

### Testing transition metal cations with aqueous sodium hydroxide

Cation in solution	Three drops of NaOH(aq) added to 3 cm <sup>3</sup> of solution of cation	10 cm <sup>3</sup> of NaOH(aq) added to 3 cm <sup>3</sup> of solution of cation
<b>Iron(II), Fe<sup>2+</sup></b>	A grey-green precipitate of Fe(OH) <sub>2</sub> forms Darkens on standing	Grey-green precipitate remains
<b>Iron(III), Fe<sup>3+</sup></b>	An orange-brown precipitate of Fe(OH) <sub>3</sub> forms	Orange-brown precipitate remains
<b>Copper(II), Cu<sup>2+</sup></b>	A pale blue precipitate of Cu(OH) <sub>2</sub> forms	Blue precipitate remains
<b>Chromium(III), Cr<sup>3+</sup></b>	A green precipitate of Cr(OH) <sub>3</sub> forms	Green precipitate dissolves to give dark green solution.
<b>Cobalt(II), Co<sup>2+</sup></b>	A blue precipitate of Co(OH) <sub>2</sub> forms Turns pink on standing	Blue precipitate remains



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### Testing transition metal cations with aqueous ammonia

Cation in solution	Three drops of $\text{NH}_3(\text{aq})$ added to $3 \text{ cm}^3$ of solution of cation	$10 \text{ cm}^3$ of $\text{NH}_3(\text{aq})$ added to $3 \text{ cm}^3$ of solution of cation
Iron(II), $\text{Fe}^{2+}$	A grey-green precipitate of $\text{Fe}(\text{OH})_2$ forms Darkens on standing	Green precipitate remains
Iron(III), $\text{Fe}^{3+}$	An orange-brown precipitate of $\text{Fe}(\text{OH})_3$ forms	Brown precipitate remains
Copper(II), $\text{Cu}^{2+}$	A pale blue precipitate of $\text{Cu}(\text{OH})_2$ forms	Blue precipitate dissolves to give dark blue solution
Chromium(III), $\text{Cr}^{3+}$	A green precipitate of $\text{Cr}(\text{OH})_3$ forms	Green precipitate dissolves to some extent in concentrated ammonia solution to give purple solution
Cobalt(II), $\text{Co}^{2+}$	A blue precipitate of $\text{Co}(\text{OH})_2$ forms Turns pink on standing	Blue precipitate dissolves to give a yellow-brown solution which rapidly darkens to a red-brown solution on standing in the air.



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## Testing transition metal cations with aqueous sodium carbonate

Cation in solution	Adding sodium carbonate
<b>Iron(II), Fe<sup>2+</sup></b>	A greenish grey precipitate of basic iron(II) carbonate, represented simply as FeCO <sub>3</sub>
<b>Iron(III), Fe<sup>3+</sup></b>	An orange-brown precipitate of Fe(OH) <sub>3</sub> and bubbles of carbon dioxide
<b>Copper(II), Cu<sup>2+</sup></b>	A blue-turquoise precipitate of basic copper(II) carbonate, represented simply as CuCO <sub>3</sub>
<b>Chromium(III), Cr<sup>3+</sup></b>	A green precipitate of Cr(OH) <sub>3</sub> and bubbles of carbon dioxide
<b>Cobalt(II), Co<sup>2+</sup></b>	A blue precipitate of basic cobalt(II) carbonate, represented simply as CoCO <sub>3</sub>

Note that the carbonate precipitates with sodium carbonate and metals in the +2 state are all hydrated, basic carbonates with variable formulae which take the form:  $xMCO_3 \cdot yM(OH)_2 \cdot zH_2O$ , where M stands for a metal ion,  $M^{2+}$ .

Hydrated metal ions in the +3 state are too acidic to form carbonate precipitates. They react to give hydroxide precipitates and carbon dioxide gas.



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