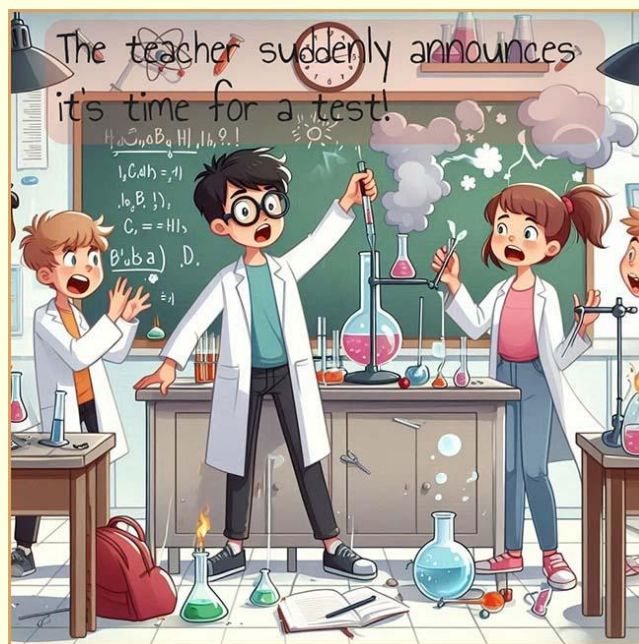


Precipitation reactions using ammonium ions

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

1. What is the primary reason why aqueous ammonia is considered a weak alkali?

- a) It contains a high concentration of hydroxide ions.
- b) It only partially dissociates in water to form hydroxide ions.
- c) It reacts completely with water to form ammonium hydroxide.
- d) It is a poor proton acceptor.

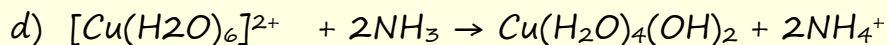
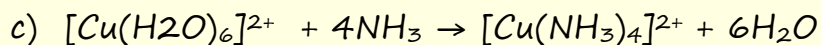
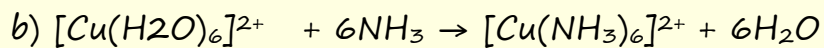
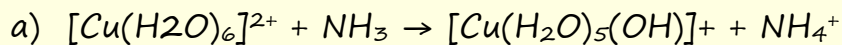


2. When a small amount of aqueous ammonia is added to a solution of copper(II) sulfate, what is observed?

- a) A pale blue precipitate forms.
- b) A deep blue solution forms immediately.
- c) No visible reaction occurs.
- d) A green solution forms.



3. Which of the following equations correctly represents the reaction of aqueous ammonia with hexaaquacopper(II) ions to form a precipitate?



4. What happens when excess aqueous ammonia is added to the precipitate formed in question 2?

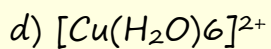
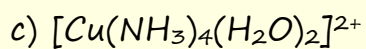
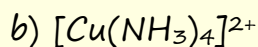
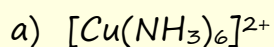
a) The precipitate dissolves to form a deep blue solution.

b) The precipitate remains unchanged.

c) The precipitate turns green.

d) The solution becomes colourless.

5. Which complex ion is formed when excess aqueous ammonia is added to copper(II) hydroxide?



6. In the reaction of transition metal complexes with excess ammonia, what role does ammonia play?

a) It acts as a Brønsted-Lowry acid. b) It acts as a Brønsted-Lowry base only.

c) It acts as a Lewis base (ligand). d) It acts as an oxidising agent.

7. When dilute ammonia is added to a solution containing hexaaquaaluminium(III) ions, what is observed?

- a) A colourless solution forms. b) A white precipitate forms.
c) A blue precipitate forms. d) The solution effervesces.

8. Does aluminium hydroxide dissolve in excess ammonia?

- a) Yes, it dissolves to form a colourless solution.
b) Yes, it dissolves to form a complex ion.
c) No, it remains insoluble.
d) It only partially dissolves.

9. What is the shape of the complex ion $[\text{Co}(\text{NH}_3)_6]^{2+}$

- a) Square planar b) Tetrahedral c) Octahedral d) Linear

10. Which of the following best describes the equilibrium when ammonia dissolves in water?

- a) $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ (Partial dissociation)
b) $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ (Complete dissociation)
c) $\text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$ (Reverse reaction favoured)
d) No reaction occurs.

11. What is the role of the lone pair of electrons on the nitrogen atom in ammonia when it acts as a ligand?

- a) It accepts a proton from a water molecule.
- b) It forms a coordinate bond to a metal ion.
- c) It neutralises hydroxide ions in solution.
- d) It is involved in hydrogen bonding with water molecules.

12. A solution containing hexaaquacobalt(II) ions is pink. What is the colour of the precipitate formed when a limited amount of aqueous ammonia is added?

- A) Green b) Colourless c) Brown d) Blue

13. In the reaction of dilute aqueous ammonia with a hexaqua metal ion, ammonia initially acts as a:

- a) Reducing agent
- b) Ligand
- c) Brønsted-Lowry base
- d) Oxidising agent

14. Which of the following equations represents the ligand exchange reaction when excess ammonia is added to copper(II) hydroxide?

- a) $\text{Cu}(\text{OH})_2 + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_2(\text{OH})_2]$
- b) $\text{Cu}(\text{OH})_2 + 6\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_6]^{2+} + 2\text{OH}^-$
- d) $\text{Cu}(\text{OH})_2 + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2]$
- d) $\text{Cu}(\text{OH})_2 + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + 2\text{OH}^-$

Answers

1. What is the primary reason why aqueous ammonia is considered a weak alkali?

- a) It contains a high concentration of hydroxide ions.
- b) It only partially dissociates in water to form hydroxide ions.
- c) It reacts completely with water to form ammonium hydroxide.
- d) It is a poor proton acceptor.

Answer: b

2. When a small amount of aqueous ammonia is added to a solution of copper(II) sulfate, what is observed?

- a) A pale blue precipitate forms.
- b) A deep blue solution forms immediately.
- c) No visible reaction occurs.
- d) A green solution forms.

Answer: a

3. Which of the following equations correctly represents the reaction of aqueous ammonia with hexaaquacopper(II) ions to form a precipitate?

- a) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + \text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_5(\text{OH})]^+ + \text{NH}_4^+$
- b) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 6\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_6]^{2+} + 6\text{H}_2\text{O}$
- c) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]^{2+} + 6\text{H}_2\text{O}$
- d) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow \text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2 + 2\text{NH}_4^+$

Answer: d

4. What happens when excess aqueous ammonia is added to the precipitate formed in question 2?

a) The precipitate dissolves to form a deep blue solution.

b) The precipitate remains unchanged.

c) The precipitate turns green.

d) The solution becomes colourless.

Answer: a

5. Which complex ion is formed when excess aqueous ammonia is added to copper(II) hydroxide?

a) $[\text{Cu}(\text{NH}_3)_6]^{2+}$ b) $[\text{Cu}(\text{NH}_3)_4]^{2+}$

c) $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ d) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$

Answer: c

6. In the reaction of transition metal complexes with excess ammonia, what role does ammonia play?

a) It acts as a Brønsted-Lowry acid. b) It acts as a Brønsted-Lowry base only.

c) It acts as a Lewis base (ligand). d) It acts as an oxidising agent.

Answer: c

7. When dilute ammonia is added to a solution containing hexaaquaaluminium(III) ions, what is observed?

a) A colourless solution forms. b) A white precipitate forms.

c) A blue precipitate forms. d) The solution effervesces. Answer: b

8. Does aluminium hydroxide dissolve in excess ammonia?

a) Yes, it dissolves to form a colourless solution.

b) Yes, it dissolves to form a complex ion.

c) No, it remains insoluble.

d) It only partially dissolves. **Answer: c**

9. What is the shape of the complex ion $[\text{Co}(\text{NH}_3)_6]^{2+}$

a) Square planar b) Tetrahedral c) Octahedral d) Linear

Answer: c

10. Which of the following best describes the equilibrium when ammonia dissolves in water?

a) $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ (Partial dissociation)

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c) $\text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$ (Reverse reaction favoured)

d) No reaction occurs. **Answer: a**

11. What is the role of the lone pair of electrons on the nitrogen atom in ammonia when it acts as a ligand?

a) It accepts a proton from a water molecule.

b) It forms a coordinate bond to a metal ion.

c) It neutralises hydroxide ions in solution.

d) It is involved in hydrogen bonding with water molecules. **Answer: b**

12. A solution containing hexaaquacobalt(II) ions is pink. What is the colour of the precipitate formed when a limited amount of aqueous ammonia is added?

- A) Green b) Colourless c) Brown d) Blue

Answer: d

13. In the reaction of dilute aqueous ammonia with a hexaaqua metal ion, ammonia initially acts as a:

- a) Reducing agent b) Ligand
c) Bronsted-Lowry base d) Oxidising agent

Answer: c

14. Which of the following equations represents the ligand exchange reaction when excess ammonia is added to copper(II) hydroxide?

- a) $\text{Cu}(\text{OH})_2 + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_2(\text{OH})_2]$
b) $\text{Cu}(\text{OH})_2 + 6\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_6]^{2+} + 2\text{OH}^-$
c) $\text{Cu}(\text{OH})_2 + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2]$
d) $\text{Cu}(\text{OH})_2 + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+} + 2\text{OH}^-$

Answer: d