Date: 27/11/2022

Test Booklet Code

34

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Answers & Solutions

Time : 120 Minute

for

Max. Marks : 216

National Standard Examination in Chemistry (NSEC) 2022

INSTRUCTIONS TO CANDIDATES

(1) There is 60 questions in this paper.

(2) Question paper has two parts. In **Part A1** (Q. No. 1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

Q. No. 22 (a) ● (c) (d)

In **Part A2** (Q. No. 49 to 60) each question has four alternatives, out of which **any number of alternative (s)** (1, 2, 3 or 4) may be correct. You have to choose ALL correct alternatives and fill the appropriate bubble (s), as shown.

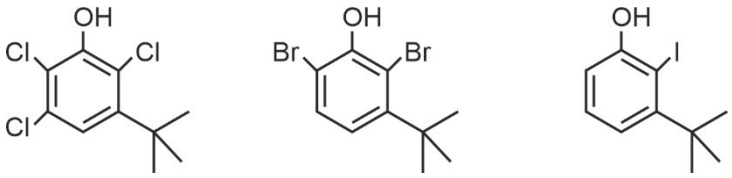
Q. No. 54 (a) ● (c) ●

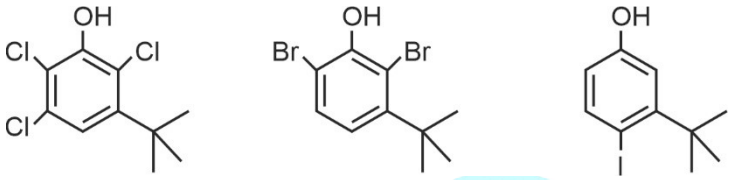
(3) For **Part A1**, each correct answer carries **3 marks** whereas 1 mark will be deducted for each wrong answer. In **Part A2**, you get **6 marks** if all the correct alternatives are marked. No negative marks in this part.

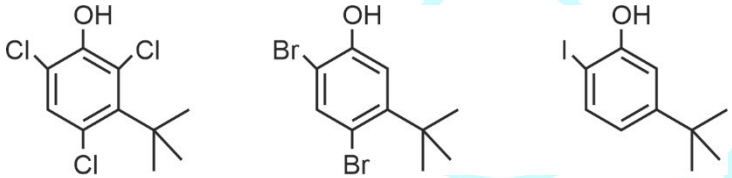
A - 1 (Attempt All Sixty Questions)

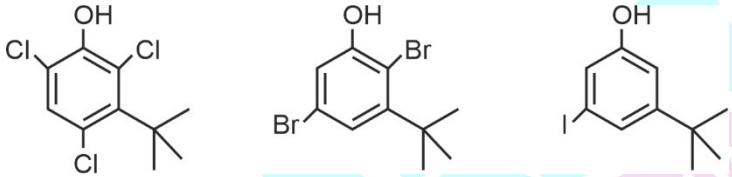
ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION

1. 3-tert-butylphenol when reacted separately with excess chlorine, bromine and iodine gave trichloro, di-bromo and mono-iodo derivatives of 3-tert-butylphenol respectively. The correct structures of the respective halogen derivatives are

(a) 

(b) 

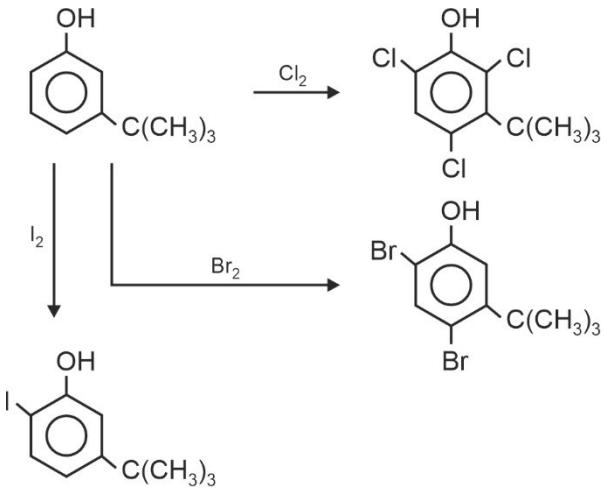
(c) 

(d) 

Answer (c)

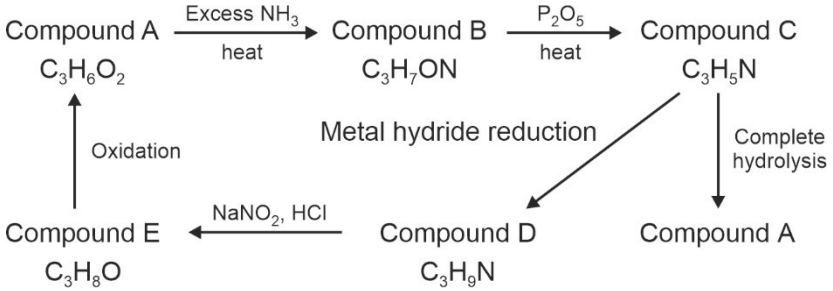
Sol. Phenol is o, p-directing in nature compound because of the +R effect of –OH.

Because of the bulkiness of bromine and iodine, only di and mono substitution respectively will occur but attack will take place only at ortho and para position.



2. Consider the following sequence of reactions:

The functional groups undergoing change in the conversion of A to E respectively are

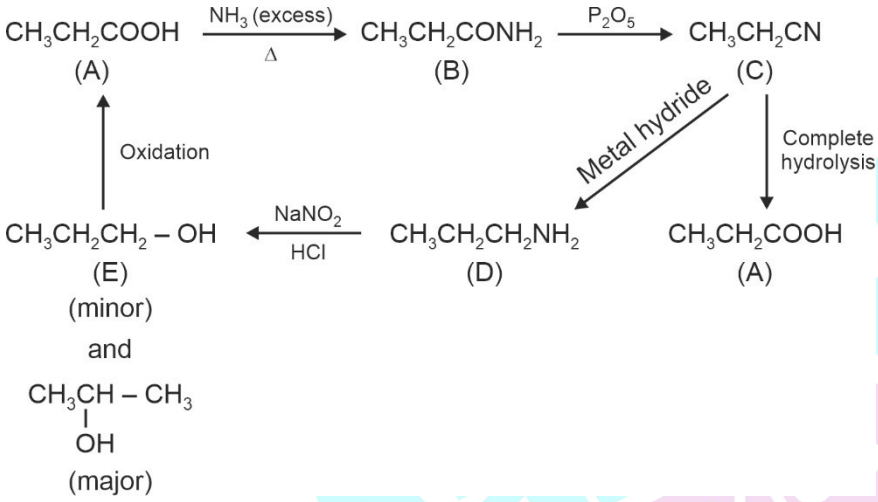


(a) –COOH, –NC, $–CONH_2$, $–NH_2$, $–CH_2OH$ (b) –COOH, –CN, $–CONH_2$, $–NH_2$, $–CH_2OH$

(c) –COOH, $–CONH_2$, –CN, $–CH_2NH_2$, $–CH_2OH$ (d) $–CONH_2$, –COOR, –NC, –NHR, >CHOH

Answer (c)

Sol. Compound A can be CH_3CH_2COOH.



3. The correct sequence of reagents which would convert p-Nitrotoluene to p-Iodobenzoic acid is

(a) (i) Br_2 + $FeBr_2$, (ii) Mg in ether, then CO_2, (iii) $3H_2$ and Pt or Ni catalyst, (iv) HNO_2, 0°C, (v) KI solution

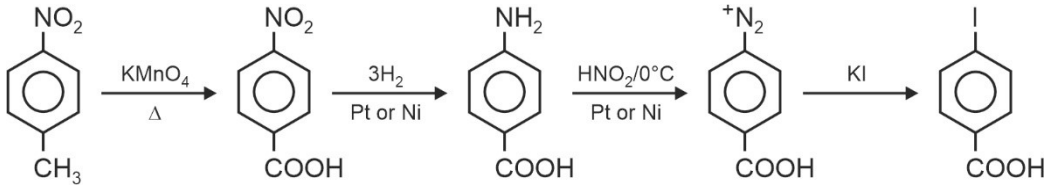
(b) (i) Br_2 in CCl_4 and heat, (ii) NaI in acetone, (iii) $3H_2$ and Pt or Ni catalyst, (iv) HNO_2, 0°C, (v) H_3PO_2

(c) (i) $3H_2$ and Pt or Ni catalyst, (ii) HNO_2, 0°C, (iii) Cu_2Br_2 + HBr, (iv) $KMnO_4$ and heat, (v) KI solution

(d) (i) $KMnO_4$ and heat, (ii) $3H_2$ and Pt or Ni catalyst, (iii) HNO_2, 0°C, (iv) KI solution

Answer (d)

Sol.



4. The results obtained by four students, each performing a set of four titrations with the same solution under identical conditions, are given below. If the expected titre value is 20.0 mL, the set of data (mL) with good accuracy and poor precision is

(a) 19.9, 20.0, 20.1, 19.9 (b) 18.1, 18.2, 18.0, 18.1

(c) 17.9, 18.1, 21.5, 21.0 (d) 20.0, 19.8, 19.4, 20.2

Answer (d)

Sol. (a) It is both accurate and precise as average of the values is near to 20. Also, the values are quite close. So, they are precise too.

(b) As the average deviates too much from the true value, it will not be accurate.

(c) It is poorly precise as the values deviate a lot from each other. It is also poorly accurate.

(d) The readings are both accurate and poorly precise as two values (19.4 and 20.2) differ quite a lot.

Hence, most appropriate option is (d).

5. The statement that is NOT correct about atomic spectra is

(a) Electric discharges through gases produce line spectra

(b) Each element in the gaseous state has a unique line spectrum

(c) The number of lines in the spectrum is same as the number of electrons in the atom

(d) Atoms can emit photons with wavelengths lower than that of visible light

Answer (c)

Sol. (a) It is correct as gases placed inside discharge tube at very high voltage produce line spectra.

(b) Each element has a unique line spectrum.

(c) It is incorrect as number of lines have no direct relation with number of electrons.

(d) Atoms can emit photons in UV spectrum which is having lower wavelength than visible light.

Hence, (c) is the correct answer.

6. A closed 2.0 L container initially holds 3.0 mol of $O_2(g)$ and 2.0 mol of $N_2(g)$ at room temperature, T. If the pressure remains constant when 1.0 mol of $O_2(g)$ is added, the final temperature of the system is (Assume ideal gas behaviour throughout)

(a) $\left(\frac{3}{5}\right)T$ (b) $\left(\frac{5}{6}\right)T$

(c) 2 T (d) $\left(\frac{6}{5}\right)T$

Answer (b)

Sol. $PV = nRT$

As P & V are constant,

$n_1T_1 = n_2T_2$

$5T_1 = 6T_2$

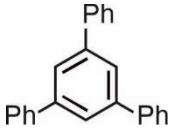
$T_2 = \frac{5}{6}T_1$ or $\frac{5}{6}T$

7. The equilibrium constant (K_c) for trimerization of phenyl acetylene to triphenyl benzene is 3.0 at 310 K. If at equilibrium, 0.9 mol dm^{-3} of triphenyl benzene is present, concentration of phenyl acetylene at equilibrium is

(a) 1/3 mol dm^{-3} (b) 3.0 mol dm^{-3}

(c) 1.732 mol dm^{-3} (d) 0.67 mol dm^{-3}

Answer (d)

Sol. $3\,Ph - C \equiv C - H \rightleftharpoons$ 

At eqn, a 0.9

$$\frac{0.9}{a^3} = 3$$

$$a^3 = \frac{0.9}{3}$$

$$a^3 = 0.3$$

$$a \simeq 0.67 \text{ mol dm}^{-3}$$

8. At 298 K, the standard free energies of formation of *cis*- and *trans*-1,2-dichloroethene are 41.549 kJ and 33.235 kJ respectively. The most appropriate mol ratio of *trans*- and *cis*-isomers at equilibrium at 298 K is

(a) 10 : 3 (b) 3 : 10

(c) 28 : 1 (d) 1 : 28

Answer (c)

Sol. Cis–1, 2-dichloroethene $\rightleftharpoons$ Trans-1, 2-dichloroethene

$$\Delta G^\circ_{reaction} = \Delta G^\circ_{f\ trans} - \Delta G^\circ_{f\ cis}$$

$$= 33.235 - 41.549$$

$$= -8.314 \text{ kJ/mol}$$

$$\Delta G^\circ = -2.303\ RT \log K_{eq}$$

$$-8.314 \times 1000 = -2.303 \times 8.314 \times 298 \times \log K_{eq}$$

$$\Rightarrow K_{eq} = 28.64 = \frac{[trans]}{[cis]}$$

9. The pH of the solution produced by complete consumption of 10 mL of 0.4 M NaOH to 'x' mL of 0.5 M CH_3COOH was found to be 4.57. The value of 'x' (mL) is (Given : K_a of $CH_3COOH = 1.8 \times 10^{-5}$)

(a) 12.0 (b) 10.4

(c) 19.8 (d) 6.5

Answer (c)

Sol. pH = 4.57 $\Rightarrow$ $[H^+] = 2.69 \times 10^{-5}$

$$\frac{[CH_3COO^-][H^+]}{[CH_3COOH]} = 1.8 \times 10^{-5}$$

$$\frac{[CH_3COO^-]}{[CH_3COOH]} = \frac{1.8}{2.69} = 0.70$$

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

0.5x	4	–	–
↓	↓	↓	
(0.5x – 4)	0	4	

$\Rightarrow \quad \frac{4}{0.5x - 4} = 0.70$

$\Rightarrow \quad x = 19.42 \text{ mL}$

$\approx 19.8 \text{ mL}$

10. The correct order of concentrations of ions/molecules present in 1.0 L of 1.0 M H_2SO_4(aq) solution is

(a) $OH^- < SO_4^{2-} < HSO_4^- < H_3O^+ < H_2O$ (b) $OH^- < HSO_4^- < SO_4^{2-} < H_3O^+ < H_2O$

(c) $H_2O < HSO_4^- < OH^- < SO_4^{2-} < H_3O^+$ (d) $H_2O < OH^- < SO_4^{2-} < HSO_4^- < H_3O^+$

Answer (a)

Sol. $H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$ K_{a_1}

$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$ K_{a_2}

$K_{a_1} >>> K_{a_2}$

Concentration order

$[H_2O] > [H_3O^+] > [HSO_4^-] > [SO_4^{2-}] > [OH^-]$

11. The pOH of the solution obtained by mixing 30 mL of a strong monobasic acid of pH 3.0 and 70 mL of a strong monoacidic base of pH 12.0 at 298 K is

(a) 3.17 (b) 2.17

(c) 5.17 (d) 0.17

Answer (b)

Sol.

HA	+	BOH	$\rightarrow$	H_2O	+	BA
30×10^{-3}		70×10^{-2}				
$\downarrow$		$\downarrow$				
0		67×10^{-2}				

$[OH^-] = \frac{67 \times 10^{-2}}{100} = 67 \times 10^{-4}$

pOH = 4 – log67

= 2.17

12. If refractive index, density, pressure, volume, heat capacity and surface tension are represented respectively as η, ρ, P, V, Q and γ, the set that contains only intensive properties is

(a) η, ρ, γ, Q (b) ρ, P, Q, γ

(c) V, Q, η, ρ (d) η, ρ, P, γ

Answer (d)

Sol. Intensive properties

$\rightarrow$ refractive index (η)

$\rightarrow$ density (ρ)

$\rightarrow$ pressure (P)

$\rightarrow$ surface tension (γ)

13. Heat of reaction and heat of formation will be the same in

I. $1/2N_2(g) + O_2(g) \rightarrow NO_2(g)$

II. $Xe(g) + 2F_2(g) \rightarrow XeF_4(g)$

III. $N_2(g) + O_3(g) \rightarrow N_2O_3(g)$

IV. $C(diamond) + O_2(g) \rightarrow CO_2(g)$

(a) Only I (b) Only I and II

(c) Only I, II and III (d) Only II, III and IV

Answer (b)

Sol. Heat of formation of a species is the heat of reaction in which 1 mole of the species is synthesized from its constituent elements. In the following reactions, heat of reaction and heat of formation are same.

I. $\frac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g)$

II. $Xe(g) + 2F_2(g) \rightarrow XeF_4(g)$

14. From the following data

$2CH_6N_2(\ell) + 5O_2(g) \rightarrow 2N_2(g) + 2CO_2(g) + 6H_2O(g)$ $\left(\Delta H_r^0 = -2606\ kJ\right)$ and

$H_2O(\ell) \rightarrow H_2O(g)$ $\left(\Delta H_v^0 = 44\ kJ\ mol^{-1}\right)$

Heat of combustion of CH_6N_2 at 298 K can be calculated as

(a) $-1567\ kJ\ mol^{-1}$ (b) $-1435\ kJ\ mol^{-1}$

(c) $-1171\ kJ\ mol^{-1}$ (d) $-2342\ kJ\ mol^{-1}$

Answer (b)

Sol. $CH_6N_2(\ell) + \frac{5}{2}O_2(g) \rightarrow N_2(g) + CO_2(g) + 3H_2O(g)\ \Delta H = -1303\ kJ$

$3H_2O(g) \rightarrow 3H_2O(\ell) \qquad \Delta H = -3 \times 44 = -132\ kJ$

$CH_6N_2(\ell) + \frac{5}{2}O_2(g) \rightarrow N_2(g) + CO_2(g) + 3H_2O(\ell)$

$\Delta H = -1303 - 132$

$= -1435\ kJ$

15. When 100 g each of the salts NaCl, $MgSO_4$, $Ca(NO_3)_2$, K_2CO_3, were dissolved separately in 1.0 kg of water, the solution with the highest boiling point will be of

(a) $Ca(NO_3)_2$ (b) $MgSO_4$

(c) NaCl (d) K_2CO_3

Answer (b)

Sol. Number of moles of NaCl = $\frac{100}{58.5} = 1.71$

Number of moles of $MgSO_4$ = $\frac{100}{120} = 0.83$

Number of moles of Ca $(NO_3)_2$ = $\frac{100}{184} = 0.61$

Number of moles of K_2CO_3 = $\frac{100}{138} = 0.725$

The product of van't Hoff factor (i) and molality (m) is given as

$i \times m\ (NaCl) = 2 \times 1.71 = 3.42$

$i \times m\ (MgSO_4) = 2 \times 0.83 = 1.66$

$i \times m\ (Ca(NO_3)_2) = 3 \times 0.61 = 1.83$

$i \times m\ (K_2CO_3) = 3 \times 0.725 = 2.175$

Since the value of i × m is least for $MgSO_4$, the boiling point of $MgSO_4$ solution will be the highest.

16. When the pH of the system is increased by 2.0 units, maximum decrease in half cell potential for the reaction will be observed in

(a) $V^{2+}(aq) \rightarrow V^{3+}(aq) + e^-$ (b) $VO_3^- + 2H^+ \rightarrow VO_2^+ + H_2O$

(c) $VO^{2+} + 2H^+ + e^- \rightarrow V^{3+} + H_2O$ (d) $VO^{2+} + H_2O \rightarrow VO_2^+ + 2H^+ + e^-$

Answer (c)

Sol. (a) $H^{\oplus}$ ion is not involved. So, no change in pH.

(b) Oxidation state of V remains unchanged at (+5). So, it is a non-redox reaction.

(c) $E = E° - \frac{0.0591}{1}\log\frac{[V^{+3}]}{[VO^{+2}][H^{\oplus}]^2}$

$= E° - \frac{0.0591}{1}\log\frac{[V^{+3}]}{[VO^{+2}]} - 2(0.0591)\,pH$

(d) $E = E° - \frac{0.0591}{1}\log\frac{[VO_2^{\oplus}][H^{\oplus}]^2}{[VO^{+2}]}$

Clearly, when pH increases by 2 units, decrease in half cell potential only takes place in (c).

17. The reaction that takes place during charging of the lead storage cell is given below

$2PbSO_4(s) + 2H_2O(\ell) \rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4(aq)$

If a current of 10.0 A is passed for 1.50 h for charging, the amount of $PbSO_4$ reacted is

(a) 25.0 g (b) 56.0 g

(c) 120.5 g (d) 170.0 g

Answer (d)

Sol. $2PbSO_4(s) + 2H_2O(\ell) \rightarrow Pb(s) + PbO_2(s) + 2H_2SO_4$

2 mole of e^- are used for 2 mole of $PbSO_4$

$\Rightarrow$ mole of $e^- = \frac{10 \times 1.5 \times 3600}{96500}$

Mole of $PbSO_4$ = mole of e^-

Mass of $PbSO_4 = \frac{10 \times 1.5 \times 3600}{96500} \times 303 \approx 170$ gm

18. A sample of water from a water tank has a resistance of 100 Ω at 298 K, when placed in a conductivity cell of cell constant 0.2 m^{-1}. On dissolving 58.5 g of NaCl in the water tank, a sample of this solution gave a resistance of 40 Ω. The molar conductivity of NaCl at this concentration is 10 $\Omega^{-1}m^2mol^{-1}$. The volume of water in the water tank is

(a) 3.33×10^6 L (b) 3333.3 L

(c) 363.5 L (d) 4.2×10^5 L

Answer (a)

Sol. $K_{H_2O} = \frac{\text{Cell constant}}{\text{Resistance}} = \frac{0.2}{100} \Rightarrow 2\times10^{-3}\ \Omega^{-1}\ m^{-1},\ K_{NaCl\ solution} = \frac{0.2}{40} = 5\times10^{-3}\ \Omega^{-1}\ m^{-1}$

$K_{NaCl} = K_{NaCl\ solution} - K_{H_2O}$

$= 3 \times 10^{-3}\ \Omega^{-1}m^{-1}$

Let 58.5 g of NaCl is dissolved in x liter of water.

$\therefore$ Molarity $= \frac{58.5}{58.5\times x} = \frac{1}{x}$

Now, $\Lambda_m = \frac{K_{NaCl}}{1000\times \text{molarity}}$

$\Rightarrow \quad x = \frac{10\times10^3}{3\times10^{-3}} = 3.33\times10^6$ L

19. Initial concentrations of the reactants and the corresponding half-lives for the reaction P + Q $\rightarrow$ R are given below. The rate law for the reaction is

Entry	$[P_0]$ (mol $dm^{-3} \times 10^{-6}$)	$[Q_0]$(mol $dm^{-3} \times 10^{-6}$)	$t_{1/2}$(s)
1	500	10	30
2	500	20	60
3	10	500	60
4	20	500	60

(a) dR/dt = k[P] (b) dR/dt = k[P]/[Q]

(c) dR/dt = k[Q] (d) –d[P]/dt = k[P]/[Q]

Answer (a)

Sol. As $t_{1/2}$ is independent of $[P_0]$

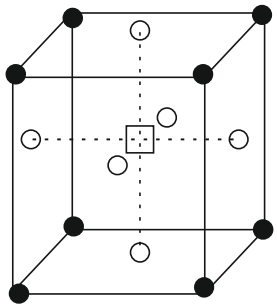
Rate $\propto [P_0]$

As $t_{1/2} \propto [Q_0]$

Rate $\propto [Q_0]^0$

$\therefore \quad \frac{dR}{dt} = k[P]$

20. The unit cell structure of a mineral perovskite crystallizes in cubic unit cell wherein calcium (filled circles) and oxide (hollow circles) constitute a cubic close packing (ccp) arrangement and titanium ion (hollow square) occupies an interstitial hole as shown below. (Charges are omitted for simplicity). The empirical formula of this compound is



(a) Ca_2TiO_3 (b) Ca_4TiO_6

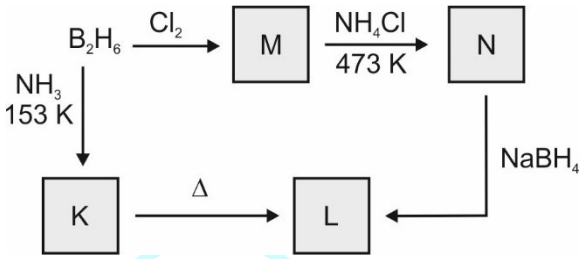
(c) $CaTiO_3$ (d) Ca_8TiO_6

Answer (c)

Sol.
- Number of Calcium = 1
- Number of Oxide = 3
- Number of Titanium = 1

$Ca_1Ti_1O_3 \Rightarrow CaTiO_3$

21. Study the sequence of reactions of diborane (B_2H_6) given below and identify the products K, L, M and N. (The shown reagents are taken in excess).



(a) $K = BNH_6$; $L = (BN)x$; $M = B_2H_5Cl$; $N = B_3N_3H_3Cl_3$

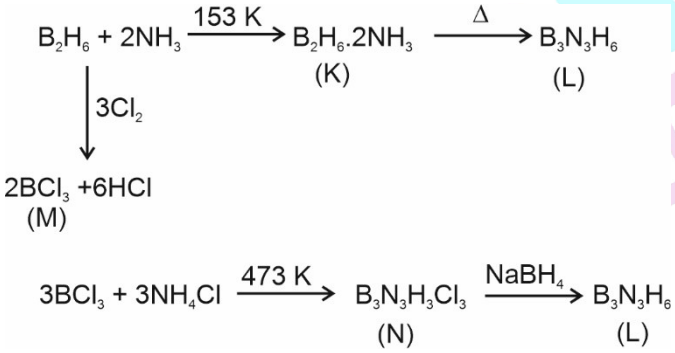
(b) $K = [B_2H_6.2NH_3]$; $L = B_3N_3H_6$; $M = B_2H_5Cl$; $N = B_3N_3Cl_6$

(c) $K = BNH_6$; $L = (BN)x$; $M = BCl_3$; $N = B_3N_3Cl_6$

(d) $K = [B_2H_6.2NH_3]$; $L = B_3N_3H_6$; $M = BCl_3$; $N = B_3N_3H_3Cl_3$

Answer (d)

Sol. The given sequence of reactions of diborane (B_2H_6) are



The unknown products are

(K) = $B_2H_6.2NH_3$

(L) = $B_3N_3H_6$

(M) = BCl_3

(N) = $B_3N_3H_3Cl_3$

22. During extraction of gold, the gold ore is treated with aqueous KCN solution as shown by the equations (not balanced) below to get compound X which is further reduced by Zn to obtain compound Y and metallic gold. Identify X and Y.

Gold ore + $CN^- + H_2O + O_2 \rightarrow [X] + OH^-$ …(i)

$[X] + Zn \rightarrow [Y] + Au$ …(ii)

(a) $X = [Au(CN)_2]^-$, $Y = [Zn(CN)_2]^{2-}$ (b) $X = [Au(CN)_2]^-$, $Y = [Zn(CN)_4]^{2-}$

(c) $X = [Au(CN)_4]^{3-}$, $Y = [Zn(CN)_4]^{2-}$ (d) $X = [Au(CN)_2]^-$, $Y = [Zn(CN)_4]^{4-}$

Answer (b)

Sol. $4M_{(s)} + 8CN^- + 2H_2O_{(aq)} + O_{2(g)} \rightarrow 4[M(CN)_2]^- + 4[OH^-]$

$2[M(CN)_2]^-_{(aq)} + Zn_{(s)} \rightarrow [Zn(CN)_4]^{2-}_{(aq)} + 2M_{(s)}$

M = Au

$X = [Au(CN)_2]^-$
$Y = [Zn(CN)_4]^{2-}$

23. The correct IUPAC name for the complex $[Au(en)_2(H_2O)_2]$ $[Au(ox)_3]$ is (en = ethylenediamine and ox = oxalate)

(a) Bisaquobisethylenediaminegold (III) trioxalatoaurate (III)

(b) Diaquobisethylenediamineaurate (III) trisoxalatogold (III)

(c) Bisaquodiethylenediamineaurate (III) trisoxalatogold (III)

(d) Diaquobisethylenediaminegold (III) trioxalatoaurate (III)

Answer (d)

Sol. $[Au(en)_2(H_2O)_2]^{+3}[Au(ol)_3]^{3-}$

Diaquobisethylenediaminegold (III) trioxalatoaurate (III)

24. Addition of dil. HCl to an aqueous solution of a mixture of two inorganic salts yielded white precipitate E and filtrate F. Precipitate E dissolved in hot water. F in alkaline alizarin gives a positive red lake test. The cations present in the precipitate E and solution F respectively are

(a) Ag^+; Fe^{3+} (b) Hg^{2+}; Ba^{2+}

(c) Pb^{2+}; Al^{3+} (d) Pb^{2+}; Zn^{2+}

Answer (c)

Sol. The aqueous solution of a mixture of two inorganic salts gives white ppt. with dil HCl which dissolves in hot water. It is due to the presence of Pb^{2+}.

$$Pb^{2+}(aq) + 2HCl \longrightarrow \underset{(E)}{PbCl_2}\downarrow + 2H^+$$

The filterate (F) is likely to contain Al^{3+} because it gives positive red lake test with alkaline alizarin

$$Al^{3+} + 3NH_4OH \longrightarrow \underset{\text{gives red lake with alizarine}}{Al(OH)_3}\downarrow + 3NH_4^+$$

25. Br_2 disproportionates to Br^- and BrO_3^- in a hot alkaline solution as $3Br_2 + 6OH^- \rightarrow 5Br^- + BrO_3^- + 3H_2O$.

The equivalent weight of Br_2 is: (M = molar mass of Br_2)

(a) M/5 (b) M/6

(c) 3M/5 (d) 5M/3

Answer (c)

Sol. $3Br_2 + 6OH^- \longrightarrow 5Br^- + BrO_3^- + 3H_2O$

$$n-\text{factor} = \frac{\text{Total number of electrons lose or gain}}{\text{Total number of molecules}}$$

$$= \frac{5}{3}$$

$$\text{Equivalent weight} = \frac{\text{Molecular mass}}{n-\text{factor}}$$

$$= \frac{M}{5/3} = \frac{3M}{5}$$

26. The number of all the possible geometrical isomers for trigonal bipyramidal $OsO_2F_3^+$ cation is

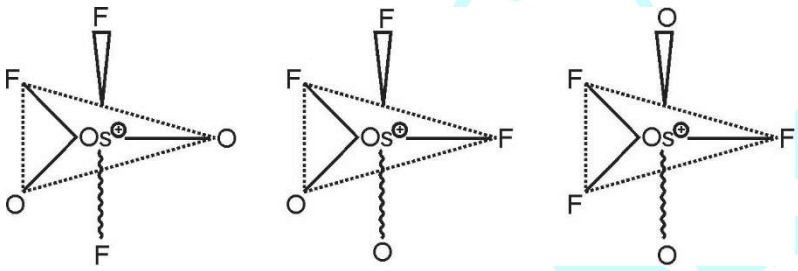
(a) 2 (b) 3

(c) 1 (d) 4

Answer (b)

Sol. $OsO_2F_3^+$

The possible geometrical isomers are :



$\therefore$ Total three isomers are possible

27. The correct order for the wavelength of absorption in the following complex ions is

(a) $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$ (b) $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$

(c) $[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$ (d) $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

Answer (a)

Sol. In all the complexes Ni is present in +2 oxidation state, therefore the CFSE value is decided by the strength of ligand.

The strength order of ligand from weak to strong is :

$H_2O < NH_3 < NO_2^-$

$\therefore$ Order of wavelength of absorption is

$[Ni(H_2O)_6]^{2+} > [Ni(NH_3)_6]^{2+} > [Ni(NO_2)_6]^{4-}$

28. Mixing of an aqueous salt solution containing nitrate ion with ferrous ion followed by gentle addition of conc. sulphuric acid from the sides of the test tube, results in brown coloration at the interface is due to

(a) interaction of ferrous ion with nitric oxide

(b) interaction between the resulting nascent oxygen, ferrous ion and nitrate ion

(c) formation of ferrous ion and nitrogen dioxide

(d) complex formation between ferrous ion and nitrate ion

Answer (a)

Sol. Addition of conc. H_2SO_4 to an aqueous solution containing NO_3^- ion and Fe^{2+} ion results in the formation of nitric oxide which reacts with aqueous Fe^{2+} ion to give a brown coloured complex at the interface.

$NO_3^- + H^+ \longrightarrow HNO_3$

$3Fe^{2+} + HNO_3 + 3H^+ \longrightarrow 3Fe^{3+} + NO + 2H_2O$

$Fe^{2+} + NO + 5H_2O \longrightarrow \underset{\text{(Brown)}}{[Fe(H_2O)_5NO]^{2+}}$

29. Aqueous solutions of hydrogen sulphide and sulphur dioxide when mixed together gives

(a) bisulphite ion and water
(b) hydrogen and sulphurous acid
(c) sulphur and water
(d) hydrogen peroxide and sulphur

Answer (c)

Sol. Mixing of an aqueous solution of hydrogen sulphide and sulphur dioxide results in the precipitation of sulphur.

$2H_2S + SO_2 \longrightarrow 3S\downarrow + 2H_2O$

Water is also formed as a byproduct

30. The ion with least coagulation value for arsenous sulphide sol is

(a) SO_4^{2-}
(b) PO_4^{3-}
(c) Al^{3+}
(d) Ba^{2+}

Answer (c)

Sol. As_2S_3 is negatively charged colloid so positive ion is needed for coagulation.

More is charge more is coagulating power lesser is coagulating value.

Al^{+3} has more coagulating power.

31. The correct order of catenation property among the following is

(a) Pb > Si > Ge > Sn
(b) Pb > Sn > Ge > Si
(c) Si > Sn > Ge > Pb
(d) Si > Ge > Sn > Pb

Answer (d)

Sol. The catenation property decreases on moving from top to bottom for the 14^{th} group elements due to decrease in their bond strength.

$\therefore$ Order of catenation property

C >> Si > Ge > Sn > Pb

32. An agriculturist wants to use different concentrations of phosphorus as fertilizer using P_4O_{10}. The correct expression to calculate P from P_4O_{10} is

(a) $P_4O_{10} \times 2.29$
(b) $P \times 0.44$
(c) $P \times 2.29$
(d) $P_4O_{10} \times 0.44$

Answer (d)

Sol. % of $P = \frac{31\times 4}{31\times 4+16\times 10}\times 100 \simeq 0.44 \times 100 \simeq 44\%$

$\therefore$ Fraction of P = 0.44 (P_4O_{10})

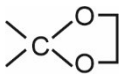
33. Given below are some names of the compounds.

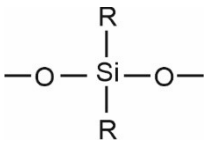
(p) Acetals; (q) silicones; (r) ferrocene; (s) glyoxal, (t) ethyl acetate, (u) gammaxene

The set which is **NOT** having a double bond between an element and O(E = O where E is any element in the periodic table) as a functional group is

(a) p, s, u, t
(b) p, q, r, s
(c) q, r, s, t
(d) p, q, r, u

Answer (d)

Sol. (p) Acetals 

(q) Silicones 

(r) $(C_5H_5)_2Fe$

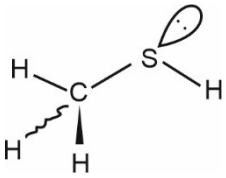
(u) $C_6H_6Cl_6$

34. Hybridization of S in CH_3SH molecule is

(a) dsp^3
(b) sp^2
(c) sp^3
(d) sp^3d

Answer (c)

Sol. The structure of CH_3SH is



'S' atom has 2 bond pair and 2 lone pair

So, it is sp^3 hybridised.

35. Using different reaction conditions nickel reacts with (p) Cl^-, (q) CN^-, (r) CO and (s) small amount of Al. Choose **incorrect** statement.

(a) (p), (q), and (r) respectively can result in tetrahedral, octahedral and square planar geometries around nickel

(b) Ligand (p) and (q) leads to homoleptic complex formation wherein final electronic configuration shows maximum multiplicity in case of (p)

(c) Ligand (r) reacts only in reducing medium to form organometallic compound

(d) In case of (s) formation of spongy product with large surface drive reduction reaction C = C compounds

Answer (a)

Sol. $Ni^{2+} + 4Cl^- \rightarrow [NiCl_4]^{2-}$

(p) Tetrahedral

$Ni^{2+} + 4CN^- \rightarrow [Ni(CN)_4]^{2-}$

(q) Square planar

$Ni + 4CO \rightarrow [Ni(CO)_4]$

(r) Tetrahedral

Ligands (p) and (q) lead to the formation of homoleptic complexes. Ni^{2+} in $[NiCl_4]^{2-}$ shows maximum multiplicity. Ligand (r) reacts in reducing medium to form $[Ni(CO)_4]$. Nickel forms an alloy with small amount of Al which on reaction with NaOH results in the formation of spongy nickel having large surface area (Raney Nickel) used as a catalyst in the reduction of alkenes.

∴ Option (a) is incorrect.

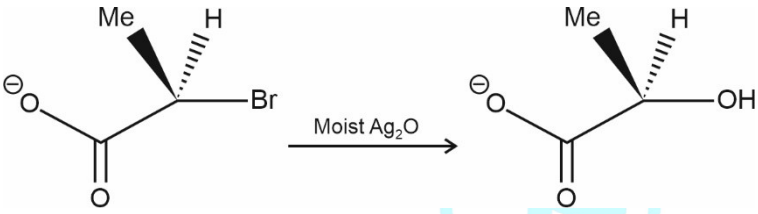
36. Optically pure 2-butanol has a specific rotation of +13.52 degrees. A synthesized and purified sample of 2-butanol has the observed specific rotation of +6.76 degrees. The correct statement based on this observation is

(a) The sample is completely racemized
(b) 25% of the sample is racemic
(c) 50% of the sample is racemic
(d) 6.76% of the sample is racemic

Answer (c)

Sol. Since the observed specific rotation of the sample of butan-2-ol is +6.76 degrees which is half of +13.76 degrees. It means half of the sample is racemised.

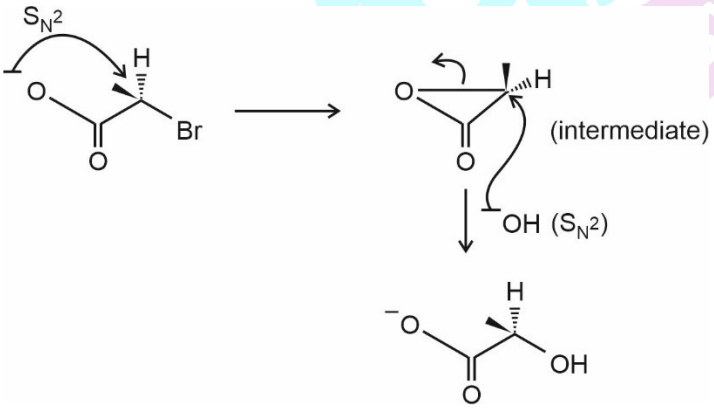
37. Certain organic reactions proceed through formation of intermediates which are highly strained and reactive. Given the following reaction, the correct statement about the mechanism of the reaction is



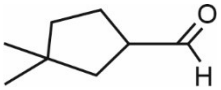
(a) Intramolecular S_N2 attack by $–COO^-$ to form an intermediate followed by the attack by HO^- via S_N2 pathway on the intermediate
(b) Intramolecular S_N2 attack by $–COO^-$ to form an intermediate followed by the attack by HO^- via S_N1 pathway on the intermediate
(c) HO^- attacks via S_N1 pathway on the reactant
(d) HO^- attacks via S_N2 pathway on the reactant

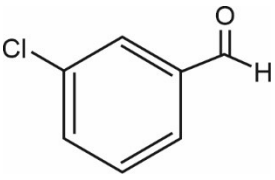
Answer (a)

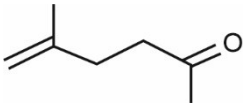
Sol.

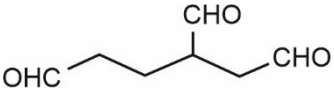


38. Which of the following compound is NOT named correctly according to the IUPAC nomenclature?

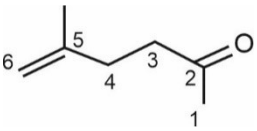
(a)  3, 3-Dimethyl cyclopentanecarbaldehyde

(b)  3-Cholobenzaldehyde

(c)  2-Methyl-1-penten-4-one

(d)  Butane-1,2,4-tricarbaldehyde

Answer (c)

Sol. 

5-methyl hex-5-en-2-one

39. Which of the following compounds contains the maximum number sp^2 hybridized carbon atoms?

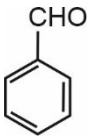
(a) 1,4 - Cyclohexadiene (b) 2,5-dimethyl-2,3,4-hexatriene

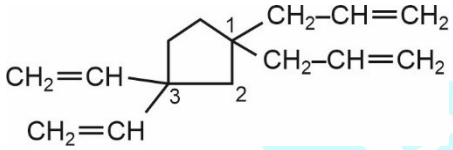
(c) Benzaldehyde (d) 1,1-diallyl-3,3-divinylcyclopentane

Answer (d)

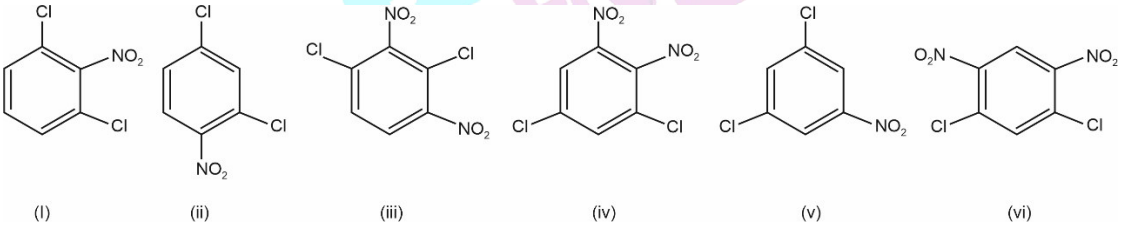
Sol. (a)  four

(b) Two

(c)  seven.

(d)  eight

40. The number of products from the following, which cannot be formed on nitration of 1, 3-dichlorobenzene with a mixture of concentrated nitric acid and sulphuric acid is



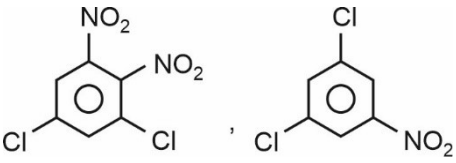
(I) (ii) (iii) (iv) (v) (vi)

(a) Four (b) Three

(c) Two (d) One

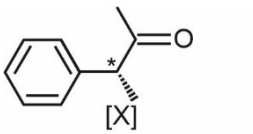
Answer (c)

Sol. Since, –Cl group is o, p-directing in nature therefore meta-nitro derivatives will not be obtained during the nitration of 1, 3-dichlorobenzene.



These two products will not be obtained during the given reaction.

41. Optically pure 3-Phenyl-2-butanone (X) with the following structure is treated with methyl magnesium iodide in anhydrous ether. The product formed after acidic hydrolysis is



[X]

3-phenyl-2-butanone

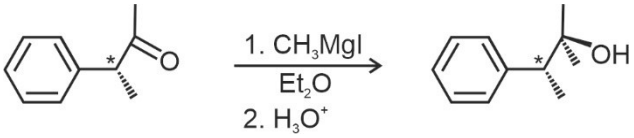
(a) diastereomeric mixture of alcohols

(b) optically pure alcohol

(c) racemic mixture of alcohols

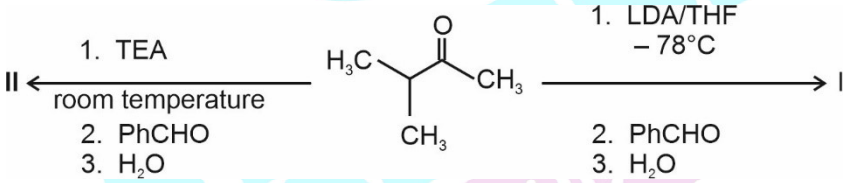
(d) optically inactive alcohol

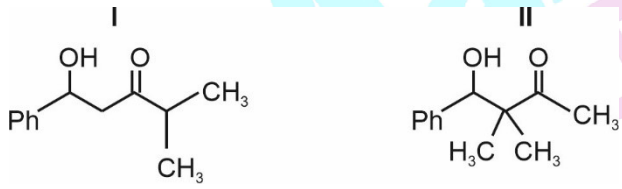
Answer (b)

Sol. 

Only a single compound will be formed which is optically active.

42. Aldehydes react with carbonyl compounds in the presence of bases by a mechanism similar to aldol condensation. Given below is the reaction of benzaldehyde with 3-methyl-2-butanone in the presence of lithium diisopropylamide (LDA), a strong bulky base and triethyl amine (TEA), a weak base. The correct structures of the major products, **I** and **II** formed in the following reactions are respectively.



(a) 

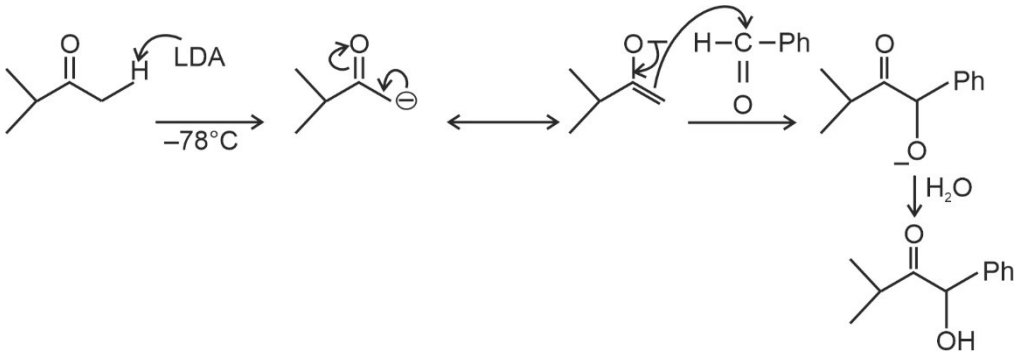
(b) 

(c) 

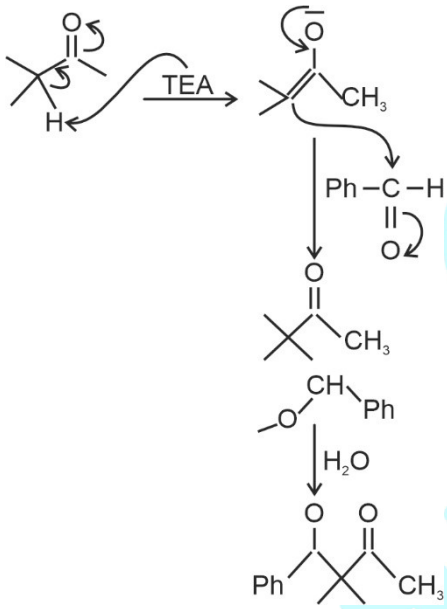
(d) 

Answer (a)

Sol. LDA is a strong bulky base, so it has tendency to abstract the least hindered hydrogen and a kinetically controlled enolate will be formed.



But TEA is a weak base, so at room temperature thermodynamically enolate will be formed.



43. The correct order of the given reagents to convert benzene to m-Chlorobromobenzene is

(1) sulfuric acid (conc.) and heat	(2) Cl_2 + $FeCl_3$ and heat	(3) $NaNO_2$ + H_3O^+ 0°C	(4) H_2 Pt catalyst	(5) Mg in ether
(6) PBr_3	(7) H_3PO_2 (aqueous)	(8) HNO_3 (conc.) + H_2SO_4(conc.) and heat	(9) Cu_2Br_2 + HBr	(10) $(CH_3CO)_2O$ + pyridine

(a) 1, 2, 5, 7 and 6

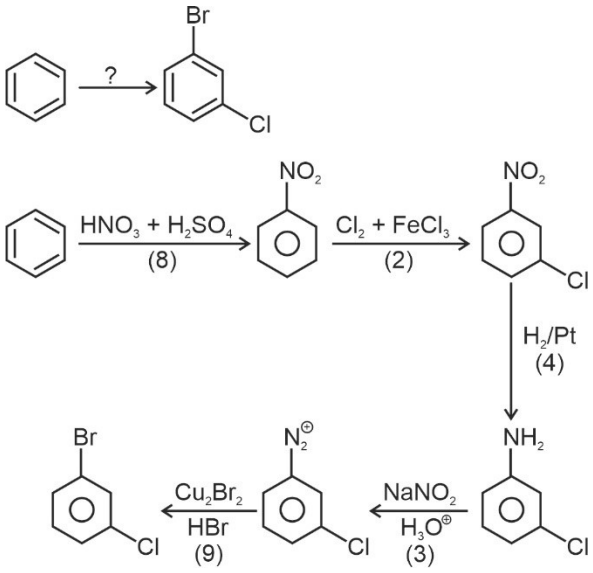
(b) 2, 8, 4, 3 and 9

(c) 8, 4, 10, 2, 3 and 9

(d) 8, 2, 4, 3 and 9

Answer (d)

Sol.

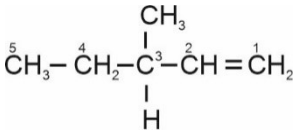


44. A chiral hydrocarbon (Molecular Formula C_6H_{12}) undergoes catalytic hydrogenation to yield an achiral product (Molecular Formula C_6H_{14}). The chiral hydrocarbon is

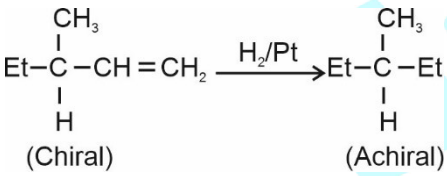
(a) cis-2-hexene
(b) 3-methyl-2-pentene
(c) 4-methyl-2-pentene
(d) 3-methyl-1-pentene

Answer (d)

Sol. The only possible structure of C_6H_{12} which is chiral is:

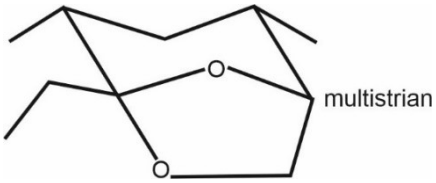


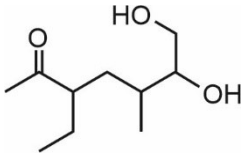
3-methyl-1-pentene

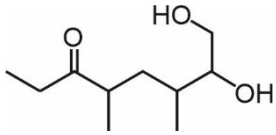


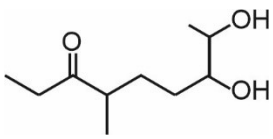
(Chiral) (Achiral)

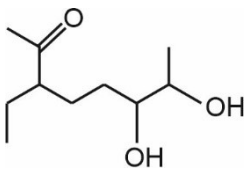
45. The structure of multistriatin, a pheromone of the elm bark beetle, is shown beside. The open chain ketodiol that on dehydrative cyclization gives multistriatin, bicyclic ketal (ignore stereo chemical aspects) is



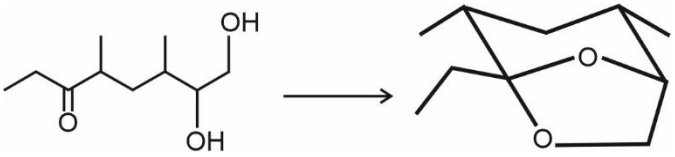
(a) 

(b) 

(c) 

(d) 

Answer (b)

Sol. 

In this dehydration ketone undergoes ketal formation on reaction with alcohols.

46. A monobasic acid (0.100 g) on complete combustion gave 0.252 g of CO_2 and 0.044 g of H_2O. For complete neutralization of 0.122 g of the acid, 10.0 mL of 0.1 M NaOH solution was required. Molecular formula of the acid is

(a) $C_7H_6O_2$ (b) $C_6H_7O_2$

(c) $C_7H_7O_2$ (d) $C_6H_6O_2$

Answer (a)

Sol. $\%C = \frac{12}{44} \times \frac{0.252}{0.1} \times 100 = 68.72\%$

$\%H = \frac{2}{18} \times \frac{0.044}{0.1} \times 100 = 4.89\%$

%O = 100 – 68.72 – 4.89 = 26.39%

C = 68.72/12 = 5.73 = 5.73/1.65 = 3.48 × 2

H = 4.89/1 = 4.89 = 4.89/1.65 = 2.97 × 2

O = 26.39/16 = 1.65 = 1.65/1.65 = 1 × 2

Empirical formula = $C_7H_6O_2$

Now, mmol of acid = 0.1 × 10 = 1

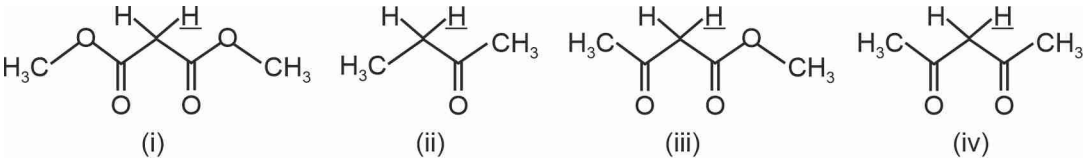
$\therefore$ m.wt of acid = 0.122 × 10^3 = 122 g

$$n = \frac{\text{m.wt}}{\text{Empirical formula wt}} = \frac{122}{122} = 1$$

$\therefore$ Molecular formula = n × empirical formula = $C_7H_6O_2$

47. Acidity of acidic compounds depend on the stability of their conjugate bases. The correct order of acidity of the underlined H in the following compound is

(Note: Assume that all the compounds exist in the keto form)



(a) (ii) > (iii) > (iv) > (i)

(b) (iv) > (iii) > (i) > (ii)

(c) (iii) > (ii) > (iv) > (i)

(d) (i) > (iii) > (iv) > (ii)

Answer (b)

Sol. The –R effect of Keto group is greater than that of an ester group because the $-\overset{\overset{O}{\|}}{C}-$ group of ester is in cross conjugation with oxygen. Hence, keto group stabilises the negative charge more than the ester group. The correct order of acidic strength is (iv) > (iii) > (i) > (ii)

48. Reaction of *para*-Chloroaniline with acetic anhydride in pyridine gave a crude mixture of 94% of *para*-chloroacetanilide and 6% unreacted amine.

From the following, the best treatment suitable for purification of *para*-chloroacetanilide is

(a) treating the reaction mixture with methyl iodide

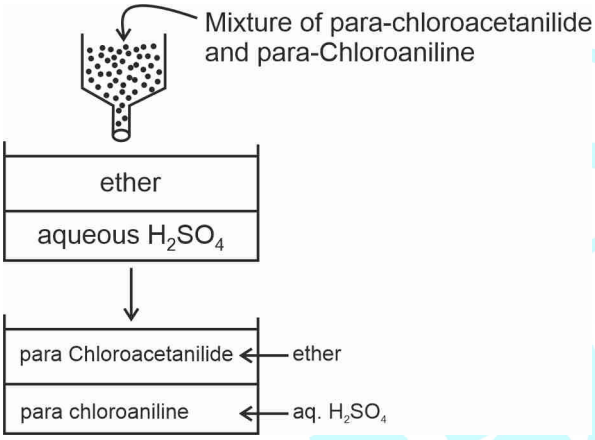
(b) washing an ether solution of the crude product with concentrated brine (aq. NaCl)

(c) washing an ether solution of the crude product with 5% cold aqueous sulfuric acid

(d) washing an ether solution of the crude product with 5% aqueous sodium carbonate

Answer (c)

Sol.

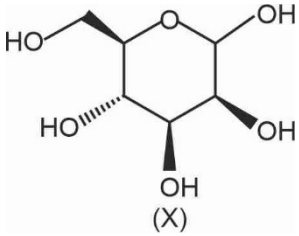


para-Chloroaniline moves in aqueous H_2SO_4 solution because of its basic nature.

A - 2

ANY NUMBER OF OPTIONS 4, 3, 2 OR 1 MAY BE CORRECT
MARKS WILL BE A WARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED

49. The correct statement/s about the pyranose form of a sugar (X) given below is/are:



(a) It exists in two anomeric pyranose forms

(b) It reacts with Tollens' reagent to give a silver mirror

(c) The penta-O-methyl derivative of (X) is non reducing.

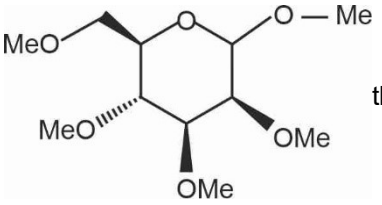
(d) It resists reduction with aqueous sodium borohydride

Answer (a, b, c)

Sol. (a) Because of the attack on (C = O bond) sp^2 hybridised centre there are two possibilities to attack:

Two products will be formed which are anomers of each other.

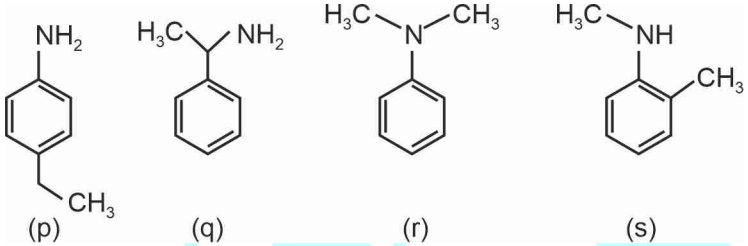
(b) Because of the presence of hemiacetal group 'X' can react with Tollen's reagent.

(c) 

there is no hemi acetyl group so it does not reduce Tollen's reagent.

(d) $NaBH_4$ can reduce carbonyl compounds.

50. Given below are isomeric amines. The **incorrect** statement/s about them from the following is/are



(a) (p) and (q) both will give unstable products respectively with $NaNO_2$ in HCl at 268 K

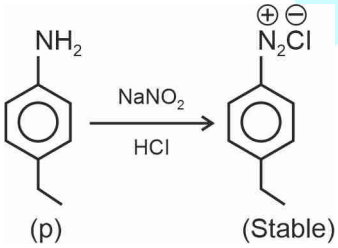
(b) Reaction of all amines with HCl is exothermic

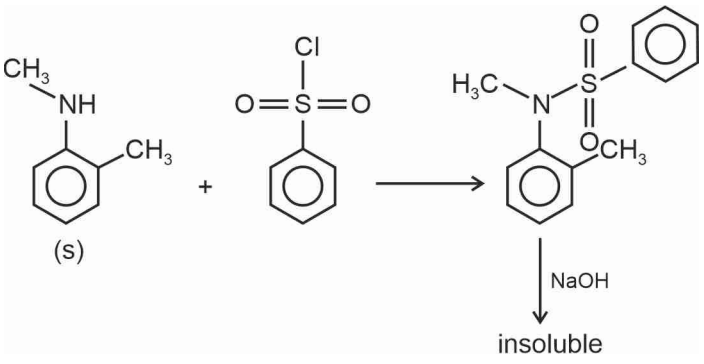
(c) Reaction of benzene sulphonyl chloride with (s) gives a solid product that is soluble in NaOH

(d) (q) has the highest basicity among these

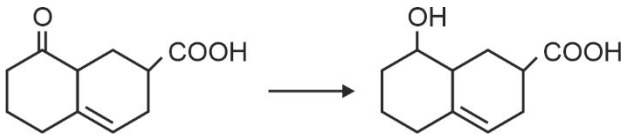
Answer (a, c)

Sol. (a) Aromatic amines gives a stable product with $NaNO_2$/HCl.



(c) 

51. Which one/s of the reduction techniques mentioned below is/are **NOT** suitable for the following chemical transformation?



(a) $NaBH_4$ based reduction

(b) $LiAlH_4$ based reduction

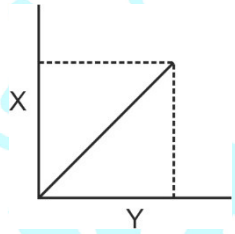
(c) DIBAL-H based reduction

(d) B_2H_6 based reduction

Answer (b, c, d)

Sol.
- $NaBH_4$ does not reduce carboxylic group but can reduce the keto group to alcohol.
- $LiAlH_4$ can reduce both keto and carboxylic group.
- B_2H_6 has more affinity towards carboxylic group to reduce to alcohol.

52. Following is a qualitative plot that can represent kinetic data obtained with a reactant R where $[R]_0$ and [R] represent the concentrations of R, at t = 0 and t = t respectively. 'Y' and 'X' are suitable parameters on the x-and y-axes.



The correct representation of the curve is

	X	Y	order	X	Y	order
(a)	$[R]_0 - [R]$	time	Zero	Rate	time	First
(b)	$[R]_0 - [R]$	time	Zero	Initial rate	$[R]_0$	First
(c)	Rate	[R]	Zero	$t_{1/2}$	[R]	First
(d)	$t_{1/2}$	[R]0	Zero	ln $\{[R]_0/[R]\}$	t	First

Answer (b, d)

Sol. For zero order,

$[R] = [R]_0 - kt$

$[R]_0 - [R] = kt$

So, graph is a straight line passing from origin

For first order,

Rate $= k[R]$

$= k[R_0]e^{-kt}$

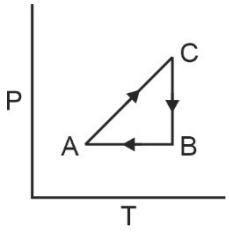
Therefore, rate exponentially decreases with time.

Initial rate = $k[R_0]$. Hence (b) is correct

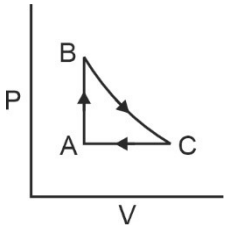
Also, for zero order, $t_{1/2} \propto [R_0]$

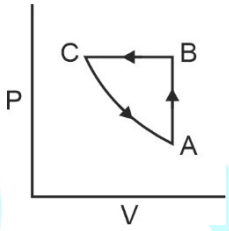
And for first order, $\ln\left\{\frac{R_0}{R}\right\} \propto t$ so, (d) is correct

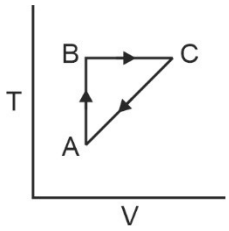
53. A given amount of an ideal gas undergoes the cyclic process ABCA as given below.

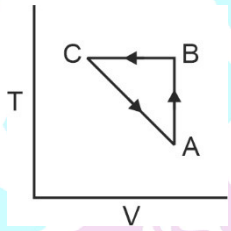


The equivalent representation/s on the same process is/are

(a)


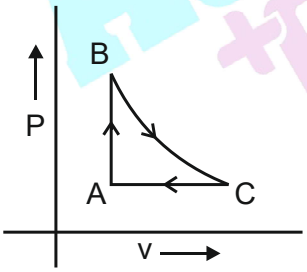
(b)


(c)


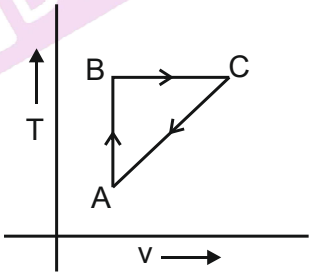
(d)


Answer (a, c)

Sol. As AB is isochoric, CA is isobaric and BC is isothermal, correct graphs are:



(a)



(c)

54. The correct statement among the following is/are

(a) When equal volumes of a solution containing Sr^{2+} (0.01 M) and another containing F^- (0.01 M) are mixed at 25°C, SrF_2 will be precipitated (K_{sp} of $SrF_2 = 8.0\times10^{-10}$ at 25°C)

(b) When equal volumes of a solution containing Ba^{2+} (1.0×10^{-4} M) and another containing F^- (1.0×10^{-2} M) are mixed at 25°C, BAF_2 will be precipitated (K_{sp} of $BaF_2 = 1.0\times10^{-6}$ at 25°C)

(c) The solubility product (K_{sp}) and the molar solubility (s) of $La(IO_3)_3$ are related as $K_{sp} = 27s^4$

(d) The solubility product and the molar solubility of $Ca_3(PO_4)_2$ are related as $27s^4$

Answer (a, c)

Sol. (a) $[Sr^{+2}][F^{\ominus}]^2 = \frac{0.01}{2} \times \left(\frac{0.001}{2}\right)^2$

$= \frac{10^{-8}}{8} = 0.125 \times 10^{-8}$

$= 1.25 \times 10^{-9} > K_{sp}$

So, precipitation occurs

(b) $[Ba^{+2}][F^{\ominus}]^2 = \frac{10^{-4}}{2} \times \left(\frac{10^{-2}}{2}\right)^2$

$= \frac{10^{-8}}{8} < K_{sp}$

So, no precipitation occurs

(c) $La(IO_3)_3 \rightleftharpoons \underset{s}{La^{+3}} + \underset{3s}{3IO_3^-}$

$K_{sp} = 27s^4$

(d) $Ca_3(PO_4)_2 \rightleftharpoons \underset{3s}{3Ca^{+2}} + \underset{2s}{2PO_4^{-2}}$

$K_{sp} = 108\ s^5$

55. For the phenomenon of adsorption, the correct statement/s among the following is/are

(a) According to Freundlich model, mass of N_2 gas absorbed per g of silica surface will increase with temperature of adsorption

(b) If S is the surface area of an adsorbent, and 'A', 'm' and 'M' are the cross-sectional area, mass adsorbed and molar mass of the adsorbate respectively, then $S = \left(\frac{m}{M}\right) AN_A$ (N_A -Avogadro's number)

(c) The number of gas molecules physiosorbed on unit mass of an adsorbent will be the same for two different gases at the same temperature.

(d) Adsorption of H_2 on Ni surface with E_a = 96 kJ mol^{-1} can be termed as chemisorption

Answer (d)

Sol. (a) For physical adsorption,

$T \uparrow \left(\frac{x}{m}\right) \downarrow$

$\Rightarrow$ a is incorrect.

(b) It is not equal to surface area, as 3-D particles are also getting adsorbed

$\Rightarrow$ (b) is incorrect

(c) 2 Gases will have different extent of adsorption

$\Rightarrow$ (c) is incorrect

(d) High E_a value, can be considered as chemisorption

56. When excess $KMnO_4$ is added to concentrated H_2SO_4, an oily green colored covalent compound Y is formed. Which of the following statements is/are true for the above reaction.

(a) Compound **Y** is formed by a dehydration reaction

(b) In compound **Y**, Mn is octahedrally surrounded by oxygen atoms

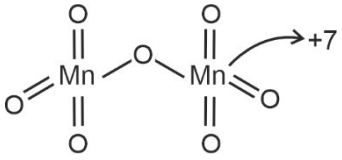
(c) **Y** is the highest oxide of Manganese

(d) Compound **Y** has Mn-O-Mn bridge

Answer (a, c, d)

Sol. $KMnO_4 + H_2SO_4 \longrightarrow \underbrace{Mn_2O_7}_{Y} + K_2SO_4 + H_2O$

$Mn_2O_7 \rightarrow$ Oily green colored covalent compound



highest oxidation state (+7)

It has  bridge.

57. Read carefully all the three statements on defects in solids:

(i) In Frenkel defect, interstitial Ag^+ site is surrounded tetrahedrally by four Cl^- ions and four Ag^+ ions, where interstitial Ag^+ and Cl^- interaction is covalent

(ii) Addition of small amount of $SrCl_2$ in NaCl yields solid solution with a formula of $Na_{1-2x}Sr_xV_{Nax}Cl$, where V = valency

(iii) In general, Schottky defect increases the density of the substance

Choose the correct alternative(s).

(a) Statement (i) is correct

(b) Statements (ii) and (iii) are correct

(c) Statements (i) and (ii) are correct

(d) Statements (i) and (iii) are correct

Answer (a, c)

Sol. (i) Ist statement is correct

(ii) Addition of $SrCl_2$ will create vacancy equal to no. of Sr^{2+} incoming and double Na^+ will go out so formula = $Na_{(1-2x)}Sr_{(x)}V_{Nax}Cl_1$ $\Rightarrow$ IInd is correct

We have considered V_{Na} as vacancy created due to sodium and hence statement-II is correct.

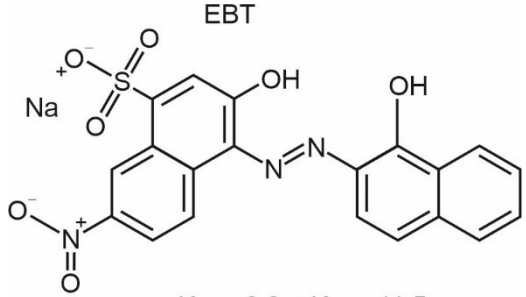
(iii) Schottky defect decreases the density of the substance

$\Rightarrow$ IIIrd statement is incorrect.

$\Rightarrow$ Statement (i) and (ii) are correct.

58. Eriochrome black T (EBT) is an indicator in titrimetric estimation of calcium at pH 10.0 giving pink colour to the solution. It has structure as shown below. Considering that the pH of solution is 10.0, which statement(s) describe(s) the complexation of EBT with Ca(II) correctly

EBT



$pK_{a2} = 6.3$, $pK_{a3} = 11.5$

(a) On dissociation of EBT, Ca(II) binds at SO_3^- to form 1:2 complex

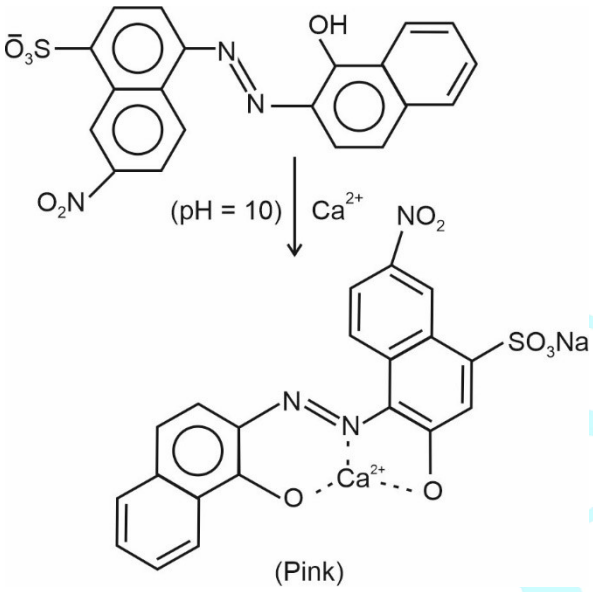
(b) Both sulphonate and nitro groups are involved in 1:1 complexation with Ca(II)

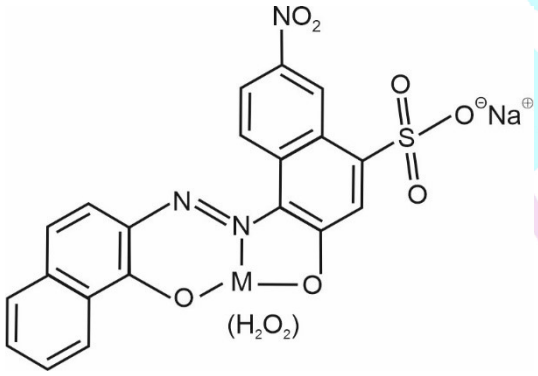
(c) EBT acts as a bidentate ligand to form a dianionic species, with deprotonation of one – OH, where Ca(II) binds to azide nitrogen and phenolic oxygen *trans* to – NO_2 group in 1:2 ratio

(d) There is a mixture of complexes of Ca(II) with EBT acting as a bidentate and tridentate ligand

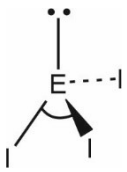
Answer (d)

Sol.





59. The correct statement(s) regarding three EI_3 molecules (where E=P, As or Sb) is/are:



(a) These compounds are formed by mutual sharing of electrons and hence considered as covalent compounds

(b) PI_3 is most susceptible towards hydrolysis in water to give phosphorous acid

(c) SbI_3 has highest boiling point amongst all

(d) In AsI_3, there is least repulsion between bond pair and lone pair and thus has the largest I-E-I angle

Answer (a, b)

Sol. (a) All EI_3 are covalent compounds

(b) Ease of hydrolysis will be highest in PI_3. Only PI_3 can give phosphorous acid. Driving force is the formation of (P = O) bond

(c) Boiling point of PI_3 = 200°C

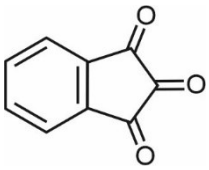
AsI_3 = 403°C

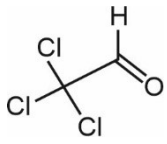
SbI_3 = 401°C

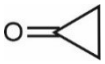
So, this statement is incorrect

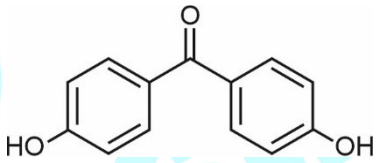
(d) Least repulsion between bond pair and lone-pair will be in SbI_3

60. Aldehydes and ketones can react with water in the presence of an acid or base to yield an equilibrium mixture of the aldehyde/ketone and the corresponding hydrates (geminal diol). Among the following, the aldehyde/ketones which will have a greater percentage of the hydrate at equilibrium are

(a) 

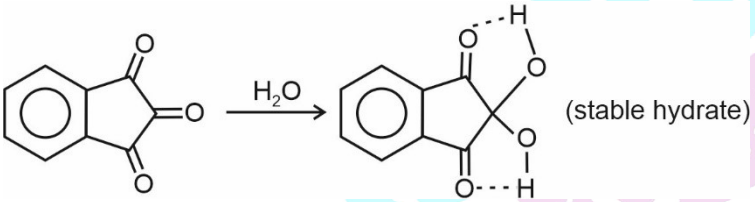
(b) 

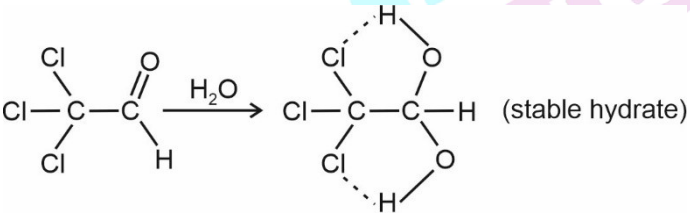
(c) 

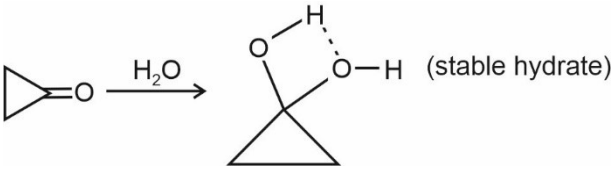
(d) 

Answer (a, b, c)

Sol.







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