• 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 $\ce{Hg^+(aq)}$ or $\ce{Hg_2^{2+}(aq)}$, depending on which reagent is in excess. The metal is also soluble in aqua regia (a mixture of hydrochloric and nitric acids) to form $\ce{HgCl4^{2-}(aq)}$.

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**Mercury(I) Ion: Hg$_2^{2+}$**

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

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**Chloride Ion**

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

$$\ce{Hg_2^{2+}(aq) + 2Cl^-(aq) <=> Hg_2Cl_2(s)}$$

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:

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

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 $\text{Sn}^{2+}$ and $\text{Fe}^{2+}$, reduce mercury(I) to the metal:

$$\text{Hg}_2^{2+}(aq) + 2\text{Fe}^{2+}(aq) \rightarrow 2\text{Hg}(l) + 2\text{Fe}^{3+}(aq)$$

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

No Reaction

$\text{SO}_4^{2-}$ (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 $\text{[HgCl}_4\text{]}^{2-}$.

Aqueous Ammonia

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

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

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

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

A yellow precipitate of \(\ce{HgO}\) is produced by \(\ce{NaOH}\):

\[
\ce{Hg^{2+}(aq) + 2OH^{-}(aq) -> HgO(s) + H2O(l)}
\]

\[
\ce{HgCl2(s) + 2OH^{-}(aq) -> HgO(s) + H2O(l) + 2Cl^{-}(aq)}
\]

The mercury(II) oxide precipitate is insoluble in excess hydroxide but is soluble in acids:

\[
\ce{HgO(s) + 2H^{+}(aq) <=> Hg^{2+}(aq) + H2O(l)}
\]
Hydrogen Sulfide

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

\[
\text{Hg}^{2+}(aq) + \text{H}_2\text{S}(aq) \rightleftharpoons \text{HgS}(s) + 2\text{H}^+(aq)
\]

\[
\text{[HgCl}_4^{-}\text{]}(aq) + \text{H}_2\text{S}(aq) \rightleftharpoons \text{HgS}(s) + 2\text{H}^+(aq) + 4\text{Cl}^-(aq)
\]

Mercury(II) sulfide is insoluble in 6 M \((\text{HNO}_3)\) or 12 M \((\text{HCl})\), even if heated. However, it is soluble in aqua regia (3:1 HCl:HNO₃) and in hot dilute \((\text{NaOH})\) containing excess sulfide.

\[
\text{3HgS}(s) + 12\text{Cl}^-(aq) + 2\text{NO}_3^-(aq) + 8\text{H}^+(aq) \rightarrow 3\text{[HgCl}_4^{-}\text{]}(aq) + 2\text{NO}(g) + 3\text{S}(s) + 4\text{H}_2\text{O}(l)
\]

\[
\text{HgS}(s) + \text{S}^2^-(aq) \rightleftharpoons \text{[HgS}_2^{-}\text{]}(aq)
\]

Tin(II) Chloride

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

\[
\text{2[HgCl}_4^{-}\text{]}(aq) + [\text{SnCl}_4^{-}\text{]}(aq) \rightleftharpoons \text{Hg}_2\text{Cl}_2(s) + [\text{SnCl}_6^{-}\text{]}(2^{-}\text{]}(aq) + 4\text{Cl}^-(aq)
\]
No Reaction

\([\text{\ce{SO}_4^{2-}}}\) (may precipitate as a mixed sulfate-oxide - a basic sulfate - \([\text{\ce{HgSO}_4 \cdot 2\text{HgO}}}\)\))