• Most common oxidation states: +1, +2
• M.P. -38.87°
• B.P. 356.57°
• Density 13.546 g/cm³
• Characteristics: Mercury is one of the few liquid elements. It dissolves in oxidizing acids, producing either \(\ce{Hg^{2+}}\) or \(\ce{Hg_2^{2+}}\), depending on which reagent is in excess. The metal is also soluble in aqua regia (a mixture of hydrochloric and nitric acids) to form \(\ce{HgCl4^{2-}}\).

Mercury(I) Ion: Hg₂²⁺

Mercury(I) compounds often undergo disproportionation, producing black metallic mercury and mercury(II) compounds.

Chloride Ion

Soluble chlorides, including hydrochloric acid, precipitate white mercury(I) chloride, also known as calomel:

\[
\ce{Hg_2^{2+}(aq) + 2Cl^-(aq) <=> Hg2Cl2(s)}
\]

Aqueous ammonia reacts with \(\ce{Hg2Cl2}\) to produce metallic mercury (black) and mercury(II) amidochloride (white), a disproportionation reaction:

\[
\ce{Hg2Cl2(s) + 2NH3(aq) -> Hg(l) + HgNH2Cl(s) + NH4^+(aq) + Cl^-(aq)}
\]
**Aqueous Ammonia**

Aqueous ammonia produces a mixture of a white basic amido salt and metallic mercury:

$$2\text{Hg}_2^{2+}(aq) + 4\text{NH}_3(aq) + \text{NO}_3^-(aq) + \text{H}_2\text{O}(l) \rightarrow 2\text{Hg}(l) + \text{Hg}_2\text{ONH}_2\text{NO}_3(s) + 3\text{NH}_4^+(aq)$$

The precipitate is not soluble in excess aqueous ammonia.

**Sodium Hydroxide**

Black finely divided mercury metal and yellow mercury(II) oxide ($\text{HgO}$) are precipitated by $\text{NaOH}$:

$$\text{Hg}_2^{2+}(aq) + 2\text{OH}^-(aq) \rightarrow \text{Hg}(l) + \text{HgO}(aq) + \text{H}_2\text{O}(l)$$
Reducing Agents

Reducing agents, such as $\ce{Sn^{2+}}$ and $\ce{Fe^{2+}}$, reduce mercury(I) to the metal:

\[
\ce{Hg_2^{2+}(aq) + 2Fe^{2+}(aq) \rightarrow 2Hg(l) + 2Fe^{3+}(aq)}
\]

Consult an activity series or a table of reduction potentials for other possible reducing agents.

No Reaction

$\ce{SO_4^{2-}}$ (unless solutions are concentrated; solubility of mercury(I) sulfate is 0.06 g per 100 mL of water at 25°C)
Mercury(II) Ion: Hg$^{2+}$

Characteristic reactions of \(\text{Hg}^{2+}\)

Chloride Ion

No reaction is visible, but Hg(II) will be present as \(\text{[HgCl}_4\]^{2-}\).

Aqueous Ammonia

Aqueous ammonia produces white amido salts whose composition depends on the mercury(II) salt present in the solution:

\[
\text{HgCl}_2(aq) + 2\text{NH}_3(aq) \rightleftharpoons \text{HgNH}_2\text{Cl}(s) + 2\text{NH}_4^+(aq) + \text{Cl}^-(aq)
\]

These salts are not soluble in excess aqueous ammonia, but do dissolve in acids:

\[
\text{HgNH}_2\text{Cl}(s) + 2\text{H}^+(aq) + \text{Cl}^-(aq) \rightleftharpoons \text{HgCl}_2(aq) + \text{NH}_4^+(aq)
\]
Sodium Hydroxide

A yellow precipitate of \(\text{HgO}\) is produced by \(\text{NaOH}\):
\[
\text{Hg}^{2+}(aq) + 2\text{OH}^-(aq) \rightarrow \text{HgO}(s) + \text{H}_2\text{O}(l)
\]
\[
\text{HgCl}_2(s) + 2\text{OH}^-(aq) \rightarrow \text{HgO}(s) + \text{H}_2\text{O}(l) + 2\text{Cl}^-(aq)
\]

The mercury(II) oxide precipitate is insoluble in excess hydroxide but is soluble in acids:
\[
\text{HgO}(s) + 2\text{H}^+(aq) \leftrightarrow \text{Hg}^{2+}(aq) + \text{H}_2\text{O}(l)
\]
Hydrogen Sulfide

Hydrogen sulfide precipitates black mercury(II) sulfide, the least soluble of all sulfide salts.

\[
\ce{Hg^{2+}(aq) + H2S(aq) <=> HgS(s) + 2H^+(aq)}
\]

\[
\ce{[HgCl4]^{2-}(aq) + H2S(aq) <=> HgS(s) + 2H^+(aq) + 4Cl^-(aq)}
\]

Mercury(II) sulfide is insoluble in 6 M \(\ce{HNO3}\) or 12 M \(\ce{HCl}\), even if heated. However, it is soluble in aqua regia (3:1 HCl:HNO3) and in hot dilute \(\ce{NaOH}\) containing excess sulfide.

\[
\ce{3HgS(s) + 12Cl^-(aq) + 2NO3^-(aq) + 8H^+(aq) -> 3[HgCl4]^{2-}(aq) + 2NO(g) + 3S(s) + 4H2O(l)}
\]

\[
\ce{HgS(s) + S2^-(aq) <=> [HgS2]^{2-}(aq)}
\]

Tin(II) Chloride

Tin(II) chloride reduces \(\ce{Hg(II)}\) to \(\ce{Hg(I)}\) or to metallic \(\ce{Hg}\), giving a white or gray precipitate:

\[
\ce{2[HgCl4]^{2-}(aq) + [SnCl4]^{2-}(aq) <=> Hg2Cl2(s) + [SnCl6]^{2-}(aq) + 4Cl^-(aq)}
\]
No Reaction

\(\ce{SO4^{2-}}\) (may precipitate as a mixed sulfate-oxide - a basic sulfate - \(\ce{HgSO4 \cdot 2HgO}\))