

Precipitation reactions using carbonate ions

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

True or false?

1. Sodium carbonate reacts with hexaaqua metal(III) ions to produce carbon dioxide gas.

2. Precipitation reactions only occur with transition metal ions.

3. A solution of iron(III) ions is more acidic than a solution of iron(II) ions.

4. Which of the following is a characteristic reaction of sodium carbonate with hexaaqua complexes?

A) Formation of a precipitate
C) Increase in pH of the solution

B) Release of carbon dioxide gas
D) All of the above



5. Which metal ion forms a green precipitate with sodium hydroxide that dissolves in excess to give a green solution?

- A) Copper(II) B) Chromium(III) C) Nickel(II) D) Iron(II)

Fill-in-the-Blank Questions

6. The pH of a solution containing hexaaqua metal(III) ions is _____ compared to a solution containing hexaaqua metal(II) ions.

7. Carbonate ions react with metal(III) hexaaqua complexes to form a precipitate of _____ and release _____ gas.

8. You add sodium carbonate to a solution of hexaaqua iron(III) ions. Write balanced equations for the reaction and explain the observations.

9. Design a simple experiment to differentiate between a solution of iron(II) ions and iron(III) ions using sodium hydroxide and sodium carbonate. Include expected observations.

10. Why does the pH of solutions containing metal(III) ions differ from those containing metal(II) ions? Use the concept of hydrolysis to explain your reasoning.

11. You are given images of two test tubes: one contains a pale green precipitate, and the other contains a brown precipitate. Which test could you perform to confirm the identity of each precipitate as $\text{Fe}(\text{OH})_2$ or $\text{Fe}(\text{OH})_3$?

12. What would happen if you added excess ammonia instead of sodium hydroxide to a solution of copper(II) sulfate? Explain the observations and write the equations.

Answers

1. Sodium carbonate reacts with hexaaqua metal(III) ions to produce carbon dioxide gas.

Answer: True.

2. Precipitation reactions only occur with transition metal ions.

Answer: False.

3. A solution of iron(III) ions is more acidic than a solution of iron(II) ions.

Answer: True.

4. Which of the following is a characteristic reaction of sodium carbonate with hexaaqua complexes?

A) Formation of a precipitate

B) Release of carbon dioxide gas

C) Increase in pH of the solution

D) All of the above

Answer: D) All of the above.

5. Which metal ion forms a green precipitate with sodium hydroxide that dissolves in excess to give a green solution?

A) Copper(II)

B) Chromium(III)

C) Nickel(II)

D) Iron(II)

Answer: B) Chromium(III).

Fill-in-the-Blank Questions

6. The pH of a solution containing hexaaqua metal(III) ions is _____ compared to a solution containing hexaaqua metal(II) ions.

Answer: Lower.

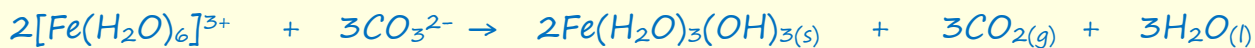
7. Carbonate ions react with metal(III) hexaaqua complexes to form a precipitate of _____ and release _____ gas.

Answer: Metal hydroxide; carbon dioxide.

8. You add sodium carbonate to a solution of hexaaqua iron(III) ions. Write balanced equations for the reaction and explain the observations.

Answer:

Equation:



Explanation: A brown precipitate of iron(III) hydroxide forms, and effervescence is observed due to the release of CO_2 gas.

9. Design a simple experiment to differentiate between a solution of iron(II) ions and iron(III) ions using sodium hydroxide and sodium carbonate. Include expected observations.

Answer:

Add sodium hydroxide drop wise:

Fe^{2+} : Green precipitate of $\text{Fe}(\text{OH})_2$, which darkens on standing.

Fe^{3+} : Brown precipitate of $\text{Fe}(\text{OH})_3$

Add sodium carbonate:

Fe^{2+} : Green precipitate with no effervescence.

Fe^{3+} : Brown precipitate with effervescence (CO_2 released).

10. Why does the pH of solutions containing metal(III) ions differ from those containing metal(II) ions? Use the concept of hydrolysis to explain your reasoning.

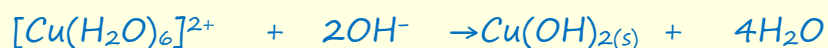
Answer: Metal(III) ions are more highly charged and polarising, so they withdraw electron density from the O-H bonds in coordinated water molecules, making them more likely to release H^+ ions. This increases the acidity (lowers the pH) of the solution.

11. You are given images of two test tubes: one contains a pale green precipitate, and the other contains a brown precipitate. Which test could you perform to confirm the identity of each precipitate as $\text{Fe}(\text{OH})_2$ or $\text{Fe}(\text{OH})_3$?

Answer: Add dilute sodium carbonate. If effervescence is observed, the precipitate is $\text{Fe}(\text{OH})_3$. If no effervescence is observed, it is $\text{Fe}(\text{OH})_2$.

12. What would happen if you added excess ammonia instead of sodium hydroxide to a solution of copper(II) sulfate? Explain the observations and write the equations.

Answer: Initially, a pale blue precipitate of $\text{Cu}(\text{H}_2\text{O})_2(\text{OH})_2$ forms:



On adding excess ammonia, the precipitate dissolves to form a deep blue solution of the tetraammine complex:

