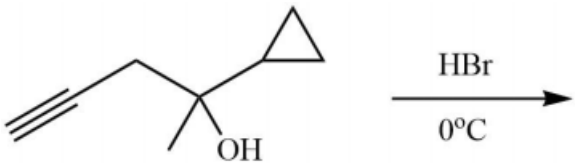
(c)



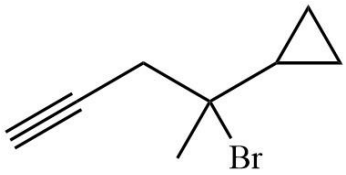
(d)



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



(a)



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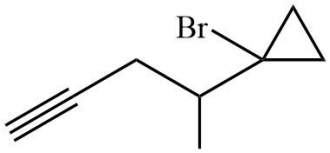

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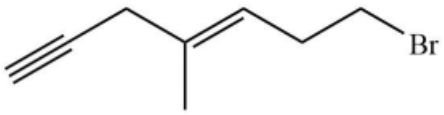

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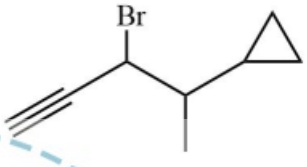


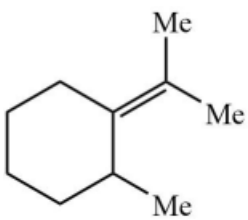
Q.38 The mobility of a divalent cation in water is $8 \times 10^{-8}\ m^2 V^{-1} s^{-1}$. The effective radius of the ion is (viscosity of water = cP; e = 1.6×10^{-19})

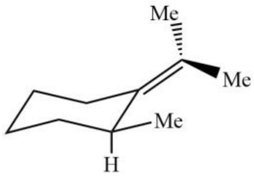
(a) 106 pm (b) 212 pm (c) 424 pm (d) 318 pm

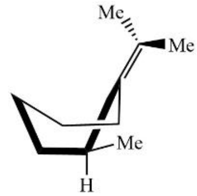
Q.39 The relationship between A and B is

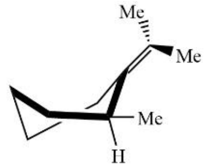
(a) Homomer (identical) (b) Enantiomer (c) Diastereomer (d) Conformer

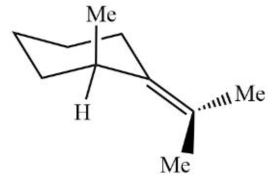
Q.40 The most stable conformation of the following molecule is



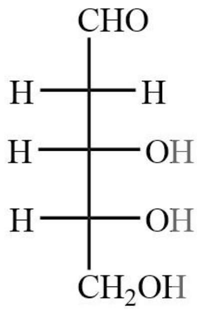
(a) 

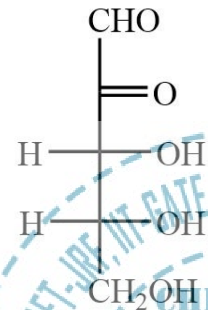
(b) 

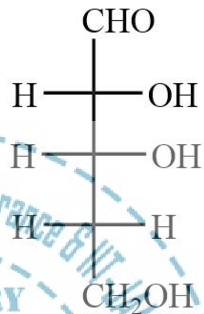
(c) 

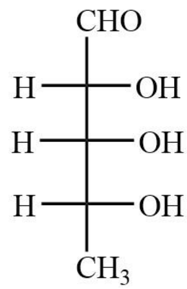
(d) 

Q.41 Reaction of deoxymonosaccharide A with 2 equivalents of HIO_4 affords propanedial, formic acid and aldehyde. The structure of A is

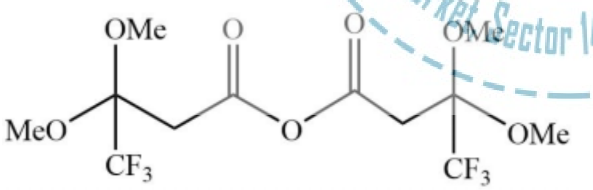
(a) 

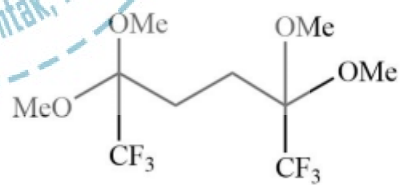
(b) 

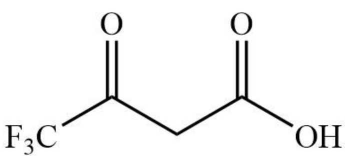
(c) 

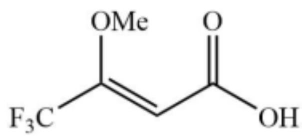
(d) 

Q.42 The major product formed in the following reaction is

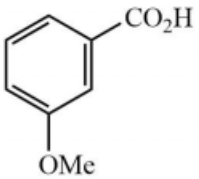
(a) 

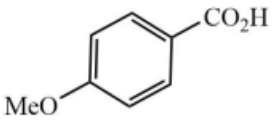
(b) 

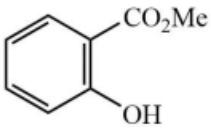
(c) 

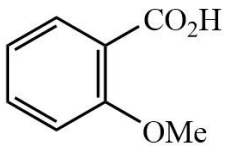
(d) 

Q.43 The compound that will show a base peak at m/z 120 in its EI mass spectrum is

(a) 

(b) 

(c) 

(d) 

Q.44 Among the following, the correct statement about π-molecular orbitals (π-MOs) of benzene is

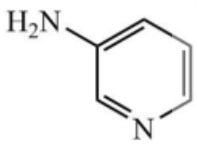
(a) Only the lowest energy MO is doubly degenrate

(b) Only LUMO is doubly degenerate

(c) Only HUMO is doubly degenerate

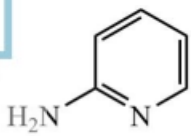
(d) Both the HOMO and LUMO are doubly degenerate

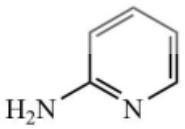
Q.45 The major product(s) formed in the following reaction is(are)

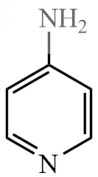
(a) 

and 

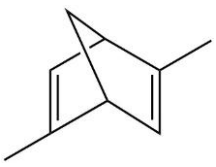
(b) 

and 

(c) only 

(d) only 

Q.46 The number of ^1H NMR signals observed for the following compound is



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

Q.47 The correct order of reactivity of the following dienes towards reaction with maleic anhydride is

(a) *E*-1-chlorobuta-1,3-diene < *E*-penta-1,3-diene < *E*-1-methoxybuta-1,3-diene

(b) *E*-penta-1,3-diene < *E*-1-chlorobuta-1,3-diene < *E*-1-methoxybuta-1,3-diene

(c) *E*-1-methoxybuta-1,3-diene < *E*-1-chlorobuta-1,3-diene < *E*-penta-1,3-diene

(d) *E*-1-methoxybuta-1,3-diene < *E*-penta-1,3-diene < *E*-1-chlorobuta-1,3-diene

Q.48 The allowed transition in an atomic system is

(a) $^3F_4 \rightarrow {}^3D_3$ (b) $^3F_4 \rightarrow {}^1D_3$ (c) $^3F_4 \rightarrow {}^3P_4$ (d) $^3F_4 \rightarrow {}^3D_2$

Q.49 The total number of symmetry elements in diborane molecule is

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

Q.50 A physical observable, 'x', appears with the probability distribution $e^{(-|2x-12|)}$. The average of 'x' would be

(a) 0 (b) 3 (c) 6 (d) 12

Q.51 The rotational partition function is expected to be the smallest for the molecule, among the following,

(a) H_2 (b) Li_2 (c) N_2 (d) F_2

Q.52 If the half-life of a reaction is inversely proportional to the square of the concentration of the reactant, the order of the reaction is

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

Q.53 The degree of polymerisation (<N>) and the fraction of monomer consumed (P) for a polymerisation reaction are related as

(a) $< N > = \frac{1}{1-P}$ (b) $< N > = \frac{1}{1+P}$ (c) $< N > = \frac{1}{P}$ (d) $< N > = \frac{1}{P^2}$

Q.54 The correct match for the compounds in Column I with the property Column II is

	Column I		Column II
P	Dichlorodifluoromethane	i	Anti-inflammatory
Q	Sulfadiazine	ii	Insecticidal
R	Cortisone	iii	Antibacterial
S	Hexachlorobenzene	iv	Ozone layer depletion

(a) P – ii; Q – I; R – iv; S – iii (b) P – iv; Q – i; R – ii; S – iii

(c) P – i; Q – iii; R – ii; S – iv (d) P – iv; Q – iii; R – i; S – ii

Q.55 For a particle of mass m in a one-dimensional box of length $2L$, the energy of the level corresponding to $n = 8$ is

(a) $\frac{h^2}{8ml^2}$ (b) $\frac{h^2}{32ml^2}$ (c) $\frac{4h^2}{ml^2}$ (d) $\frac{2h^2}{ml^2}$

Q.56 The correct statement about HCl and DCl, among the following, is

(a) DCl has a smaller zero-point energy than HCl

(b) HCl has a smaller vibration frequency than DCl

(c) The force constant k of the HCl bond is half that of DCl

(d) The reduced mass of DCl is smaller than that of HCl

Q.57 The electrical double layer model among the following the consists of both foxed and diffuse layers is

(a) Helmholtz (b) Gouy (c) Stern (d) Debye-Hückel

Q.58 The lowest energy unnormalized wave function of H_2^+ molecule is (r_1 and r_2 are the distance between the electron and nuclei 1 and 2, respectively)

(a) $\psi = (e^{-r_1/a_0} + e^{-r_2/a_0})$ (b) $\psi = (e^{-r_1/a_0} - e^{-r_2/a_0})$

(c) $\psi = e^{-r_1/a_0}$ (d) $\psi = e^{-r_2/a_0}$

Q.59 Nearest neighbour distance in a crystal system of side length a is $\frac{a}{\sqrt{2}}$ in

(a) Face-centered cube (b) Body-centered cube (c) Trigonal primitive (d) Primitive cube

Q.60 One mole a mono-atomic ideal gas is transformed from 300 K and 2 atm to 600 K and 4 atm. The entropy change for this process is

(a) $\frac{3}{2}Rln2$ (b) $\frac{1}{2}Rln2$ (c) $\frac{7}{2}Rln2$ (d) $\frac{5}{2}Rln2$

Section-C

Q.61 The cations formed upon dissolving SnF_4 and AuF_3 in liquid BrF_3 separately, respectively are

(a) SnF_3^+ and BrF_2^+ (b) BrF_2^+ and AuF_2^+ (c) BrF_2^+ only (d) SnF_3^+ and AuF_2^+

Q.62 Consider the following reactions.

The reaction(s) which will not produce ethane as a product is/are

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

Q.63 Donor mode of NO ligand depends on metal. Now consider the following complexes (in gaseous state).

A. $[IrCl(CO)(PPh_3)_2(NO)]^+$ B. $[RuCl(PPh_3)_2(NO)_2]^+$

C. $[Co(NCS)(diars)_2(NO)]^+$ where diars = *o*-$(Me_2As)_2C_6H_4$ D. $[Cr(CN)_5(NO)]^{3-}$

The complexes that do not exhibit bent NO coordination is/are

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

Q.64 An aqueous solution of metal ion (A) gives a blood-red coloured product (B) upon reaction with KSCN. Upon dropwise addition of NaF, the complex turns to a colourless compound (C). Identify A, B and C.

(a) aq.Fe(II), $[Fe(SCN)(H_2O)_5]^+$ and $[Fe(H_2O)_6]^{2+}$ (b) aq.Fe(III), $[Fe(SCN)(H_2O)_5]^+$ and $[FeF_6]^{2+}$

(c) aq.Fe(II), $[Fe(SCN)(H_2O)_5]^+$ and FeF_3 (d) aq.Fe(III), $[Fe(SCN)_3(H_2O)_3]^+$ and FeF_3

Q.65 Considering σ-bonding only, in the MO diagram of a metal complex with trigonal bipyramidal (TBP) geometry, the d-orbitals which remain non-bonding are:

(a) d_{z^2} and d_{xz} (b) d_{xz} and d_{yz} (c) $d_{x^2-y^2}$ and d_{xz} (d) d_{z^2} and d_{yz}

Q.66 Choose the correct statement/s among the following:

(i) LiF is more soluble than $LiClO_4$ in water.

(ii) The standard reduction potential [E^0] of Li is more negative than that of Na.

(iii) The heat of hydration of $Li^+(g)$ is grater than that of $Na^+(g)$

(a) (i) and (ii) (b) (i) and (iii) (c) (ii) and (iii) (d) (iii) only

Q.67 Choose the correct statement/s among the following:

(i) The dihedral angle in O_2F_2 is 0°.

(ii) OF_2 is generally prepared by reacting fluorine gas with dilute (2%) aq. NaOH solution.

(iii) O_2F_2 can be readily reduced by H_2S.

(a) (i) and (ii) only (b) (i), (ii) and (iii) (c) (ii) and (iii) only (d) (ii) only

Q.68 The correct set of information is

(a) $[Mn(H_2O)_6]^{2+}$: $\mu_{observed} = \mu_{spin}$; $[Co(H_2O)_6]^{3+}$: Paramagnetic

(b) $[Mn(H_2O)_6]^{2+}$: $\mu_{observed} > \mu_{spin}$; $[Co(H_2O)_6]^{3+}$: Diamagnetic

(c) $[Mn(H_2O)_6]^{2+}$: $\mu_{observed} = \mu_{spin}$; $[Co(H_2O)_6]^{3+}$: Diamagnetic

(d) $[Mn(H_2O)_6]^{2+}$: $\mu_{observed} > \mu_{spin}$; $[Co(H_2O)_6]^{3+}$: Paramagnetic

Q.69 Consider the following statements regarding electronic spectra of high spin complexes

A. Ti^{3+} complexes exhibit one sharp band.

B. $Co^{2+}$and Cr^{3+} complexes exhibit two broad bands.

C. Mn^{2+} complexes exhibit a series of very weak and sharp bands.

D. Ni^{2+} complexes exhibit three broad bands.

The correct statements are:

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

Q.70 Match the appropriate geometry on the right with each of the species on the left:

(A)	$FXeO(OSO_2F)$	(i)	Linear
(B)	$FXeN(SO_2F)_2$	(ii)	Pyramidal
(C)	XeO_3	(iii)	T-shaped
(D)	$XeOF_2$	(iv)	Bent

(a) (A)-(i), (B)-(i), (C)-(ii), (D)-(iii) (b) (A)-(i), (B)-(i), (C)-(ii), (D)-(iv)

(c) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii) (d) (A)-(i), (B)-(iv), (C)-(ii), (D)-(iii)

Q.71 Hydrolysis of *trans* – $[Co\ L\ Cl(en)_2]^+$ (L=NO_2^-, NCS^-, OH, Cl^-) results in a product (A). The tendency to form *cis*-isomer of the product (A) follows the order

(a) $L = NO_2^- < NCS^- < OH < Cl^-$ (b) $L = NO_2^- < Cl^- < NCS^- < OH$

(c) $L = OH < Cl^- < NO_2^- < NCS^-$ (d) $L = OH < NCS^- < Cl^- < NO_2^-$

Q.72Among the following reactions, those that are feasible in liquid NH_3 are

(i) $KNO_3 + AgCl \rightarrow KCl + AgNO_3$

(ii) $NH_4Br + KNH_2 \rightarrow KBr + 2NH_3$

(iii) $Fe(CO)_5 + 2e^- \rightarrow [Fe(CO)_4]^{2-} + CO$

(a) (i), (ii), and (iii) (b) (i) and (ii) only (c) (i) and (iii) only (d) (ii) and (iii) only

Q.73 The correct statements about $[Ru_6C(CO)_{17}]$ cluster from the following

(a) it is an 86 electron cluster

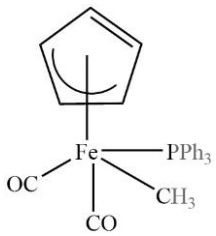
(b) it is a *closo* structure type

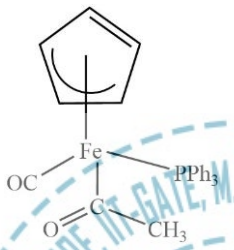
(c) its shape is capped square pyramid

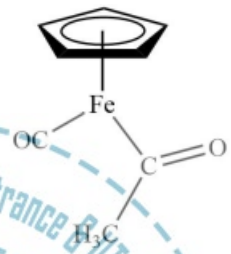
(d) carbon interacts with all the Ru centers in the cluster are

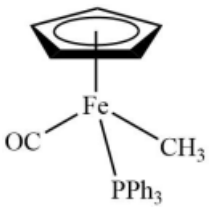
(a) a, b, c and d (b) a and b only (c) a, b and c (d) a, b and d

Q.74 A plausible structure of the *intermediate* involved in the following reaction is

(a) 

(b) 

(c) 

(d) 

Q .75 In the synthesis of polydimethylsiloxane, the chain forming, branching and terminating agents respectively, are

(a) Me_2SiCl_2, Me_3SiCl and $MeSiCl_3$ (b) Me_2SiCl_2, $MeSiCl_3$ and Me_3SiCl

(c) MeSiCl3, Me2SiCl2 and Me_3SiCl (d) Me_2SiCl_2, Me_3SiCl and Me_4Si

Q.76 The set among the following in which all numbers are magic numbers of nucleons is

(a) 20, 28, 50 and 126 (b) 24, 28, 82 and 126 (c) 20, 50, 80 and 184 (d) 28, 50, 82 and 180

Q.77 Incorrect statement for amperometric titration is

(a) It is based on measurement of diffusion current

(b) Its sensitivity is always higher than those of spectrophotometric titrations

(c) It does not generally require an indictor

(d) It requires inert atmosphere (N_2/Ar)

Q.78 Consider the following statements with respect to cytochrome P-450

A. It has histidine coordinated to iron centre.

B. It is a membrane bound metalloenzyme

C. It has Fe(III) ion in the resting state of the enzyme

The correct statement(s) is/are

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

Q.79 Consider the following transformation reactions in the context of co-enzyme B_{12}

A. 1,2-Carbon shift B. Hydration of CO_2 C. Benzene to phenol

D. Dimethyl sulphide to dimethyl sulfoxide

The correct statement(s) for co-enzyme B_{12} is/are

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

Q.80 The correct statement(s) regarding B among the following

(i) Nuclear spin of ^{11}B is grater than that of ^{10}B

(ii) The polarities of B-H bond and C-H bonds are opposite

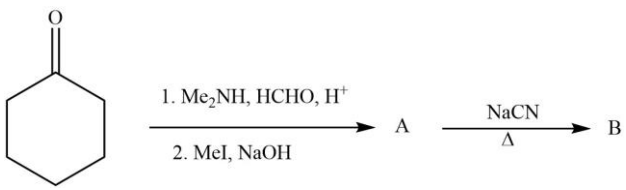
(iii) Cross-section of neutron absorption for ^{10}B is much more than that of ^{11}B

(iv) B reacts with boiling aq. NaOH solution to form $NaB(OH)_4$

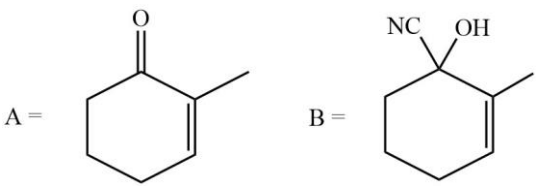
are

(a) (ii) and (iii) (b) (i) and (ii) (c) (iii) and (iv) (d) (ii) and (iv)

Q.81 The major products A and B in the following reaction sequence are



(a)



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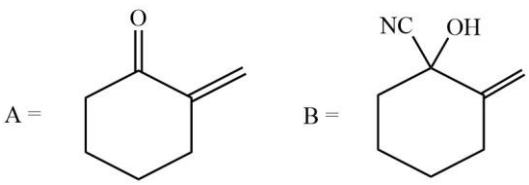

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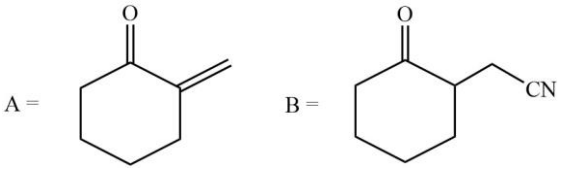

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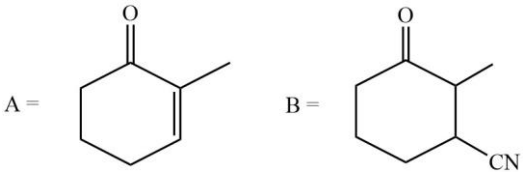
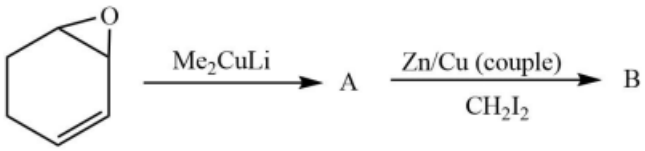
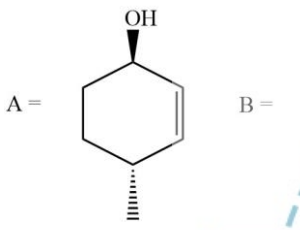


Q.82 The major products A and B in the following reaction sequence are



(a)



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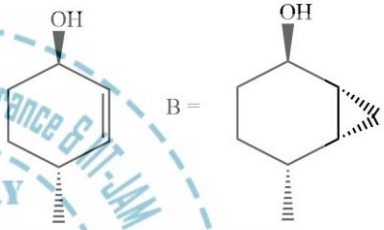

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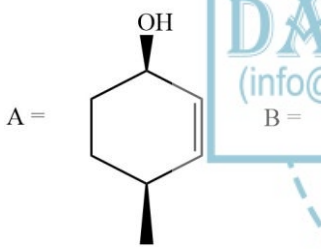

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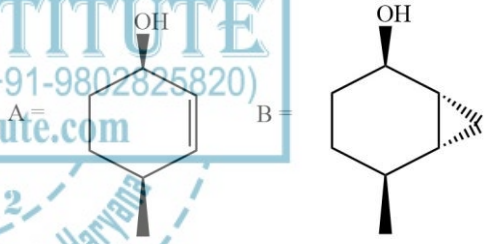
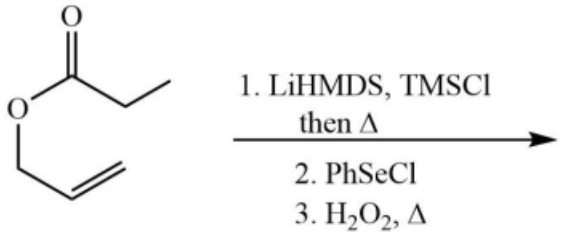
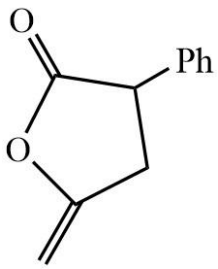
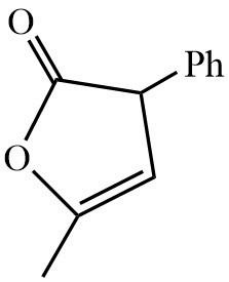
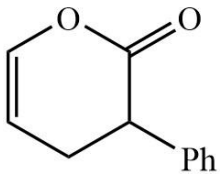


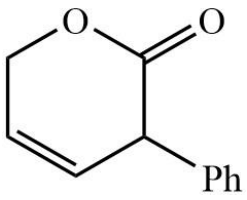
Q.83 The major product in the following reaction is



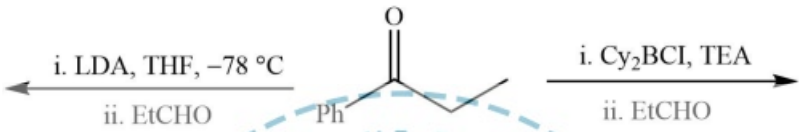
(a) 

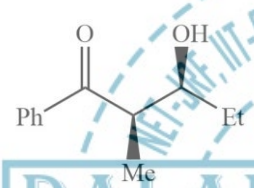
(b) 

(c) 

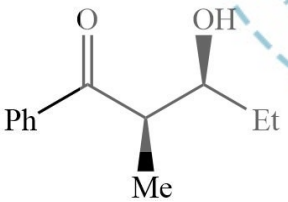
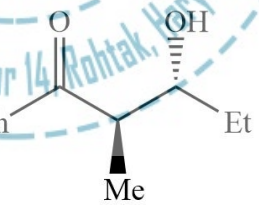
(d) 

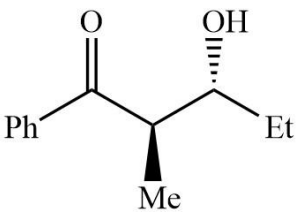
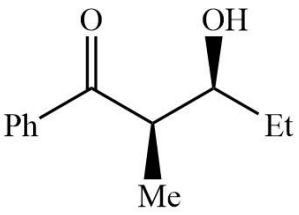
Q.84 The major products A and B in the following reaction sequence are



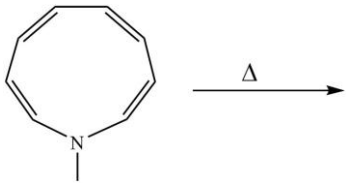
(a) A = B = 

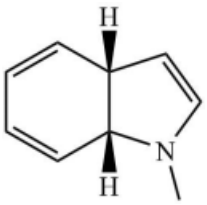
(b) A = B = 

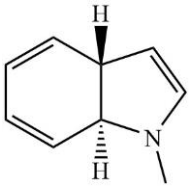
(c) A =  B = 

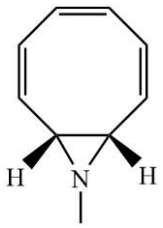
(d) A =  B = 

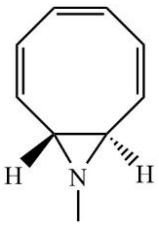
Q.85 The major product in the following reaction is



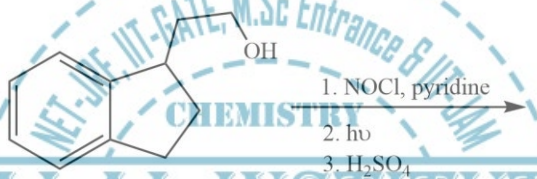
(a) 

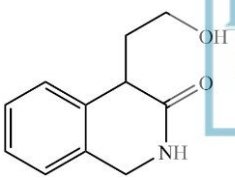
(b) 

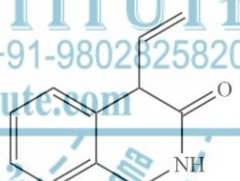
(c) 

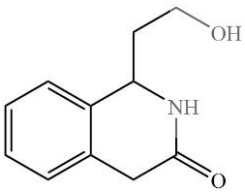
(d) 

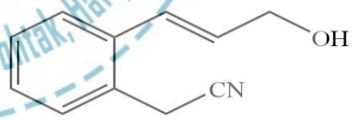
Q.86 The major product in the following reaction is



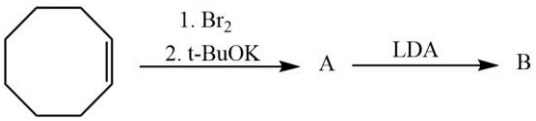
(a) 

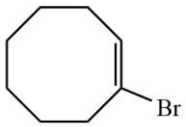
(b) 

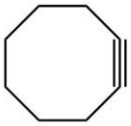
(c) 

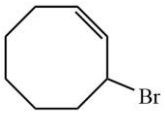
(d) 

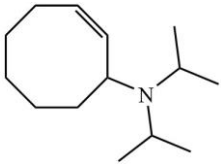
Q.87 The major products A and B in the following reaction sequence are

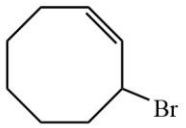


(a) A = 

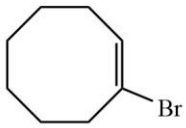
B = 
cyclooctyne

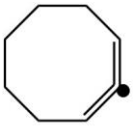
(b) A = 

B = 

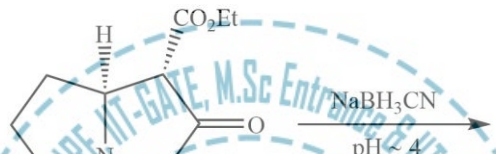
(c) A = 

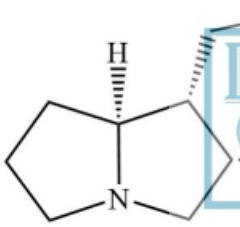
B = 
cyclooct-1,2-diene

(d) A = 

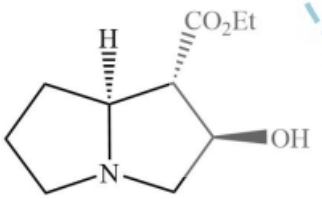
B = 
cyclooct-1,2-diene

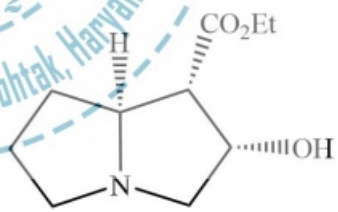
Q.88 The major product in the following reaction is



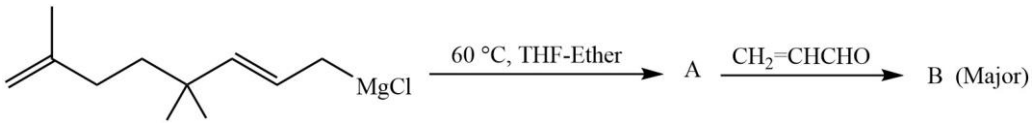
(a) 

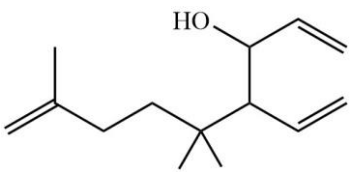
(b) 

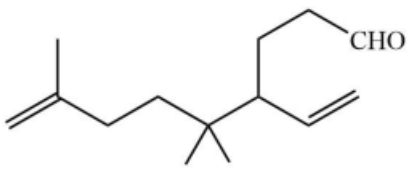
(c) 

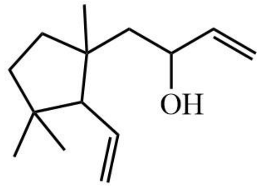
(d) 

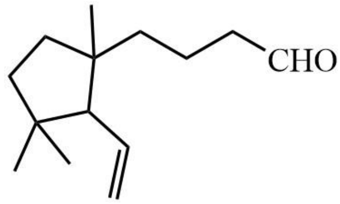
Q.89 The structure of product B formed in the following reaction sequence is



(a) 

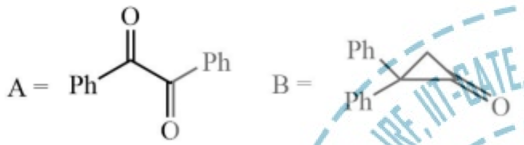
(b) 

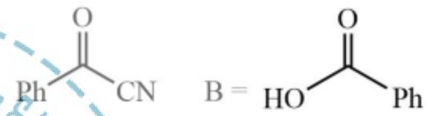
(c) 

(d) 

Q.90 The major products A and B in the following reaction sequence are

$$2PhCHO \xrightarrow[2.\ MnO_4]{1.\ NaCN} A \xrightarrow{NaOH} B$$

(a) 

(b) 

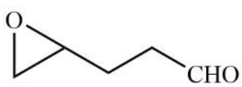
(c) 

(d) 

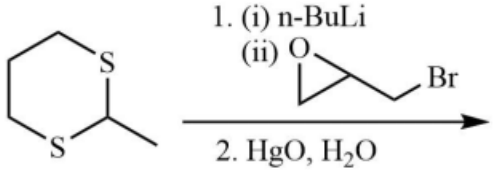
Q.91 Reaction of styrene ($PhCH=CH_2$) with HBr gives a mixture of regioisomers A (major) and B (minor). The ^1H NMR spectrum of the mixture shows four signals, amongst others, at δ 5.17, 3.53, 3.15 and 2.00 ppm with relative integration of 2:1:1:6, respectively. The molar ratio of A and B is

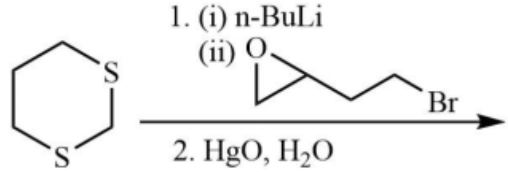
(a) 3:2 (b) 4:1 (c) 2:1 (d) 3:1

Q.92 The correct sequence of reactions for the preparation of A is

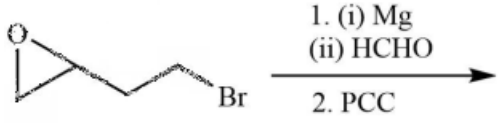


A

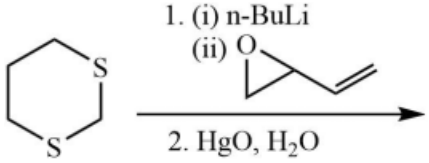
(a) 

(b) 

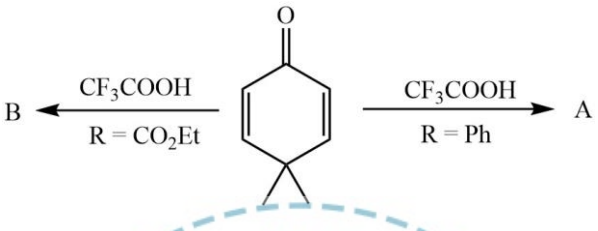
(c)



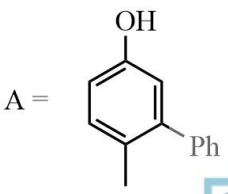
(d)

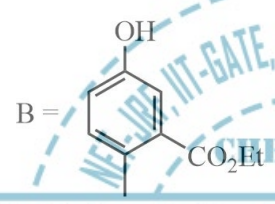


Q.93 Structures of A and B in the following reactions are

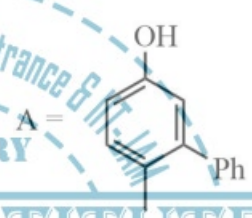


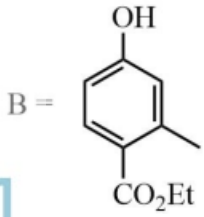
(a)



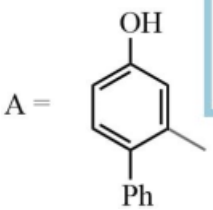


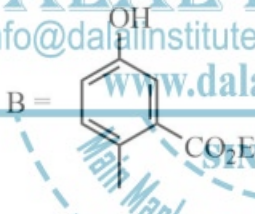
(b)



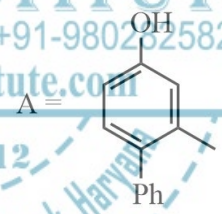


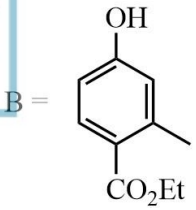
(c)



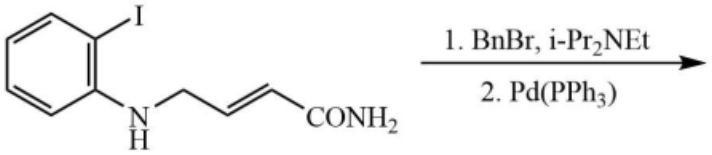


(d)

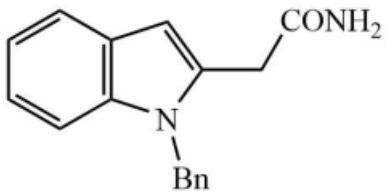




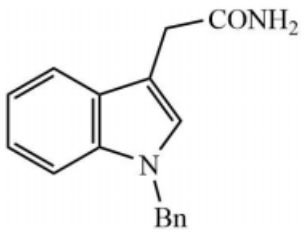
Q.94 The major product in the following reaction is

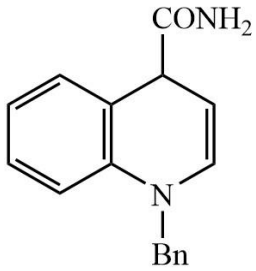


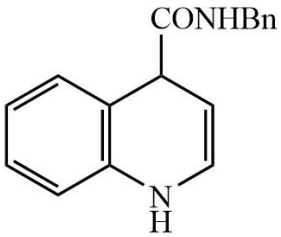
(a)



(b)

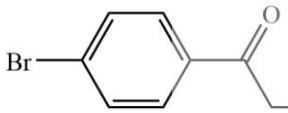


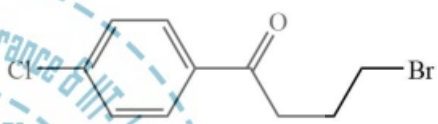
(c) 

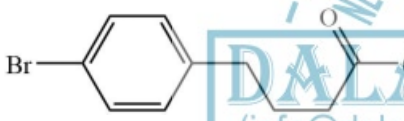
(d) 

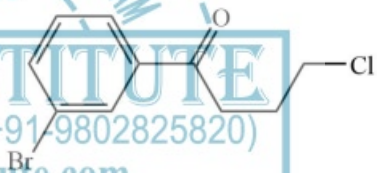
Q.95 The compound that exhibits following spectral data is

IR: (ν) 1685 cm^{-1}; ^1H NMR: δ 7.84 (d, J = 8Hz, 2H), 7.60 (d, J = 8Hz, 2H), 3.65 (t, J = 7Hz, 2H), 3.18 (t, J = 7Hz, 2H), 3.65 (pentet, J = 7Hz, 2H) ppm; ^{13}C NMR: δ 28, 36, 45, 128, 130, 133, 137, 197 ppm; EIMS m/z: 200, 198, (1:1), 185, 183(1:1)

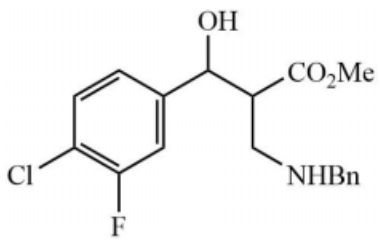
(a) 

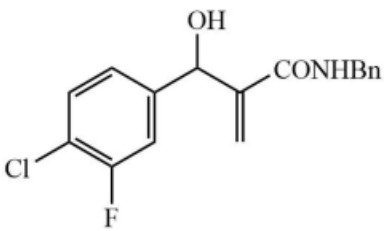
(b) 

(c) 

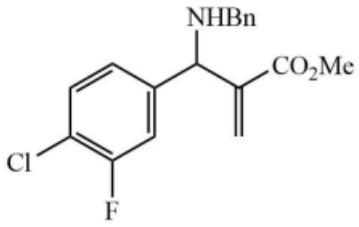
(d) 

Q.96 The major product of the following reaction sequence is

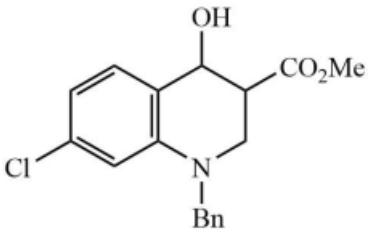
(a) 

(b) 

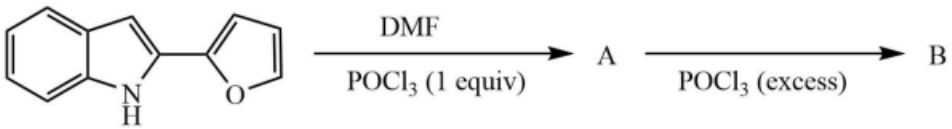
(c)



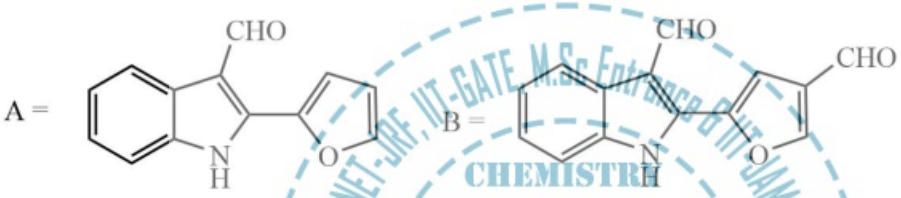
(d)



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

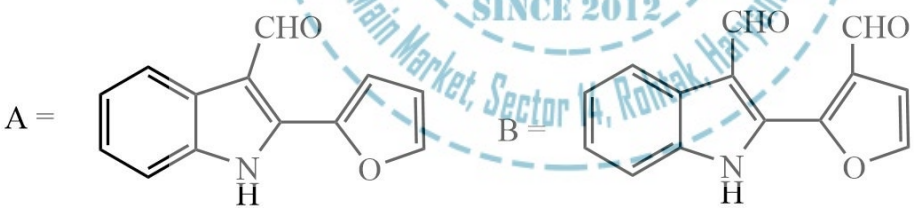


(a)



(b)

(c)



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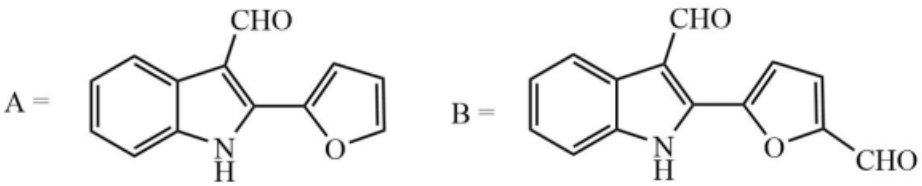
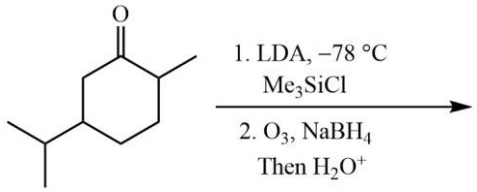
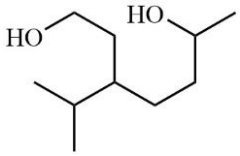
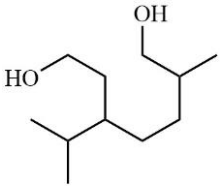
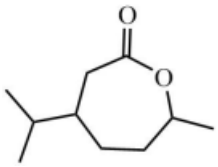


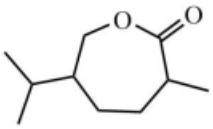
Q.98 The major product in the following reaction is



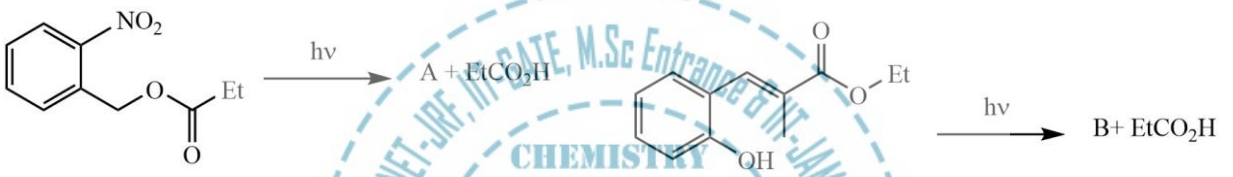
(a) 

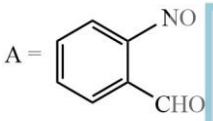
(b) 

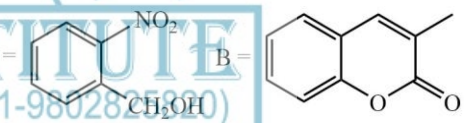
(c) 

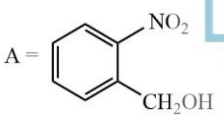
(d) 

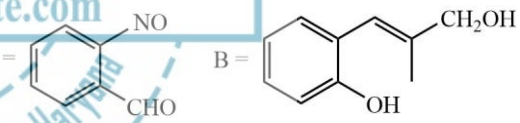
Q.99 Structures of the products A and B in the following photo-deprotection reactions are



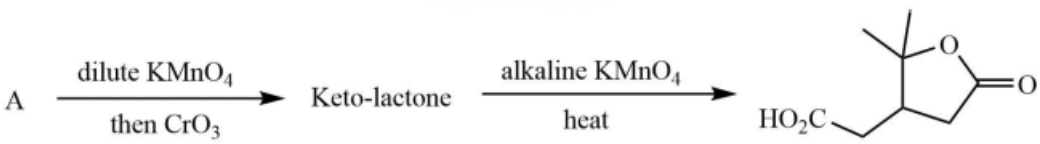
(a) 

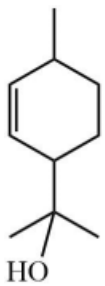
(b) 

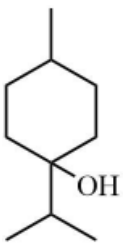
(c) 

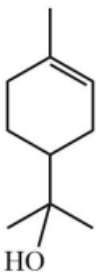
(d) 

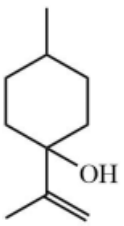
Q.100 Structure of the monoterpene A that undergoes following degradation is



(a) 

(b) 

(c) 

(d) 

Q.101 The correct relationship among the following, for a tetragonal ($a = b \neq c$; $\alpha = \beta = \gamma = 90°$) crystal system, is

(a) $sin^2\theta = \frac{\lambda^2}{4a^2}[c^2(h^2 + k^2) + a^2l^2]$ (b) $sin^2\theta = \frac{\lambda^2}{4a^2c^2}[c^2(h^2 + k^2) + a^2l^2]$

(c) $sin^2\theta = \frac{\lambda^2}{4c^2}[a^2(h^2 + k^2) + c^2l^2]$ (d) $sin^2\theta = \frac{\lambda^2}{4a^2}[h^2 + k^2 + l^2]$

Q.102 If the overpotential of an electrolysis process is increased from 0.5V to 0.6V, then the ratio of current densities $\left(ln\frac{J_{0.6}}{J_{0.5}}\right)$ of the electrolysis will be equal to (given transfer co-efficient =0.5)

(a) $0.5\frac{F}{RT}$ (b) $0.05\frac{F}{RT}$ (c) $0.1\frac{F}{RT}$ (d) $0.01\frac{F}{RT}$

Q.103 A non-ideal gas follows the equation

$$P = \frac{RT}{V_m}\left[1 + \frac{B}{V_m}\right]$$

Where B is a function of temperature only. The deviation in internal energy from that of an ideal gas, $U - U_{ideal}$, is given by

(a) $\frac{-RT}{V_m}\left(\frac{\partial B}{\partial T}\right)_V$ (b) $\frac{-RT^2}{V_m}\left(\frac{\partial B}{\partial T}\right)_V$ (c) $\frac{-RT^2}{V_m}B$ (d) $\frac{-RT}{V_m}B$

Q.104 The gas phase decomposition of A at 1000K follows two decomposition paths

	Elementary process	Rate constant
(i)	$A \rightarrow B + C$	3 s^{-1}
(ii)	$A \rightarrow P + Q$	5 s^{-1}

The maximum theoretical percentage yield of P at 1000K is

(a) 62.5 (b) 60 (c) 166 (d) 37.5

Q.105 Photochemistry of a molecule, M, is described as by the mechanism

	Elementary process	Rate
(i)	$M + h\nu \rightarrow M^*$	I_{abs}

(ii)	$M^* + Q \rightarrow M + Q$	$k_Q[Q][M^*]$
(iii)	$M^* \rightarrow M + h\nu_F$	$0.2[M^*]$

The intercept at [Q] = 0 is 4 for the inverse of fluorescence intensity ($1/I_F$)*vs*[Q] plot. The value of I_{abs} is

(a) 4 (b) 0.25 (c) 20 (d) 0.8

Q.106 The chemical potential (μ) of a 2 molar Na_2SO_4 solution is expressed in terms of mean ionic activity co-efficient ($\gamma_\pm$) as

(a) $\mu^0 + 5RTln2 + 3RTln\gamma_\pm$ (b) $\mu^0 + 3RTln2 + 3RTln\gamma_\pm$

(c) $\mu^0 + 3RTln\gamma_\pm$ (d) $\mu^0 + 4RTln\gamma_\pm$

Q.107 The Birge-Sponer plot between $\Delta G_{v+\frac{1}{2}} = (\varepsilon_{v+1} - \varepsilon_v)$ and $(v + 1)$ for CO is a straight line with slope of –14 cm^{-1} and intercept of 2170 cm^{-1}. The approximate value of dissociation energy of CO (in cm^{-1}) is (assume CO as an anharmonicoscillater with energy expression $\varepsilon_v = \left(v + \frac{1}{2}\right)\omega - \left(v + \frac{1}{2}\right)^2 x_e\omega$; D = $\frac{\omega}{4x_e}$

(a) 42044 (b) 84088 (c) 168175 (d) 336350

Q.108 The energy functional form a trial wave function is

$$E(\alpha) = (\alpha^2 - 3\alpha)/6$$

The variationally optimized energy is

(a) $-\frac{1}{2}$ (b) $-\frac{3}{8}$ (c) $\frac{3}{2}$ (d) $-\frac{3}{8}$

Q.109 A satisfactory spin wave function for an excited helium atom is

(a) $\frac{1}{\sqrt{2}}[\alpha(1)\beta(2) - \alpha(2)\beta(1)]$ (b) $\alpha(1)\beta(2)$

(c) $\frac{1}{\sqrt{2}}[\alpha(1)\alpha(2) + \beta(2)\beta(1)]$ (d) $\alpha(2)\beta(1)$

Q.110 For a linear molecule the mean energies for translation, rotation (T >> θ_R) and vibration (T >> θ_v) follow ratio:

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

Q.111 The highest energy π – molecular orbital for the allyl system is

(a) $\frac{1}{\sqrt{2}}\chi_1+\Gamma\chi_2+\frac{1}{\sqrt{2}}\chi_3$ (b) $\frac{1}{\sqrt{2}}\chi_1-\frac{1}{\sqrt{2}}\chi_3$

(c) $\frac{1}{2}\chi_1-\frac{1}{\sqrt{2}}\chi_2+\frac{1}{2}\chi_3$ (d) $\frac{1}{\sqrt{2}}\chi_1-\frac{1}{2}\chi_2-\frac{1}{\sqrt{2}}\chi_3$

Q.112 An unnormalized wave function of the hydrogen atom is given by $r^2e^{-\frac{r}{3}}(3cos^2\theta-1)$. The three quantum numbers *n*, *l* and *m* associated with this orbital are, respectively

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

Q.113 The π-orbital $p_1+p_2-p_3-p_4$ of cis-butadiene belongs to the irreducible representation

C_{2v}	E	C_2	σ_v	σ_v'
A_1	1	1	1	1
A_2	1	1	−1	−1
B_1	1	−1	1	−1
B_2	1	−1	−1	1

(a) A_1 (b) A_2 (c) B_1 (d) B_2

Q.114 The number of times the A_1 representation appears in the representation Γ of the C_{2v} point group given below is

C_{2v}	E	C_2	σ_v	σ_v'
Γ	3	1	1	3

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

Q.115 The population of protons spins in the highest energy level of a sample in magnetic fields of 1.5 T and 7.0 T are *N'* and *N*, respectively. The value of ln $\frac{N'}{N}$ is (γ, *h, k, T* are gyromagnetic ratio of the proton, Plank's constant and temperature of the sample, respectively; assume that the partition functions for both systems can be approximated as 1)

(a) $5.5\gamma\hbar/kT$ (b) $\frac{3}{14}\gamma\hbar/kT$ (c) $\frac{14}{3}\gamma\hbar/kT$ (d) $8.5\gamma\hbar/kT$

Q.116 The difference between standard molar entropies of two mono-atomic gases A and B ($S^0_{m,A} - S^0_{m,B}$) at a given temperature is (given that a molar mass of A is twice the molar mass of B)

(a) 3/2Rln2 (b) Rln2 (c) 5/2Rln2 (d) 7/2Rln2

Q.117 Above the critical micelle concentration (CMC), the option which correctly describes the variation of molar conductivity with increase in concentration of sodium dodecylsulphate in aqueous solution is

(a) molar conductivity increases sharply, but the solution does not remain colloidal

(b) molar conductivity decreases sharply, but the solution remains colloidal

(c) molar conductivity decreases sharply and dissociation into monomer also occurs sharply

(d) molar conductivity increases sharply with large loss of entropy

Q.118 When two moles of liquid A are mixed with two moles of liquid B at 300K, the excess molar Gibbs free energy of solution is –1.5 kJ mol^{-1}. The corresponding value of Gibbs free energy of mixing(in kJ) is closest to

(a) –12.9 (b) –6.0 (c) –1.5 (d) –0.9

Q.119 A sample of 2.0 moles of O_2(g) (assumed ideal) at 500K is expressed from 5 L to 50 L under adiabatic and reversible conditions. The change in its internal energy (in kJ) is

(R= 8.314J K^{-1} mol^{-1}; $C_{V,m} = \frac{5}{2}R$)

(a) –22.5 (b) –12.5 (c) –19.1 (d) –7.5

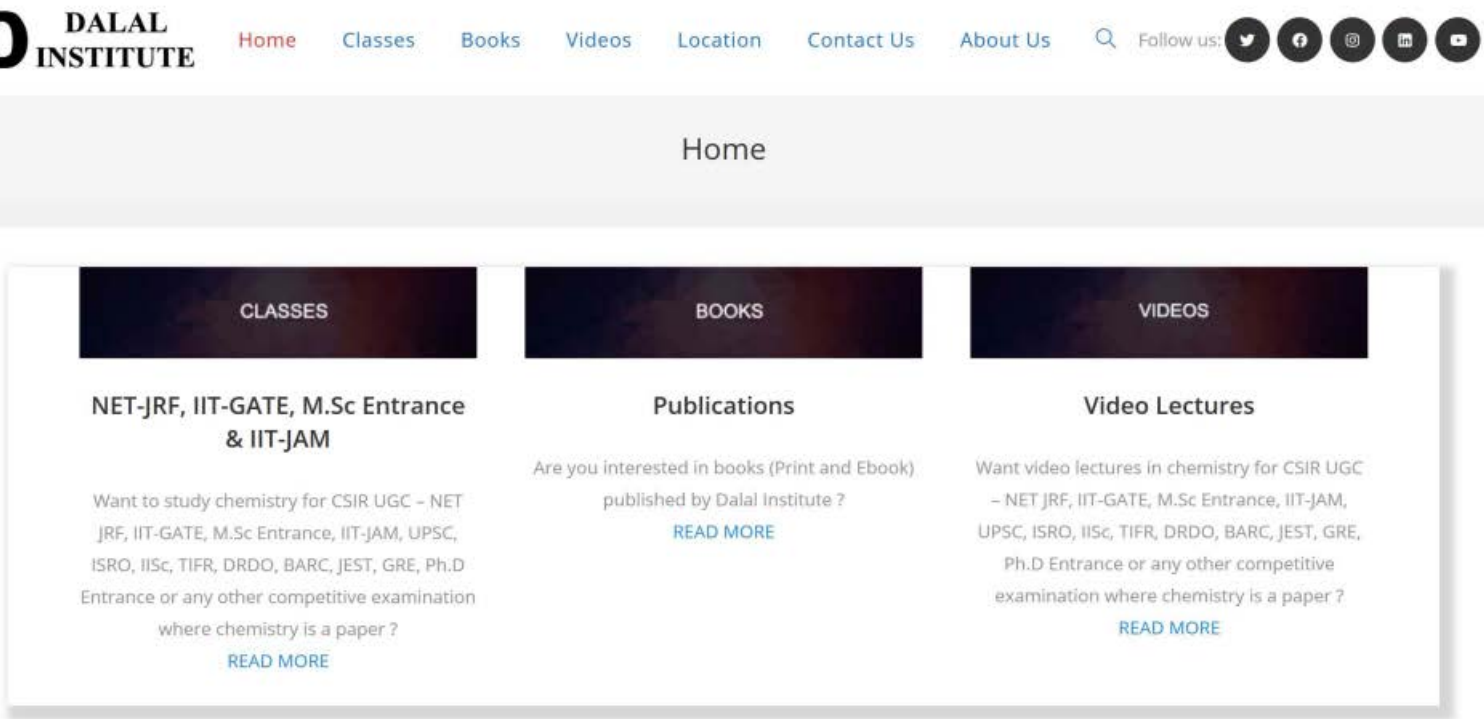
Q.120 The reaction rate of a self-catalyzed polyesterification reaction is given as $-\frac{d[COOH]}{dx} = k[COOH]^2[OH]$. If $[M]_0$ is the initial concentration of hydroxyl and carbonyl monomer, then the degree of polymerisation, <N> is given by

(a) $<N> = 2[M]_0^2 kt$

(b) $< N >^2 = 2[M]_0^2 kt$

(c) $< N >^2 = 2[M]_0^2 kt+1$

(d) $< N >^2 = 2[M]_0 kt+1$



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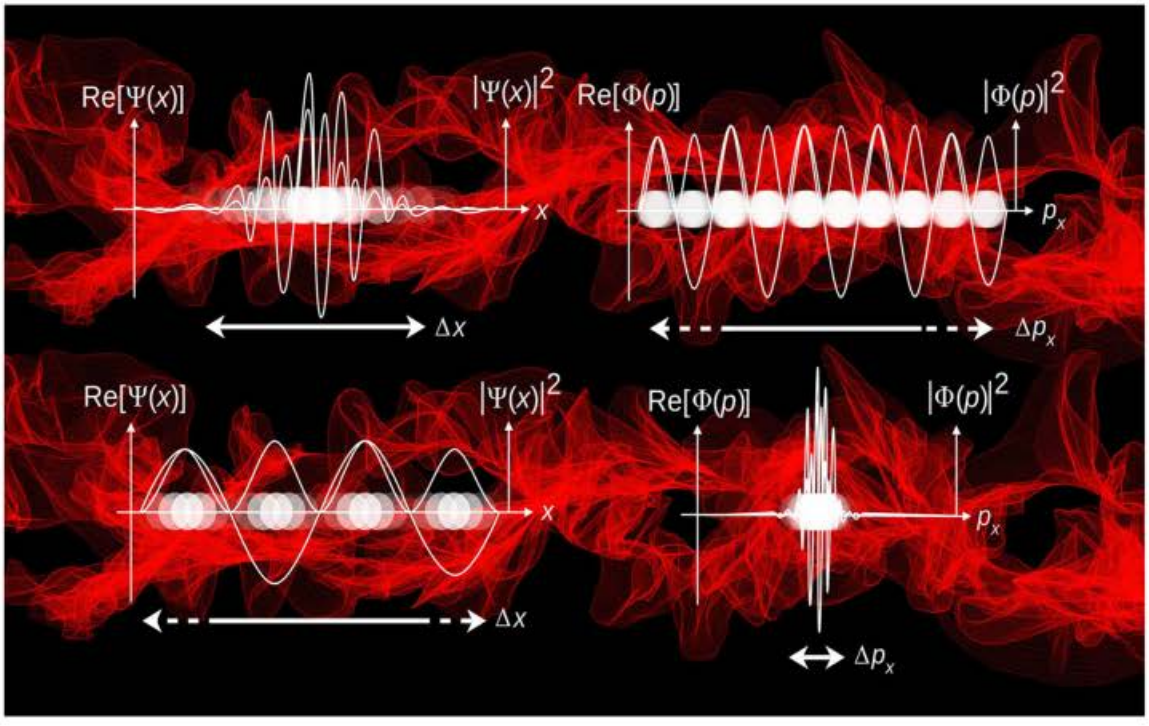

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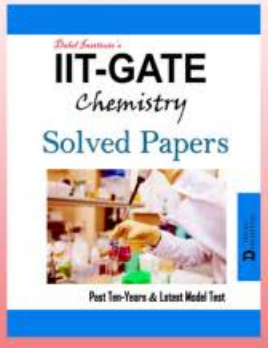

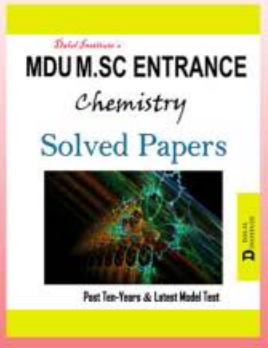

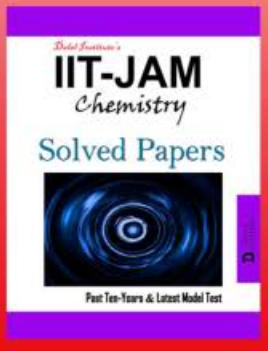

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