

Precipitation Reactions

Answer all the questions below as fully as you can then check your answers

1. What happens when sodium hydroxide is added to a solution of hexaaquacopper(II) ions?

- A. A green precipitate forms
- B. A blue precipitate forms
- C. The solution remains blue and no precipitate forms
- D. A red precipitate forms

An acidity or hydrolysis reaction is when a metal complex reacts with water to release a hydronium ion.

Transition metal ions will form solid insoluble precipitates when sodium hydroxide is added.

Amphoteric substances react with both acids and alkalis.

2. When excess sodium hydroxide is added to a solution containing Al^{3+} ions, which of the following complexes is formed?

- A. $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$
- B. $[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3]$
- C. $[\text{Al}(\text{OH})_4]^-$
- D. $[\text{Al}(\text{OH})_6]^{3-}$

3. The precipitate formed when Fe^{2+} ions react with sodium hydroxide is:

A. Brown B. Blue C. Green D. White

4. Write the equation for the formation of the blue precipitate formed when sodium hydroxide is added to a solution of copper(II) sulfate.

b. What is the effect of adding nitric acid to a precipitate of copper(II) hydroxide? Explain using Le Chatelier's principle.

5. A solution contains 0.1 mol of Al^{3+} ions. Calculate the minimum amount of sodium hydroxide (in moles) required to form the tetrahydroxoaluminate(III) ion, $[\text{Al}(\text{OH})_4]^-$.

6. Describe the colour changes observed when sodium hydroxide is added to a solution of iron(III) chloride. Write balanced equations for the reactions and describe what happens when an excess of sodium hydroxide is added.

7. True or false? The addition of sodium hydroxide to a solution containing Cr^{3+} ions forms a precipitate that dissolves in excess NaOH.

b. Aluminium hydroxide $[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3]$ reacts with acids but not bases.

8. Compare and contrast the behaviour of Al^{3+} and Cr^{3+} ions in precipitation reactions with sodium hydroxide. Include equations in your explanation.

Answers

1. What happens when sodium hydroxide is added to a solution of hexaaquacopper(II) ions?

- A. A green precipitate forms B. A blue precipitate forms
C. The solution remains blue and no precipitate forms
D. A red precipitate forms

Answer: B

2. When excess sodium hydroxide is added to a solution containing Al^{3+} ions, which of the following complexes is formed?

- A. $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ B. $[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3]$
C. $[\text{Al}(\text{OH})_4]^-$ D. $[\text{Al}(\text{OH})_6]^{3-}$

Answer: C

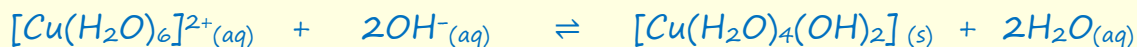
3. The precipitate formed when Fe^{2+} ions react with sodium hydroxide is:

- A. Brown B. Blue C. Green D. White

Answer: C

4. Write the equation for the formation of the blue precipitate formed when sodium hydroxide is added to a solution of copper(II) sulfate.

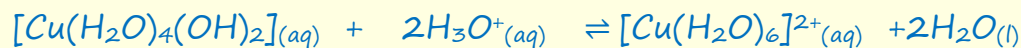
Answer:



b. What is the effect of adding nitric acid to a precipitate of copper(II) hydroxide? Explain using Le Chatelier's principle.

Answer:

Adding nitric acid increases the concentration of H_3O^+ ions, shifting the equilibrium to the left:



The precipitate dissolves, reforming the hexaaquacopper(II) ion.

5. A solution contains 0.1 mol of Al^{3+} ions. Calculate the minimum amount of sodium hydroxide (in moles) required to form the tetrahydroxoaluminate(III) ion, $[\text{Al}(\text{OH})_4]^-$.

Answer:

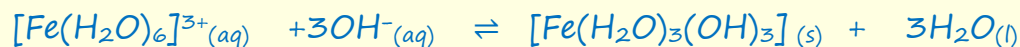
Each Al^{3+} ion reacts with 4 OH^- ions to form $[\text{Al}(\text{OH})_4]^-$.

Moles of NaOH required = $0.1 \text{ mol} \times 4 = 0.4 \text{ mol}$

6. Describe the colour changes observed when sodium hydroxide is added to a solution of iron(III) chloride. Write balanced equations for the reactions and describe what happens when an excess of sodium hydroxide is added.

Answer:

Initially, a brown precipitate of iron(III) hydroxide forms:

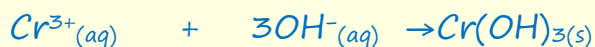


Excess sodium hydroxide does not dissolve this precipitate because $[\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3]$ is not amphoteric.

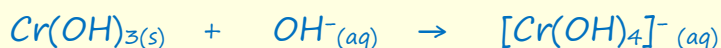
7. True or false? The addition of sodium hydroxide to a solution containing Cr^{3+} ions forms a precipitate that dissolves in excess NaOH.

Answer: True

Initially, a green precipitate of chromium(III) hydroxide, $\text{Cr}(\text{OH})_3$, forms:



In excess sodium hydroxide, the green precipitate dissolves to form a green solution containing the tetrahydroxochromate(III) complex ion, $[\text{Cr}(\text{OH})_4]^-$:



This behaviour is characteristic of amphoteric hydroxides, which can react with both acids and bases.

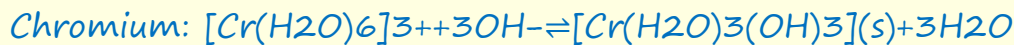
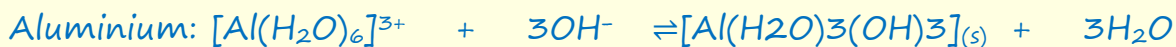
b. Aluminium hydroxide $[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3]$ reacts with acids but not bases.

Answer: False, aluminium hydroxide is an amphoteric oxide and will react with both acids and bases.

8. Compare and contrast the behaviour of Al^{3+} and Cr^{3+} ions in precipitation reactions with sodium hydroxide. Include equations in your explanation.

Answer:

Both Al^{3+} and Cr^{3+} form insoluble hydroxide precipitates initially:



Both precipitates dissolve in excess NaOH to form soluble anionic complexes:

