

ZINC GROUP - GROUP 12

Section - 6

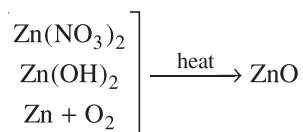
The elements of group 12 have a $d^{10}s^2$ configuration and they typically form divalent ions. Since they have a fully filled orbital in native as well as any other state, they do not behave as typical transition metals (like they are very soft). The members of this group are zinc (Zn), cadmium (Cd) and mercury (Hg).

Zinc & its Compounds

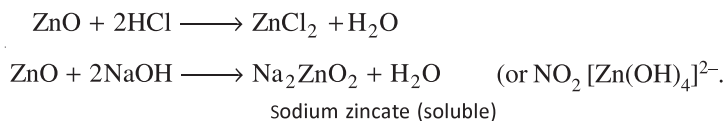
Zinc is bluish white crystalline metal which shows some similarities to Mg. It is brittle at ordinary temperature, malleable and ductile at $100^\circ - 150^\circ \text{C}$ and again becomes brittle at 220°C . Some properties are :

- $2\text{Zn} + \text{O}_2 \xrightarrow{\Delta} 2\text{ZnO}$
- $\text{Zn}(\text{red hot}) + \text{H}_2\text{O}(\text{g}) \longrightarrow \text{ZnO} + \text{H}_2$
- Reaction with acids :
 - $\text{Zn} + 2\text{H}_2\text{SO}_4(\text{conc.}) \longrightarrow \text{ZnSO}_4 + \text{H}_2\text{O} + \text{SO}_2$
 - $4\text{Zn} + 10\text{HNO}_3(\text{very dil.}) \longrightarrow 4\text{Zn}(\text{NO}_3)_2 + \text{NH}_4\text{NO}_3 + 3\text{H}_2\text{O}$
 - $3\text{Zn} + 8\text{HNO}_3(\text{moderately conc.}) \longrightarrow 3\text{Zn}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$
 - $\text{Zn} + 4\text{HNO}_3(\text{hot conc.}) \longrightarrow \text{Zn}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
- Reaction with NaOH : $\text{Zn} + 2\text{NaOH}(\text{hot}) \longrightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2$
Sodium zincate(soluble)
- Uses :** Zinc is used in larger amounts for coating iron to prevent it from rusting, make alloys (brass is Zn + Cu), sheets used for roofing and as a reducing agent. It also has an important role in biological systems.

(a) Zinc oxide (ZnO) : ZnO is a white, light powder insoluble in water and made by heating zinc salts.



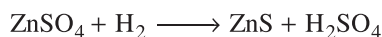
- ZnO is white when cold and becomes yellow on heating. The colour occurs due to loss of O atoms on heating, creating defects in structure.
- ZnO is amphoteric. In acids it forms salts and in alkali, zincates such as $[\text{Zn}(\text{OH})_4]^{2-}$.



- ZnO is the only important commercial oxide in this group. It is used mainly in vulcanization of rubber. It is also used as white shoe polish and manufacture of glass.

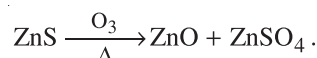
(b) Zinc Sulphide (ZnS) :

ZnS is also white and insoluble in water. It turns yellow on exposure to light. Zinc oxide or zinc sulphate or other zinc salts form zinc sulphide in the presence of H_2S gas.



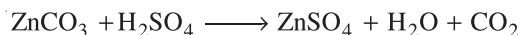
- It shows phosphorescence due to impurities of Mn, Cu, Ag etc. and hence is used as a phosphorescent.

2. On heating in oxygen at high temperature ZnO is formed while ZnSO₄ is the major product at low temperature.



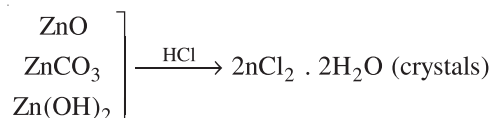
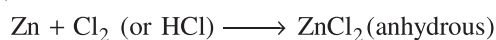
(c) Zinc Sulphate [ZnSO₄·7H₂O] (White vitriol) :

White vitriol is isomorphous with epsom salts and green vitriol. It is highly soluble in water and prepared as follows:



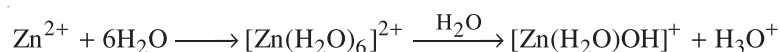
1. $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O} \xrightarrow{100^\circ\text{C}} \text{ZnSO}_4 \cdot 6\text{H}_2\text{O} \xrightarrow{280^\circ\text{C}} \text{ZnSO}_4 \xrightarrow{800^\circ\text{C}} \text{ZnO} + \text{SO}_2 + \text{O}_2$
2. It is used in medicine as an eye lotion and in manufacture of white point.

(d) Zinc Chloride (ZnCl₂) : It is a white deliquescent solid very soluble in water.



Heating hydrated ZnCl₂ simply decomposes it to ZnO instead of dehydrating to anhydrous form.

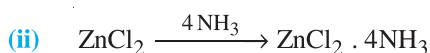
1. Aqueous solutions of Zn²⁺ are acidic because of hydrolysis.



2. $\text{ZnCl}_2 + \text{H}_2\text{S} \longrightarrow \text{ZnS} \downarrow + 2\text{HCl}$

3. $\text{ZnCl}_2 \xrightarrow{\text{NaOH}} \text{Zn(OH)}_2 \downarrow \text{ (White gelatinous precipitate)} \xrightarrow{\text{NaOH}} \text{Na}_2\text{ZnO}_2$
Sodium zincate

4. (i) $\text{ZnCl}_2 \xrightarrow{\text{NH}_4\text{OH}} \text{Zn(OH)}_2 \downarrow \xrightarrow{\text{NH}_4\text{OH}/\text{NH}_4\text{Cl}} [\text{Zn}(\text{NH}_3)_4]\text{Cl}_2$
Tetramminezinc Chloride



5. Concentrated solutions of zinc chloride are corrosive and dissolve paper. It is used for treating textiles. ZnCl₂ is also used as a flux for soldering.

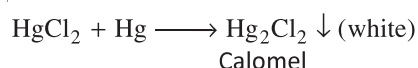
Mercury & its Compounds

Mercury is a silvery liquid which does not tarnish readily. All mercury (and cadmium) compounds are toxic. It has two oxidation states +I and +II. Hg(I) compounds (*mercurous* compounds) are few in number and contain the ion (Hg – Hg)²⁺ and Hg⁺. Hg(II) compounds (*mercuric* compounds) are more covalent and stable.

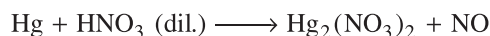
Hg is used in thermometers, barometers and mercury vapour street lights.

I. Hg^{+I} State (Mercurous)

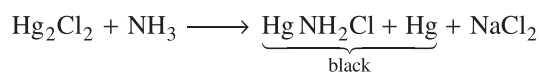
Mercurous compound can be made by reducing the Hg(II) salts with the metal.



Alternatively, mercury (I) nitrate can be made by dissolving Hg in dilute HNO_3 .



- Hg_2Cl_2 also known as calomel is used in calomel electrodes. It is a white powder which turns black in NH_3 (which is used in detection of mercurous ion).



II. Hg^{+II} State (Mercuric)

Salts are usually anhydrous. Mercuric chloride (HgCl_2) is called 'Corrosive Sublimate' and prepared as follows :



It is a colourless crystalline highly poisonous solid used as an antiseptic since the middle Ages. It is also used to make *Nessler's Reagent* which is used to detect NH_3 .



IN-CHAPTER EXERCISE - E

- Write balanced equations for the reaction of alkaline perbromate with zinc giving tetrahydroxozincate anion.
- Excess of dilute sodium hydroxide solution is gradually added with shaking to an aqueous solution of zinc sulphate. What would you observe?
- Explain the following:
 - The addition of NaOH solution to a solution of zinc chloride produces a white precipitate which dissolves on further addition of NaOH .
 - The addition of NH_4OH to ZnSO_4 solution produces white precipitate but no precipitate is formed if it contains NH_4Cl .
- Mercurous chloride turns black on adding NH_4OH to it. Explain.
- A white substance A reacts with dilute H_2SO_4 to produce a colourless gas B and a colourless solution C. The reaction between B and acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution produces a green solution and a slightly coloured precipitate D. The substance D burns in air to produce a gas E which reacts with B to yield D and a colourless liquid. Anhydrous copper sulphate is turned blue on addition of this colourless liquid. Addition of aqueous NH_3 or NaOH to C produces first a precipitate, which dissolves in the excess of the respective reagent to produce a clear solution in each case. Identify A, B, C, D and E. Write the equations of the reactions involved.

ANSWERS TO IN-CHAPTER EXERCISES

C	3. BC	4. ABD		
D	2. B	3. C	4. C	5. B