Action of Alkalis (NaOH, KOH) on Certain Metals

Certain metals like Al, Zn and Pb react with hot concentrated caustic alkali (NaOH, KOH) to give the corresponding soluble salt and liberate hydrogen gas.

1. Aluminium Metal (Al)

$$2Al + 2NaOH + 2H_2O \longrightarrow \underset{\substack{\text{Sodium meta aluminate}\\\text{(Colourless)}}}{2NaAlO_2} + \underset{\text{Hydrogen gas}}{3H_2}$$

$$2Al + 2KOH + 2H_2O \longrightarrow \underset{\substack{\text{Potassium}\\\text{meta aluminate}}}{2KAlO_2} + 3H_2$$

2. Zinc Metal (Zn)

$$Zn + \underset{\text{(Hot and conc.)}}{2KOH} \longrightarrow \underset{\substack{\text{Potassium}\\\text{zincate}\\\text{(Colourless)}}}{K_2ZnO_2} + \underset{\text{Hydrogen gas}}{H_2}$$

$$Zn + \underset{\text{(Hot and conc.)}}{2NaOH} \longrightarrow \underset{\substack{\text{Sodium}\\\text{zincate}\\\text{(Colourless)}}}{Na_2ZnO_2} + \underset{\text{Hydrogen gas}}{H_2}$$

3. Lead Metal (Pb)

$$Pb + 2NaOH \longrightarrow \underset{\substack{\text{Sodium plumbate}\\\text{(Colourless)}}}{Na_2PbO_2} + \underset{\text{Hydrogen gas}}{H_2}$$

$$\underset{\text{Lead}}{Pb} + \underset{\substack{\text{Potassium}\\\text{hydroxide}}}{KOH} \longrightarrow \underset{\substack{\text{Potassium plumbate}\\\text{(Colourless)}}}{K_2PbO_2} + \underset{\substack{\text{Hydrogen}\\\text{gas}}}{H_2}$$

Action of Alkalis on Metal Oxides and Hydroxides

Most of the metal oxides are basic in nature and dissolve in water to give hydroxides or alkalis. These metal oxides and hydroxides neutralise acids but do not react with bases.

e.g.

$$\underset{\substack{\text{Sodium}\\\text{oxide}}}{Na_2O} + H_2O \longrightarrow \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{2NaOH}$$

$$Na_2O + 2HCl \longrightarrow 2NaCl + H_2O$$

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

Oxides and hydroxides of few metals like Zn, Pb and Al, i.e. ZnO, PbO, Al_2O_3 and $Zn(OH)_2$, $Pb(OH)_2$, $Al(OH)_3$ are **amphoteric** in nature, i.e. **they react with acids as well as alkalis to give salt and water.** e.g. ZnO (zinc oxide) and $Zn(OH)_2$ (zinc hydroxide) react with both acid as well as conc. bases/alkalis (NaOH and KOH) to give salt and water.

1. Zinc Oxide/Zinc Hydroxide

(*i*) $\underset{\text{Zinc oxide}}{ZnO} + \underset{\text{Potassium hydroxide}}{KOH} \longrightarrow \underset{\text{Potassium zincate}}{K_2ZnO_2} + H_2O$

$Zn(OH)_2 + KOH \longrightarrow \underset{\text{Potassium zincate}}{K_2ZnO_2} + 2H_2O$

(*ii*) $\underset{\text{Zinc oxide}}{ZnO} + \underset{\text{Sodium hydroxide (Base)}}{2NaOH} \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + \underset{\text{Water}}{H_2O}$

$\underset{\text{Zinc hydroxide}}{Zn(OH)_2} + \underset{\text{(Base)}}{2NaOH} \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + \underset{\text{Water}}{2H_2O}$

2. Aluminium Oxide/Aluminium Hydroxide

(*i*) $\underset{\text{Aluminium oxide}}{Al_2O_3} + 2NaOH \longrightarrow \underset{\text{Sodium meta aluminate (White)}}{2NaAlO_2} + \underset{\text{Water}}{H_2O}$

$\underset{\text{Aluminium hydroxide}}{Al(OH)_3} + NaOH \longrightarrow \underset{\text{Sodium meta aluminate (Colourless)}}{NaAlO_2} + \underset{\text{Water}}{2H_2O}$

(*ii*) $\underset{\text{Aluminium oxide (White)}}{Al_2O_3} + 2KOH \longrightarrow \underset{\text{Potassium meta aluminate (White)}}{2KAlO_2} + \underset{\text{Water}}{H_2O}$

$\underset{\text{Aluminium hydroxide}}{Al(OH)_3} + KOH \longrightarrow KAlO_2 + 2H_2O$

3. Lead Oxide/Lead Hydroxide

(*i*) $\underset{\text{Lead oxide (Yellow)}}{PbO} + 2\,NaOH \longrightarrow \underset{\text{Sodium plumbate (Colourless, soluble)}}{Na_2PbO_2} + \underset{\text{Water}}{H_2O}$

$\underset{\text{Lead hydroxide}}{Pb(OH)_2} + 2\,NaOH \longrightarrow Na_2PbO_2 + 2H_2O$

(*ii*) $\underset{\text{Lead oxide (Yellow)}}{PbO} + 2KOH \longrightarrow \underset{\text{Potassium plumbate (Colourless, soluble)}}{K_2PbO_2} + \underset{\text{Water}}{H_2O}$

$\underset{\text{Lead hydroxide}}{Pb(OH)_2} + 2KOH \longrightarrow K_2PbO_2 + 2H_2O$

Previous Years' Examination Questions

1 Marks Questions

1. The salt solution which does not react with ammonium hydroxide is
   (a) calcium nitrate (b) zinc nitrate
   (c) lead nitrate (d) copper nitrate **2018**

2. Write a balanced chemical equation.
   Reaction of sodium hydroxide solution with iron (III) chloride solution. **2018**

3. State one relevant observation for
   'Lead nitrate solution is treated with sodium hydroxide solution dropwise till it is in excess.' **2018**

4. A chloride which forms a precipitate that is soluble in excess of ammonium hydroxide, is
   (a) calcium chloride (b) ferrous chloride
   (c) ferric chloride (d) copper chloride **2017**

5. Identify the substance underlined, in the given case.
   'Cation that does not form a precipitate with ammonium hydroxide but forms precipitate with sodium hydroxide.' **2017**

6. State one relevant observation for
   'Action of sodium hydroxide solution on ferrous sulphate solution.' **2017**

7. Fill in the blank with the correct choice given in the bracket.
   ..... ($AgCl/PbCl_2$), a white precipitate is soluble in excess NH_4OH . **2016**

8. State your observation.
   When excess sodium hydroxide is added to calcium nitrate solution. **2014, 2013**

9. Give a chemical test to distinguish between the following pair of compound.
   Calcium nitrate solution and zinc nitrate solution. **2013,2006**

10. Name the gas evolved on reaction of aluminium with boiling concentrated caustic alkali solution. Write the equation. **2012, 2004**

11. State one observation.
    Sodium hydroxide solution is added to ferric chloride solution at first a little and then in excess. **2012, 2000**

12. State one chemical test between ferrous nitrate and lead nitrate. **2012**

13. What would you observe when ammonium hydroxide is first added in a small quantity and then in excess to a solution of copper sulphate? **2011, 2003**

14. Hydroxide of this metal is soluble in sodium hydroxide solution.
    (a) Magnesium (b) Lead (c) Silver (d) Copper **2011**

15. Write balanced chemical equation zinc oxide dissolves in sodium hydroxide. **2011, 2010**