PART : CHEMISTRY

1. How much water should be added to 1 L of an aqueous solution of HCl having pH = 1 to prepare a solution of pH = 2 ?

(1) 0.9 L (2) 1.0 L (3) 9.0 L (4) 10.0 L

Ans. **(3)**

Sol. At pH = 1

Concentration of $[H^+] = 10^{-1} = 0.1$ M

At pH = 2

Concentration of $[H^+] = 10^{-2} = 0.01$ M

Now for dilution

$M_1V_1 = M_2V_2$

$0.1 \times 1 = 0.01 \times V_2$

$V_2 = 10$ L

Final Volume is = 10 – 1 = 9 L

2. Consider the following reaction :

$$CaCl_2 + Na_2CO_3 \xrightarrow{Z} X + Y$$

identify the X, Y and Z

(1) X = $CaCO_3$; Y = NaCl ; Z = HCl (2) X = CaO ; Y = NaCl ; Z = KCl

(3) X = CaO ; Y = NaCl + CO_2 ; Z = NaCl (4) X = $CaCO_3$; Y = NaCl ; Z = KCl

Ans. **(1)**

Sol.

$$CaCl_2 + Na_2CO_3 \xrightarrow{HCl} CaCO_3 + NaCl$$

3. Which of the following order of density is correct for IA group elements :

(1) Li < K < Na < Rb < Cs (2) Li < Na < K < Rb < Cs

(3) Cs < Rb < K < Na < Li (4) Ca < K < Na < Rb < Li

Ans. **(1)**

Sol. Density increase down the group but K is lighter than Na.

Order = Li < K < Na < Rb < Cs

Density / g cm^{-3} ; Li = 0.53 ; Na = 0.97 ; K = 0.86 ; Rb = 1.53 ; Cs = 1.90

Due to their large size the atoms of alkali metals are less closely pocked.

Consequently have low density

On going down the group, both the atomic size and atomic mass increase but the increase in atomic mass compensates the bigger atomic size.

As a result, the density of alkali metals increases from Li to Cs.

K is however, lighter then Na. It is probably due to an unusual increase in atomic size of potassium.

4. Match the following :

	Column-I (Type of hydride)		**Column-II (Formula)**
(A)	Electron deficient	(P)	MgH_2
(B)	Electron precise	(Q)	HF
(C)	Electron rich	(R)	CH_4
(D)	Saline hydride	(S)	B_2H_6

(1) (A) → (S) ; (B) → (R) ; (C) → (Q) ; (D) → (P)

(2) (A) → (Q) ; (B) → (R) ; (C) → (P) ; (D) → (S)

(3) (A) → (P) ; (B) → (Q) ; (C) → (R) ; (D) → (S)

(4) (A) → (S) ; (B) → (Q) ; (C) → (R) ; (D) → (P)

Ans. **(1)**

Sol. Electron deficient hydride : Hydride which of not sufficient number of electron to form normal covalent bond. e.g. Hydride of group 13 (BH_3, (B_2H_6), AlH_3(Al_2H_6))
Electron precise hydride : hydride which contain sufficient valence electron to form covalent bond
e.g. Hydride of group 14 (CH_4 , SiH_4 , GeH_4 , SnH_4 , PbH_4)
Electron rich hydride which contains excess of valence electron to form covalent bond.
e.g. Hydride of group 15 (NH_3 , PH_3), and hydride of group 17 (HF, HCl, Br)
Saline hydride : hydrides of Alkaline and alkaline earth metal
e.g. (NaH, KH, MgH_2, CH_2)

5. **Statement- I :** Boron is extremely hard due to its high lattice enthalpy.
Statement- II : M.P. and B.P. is higher than other elements of its group.
(1) Both **Statement-I** and **Statement-II** are correct.
(2) Both **Statement-I** and **Statement-II** are incorrect.
(3) **Statement-I** is correct and **Statement-II** is incorrect.
(4) **Statement-I** is incorrect and **Statement-II** is correct.

Ans. **(1)**

Sol. Boron is non-metallic in nature. It is extremely hard and black coloured solid. Due to very strong crystalline lattice, boron has unusually high melting point. Rest of the member are soft metals with low melting point and high electrical conductivity.

Melting point / K *(B > Al > Ga < In < Tl)*	2453	933	303	430	576
Boiling point / K *(B > Al > Ga > In > Tl)*	3923	2740	2676	2353	1730

6. **Assertion :** 5f electrons can participate in bonding upto a greater extent as compare to 4f electrons.
Reason : Electrons of both orbitals resemble in their angular part of wave function but 5f orbitals is not as buried as 4f orbitals.
(1) Both **Assertion** and **Reason** are correct and **Reason** is the correct explanation of **Assertion**.
(2) Both **Assertion** and **Reason** are correct and **Reason** is not the correct explanation of **Assertion**.
(3) **Reason** is correct and **Assertion** is not correct
(4) **Assertion** is correct and **Reason** is not correct

Ans. **(1)**

Sol. As number of valence shell is higher, electrons of it's orbitals can participate in bonding in greater extents. 4f electron is more shielded as compare to 5f electrons. 5f orbitals is not as buried as 4f orbitals.

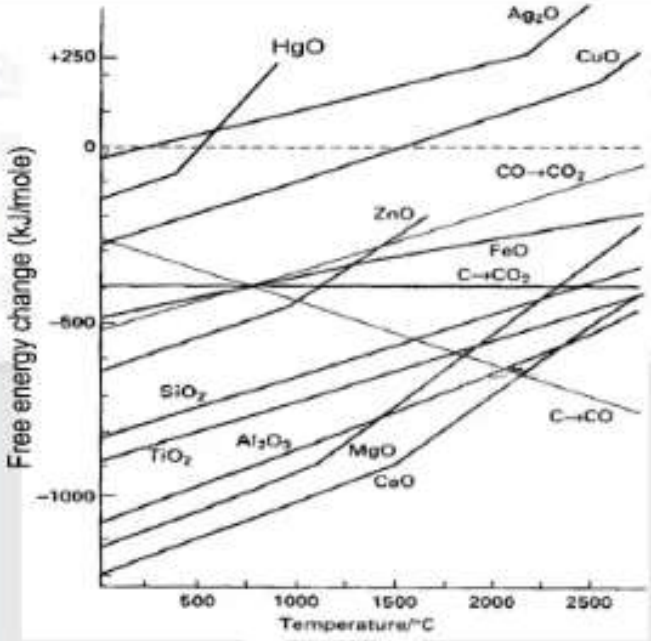
7. **Statement- I :** Change in slope of Ellingham diagram is about 1125°C for Mg.
Statement- II : Large change in entropy during change in physical state of element.
(1) Both **Statement-I** and **Statement-II** are correct.
(2) Both **Statement-I** and **Statement-II** are incorrect.
(3) **Statement-I** is correct and **Statement-II** is incorrect.
(4) **Statement-I** is incorrect and **Statement-II** is correct.

Ans. **(1)**

Sol. The diagram predicts that MgO and ZnO ought to decompose if heated strongly enough, but it does not hold out much hope for obtaining say pure Mg by straight forward heating of the oxide to a high temperature where the boiling point of the metal is exceeded. However the slope increases since the reaction is now involving a larger entropy change as the randomness increases in reactants. For example,

$2\,Mg(g) + O_2(g) \longrightarrow 2\,MgO(s)$

Here, three moles of gas phases are converted into solid phase in the reaction. This takes place above 1120°C, which is the boiling point of Mg.



8. What is the order of reaction $2NO(g) + Br_2(g) \longrightarrow 2NOBr(g)$, obeys the following mechanism.

(i) $NO(g) + Br_2(g) \underset{}{\overset{\text{Fast}}{\rightleftharpoons}} NOBr_2(g)$

(ii) $NOBr_2(g) + NO(g) \xrightarrow{\text{Slow}} 2NOBr(g)$

Ans. (3)

Sol. $2NO + Br_2 \longrightarrow 2NOBr$

(i) $NO + Br_2 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} NOBr_2$ Fast

(ii) $NOBr_2 + NO \xrightarrow[k_3]{\text{Slow}} 2NOBr$ $\qquad r = k_3\,[NOBr_2]\,[NO]$

$$K_{eq} = \frac{k_1}{k_2} = \frac{[NOBr_2]}{[NO][Br_2]} \Rightarrow [NOBr_2] = \frac{k_1 \times [NO][Br_2]}{k_2}$$

$$r = \frac{k_1 k_3}{k_2}\,[NO]^2\,[Br_2] \qquad r = k\,[NO]^2\,[Br_2]$$

so net order of reaction = 2 + 1 = 3

9. Match the following :

	Column-I (Complex)		Column-II (CFSE value = $X\Delta_O$) X is :
(A)	$[Ti(H_2O)_6]^{+3}$	(I)	–0.6
(B)	$[Cu(NH_3)_6]^{+2}$	(II)	–0.4
(C)	$[NiF_6]^{-4}$	(III)	0
(D)	$[Fe(Cl)_6]^{-3}$	(IV)	–1.2

(1) (A) → (II) ; (B) → (I) ; (C) → (IV) ; (D) → (III) (2) (A) → (II) ; (B) → (III) ; (C) → (I) ; (D) → (IV)
(3) (A) → (I) ; (B) → (II) ; (C) → (III) ; (D) → (IV) (4) (A) → (IV) ; (B) → (II) ; (C) → (III) ; (D) → (I)

Ans. (1)

Sol. For octahedral complex : CFSE = $[-0.4\,(n)\,t_{2g} + 0.6\,(n')\,e_g]\,\Delta_0 + {}^*nP$.

Complex	ion	configuration	ligand	SFL/WFL	t_{2g}, eg configuration	CFSE value
$[Ti(H_2O)_6]^{+3}$	Ti^{+3}	d^1	H_2O	WFL	$t_{2g}^{1,0,0}\,eg^{0,0}$	$-0.4\,\Delta_0$
$[Cu(NH_3)_6]^{+2}$	Cu^{+2}	d^9	NH_3	SFL	$t_{2g}^{2,2,2}\,eg^{2,1}$	$-0.6\,\Delta_0$
$[NiF_6]^{-4}$	Ni^{+2}	d^8	F	WFL	$t_{2g}^{2,2,2}\,eg^{1,1}$	$-1.2\,\Delta_0$
$[Fe(Cl)_6]^{-3}$	Fe^{+3}	d^5	Cl	WFL	$t_{2g}^{1,1,1}\,eg^{1,1}$	$0\,\Delta_0$

10. Which of the following have same bond order and magnetic momentum (spin only) as acetylides ion :

(a) NO^+ (b) O_2^- (c) O_2^+ (d) N_2^-

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

Ans. (1)

Sol.

Species	total number of electron	bond order	unpaired electron (n)	magnetic momentum $\sqrt{(n\times(n+2)}$BM
Acetylides ion (C_2^{-2})	14	3	0	0
NO^+	14	3	0	0
O_2^-	17	1.5	1	$\sqrt{3}$
O_2^{+2}	14	3	0	0
N_2^-	15	2.5	1	$\sqrt{3}$

11. For lead storage battery consider the following statement.

(i) At cathode $PbSO_4$(aq) convert into Pb(s) during discharging.

(ii) At anode Pb(s) convert into $PbSO_4$(aq) during discharging.

(iii) It contains 38% solution of sulphuric acid as an electrolyte.

(iv) It has PbO_2 grids as anode.

(1) only (i) and (ii) (2) only (ii) and (iii) (3) only (i) and (iv) (4) only (iii) and (iv)

Ans. (2)

Sol. Lead storage batteries used is automobiles (Cars/bikes):

Anode : Pb(s) **Cathode** : PbO_2(s)

H_2SO_4(conc.) about 38% solution of H_2SO_4 is taken as an electrolyte.

Anode : $Pb(s) \longrightarrow Pb^{2+}(aq) + 2e^-$

$Pb^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s)$

$Pb(s) + SO_4^{2-}(aq) \longrightarrow PbSO_4 + 2e^-$

Most of the $PbSO_4$(s) ppt sticks to the lead rod.

Cathode : $2e^- + 4H^+ + PbO_2(s) \longrightarrow Pb^{2+}(aq) + 2H_2O(\ell)$

$Pb^{2+}(aq) + SO_4^{2-}(aq) + 4H^+ + 2e^- \longrightarrow PbSO_4(s) + 2H_2O(\ell)$

$PbSO_4$(s) sticks to cathode rod.

$Pb(s) + PbO_2 + 4H^+ + 2SO_4^{2-}(aq) \longrightarrow 2PbSO_4(s) + 2H_2O(\ell)$

$E_{cell} = 2.05$ V

12. Critical temperature (T_c) of the four gases A, B, C and D are 5.3, 20.3, 128.5 and 166.5 (in K). find the correct order of adsorption of these gases are :

(1) A > B > C > D (2) D > C > B > A (3) C > D > A > B (4) A > B > D > C

Ans. (2)

Sol. Gas which has higher value of critical temperature shows more adsorption or get easily liquefied.

13. Calculate the vapour pressure (in torr) of 1 m aqueous solution of $MgCl_2$ having degree of dissociation (α) 80% if vapour pressure of pure water 100 torr. At constant temperature.

(1) 95.53 (2) 98.23 (3) 68.12 (4) 98.26

Ans. (1)

Sol. $\frac{P^\circ_A - P_s}{P_s} = \frac{i \cdot n}{N}$

$i = 1 + (n-1)\alpha$

$i = 1 + (3-1) \times 0.8 = 2.6$

1 m = 1 mole of solute $MgCl_2$ dissolve in 1000 g of solvent water.

so $\frac{100 - P_s}{P_s} = \frac{2.6 \times 1}{1000/18} = 100 - P_S = 0.0468 \times P_S$

$1.0468\ P_S = 100$ so $P_S = 95.529$ torr

14. A Metal chloride contains 55% by Mass of chlorine. 100 ml of its vapour gives 0.57g of chlorine at STP. Calculate the molecular Mass of metal chloride. (report your answer in nearest intetger).

Ans. 232

Sol. number of mole of metal chloride $= \frac{100}{22400}$

100 ml of metal chloride gives = 0.57g of Cl_2 at STP

so 22400 ml = 1 mole of metal chloride gives = $\frac{0.57}{100} \times 22400$g of Cl_2 at STP

Mass of chlorine = 55 % by Mass of metal chloride

$$\frac{0.57}{100} \times 22400 = \text{Moler Mass of Metal Chloride} \times \frac{55}{100}$$

Moler Mass of Metal Chloride = 232.14 g/Mole

15. A gas with molecular weight 42 amu will have same root mean square velocity at 27°C as that of most probable speed of which gas at 27°C.

(1) CO_2 (2) CO (3) N_2O (4) NO_2

Ans. (2)

Sol. $(U_{rms})_{Agas} = (U_{mps})_{Bgas}$

$$\sqrt{\frac{3RT}{M_A}} = \sqrt{\frac{2RT}{M_B}}$$

$$\sqrt{\frac{3RT}{42}} = \sqrt{\frac{2RT}{M_B}}$$

$M_B = 28$ so gas is CO

16. If isothermol reversible process is carried out at $P_1 = 3$ atm, from $V_{initial} = 2$ L to $V_{final} = 3$ L and T = 350 K. Calculate the charge in entropy for the system (in Jule)

Ans. (0.72)

Sol. $(\Delta S)_{system} = nR\ln\frac{V_2}{V_1}$

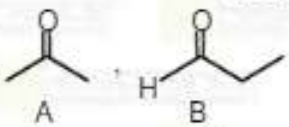
$$= \frac{P_iV_i}{TR} \times R\ln\frac{V_2}{V_1}$$

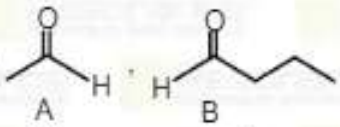
$$= \frac{3\times2}{350}\ln\frac{3}{2}$$

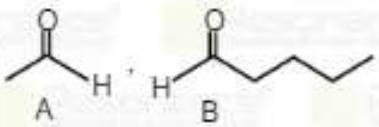
= 0.0071 L atm = 0.071 × 101.3 = 0.719 J

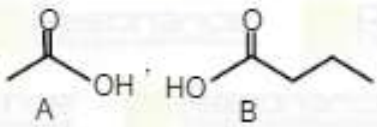
17. Find the product of following given reaction:

Hex-2-ene $\xrightarrow[H_2O_2]{O_3}$ A + B

(1)  A , B

(2)  A , B

(3)  A , B

(4)  A , B

Ans. (4)

Sol. This is oxidative Ozonolysis of alkene which will give carboxylic acid

$CH_3–CH=CH–CH_2–CH_2–CH_3$

$\xrightarrow{O_3 / H_2O_2}$

$CH_3–COOH + CH_3–CH_2–CH_2–COOH$

18. The correct match of the amino acids and their code.

	Column-I		Column-II
(a)	Biodegradable polymer	(p)	Polyacrylonitrile
(b)	Synthetic polymer	(q)	Nylon-2-Nylon-6
(c)	Addition polymer	(r)	Dacron
(d)	Polyester	(s)	2-Chlorobuta-1,3-diene

(1) a – (q) ; b – (p) ; c – (s) ; d – (r)
(2) a – (p) ; b – (q) ; c – (s) ; d – (r)
(3) a – (r) ; b – (s) ; c – (p) ; d – (q)
(4) a – (s) ; b – (r) ; c – (q) ; d – (p)

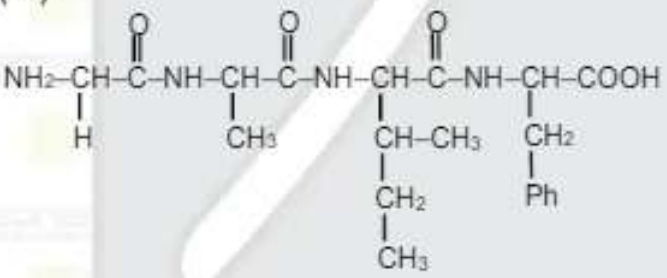
Ans. **(1)**

Sol. (p) Nylon-2-Nylon-6 is Biodegradable polymer.
(q) Polyacrylonitrile (PAN) is synthetic rubber.
(r) 2-Chlorobuta-1,3-diene is a Addition polymer.
(s) Dacron is polyester of Terphthalic acid and Glycol.

19. Number of Sp^2 Hybridised C-atoms in given oligo-peptide chain.
alanine – Isoleucine – Phenyl alanine–Glycine
(Gly – Ala – Ile –Phe)

Ans. **(10)**

Sol.



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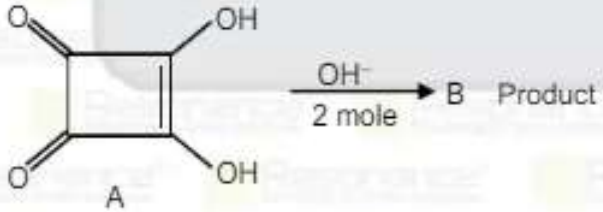
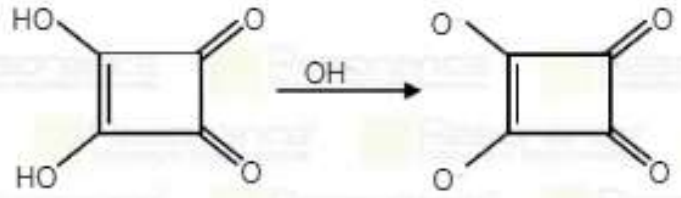


A

Choose correct option regarding product B.
(a) Product B is aromatic compound.
(b) Compound B can show Tautomerisation.
(c) All C–C Bond length are same in product B.
(d) Sp^2 carbon atoms present in product B.
(1) (a), (b) (c), (d) (2) (a), (b), (c) (3) (a), (c), (d) (4) (a), (b), (d)

Ans. **(3)**

Sol.



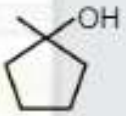
Squaric acid

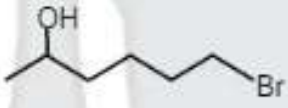
Aromatic compound with same C–C bond length

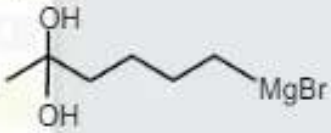
21.

(1) Mg/ether
(2) $H_3O^{\oplus}$

Product is

(1) 

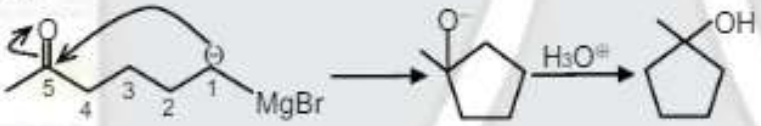
(2) 

(3) 

(4) 

Ans. **(1)**

Sol.



22. The correct match of the amino acids and their code.

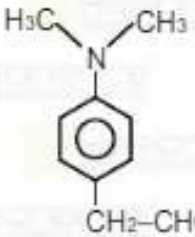
	List-I		List-II
(A)	Nitrogen oxide	(i)	Acid rain
(B)	CO_2	(ii)	Global warming
(C)	CH_4	(iii)	Water pH become = 5.6
(D)	Excessive use of detergent	(iv)	Eutrification

(1) (A) – (i) ; (B) – (iii) ; (C) – (ii) ; (D) – (iv)
(2) (A) – (ii) ; (B) – (iii) ; (C) – (i) ; (D) – (iv)
(3) (A) – (iii) ; (B) – (i) ; (C) – (iv) ; (D) – (i)
(4) (A) – (i) ; (B) – (iv) ; (C) – (ii) ; (D) – (iii)

Ans. **(1)**

Sol. NCERT based

23.

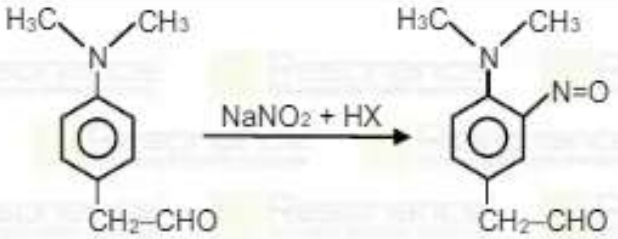


$NaNO_2 + HX$ → Product

Choose correct option for product.
(1) Electrophile $NO^{\oplus}$ attack on ortho position of $-N(CH_3)_2$.
(2) Product is p–amino Nitroso benzene.
(3) It is a slow reaction.
(4) Product is p–amino Nitroso benzene and It is slow reaction.

Ans. **(1)**

Sol.



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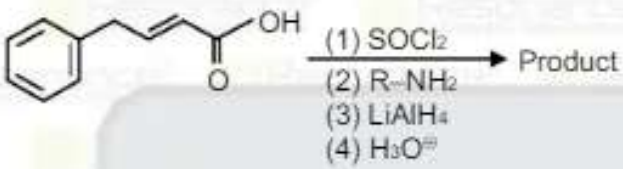
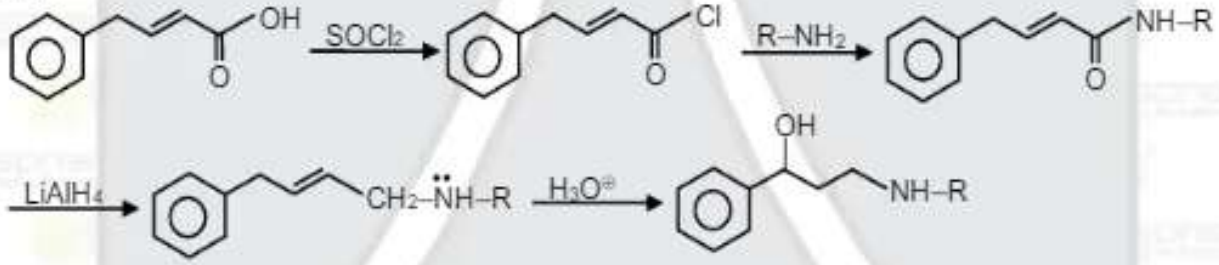


Ans. **(1)**

Sol.



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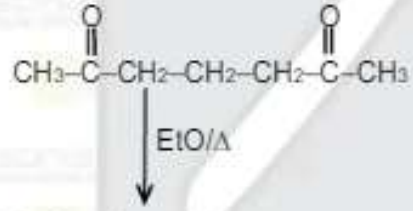
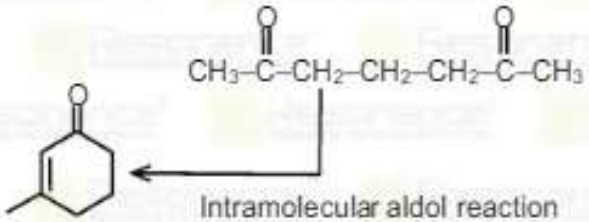


Product is :

Ans. **(1)**

Sol.

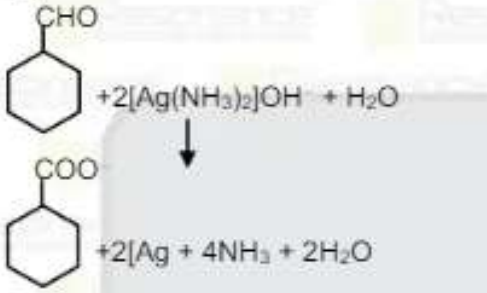


26. 

Calculate mass of Tollen's required.

(1) 18.70 Kg (2) 37.40 Kg (3) 9.35 Kg (4) 55.10 Kg

Ans. **(1)**

Sol. 

No. of Moles of NH_3 formed = $\frac{4\times10^3}{17}$ (given)

No. of moles of tollen consumed = $\frac{2\times10^3}{17}$

mass of tollen's reagent = $\frac{2\times10^3}{17}\times159$ gm

= 18.70 Kg (18705 gm)