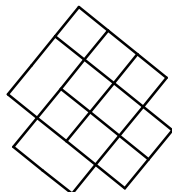

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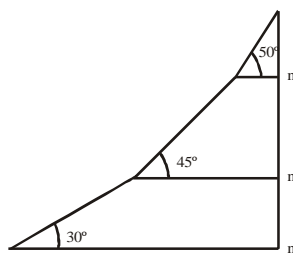
Part-A

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.

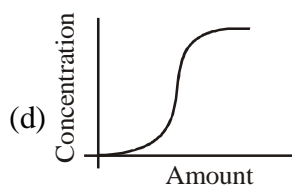
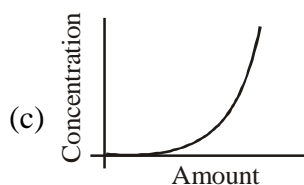
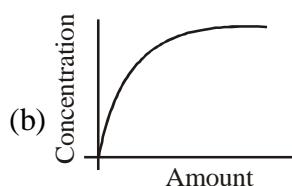
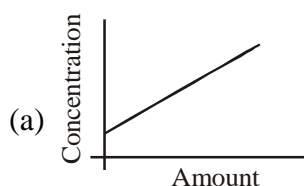
2. How many squares are there in this figure?



- (a) 9 (b) 14 (c) 15 (d) 17
3. A mountain road has 3 sections of different slopes as shown. What is the average slope 'm' of the entire climb?

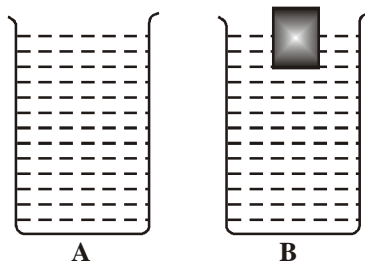


- (a) 1 (b) $(1/3) < m < (1/2)$
(c) $1 < m < \sqrt{3}$ (d) $(1/\sqrt{3}) < m < 1$
4. Which of the following graphs shows the concentration of a sugar solution as a function of the cumulative amount of sugar added in the process of preparing a saturated solution (the temperature remaining constant)?

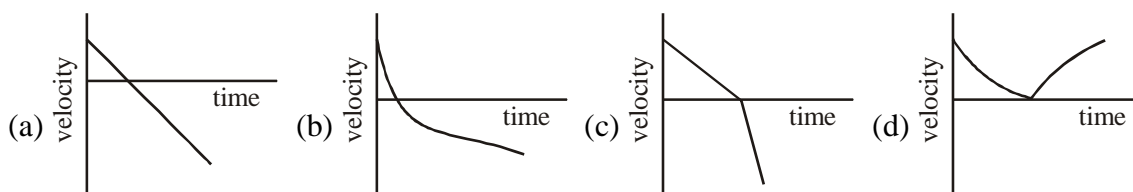


5. There are sand-piles which are geometrically similar but of different heights. The ratio of the masses of the sand comprising two randomly chosen piles will be equal to the ratio of the
- (a) Pile heights. (b) Squares of the piles heights
(c) Cubes of the pile heights. (d) Cube-roots of the pile heights.

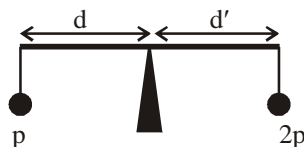
6. There are two identical vessels of volume 'V' each, one empty, and the other containing a block of wood of weight 'w'. The vessels are then filled with water up to the brim. The two arrangements are shown as A and B in the figure. If the density of water is ρ and g is the acceleration due to gravity, 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 $V\rho g - w$
 (d) B is heavier than A by an amount $V\rho g - w$
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
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.
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.
10. The reason why a lunar eclipse does not occur at every full moon is:
 (a) The position of the sun is not favourable 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.
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?

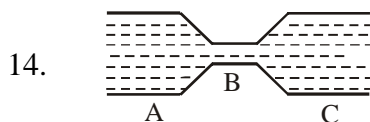


12. A rigid uniform bar of a certain mass has two bobs of the same size, but with different densities p and $2p$ suspended identically from its ends. When the bar is level on a fulcrum as shown in the figure, d and d' are related by



- (a) $2d = d'$ (b) $d > 2d'$ (c) $d = 2d'$ (d) $d < 2d'$
13. There are two points A and A' on the equator at longitudes 0° and 90°E , and two other points B and B' on the same longitudes, respectively, but at latitude 60°S . 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) $AA' = \sqrt{2} BB'$



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.

15. Match the two lists

Raw Material

- A. Limestone
 B. Gypsum
 C. Silica sand
 D. Clay

Product

1. Porcelain
 2. Glass
 3. Plaster of paris
 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 |

16. The ^{14}C dating method is not usually used for dating organic substances older than $\sim 60,000$ 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.

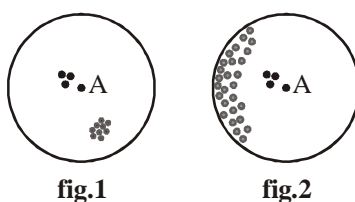
17. A seismograph receives a S-wave 60s after it receives the P-wave. If the velocities of P and S waves are 7 km/s and 6 km/s respectively, then the distance of the seismic focus from the seismograph is:

- (a) 2520 km (b) 42 km (c) 7070 km (d) 72 km

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

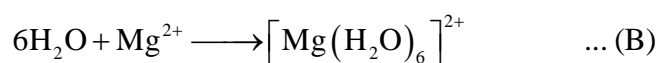
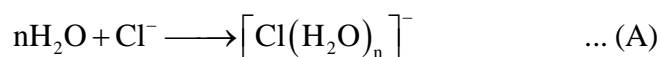
19. The scatter plots represent the values measured by two similar instruments. Point A in the figures represents the true value. Which of the following is a correct description of the quality of these measurements?



- (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.
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.

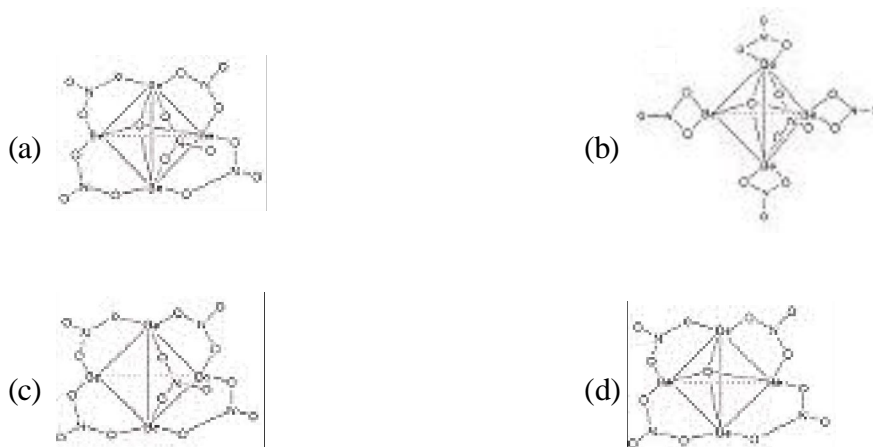
Part - B

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

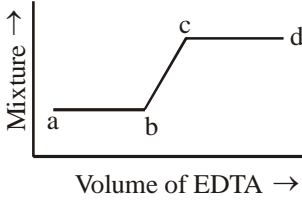


water behaves as

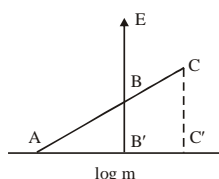
- (a) An acid in both (A) and (B) (b) An acid in (A) and a base in (B)
- (c) A base in (A) an acid in (B) (d) A base in both (A) and (B)
22. The size of the d orbitals in Si, P, S and Cl follows the order.
- (a) $\text{Cl} > \text{S} > \text{P} > \text{Si}$ (b) $\text{Cl} > \text{P} > \text{S} > \text{Si}$ (c) $\text{P} > \text{S} > \text{Si} > \text{Cl}$ (d) $\text{Si} > \text{P} > \text{S} > \text{Cl}$
23. The correct structure of basic beryllium nitrate is:



24. The total number of lone pairs of electrons in I_3^- is:
- (a) Zero (b) Three (c) Six (d) Nine

25. If Mossbauer spectrum of $\text{Fe}(\text{Co})_5$ is recorded in the presence of a magnetic field, the original spectrum with two lines changes into the one with
 (a) Three lines (b) Four lines (c) Five lines (d) Six lines
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 $ab \equiv [\text{Fe}^{3+}]$ and volume $cd \equiv [\text{Cu}^{2+}]$
 (b) Volume $ab \equiv [\text{Cu}^{2+}]$ and volume $cd \equiv [\text{Fe}^{3+}]$
 (c) Volume $ab \equiv [\text{Fe}^{3+}]$ and volume $ab \equiv$ excess EDTA
 (d) Volume $ab \equiv [\text{Cu}^{2+}]$ and volume $cd \equiv$ excess EDTA
- 
27. In 'carbon-dating' application of radioisotopes, ^{14}C emits
 (a) β - particle (b) α - particle (c) γ - radiation (d) Positron.
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
29. The oxidation state of iron in met-hemoglobin is
 (a) Three (b) Two (c) Four (d) Zero
30. The reactions of $\text{Ni}(\text{CO})_4$ with the ligand L ($\text{L} = \text{PMe}_3$ or $\text{P}(\text{OMe})_3$) yields $\text{Ni}(\text{CO})_3\text{L}$. The reaction is
 (a) Associative (b) Dissociative (c) Interchange (I_a) (d) Interchange (I_d)
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
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) $t_{2g}^3 e_g^2$
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.
34. For the reaction, $\text{trans} - [\text{IrCl}(\text{CO})(\text{PPh}_3)_2] + \text{Cl}_2 \rightarrow \text{trans} - [\text{IrCl}_3(\text{CO})(\text{Phh}_3)_2]$, the correct observation
 (a) ν_{CO} (product) $>$ ν_{CO} (reactant) (b) ν_{CO} (product) $<$ ν_{CO} (reactant)
 (c) ν_{CO} (product) = ν_{CO} (reactant) (d) ν_{CO} (product) = ν_{CO} (free CO)
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.

36. Among the following the strongest oxidizing agent is:
 (a) $[\text{WO}_4]^{2-}$ (b) $[\text{CrO}_4]^{2-}$ (c) $[\text{MoO}_4]^{2-}$ (d) $[\text{ReO}_4]^{-1}$
37. The least basic among the following is:
 (a) $\text{Al}(\text{OH})_3$ (b) $\text{La}(\text{OH})_3$ (c) $\text{Ce}(\text{OH})_3$ (d) $\text{Lu}(\text{OH})_3$
38. For any operator A and its adjoint A^\dagger , the **INCORRECT** statement is:
 (a) AA^\dagger is hermitian (b) $AA^\dagger + A^\dagger A$ is hermitian.
 (c) $A + A^\dagger$ is hermitian (d) $A - A^\dagger$ is hermitian.
39. For hydrogen-like atom with a nuclear charge Z, the energy of orbital with principal quantum number 'n' follows the relation.
 (a) $E_n \propto n^2 Z^2$ (b) $E_n \propto -\frac{Z^2}{n}$ (c) $E_n \propto -\frac{Z}{n}$ (d) $E_n \propto -\frac{Z^2}{n^2}$
40. The average value of the radius $\langle r \rangle$ 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) $0.5 a_0$.
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.
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}
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) $\Delta v = 0, \pm 1$
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
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.
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
47. The correct value of E° , of a half cell in the following graph of E vs $\log m$ (molality) is:



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

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.

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) $15,000 \text{ J mol}^{-1}$ (d) $125,000 \text{ J mol}^{-1}$

50. During the addition polymerisation, the reaction proceeds via
 (a) Step-growth process (b) Free-radical chain reaction
 (c) Cascade process (d) Addition reaction

51. How many atoms are there in an element packed in a fcc structure
 (a) 1 (b) 2 (c) 4 (d) 8

52. The structure obtained when all the tetrahedral holes are occupied in a fcc structure is of the type
 (a) NaCl (b) CsCl (c) CaF_2 (d) ZnS

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

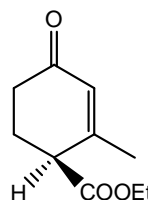
54. The data obtained from two sets of experiments A and B have the following characteristics

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

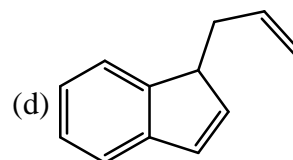
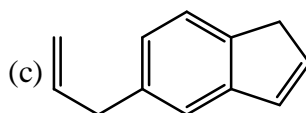
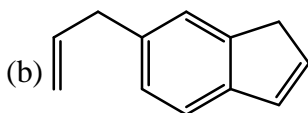
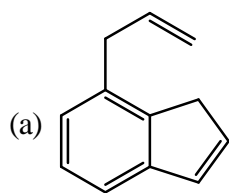
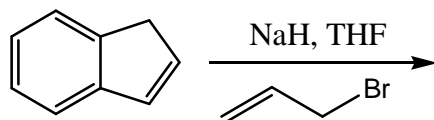
It may be concluded that

- (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 cannot be assessed.

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

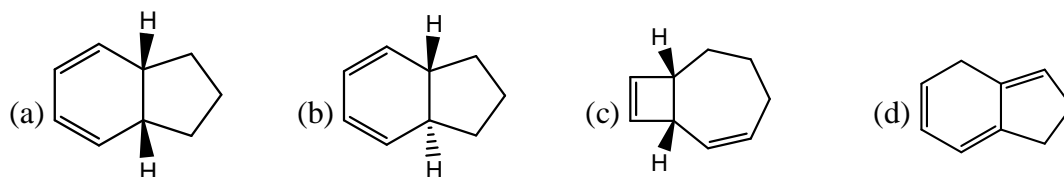
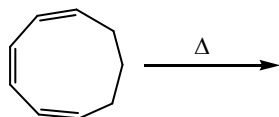


56. The major product formed in the following reaction is:

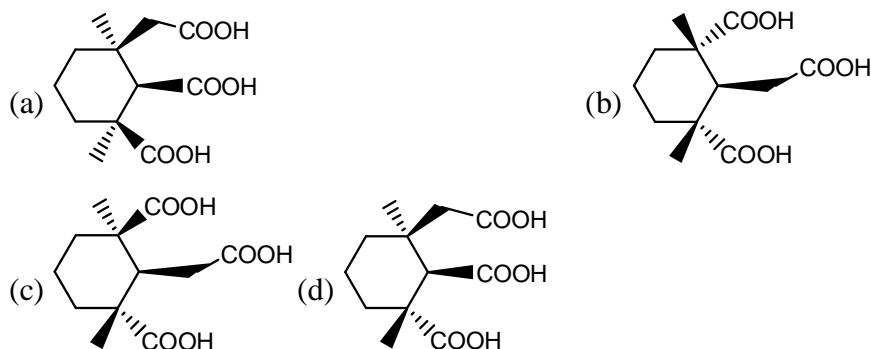


57. The number of signals that appear in the broadband decoupled ^{13}C NMR spectrum of phenanthrene and anthracene, respectively are
 (a) ten and four (b) ten and ten (c) seven and four (d) seven and seven.

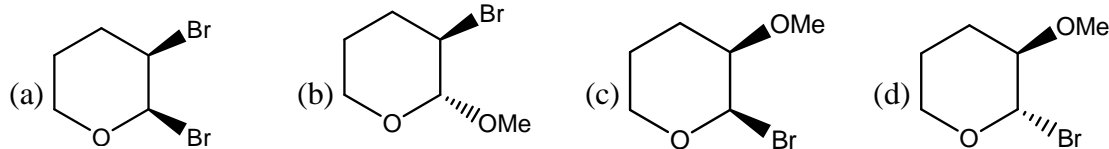
58. The co-enzyme that is involved in the reduction of a double bond in fatty acid biosynthesis is:
 (a) NADH (b) Biotin (c) Pyridoxal (d) FADH₂.
59. Epoxidation of (R)-cyclohex-2-enol with peracetic acid yields a 95:5 mixture of compounds A and B. Compounds A and B are
 (a) Enantiomers (b) Diastereomers (c) Constitutional isomers (d) Homomers
60. The major product formed in the following concerted reaction is



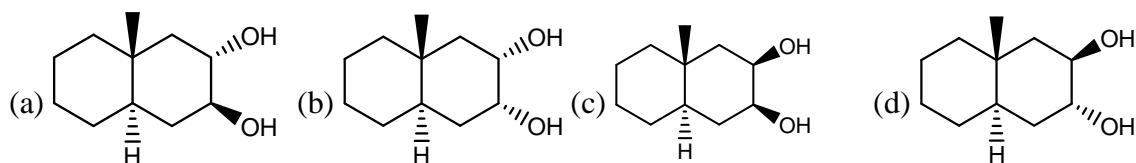
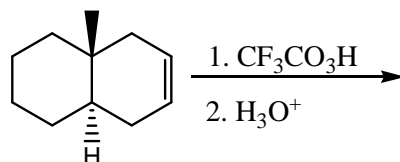
61. The structure of meso-tricarboxylic acid that is formed on potassium permanganate oxidation of abietic acid is:



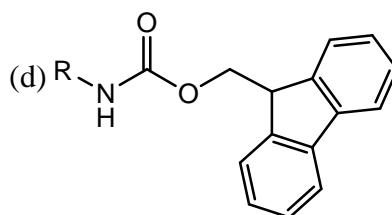
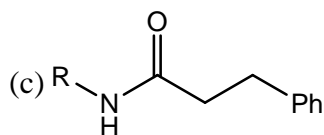
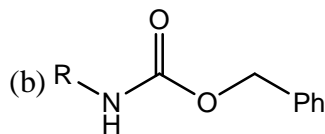
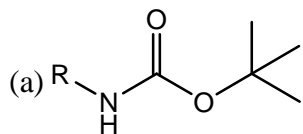
62. The major product formed in the following reaction is:



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



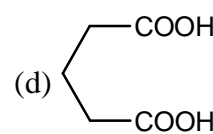
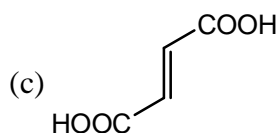
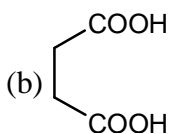
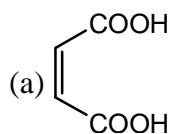
64. Among the following, the synthetic equivalent for acyl anion is:
 (a) Nitroethane and base (b) α -chloroacrylonitrile
 (c) Ethylmagnesium bromide (d) Acetyl chloride and triethylamine
65. Among the following, the compound that undergoes deprotection easily on treatment with hydrogen in the presence of 10% Pd/C to generate RNH_2 is:



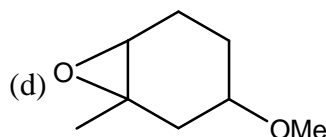
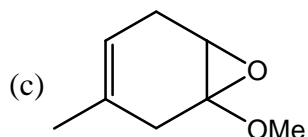
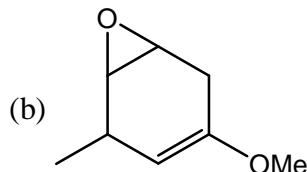
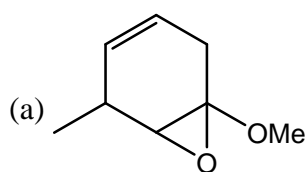
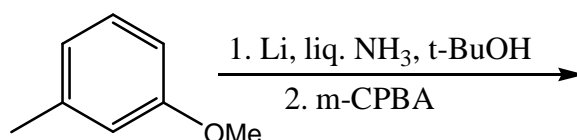
66. Among the following, the amino acid which is basic in nature is:
 (a) Tyrosine (b) Asparagine (c) Leucine (d) Arginine

67. "Phosphorescence" is represented as
 (a) $T_1 \longrightarrow S_0 + h\nu$ (b) $T_1 \longrightarrow S_0 + \Delta$ (c) $S_1 \longrightarrow S_0 + h\nu$ (d) $S_1 \longrightarrow T_1 + \Delta$

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



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

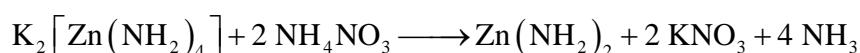
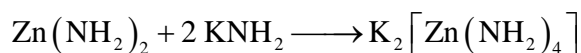


70. In the 400G MHz ^1H NMR spectrum, of organic compound exhibited a doublet. The two lines of the doublet are at δ 2.35 and 2.38 ppm. The coupling constant (J) value is
 (a) 3 Hz (b) 6 Hz (c) 9 Hz (d) 12 Hz

Part - C

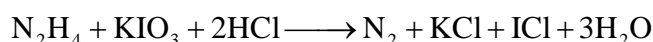
71. The strength of $p_{\pi} - d_x$ bonding in E–O (E = Si, P, S and C) follows the order
 (a) Si – O > P – O > S – O > Cl – O (b) P – O > Si – O > S – O > Cl – O
 (c) S – O > Cl – O > P – O > Si – O (d) Cl – O > S – O > P – O > Si – O

72. In the following reactions carried out in liquid NH_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
73. The pair of lanthanides with the highest third-ionization energy is:
 (a) Eu, Gd (b) Eu, Yb (c) Dy, Yb (d) Lu, Yb
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)
75. The quantitative determination of N_2H_4 with KIO_3 proceeds in a mixture of $\text{H}_2\text{O}/\text{CCl}_4$ as follows



The end point for the titrimetric reaction is:

- (a) Consumption of N_2H_4 (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.
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
77. The decreasing order of dipole moment of molecules is
 (a) $\text{NF}_3 > \text{NH}_3 > \text{H}_2\text{O}$ (b) $\text{NH}_3 > \text{NF}_2 > \text{H}_2\text{O}$
 (c) $\text{H}_2\text{O} > \text{NH}_3 > \text{NF}_3$ (d) $\text{H}_2\text{O} > \text{NF}_3 > \text{NH}_3$

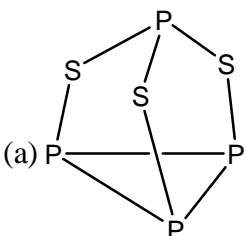
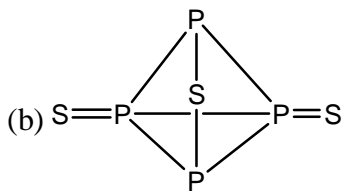
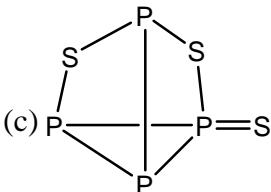
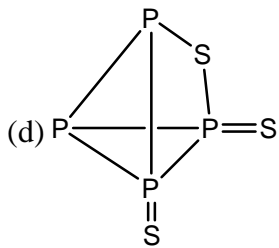
Therefore, order of dipole moment is $\text{H}_2\text{O} > \text{NH}_3 > \text{NF}_3$.

78. The cluster having arachno type structure is:

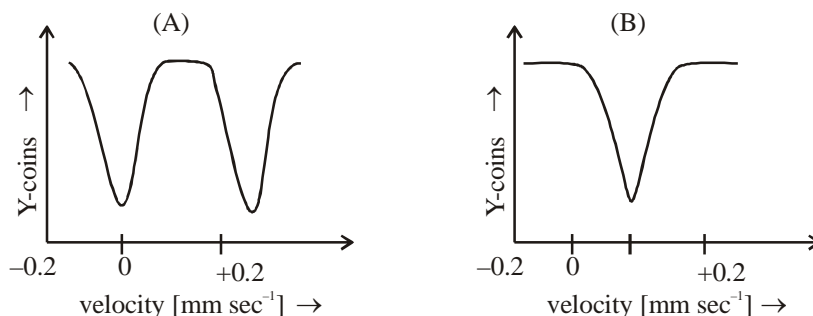


79. The carbonyl resonance in ^{13}C NMR spectrum of $[(\eta^5 - \text{C}_3\text{H}_5)\text{Rh}(\text{CO})_3]$ (^{103}Rh , nuclear spin, $I=1/2$, 100%) shows a triplet at -65°C owing to the presence of
 (a) Terminal CO (b) $\mu_2 - \text{CO}$ (c) $\mu_3 - \text{CO}$ (d) $\eta^5 - \text{C}_3\text{H}_5$

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 .

81. The metal complex that exhibits a triplet as well as doublet in its ^{31}P NMR spectrum is
 (a) $\text{mer} - [\text{IrCl}(\text{Co})(\text{PPh}_3)_2]$ (b) $\text{trans} - [\text{IrCl}(\text{Co})(\text{PPh}_3)_2]$
 (c) $\text{fac} - [\text{IrCl}(\text{Co})(\text{PPh}_3)_2]$ (d) $[\text{Ir}(\text{PPh}_3)_4]^+$
82. The complex that **DOES NOT** obey 18- electron rule is:
 (a) $[(\eta^5 - \text{C}_5\text{H}_5)\text{RuCl}(\text{CO})(\text{PPh}_3)]$ (b) $[\text{W}(\text{CO})_3(\text{SiMe}_3)(\text{Cl})(\text{NMe}_2)_2]$
 (c) $[\text{IrCl}_3(\text{PPh}_3)_2(\text{AsPh}_2)]^-$ (d) $[\text{Os}(\text{N})\text{Br}_2(\text{PMe}_3)(\text{NMe}_2)]^-$
83. The number of spin-allowed ligand field transitions for octahedral Ni(II) complexes with $^3\text{A}_{2g}$ ground state is:
 (a) Two (b) Three (c) One (d) Four
84. The correct structure of P_4S_3 is:
 (a) 
 (b) 
 (c) 
 (d) 
85. The final product of the reaction $[\text{Mn}(\text{CO})_6]^+ + \text{MeLi} \longrightarrow$ is:
 (a) $[\text{Mn}(\text{CO})_6]^+ \text{Me}^-$ (b) $[\text{Mn}(\text{CO})_5 \text{Me}]$
 (c) $[\text{Mn}(\text{CO})_6]$ (d) $[(\text{MeCO})\text{Mn}(\text{CO})_5]$
86. The reaction that yields $\text{Li}[\text{AlH}_4]$ is:
 (a) $\text{HCl}(\text{excess}) + \text{AlCl}_3 + \text{Li} \rightarrow$ (b) $\text{H}_2 + \text{Al} + \text{Li} \rightarrow$
 (c) $\text{LiH}(\text{excess}) + \text{AlCl}_3 \rightarrow$ (d) $\text{LiH}(\text{excess}) + \text{Al} \rightarrow$
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
88. The carbon-14 activity of an old wood sample is found to be $14.2 \text{ disintegrations min}^{-1}\text{g}^{-1}$. Calculate age of old wood sample, if for a fresh wood sample carbon-14 activity is $15.3 \text{ disintegrations min}^{-1}\text{g}^{-1}$ ($t_{1/2}$ carbon-14 is 5730 years), is:
 (a) 5, 000 years (b) 4, 000 years (c) 877 years (d) 617 years

89. The reaction $3[\text{Rh}_4(\text{CO})_{12}] \rightarrow 2[\text{Rh}_6(\text{CO})_{16}] + 4\text{CO}$ [25°C, 500 atm CO] is:
- Exothermic as more metal-metal bonds are formed.
 - Endothermic as stronger metal-carbonyl bonds are cleaved while weaker metal-metal bonds are formed.
 - Is entropically favorable but enthalpically unfavorable such that $\Delta G = 0$
 - Thermodynamically unfavourable ($\Delta G > 0$).
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 eluant coming out becomes neutral. The collected eluant is completely neutralized by 17 ml. of 0.5 M NaOH. The ion exchange capacity of the resin is:
- 1.00 meq/g
 - 1.25 meq/g
 - 1.50 meq/g
 - 1.75 meq/g
91. The molar extinction coefficient of B (MW = 180) is $4 \times 10^3 \text{ lit mol}^{-1} \text{ cm}^{-1}$. 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:
- 10.20
 - 14.60
 - 20.40
 - 29.12
92. The changes (from A-D given below) which occur when O_2 binds to hemerythrin are
- One iron atoms is oxidized
 - Both the iron atoms are oxidized
 - O_2 binds to one iron atom and is also hydrogen bonded.
 - O_2 binds to both the iron atoms and is also hydrogen bonded.
- B and C
 - B and D
 - A and D
 - A and C
93. In photosynthetic systems the redox metalloproteins involved in electron transfer are cytochrome (cyt, b), cytochrome bf complex (cyt bf) and plastocyanin (PC). The pathway of electron flow is
- $\text{PC} \rightarrow \text{cyt b} \rightarrow \text{cyt bf}$
 - $\text{cyt bf} \rightarrow \text{cyt b} \rightarrow \text{PC}$
 - $\text{cyt b} \rightarrow \text{cyt bf} \rightarrow \text{PC}$
 - $\text{PC} \rightarrow \text{cyt bf} \rightarrow \text{cyt b}$
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)
- 3 and 30
 - 5 and 33
 - 5 and 30
 - 4 and 24
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 with (i) and B with (ii)
- A with (ii) and B with (i)
- A with (iii) and B with (ii)
- A with (ii) and B with (iii)

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) $\frac{2}{3}$
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
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
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) $\alpha + 2\beta, \alpha - 2\beta$
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) $[a(1)\beta(2) - \beta(1)\alpha(2)]$
- (c) $\alpha(1)\alpha(2)$ (d) $[\alpha(1)\beta(2) + \beta(1)\alpha(2)]$
101. A square pyramidal, MX_4 , molecule belongs to C_{4v} 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) 5 1 1 1 3 (b) 1 1 1 1 1 (c) 5 1 1 1 1 (d) 4 1 1 1 3
102. Character table of C_{2v} point group is:

C_{2v}	E	C_2	σ_v	$\sigma_{v'}$	
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
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) $1500 \text{ M}^{-1} \text{ cm}^{-1}$ (b) $3010 \text{ M}^{-1} \text{ cm}^{-1}$ (c) $5000 \text{ M}^{-1} \text{ cm}^{-1}$ (d) $6020 \text{ M}^{-1} \text{ cm}^{-1}$.

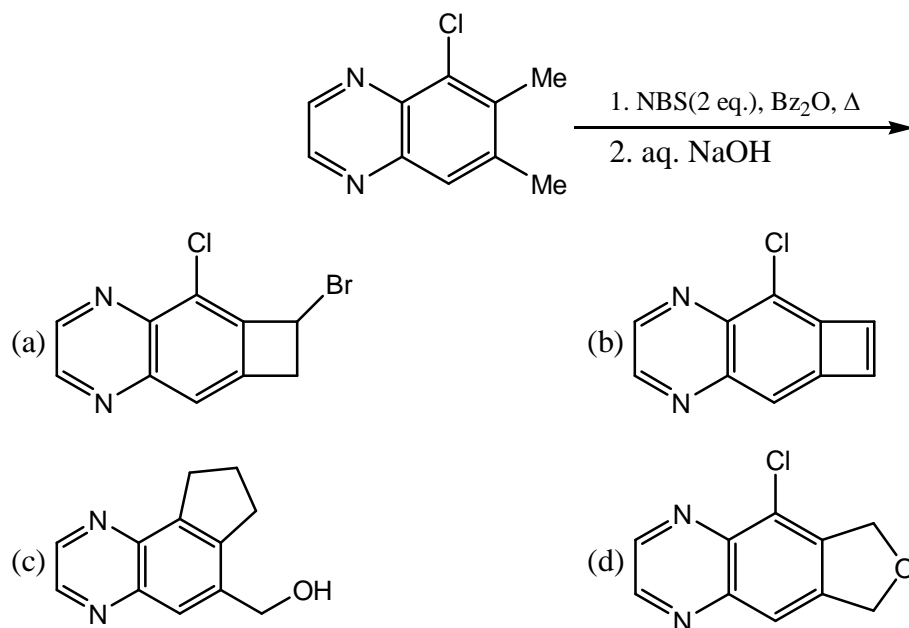
104. The set of allowed electronic transitions among the following is:
- (A) $^4\Sigma \rightarrow ^2\Pi$ (B) $^3\Sigma \rightarrow ^3\Pi$ (C) $^1\Delta \rightarrow ^1\Delta$ (D) $^2\Pi \rightarrow ^2\Pi$ (E) $^3\Sigma \rightarrow ^3\Delta$
(a) A, B, E (b) A, C, E (c) B, C, D (d) C, D, E
105. The following data were obtained from the vibrational fine structure in the vibronic spectrum of a diatomic molecule:
- $$\omega_e = 512 \text{ cm}^{-1}, \omega_e x_e = 8 \text{ cm}^{-1}$$
- 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} .
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) $w > 0, q > 0$
107. The gas phase reaction $2\text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$ is an exothermic process. In 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.
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) $-\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$
109. The energy levels of the harmonic oscillator (neglecting zero point energy) are $\epsilon_n = nh\nu$ for $n = 0, 1, 2, \dots, \infty$. Assuming $h\nu = K_B T$, the partition function is:
- (a) e (b) $\frac{1}{e}$ (c) $1 - \frac{1}{e}$ (d) $\frac{1}{1 - \frac{1}{e}}$
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) $k_B \ln 720$
111. The correct Nernst equation for the concentration cell:
- $$\text{Pt} | \text{H}_2(\text{p}) | \text{HCl}(\text{a}_{\pm})_1 | \text{AgCl}(\text{s}) | \text{Ag} \quad \text{Ag} | \text{AgCl}(\text{s}) | \text{HCl}(\text{a}_{\pm})_2 | \text{H}_2(\text{p}) | \text{Pt}$$
- without liquid junction would be
- (a) $E = \frac{2RT}{F} \ln \frac{(\text{a}_{\pm})_1}{(\text{a}_{\pm})_2}$ (b) $E = \frac{RT}{F} \ln \frac{(\text{a}_{\pm})_2}{(\text{a}_{\pm})_1}$
(c) $E = \frac{2RT}{F} \ln \frac{(\text{a}_{\pm})_2}{(\text{a}_{\pm})_1}$ (d) $E = \frac{RT}{2F} \ln \frac{(\text{a}_{\pm})_2}{(\text{a}_{\pm})_1}$

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 $|\pm Ze\phi| \ll k_B T$
113. In the base (OH⁻) hydrolysis of a transition metal complex $[ML_6]^{Z+}$, the slope between $\log(k/k_0)$ and \sqrt{I} is found to be -2.1. The charge on the complex is:
 (a) +1 (b) +2 (c) +3 (d) +4
114. The rate law for one of the mechanism of the pyrolysis of CH₃CHO at 520°C and 0.2 bar is

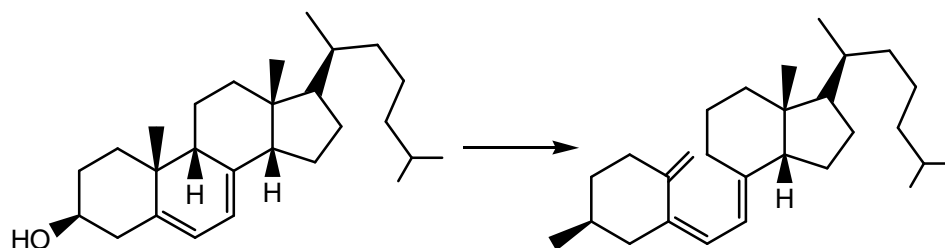
$$\text{Rate} = -k_2 \left(\frac{k_1}{2k_1} \right)^{1/2} [\text{CH}_3\text{CHO}]^{3/2}$$
 The overall activation energy E, in terms of the rate law is:
 (a) $E_a(2) + E_a(1) + 2E_a(4)$ (b) $E_a(2) + \frac{1}{2}E_a(1) - E_a(4)$
 (c) $E_a(2) + \frac{1}{2}E_a(1) - \frac{1}{2}E_a(4)$ (d) $E_a(2) - \frac{1}{2}E_a(1) + \frac{1}{2}E_a(4)$
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⁻¹s⁻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}
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.
117. The wavelength and the spectral region for a single electron transfer across the band gap in a semiconductor ($E_x - 1.98 \times 10^{-19}$) are $[h = 6.626 \times 10^{-34} \text{ Js}, c = 3 \times 10^8 \text{ ms}^{-1}]$
 (a) 1000 nm, UV (b) 1000 nm, IR (c) 500 nm, visible (d) 500 nm, FAR IR
118. The lattice parameter of an element stabilized in a fcc structure is 4.04 Å. The atomic radius of the element is:
 (a) 2.86 Å (b) 1.43 Å (c) 4.29 Å (d) 5.72 Å
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

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

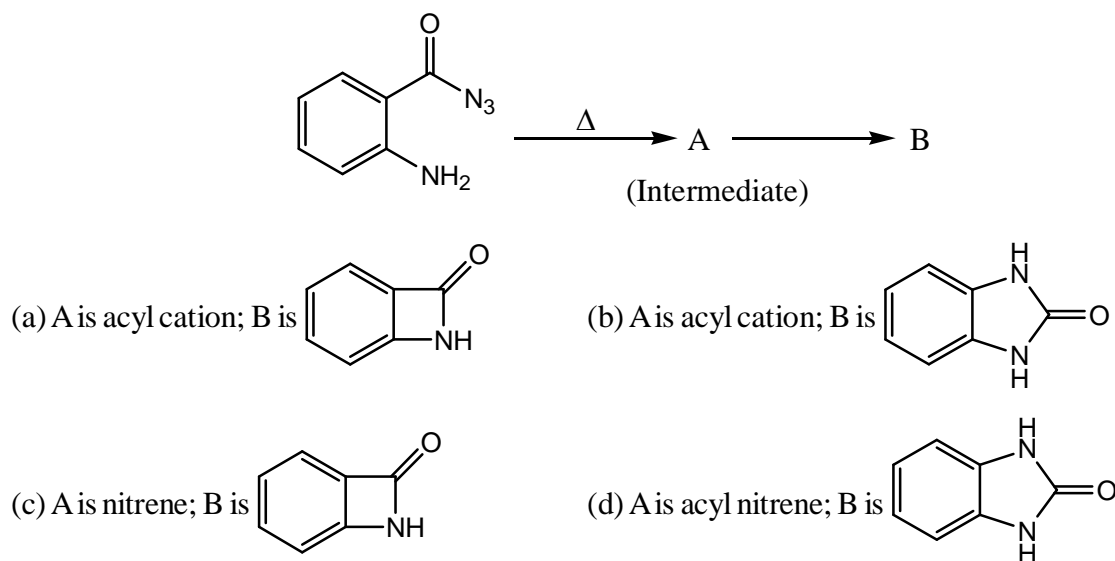


124. The two step conversion of 7-dehydrocholesterol to vitamin D₃ proceeds through

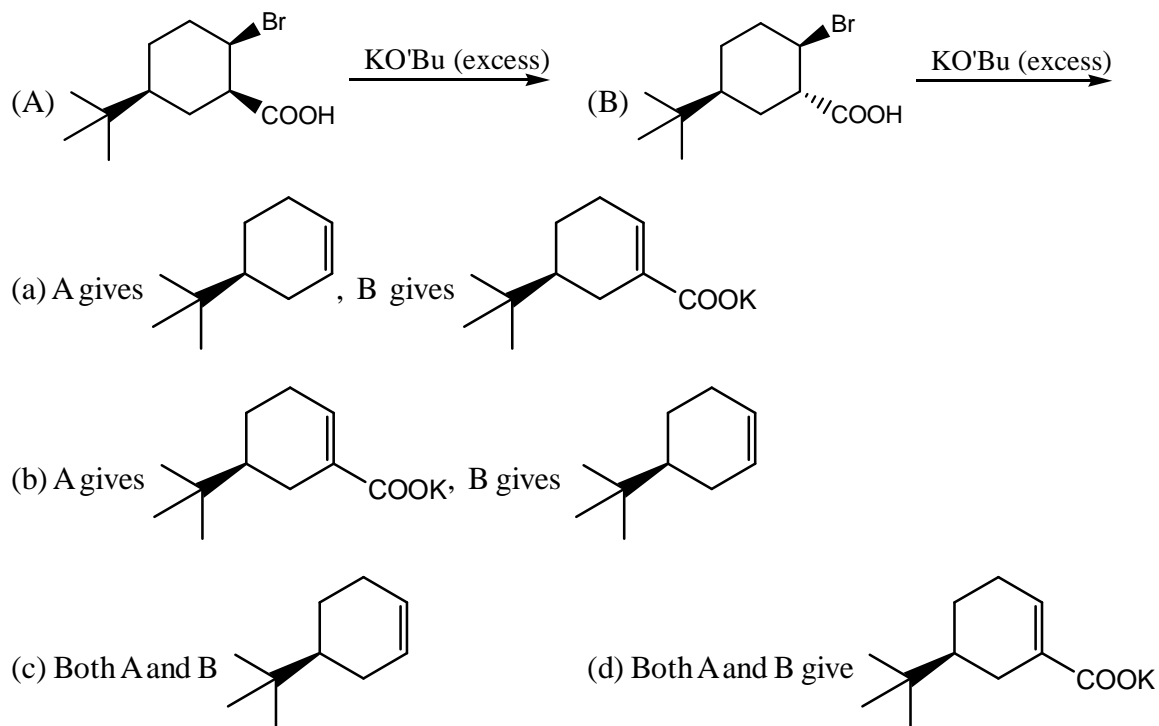


- (a) Photochemical electrocyclic disrotatory ring opening; and thermal antarafacial [1, 7]-H shift.
 (b) Photochemical electrocyclic conrotatory ring opening; and thermal antarafacial [1, 7]-H shift.
 (c) Thermal electrocyclic conrotatory ring opening; and photochemical suprafacial [1, 7]-H shift.
 (d) Thermal electrocyclic disrotatory ring opening; and thermal suprafacial [1, 7]-H shift.

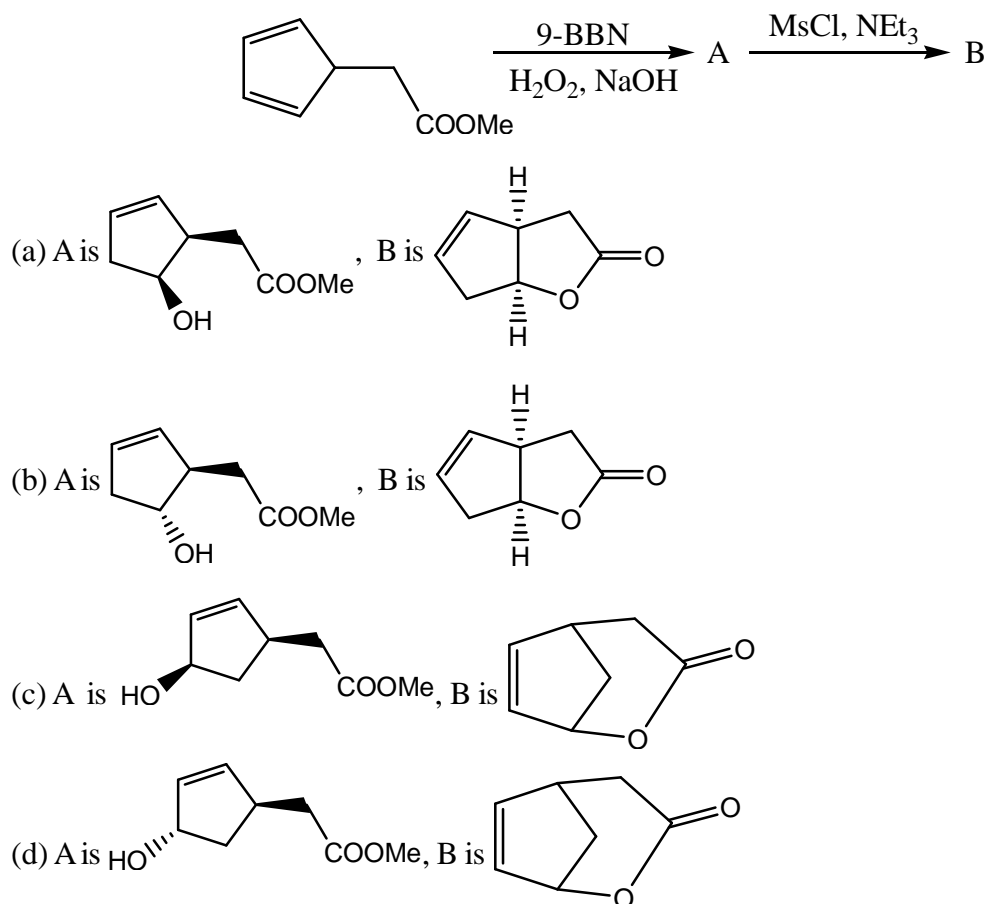
125. The intermediate A and the major product B in the following reaction are



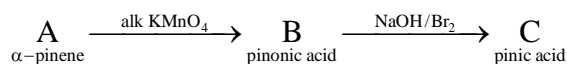
126. For the following two reactions A and B, the correct statement is:



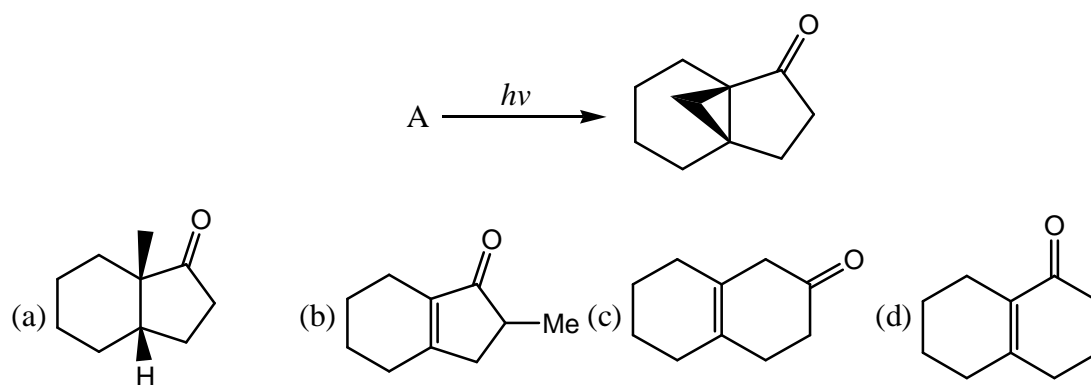
127. The major compound B formed in the reaction sequence given below exhibited a carbonyl absorption band at 1770 cm^{-1} in the IR spectrum. The structure A and B are



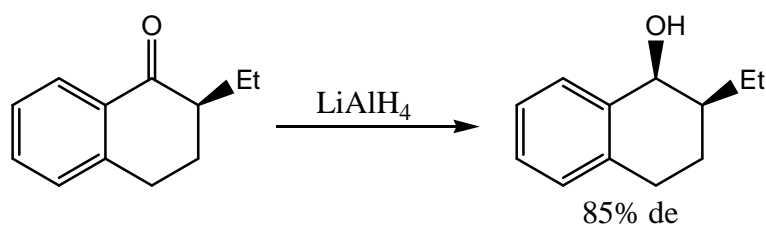
128. Consider the following reaction sequence starting with monoterpene α – pinene . Identify the correct statement



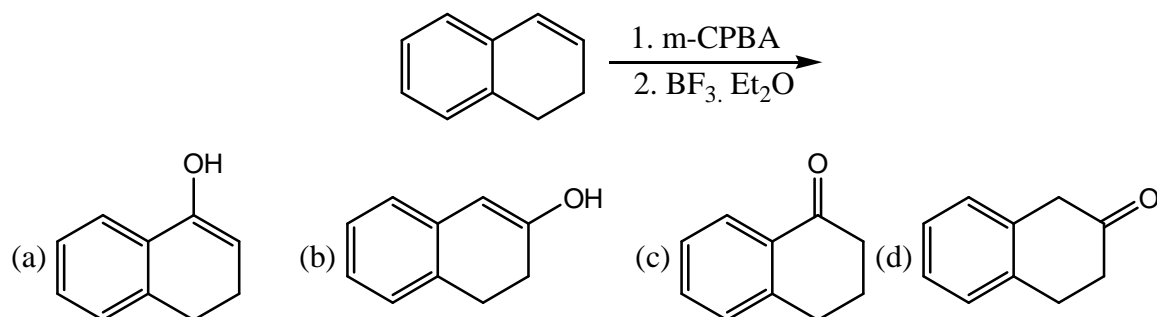
- (a) A has a disubstituted double bond; B and C are dicarboxylic acids.
 (b) A has a trisubstituted double bond; B is a methyl ketone; and C is a dicarboxylic acid.
 (c) A has a disubstituted double bond; B is a methyl ketone; and C is a dicarboxylic acid.
 (d) A has an exocyclic double bond; B and C are monocarboxylic acids.
129. The major product formed when (3R, 4S)-3, 4-dimethylhexa-1, 5-diene is heated at 240° 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
130. Structure of the starting material A in the following photochemical Norrish reaction, is



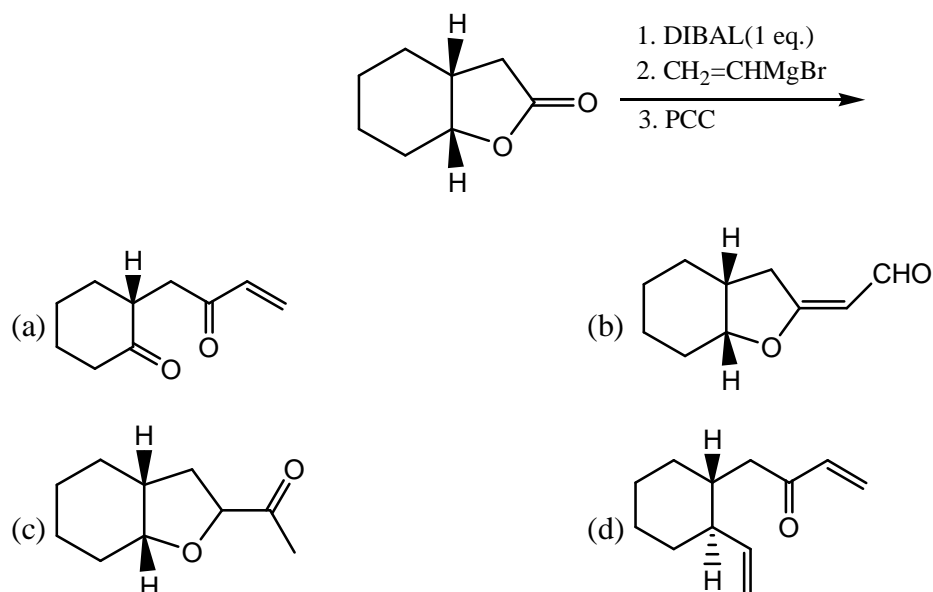
131. Considering the following reaction, among a-c, the correct statements are



- (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)
132. The major product formed in the following reaction sequence is



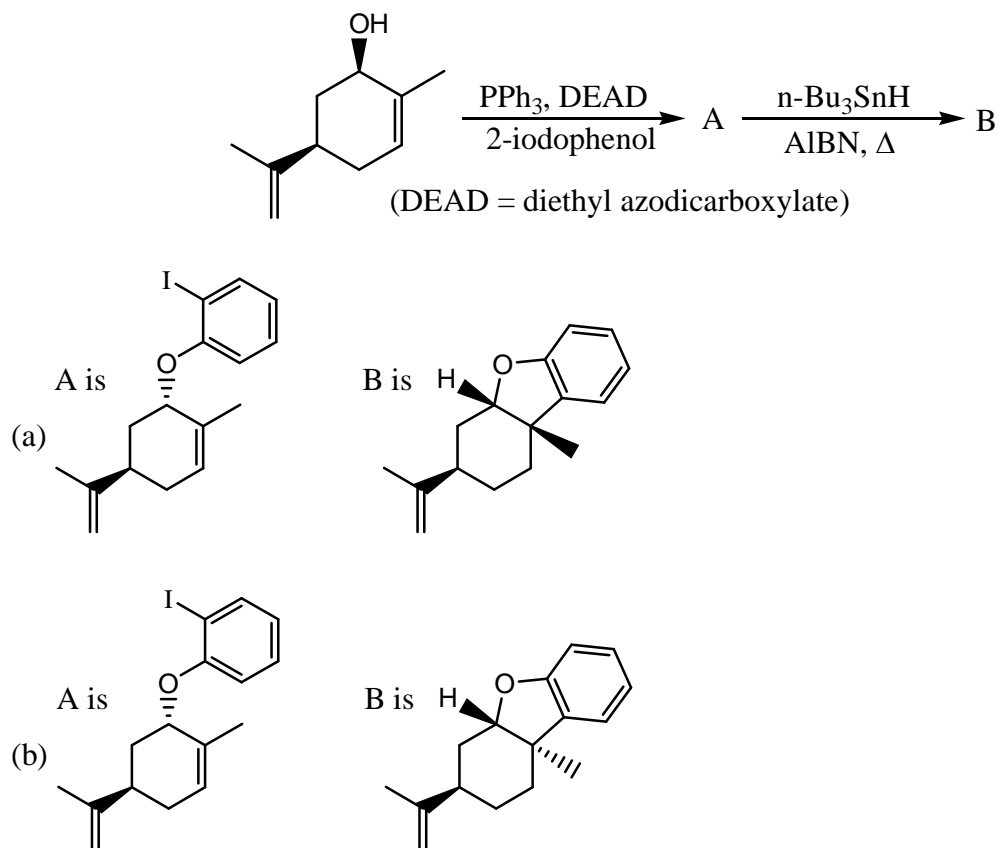
133. The major product formed in the following reaction sequence is:

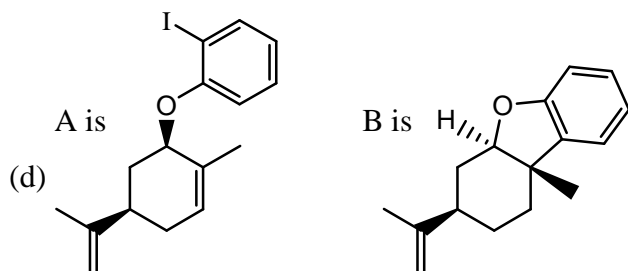
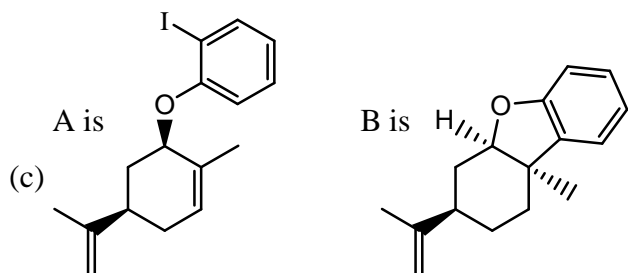


134. Match the following

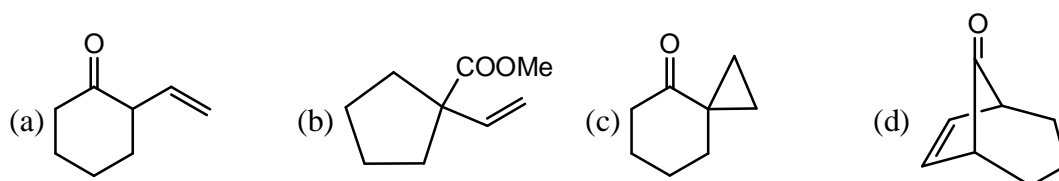
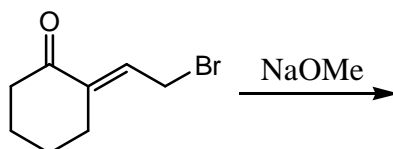
Compound	¹³ C NMR chemical shift (δ ppm)
(A) Acetic acid	(i) 95
(B) Acetonitrile	(ii) 115
(C) Acetone	(iii) 175
(D) Carbon tetrachloride	(iv) 205
(a) (A)-(iii), (B)-(ii), (C)-(iv), (D)-(i)	(b) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)
(c) (A)-(i), (B)-(ii), (C)-(iv), (D)-(ii)	(d) (A)-(iii), (B)-(i), (C)-(iii), (D)-(iv)

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

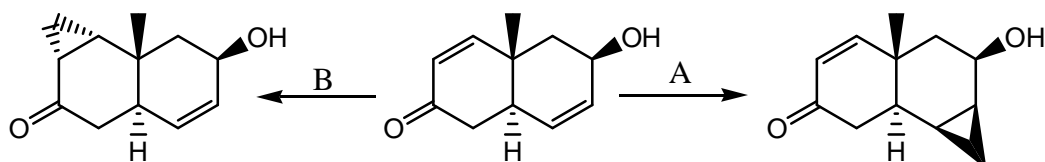




136. The major product formed in the following reaction is:

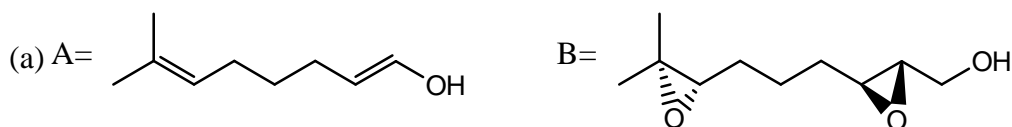
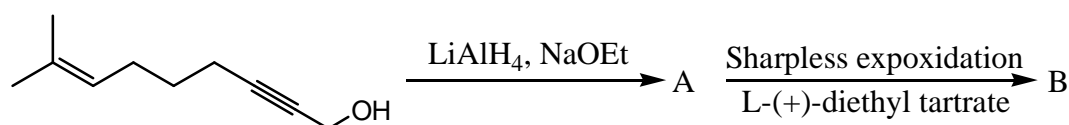


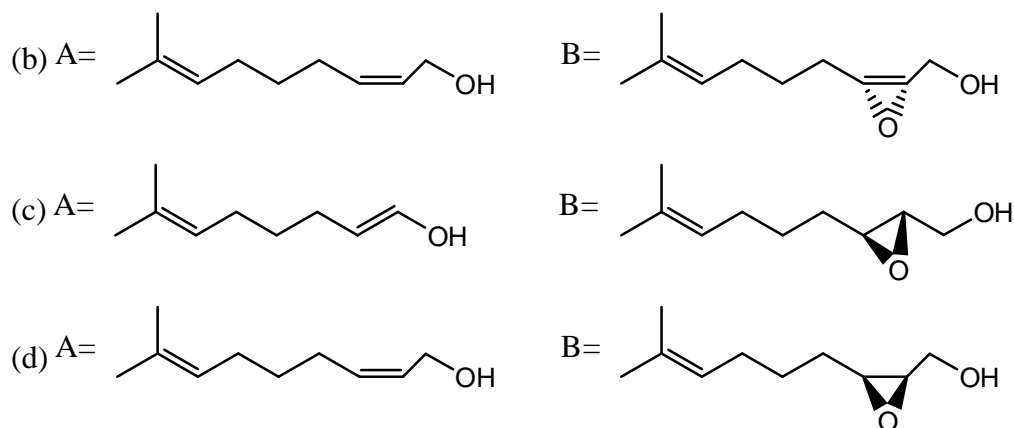
137. The reagents A and B in the following reactions are



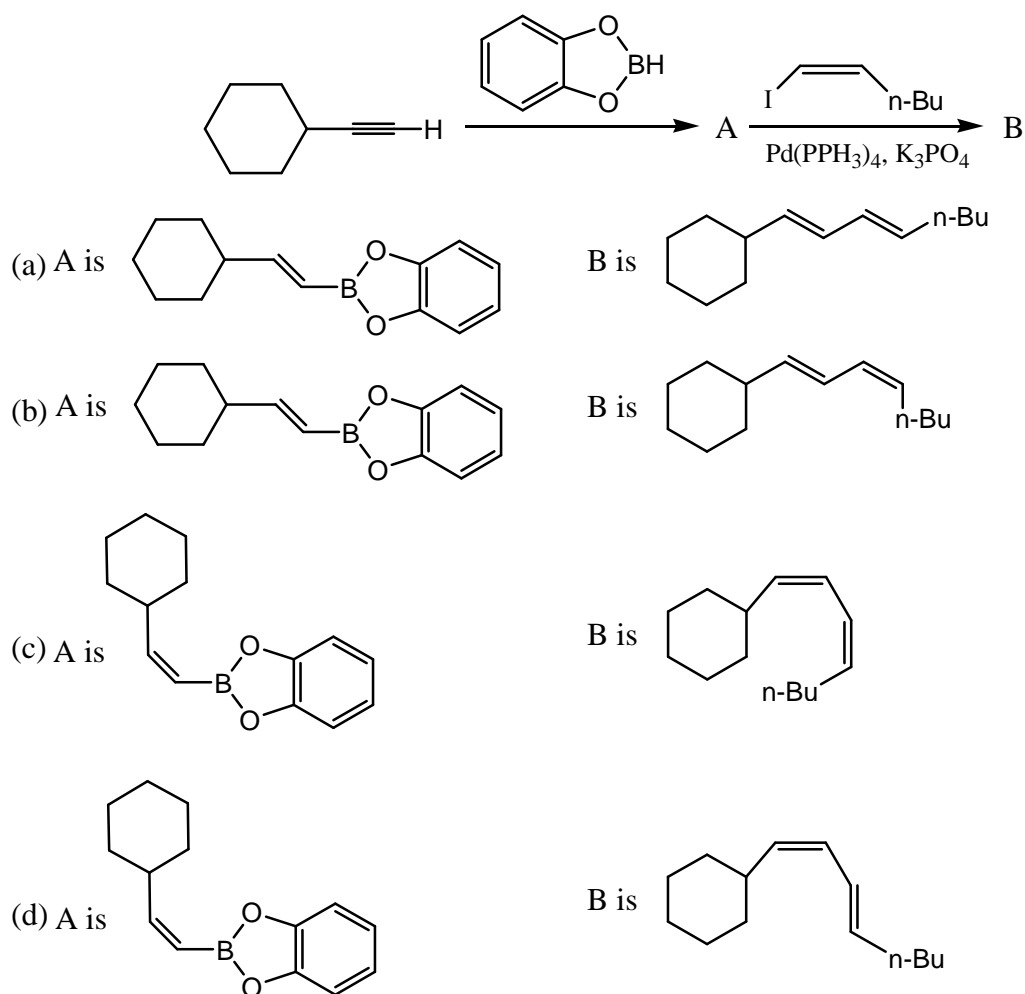
- (a) A = CH_2I_2 , Zn - Cu; B = $\text{Me}_3\text{S}^+\text{I}^-$, NaH
 (b) A = CH_2I_2 , Zn - Cu; B = $\text{Me}_3\text{S}^+(\text{O})\text{I}^-$, NaH
 (c) A = $\text{Me}_3\text{S}^+\text{I}^-$, NaH; B = $\text{Me}_3\text{S}^+(\text{O})\text{I}^-$, NaH
 (d) A = $\text{Me}_3\text{S}^+(\text{O})\text{I}^-$, NaH B = CH_2I_2 , Zn - Cu

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

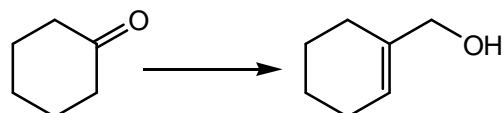




139. The major products A and B formed in the following reaction sequence are

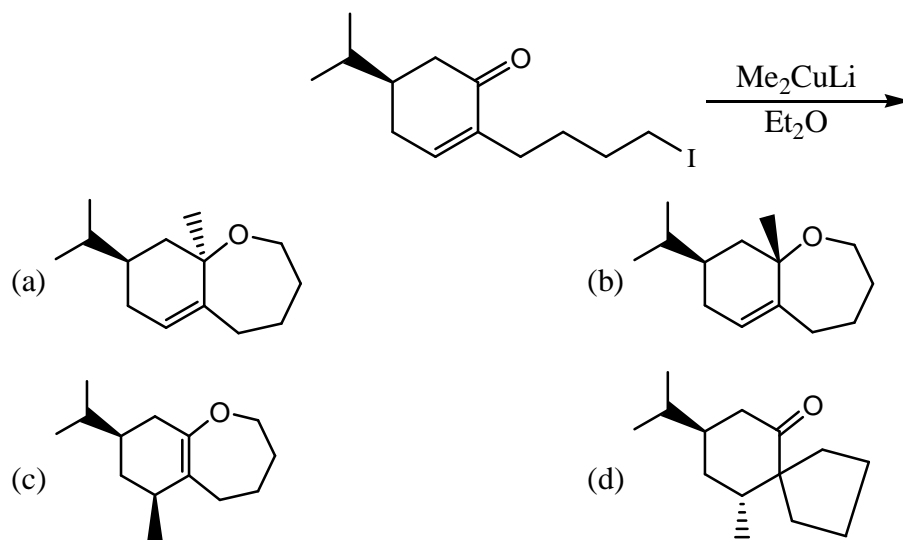


140. The correct reagent combination/reaction sequence for effecting the following conversion is:

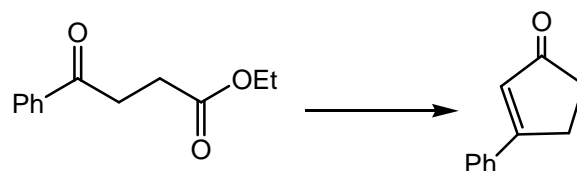


- (a) (1) $\text{Me}_3\text{SiCH}_2\text{OMe}$, BuLi; (2) H_3O^+ ; (3) NaBH_4 , MeOH
 (b) (1) $\text{Ph}_3\text{P}^+\text{CH}_2\text{MeCl}$, BuLi; (2) H_3O^+ ; (3) NaBH_4 , MeOH
 (c) (1) NH_2NHTs ; (2) NaOEt; (3) ClCOOEt
 (d) (1) NH_2NHTs ; (2) 2 eq. BuLi; (3) HCHO

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

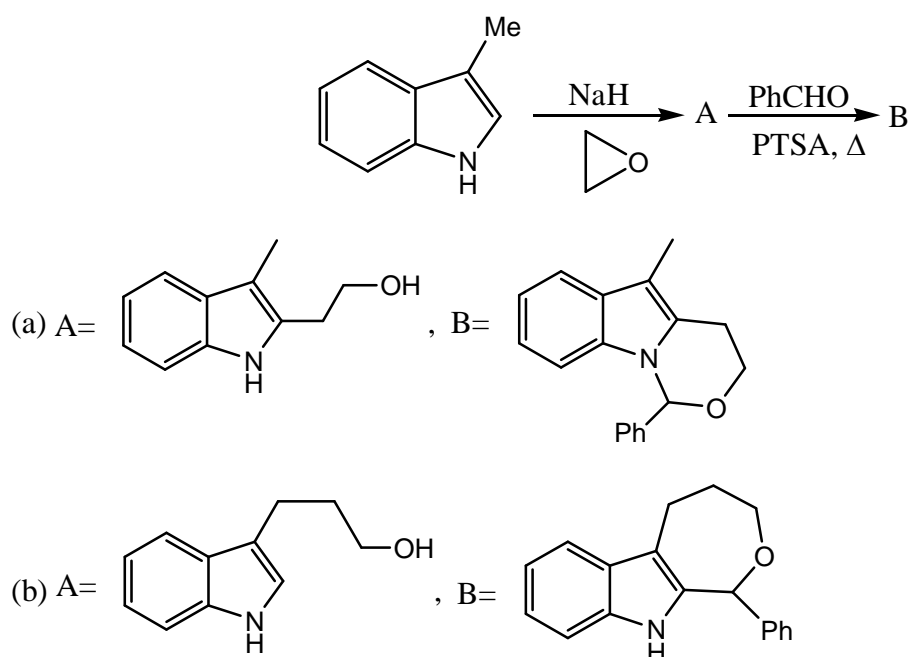


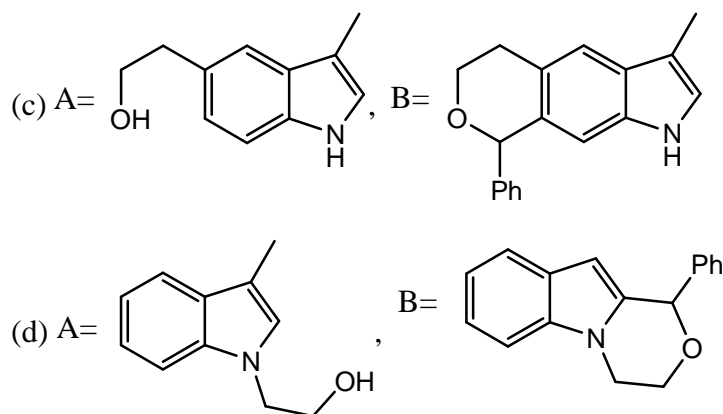
142. The correct sequence of reagents for effecting the following conversion is:



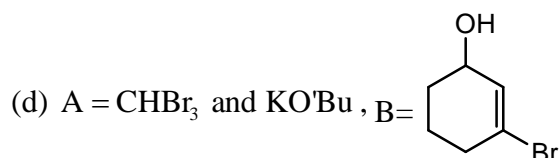
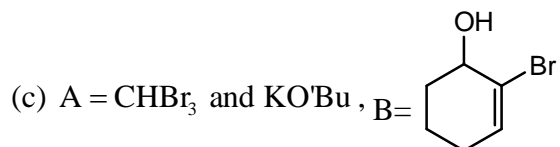
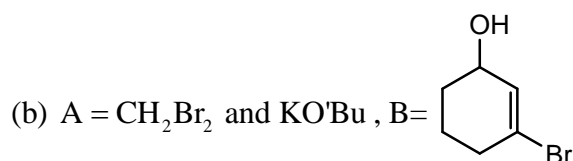
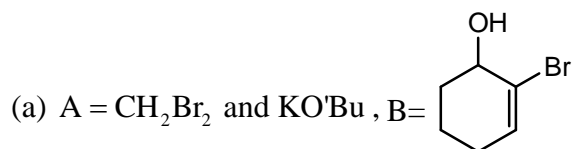
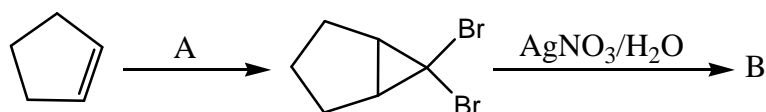
- (a) (1) $(\text{CH}_2\text{OH})_2$, PTSA, Δ ; (2) P_2CTi AlMe_2 (Tebbe's reagent) (3) H_3O^+ ; (4) KOH
- (b) (1) $(\text{CH}_2\text{OH})_2$, PTSA, Δ ; (2) $\text{Ph}_3\text{P}-\text{CH}_2$; (3) H_3O^+ ; (4) KOH
- (c) (1) P_2CTi AlMe_2 (Tebbe's reagent); (2) H_3O^+ ; (3) KOH
- (d) $\text{Ph}_3\text{P}=\text{CH}_2$; (2) H_3O^+ ; (3) KOH

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

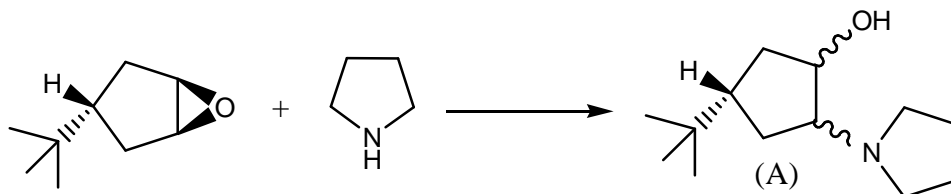




144. The reagent A required, and the major product B formed in the following reaction sequence are



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.