



**ISM DHANBAD M.Sc. CHEMISTRY ENTRANCE - 2014**

Time : 3 Hours

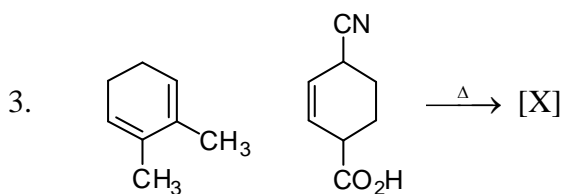
Max. Marks : 100

**Instructions:**

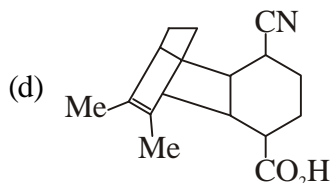
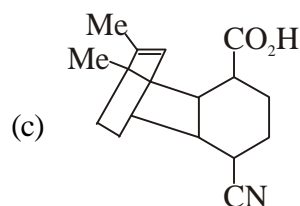
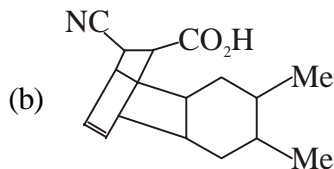
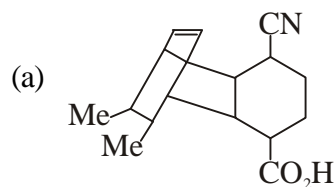
- (i) **Section-A:** Q.1 – Q.50 carry **1 mark** each. **Section-B:** Q.51 – Q.75 carry **2 marks** each.
- (ii) Questions not attempted will result in zero mark and wrong answer will result in **NEGATIVE** marks. **1/4 of mark will be deducted for each wrong answer.** More than one answer against a question will be treated as an incorrect response.

**Section-A**

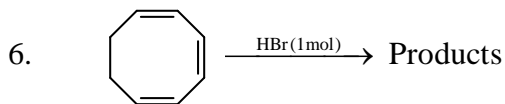
1. At 18°C, the resistance of 0.1N KCl in a conductivity cell is 86.8 ohms and that of 0.05 N NaCl is 203 ohm. What is the equivalent conductivity of 0.05N NaCl? (specific conductance of 0.1N KCl at 180°C is 0.011192 ohms)
- (a)  $95.71 \Omega^{-1} \text{cm}^{-1}$  (b)  $0.00422 \Omega^{-1} \text{cm}^{-1}$   
(c)  $9.571 \Omega^{-1} \text{cm}^{-1}$  (d)  $0.0422 \Omega^{-1} \text{cm}^{-1}$
2. A certain electrode has a reduction potential 0.140V when measured against a saturated calomel electrode. The potential versus a standard hydrogen electrode is
- (a) 0.384 V (b) 1.23 V  
(c) 0.534 V (d) 0.453 V



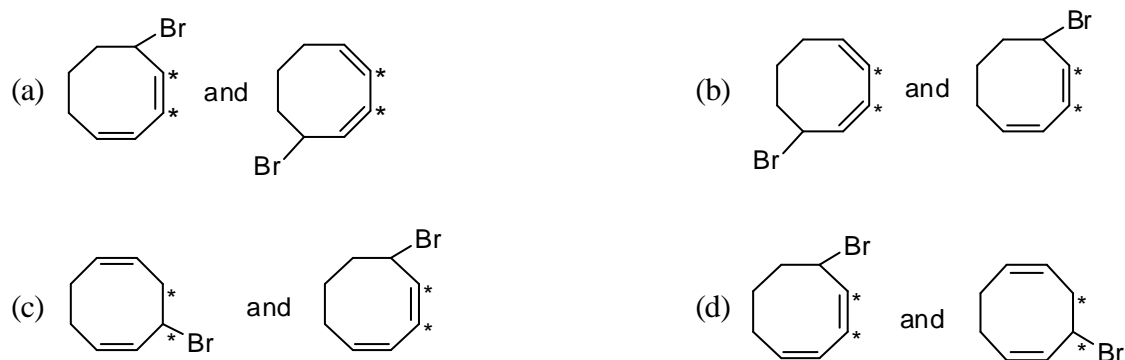
The 'X' will be



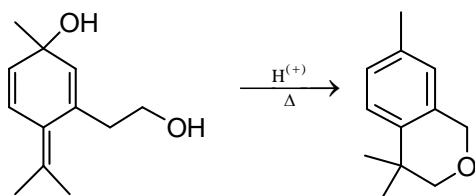
4. What is the entropy change for vaporization of 1 mol of liquid water to steam at 100°C if  $\Delta H_{\text{vap}} = 40.8 \text{ kJ mol}^{-1}$ .
- (a)  $219.31 \text{ JK}^{-1} \text{ mol}^{-1}$  (b)  $109.38 \text{ JK}^{-1} \text{ mol}^{-1}$   
 (c)  $89 \text{ JK}^{-1} \text{ mol}^{-1}$  (d)  $329 \text{ JK}^{-1} \text{ mol}^{-1}$
5. What is the concentration of  $[\text{H}^+]$  in a 0.100M solution of  $\text{NaHCO}_3$ ? For  $\text{H}_2\text{CO}_3$  at 25°C  
 $K_{a_1} = 4.5 \times 10^{-7}$  and  $K_{a_2} = 4.8 \times 10^{-11}$
- (a)  $3.2 \times 10^{-7} \text{ M}$  (b)  $2.3 \times 10^{-5} \text{ M}$   
 (c)  $4.6 \times 10^{-9} \text{ M}$  (d)  $5.29 \times 10^{-7} \text{ M}$



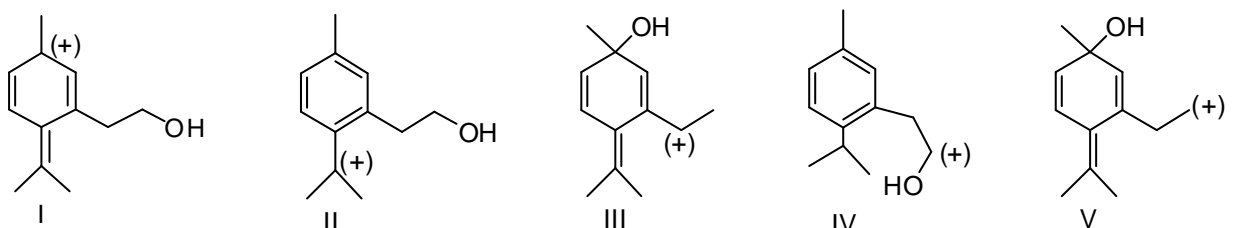
In this reaction thermodynamically and kinetically controlled products are



7. Consider the following acid catalyzed transformation

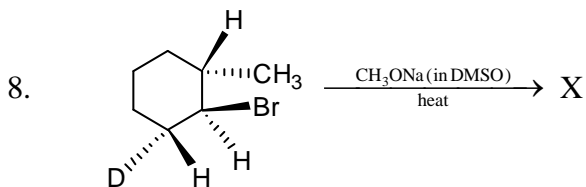


Following intermediates are expected in this transformation

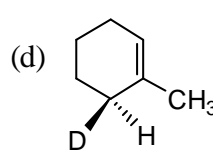
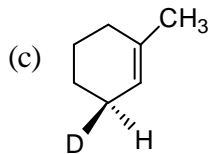
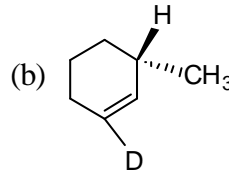
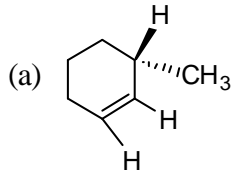


The intermediate which are not produced during this transformations is / are

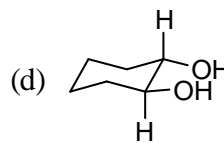
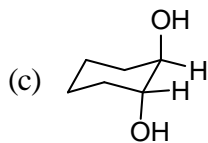
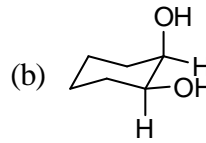
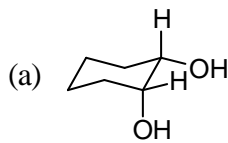
- (a) I, III & V (b) III, IV & V  
 (c) II, III, IV & V (d) IV



The 'X' is



9. The most stable form of cyclohexane-1, 2-diol is



10. What type of crystal structure should be expected for magnesium sulphide?

- (a) spinel (b) Perovskite (c) rock salt (d) rutile

11. At time  $t = 0$  a particle in the potential  $V(x) = m\omega^2 x^2 / 2$  is described by the wave function

$$\Psi(x, 0) = A \sum_n (1/\sqrt{2})^n \Psi_n(x). \text{ Where } \Psi_n(x) \text{ are eigen states of the energy with eigenvalues}$$

$E_n = (n + 1/2)\hbar\omega$ . You are given that  $(\Psi_n, \Psi_{n'}) = \delta_{nn'}$ . The expectation value of the energy at  $t = 0$ .

- (a)  $3\hbar\omega/2$  (b)  $\hbar\omega/2$  (c)  $\hbar\omega$  (d) None of the above

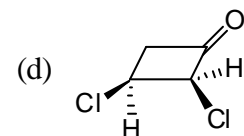
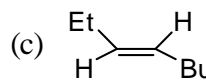
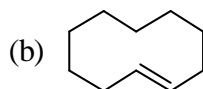
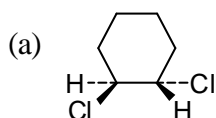
12. The geometry of  $\text{I}_3^-$  ion is

- (a) Trigonal (b) Linear (c) Non-linear (d) None of the above

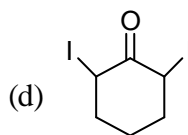
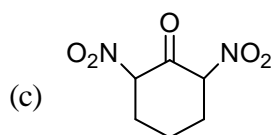
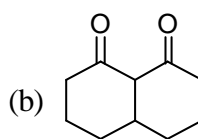
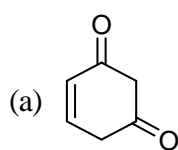
13. The final temperature of the system after a 100g piece of lead at  $45.0^\circ\text{C}$  is added to a mixture of 2.00g of ice in 10.0g of water at  $0^\circ\text{C}$ .

- (a)  $5^\circ\text{C}$  (b)  $10^\circ\text{C}$  (c)  $0^\circ\text{C}$  (d) None of the above

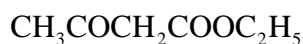
14. Which is not a *trans* isomer



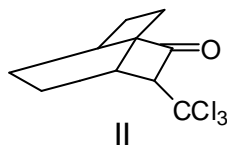
15. At its melting point  $0^{\circ}\text{C}$ , the enthalpy of fusion water is  $1.435 \text{ cal/mol}$ . What is the molar entropy change for melting at  $0^{\circ}\text{C}$ ?
- (a)  $4.52 \text{ cal/mol-K}$  (b)  $5.26 \text{ cal/mol-K}$   
 (c)  $56.5 \text{ cal/mol-K}$  (d) None of the above
16. What is the oxidation number of O in  $\text{O}_2^+$ .
- (a)  $+1/2$  (b)  $-1/2$  (c)  $-1$  (d)  $-2$
17. Calculate the pressure exerted by  $8.5\text{g}$  of ammonia contained in a  $0.5\text{L}$  vessel at  $300\text{K}$ . For  $\text{NH}_3$   $a = 4.0 \text{ atm L}^2 \text{ mol}^{-2}$ ,  $b = 0.036 \text{ L mol}^{-1}$ .
- (a)  $3.5 \text{ atm}$  (b)  $10.1 \text{ atm}$  (c)  $21.51 \text{ atm}$  (d) None of the above
18. Which of the following has highest heat of hydrogenation
- (a) But-1-ene (b) *cis*-But-2-ene  
 (c) *trans*-But-2-ene (d) isobutene
19. Which will have least stable enol form?



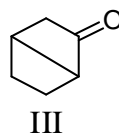
20. The term-symbol for the ground state of atomic O is
- (a)  ${}^7\text{S}_3$  (b)  ${}^3\text{P}_2$  (c)  ${}^3\text{D}_1$  (d)  ${}^3\text{D}_3$
21. You have four compounds



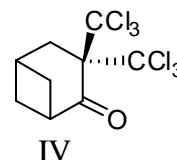
I



II



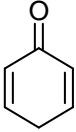
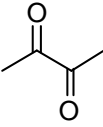
III

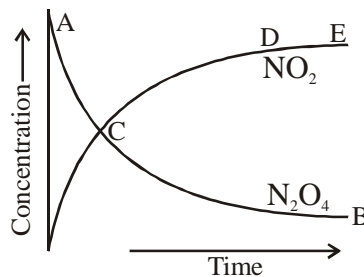


IV

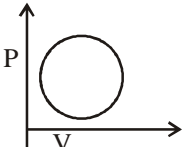
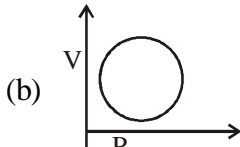
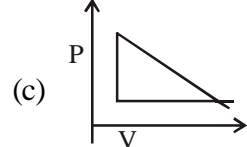
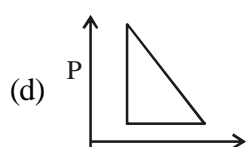
Identify the compound(s) which cannot form planar carbanion

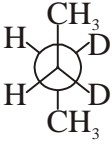
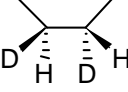
- (a) II, III & IV (b) IV (c) I, II, III & IV (d) II & III
22. What is the half-life of a first order reaction for which  $k = 7.1 \times 10^{-5} \text{ s}^{-1}$
- (a) 2.2 h (b) 1.0 h (c) 2.0 h (d) 2.7 h
23. A gas obeys  $P(V-b) = RT$ . Which of the following are correct about this gas
- I. Isochoric curves have the slope =  $R/V-b$   
 II. Isobaric curves have slope =  $R/P$  and intercept  $b$   
 III. For the gas-compressibility factor =  $1+Rb/RT$   
 IV. The attraction forces are overcome by repulsive forces
- (a) I (b) II, III (c) III (d) I, II, III & IV




24. A solid has a structure in which W atoms are located at the cubic corner of unit cell, O atoms are located at the cube edges and Na atoms at the cube centres. What is the formula for the compound?  
 (a)  $\text{NaWO}_3$  (b)  $\text{Na}_2\text{WO}_3$  (c)  $\text{NaWO}_2$  (d) None of the above
25. Maximum enol content is in  
 (a)  (b)   
 (c)  $\text{CH}_3\text{COCH}_2\text{COCH}_3$  (d)  $\text{PhCOCH}_2\text{COOCH}_3$
26. What is the coordination number of copper in  $\text{Cu}(\text{en})_2^{2+}$   
 (a) 6 (b) 4 (c) 8 (d) 2
27. A bottle is labelled "86.0%" by weight  $\text{H}_2\text{SO}_4$  density 1.787 g/mL. What is the molarity of  $\text{H}_2\text{SO}_4$ ?  
 (a) 8.78M (b) 10.5M (c) 15.7M (d) 18.2M
28.  $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$ ,  $K_c = 4$ . This reversible reaction is studied graphically as shown in the following figure



Select the correct statement out of I, II, III

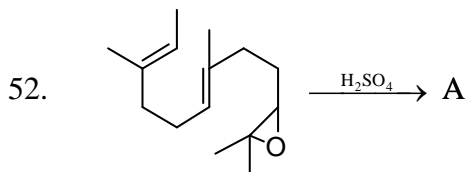
- I. Reaction quotient has maximum value  
 II. Reaction proceeds left to right at a point when  $[\text{N}_2\text{O}_4] = [\text{NO}_2] = 0.1\text{M}$   
 III.  $K = Q$  when point D or F is reached  
 (a) I, II (b) II, III (c) I (d) I, II & III
29. The geometry of  $\text{XeF}_6$  molecule is  
 (a) Tetrahedral (b) Octahedral (c) Pyramidal (d) Distorted octahedral
30. The following are the P-V diagram for the cyclic processes for a gas. In which of the cases heat is not absorbed by the gas?  
 (a)  (b)  (c)  (d) 
31. What is the unit of rate constant 'k' for third order reaction?  
 (a)  $\text{mol L}^{-1} \text{s}^{-1}$  (b)  $\text{s}^{-1}$  (c)  $\text{L}^2 \text{mol}^{-2} \text{s}^{-1}$  (d)  $\text{L mol}^{-1} \text{s}^{-1}$
32. The equivalent conductances of sodium butyrate, sodium chloride and hydrochloric acid are 83, 127 and 426  $\text{ohm}^{-1} \text{cm}^2$  at  $25^\circ\text{C}$  respectively. The equivalent conductance of butyric acid at infinite dilution will be  
 (a) 234  $\text{ohm}^{-1} \text{cm}^2$  (b) 516  $\text{ohm}^{-1} \text{cm}^2$   
 (c) 382  $\text{ohm}^{-1} \text{cm}^2$  (d) 134  $\text{ohm}^{-1} \text{cm}^2$

33. The Vander Waal constant 'a' for real gas at critical point is  
 (a)  $\frac{27(RT_c)^2}{64P_c}$  (b)  $\frac{RT_c}{8P_c}$  (c)  $\frac{8RT_c}{27P_c}$  (d)  $\frac{8PV_c}{3T_c}$
34. What is the coordination number of a Ti atom in rutile?  
 (a) 4 (b) 6 (c) 8 (d) 3
35. The configuration of  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H} - \text{C} - \text{D} \\ | \\ \text{H} - \text{C} - \text{D} \\ | \\ \text{CH}_3 \end{array}$  is similar to  
 (a)  (b)  (c)  $\begin{array}{c} \text{D} \\ | \\ \text{H}_3\text{C} - \text{C} - \text{H} \\ | \\ \text{H} - \text{C} - \text{D} \\ | \\ \text{CH}_3 \end{array}$  (d)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H} - \text{C} - \text{D} \\ | \\ \text{D} - \text{C} - \text{H} \\ | \\ \text{CH}_3 \end{array}$
36. The iron complex which is present in the stomach and which supplies iron to the transport protein transferrin has the formula  $[\text{Fe}(\text{OH}_2)_4(\text{HPO}_4)]^n$ . What is the value of charge  $n$ ?  
 (a)  $2^-$  (b)  $1^-$  (c) 0 (d)  $1^+$
37. Which of the following hybrid orbitals are used by nitrogen in  $\text{N}_2\text{F}_2$ ?  
 (a) sp (b)  $sp^2$  (c)  $sp^3$  (d) p only
38. The kinetic energy operator is  
 (a) Hamiltonian (b) Hermitian (c) Linear (d) Non-linear
39. For the  $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$  ion the mean pairing energy P is found to be  $23500 \text{ cm}^{-1}$ . The magnitude of  $\Delta$  is  $13900 \text{ cm}^{-1}$ . The crystal field stabilization energy for the complex in configuration corresponding to low spin state will be  
 (a)  $8340 \text{ cm}^{-1}$  (b)  $1260 \text{ cm}^{-1}$  (c)  $1300 \text{ cm}^{-1}$  (d)  $2050 \text{ cm}^{-1}$
40. The formula of dichlorobis (ethelene diamine) cobalt (II) monohydrate is  
 (a)  $[\text{Co}(\text{en})_2\text{Cl}_2]\text{H}_2\text{O}$  (b)  $[\text{Co}(\text{H}_2\text{O})(\text{Cl})\text{en}_2]\text{Cl}$   
 (c)  $[\text{Co}(\text{H}_2\text{O})\text{Cl}_2\text{en}_2]$  (d) None of the above
41. The vibrational degrees of freedom for non linear molecule having N atoms is  
 (a) N-2 (b) 3N-5 (c) 3N-6 (d) N-1
42. The decomposition of  $\text{N}_2\text{O}$  into  $\text{N}_2$  and O in the presence of gaseous argon follows second order kinetics with  $k = (5.0 \times 10^{11} \text{ L mol}^{-1} \text{ s}^{-1})e^{-29000\text{K}/T}$ . The energy of activation of the molecule is  
 (a)  $241 \text{ kJ mol}^{-1}$  (b)  $234 \text{ kJ mol}^{-1}$  (c)  $328 \text{ kJ mol}^{-1}$  (d)  $435 \text{ kJ mol}^{-1}$
43. The hybrid orbitals used by manganese in the complex  $[\text{MnBr}_4]^{2-}$  are  $sp^3$ . How many unpaired electrons are present?  
 (a) 2 (b) 5 (c) 3 (d) 6
44. Which of the following has greatest affinity to water  
 (a)  $\text{P}_4\text{O}_{10}$  (b)  $\text{Cl}_2\text{O}_7$  (c)  $\text{I}_2\text{O}_5$  (d)  $\text{SO}_2$
45. What is the probability that a particle in a one-dimensional box of length  $a$  is to be found between 0 and  $a/2$ .  
 (a) 0 (b) 1 (c) 1/2 (d) 2/3

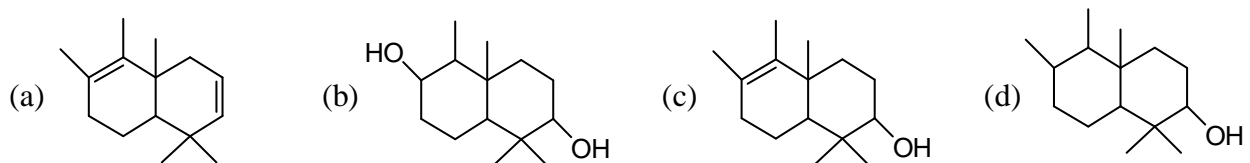
46. The mean bond enthalpy of  $F_2$ ,  $SF_4$  and  $SF_6$  are +158, +343 and +327  $\text{kJ mol}^{-1}$ . The reaction enthalpy for the production of  $SF_6(g)$  from  $SF_4(g)$
- (a) +130 kJ (b) -432 kJ (c) -235 kJ (d) 328 kJ
47. The final temperature of a system after 1.6 mol of an unknown crystalline metal at  $60^\circ\text{C}$  was immersed in 100g of water at  $20^\circ\text{C}$ .
- (a)  $54^\circ\text{C}$  (b)  $34^\circ\text{C}$  (c)  $56^\circ\text{C}$  (d)  $24^\circ\text{C}$
48.  $A + \text{maleic acid} \xrightarrow{\Delta} B \xrightarrow[\text{CaO}/\Delta]{\text{NaOH}} C \xrightarrow[\Delta]{\text{Pd}} D \xrightarrow[\text{H}_2\text{O}+\text{Zn}]{\text{O}_3} 3 \begin{array}{c} \text{CHO} \\ | \\ \text{CHO} \end{array}$
- The A will be
- (a)  (b)  (c)  (d) Ethene
49. The molecule  $\text{CH}_3\text{Br}$  is
- (a) Spherical top (b) Asymmetric top (c) Prolate (d) Oblate
50. The work done when a system raises a column of water of radius 5.0 mm through 10 cm is
- (a)  $1.25 \times 10^4\text{J}$  (b)  $-3.85 \times 10^{-3}\text{J}$  (c)  $5.25 \times 10^4\text{erg}$  (d)  $-32.7 \times 10^{-5}\text{J}$

### Section-B

51. Which complex of  $\text{Co}^{2+}$  will have the weakest crystal field splitting?
- (a)  $\text{Co}(\text{Cl})_6^{4-}$  (b)  $\text{Co}(\text{CN})_6^{4-}$  (c)  $[\text{Co}(\text{NH}_3)_6]^{2+}$  (d)  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$

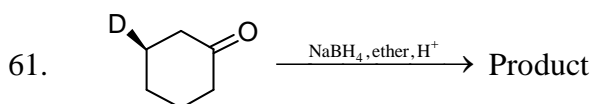


“A” is



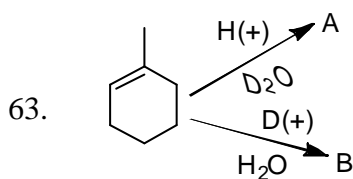
53. At  $100^\circ\text{C}$  the vapour pressure of a solution of 6.5 gm of a solute in 100gm water is 732 mm. What is the boiling point of the solution? ( $K_b = 0.52$ ). Assume the laws of dilute solution
- (a)  $103.12^\circ\text{C}$  (b)  $101.06^\circ\text{C}$  (c)  $102.3^\circ\text{C}$  (d) None of the above
54. A sample of alloy duralumin contains 4.2% copper by mass. The percent of the alloy consists of the compound  $\text{CuAl}_2$
- (a) 10.6% (b) 2.65% (c) 7.8% (d) 1.23%
55. The magnetic moment of  $[\text{Mn}(\text{CN})_6]^{3-}$  is 2.8 BM. The geometries of the complex ion
- (a) Tetrahedral (b) Octahedral  
(c) Trigonal bipyramidal (d) Square pyramidal

56. Which of the  $d$  orbitals lies in the  $xy$  plane  
 (a)  $d_{xz}$  (b)  $d_{xy}$   
 (c)  $d_{x^2-y^2}$  (d)  $d_{xy}$  and  $d_{x^2-y^2}$
57. The formula of potassium tetrachlorodifluoronickelate(II) is  
 (a)  $K_4[NiCl_4F_2]$  (b)  $K[NiCl_4F_2]$   
 (c)  $K_4[NiCl_2F_4]$  (d)  $K_2[NiCl_4F_2]$
58. 500 mL of 0.2M aqueous solution of acetic acid is mixed with 500 mL of 0.2 M HCl at 25°C. The degree of dissociation of acetic acid in the resulting solution will be  
 (a)  $3 \times 10^{-3}$  (b)  $2 \times 10^{-4}$   
 (c)  $5 \times 10^{-6}$  (d) None of the above
59. An insulated container is divided into two equal portions. One portion contains an ideal gas at pressure P and temperature T. The other portion is a perfect vacuum. If a hole is opened between the two portions, the change in internal energy is  
 (a) 2 (b) 5 (c) 0 (d) None of the above
60. A metal burns in air to give a white ash. When this material is dissolved in water the odour of ammonia can be detected. What is the metal?  
 (a) Ca (b) Mg (c) Ba (d) K



The product of this reaction will be

- (a) Optically inactive diastereomeric pair (b) Optically active diastereomeric pair  
 (c) Product forms with partial racemisation (d) Products form with 100% racemisation
62. Aluminium sulphide reacts with water to form hydrogen sulphide and a white precipitate. Identify the later substance?  
 (a)  $Al_2O_3$  (b)  $Al(OH)_3$  (c)  $Al_2S_3$  (d) Al

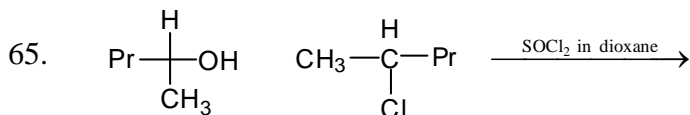


A and B will be



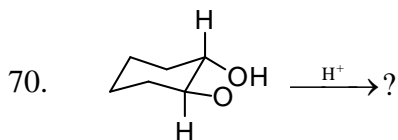
64. Glycerine +  $3HNO_3 \longrightarrow$  Trinitroglycerine, T, N, G is  
 (a) An anhydride (b) A nitro compound (c) An ester (d) A nitrile





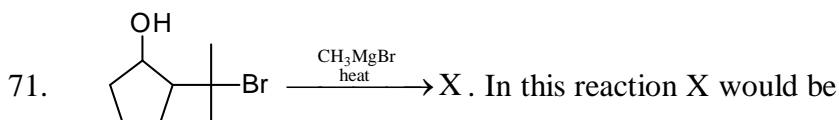
The configuration of the product will be

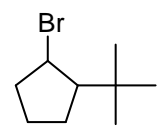
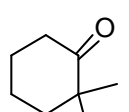
- (a) R (b) S  
 (c) Racemic mixture (d) Unpredictable
66. What is the hybridization states of each carbon atom in  $\text{CH}_3\text{CH}=\text{CHCH}_3$   
 (a)  $\text{sp}^3 \text{ sp}^2 \text{ sp}^3 \text{ sp}^2$  (b)  $\text{sp}^3 \text{ sp}^2 \text{ sp}^2 \text{ sp}^3$   
 (c)  $\text{sp}^3 \text{ sp}^3 \text{ sp}^2 \text{ sp}^2$  (d) None of the above
67. Which Group III element is expected to have a physical and chemical properties that are least similar to the other elements in that family?  
 (a) B (b) Al (c) Ga (d) Tl
68. Predict the value of 'x' in  $\text{H}_x\text{Cr}(\text{CO})_5$   
 (a) 2 (b) 9 (c) 6 (d) 3
69. The value of 'x' in the formula  $\text{Mo}(\text{CO})_x$  is  
 (a) 2 (b) 4 (c) 8 (d) 6



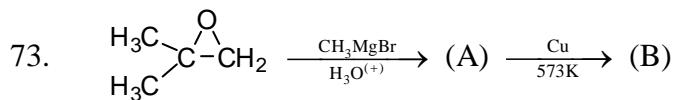
The product of this reaction will be

- (a) Cyclo pentane Carbaldehyde (b) 2-hydroxyl cyclohexanone  
 (c) Cyclohexanone (d) All of the above

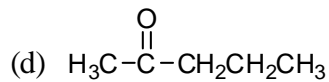
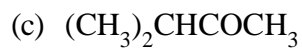
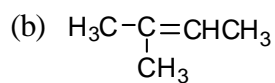
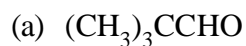


- (a)  (b)  (c)  $\text{CH}_4$  (d) Both (b) & (c)

72. A lead bullet weighing 18.0g and travelling at 500 m/s is embedded in a wooden block of 1.00 kg. If both the bullet and the block were initially at  $25^\circ\text{C}$ , what is the final temperature of the block containing bullet? Assume no temperature loss to the surrounding. (Heat capacity of wood =  $0.5 \text{ kcal kg}^{-1} \text{ K}^{-1}$ ; heat capacity of lead =  $0.030 \text{ kcal kg}^{-1} \text{ K}^{-1}$ )  
 (a)  $23.41^\circ\text{C}$  (b)  $29.02^\circ\text{C}$  (c)  $34.52^\circ\text{C}$  (d)  $26.08^\circ\text{C}$



Here B is



74. The compound alloy  $\text{Cu}_3\text{Au}$  crystallizes in a cubic lattice with Cu at the face centers and Au at the corners. How many formula units of the compound are there in each unit cell?

(a) 2

(b) 3

(c) 1

(d) None of the above

