CSIR UGC – NET JRF: December 2018

Chemical Science

❖ Question Paper

Section-A

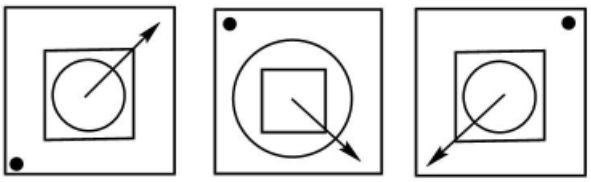
Q.1 A mineral contains a cubic and spherical cavity. The length of the side of the cube is the same as the diameter of the sphere. If the cubic cavity is half filled with a liquid, what is the approximate ratio of the volume in liquid cavity to that in the cubic cavity to that in spherical cavity?

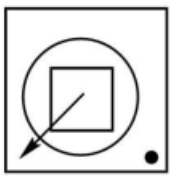
(a) 2:1 (b) 1:1 (c) 1:2 (d) 1:4

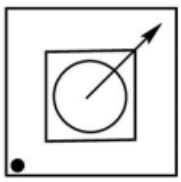
Q.2 Out of 6 unbiased coins, 5 are tossed independently and they all result in heads. If the 6^{th} is now independently tossed, the probability of getting head is

(a) 1 (b) 0 (c) 1/2 (d) 1/6

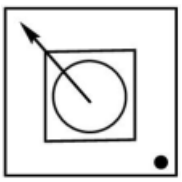
Q.3 What could the forth figure in the sequence be?



(a) 

(b) 

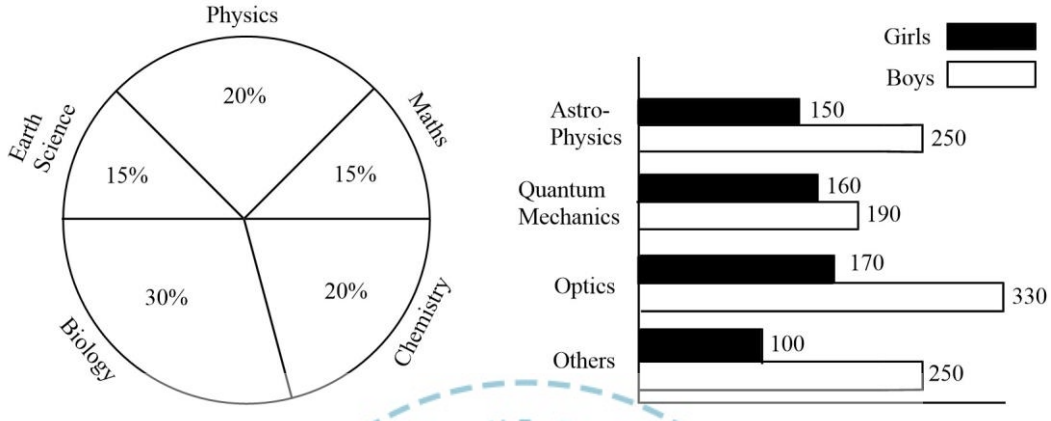
(c) 

(d) 

Q.4 The average age of A, B and C, whose ages are integers x, y and z respectively ($x \leq y \leq z$), is 30. If the age of B is exactly 5 more than that of A, what is the minimum possible value of z?

(a) 31 (b) 33 (c) 35 (d) 37

Q.5 Percentage-wise distribution of all science students in a university is given in the pie-diagram. The bar chart shows the distribution of physics student in different sub-areas, where a student takes one and only one sub-area. What percentage of the total students is girls studying quantum mechanics?



(a) 10 (b) 1 (c) 0.2 (d) 2

Q.6 What is the total number of parallelograms in the given diagram?

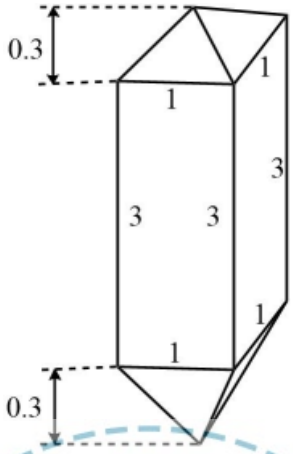
(a) 27 (b) 24are shown (c) 22 (d) 14

Q.7 Election results of a city, which contains 3 segments (A, B and C) are given in the table. Percentage votes obtained by parties X, Y and Z are shown below. Which party won the election?

Segment	Total voters	% of voting	X	Y	Z
A	2,00,000	60	30	30	40
B	2,50,000	70	40	30	30
C	3,00,000	80	30	40	30

(a) X (b) Y (c) Z (d) It was a tie between X and Y

Q.8 The diagram shows the dimensions (in cm) of a zircon crystal having a square prism and two identical square pyramids. What is the volume of this crystal (in cm^3)?



(a) 3.2 (b) 3.6 (c) 6.4 (d) 7.2

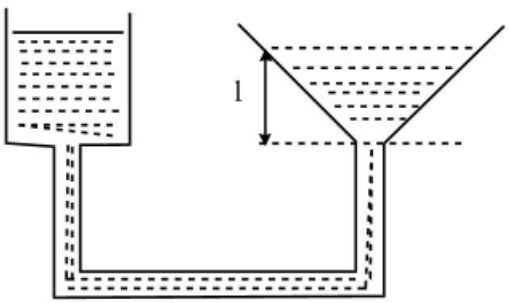
Q.9 A boy throws a ball with a speed v at a vehicle that is approaching him with a speed V. After bouncing from the vehicle, the ball hits the boy with a speed

(a) v (b) $v + V$ (c) $v + 2V$ (d) $v + 4V$

Q.10 Four friends were sharing a pizza. They decided that the oldest friend will get extra piece of pizza. Bahu is two months older than Kattappa, who in turn is three months younger than Bhalla. Devsena is one month older than Kattappa. Who should get the extra piece of pizza?

(a) Bahu (b) Devsena (c) Bhalla (d) Kattappa

Q.11 A funnel is connected to a cylindrical vessel of cross-sectional area A shown, to make an interconnected system of vessel. Water is poured in the cylinder such that the height of water in the funnel is l as shown. If the level of water in the cylindrical vessel is pushed down by a distance x << l, levels of water in the funnel:



(a) remains unchanged

(b) rises by $\frac{Ax}{\pi l^2}$

(c) rises by $\frac{\pi l^2}{Ax}$

(d) rises by $\frac{Ax^2}{\pi^2 l^4}$

Q.12 Marks (out of 30) of seven students in an examination are 4, 15, 6, 7, 5, a and b, where a (>0) is a multiple of 4and b is a prime. What is the maximum possible value of the difference between the maximum and minimum marks?

(a) 25 (b) 26 (c) 27 (d) 29

Q.13 Two persons A and B start walking in opposite directions from a point. A travel twice as fast as B. the speed at which B travels is 1 km/h. if A travels 2 km and turns back and starts walking towards B, at what distance from the starting point will A cross B?

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

Q.14 A person wanted to travel from Charbag to Alambag with an average speed of 60 km/h by car. The distance between Charbag and Aambag is 2 km. due to heavy traffic, he could travel at 30 km/hfor the first kilometre of his journey. What should his speed be for the remaining journey to Achieve his average speed target of 60 km/h?

(a) Cannot achieve his target with any finite speed (b) 60 km/h

(c) 90 km/h (d) 120 km/h

Q.15 The average rainfall over a given place during the three-year period of 2003-2005 was 65 cm. During the three-year period 2002-2004 the average rainfall was 63 cm. The actual rainfall during 2005 was 60 cm. What was the rainfall in 2002?

(a) 55 cm (b) 60 cm (c) 54 cm (d) 53 cm

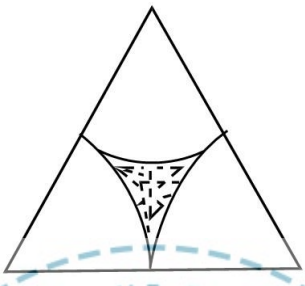
Q.16 In a four consecutive day schedule, four pilots flew fights each on a different day. Mr. A was schedule to work on Monday, but he traded with Ms. B who was originally scheduled to work on Wednesday, Ms. C traded with Mr. D, who was originally scheduled to work on Thursday. After all the switching was done, who worked on Tuesday?

(a) Mr. A (b) Mr. D (c) Ms. B (d) Ms. C

Q.17 After 6 g of carbon is completely burnt in an atmosphere of 40 g of oxygen, the percentage oxygen left is:

(a) 80 (b) 60 (c) 40 (d) 20

Q.18 What fraction of the equilateral triangle shown below with three identical sectors of a circle is shaded?



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

Q.19 How many different vegetables can be made from cauliflower, tomatoes, onions, potatoes and carrots?

(a) 16 (b) 28 (c) 31 (d) 32

Q.20 A bottle of perfume is opened and a person at a distance of 10 m gets the smell after 10 seconds. The time taken for a person 20 m away to get the smell is about

(a) 20s (b) 40s (c) 14s (d) 80s

Section-B

Q.21 The correct order of accepter ability of the phosphorus ligands is

(a) $PMe_3 > PPh_3 > P(OPh)_3 > PF_3$ (b) $PF_3 > P(OPh)_3 > PPh_3 > PMe_3$

(c) $PF_3 > PMe_3 > PPh_3 > P(OPh)_3$ (d) $P(OPh)_3 > PF_3 > PMe_3 > PPh_3$

Q.22 In the $^{31}P\{^1H\}$ NMR spectrum of a diamagnetic complex mer-$[M(PR_3)_3Cl_3]$ (M = transition metal, I = 0) expected number of resonance(s) is

(a) Three (b) One (c) Two (d) Six

Q.23 Consider the species NO, I_2, I_2^-, Cu^{2+} and VO^{2+}. The number of paramagnetic species among them and the EPR inactive species, respectively are

(a) 4 and I_2^-

(b) 4 and I_2

(c) 3 and VO^{2+}, Cu^{2+}

(d) 3 and NO, Cu^{2+}

Q.24 Identify the correct statement(s) for $H_3B{\cdot}CO$.

(A)sp^2 hybridized orbital of B accepts the lone pair of CO.

(B) Its ν_{co} value is more than that for free CO.

(C)Formal oxidation state of C is +4 in the compound.

Answer is

(a) (a) and (b)

(b) (b) only

(c) (a) only

(d) (a) and (c)

Q.25 Match the items of Column I with those of Column II.

	Column I		Column II
A.	Leaser source	i	Electron Capture Detector
B.	Thermometric titration	ii	Polarography
C.	Gelatin	iii	Heat of reaction
D.	Gas-Liquid chromatography	iv	Spectrofluorimetry

Correct answer is

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

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

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

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

Q.26 Consider compounds PF_5, SbF_5, PH_3 and SbH_3. The strongest acid and the strongest base among these are, respectively,

(a) PF_5 and PH_3

(b) SbF_5 and PH_3

(c) SbF_5 and SbH_3

(d) PF_5 and SbH_3

Q.27 $SiCl_4$, $P(O)Cl_3$, NF_3, *trans*-$[SnCl_4(py)_2]$ (py = pyridine), those with zero dipole moment are

(a) $SiCl_4$ and NF_3

(b) $SiCl_4$, $P(O)Cl_3$ and *trans*-$SnCl_4(py)_2$

(c) $SiCl_4$ and *trans*-$SnCl_4(py)_2$

(d) NF_3 and *trans*-$SnCl_4(py)_2$

Q.28 The standard reduction potential in acid medium for F_2, Cl_2, Na and Zn are in the order

(a) $F_2 > Cl_2 > Na > Zn$

(b) $F_2 > Cl_2 > Zn > Na$

(c) $Na > Zn > Cl_2 > F_2$

(d) $Cl_2 > F_2 > Zn > Na$

Q.29 The character of LUMO of CN^- and O_2 respectively, are

(a) σ_g and π_u (b) π_u and σ_g (c) π_g and σ_u (d) π_g and σ_u

Q.30 The intermediate $[Fe(SCN)(H_2O)_5]^{2+}$ is detected in the reaction of $[Co(NSC)(H_2O)_5]^{2+}$ with $[Fe(H_2O)_6]^{2+}$ in aqueous medium to produce $[Co(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{3+}$. The mechanism of the reaction is

(a) Interchange dissociative

(b) Interchange associative

(c) Inner sphere electron transfer

(d) Outer sphere electron transfer

Q.31 The chelate rings made by macrocyclic ligand in vitamin B_{12} are

(a) one five-membered and three six-membered

(b) two five-membered and two six-membered

(c) three five-membered and one six-membered

(d) four six-membered

Q.32 For magnesium complex of $EDTA^{2-}$, the number of N-donar and O-donar centers, are respectively,

(a) two and four (b) two and two (c) two and six (d) two and eight

Q.33 The correct set of electronic configurations for metal ions in octahedral coordination geometry for strong John-teller distortion is

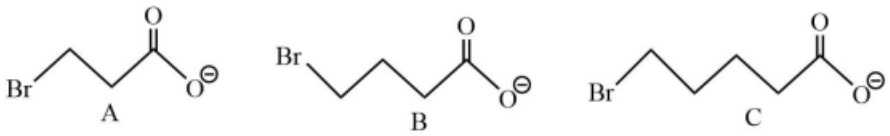
(a) $t_{2g}^6 e_g^1$, $t_{2g}^3 e_g^1$, $t_{2g}^6 e_g^3$

(b) t_{2g}^1, $t_{2g}^3 e_g^2$, $t_{2g}^6 e_g^1$

(c) t_{2g}^3, $t_{2g}^3 e_g^1$, $t_{2g}^3 e_g^2$

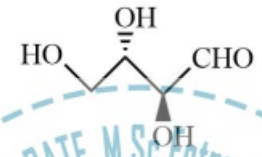
(d) $t_{2g}^3 e_g^2$, $t_{2g}^6 e_g^2$, $t_{2g}^6 e_g^3$

Q.34 The order of reactivity of cyclization of following bromocarboxylates to generate corresponding lactones is



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

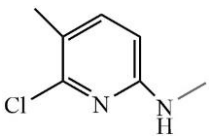
Q.35 Oxidation of a with HNO_3/H_2O provides the product(s), which is(are)

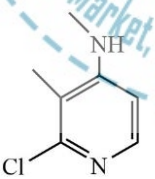


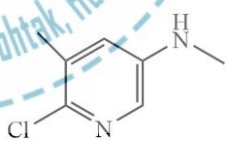
(a) optically inactive as it is racemic mixture (b) optically inactive as it is *meso*

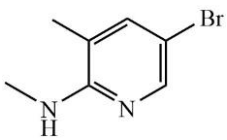
(c) optically active as it is a single diasteromer (d) optically active as it is a single enantiomer

Q.36 The major product in the following reaction is

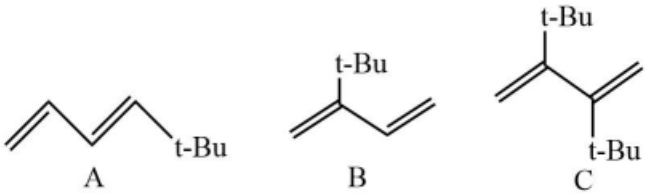
(a) 

(b) 

(c) 

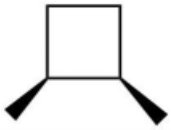
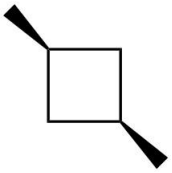
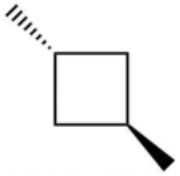
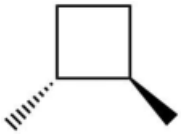
(d) 

Q.37 The order of reactivity of the following dienes towards Diels-Alder reaction is

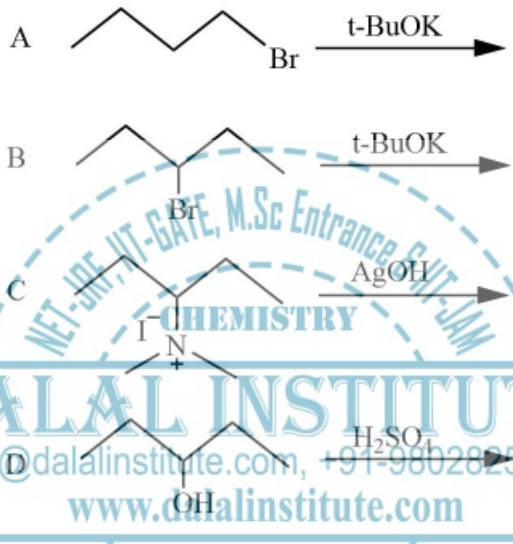


(a) B > A > C (b) A > C > B (c) B > C > A (d) C > B > A

Q.38 Among the following, the optically active compound is

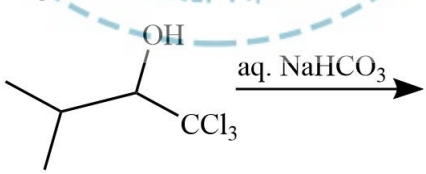
(a)  (b)  (c)  (d) 

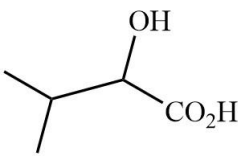
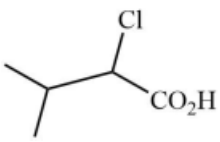
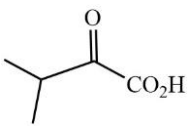
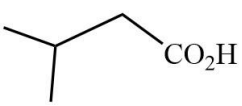
Q.39 Among the following, reaction(s) which provide(s) 1-butene as the major product is(are)



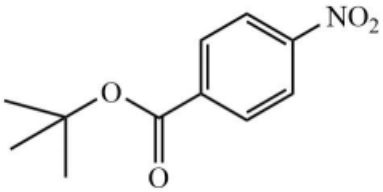
(a) A alone (b) A and B (c) A and C (d) C and D

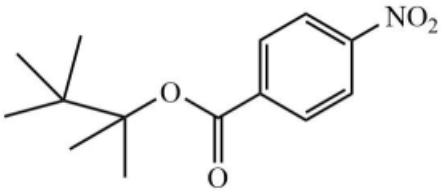
Q.40 The major product in the following reaction is

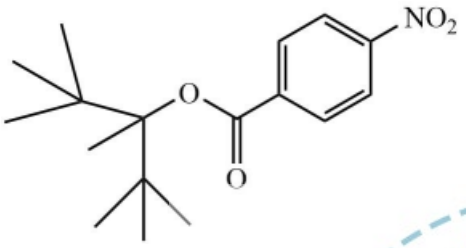


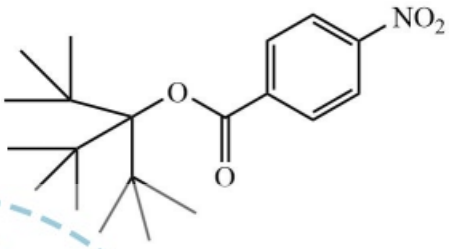
(a)  (b)  (c)  (d) 

Q.41 Among the following, the compound that will have highest rate for nucleophilic substitution through S_N1 mechanism is

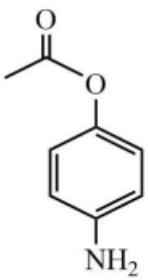
(a) 

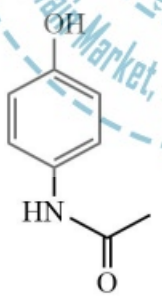
(b) 

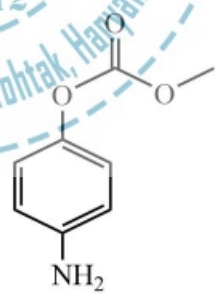
(c) 

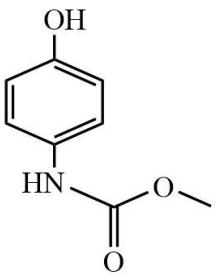
(d) 

Q.42 The major product in the following reaction is

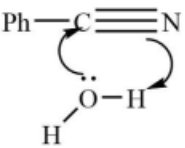
(a) 

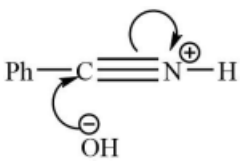
(b) 

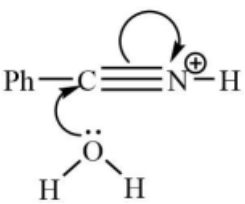
(c) 

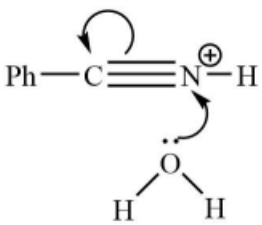
(d) 

Q.43 The mechanism of acid catalysed hydrolysis of benzonitrile involves

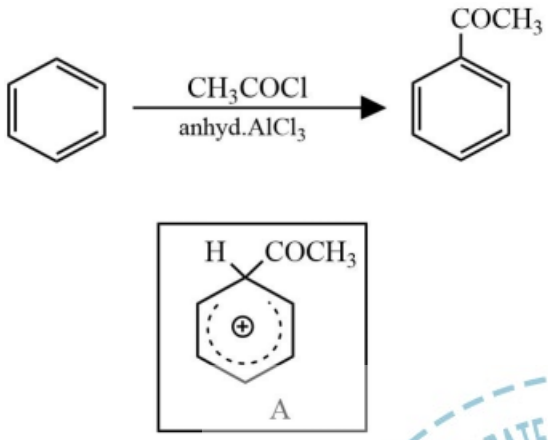
(a) 

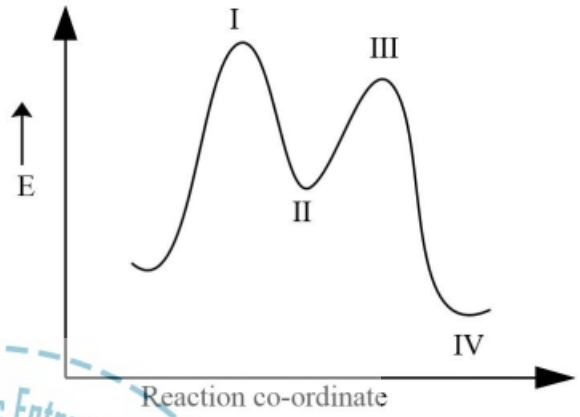
(b) 

(c) 

(d) 

Q.44 In the following energy profile diagram of the reaction given below, the species A would correspond to the position





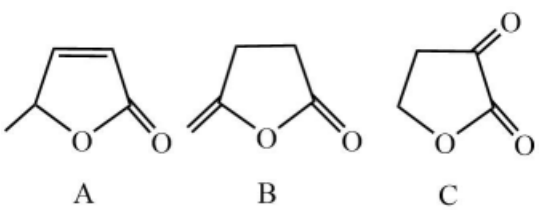
(a) I (b) II (c) III (d) IV

Q.45 Following reaction is an example

(a) Alder-Ene Reaction (b) Michael Addition

(c) Sigmatropic Rearrangement (d) Wanger-Meerwein Rearrangement

Q.46 In IR-spectra, the stretching frequency (in cm^{-1}) of the carbonyl group of the following compounds is in the order



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

Q.47 The uncertainty in the position of a moving electron is 100 pm. The uncertainty in its speed is closest to ($m_e = 9.11 \times 10^{-31}$kg; h = 6.63×10^{-34}J.s)

(a) 6.0×10^{2} m.s^{-1} (b) 6.0×10^{5} m.s^{-1}

(c) 6.0×10^{8} m.s^{-1} (d) 6.0×10^{11} m.s^{-1}

Q.48 The spectrum of sodium atom has a closely separated doublet at 16965.2 and 16973.4 cm^{-1}. The higher energy transition is due to

(a) $^2P_{3/2} \rightarrow {}^2S_{1/2}$ (b) $^2P_{1/2} \rightarrow {}^2S_{1/2}$ (c) $^2P_{3/2} \rightarrow {}^2P_{1/2}$ (d) $^2S_{1/2} \rightarrow {}^2P_{3/2}$

Q.49 N_2O molecule belongs to the point group

(a) $D_{\infty h}$ (b) $C_{\infty v}$ (c) C_{2V} (d) S_2

Q.50 For a closed system in the absence of non-PV work, the correct statement is:

(a) $dU = TdS - PdV$ (b) $dG = VdP + SdT$

(c) $dU = TdS + PdV$ (d) $dU = VdP - SdT$

Q.51 The volume change in a certain phase transition is 2.0 mL mol^{-1} at the transition point. From this, we may conclude that the transition is most likely a

(a) first order phase transition (b) second order phase transition

(c) third order phase transition (d) λ phase transition

Q.52 Root mean square speed of the molecules of a perfect gas is proportional to

(a) $1/T^{1/2}$ (b) T (c) $T^{1/2}$ (d) 1/T

Q.53 For a second-order reaction, the straight line among the following plots is:

(a) [X] versus time (b) 1/[X] versus time (c) log[X] versus 1/time (d) log[X] versus time

Q.54 The activation energy of a reaction reduces by 12 kcal mol^{-1} in the presence of an enzyme at 300 K. assuming pseudo-first order kinetics, calculate the factor by which the reaction rate is increased. [Given: R = 2 cal $K^{-1}mol^{-1}$]

(a) 2×10^{-9} (b) 1.02 (c) 8.7×10^{6} (d) 5×10^{8}

Q.55 The correct statement among the following is:

(a) Salt bridge is required for the mixing of the solutions in the two half cells.

(b) Salt bridge allows current to flow between the half cells without mixing the solutions.

(c) Salt bridge enhances the rate of reaction.

(d) Salt bridge consists of a non-electrolyte in a gel.

Q.56 The standard free energy of the reaction

$$AgBr(s) \rightarrow Ag^{+}(aq) + Br^{-}(aq)$$

is closest to

(E^{0} (AgBr/Ag, Br^{-}) = +0.007 V, E^{0} (Ag/Ag^{+}) = 0.80 V; F = 96500 C mol^{-1})

(a) 7 kJ mol^{-1} (b) 70 J mol^{-1} (c) 70 kJ mol^{-1} (d) 7 J mol^{-1}

Q.57 The internal pressure of a liquid drop (radius = 10^{-6}) is greater than the external pressure by 1.5×10^{5} N m^{-2}. The surface tension () of the liquid is closest to

(a) 150 (b) 125 (c) 125 (d) 75

Q.58 In a cubic crystal, the (111) and (222) reflections are observed, but not the (001) reflection. The Bravais lattice is

(a) Body centred cubic (b) Face centred cubic (c) Simple cubic (d) Side centred cubic

Q.59 The dispersity of a polymeric sample is

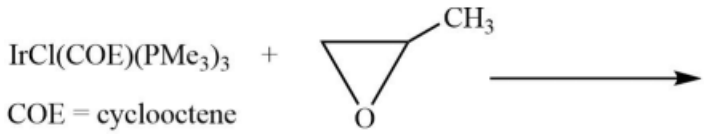
(a) $\frac{< M^2 >}{< M >^2}$ (b) $\frac{< M >^2}{< M^2 >}$ (c) $\frac{< M^2 >}{< M >}$ (d) $\frac{< M >}{< M >^2}$

Q.60 The keto-hexose among the following is

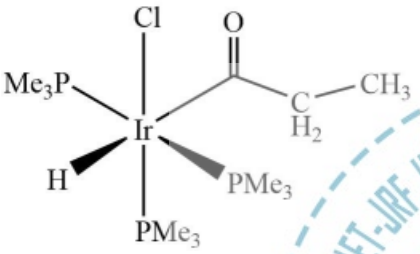
(a) Xylose (b) Galactose (c) Fructose (d) Mannose

Section-C

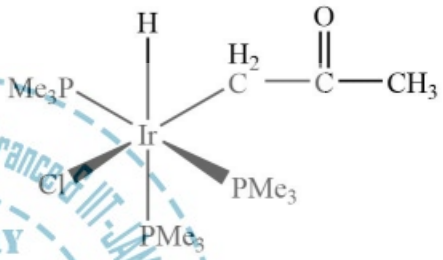
Q.61 The product for the reaction given below is



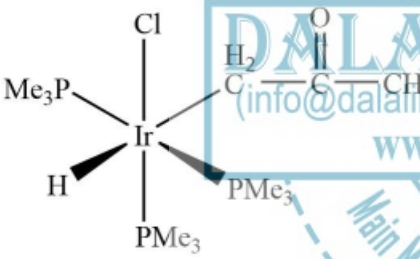
(a)



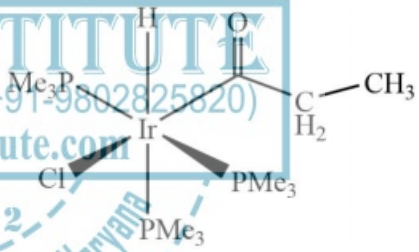
(b)



(c)



(d)



Q.62 The $^{31}P\{^{1}H\}$ NMR spectrum of *cis*-$[Pt(PEt_3)_2Cl_2]$ (^{195}Pt (33.8% abundance) I = ½; its other isotopes are NMR inactive; ^{31}P : I = ½) is comprised with satellite peaks a

(a) triplet (b) singlet (c) doublet (d) Quartet

Q.63 The correct order of intensity of the d-d transitions in the complexes of a 3d transitions metal ion M^{2+} is

(a) *Cis*-$[M(H_2O)_4Cl_2]$ > *trans*-$[M(H_2O)_4Cl_2]$ > $[M(H_2O)_6]^{2+}$

(b) $[M(H_2O)_6]^{2+}$ > *Cis*-$[M(H_2O)_4Cl_2]$ > *trans*-$[M(H_2O)_4Cl_2]$

(c) *trans*-$[M(H_2O)_4Cl_2]$ > *Cis*-$[M(H_2O)_4Cl_2]$ > $[M(H_2O)_6]^{2+}$

(d) $[M(H_2O)_6]^{2+}$ > *Cis*-$[M(H_2O)_4Cl_2]$ ≈ *trans*-$[M(H_2O)_4Cl_2]$

Q.64 The reaction of decaborane $B_{10}H_{14}$ with acetylene in the presence of Et_2S gives

(a) $C_2B_{10}H_{12}$ (b) $C_2B_8H_{10}$ (c) $C_2B_{10}H_{14}$ (d) $C_2B_9H_{11}$

Q.65 In compound $N_3P_3F_6$, the geometry around nitrogen and phosphorus, respectively, are

(a) pyramidal and tetrahedral (b) planar and tetrahedral

(c) pyramidal and planar (d) planar and tetrahedral

Q.66 The number of 2c-2e bonds ('x') of a molecule is related to 'N' (valance electrons) and 'n'(skeletal atoms) by x = (8n–N)/2. For P_4S_3, the values of x, N and n, respectively, are

(a) 9, 38, 7 (b) 7, 24, 9 (c) 9, 38, 7 (d) 9, 24, 7

Q.67 match the following complexes with their ν_{CO} stretching frequency

	Complex		ν_{CO} (cm^{-1}) values
(A)	$Mo(PF_3)(CO)_3$	(i)	1835, 1934
(B)	$Mo(P(OMe)_3)(CO)_3$	(ii)	1888, 1977
(C)	$Mo(PPh_3)_3)(CO)_3$	(iii)	2055, 2090
(D)	$Mo(pyridine)_3(CO)_3$	(iv)	1746, 1888

The correct match is

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

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

Q.68 ν_{CN} in $[Fe(CN)_6]^{3-}$ (A) and $[Fe(CN)_6]^{4-}$ (B) and ν_{CO} in $[Cr(CO)_3(NH_3)_3]$ (C) and $[Cr(CO)_6]$ (D) are compared below. The pair with correct order is:

(a) A>B ; C>D (b) A>B ; C<D (c) A<B ; C>D (d) A<B ; C<D

Q.69 Consider the following statements for $FeO_4]^{2-}$

A. It is stable in the pH range 0-14.

B. It is stable in strongly basic medium only.

C. It is very strong oxidising agent.

D. The isomer shift in its Mossbauer spectrum is more negative compared to that of $FeCl_3$.

The correct statements are

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

Q.70 The isomer A and B undergo base hydrolysis by forming a trigonal bipyramidal intermediate. The correct statement is

(a) A react more faster than B and both result in a mixture of products

(b) B react more faster than A and both result in a mixture of products

(c) A react more faster than B and B result in a mixture of products

(d) A react more faster than B and A result in a mixture of products

Q.71 B_2H_6 reacts with

A. water to give boric acid and H_2

B. oxygen to give B_2O_3 and H_2

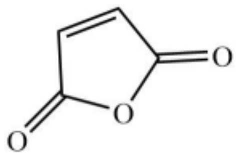
C. water to give boric acid and H_2O

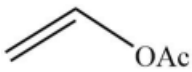
D. oxygen to give B_2O_3 and H_2O

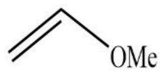
Correct statements from the above are:

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

Q.72 The ligand that binds strongly to the nickel center in (2,2'-bipyridine) Ni(0) complex is

(a) 

(b) 

(c) 

(d) 

Q.73 Match the items given in Column I with those given Column II

Column I		Column II	
A.	Magic number	i	Nuclear fission
B.	Liquid drop model of nucleus	ii	Q-value
C.	Actinides	iii	Radioactivity
D.	Threshold energy	iv	Shell model of nucleus

The correct match is

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

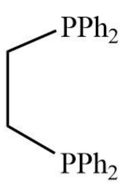
(c) A - iii; B - iv; C - i; D - ii (d) A - vi; B - iii; C - i; D – ii

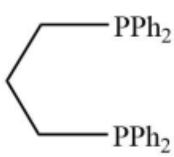
Q.74 The cluster type and geometry of the species $[Rh_9P(CO)_{21}]^{2-}$ are

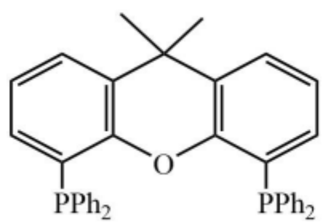
(a) *closo*, tricapped trigonal prism (b) *arachno*, trigonal prism

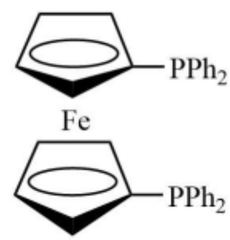
(c) *nido*, capped square antiprism (d) *nido*, bicapped trigonal prism

Q.75 Hydroformylation of 1- propene with $[HRh(CO)L_2]$ leads to linear and branched formylated products. The linear hydroformylated product is formed with highest selectivity when 'L' in the rhodium complex is

(a) 

(b) 

(c) 

(d) 

Q.76 The hydrocarbon having an analogous structure to that of P_4O_6 is

(a) $[(CH)_4(\mu - CH_2)_6]$ (b) $[(CH)_6(\mu - CH_2)_4]$ (c) $[(CH_2)_4(\mu - CH)_6]$ (d) $[(CH_2)_4(\mu - CH)_4]$

Q.77 Match the items given below in the three columns

Metalloprotein		Species coordinated to metal centre(s)		Resonance Raman O–O stretching frequency (cm^{-1})	
A.	Oxymyoglobin	I	η^2: η^2–O_2^{2-}	X.	844
B.	Oxyhemocyanin	II	HO_2^-	Y.	803
C.	Oxyhemerythrin	III	O_2^-	Z.	1105

Correct matches

(a) A-III-Z; B-I-Y; C-II-X (b) A-II-Y; B-I-X; C-III-Z

(c) A-III-Y; B-I-Z; C-II-X (d) A-I-X; B-II-Y; C-III-Z

Q.78 A solid sample of $Na[Fe(EDTA)(H_2O)_n]$ (X) showed 5.6% weight loss at 120°C in a thermogravimetric experiment. Identify the complex left after this weight loss.

(a) $Na[Fe(EDTA)(H_2O)]$ (b) $Na[Fe(EDTA)]$

(c) $Na[Fe(EDTA)(H_2O)_3]$ (d) $Na[Fe(EDTA)(H_2O)_2]$

Q.79 Consider the two sets of molecules.

Set A: $[AlF_6]^{3-}$, $[PF_6]^-$, $[SF_6]$ and $[SiF_6]^{2-}$

Set B: $[Ba(H_2O)_6]^{2+}$, $[Mg(H_2O)_6]^{2+}$, $[Ca(H_2O)_6]^{2+}$, $[Sr(H_2O)_6]^{2+}$.

The slowest ligand exchange rate in Set A and Set B are, respectively

(a) $[AlF_6]^{3-}$ and $[Sr(H_2O)_6]^{2+}$. (b) $[SF_6]$ and $[Mg(H_2O)_6]^{2+}$.

(c) $[SiF_6]^{2-}$ and$[Ca(H_2O)_6]^{2+}$. (d) $[PF_6]^-$ and$[Ca(H_2O)_6]^{2+}$.

Q.80consider the following statements for Eu^{3+}

A. The positions of sharp bands in UV-vis spectra of its complexes depend heavily on the ligand environment.

B. Its ground state term symbol is $^7F_0$.

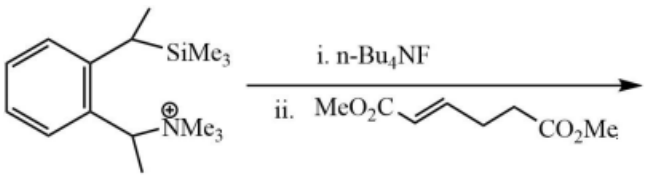
C. The observed magnetic moment is due to populated higher J level.

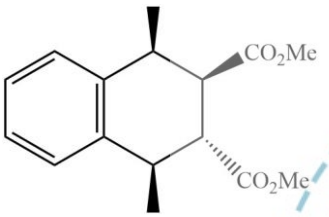
D. At 2 K its magnetic moment approaches to zero.

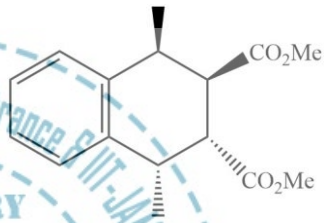
The set of correct statements is

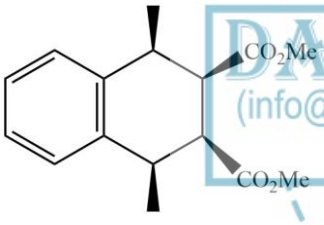
(a) A, C and D. (b) B, C and D. (c) A, B and D (d) A, B and C.

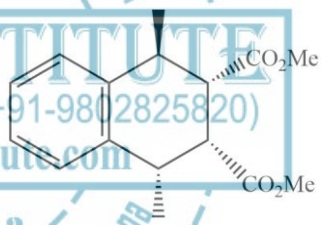
Q.81 The major product in the following reaction is



(a)


(b)


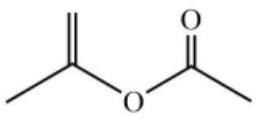
(c)


(d)


Q.82 Structure of the compound displaying following characteristic spectral data

IR: 1720 cm^{-1}

^1H NMR: 6.2(br s, 1H), 5.5(br s, 1H), 4.2(q, 2H), 2.0(s, 3H), 1.1(t, 3H) is

(a)


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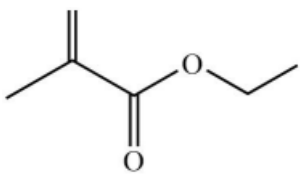
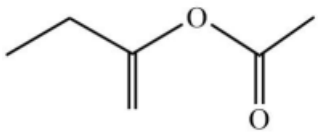
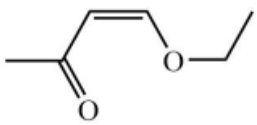
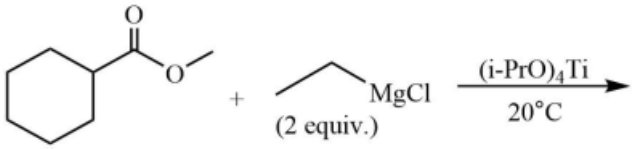
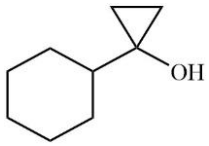


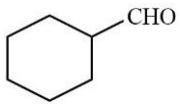
(c)


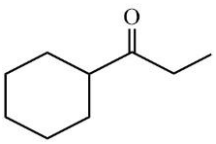
(d)


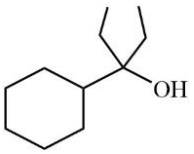
Q.83 The major product in the following reaction is



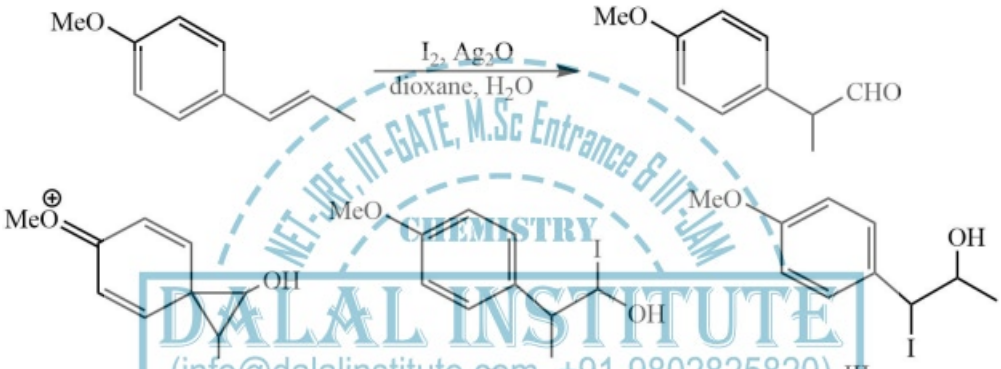
(a) 

(b) 

(c) 

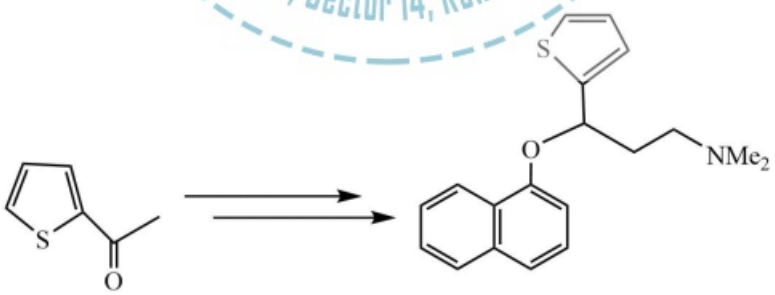
(d) 

Q.84 The intermediate(s) involved in the following reaction is(are)



(a) I only (b) II only (c) I and II only (d) I and III only

Q.85 Correct sequence of reagents to be used for the following conversion is



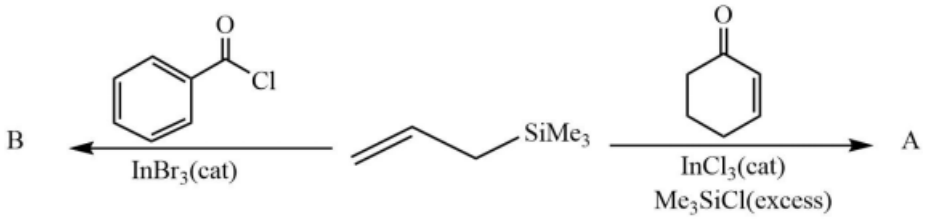
(a) (I) NaH, 1-fluoronapthalene; (II) $NaBH_4$; (III) i. $(CH_2O)_n$, $Me_2NH.HCl$ ii. 5 N NaOH.

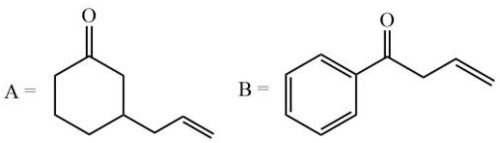
(b) (I) $NaBH_4$; (II) NaH, 1-fluoronapthalene; (III) i. $(CH_2O)_n$, $Me_2NH.HCl$ ii. 5 N NaOH.

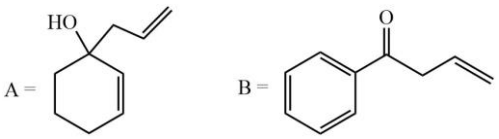
(c) (I) i. $(CH_2O)_n$, $Me_2NH.HCl$; ii. 5 N NaOH (II) $NaBH_4$; (III) NaH, 1-fluoronapthalene.

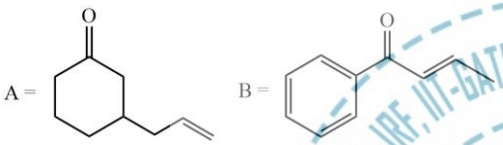
(d) (I) i. $(CH_2O)_n$, $Me_2NH.HCl$; ii. 5 N NaOH (II) NaH, 1-fluoronapthalene; (III) $NaBH_4$.

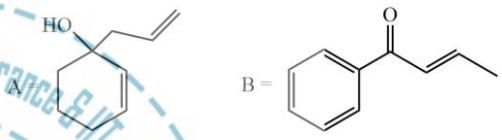
Q.86 The major product A and B formed in the following reaction are



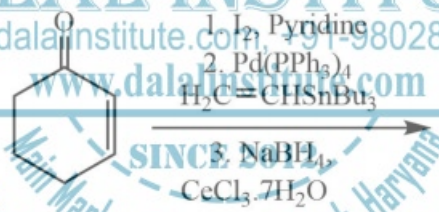
(a) 

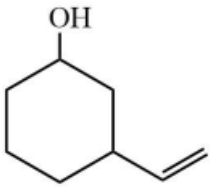
(b) 

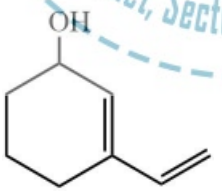
(c) 

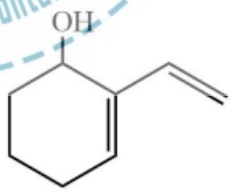
(d) 

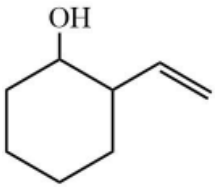
Q.87 The major product in the following reaction is



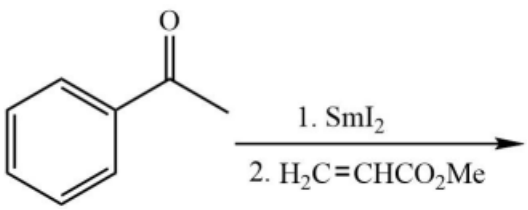
(a) 

(b) 

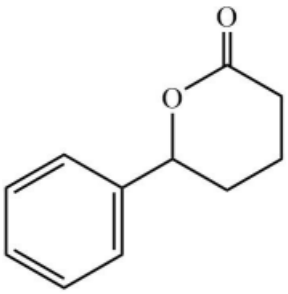
(c) 

(d) 

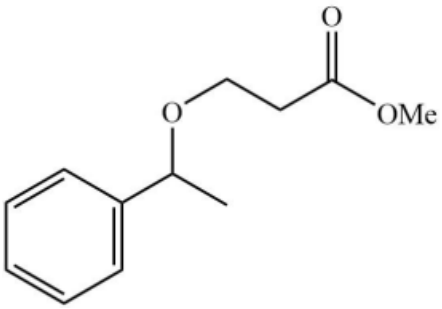
Q.88 The major product in the following reaction is



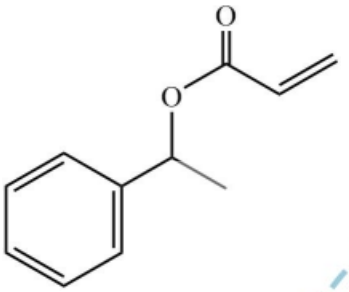
(a)



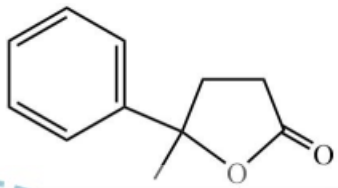
(b)



(c)

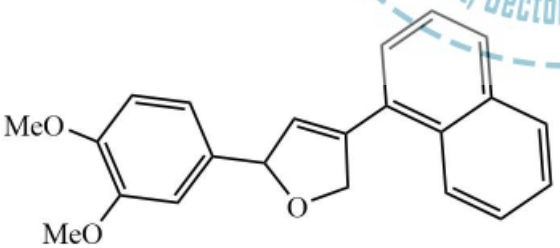


(d)

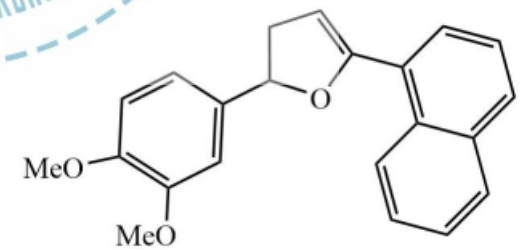


Q.89 The major product in the following reaction is

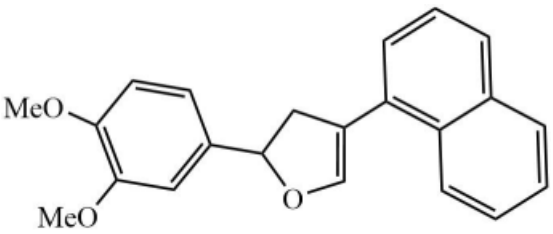
(a)



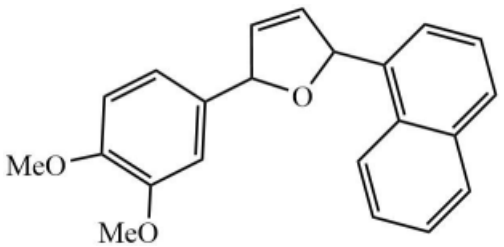
(b)



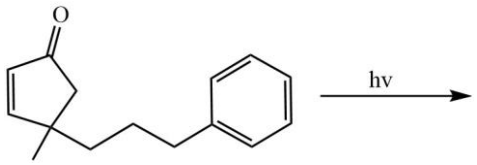
(c)

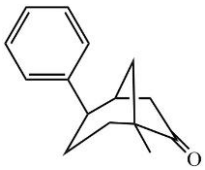


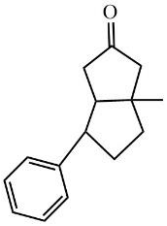
(d)

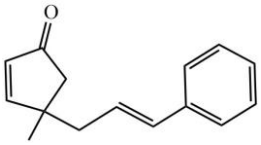


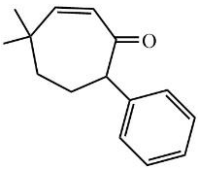
Q.90 The major product in the following photochemical reaction is



(a) 

(b) 

(c) 

(d) 

Q.91 Correct sequence of reagent to be used for the following conversion is

(a) (I) LDA, EtBr; (II) EtLi; (III) H_3O^+

(b) (I) EtLi; (II) LDA, EtBr; (III) H_3O^+

(c) (I) H_3O^+; (II) EtLi; (III) LDA, EtBr

(d) (I) EtLi; (II) H_3O^+; (III) LDA, EtBr

Q.92 Both, 1-chloro- phenylpropan-2-one and 1-chloro-3- phenylpropan-2-one give same product A when heated in the presence of NaOMe. The product A is

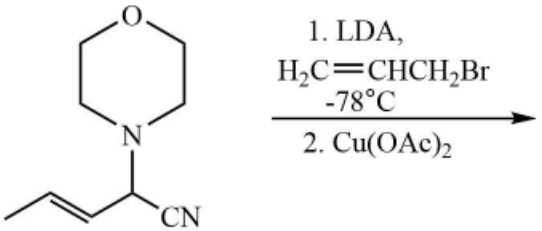
(a) methyl 3-phenylpropanoate

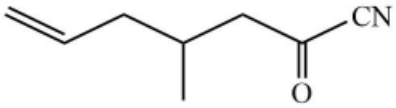
(b) methyl 2-phenylpropanoate

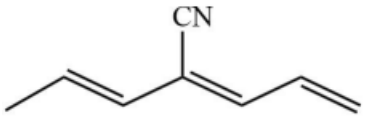
(c) Methyl 2-methoxy-2-phenylacetate

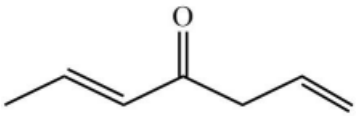
(d) 1-methoxy3-phenylpropan-2-one

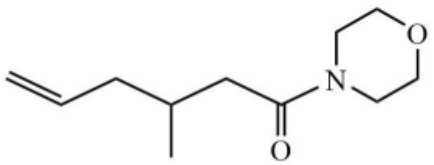
Q.93 The major product in the following reaction sequence is



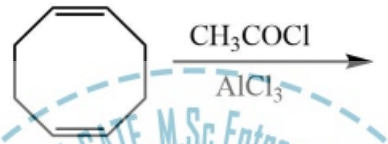
(a) 

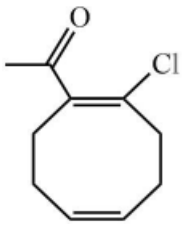
(b) 

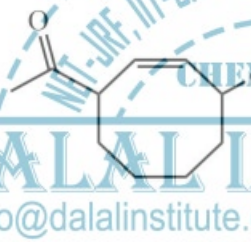
(c) 

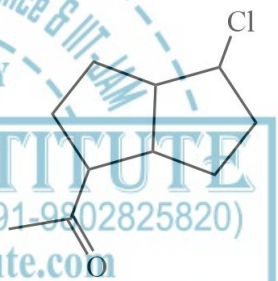
(d) 

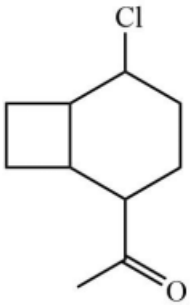
Q.94 The major product in the following reaction is



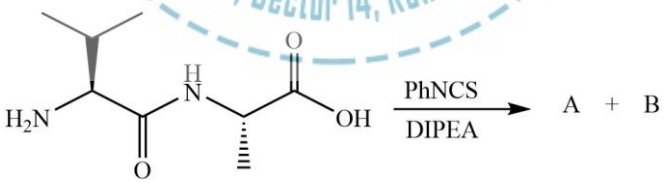
(a) 

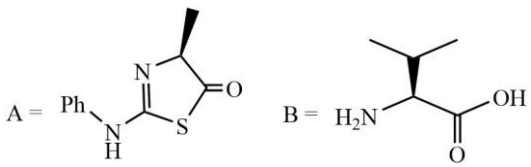
(b) 

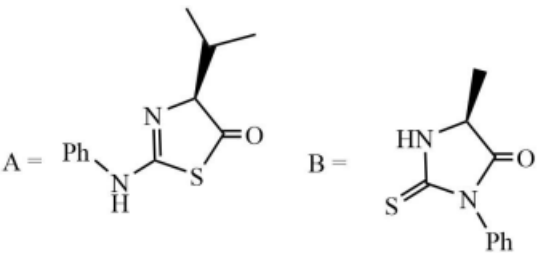
(c) 

(d) 

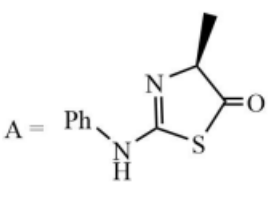
Q.95 The structure of products A and B formed in the Edman degradation of the dipeptide are



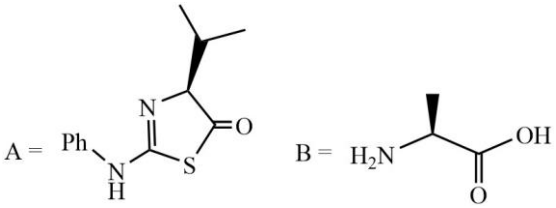
(a) 

(b) 

(c)



(d)



Q.96 Partial spectroscopic data is given below for an organic compound:

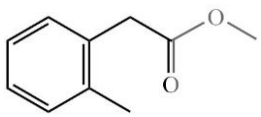
i. 4 signals between δ 120-150 ppm in ^{13}C NMR spectrum

ii. 2 doublets between δ 6.8-8.5 ppm in ^{1}H NMR spectrum

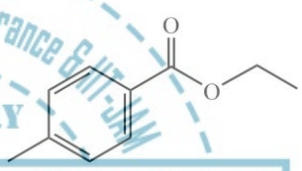
iii. an absorption band at 1724 cm^{-1} in IR spectrum

the structure of the compound is

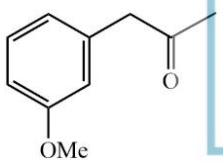
(a)



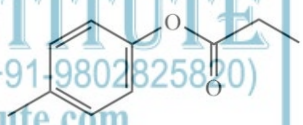
(b)



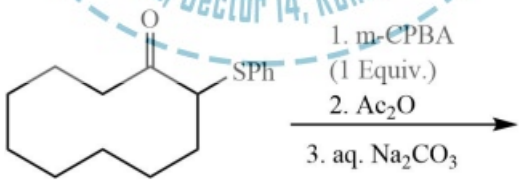
(c)



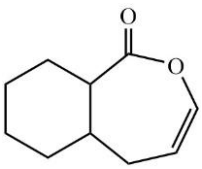
(d)



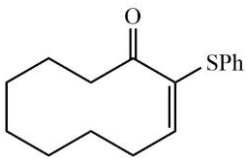
Q.97 The major product in the following reaction is



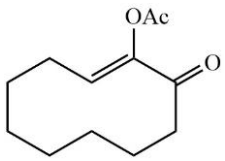
(a)



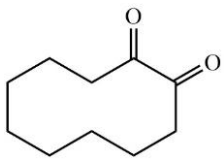
(b)



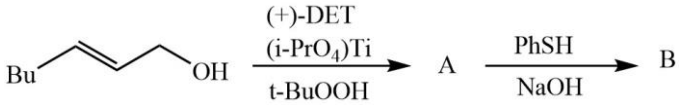
(c)

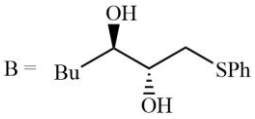


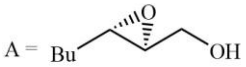
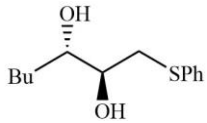
(d)

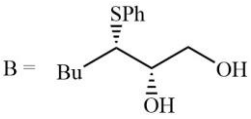


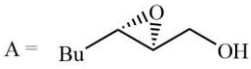
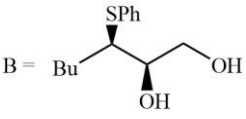
Q.98 The major products A and B in the following reaction sequence are



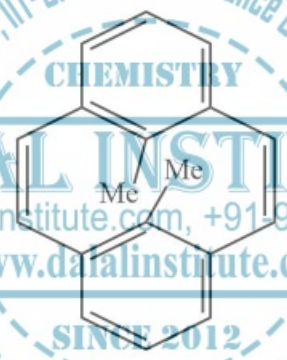
(a) A =  B = 

(b) A =  B = 

(c) A =  B = 

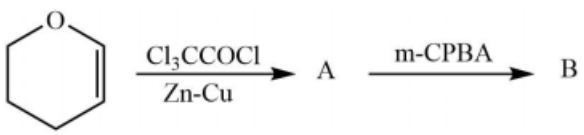
(d) A =  B = 

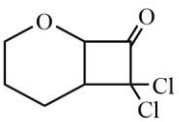
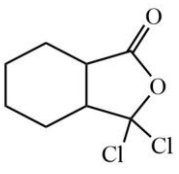
Q.99 The compound P undergoes a pericyclic reaction under photochemical conditions to give compound Q. In compound Q, the relative stereochemistry and ^{1}H NMR chemical shift values of methyl groups (in δ ppm), respectively, are

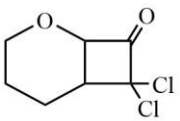
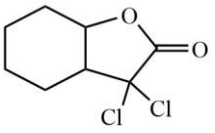


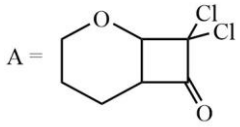
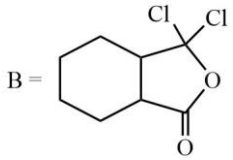
(a) *cis*; –5 (b) *trans*; 17 (c) *cis*; 17 (d) *trans*; –5

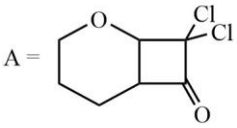
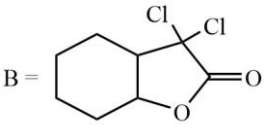
Q.100 The major products A and B in the following reaction sequence are



(a) A =  B = 

(b) A =  B = 

(c) A =  B = 

(d) A =  B = 

Q.101 Arrange the following molecules in order of increasing fundamental vibrational frequencies

(a) $O_2^{2-} < O_2^{-} < O_2 < O_2^{+}$ (b) $O_2 < O_2^{+} < O_2^{-} < O_2^{2-}$

(c) $O_2^{2-} < O_2^{-} < O_2^{+} < O_2$ (d) $O_2^{+} < O_2 < O_2^{-} < O_2^{2-}$

Q.102 One of the Hückel molecular orbitals of 1,3-butadiene is

$$\varphi = 0.60\chi_1 + 0.37\chi_2 - 0.37\chi_3 - 0.60\chi_4$$

The energy of this orbital in terms of the coulomb (α) and resonance(β) integrals is:

(a) $\alpha + 1.62\beta$ (b) $\alpha + 0.62\beta$ (c) $\alpha - 0.62\beta$ (d) $\alpha - 1.62\beta$

Q.103 A molecule AB_2 shows the following IR and Raman spectra

$\tilde{\nu}$ (cm^{-1})	IR	Raman
2215	vs, PR	s, depol.
1250	vs, PR	vs, pol.
560	s, PQR	–

The structure of the molecule is:

(a) Linear symmetrical ($D_{\infty h}$) (b) Bent symmetrical (C_{2v})

(c) Linear asymmetrical ($C_{\infty v}$) (d) Bent asymmetrical (C_s)

Q.104 For a one-dimensional (x) harmonic oscillator perturbed by an x^3 potential, the sum of the frist order and second order corrections to the ground state energy is:

(a) <0 (b) 0 (c) >0 (d) ≥0

Q.105 Difference of average values of position <x> for states $n = 1$ and $n = 2$ of a particle confined in a one-dimensional (x) box of length L is:

(a) $L/4$ (b) $L/2$ (c) $L/3$ (d) 0

Q.106 The Hermitian operator among the following is:

(a) $i\hbar\frac{d^2}{dx^2}$ (b) $-i\hbar\frac{d}{dx}$ (c) $i\hbar x$ (d) $i\hbar$

Q.107 The translational partition function for Ar confined to a volume of 1L at 300 K, having thermal wavelength of 1.60×10^{-11} m, is closest to

(a) 24.4×10^{29} (b) 2.44×10^{29} (c) 0.244×10^{29} (d) 244×10^{29}

Q.108 Consider a phase transition between two incompressible phases. The correct statement among the following is:

(a) The transition is independent of pressure.

(b) The transition is independent of temperature.

(c) The enthalpy of such transition is always zero.

(d) The enthalpy of such transition is always non-zero.

Q.109 The third and fourth lines in the rotational Raman spectrum of CO are separated by 8 cm^{-1}. The CO bond length is given by:

(a) $\sqrt{\frac{h}{16\pi^2\mu c}}$ (b) $\sqrt{\frac{3h}{32\pi^2\mu c}}$ (c) $\sqrt{\frac{h}{32\pi^2\mu c}}$ (d) $\sqrt{\frac{5h}{32\pi^2\mu c}}$

Q.110 Conductivities of water and a saturated solution of a sparingly soluble salt AB_2 are 7 and 21 μS m^{-1}, respectively. Given, $\lambda^0_{A^{2+}} = 12.72$ mS m^2 mol^{-1} and $\lambda^0_{B^-} = 7.64$ mS m^2 mol^{-1}, the solubility of AB_2 in mol m^{-3}, is

(a) 5.0×10^{-4} (b) 5.0×10^{-3} (c) 5.0×10^{-5} (d) 5.0×10^{-6}

Q.111 The equilibrium constant of the following reaction

$$Sn(s) + Sn^{4+}(aq) \rightleftharpoons 2Sn^{2+}(aq)$$

At 300 K is close to

(Given: $E^0_{Sn^{4+}/Sn^{2+}}$ = +0.15V and $E^0_{Sn^{2+}/Sn}$ = –0.15V: R = 8.314 $JK^{-1}mol^{-1}$; F = 96485 $C\ mol^{-1}$)

(a) $10^{6.08}$ (b) $10^{8.08}$ (c) $10^{10.08}$ (d) $10^{12.08}$

Q.112 Langmuir adsorption isotherm for the dissociative adsorption of D_2 (p = partial pressure of D_2 and k = ratio of rate constants for adsorption and desorption) is:

(a) $\theta = \frac{kp}{1+kp}$ (b) $\theta = \frac{k}{1+kp}$ (c) $\theta = \frac{(kp)^{1/2}}{1+(kp)^{1/2}}$ (d) $\theta = \left(\frac{p}{1+kp}\right)^{1/2}$

Q.113 Entropy of a perfect gas is

(a) independent of V. (b) Proportional to V. (c) Proportional to $\ln V$. (d) Proportional to V^2.

Q.114 The contour and root mean square length (in nm) of a polymer chain modelled as a random coil, with N = 1000 and l = 150 pm, are closet to

(a) 1.50 and 47.4 (b) 15.0 and 4.74 (c) 150 and 47.4 (d) 150 and 4.74

Q.115 The free energy $[A - A(0)]$ of a system with 10 non-interacting spins (S = 1) is

(a) $-k_B T\ln(3)$ (b) $-10k_B T\ln(3)$ (c) $-k_B T\ln(0.3)$ (d) $-10k_B T\ln(0.3)$

Table – 1

D_{2h}	E	$C_2(z)$	$C_2(y)$	$C_2(x)$	i	$\sigma\ (xy)$	$\sigma\ (xz)$	$\sigma\ (yz)$	*tensors*
A_g	1	1	1	1	1	1	1	1	x^2, y^2, z^2
B_{1g}	1	1	–1	–1	1	1	–1	–1	R_z, xy
B_{2g}	1	–1	1	–1	1	–1	1	–1	R_y, xz
B_{3g}	1	–1	–1	1	1	–1	–1	1	R_x, yz

A_u	1	1	1	1	−1	−1	−1	−1	
B_{1u}	1	1	−1	−1	−1	−1	1	1	X
B_{2u}	1	−1	1	−1	−1	1	−1	1	Y
B_{3u}	1	−1	−1	1	−1	1	1	−1	Z

Q.116 The π_u-orbital of ethylene, when placed in the xy-plane with C = C bond aligned to the x-axis, transforms according to the irreducible representation (Use Table 1)

(a) a_u (b) b_{1u} (c) b_{2u} (d) b_{3u}

Q.117 The $b_{1u} \rightarrow b_{2g}$ transition in ethylene is

(a) not allowed. (b) allowed by x-polarised light.

(c) allowed by y-polarised light. (d) allowed by z-polarised light.

(use Table 1)

Q.118 A metal crystallizes with cubic close-packed structure. The $sin^2\theta$ values of Bragg reflections of Miller planes (200) and (111) are 0.18 and 0.14, respectively. The unit cell length is

(a) λ/2 (b) λ/0.2 (c) λ/0.4 (d) 0.4λ

Q.119 k_{uni} is the effective first-order rate constant of the following unimolecular reaction

$$A + M \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} A^* + M$$

$$A^* \xrightarrow{k_2} P$$

The slope and intercept of the plot of $1/k_{uni}$ vs. 1/[M] are 4×10^6 and 8×10^{11}, respectively. The value of k_{-1}/k_2 is:

(a) 2×10^5 (b) 0.5×10^5 (c) 32×10^5 (d) 2×10^{-5}

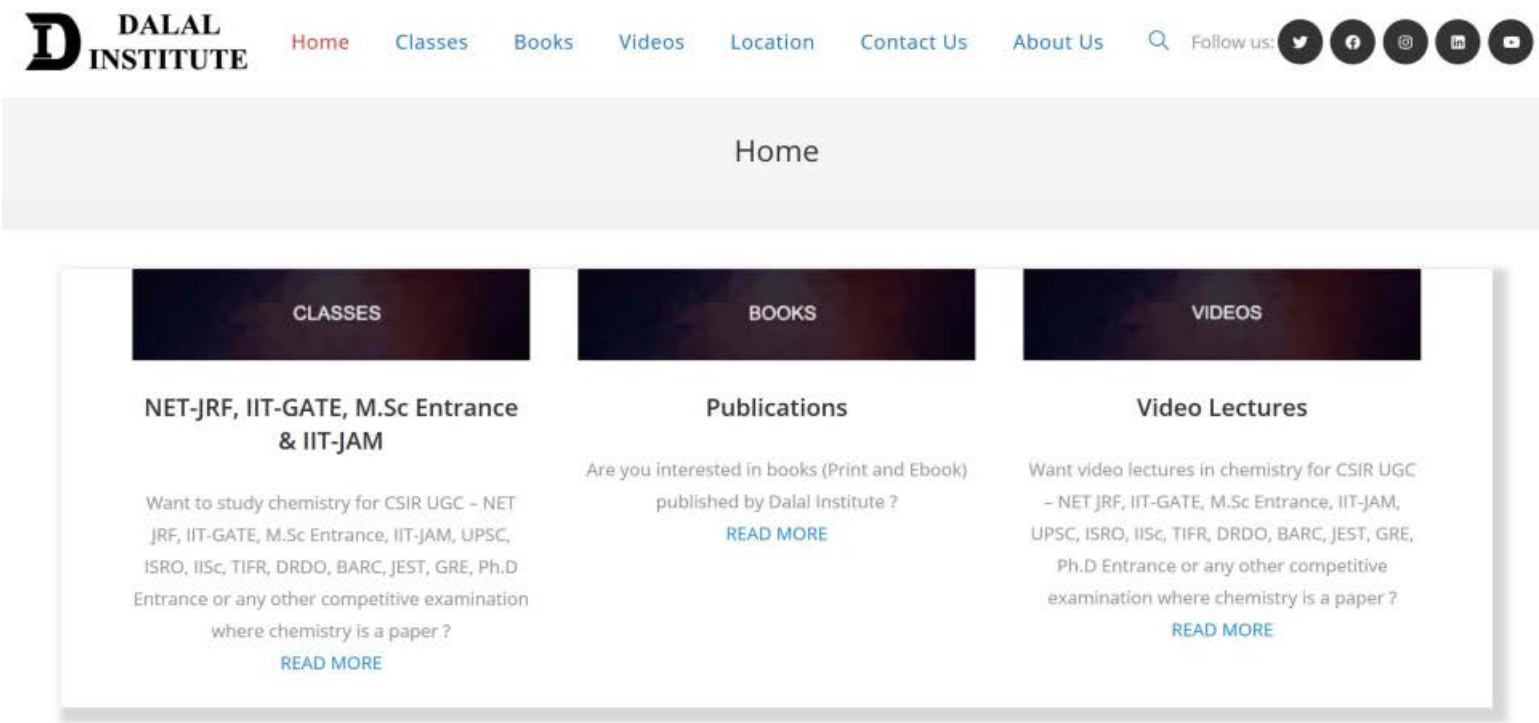
Q.120 The decomposition mechanism of ozone is

$$O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O$$

$$O_3 + O \xrightarrow{k_2} 2O_2$$

If $k_{-1}[O_2] << k_2[O_3]$, then the order of the reaction with respect to ozone is

(a) zero (b) one (c) two (d) complex



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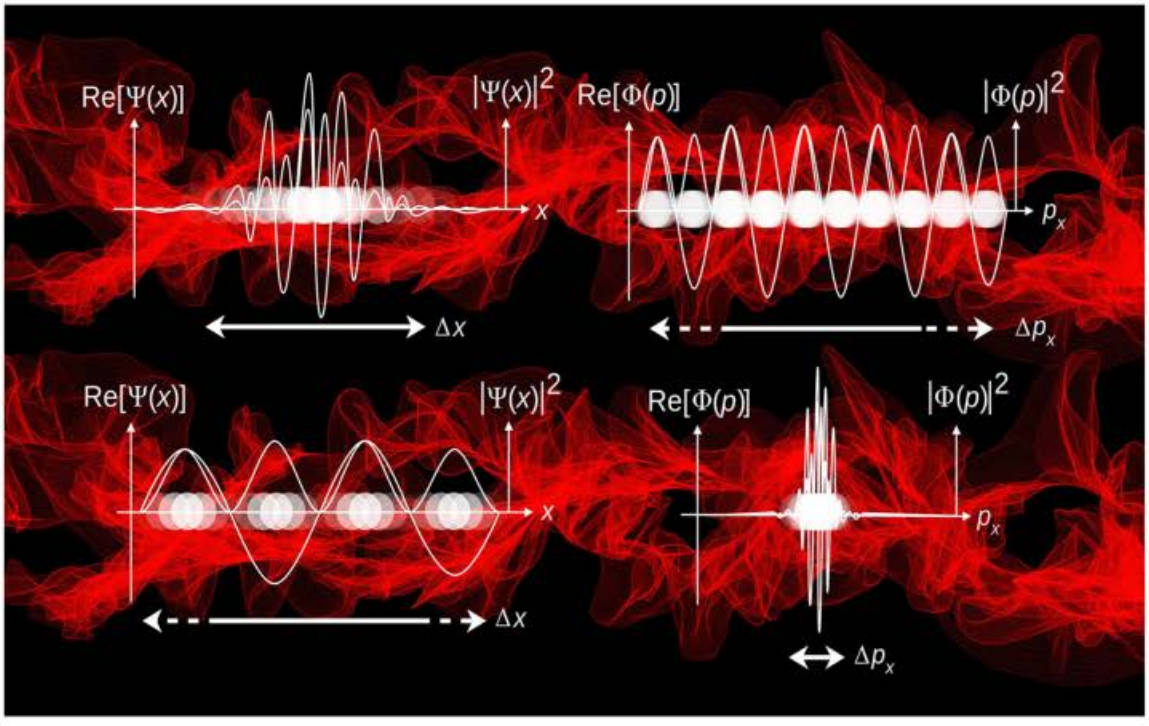

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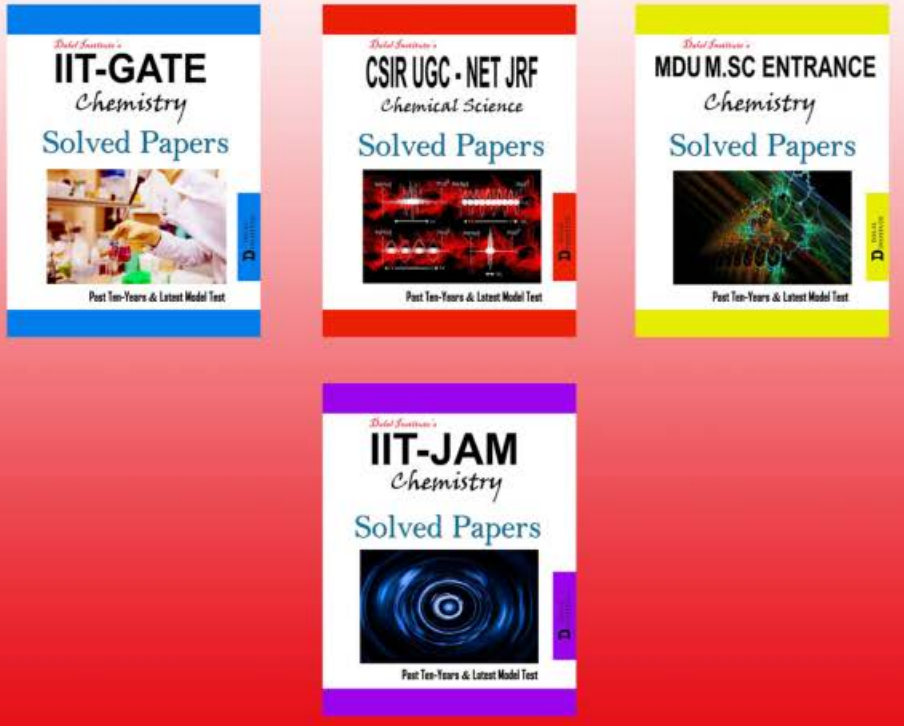

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