CSIR UGC – NET JRF: June 2012

Chemical Science

❖ Question Paper

Section-A

Q.1 In still air, fragrance of a burning incense stick will be smelt by an observer quickest when the experiment is carried out at

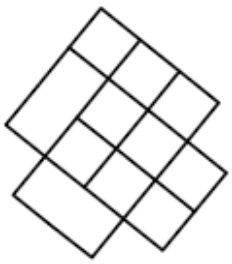
(a) Low altitude and high air temperature.

(b) High altitude and low air temperature.

(c) Low altitude and low air temperature.

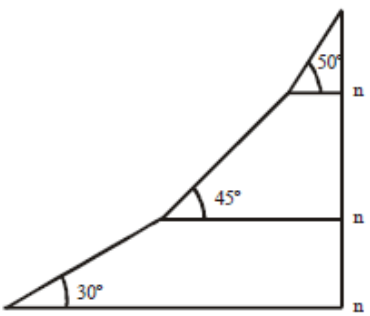
(d) High altitude and high air temperature.

Q.2 How many squares are there in this figure?



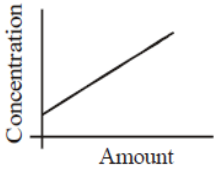
(a) 9 (b) 14 (c) 13 (d) 17

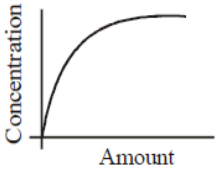
Q.3 A mountain road has 3 sections of different slopes as shown. What is the average slope 'm' of the entire climb?

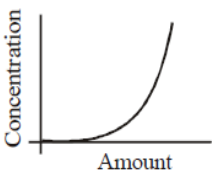


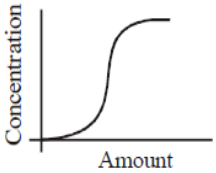
(a) 1 (b) $(1/3) < m < (1/2)$ (c) $1 < m < \sqrt{3}$ (d) $(1/\sqrt{3}) < m < 1$

Q.4 Which of the following graphs shows the concentration of a sugar solution as a function of the cumulative amount of sugar added in the process of preparing a saturated solution (the temperature remaining constant)?

(a) 

(b) 

(c) 

(d) 

Q.5 There are sand-piles which are geometrically similar but of different heights. The ratio of the masses of the sand comprising two randomly chosen piles will be equal to the ratio of the

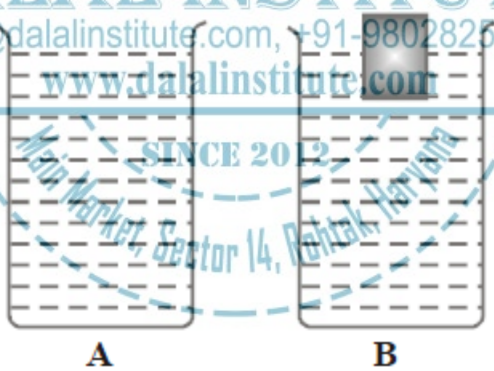
(a) Pile heights.

(b) Squares of the piles heights

(c) Cubes of the pile heights.

(d) Cube-roots of the pile heights.

Q.6 There are two identical vessels of volume 'V' each, one empty, and the other containing a block of wood of weight 'w'. The vessels are then filled with water up to the brim. The two arrangements are shown as A and B in the figure. If the density of water is ρ and g is the acceleration due to gravity, then



(a) A and B have equal weights.

(b) A is heavier than B by an amount w.

(c) A is heavier than B by an amount V ρ g – w.

(d) B is heavier than A by an amount V ρ g – w.

Q.7 If the father has blood group O and the mother has blood group B, what are the possible blood groups of their children?

(a) O, AB, A

(b) A, B

(c) A, O

(d) B, AB

Q.8 Nuclei of ^{32}P and ^{32}S, accelerated through the same potential difference enter a uniform, transverse magnetic field (Z = 15 for P and Z = 16 for S). As they emerge from the magnetic field.

(a) Both nuclei emerge undeflected

(b) ^{32}P is deflected less than ^{32}S.

(c) ^{32}P is deflected more than ^{32}S

(d) Both are equally deflected

Q.9 A person chewing a bubble gum did not experience ear pain in a jet plane while landing whereas another person not chewing a gum had ear pain. The reason could be

(a) Chewing gum is a pain killer.

(b) Chewing equilibrates pressure on both sides of the ear drum.

(c) Chewing gum closes the ear drum.

(d) Chewing distracts the person.

Q.10 The reason why a lunar eclipse does not occur at every full moon is:

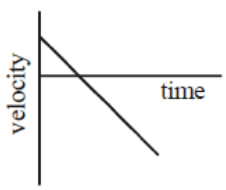
(a) The position of the sun is not favorable at all full moons.

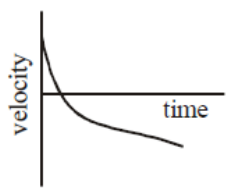
(b) The orbital planes of the moon and that of the earth are inclined to each other by a small angle

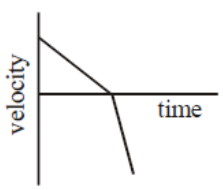
(c) The shape of earth is not a perfect sphere.

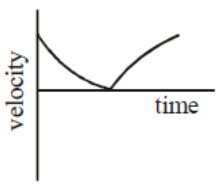
(d) The moon reflects only from one hemisphere.

Q.11 A boy throws a stone vertically upwards with a certain initial velocity. Which of the following graphs depicts the velocity as a function of time, if the acceleration due to gravity is assumed to be uniform and constant?

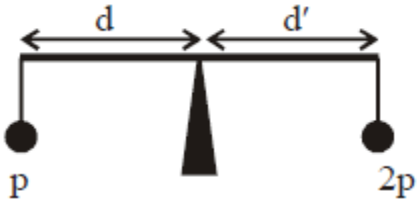
(a) 

(b) 

(c) 

(d) 

Q.12 A rigid uniform bar of a certain mass has two bobs of the same size, but with different densities p and 2p suspended identically from its ends. When the bar is level on a fulcrum as shown in the figure, d and d' are related by

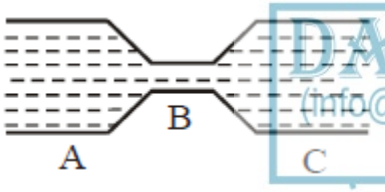


(a) $2d = d'$ (b) $d > 2d'$ (c) $d = 2d'$ (d) $d < 2d'$

Q13 There are two points A and A' on the equator at longitudes 0º and 90ºE, and two other points B and B' on the same longitudes, respectively, but at latitude 60ºS. The distances (along the latitudes) between the points A, A' and B, B' are related by

(a) $AA' = BB'$ (b) $AA' = 2\,BB'$ (c) $AA' = \sqrt{3}\,BB'$ (d) $AA' = \sqrt{2}\,BB'$

Q.14 Water is flowing through a tube as shown. The cross-sectional areas at A and C are equal, and greater than the cross-sectional area at B. If the flow is steady, then the pressure on the walls at B is



(a) Less than that at A and that at C. (b) More than that at A and that at C.

(c) Same as that at A and that at C. (d) More than that at A but less than that at C.

Q.15 Match the two lists

Raw Material	Product
A. Limestone	1. Porcelain
B. Gypsum	2. Glass
C. Silica sand	3. Plaster of Paris
D. Clay	4. Cement

	A	B	C	D
(a)	1	2	3	4

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

Q.16 The ^{14}C dating method is not usually used for dating organic substances older than ~60, 000 years, because

(a) Such objects rarely contain carbon.

(b) Such objects accumulated ^{14}C after their formation.

(c) In those times there was no production of ^{14}C.

(d) Most of the ^{14}C in the sample would have decayed.

Q.17 A seismograph receives a S-wave 60 s after it receives the P-wave. If the velocities of P and S waves are 7 km/s and 6 km/s respectively, then the distance of the seismic focus from the seismograph is:

(a) 2520 km (b) 42 km (c) 707 km (d) 72 km

Q.18 The decay of a radioactive isotope P produces a stable daughter isotope D. The ratio of the number of atoms of D to the number of atoms of P after 2 half-lives would be

(a) ¼ (b) ¾ (c) 3 (d) 2

Q.19 The scatter plots represent the values measured by two similar instruments. Point A in the figures represents the true value. Which of the following is a correct description of the quality of these measurements?

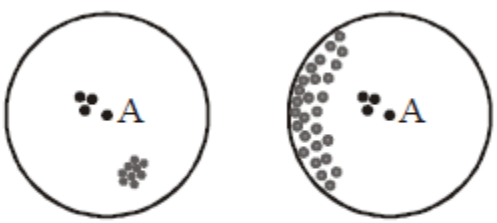


fig.1 fig.2

(a) Fig-1: good accuracy, good precision; Fig-2: good accuracy, good precision.

(b) Fig-1: poor accuracy, poor precision; Fig-2: good accuracy, poor precision.

(c) Fig-1: poor accuracy, good precision; Fig-2: poor accuracy, good precision.

(d) Fig-1: poor accuracy, poor precision; Fig-2: poor accuracy, good precision.

Q.20 Even though the concentration of CO_2 is the same at sea level and at high altitude, the photosynthetic rate is higher in a plant grown at sea level than in a plant (of the same species) grown at high altitude. The reason for this is

(a) Light intensity is more at sea level.

(b) Temperature is lower at higher altitude.

(c) Atmospheric pressure is higher at sea level.

(d) Relative humidity is higher at sea level.

Section-B

Q.21 In the reactions (A) and (B),

$$nH_2O + Cl^- \longrightarrow [Cl(H_2O)_6]^- \quad \ldots\ldots\ldots(A)$$

$$6H_2O + Mg^{2+} \longrightarrow [Mg(H_2O)_6]^{2+} \quad \ldots\ldots\ldots(B)$$

water behaves as

(a) An acid in both (A) and (B)

(b) An acid in (A) and a base in (B)

(c) A base in (A) an acid in (B)

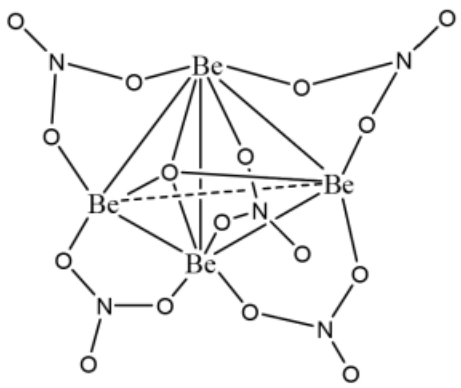
(d) A base in both (A) and (B)

Q.22 The size of the d orbitals in Si, P, S and Cl follows the order.

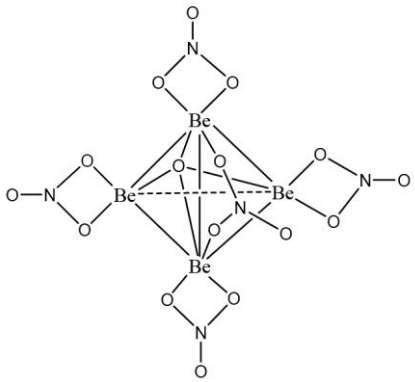
(a) Cl > S > P > Si (b) Cl > P > S > Si (c) P > S > Si > Cl (d) Si > P > S > Cl

Q.23 The correct structure of basic beryllium nitrate is:

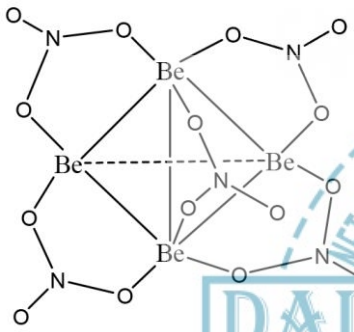
(a)



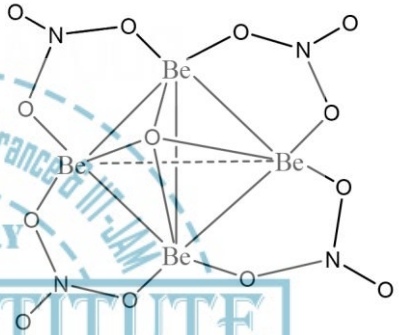
(b)



(c)



(d)



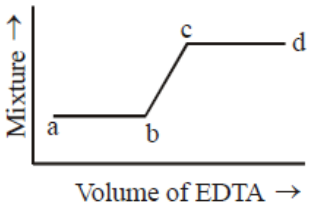
Q.24 The total number of lone pairs of electrons in I_3^- is:

(a) Zero (b) Three (c) Six (d) Nine

Q.25 If Mossbauer spectrum of $Fe(Co)_5$ is recorded in the presence of a magnetic field, the original spectrum with two lines changes into the one with

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

Q.26 The spectrophotometric response for the titration of a mixture of Fe^{3+} and Cu^{2+} ions against EDTA is given below.



The correct statement is:

(a) Volume ab = $[Fe^{3+}]$ and volume cd = $[Cu^{2+}]$

(b) Volume ab = $[Cu^{2+}]$ and volume cd = $[Fe^{3+}]$

(c) Volume ab = $[Fe^{3+}]$ and volume cd = excess EDTA

(d) Volume ab = $[Cu2^{2+}]$ and volume cd = excess EDTA

Q.27 In 'carbon-dating' application of radioisotopes, ^{14}C emits

(a) β – particle (b) α – particle (c) γ – particle (d) Positron

Q.28 The actual base pairs present in the double helical structure of DNA containing adenine (A), thymine (T), cytosine (C) and guanine (G), are

(a) AG and CT (b) AC and GT (c) AG and AC (d) AT and GC

Q.29 The oxidation state of iron in met-hemoglobin is

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

Q.30 The reaction of $Ni(CO)_4$ with the ligand L (L = PMe_3 or $P(OMe)_3$)L yields $Ni(CO)_3L$. The reaction is

(a) Associative (b) Dissociative (c) Interchange (I_a) (d) Interchange (I_d)

Q.31 As a ligand Cl^- is:

(a) Only a σ – donor (b) Only a π – donor

(c) Both a σ – donor and a π – donor (d) A σ – donor and a σ – acceptor

Q.32 The correct d-electron configuration showing spin-orbit coupling is

(a) $t_{2g}^4\, e_g^2$ (b) $t_{2g}^6\, e_g^0$ (c) $t_{2g}^4\, e_g^0$ (d) $t_{2g}^3\, e_g^2$

Q.33 The correct statement for the aggregating nature of alkyl lithium (RLi) reagent is:

(a) The carbanion nucleophilicity increases with aggregation.

(b) The observed aggregation arises from its electron deficient nature.

(c) Carbanion nucleophilicity does not depend on aggregation.

(d) The extent of aggregation is maximum in polar dative solvents.

Q.34 For the reaction, trans-$[IrCl(CO)(PPh_3)_2] + Cl_2 \rightarrow [IrCl_3(CO)(PPh_3)_2]$, the correct observation is:

(a) $v_{CO}(product) > v_{CO}(reactant)$ (b) $v_{CO}(product) < v_{CO}(reactant)$

(c) $v_{CO}(product) = v_{CO}(reactant)$ (d) $v_{CO}(product) = v_{CO}(free\ CO)$

Q.35 The nucleophilic attack on olefins under mild conditions:

(a) Is always facile.

(b) Is more facile than electrophilic attack on olefins.

(c) Is facile for electron-rich olefins.

(d) Requires activation by coordination to metal.

Q.36 Among the following the strongest oxidizing agent is:

(a) $[WO_4]^{2-}$ (b) $[CrO_4]^{2-}$ (c) $[MoO_4]^{2-}$ (d) $[ReO_4]^{1-}$

Q.37 The least basic among the following is:

(a) $Al(OH)_3$ (b) $La(OH)_3$ (c) $Ce(OH)_3$ (d) $Lu(OH)_3$

Q.38 For any operator A and its adjoint A† , the INCORRECT statement is:

(a) AA† is Hermitian (b) AA† + A†A is Hermitian

(c) A + A† is Hermitian (d) A – A† is Hermitian

Q.40 The average value of the radius <r> in the 1s state of the hydrogen atom is (a_0 is Bohr radius)

(a) a_0 (b) $1.5\ a_0$ (c) $0.75\ a_0$ (d) $0.5\ a_0$

Q.41 Among the following, the CORRECT statement is:

(a) The number of irreducible representations is equal to classes of symmetry operations.

(b) The number of irreducible representations is equal to the order of the symmetry point group.

(c) The irreducible representations contained in any point group are always of one dimension.

(d) A symmetry point group may not contain a totally symmetric irreducible representation.

Q.42 For a diatomic molecule AB, the energy for the rotational transition from J = 0 to J = 1 state is 3.9 cm^{-1}. The energy for the rotational transition from J = 3 to J = 4 state would be

(a) 3.9 cm^{-1} (b) 7.8 cm^{-1} (c) 11.7 cm^{-1} (d) 15.6 cm^{-1}

Q.43 For the vibrational Raman spectrum of a homonuclear diatomic molecule, the selection rule under harmonic approximation is

(a) $\Delta v = 0$ only (b) $\Delta v = \pm 1$ only (c) $\Delta v = \pm 2$ only (d) $\Delta v = 0, \pm 1$

Q.44 With increase in temperature, the Gibbs free energy for the adsorption of a gas on to a solid surface

(a) Becomes more positive from a positive value. (b) Becomes more negative from a positive value.

(c) Becomes more positive from a negative value. (d) Becomes more negative from a negative value.

Q.45 The vapour of a pure substance, when cooled under a pressure less than its triple-point pressure.

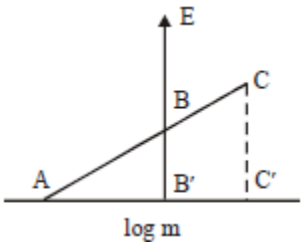
(a) Liquefies (b) Liquefies first and then solidifies

(c) Solidifies directly (d) Remains unchanged

Q.46 The quantities, which are held fixed in a canonical ensemble are

(a) N, T and P (b) V, T and N (c) N, V and E (d) μ, V and P

Q.47 The correct value of E^o, of a half cell in the following graph of E vs log m(molality) is:



(a) CC'/ AC' (b) AB' (c) BB' (d) CC'

Q.48 One of the assumptions made in the conventional activated complex theory is:

(a) Equilibrium is maintained between reactants and the activated complex.

(b) Equilibrium is maintained between the reactants and the products.

(c) Equilibrium is maintained between the products and the activated complex.

(d) Equilibrium is maintained between the reactants, the activated complex and the products.

Q.49 For a reaction, the rate constant k at 27°C was found to be $k = 5.4 \times 10^{11} e^{-50}$. The activation energy of the reaction is

(a) 50 J mol^{-1} (b) 415 J mol^{-1} (c) 15000 J mol^{-1} (d) 125000 J mol^{-1}

Q.50 During the addition polymerization, the reaction proceeds via

(a) Step-growth process (b) Free-radical chain reaction

(c) Cascade process (d) Addition reaction

Q.51 How many atoms are there in an element packed in a fcc structure

(a) 1 (b) 2 (c) 4 (d) 8

Q.53 Dispersion of a solid in a liquid, a liquid in a gas and a liquid in a liquid are respectively known as

(a) Aerosol, emulsion, sol (b) Sol, aerosol, emulsion

(c) Emulsion, sol, aerosol (d) Aerosol, sol, emulsion

Q.54 The data obtained from two sets of experiments A and B have the following characteristics

Experiment	A	B
Mean	50 units	100 units
Standard deviation	2 units	2 units

It may be concluded that

(a) A is more precise than B

(b) A is less precise than B

(c) A and B are of the same precision

(d) Relative precision of A and B cant be assessed

Q.55 The IUPAC name of the compound given below is:

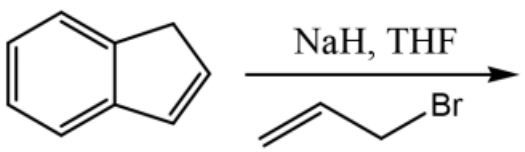
(a) Ethyl (R)-2-methyl-4-oxocyclohex-2-enecarboxylate.

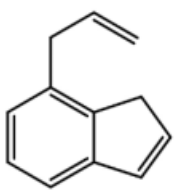
(b) Ethyl (S)-2-methyl-4-oxocyclohex-2-enecarboxylate.

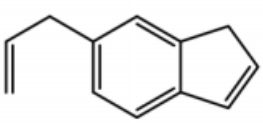
(c) (R)-4-ethoxycarbonyl-3-methylcyclo-hex-2-enone.

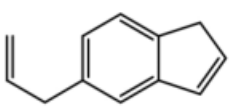
(d) (S)-4-ethoxycarbonyl-3-methylcyclo-hex-2-enone

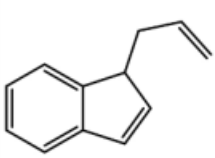
Q.56 The major product formed in the following reaction is:



(a) 

(b) 

(c) 

(d) 

Q.57 The number of signals that appear in the broadband decoupled ^{13}C NMR spectrum of phenanthrene and anthracene, respectively are

(a) Ten and four (b) Ten and ten (c) Seven and Four (d) Seven and Seven

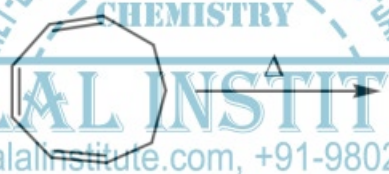
Q.58 The co-enzyme that is involved in the reduction of a double bond in fatty acid biosynthesis is:

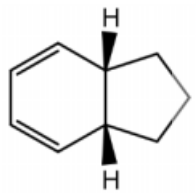
(a) NADH (b) Biotin (c) Pyridoxal (d) $FADH_2$

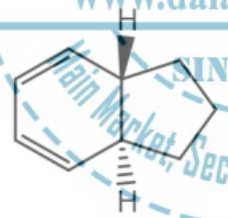
Q.59 Epoxidation of (R)-cyclohex-2-enol with peracetic acid yields a 95:5 mixture of compounds A and B. Compounds A and B are

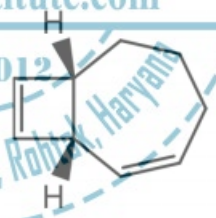
(a) Enantiomers (b) Diastereomers (c) Constitutional isomers (d) Homomers

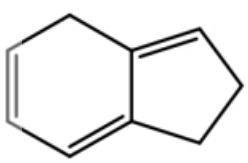
Q.60 The major product formed in the following concerted reaction is



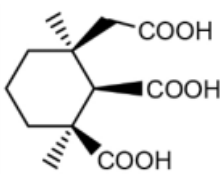
(a) 

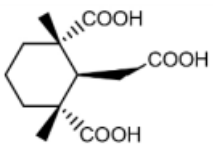
(b) 

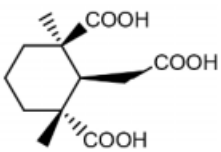
(c) 

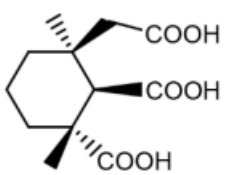
(d) 

Q.61 The structure of meso-tricarboxylic acid that is formed on potassium permanganate oxidation of abietic acid is:

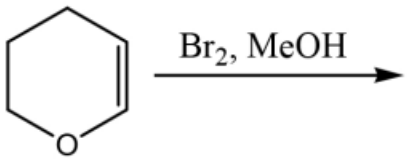
(a) 

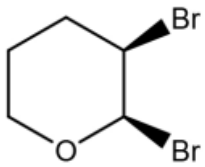
(b) 

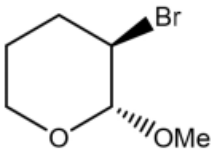
(c) 

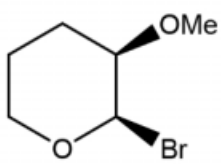
(d) 

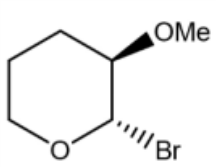
Q.62 The major product formed in the following reaction is:



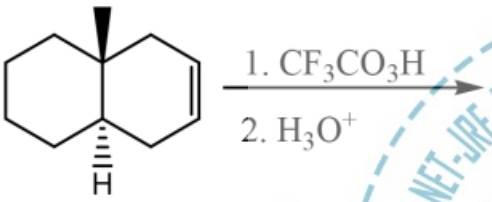
(a) 

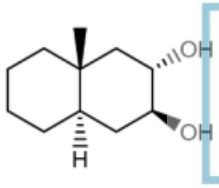
(b) 

(c) 

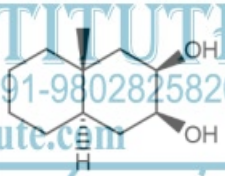
(d) 

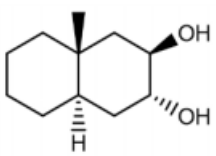
Q.63 The major product formed in the following reaction is:



(a) 

(b) 

(c) 

(d) 

Q.64 Among the following, the synthetic equivalent for acyl anion is:

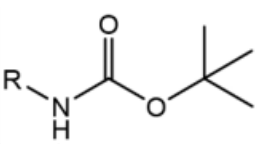
(a) Nitroethane and base

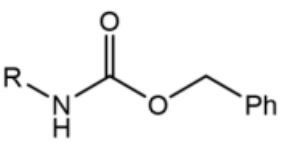
(b) α - chloroacrylonitrile

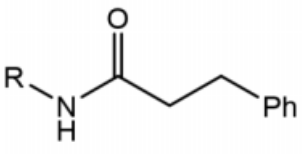
(c) Ethylmagnesium bromide

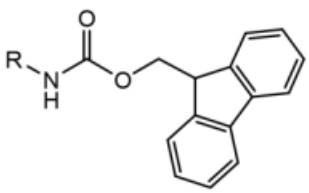
(d) Acetyl chloride and triethylarmine

Q.65 Among the following, the compound that undergoes deprotection easily on treatment with hydrogen in the presence of 10% Pd/C to generate RNH_2 is:

(a) 

(b) 

(c) 

(d) 

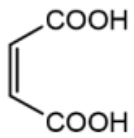
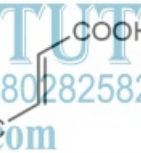
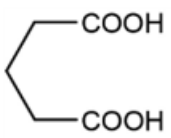
Q.66 Among the following, the amino acid which is basic in nature is:

(a) Tyrosine (b) Asparagine (c) Leucine (d) Arginine

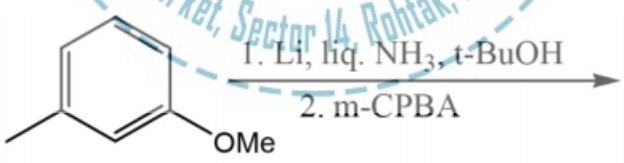
Q.67 "Phosphorescence" is represented as

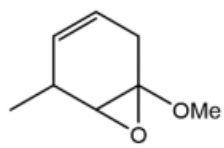
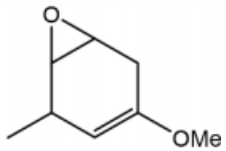
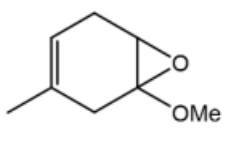
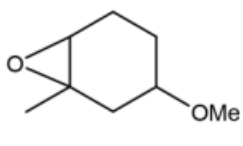
(a) $T_1 \rightarrow S_0 + hv$ (b) $T_1 \rightarrow S_0 + \Delta$ (c) $S_1 \rightarrow S_0 + hv$ (d) $S_1 \rightarrow T_1 + \Delta$

Q.68 Among the following diacids, the one that forms an anhydride fastest on heating with acetic anhydride is:

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

Q.69 The major product formed in the following reaction sequence is:



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

Q.70 In the 400G MHz ^{1}H NMR spectrum, of organic compound exhibited a doublet. The two lines of the doublet are at δ 2.35 and 2.38 ppm. The coupling constant (J) value is

(a) 3Hz (b) 6 Hz (c) 9 Hz (d) 12 Hz

Section-C

Q.71 The strength of $p_\pi - d_x$ bonding in E–O (E = Si, P, S and C) follows the order

(a) Si – O > P – O > S – O > Cl – O

(b) P – O > Si – O > S – O > Cl – O

(c) S – O > Cl – O > P – O > Si – O

(d) Cl – O > S – O > P – O > Si – O

Q.72 In the following reactions carried out in liquid NH_3

$$Zn(NH_2)_2 + 2KNH_2 \rightarrow K_2[Zn(NH_2)_4]$$

$$K_2[Zn(NH_2)_4] + 2NH_4NO_3 \rightarrow Zn(NH_2)_2 + 2KNO_3 + 4NH_3$$

KNH_2 and NH_4NO_3 act respectively as

(a) Solvo-acid and Solvo-base

(b) Solvo-base and solvo-acid

(c) Conjugate acid and conjugate base

(d) Conjugate base and conjugate acid

Q73 The pair of lanthanides with the highest third-ionization energy is:

(a) Eu, Gd (b) Eu, Yb (c) Dy, Yb (d) Lu, Yb

Q.74 The lanthanide(III) ion having the highest partition coefficient between tri-n-butylphosphate and concentrated HNO_3 is:

(a) La(III) (b) Eu(III) (c) Nd(III) (d) Lu(III)

Q.75 The quantitative determination of N_2H_4 with KIO_3 proceeds in a mixture of H_2O/CCl_4 as follows

$$N_2H_4 + KIO_3 + 2HCl \rightarrow N_2 + KCl + ICl + 3H_2O$$

The end point for the titrimetric reaction is:

(a) Consumption of N2H4.

(b) ICl formation.

(c) Disappearance of the yellow color due to Cl_2 in CCl_4 layer.

(d) Displacement of the rod color due to I_2 in CCl_4 layer.

Q.76 Among the halides, NCl_3(A), PCl_3(B) and $AsCl_3$(C), those which produce two different acids.

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

Q.77 The decreasing order of dipole moment of molecules is

(a) $NF_3 > NH_3 > H_2O$ (b) $NH_3 > NF_2 > H_2O$ (c) $H_2O > NH_3 > NF_3$ (d) $H_2O > NF_3 > NH_3$

Q.78 The cluster having archano type structure is:

(a) $[Os_5(CO)_{16}]$ (b) $[Os_3(CO)_{12}]$ (c) $[Ir_4(CO)_{12}]$ (d) $[Rh_6(CO)_{16}]$

Q. 79 The carbonyl resonance in ^{13}C NMR spectrum of $[(\eta^5 - C_5H_5)Rh(CO)]_3$ (^{103}Rh, nuclear spin, I=1/2, 100%) shows a triplet at –65° C owing to the presence of

(a) Terminal CO (b) μ – CO (c) μ_3 – CO (d) $\eta^5 - C_2H_5$

Q.80 Low oxidation state complexes are often air-sensitive, but are rarely water sensitive because

(a) Air is reducing in nature while water is inert.

(b) Both air and water are oxidizing in nature.

(c) Both air and water are not π – acceptors.

(d) Complexes with low oxidation states will easily lose electrons to O_2 but will not bind to a π – donor molecule like H_2O.

Q.81 The metal complex that exhibits a triplet as well as doublet in its ^{31}P NMR spectrum is

(a) mer–$[IrCl(Co)(PPh_3)_2]$ (b) trans–$[IrCl(Co)(PPh_3)_2]$

(c) fac–$[IrCl(Co)(PPh_3)_2]$ (d) $[Ir(PPh_3)_4]^+$

Q.82 The complex that DOES NOT obey 18- electron rule is:

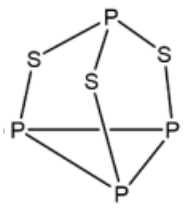
(a) $[(\eta^5 - C_5H_5)RuCl(CO)(PPh_3)]$ (b) $[W(CO)_3(SiMe_3)(Cl)(NCMe)_2]$

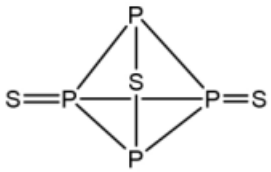
(c) $[IrCl_3(PPh_3)_2(AsPh_2)]^-$ (d) $[Os(N)Br_2(PMe_3)(NMe_2)]^-$

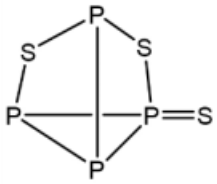
Q.83 The number of spin-allowed ligand field transitions for octahedral Ni(II) complexes with $^3A_{2g}$ ground state is:

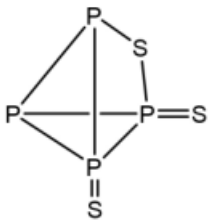
(a) Two (b) Three (c) One (d) Four

Q.84 The correct structure of P_4S_3 is:

(a) 

(b) 

(c) 

(d) 

Q.85 The final product of the reaction $[Mn(CO)_6]^+ + MeLi \rightarrow$ is

(a) $[Mn(CO)_6]^+Me^-$ (b) $[Mn(CO)_5Me]$ (c) $[Mn(CO)6]$ (d) $[(MeCO)Mn(CO)_5]$

Q.86 The reaction that yields $Li[AlH_4]$ is

(a) $HCl(excess) + AlCl_3 + Li \rightarrow$ (b) $H_2 + Al + Li \rightarrow$

(c) $LiH(excess) + AlCl_3 \rightarrow$ (d) $LiH(excess) + Al \rightarrow$

Q.87 The number of microstates for d^5 electron configuration is:

(a) 21×6^3 (b) 14×6^3 (c) 7×6^2 (d) 28×6^3

Q.88 The carbon-14 activity of an old wood sample is found to be 14.2 disintegrations $min^{-1}g^{-1}$. Calculate age of old wood sample, if for a fresh wood sample carbon-14 activity is 15.3 disintegrations $min^{-1}g^{-1}$ ($t_{1/2}$ carbon-14 is 5730 years), is:

(a) 5, 000 years (b) 4, 000 years (c) 877 years (d) 617 years

Q.89 The reaction $3[Rh_4(CO)_{12}] \rightarrow 2[Rh_6(CO)_{16}] + 4CO$ [25°C, 500 atm CO] is:

(a) Exothermic as more metal-metal bonds are formed.

(b) Endothermic as stronger metal-carbonyl bonds are cleaved while weaker metal-metal bonds are formed.

(c) Is entropically favorable but enthalpically unfavorable such that $\Delta G = 0$.

(d) Thermodynamically unfavorable ($\Delta G = 0$).

Q.90 A column is packed with 0.5 g of a strongly acidic ion exchange resin in H^+ form. A 1.0 M NaCl solution is passed through the column until the eluent coming out becomes neutral. The collected eluent is completely neutralized by 17 ml. of 0.5 M NaOH. The ion exchange capacity of the resin is:

(a) 1.00 meq/g (b) 1.25 meq/g (c) 1.50 meq/g (d) 1.75 meq/g

Q.91 The molar extinction coefficient of B (MW = 180) is 4×10^3 lit mol^{-1} cm^{-1}. One liter solution of C which contains 0.1358 g pharmaceutical preparation of B, shows an absorbance of 0.411 in a 1 cm quartz cell. The percentage (w/w) of B in the pharmaceutical preparation is:

(a) 10.20 (b) 14.60 (c) 20.40 (d) 29.12

Q.92 The changes (from A-D given below) which occur when O_2 binds to hemerythrin are

(A) One iron atom is oxidized

(B) Both the iron atoms are oxidized

(C) O_2 binds to one iron atom and is also hydrogen bonded.

(D) O_2 binds to both the iron atoms and is also hydrogen bonded.

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

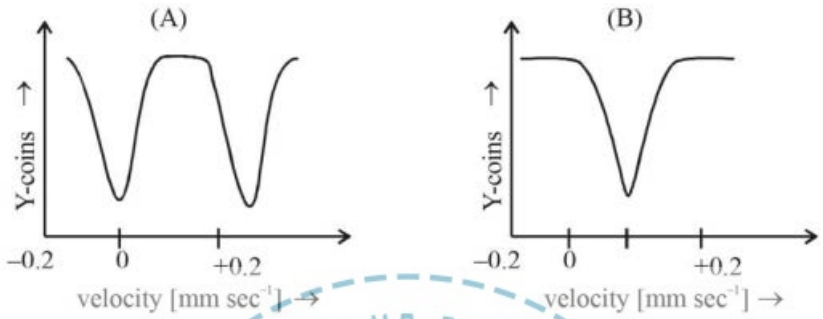
Q.93 In photosynthetic systems the redox metalloproteins involved in electron transfer are cytochrome (cyt, b), cytochrome bf complex (cyt bf) and plastocyamin (PC). The pathway of electron flow is

(a) PC → cyt b → cyt bf (b) cyt bf → cyt b → PC (c) cyt b → cyt bf → PC (d) PC → cyt bf → cyt b

Q.94 The total numbers of fine and hyperfine EPR lines expected for octahedral high-spin Mn(II) complexes are respectively (I = 5/2 for Mn)

(a) 3 and 30 (b) 5 and 33 (c) 5 and 30 (d) 4 and 24

Q.95 The Mossbauer spectra of two iron complexes are shown below. They may arise from (i) high-spin iron(III), (ii) high-spin iron(II) and (iii) low-spin iron(III)



The correct matches of spectra (A) and (B) with the iron complexes are

(a) A with (i) and B with (ii) (b) A with (ii) and B with (i)

(c) A with (iii) and B with (ii) (d) A with (ii) and B with (iii)

Q.96 The probability of finding the particle in a one-dimensional box of length 'L' in the region between $\frac{L}{4} and \frac{3L}{4}$ for quantum number n = 1 is:

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

Q.97 A particle in three-dimensional cubic box of length L has energy of $\frac{14h^2}{8mL^2}$. The degeneracy of the state is

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

Q.98 The following are the three statements about perturbation theory

(A) Second order perturbation correction to the ground state energy is ALWAYS negative.

(B) Sum of the zeroth order and the first order corrections to the ground state energy is ALWAYS greater than the exact ground state energy.

(C) Sum of the zeroth order and first order corrections to the ground state energy is less than the exact state energy.

From the following which one is correct?

(a) Only A is true (b) Both A and B are true

(c) Only C is true (d) Both B and C are true

Q.99 Using Huckel molecular orbital approximation, the two roots of secular equation of ethene are

(a) $. \alpha + \sqrt{2}\beta, \alpha - \sqrt{2}\beta$ (b) $\alpha + \beta, \alpha$ (c) $\alpha + \beta, \alpha - \beta$ (d) $\alpha + 2\beta, \alpha - 2\beta$

Q.100 For H_2 molecule in the excited state $\sigma_g^1\ \sigma_s^1$, the spin part of the triplet state with $m_s = 0$ is proportional to

(a) $\alpha(1)\beta(2)$ (b) $[\alpha(1)\beta(2) - \beta(1)\alpha(2)]$

(c) $\alpha(1)\alpha(2)$ (d) $[\alpha(1)\beta(2) + \beta(1)\alpha(2)]$

Q.101 A square pyramidal, MX4, molecule belongs to C4V point group. The symmetry operations are: E, $2C_4$, C_2, $2\sigma_v$ and $2\sigma_d$. The trace for the reducible representation, when symmetry operations of C_{4V} applied to MX_4, is:

(a) 51113 (b) 11111 (c) 51111 (d) 41113

Q.102 Character table of C_{2v} point group is:

C_{2v}	E	C_2	σ_v	σ_v'	
A_1	1	1	1	1	z
A_2	1	1	–1	–1	1
B_1	1	–1	1	–1	x
B_2	1	–1	–1	1	y

If the initial and final states belong to A_1 and B_1 irreducible representation respectively, the allowed electronic transition from A_1 to B_1 is:

(a) z-polarized (b) y-polarized (c) x-polarized (d) x, z-polarized

Q.103 Using cuvettes of 0.5 cm path length, a 10^{-4} M solution of a chromophore shows 50% transmittance at certain wave length. The molar extinction coefficient of the chromophore at this wave length is (log 2 = 0.301)

(a) 1500 M^{-1} cm^{-1} (b) 3010 M^{-1} cm^{-1} (c) 5000 M^{-1} cm^{-1} (d) 6020 M^{-1} cm^{-1}

Q.104 The set of allowed electronic transitions among the following is:

A. $^4\Sigma \rightarrow {}^2\Pi$; B. $^3\Sigma \rightarrow {}^3\Pi$; C. $^1\Delta \rightarrow {}^1\Delta$; D. $^2\Pi \rightarrow {}^2\Pi$; E. $^4\Sigma \rightarrow {}^3\Delta$

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

Q105 The following data were obtained from the vibrational fine structure in the vibronic spectrum of a diatomic molecule: ω_e = 512 cm^{-1}, $\omega_e X_e$ = 8 cm^{-1}

where ω_e is the energy associated with the natural frequency of vibration and X_e is the anharmonicity constant. The dissociation energy (D_e) of the molecule is:

(a) 4096 cm^{-1} (b) 6144 cm^{-1} (c) 8192 cm^{-1} (d) 16384 cm^{-1}

Q.106 An ideal gas was subjected to a reversible, adiabatic, expansion and then its initial volume was restored by a reversible, isothermal compression. If 'q' denotes the heat added to the system and 'w' the work done by the system, then

(a) w < 0, q < 0 (b) w > 0, q < 0 (c) w < 0, q > 0 (d) w > 0, q > 0

Q.107 The gas phase reaction $2NO_2(g) \rightarrow N_2O_4(g)$ is an exothermic process. It an equilibrium mixture of NO_2 and N_2O_4 , the decomposition of N_2O_4 can be induced by

(a) Lowering the temperature (b) Increasing the pressure

(c) Introducing an inert gas at constant volume (d) Introducing an inert gas at constant pressure

Q.108 Indicate which one of the following relations is NOT correct.

(a) $-\left(\frac{\partial T}{\partial V}\right)_S = \left(\frac{\partial P}{\partial S}\right)_V$ (b) $-\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$ (c) $-\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ (d) $-\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$

Q.109 The energy levels of the harmonic oscillator (neglecting zero-point energy) are ε_v = nhν for n = 0, 1, 2, ...∞. Assuming hν = k_BT , the partition function is:

(a) e (b) 1/e (c) 1 – 1/e (d) 1 / (1 – 1/e)

Q.110 The correct entropy for 6 identical particles with their occupation number {0, 1, 2, 3} in four states is

(a) $k_B \ln 6$ (b) $k_B \ln 12$ (c) $k_B \ln 60$ (d) $k_B \ln 720$

Q.111 The correct Nernst equation for the concentration cell:

$$Pt \mid H_2(p) \mid HCl(a_{\pm})_1 \mid AgCl(s) \mid Ag \; Ag \mid AgCl(s) \mid HCl(a_{\pm})_1 \mid H_2(p) \mid Pt$$

without liquid junction would be

(a) $E = \frac{2RT}{F} ln \frac{(a\pm)_1}{(a\pm)_2}$ (b) $E = \frac{RT}{F} ln \frac{(a\pm)_2}{(a\pm)_1}$ (c) $E = \frac{2RT}{F} ln \frac{(a\pm)_2}{(a\pm)_1}$ (d) $E = \frac{RT}{2F} ln \frac{(a\pm)_2}{(a\pm)_1}$

Q.112 Main assumption(s) involved in the derivation of Debye-Huckel equation is(are) the validity of

(a) Only Poission equation.

(b) Poission equation and Boltzmann distribution.

(c) Poission equation, Boltzmann distribution and $|\pm Ze\phi| \gg k_B T$.

(d) Poission equation, Boltzmann distribution and $|\pm Ze\phi| \ll k_B T$.

Q.113 In the base (OH–) hydrolysis of a transition metal complex $[ML_6]^{z+}$, the slope between log(k/k0) and $\sqrt{1}$ is found to be –2.1. The charge on the complex is:

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

Q.114 The rate law for one of the mechanism of the pyrolysis of CH_3CHO at 520ºC and 0.2 bar is

Rate = $-\left|k_2 \left(\frac{k_1}{2k_1}\right)^{1/2}\right| [CH_3CHO]^{3/2}$

The overall activation energy E, in terms of the rate law is:

(a) $E_a(2) + E_a(1) + 2E_a(4)$ (b) $E_a(2) + \frac{1}{2} E_a(1) - 2E_a(4)$

(c) $E_a(2) + (½)E_a(1) - (½)E_a(4)$ (d) $E_a(2) - (½)E_a(1) + (½)E_a(4)$

Q.115 In the Michaelis-Menten mechanism for enzyme kinetics, the expression obtained is:

$$\frac{V}{[E]_0[S]} = 1.4 \times 10^{12} - \frac{10^4 V}{[E]_0}$$

The values of k_3(k_{exp}, mol $L^{-1}s^{-1}$) and K(Michaelis constant, mol L^{-1}), respectively are

(a) 1.4×10^{12} ,10^4 (b) 1.4×10^8 ,10^4 (c) 1.4×10^8 ,10^{-4} (d) 1.4×10^{12} ,10^{-4}

Q.116 The most used acid catalyst in oil industry and the relevant process are respectively

(a) Aluminophosphate and reforming (b) Aluminosilicate and cracking

(c) Aluminosilicate and reforming (d) Aluminophosphate and cracking

Q.117 The wavelength and the spectral region for a single electron transfer across the band gap in a semiconductor (E_x – 1.98×10^{-19}) are [h = 6.626×10^{-14} Js, c = 3×105 ms^{-1}]

(a) 1000 nm, UV (b) 1000 nm, IR (c) 500 nm, visible (d) 500 nm, Far IR

Q.118 The lattice parameter of an element stabilized in a fcc structure is 4.04 Å. The atomic radius of the element is:

(a) 2.86Å (b) 1.43Å (c) 4.29Å (d) 5.72Å

Q.119 The number-average molar mass ($\bar{M}_n$) and weight-average molar mass ($\bar{M}_w$) of a polymer are obtained respectively by

(a) Osmometry and light scattering measurements.

(b) Osmometry and viscosity measurements.

(c) Light scattering and sedimentation measurements.

(d) Viscosity and light scattering measurements.

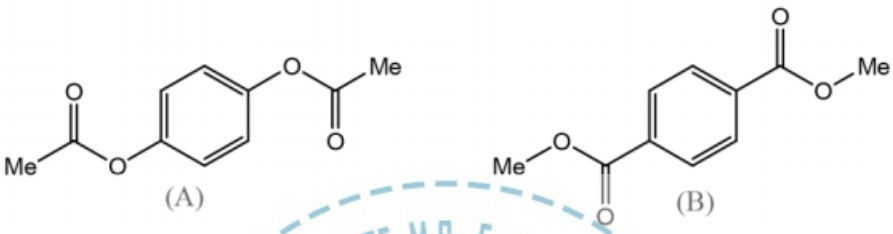
Q.120 Two data sets involving the same variables X and Y are given below

X	4.1	4.2	4.3	4.4	4.5	4.6
Y(set A)	10.2	10.6	10.9	11.5	11.8	12.2
Y(set B)	10.2	10.6	11.1	11.3	11.8	12.2

If the slopes and intercepts of the regression lines for the two sets are denoted by (m_A, m_B) and (C_A, C_B), respectively, then

(a) $m_A > m_B$, $C_A > C_B$ (b) $m_A < m_B$, $C_A > C_B$ (c) $m_A > m_B$, $C_A < C_B$ (d) $m_A < m_B$, $C_A < C_B$

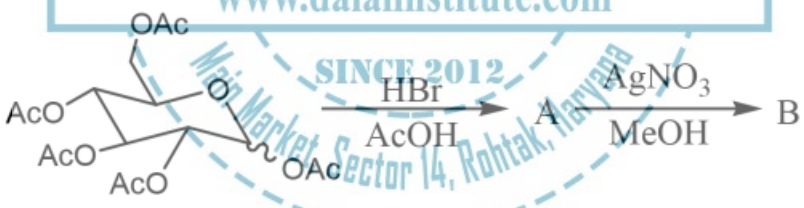
Q.121 Compounds A and B exhibit two singlets, each in their ^{1}H NMR spectra. The expected chemical shifts are at δ



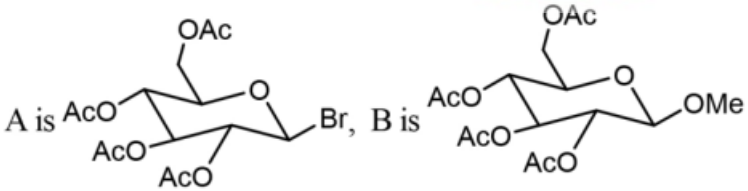
(a) 6.9 and 2.1 for A; 7.7 and 3.9 for B (b) 7.7 and 3.9 for A; 6.9 and 2.1 for B

(c) 6.9 and 3.9 for A; 7.7 and 2.1 for B (d) 7.7 and 2.1 for A; 6.9 and 3.9 for B

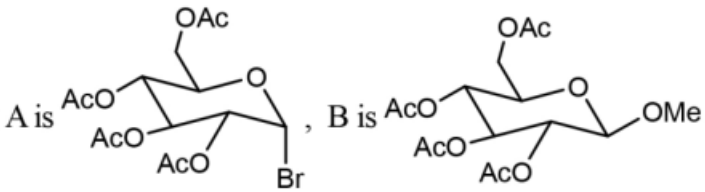
Q.122 In the following reaction sequence, the major products A and B are



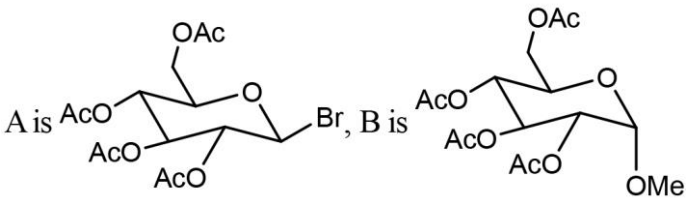
(a)



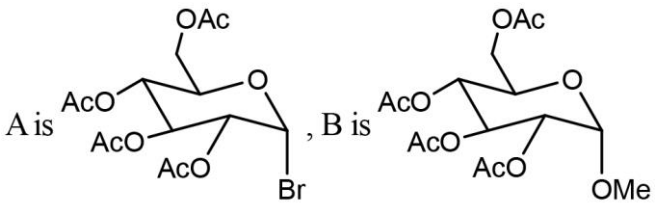
(b)



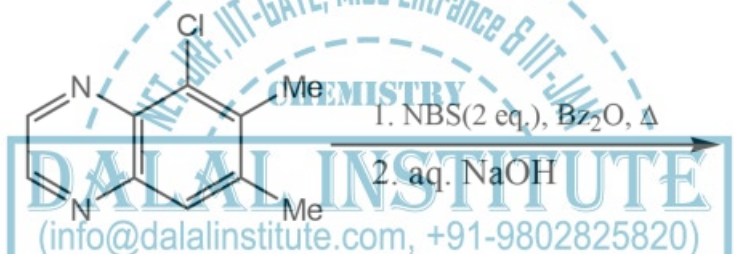
(c)



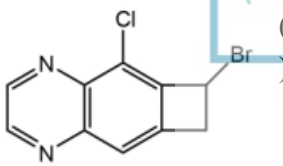
(d)



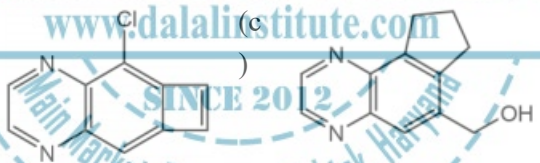
Q.123 The structure of the tricyclic compound formed in the following two step sequence is



(a)

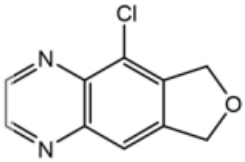


(b)

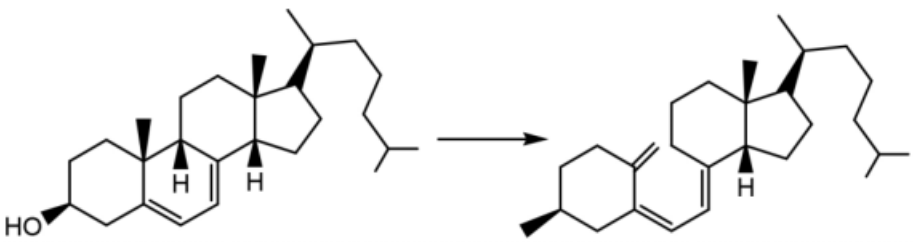


(c)

(d)



Q.124 The two-step conversion of 7-dehydrocholesterol to vitamin D_3 proceeds through



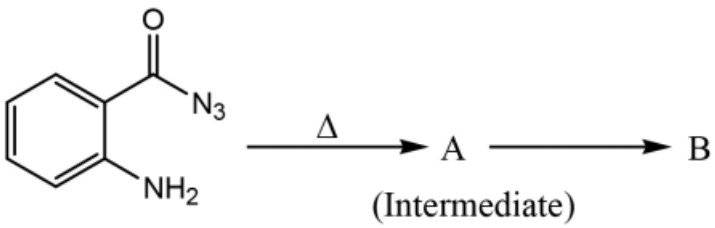
(a) Photochemical electrocyclic disrotatory ring opening; and thermal antarafacial [1, 7]-H shift.

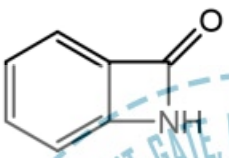
(b) Photochemical electrocyclic conrotatory ring opening; and thermal antarafacial [1, 7]-H shift.

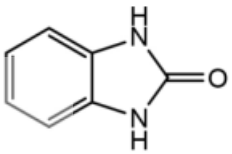
(c) Thermal electrocyclic conrotatory ring opening; and photochemical superafacial [1, 7]-H shift.

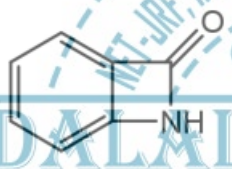
(d) Thermal electrocyclic disrotatory ring opening; and thermal superafacial [1, 7]-H shift.

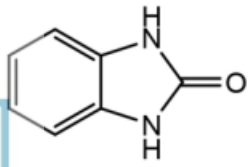
Q.125 The intermediate A and the major product B in the following reaction are



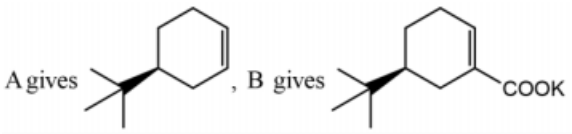
(a) A is acyl cation; B is 

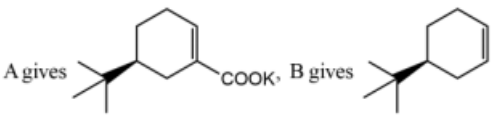
(b) A is acyl cation; B is 

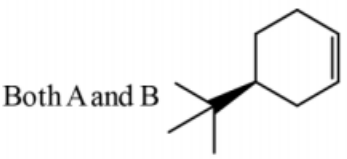
(c) A is nitrene; B is 

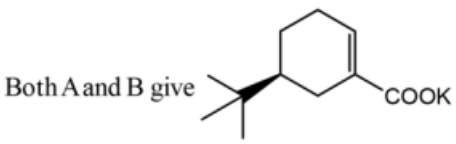
(d) A is acyl nitrene; B is 

Q.126 For the following two reactions A and B, the correct statement is:

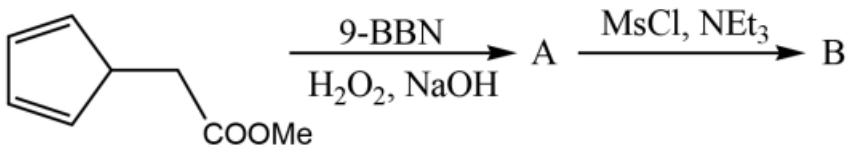
(a) 

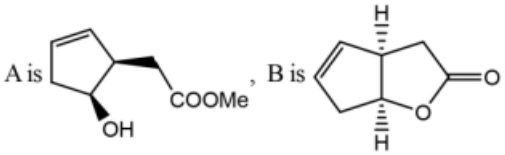
(b) 

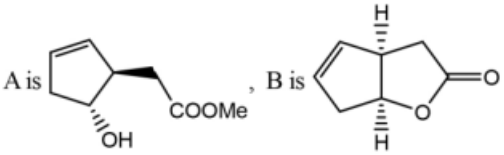
(c) 

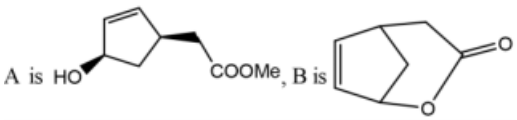
(d) 

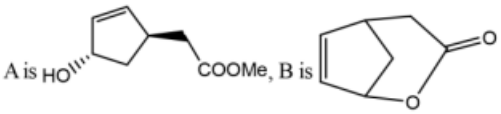
Q.127 The major compound B formed in the reaction sequence given below exhibited a carbonyl absorption band at 1770 cm^{-1} in the IR spectrum. The structure A and B are



(a) 

(b) 

(c) 

(d) 

Q.128 Consider the following reaction sequence starting with monoterpene α – pinene . Identify the correct statement

(a) A has a disubstituted double bond; B and C are dicarboxylic acids.

(b) A has a trisubstituted double bond; B is a methyl ketone; and C is a dicarboxylic acid.

(c) A has a disubstituted double bond; B is a methyl ketone; and C is a dicarboxylic acid.

(d) A has an exocylic double bond; B and C are monocarboxylic acids.

Q129 The major product formed when (3R, 4S)-3, 4-dimethylhexa-1, 5-diene is heated at 240º is:

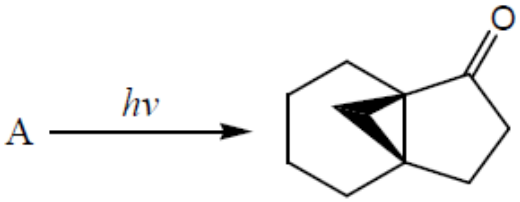
(a) (2Z, 6Z)-octa-2, 6-diene

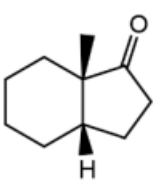
(b) (2E, 6E)-octa-2, 6-diene

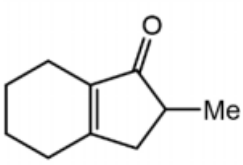
(c) (2E, 6Z)-octa-2, 6-diene

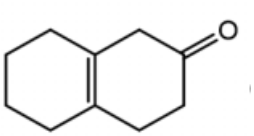
(d) (3Z, 5E)-octa-3, 5-diene

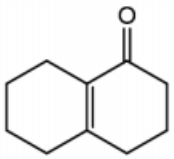
Q.130 Structure of the starting material A in the following photochemical Norrish reaction, is



(a) 

(b) 

(c) 

(d) 

Q.131 Considering the following reaction, among a-c, the correct statements are

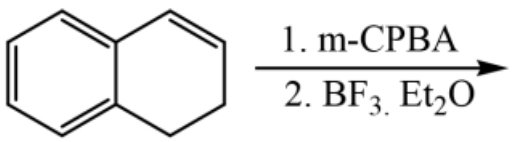
(A) The carbonyl group has enantiotopic faces;

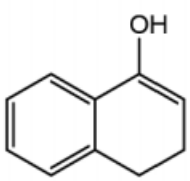
(B) The hydride attack is re-facial;

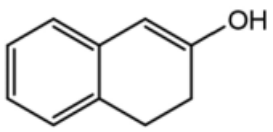
(C) It is a diastereoselective reduction.

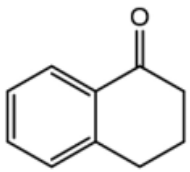
(a) A and B only (b) A and C only (c) B and C only (d) A, B and C only

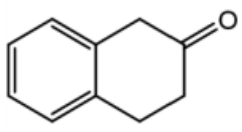
Q.132 The major product formed in the following reaction sequence is



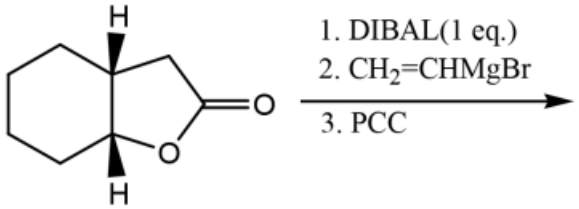
(a) 

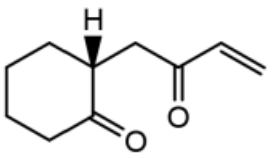
(b) 

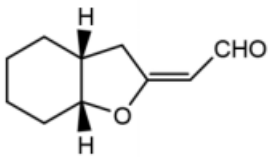
(c) 

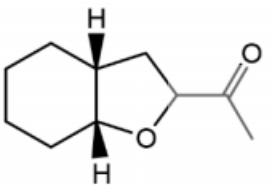
(d) 

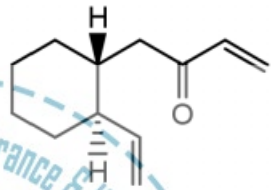
Q.133 The major product formed in the following reaction sequence is:



(a) 

(b) 

(c) 

(d) 

Q.134 Match the following

Compound	^{13}C NMR chemical shift (δ ppm)
(A) Acetic acid	(i) 95
(B) Acetonitrile	(ii) 115
(C) Acetone	(iii) 175
(D) Carbon tetrachloride	(iv) 205

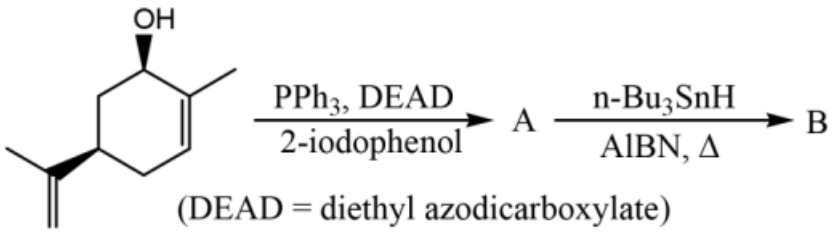
(a) (A)-(iii), (B)-(ii), (C)-(iv), (D)-(i)

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

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

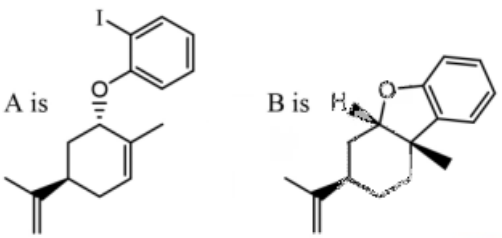
(d) (A)-(iii), (B)-(i), (C)-(iii), (D)-(iv)

Q.135 The major products A and B in the following reaction sequence are

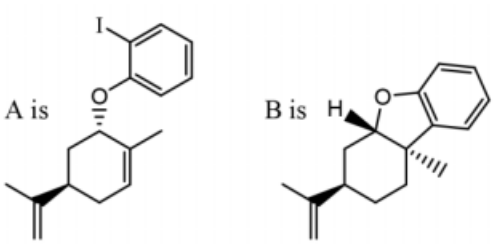


(DEAD = diethyl azodicarboxylate)

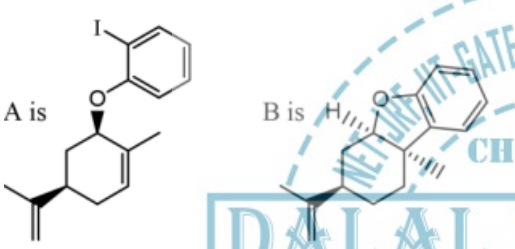
(a)



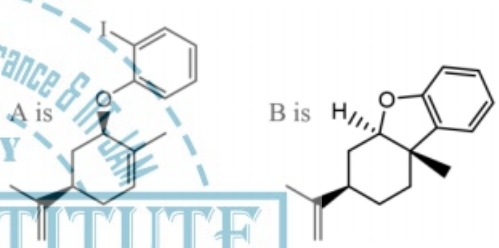
(b)



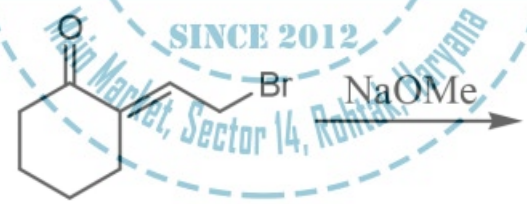
(c)



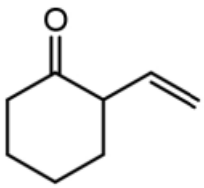
(d)



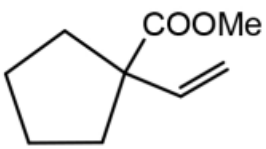
Q.136 The major product formed in the following reaction is:



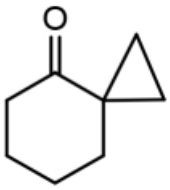
(a)



(b)

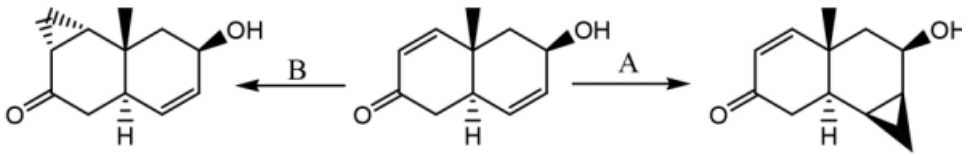


(c)



(d)

Q.137 The reagents A and B in the following reactions are



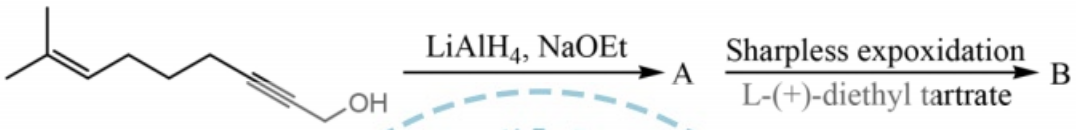
(a) A = CH_2I_2, Zn – Cu; B = $Me_3S^+I^-$, NaH

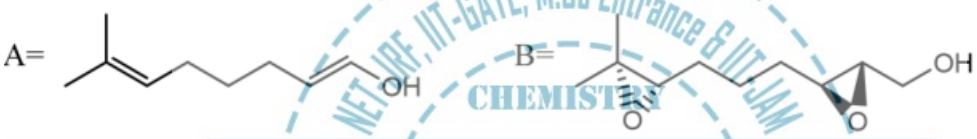
(b) A = CH_2I_2, Zn – Cu; B = $Me_3S^+(O)I^-$, NaH

(c) A = $Me_3S^+I^-$, NaH; B = $Me_3S^+(O)I^-$, NaH

(d) A = = $Me_3S^+(O)I^-$, NaH, B = CH_2I_2, Zn – Cu

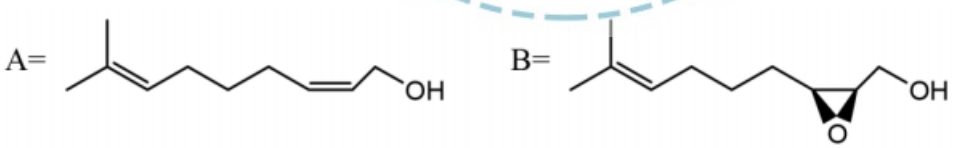
Q.138 The major products A and B formed in the following reaction sequence are



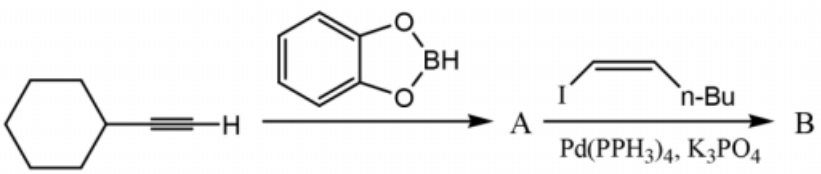
(a) 

(b) 

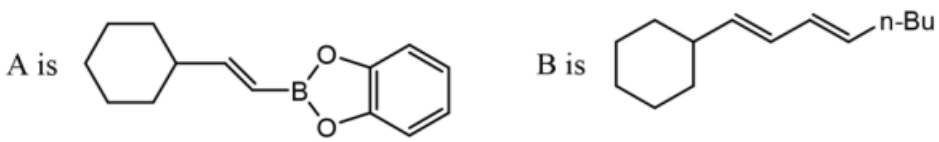
(c) 

(d) 

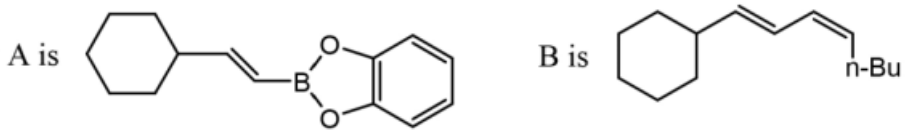
Q.139 The major products A and B formed in the following reaction sequence are



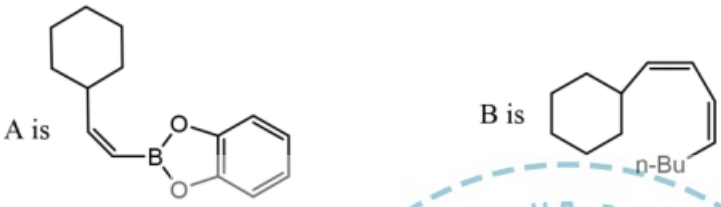
(a)



(b)



(c)



(d)

Q.140 The correct reagent combination/reaction sequence for effecting the following conversion is:

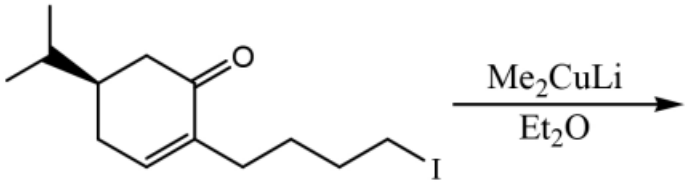
(a) (1) Me_3SiCH_2OMe, BuLi; (2) H_3O^+; (3) $NaBH_4$, MeOH.

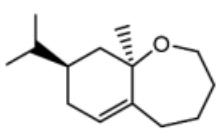
(b) (1) $Ph_3P^+CH_2MeCl$, BuLi; (2) H_3O^+; (3) $NaBH_4$, MeOH

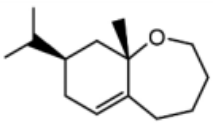
(c) (1) NH_2NHTs; (2) NaOEt; (3) ClCOOEt

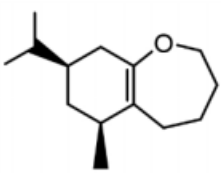
(d) (1) NH_2NHTs; (2) 2 eq. BuLi; (3) HCHO

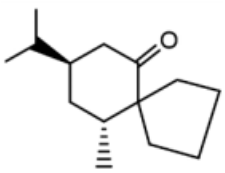
Q.141 The major product formed in the following reaction is:



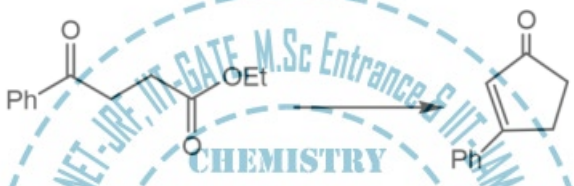
(a) 

(b) 

(c) 

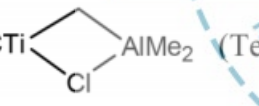
(d) 

Q.142 The correct sequence of reagents for effecting the following conversion is:



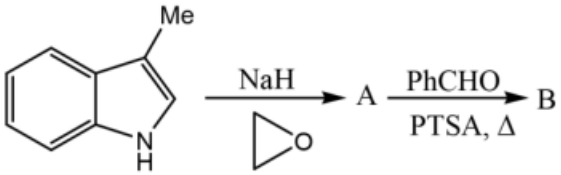
(a) (1) $(CH_2OH)_2$, PTSA, Δ; (2)  (Tebbe's reagent) (3) H_3O^+; (4) KOH

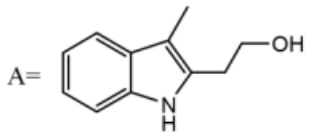
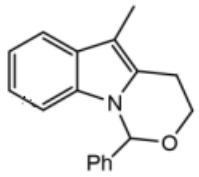
(b) (1) $(CH_2OH)_2$, PTSA, Δ; (2) $Ph_3P{=}CH_2$; (3) H_3O^+; (4) KOH

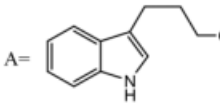
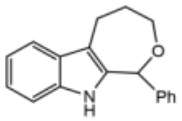
(c) (1)  (Tebbe's reagent); (2) H_3O^+; (3) KOH

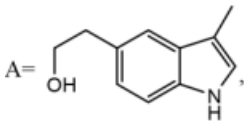
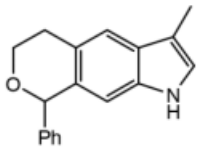
(d) $Ph_3P{=}CH_2$; (2) H_3O^+; (3) KOH

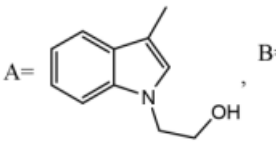
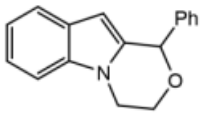
Q.143 The major products A and B formed in the following reaction sequence are



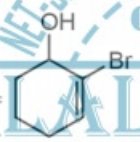
(a) A=  , B= 

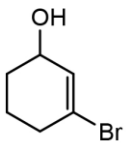
(b) A=  , B= 

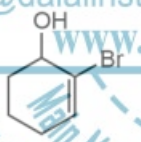
(c) A=  , B= 

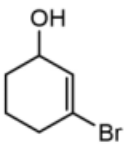
(d) A=  , B= 

Q.144 The reagent A required, and the major product B formed in the following reaction sequence are

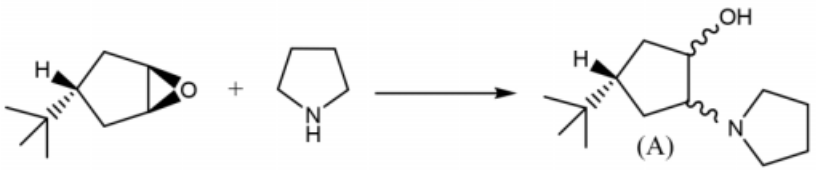
(a) $A = CH_2Br_2$ and KO'Bu , B= 

(b) $A = CH_2Br_2$ and KO'Bu , B= 

(c) $A = CHBr_3$ and KO'Bu , B= 

(d) $A = CHBr_3$ and KO'Bu , B= 

Q.145 Among the choices, the correct statements for A formed in the following reaction.

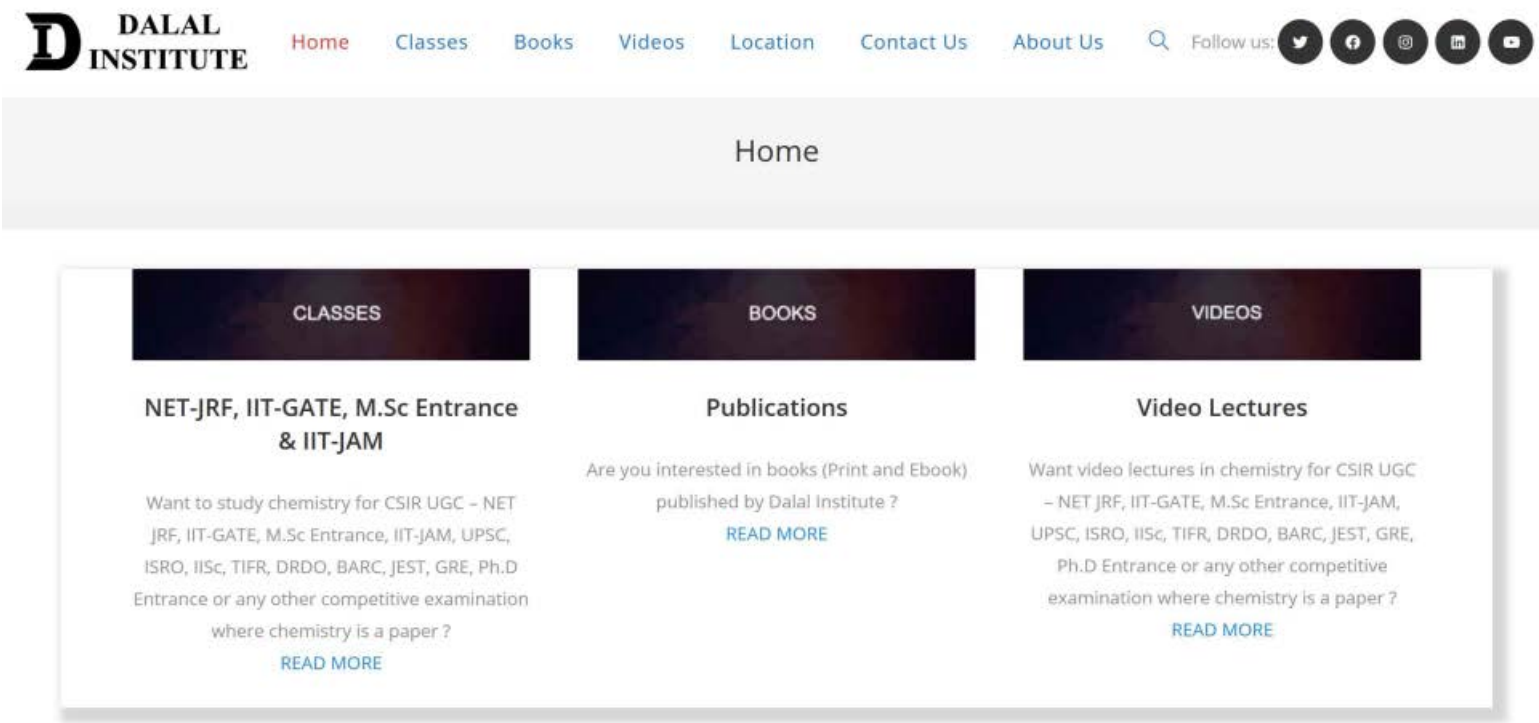


(a) A is a single enantiomer

(b) A is a racemic mixture

(c) A is a mixture of two Diastereomers

(d) A is a mixture of two epimers



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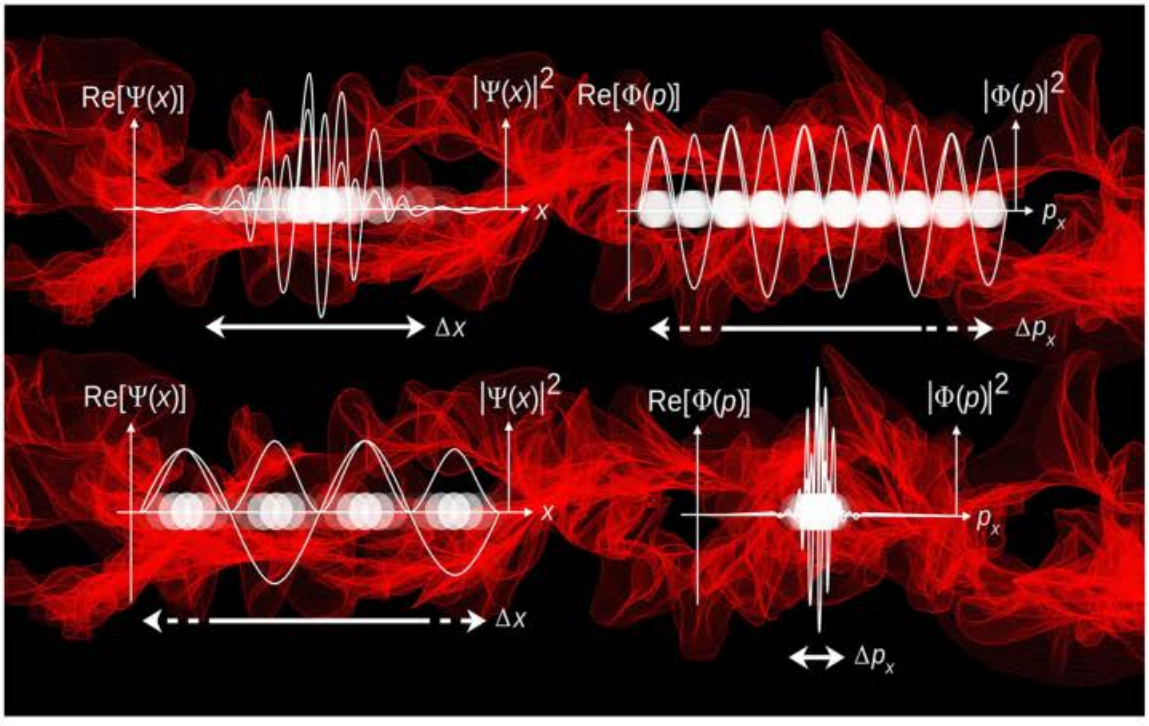

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