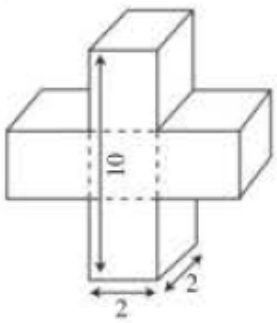
CSIR UGC – NET JRF: June 2014

Chemical Science

❖ Question Paper

Section-A

Q.1 The following diagram shows 2 perpendicularly inter-grown prismatic crystals (twins) of identical shape and size. What is the volume of the object shown (units are arbitrary) ?



(a) 60 (b) 65 (c) 72 (d) 80

Q.2 Suppose in a box there are 20 red, 30 black, 40 blue and 50 white balls. What is the minimum number of balls to be drawn, without replacement, so that you arc certain about getting 4 red , 5 black, 6 blue and 7 white balls?

(a) 140 (b) 97 (c) 104 (d) 124

Q.3 In the growing years of a child, the height increases as the square root of the age while the weight increases in direct proportion to the age. The ratio of the weight to the square of the height in this phase of growth

(a) Is constant. (b) Reduce with age.

(c) Increase with age. (d) Is constant only if the weight and height at birch are both zero.

Q.4 Students in group A obtained the following marks: 40, 80, 70, 50, 60, 90, 30. Students in group B obtained 40, 80, 35, 70, 85 , 45, 50, 75, 60 marks. Define dispersion (D) = (maximum marks – minimum marks), and relative dispersion (RD) = $\frac{dispersion}{mean}$. Then

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(a) RD of group A = RD of group B (b) RD of group A > RD of group B

(c) RD of group A < RD of group B (d) RD of group A < RD of group B

Q.5 In 450 g of pure coffee powder 50 g of chicory is added. A person buys JOO g of this mixture and adds 5 g of chicory co that. What would be the rounded-off percentage of chicory in this final mixture?

(a) 10 (b) 5 (c) 14 (d) 15

Q.6 The time gap between the two instants, one before and one after 12·00 noon, when the angle between the hour hand and the minute hand is 66°, is

(a) 12 min (b) 16 min (c) 18 min (d) 24 min

Q.7 suppose

$x \Delta y = (x - y)^2$; $x \circ y = (x - y)^2$; $x * y = (x - y)^{-1}$; $x.y = x \times y$

+, – and × have their usual meanings. What is the value of $\{(197 \circ 315) - (197 \Delta 315)\} . (197 * 315)$?

(a) 118 (b) 512 (c) 2 (d) 4

Q.8 If Ax B = 24, B × C = 32, C × D = 48 then A × D

(a) Cannot be found (b) Is a perfect square (c) Is a perfect cube (d) Is odd

Q.9 If all horses are donkeys, some donkeys are monkeys and some monkeys are men, then which statement must be true?

(a) All donkeys are men (b) Some donkeys may be men

(c) Some horses are men (d) All horses are also monkeys

Q.10 A rectangular area of sides 9 and 6 units is to be covered by square tiles of sides 1, 2 and 5 units. The minimum number of tiles needed for this is

(a) 3 (b) 11 (c) 12 (d) 15

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Q.11 Suppose n is a positive integer. Then $(n^2 + n)(2n + 1)$

(a) May not be divisible by 2.

(b) Is always di visible by 2 but may not be divisible by 3.

(c) Is always di visible by 3 but may not be divisible by 6.

(d) Is always divisible by 6.

Q.12 There is a train of length 500 m, in which a man is standing at the rear end. At the instant the rear end crosses a stationary observer on a platform, the man starts walking from the rear to the front and the front to the rear of the train at a constant speed of 3 km/hr. The speed of the train is 80 km/hr. The distance of the man from the observer at the end of 30 minutes is

(a) 41.5 km (b) 40.5 km (c) 40.0 km (d) 41.0 km

Q.13 Three identical flat equilateral-triangular plates of side 5 cm each are placed together such that they form a trapezium. The length of the longer of the two parallel sides of this trapezium is

(a) $5\sqrt{\frac{3}{4}}$ cm (b) $5\sqrt{2}$ cm (c) 10 cm (d) $10\sqrt{3}\ cm$

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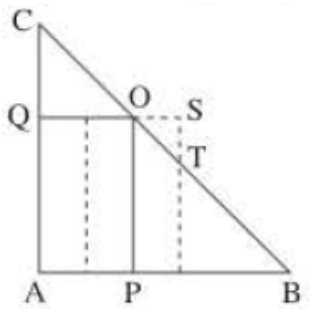
Q.14 An archer climbs to the top of a 10 m high building and aims at a bird atop a tree 17 m away. The line of sight from the archer to the bird makes an angle of 45° to the horizontal. What is the height of the tree?

(a) 17m (b) 27m (c) 37m (d) 47m

Q.15 Consider a right-angled triangle ABC where AB = AC = 3. A rectangle APOQ is drawn inside it, as shown, such that the height of the rectangle is twice its width. The rectangle is moved horizontally by a distance 0·2 as shown schematically in the diagram (not to scale).



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What is the value of the ratio $\frac{Area\ of \Delta ABC}{Area\ of\ \Delta OST}$?

(a) 625 (b) 400 (c) 225 (d) 125

Q.16 80 gsm paper is cut into sheets of 200 mm × 300 mm size and assembled in packets of 500 sheets. What will be the weight of a packet? (gsm = g/m^2)

(a) 1.2 kg (b) 2.4 kg (c) 3.6 kg (d) 4.8 kg

Q.17 Find the missing letter

A	B	C	D
F	I	L	O
K	P	U	Z
P	W	D	?

(a) P (b) K (c) J (d) L

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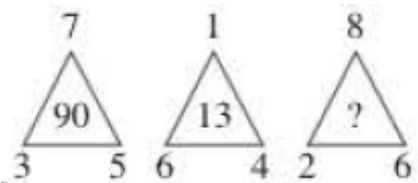
Q.18 A merchant buys equal numbers of shirts and trousers and pays Rs. 38,000. If the cost of 3 shirts is Rs. 800 and that of a trouser is Rs. 1,000, then how many shirts were bought ?

(a) 60 (b) 30 (c) 15 (d) 10

Q.19 Consider the set of numbers {17^1, 17^2, .. .,17^{300}}. How many of these numbers end with the digit 3?

(a) 60 (b) 75 (c) 100 (d) 150

Q20 Find the missing number in the triangle.



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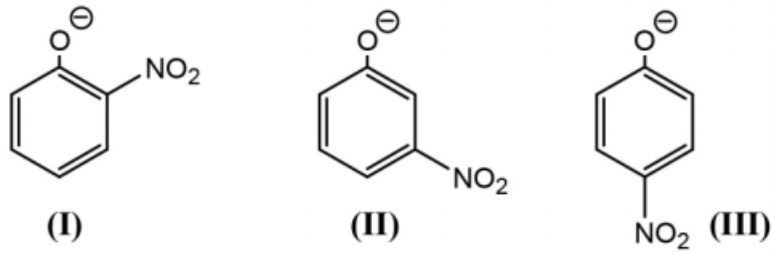
(a) 16 (b) 96 (c) 50 (d) 80

Section-B

Q.21 The correct order of basicity for the following anions is

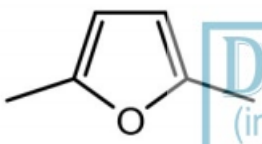


(I) (II) (III)

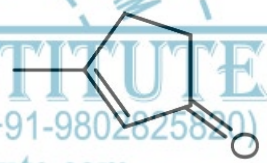
(a) II > III > I (b) I > II > III (c) II > I > III (d) III > II > I

Q.22 The major product formed in the reaction of 2, 5-hexanedione with P_2O_5 is

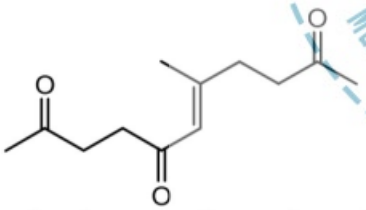
(a)



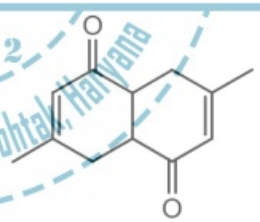
(b)



(c)



(d)



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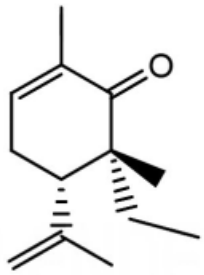
Q.23 The absolute configuration of the two stereogenic (chiral) centres in the following molecule is



(a) 5R, 6R (b) 5R, 6S (c) 5S 6R (d) 5S, 6S

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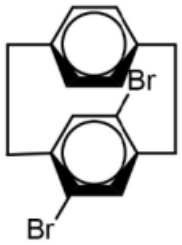
Q.24 The correct statement about the following molecule is



(a) Molecular is chiral and possesses a chiral plane.

(b) Molecule is chiral and possesses a chiral axis.

(c) Molecule is achiral as it possesses a plane of symmetry.

(d) Molecule is achiral as it possesses a centre of symmetry.

Q.25 Consider the following statements about cis- and trans-decalins

(A) Cis-isomer is more stable than trans-isomer.

(B) Trans-isomer is more stable than cis-isomer.

(C) Trans-isomer undergoes ring-flip.

(D) Cis-isomer undergoes ring-flip.

The correct statements among the above are

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

Q.26 In bis(dimethylglyoximato)nickel(II), the number of Ni–N, Ni–O and intramolecular hydrogen bond(s), respectively are

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

Q.27 Among the following species, (A) Ni(II) as dimethylglyoximate, (B) Al(III) as oximate, (C) Ag(I) as chloride, those that precipitate with the urea hydrolysis method are

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

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Q.28 If an enzyme fixes N_2 in plants by evolving H_2, the number of electrons and protons associated with that, respectively are

(a) 6 and 6 (b) 8 and 8 (c) 6 and 8 (d) 8 and 6

Q.29 The particles postulated to always accompany the positron emission among

(A) Neutrino, (B) Anti-neutrino, (C) Electron, are

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

Q.30 Toxicity of cadmium and mercury in the body is being reversed by proteins, mainly using the amino acid residue,

(a) Glycine (b) Leucine (c) Lysine (d) Cysteine

Q.31 $NiBr_2$ reacts with $(Et)(Ph_2)P$ at –78°C in CS_2 to give red compound 'A', which upon standing at room temperature turns green to give compound, 'B' of the same formula. The measured magnetic moments of 'A' and 'B' are 0.0 and 3.2 BM, respectively. The geometries of 'A' and 'B' are

(a) Square planar and tetrahedral (b) Tetrahedral and square planar

(c) Square planar and octahedral (d) Tetrahedral and octahedral

Q.32 The correct non-linear and iso-structural pair is

(a) SCl_2 and I_3^- (b) SCl_2 and I_3^+ (c) SCl_2 and ClF_2^- (d) I_3^+ and ClF_2^-

Q.33 Ozone present in upper atmosphere protects people on the earth

(a) Due to its diamagnetic nature.

(b) Due to its blue colour.

(c) Due to absorption of radiation of wavelength at 255nm.

(d) By destroying chlorofluoro carbons.

Q.34 If L is a neutral monodentate ligand, the species, $[AgL_4]^{2+}$, $[AgL_6]^{2+}$ and $[AgL_4]^{3+}$, respectively are

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(a) Paramagnetic, paramagnetic and diamagnetic (b) Paramagnetic, diamagnetic and paramagnetic

(c) Diamagnetic, paramagnetic and diamagnetic (d) Paramagnetic, diamagnetic and diamagnetic

Q.35 Chromite ore on fusion with sodium carbonate gives

(a) Na_2CrO_4 and Fe_2O_3 (b) $Na_2Cr_2O_7$ and Fe_2O_3

(c) $Cr_2(CO_3)_3$ and $Fe(OH)_3$ (d) Na_2CrO_4 and $Fe_2(CO_3)_3$

Q.36 The ligand(s) that is (are) fluxional in $[(\eta^5 - C_5H_5)(\eta^1 - C_5H_5)Fe(CO)_2]$ in the temperature range 221-298K, is (are)

(a) $\eta^5 - C_5H_5$ (b) $\eta^1 - C_5H_5$ (c) $\eta^5 - C_5H_5$ and CO (d) $\eta^1 - C_5H_5$ and CO

Q.37 $[CoL_6]^3$ is red in colour whereas $[CoL'_6]^{3+}$ is green. L and L' respectively corresponds to,

(a) NH_3 and H_2O (b) NH_3 and 1, 10-phenanthroline

(c) NH_3 and 1, 10-phenanthroline (d) H_2O and NH_3

Q.38 The oxidation state of Ni and the number of metal-metal bonds in $[Ni_2(CO)_6]^{2-}$ that are consistent with the 18 electron rule are

(a) Ni(–II), 1 bond (b) Ni(IV), 2 bonds (c) Ni(–I), 1 bond (d) Ni(IV), 3 bonds

Q.39 Structures of $SbPh_5$ and PPh_5 respectively are

(a) Trigonal bipyramidal, square pyramidal (b) Square pyramidal, trigonal bipyramidal

(c) Trigonal bipyramidal, trigonal bipyramidal (d) Square pyramidal, square pyramidal

Q.40 The typical electronic configurations of the transition metal centre for oxidative addition

(a) d^0 and d^8 (b) d^6 and d^8 (c) d^8 and d^{10} (d) d^5 and d^{10}

Q.41 Gelatin added during the polarographic measurement carried out using dropping mercury electrode

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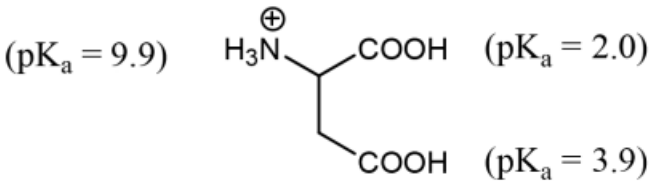
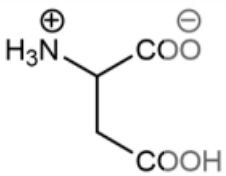
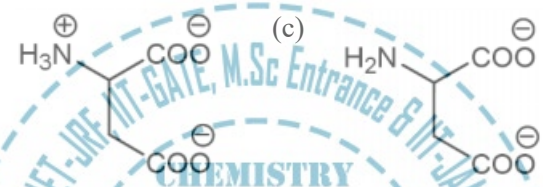
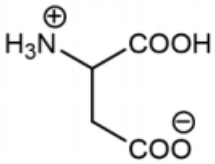
(a) Reduces streaming motion of Hg drop (b) Decreases viscosity of the solution

(c) Eliminates migrating current (d) Prevents oxidation of Hg

Q.42 The pK_a values of the following salt of aspartic acid are indicated below. The predominant species that would exist at pH = 5 is



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

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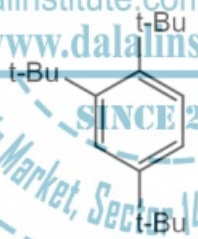
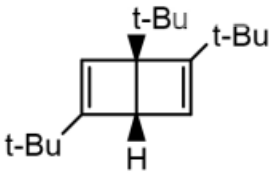
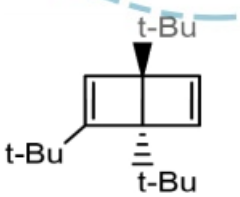
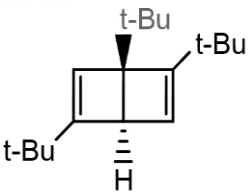
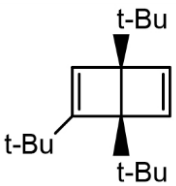
Q.43 The major product formed in the following photochemical reaction is



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

Q.44 The pair of solvents in which PCl_5 does NOT ionize, is

(a) CH_3CN, CH_3NO_2 (b) CH_3CN, CCl_4 (c) C_6H_6, CCl4 (d) CH_3CN, C_6H_6

Q.45 The major product formed in the following reaction is

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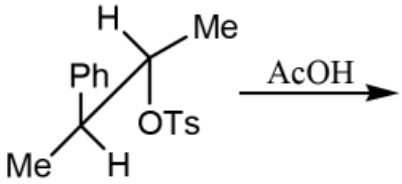

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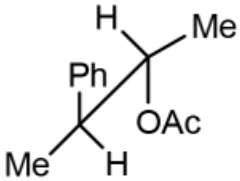

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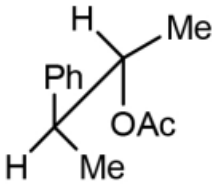

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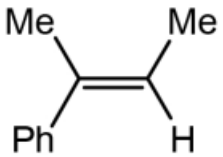

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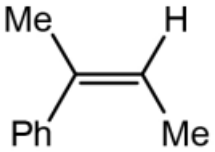
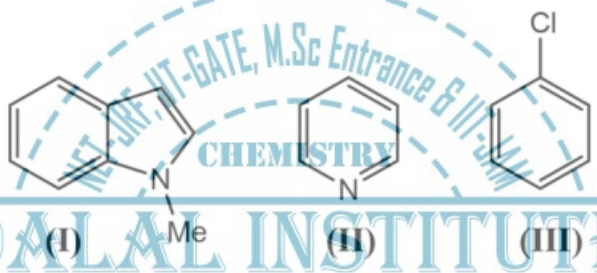


Q.46 The correct order for the rates of electrophilic aromatic substitution of the following compound is



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

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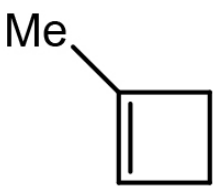
Q.47 The commutator of the kinetic energy operator, $\hat{T}_x$ and the momentum operator, $\hat{P}_x$ for the one-dimensional case is

(a) iħ (b) $i\hbar\frac{d}{dx}$ (c) 0 (d) iħx

Q.48 The major product formed in the reaction of trans-1-bromo-3-methylcyclobutane with sodium iodide in DMF is

(a)


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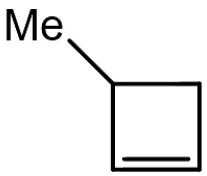

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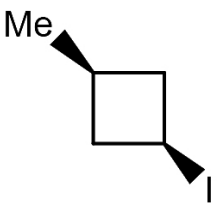

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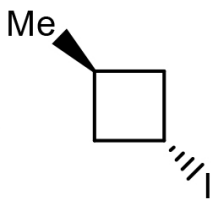

Q.49 When Si is doped with a Group V element,

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(a) Donor levels are created close to the valence band.

(b) Donor levels are created close to the conduction band.

(c) Acceptor levels are created close to the valence bond

(d) Acceptor levels are created close to the conduction band.

Q.50 The symmetry point group of propyne is

(a) C_3 (b) C_{3v} (c) D_3 (d) D_{3d}

Q.51 For a first order reaction A → products, the plot of $\ln\left(\frac{[A]_t}{[A]_0}\right)$ vs time, where $[A]_0$ and $[A]_t$ refer to concentration at time t = 0 and t respectively, is

(a) A straight line with a positive slope passing through origin.

(b) A straight line with a negative slope passing through origin.

(c) An exponential curve asymptotic to the time axis.

(d) Curve asymptotic to the $\ln\left(\frac{[A]_t}{[A]_0}\right)$ axis.

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Q.52 In radical chain polymerization, the quantity given by the rate of monomer depletion, divided by the rate of propagating radical formation is called

(a) Kinetic chain length (b) Propagation efficiency

(c) Propagation rate constant (d) Polymerization time

Q.53 Number of rotational symmetry axes for triclinic crystal system is

(a) 4 (b) 3 (c) 1 (d) 0

Q.54 Generally, hydrophobic colloids are flocculated efficiently by ions of opposite type and high charge number. This is consistent with the

(a) Peptization principle (b) Krafft theory

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(c) Hardy-Schulze rule (d) Langmuir adsorption mechanism

Q.55 Examine the following first order consecutive reactions. The rate constant (in s^{-1} units) for each step is given above the arrow mark

A. $P \xrightarrow{10^5} Q \xrightarrow{10^8} R$; B. $P \xrightarrow{10^5} Q \xrightarrow{10^3} R$

C. $P \xrightarrow{10^7} Q \xrightarrow{10^7} R$; D. $P \xrightarrow{10^2} Q \xrightarrow{10^6} R$

Steady-state approximation can be applied to

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

Q.56 The figure below represents the path followed by a gas during expansion from A → B. The work done is (L atm)

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(a) 0 (b) 9 (c) 5 (d) 4

Q.57 An aqueous solution of an optically pure compound of concentration 100 mg in 1 mL of water and measured in a quartz tube of 5 cm length was found to be –3°. The specific rotation is

(a) – 30° (b) – 60° (c) – 6° (d) +6°

Q.58 Two phases (α and β) of a species are in equilibrium. The correct relations observed among the variables, T, p and μ are

(a) $T_\alpha = T_\beta, p_\alpha \neq p_\beta, \mu_\alpha = \mu_\beta$ (b) $T_\alpha \neq T_\beta, p_\alpha = p_\beta, \mu_\alpha = \mu_\beta$

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(c) $T_\alpha = T_\beta, p_\alpha = p_\beta, \mu_\alpha = \mu_\beta$ (d) $T_\alpha = T_\beta, p_\alpha = p_\beta, \mu_\alpha \neq \mu_\beta$

Q.59 The number of configurations in the most probable state, according to Boltzmann formula, is

(a) $e^{S/kB}$ (b) $e^{-S/kB}$ (c) $e^{-E/kBT}$ (d) $e^{-\Delta G/kBT}$

Q.60 The correct match of the ^1H NMR chemical shifts (δ) of the following species/compounds is

(a) I : 5.4; II: 7.2; III: 9.2 (b) I : 9.2; II : 7.2;III :5.4

(c) I : 9.2; II: 5.4; III: 7.2 (d) I: 7.2; II : 9.2; III :5.4

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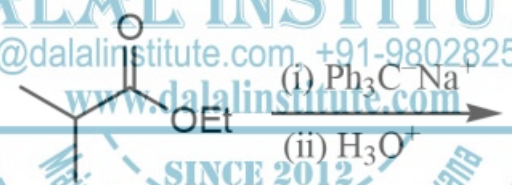
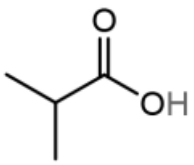
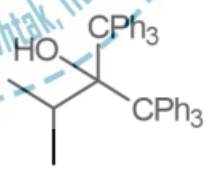
Q.61 The major products formed in the following are

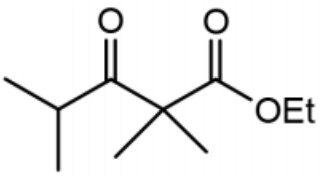


(a) 

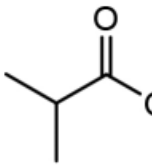
+ $Ph_3C–CH_2CH_3$

(b) 

+ EtOH

(c) 

+ EtOH

(d) 

+ $H_2C{=}CH_2$

Q.62 In a Diels-Alder reaction, the most reactive diene amongst the following is

(a) (4E)-1 , 4-hexadiene (b) (4Z)-1 , 4-hexadiene

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(c) (2E, 4E)-2, 4-hexadiene (d) (2Z, 4Z)-2, 4-hexadiene

Q.63 Consider the statements about the following structures X and Y

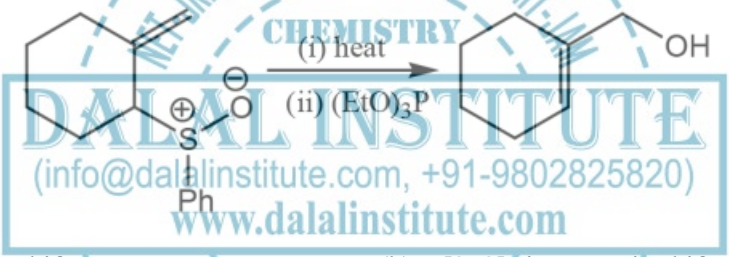
(A) X and Y are resonance structures (B) X and Y are tautomers

(C) Y is more basic than X (D) X is more basic than Y

The correct statement(s) among the above is/are

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

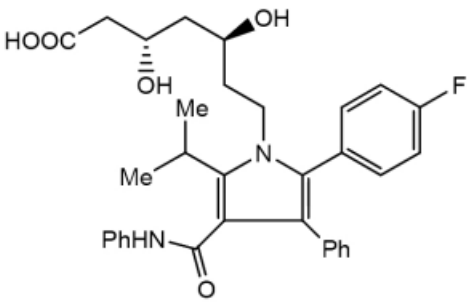
Q.64 Pericyclic reaction involved in one of the steps of the following reaction sequence is



(a) [1, 3] sigmatropic shift (b) [3, 3] sigmatropic shift

(c) [1, 5] sigmatropic shift (d) [2, 3] sigmatropic shift

Q.65 Atorvastatin (structure given below) is a



(a) Cholesterol lowering drug (b) Blood sugar lowering drug

(c) Anti-plasmodial drug (d) Anti-HIV drug

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Q.66 The maximum bond order obtained from the molecular orbitals of a transition metal dimer, formed as linear combinations of d-orbitals alone, is

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

Q.67 The term symbol that is NOT allowed for the np^2 configuration is

(a) ^1D (b) ^3P (c) ^1S (d) ^3D

Q.68 If the ionization energy of H atom is x, the ionization energy of Li^{2+}, is

(a) 1x (b) 3x (c) 9x (d) 27x

Q.69 If temperature is doubled and the mass of the gaseous molecule is halved, the rms speed of the molecular will change by a factor of

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

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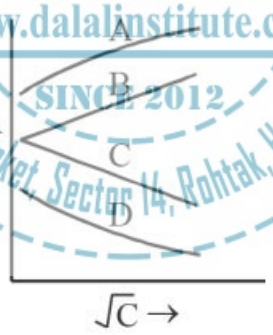
Q.70 In the graph below, the correct option, according to Kohlrausch law, is



(a) A is a weak electrolyte and Bis a strong electrolyte.

(b) A is a strong electrolyte and B is a weak electrolyte.

(c) C is a strong electrolyte and D is a weak electrolyte.

(d) C is weak electrolyte and D is a strong electrolyte

Section-C

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Q.71 Reaction of $[Ru(NH_3)_5(isonicotinamide)]^{3+}$ with $[Cr(H_2O)_6]^{2+}$ occurs by inner sphere mechanism and rate of the reaction is determined by dissociation of the successor complex. It is due to the

(a) Inert ruthenium bridged to inert chromium centre.

(b) Inert ruthenium bridged to labile chromium centre.

(c) Labile ruthenium bridged to inert chromium centre.

(d) Labile ruthenium bridged to labile chromium centre

Q.72 Consider the second order rate constants for the following outer-sphere electron transfer reactions:

$[Fe(H_2O)_6]^{3+}$ / $[Fe(H_2O)_6]^{2}$+ 4.0 $M^{-}1$ $sec^{-}1$

$[Fe(phen)_3]^{3+}$ / $[Fe(phen)_3]^{2+}$ 3.0 M^{-1} $sec^{-}1$

(phen = 1, 10-phenanthroline)

The enhanced rate constant for the second reaction is due to the fact that

(a) The 'phen' is a π-acceptor ligand that allows mixing of electron donor and acceptor orbitals that enhances the rate of electron transfer.

(b) The 'phen' is a π-donor ligand that enhances the rate of electron transfer.

(c) The 'phen' forms charge transfer complex with iron and facilitates the electron transfer.

(d) The 'phen' forms kinetically labile complex with iron and facilitates the electron transfer.

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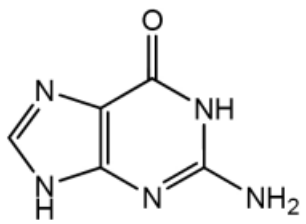
Q.73 The compound $[Re_2(Me_2PPh)_4Cl_4]$ (M) having a configuration of $\sigma^2\pi^4\delta^2\delta^{*2}$ can be oxidized to M^+ and M^{2+}. The formal metal-metal order in M, M^+ and M^{2+} respectively, are

(a) 3.0, 3.5 and 4.0 (b) 3.5, 4.0 and 3.0 (c) 4.0, 3.5 and 3.0 (d) 3.0, 4.0 and 3.5

Q.74 In low chloride ion concentration, the anticancer drug cis-platin hydrolyses to give a diaqua complex and this binds to DNA via adjacent guanine



(guanine)

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The coordinating atom of guanine to Pt(II) is

(a) N1 (b) N3 (c) N7 (d) N9

Q.75 The ^{19}F NMR spectrum of ClF_3 shows

(a) Doublet and triplet for a T-shaped structure
(b) Singlet for a trigonal planar structure
(c) Singlet for a trigonal pyramidal structure
(d) Doublet and singlet for a T-shaped structure

Q.76 The low temperature (–98°C) ^{19}F NMR spectrum of SF_4 shows doublet of triplets. It is consistent with the point group symmetry.

(a) C_{3v} (b) C_{4v} (c) T_d (d) C_{2v}

Q.77 Amongst organolithium (A), Grignard (B) and organoaluminium (C) compounds, those react with $SiC1_4$ to give compound containing Si–C bond are

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

Q.78 In its electronic spectrum, $[V(H_2O)_6]^{3+}$ exhibits two absorption bands, one at 17,800 (v_1) and the second at 25,700 (v_2) cm^{-1}. The correct assignment of these bands, respectively, is

(a) $v_1 = {}^3T_{1g}(F) \rightarrow {}^3T_{2g}(F)$, $v_2 = {}^3T_{1g}(F) \rightarrow {}^3T_{1g}(P)$

(b) $v_1 = {}^3T_{1g}(F) \rightarrow {}^3T_{1g}(P)$, $v_2 = {}^3T_{1g}(F) \rightarrow {}^3T_{2g}(P)$

(c) $v_1 = {}^3A_{2g} \rightarrow {}^3T_{1g}(F)$, $v_2 = {}^3A_{2g} \rightarrow {}^3T_{2g}(F)$

(d) $v_1 = {}^3A_{2g} \rightarrow {}^3T_{2g}(F)$, $v_2 = {}^3A_{2g} \rightarrow {}^3T_{1g}(F)$

Q.79 Reactions of elemental as with hot and cone. HNO_3 and H_2SO_4, respectively, give

(a) As_4O_6 and $As_2(SO_4)_3$
(b) $As(NO_3)_5$ and $As_2(SO_4)_3$
(c) As_4O_6 and H_3AsO_4
(d) H_3AsO_4 and As_4O_6

Q.80 The total valence electron count and the structure type adopted by the complex $[Fe_5(CO)_{15}C)]$ respectively, are

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(a) 74 and nido (b) 60 and closo (c) 84 and archano (d) 62 and nido

Q.81 ^1H NMR spectrum of $[\eta^5 -C_5H_5Rh)(C_2H_4)_2]$ at –20°C shows a typical AA' XX' pattern in the olefinic region. On increasing the temperature to ~ 70°C, the separate lines collapse into a single line which is due to

(a) Free rotation of the ethylene ligand about the metal-olefin bond.

(b) Intramolecular exchange between the ethylene ligands.

(c) Intermolecular exchange between the ethylene ligands.

(d) Change in hapticity of the cyclopentadienyl ligand.

Q.82 The nuclides among the following, capable of undergoing fission by thermal neutrons, are

A. ^{233}U B. ^{235}U C. ^{239}Pu D. ^{232}Th

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

Q.83 The use of dynamic inert atmosphere in thermogravimetric analysis (TGA)

(a) Decreases decomposition temperature (b) Decrease weight loss

(c) Reduces rate of decomposition (d) Increases weight loss

Q.84 The correct statements for hollow cathode lamp (HCL) from the following are

(A) HCL is suitable for atomic absorption spectroscopy (AAS).

(B) Lines emitted from HCL are very narrow.

(C) The hardening of lamp makes it unsuitable for AAS

(D) Transition elements used in lamps have short life.

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

Q.85 Identify the correct statement about $[Ni(H_2O)_6]^{2+}$ and $[Cu(H_2O)_6]^{2+}$

(a) All Ni–O and Cu–O bond lengths of individual species are equal.

(b) Ni–O(equatorial) and Cu–O(equatorial).

(c) All Ni–O bond lengths are equal whereas Cu–O(equatorial) bonds are shorter than Cu–O(axial) bonds.

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(d) All Cu–O bond lengths are equal whereas Ni–O(equatorial) bonds are shorter than Ni–O(axial) bonds.

Q.86 Reaction of nitrosyl tetrafluoroborate to Vaska's complex gives complex A with $\angle M-N-O = 124^o$. The complex A and its N–O stretching frequency are, respectively

(a) $[IrCl(CO)(NO)(PPh_3)_2]BF_4$, 1620 cm^{-1} (b) $[IrCl(CO)(NO)_2(PPh_3)](BF_4)_2$, 1730 cm^{-1}

(c) $[IrCl(CO)(NO)_2(PPh_3)](BF_4)_2$, 1520 cm^{-1} (d) $[IrCl(CO)(NO)(PPh_3)_2]$, 1820 cm^{-1}

Q.87 The correct order of decreasing electronegativity of the following atoms is,

(a) As > Al > Ca > S (b) S > As > Al > Ca (c) Al > Ca > S > As (d) S > Ca > As > Al

Q.88 A 1 : 2 mixture of $Me_2NCH_2CH_2CH_2PPh_2$ and KSCN with $K_2[PdCl_4]$ gives a square planar complex A. Identify the correct pairs of donor atoms trans to each other in complex A from the following combinations.

(a) P, N (b) N, S (c) P, S (d) N, N

Q.89 For a low energy nuclear reaction, $^{24}Mg(d, \alpha)^{22}Na$, the correct statements from the following are

(A) Kinetic energy of d particle is not fully available for exciting ^{24}Mg.

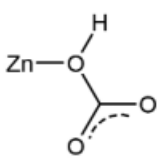
(B) Total number of protons and neutrons is conserved.

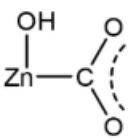
(C) Q value of nuclear reaction is much higher in magnitude relative to heat of chemical reaction.

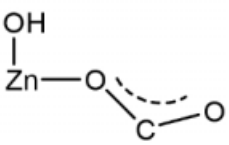
(D) Threshold energy is ≤ Q value.

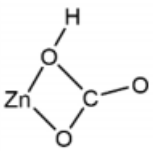
(a) A, B and C (b) A, B and D (c) B, C and D (d) A, C and D

Q.90 At pH 7, the zinc(II) ion in carbonic anhydrase reacts with CO_2 to give

(a) 

(b) 

(c) 

(d) 

Q. 91 Molybdoenzymes can both oxidize as well as reduce the substrates, because

(a) Mo(VI) is more stable than Mo(IV).

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(b) Mo(IV) can transfer oxygen atom to the substrate and Mo(VI) can abstract oxygen atom from the substrate.

(c) Conversion of Mo(VI) to Mo(IV) is not favoured.

(d) Mo(VI) can transfer oxygen atom to the substrate and Mo(IV) can abstract oxygen atom from the substrate.

Q.92 A comparison of the valence electron configuration of the elements, Sm and Eu suggests that

(a) Sm is a better one electron reductant than Eu.

(b) Sm is a better one electron oxidant than Eu.

(c) Facile oxidation state is +2 for both the elements.

(d) Both of these display similar redox behaviour.

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Q.93 The cooperative binding of O_2 in hemoglobin is due to

(a) A decrease in size of iron followed by changes in the protein conformation.

(b) An increase in size of iron followed by changes in the protein conformation.

(c) A decrease in size of iron that is NOT accompanied by the protein conformational changes.

(d) An increase in size of iron that is NOT accompanied by the protein conformational changes.

Q.94 Amongst the following which is not isolobal pairs

(a) $Mn(CO)_5$, CH_3 (b) $Fe(CO)_4$, O (c) $Co(CO)_3$, R_2Si (d) $Mn(CO)_5$, RS

Q.95 The correct order of the size of S, S^{2-}, S^{2+} and S^{4+} species is,

(a) $S > S^{2+} > S^{4+} > S^{2-}$ (b) $S^{2+} > S^{4+} > S^{2-} > S$ (c) $S^{2-} > S > S^{2+} > S^{4+}$ (d) $S^{4+} > S^{2-} > S > S^{2+}$

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

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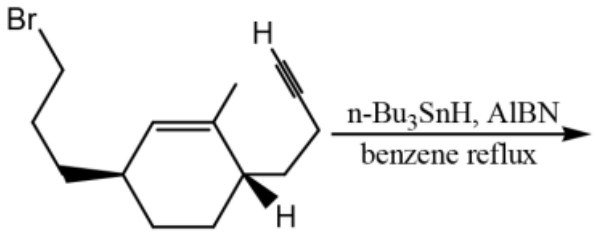
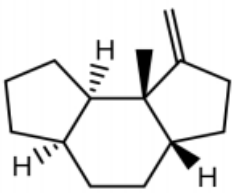


(a)


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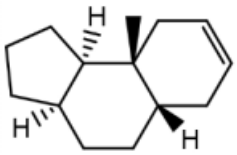

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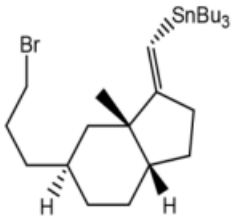

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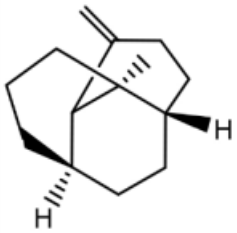

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Q.97 The correct combination of reagents to effect the following conversion is

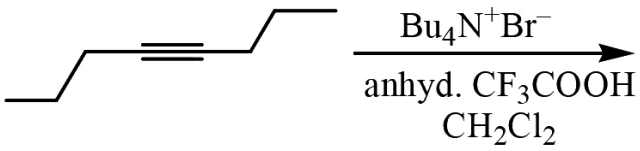
(a) (i) $Ph_3P^+CH_2OMeCl^-$, BuLi, (ii) H_3O^+, Jones' reagent.

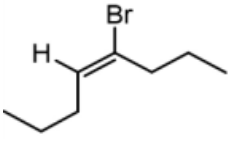
(b) (i) H_2N^-NHTs; (ii) BuLi (2 equiv); (iii) DMF.

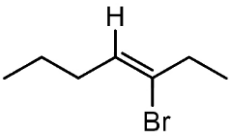
(c) (i) H_2N^-NHTs; (ii) BuLi (2 equiv); (iii) CO_2

(d) (i) $ClCH_2CO_2Et$, LDA; (ii) $BF_3.OEt_2$; (iii) DMSO, $(COCl)_2$, Et_3N, –78°C to rt.

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



(a)


(b)


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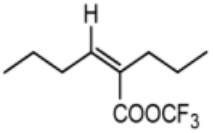
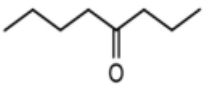


(d)


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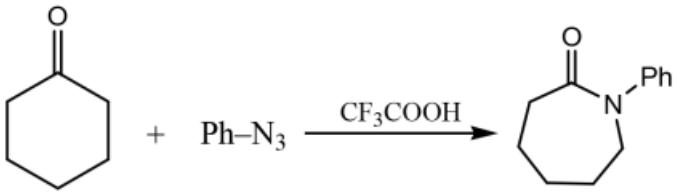
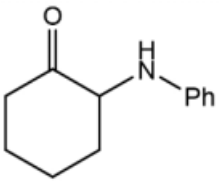
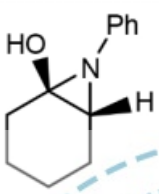
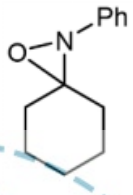
Q.99 Consider the following reaction,

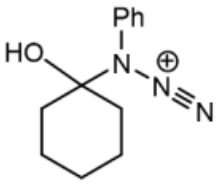


The appropriate intermediate involved in this reaction is

(a) 

(b) 

(c) 

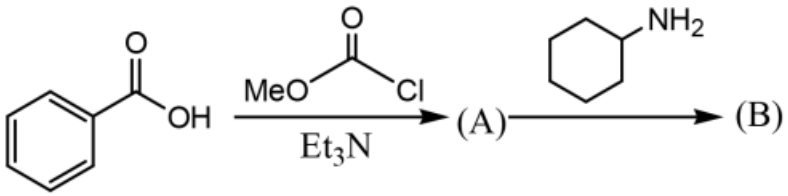
(d) 

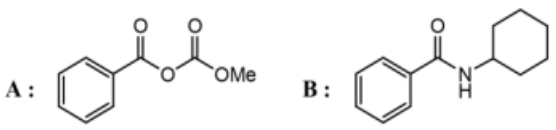
Q.100 The correct ^{13}C NMR chemical (δ) shift values of carbons labeled a-e in the following ester are

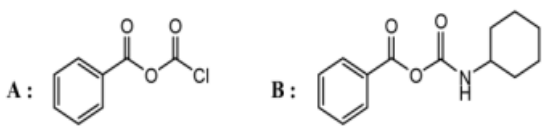
(a) a : 19; b : 143; c : 167; d : 125; e : 52 (b) a : 52; b : 143; c : 167; d : 125; e : 19

(c) a : 52; b : 167; c : 143; d : 125; e : 19 (d) a: 52; b: 167; c : 125; d : 143; e : 19

Q.101 The products A and Bin the following reaction sequence are



(a) 

(b) 

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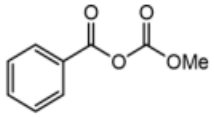
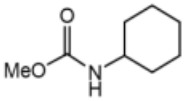
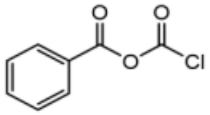
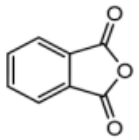
(c) A :  B : 

(d) A :  B : 

Q.102 The biosynthesis of isopentenyl pyrophosphate from acetyl CoA involves:

A Four molecules of acetyl CoA

B. Three molecules of ATP

C. Two molecules of NADPH

D. Two molecules of lipoic acid

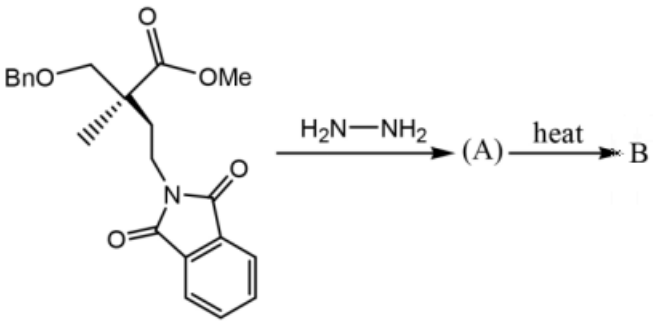
The correct options among these are

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

Q.103 Amongst the following, the major products formed in the following photochemical reactions are

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

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



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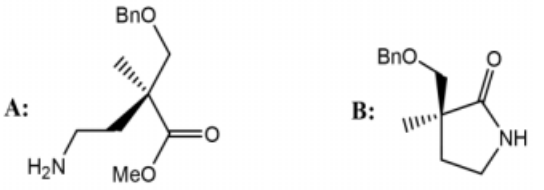
(a)



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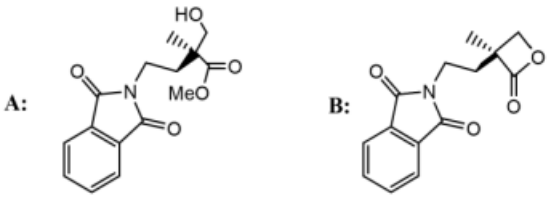

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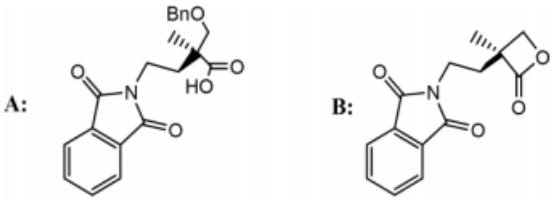

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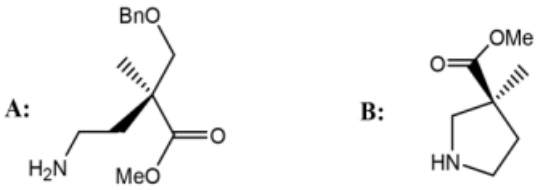
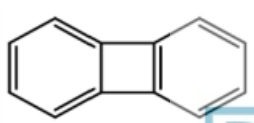


Q.105 Anthranilic acid, on treatment with iso-amyl nitrite furnishes a product which displays a strong peak at 76 (m/e) in its mass spectrum. The structure of the product is

(a)



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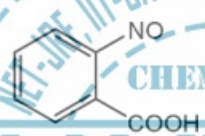

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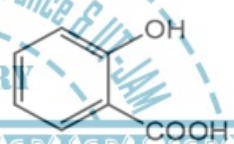
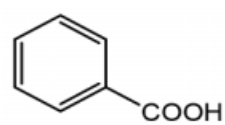


(d)



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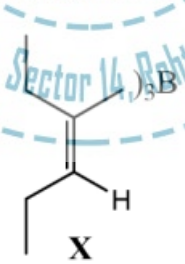
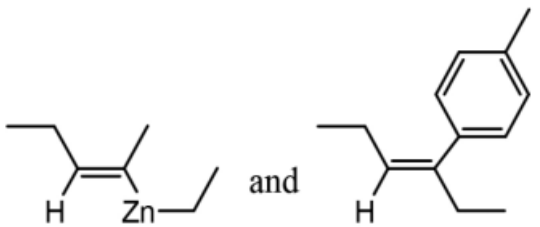
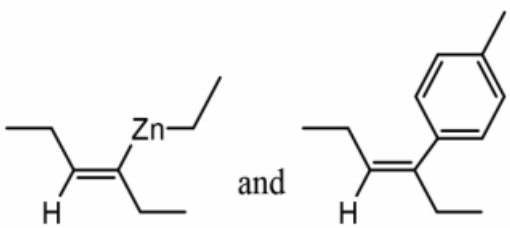
Q.106 The organoborane X, when reacted with Et_2Zn followed by p-iodotoluene in the presence of catalytic amount of $Pd(PPh_3)_4$ furnishes a tri-substituted alkene. The intermediate and the product of the reaction, respectively, are



(a)



(b)



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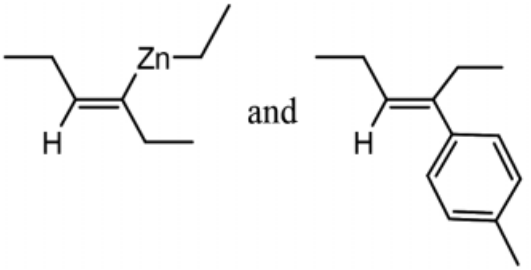
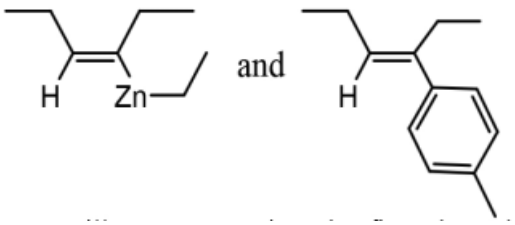
(c) 

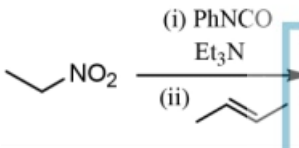
(d) 

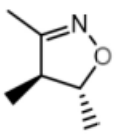
Q.107 Using Boltzmann distribution, the probability of an oscillator occupying the first three levels (n = 0, 1 and 2) is found to be $p_0 = 0.633$, $p_1 = 0.233$ and $p_2 = 0.086$.

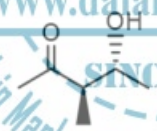
The probability of finding an oscillator in energy levels in $n \geq 3$ is

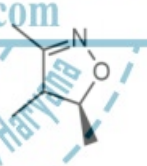
(a) 0.032 (b) 0.048 (c) 0.952 (d) 1.000

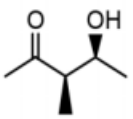
Q.108 The major products A and B in the following reaction sequence are

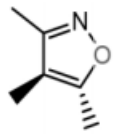


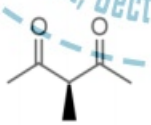
(a) **A:** 

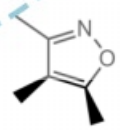
B: 

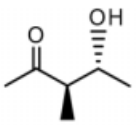
(b) **A:** 

B: 

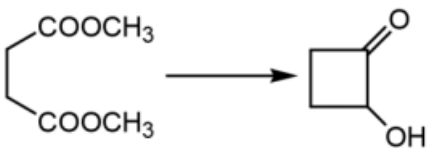
(c) **A:** 

B: 

(d) **A:** 

B: 

Q.109 The correct combination of reagents required to effect the following conversion is



(a) (i) Na, xylene, Me_3SiCl, heat; (ii) H_3O^+ (b) (i) Na, xylene, heat; (ii) H_2O_2, NaOH

(c) (i) NaOEt, EtOH; (ii) Na, xylene, heat (d) (i) $TiCl_3$, Zn-Cu, Me_3SiCl, heat; (ii) H_3O^+

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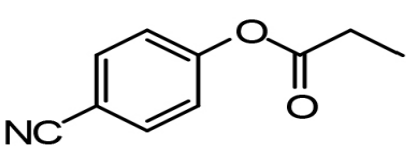
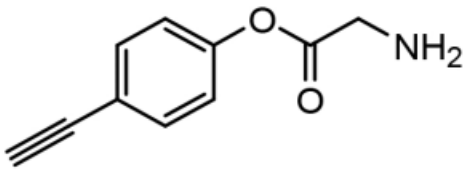
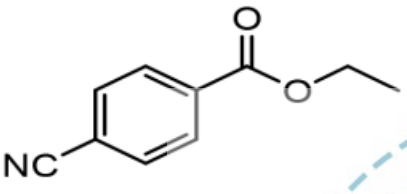
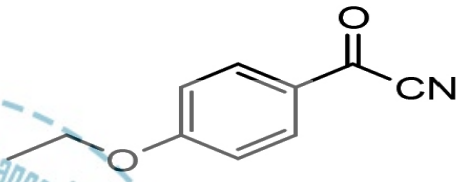
Q.110 An organic compound gives following spectral data:

IR : 2210, 1724cm^{-1}, ^{1}HNMR : δ 1.4(t, J=7.1Hz, 3H), 4.4(q, J=7.1Hz, 2H); ^{13}CNMR: δ 16, 62, 118, 119, 125, 127, 168. The compound is

(a) 

(b) 

(c) 

(d) 

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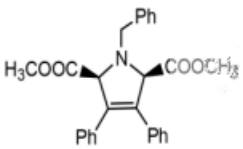
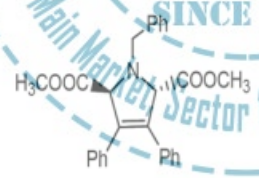
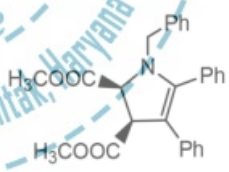
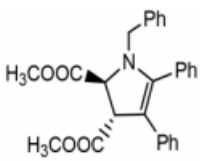
Q.111 The major product formed in the following reaction is

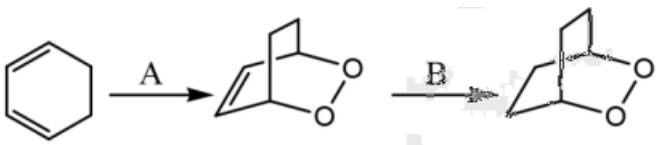
(a) 

(b) 

(c) 

(d) 

Q.112 The correct combination of reagents for effecting the following sequence of reactions is



(a) A= O_3/O_2; B = $K^{+-}OOC–N=N–COO^{-}K^{+}$ AcOH.

(b) A= O_2, Rose Bengal, hv; B = $K^{+-}OOC–N=N–COO^{-}K^{+}$, AcOH.

(c) A= O_2, Rose Bengal, hv; B = H_2, Pd/C

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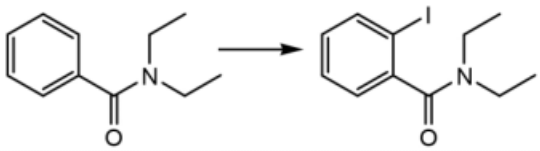
(d) A= O_2, Rose Bengal, Δ; B = H_2, Pd/C

Q.113 The correct combination of reagents required to effect the following conversion is



(a) I_2, HNO_3

(b) s-BuLi, –78°C followed by KI

(c) NaOEt followed by ICH_2CH_2I

(d) s-BuLi, –78°C followed by ICH_2CH_2I

Q.114 Consider a particle confined in a cubic box. The degeneracy of the level, that has an energy twice that of the lowest level, is

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

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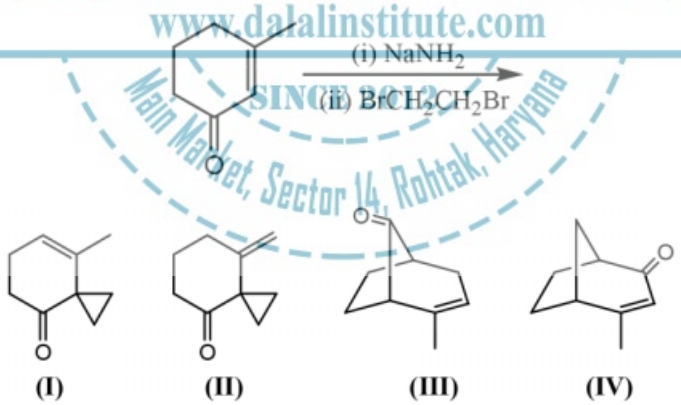
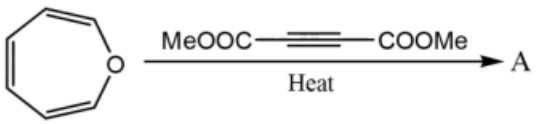
Q.115 Only two products are obtained in the following reaction sequence. The structures of the products from the list I-IV are



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

Q.116 The major product A formed in the following reaction is



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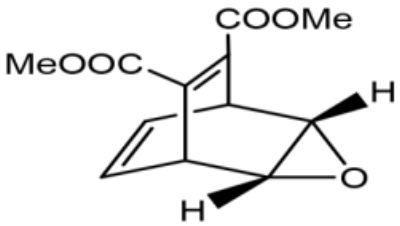
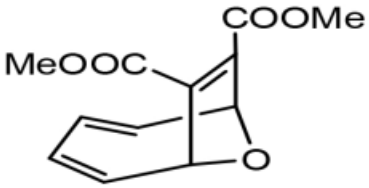
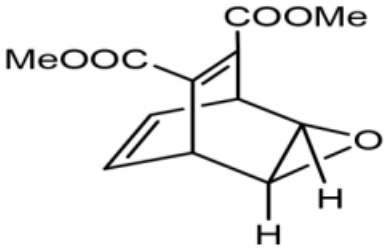
(a)



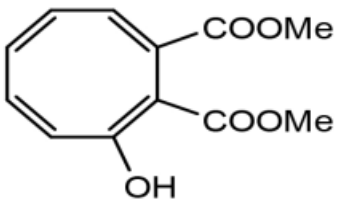
(b)



(c)

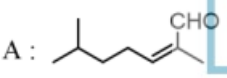


(d)

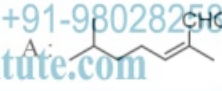


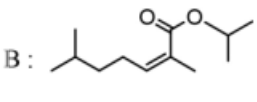
Q.117 The products A and Bin the following reaction sequence are

(a)



(b)





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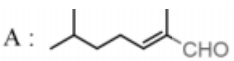
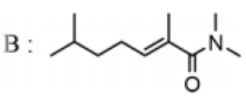


(d)



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Q.118 The spatial part of the wave function of the atom in its ground state is ls(l) ls(2). The spin part would be

(a) $\alpha(1)\alpha(2)$

(b) $\beta(1)\beta(2)$

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

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

Q.119 The number of phases, components and degrees of freedom, when Ar is added to an equilibrium mixture of NO, O_2 and NO_2 in gas phase are, respectively

(a) 1, 3, 5 (b) 1, 4, 5 (c) 1, 3, 4 (d) 1, 4, 4

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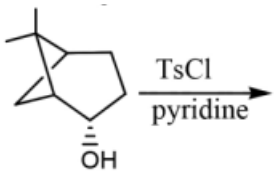
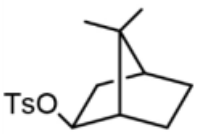
Q.120 The major product formed in the following reaction is



(a) 

(b)

(c)

(d)

Q.121 A particle in a one-dimensional harmonic oscillator in x-direction is perturbed by a potential λx (λ is a number). The first-order correction to the energy of the ground state

(a) Is zero (b) Is negative (c) Is positive (d) May be negative or positive but NOT zero.

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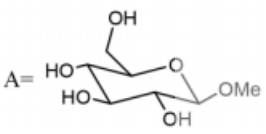
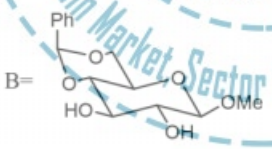
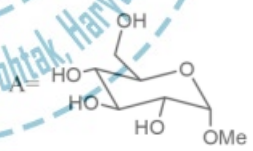
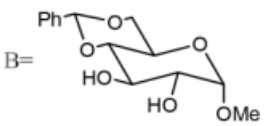
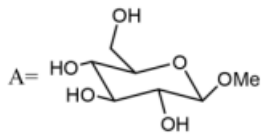
Q.122 The points A and B in the following sequence of reactions are

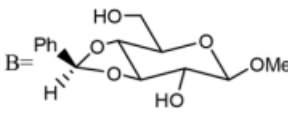
(a) 

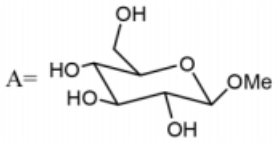


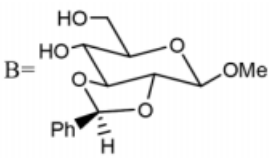
(b) 



(c) 



(d) 



Q.123 The mass spectrum of the product A, formed in the following reaction, exhibits M, M+2, M + 4 peaks in the ratio of about 1 : 2 : 1. The reagent HX and the product A are

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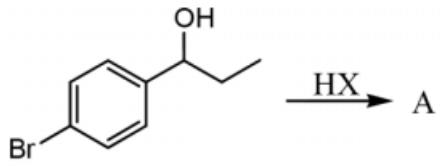
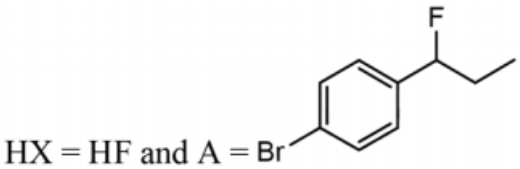
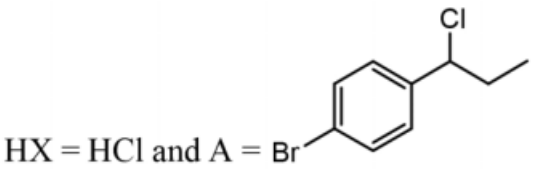
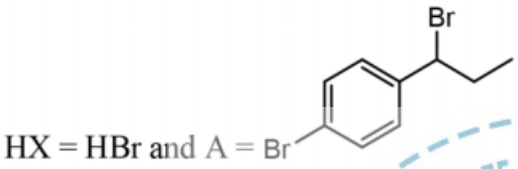
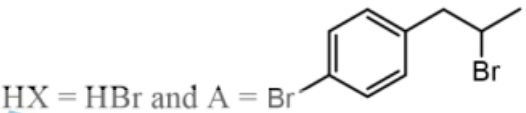


(a) 

(b) 

(c) 

(d) 

Q.124 Match the following natural products in column A with their structural features in column B

Column A	Column B
I. Colchicine	A. Tetrahydrooxepine
II. Strychnine	B. Phenanthrene
III. Quinine	C. Tropolone
IV. Ephedrine	D. Phenylethylamine
	E. Quinoline
	F. Benzofuran

Identify the correct match from the following

(a) I-C, II-A, III-E, IV-D

(b) I-F, II-A, III-B, IV-E

(c) I-A, II-D, III-F, IV-D

(d) I-C, II-A, III-E, IV-F

Q.125 particle in a one-dimensional box (potential zero between to a and infinite outside) has the ground state energy $E_0 = \frac{0.125h^2}{ma^2}$. The expectation value of the above Hamiltonian with ma $\Psi(x) = x(x - a)$ yields an energy E_1. Using a linear combination of two even functions $x(x - a)$ and $x^2(x - a)^2$, we obtain variational minimum to the ground state energy as E_2Which of the following relations holds for E_0, E, and E_2?

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(a) $E_0 < E_1 < E_2$ (b) $E_0 < E_2 < E_1$ (c) $E_1 < E_0 < E_2$ (d) $E_2 < E_0 < E_1$

Q.126 The dissociation constant of a weak acid HX at a given temperature is 2.5×10^{-5}. The pH of 0.01 M NaX at this temperature is

(a) 7.3 (b) 7.7 (c) 8.3 (d) 8.7

Q.127 The ground state energy of hydrogen atom is –13.598 eV. The expectation values of kinetic energy, $\langle T \rangle$ and potential energy, $\langle V \rangle$, in units of eV, are

(a) $\langle T \rangle = 13.598, \langle V \rangle = -27.196$ (b) $\langle T \rangle = -27.196, \langle V \rangle = 13.598$

(c) $\langle T \rangle = -6.799, \langle V \rangle = -6.799$ (d) $\langle T \rangle = 6.799, \langle V \rangle = -20.397$

Q.128 If $\Psi = 0.8\varphi_A + 0.4\varphi_B$ is a normalized molecular orbital of a diatomic molecule AB, constructed from φ_A and φ_B which are also normalized, the overlap between φ_A and φ_B is

(a) 0.11 (b) 0.31 (c) 0.51 (d) 0.71

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Q.129 At a given temperature consider

$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(s) + 3CO_2(g)$; $K_1 = 0.05$

$2CO_2(g) \rightleftharpoons 2CO(g) + O_2(g)$; $K_2 = 2 \times 10^{-12}$

The equilibrium constant for the reaction

$2Fe_2O_3(s) \rightleftharpoons 4Fe(s) + 3O_2$ is

(a) 1×10^{-13} (b) 2×10^{-38} (c) 4×10^{-15} (d) 2×10^{-24}

Q.130 In a bomb calorimeter, the combustion of 0.5 g of compound A (molar mass= 50 g mot^{-1}) increased the temperature by 4K. If the heat capacity of the calorimeter along with that of the material is 2.5 kJ K^{-1}, the molar internal energy of combustion, in kJ, is

(a) 1000 (b) –1000 (c) 20 (d) –20

Q.131 The translational, rotational and vibrational partition functions for a molecule are

$f_{translation} \simeq 10^{10}\ m^{-1}$, $f_{rotation} \simeq f_{vibration} \simeq 1$, $(k_BT/h) \simeq 10^{13}$ at room temperature, $N_A \simeq 6 \times 10^{23}$.

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Using the approximate data given above, the frequency factor (A) for a reaction of the type:

Atom + diatomic molecule → non-linear transition state → product, according to the conventional transition state theory is

(a) 2×10^3 (b) 6×10^7 (c) 2×10^{12} (d) 6×10^{13}

Q.132 The interplanar spacing of (110) planes in a cubic unit cell with lattice parameter a= 4.242 Å is

(a) 5Å (b) 6Å (c) 7.35Å (d) 2.45Å

Q.133 A compound A_xB_y has a cubic structure with A atoms occupying all comers of the cube as well as all the face centre positions. The B atoms occupy four tetrahedral voids. The values of x and y respectively, are

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

Q.134 The number of lines in the ESR spectrum of CD_3 is (the spin of D is 1)

(a) 1 (b) 3 (c) 4 (d) 7

Q.135 The C = O bond length is 120 pm in CO_2. The moment of inertia of CO_2 would be close to (masses of C and O are 1.9×10^{-27} kg and 2.5×10^{-27} kg, respectively)

(a) 1.8×10^{-45} kgm^2 (b) 3.6×10^{-45} kgm^2 (c) 5.4×10^{-45} kgm^2 (d) 7.2×10^{-45} kgm^2

Q.136 The fluorescence lifetime of a molecule in a solution is 5×10^{-9} s. The sum of all of the non-radiative rate constants $(\sum k_{nr})$ for the decay of excited state is 1.2×108 s^{-1}. The fluorescence quantum yield of the molecule is

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

Q.137 Solutions of three electrolytes have the same ionic strength and different dielectric constants as 4, 25 and 81. The corresponding relative magnitude of Debye-Huckel screening, lengths of the three solutions are

(a) 4, 25 and 81 (b) 2, 5 and 9 (c) 1/2, 1/5 and 1/9 (d) 1, 1 and 1

Q.138 Simple Huckel molecular orbital theory

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(a) Considers electron-electron repulsion explicitly.

(b) Distinguishes cis-butadiene and trans-butadiene.

(c) Distinguishes cis-butadiene and cyclobutadiene.

(d) Has different coulomb integrals for non-equivalent carbons.

Q.139 For the non-dissociative Langmuir type adsorption of a gas on a solid surface at a particular temperature, the fraction of surface coverage is 0.6 at 30 bar. The Langmuir isotherm constant (in bar^{-1} units) at this temperature is

(a) 0.05 (b) 0.20 (c) 2.0 (d) 5.0

Q.140 For a set of 10 observed data points, the mean is 8 and the variance is 0.04. The 'standard deviation' and the 'coefficient of variation' of the data are, respectively

(a) 0.005, 0.1 % (b) 0.02, 0.2% (c) 0.20, 2.5% (d) 0.32, 1.0%

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Q.141 In the Lineweaver-Burk plot of $(\text{initial rate})^{-1}$ vs. $(\text{initial substrate concentration})^{-1}$ for an enzyme catalyzed reaction following Michaelis-Menten mechanism, the y-intercept is 5000 M^{-1} s. If the initial enzyme concentration is 1×10^{-9} M, the turnover number is

(a) 2.5×10^3 (b) 1×10^4 (c) 2.5×10^4 (d) 2.0×10^5

Q.142 The E ⊗ E direct product in D_3 point group contains the irreducible representations

D_3	E	$2C_3$	$3C_2$
A_1	1	1	–1
A_2	1	1	–1
E_2	2	–1	0

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

Q.143 The result of the product C_2 (x)C_2 (y) is

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(a) E (b) σ_{xy} (c) $C_2(z)$ (d) i

Q.144 Given;

A. $Fe(OH)_2$ (s) + $2e^- \rightarrow Fe(s) + 2OH^-(aq)$; $E^0 = -0.877V$

B. $Al_3+(aq) + 3e^- \rightarrow Al(s)$; $E^0 = -1.66V$

C. $AgBr(aq) + e^- \rightarrow Ag(s) + Br^-(aq)$; $E^0 = 0.071V$

The overall reaction for the cells in the direction of spontaneous change would be

(a) Cell with A and B : Fe reduced
Cell with A and C : Fe reduced

(b) Cell with A and B : Fe reduced
Cell with A and C : Fe oxidized

(c) Cell with A and B: Fe oxidized
Cell with A and C : Fe oxidized

(d) Cell with A and B : Fe oxidized
Cell with A and C : Fe reduced

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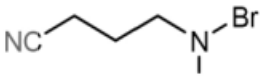
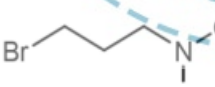
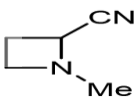
Q.145 The reagent A used and the major product B formed in the following reaction sequence are

(a) A : $LiAlH_4$ B:

(b) A : $LiAlH_4$ B: 

(c) A : $NaBH_4$ B: 

(d) A : $H_2Pd - C$ 

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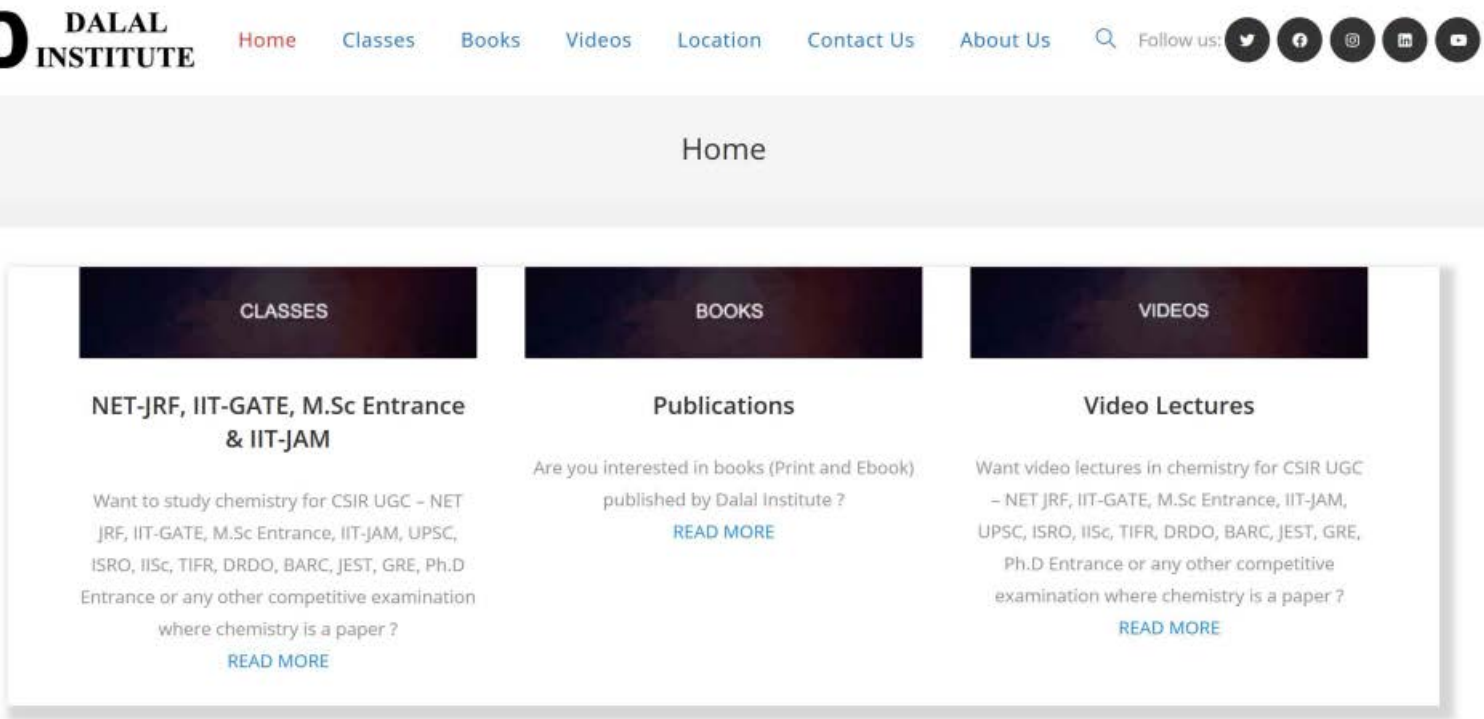

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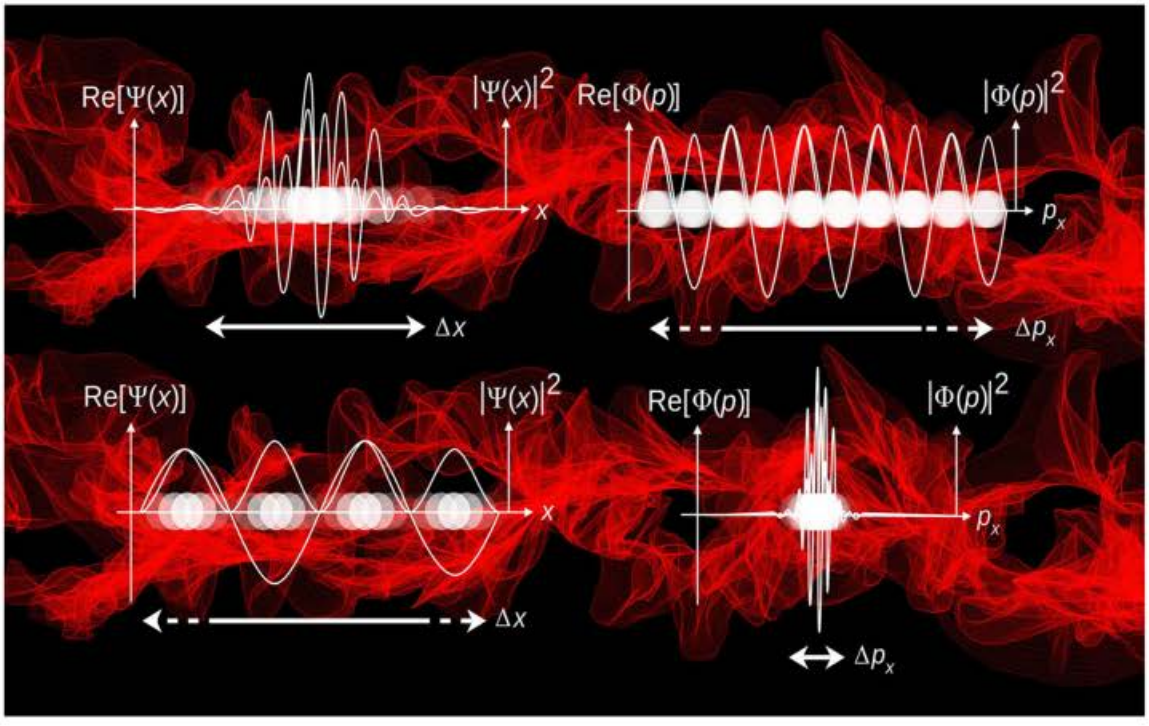

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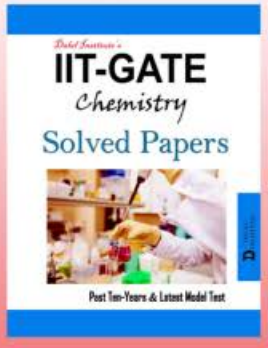

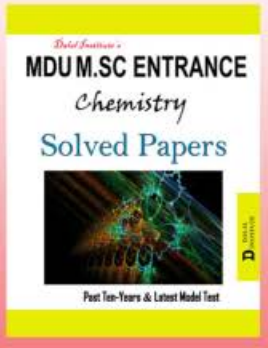

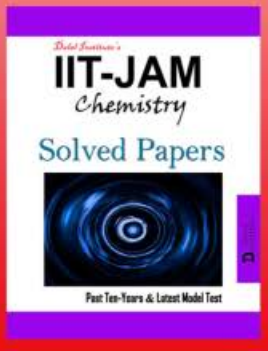

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