

Experiment 7

Preparation and Relative Stability of Copper(II) Complexes

Student Handout

Purposes

1. To synthesise tetraamminecopper(II) sulphate(VI) monohydrate ($[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$).
 2. To investigate the relative stability of some copper(II) complexes.
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Background

Many transition metals can coordinate to one or more ligands to form complexes. The stronger the ligand binds to the metal centre, the more stable the complex is. Generally speaking, stronger ligand can displace weaker one in the complex.

In this investigation, you will prepare tetraamminecopper(II) sulphate(VI) monohydrate and perform chemical tests to arrange the stability of copper complex ions, $\text{Cu}(\text{H}_2\text{O})_4^{2+}$, CuCl_4^{2-} and $\text{Cu}(\text{NH}_3)_4^{2+}$, in ascending order.

Tasks

1. Design step-by-step procedures for the synthesis of $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$ and chemical tests.
 2. Write down safety precautions for the chemicals used or produced.
 3. Seek advice from your teacher for your designed synthetic procedures, suggested chemical tests and safety precautions.
 4. Perform the experiment and record your observations/data.
 5. Prepare a report according to your teacher's instruction.
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Safety

Avoid direct contact of chemicals with skin. Dispose of chemical wastes, broken glassware and excess materials according to your teacher's instruction.



EYE PROTECTION
MUST BE WORN

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Safety information on the chemicals used or produced in the investigation are available in the Materials Safety Data Sheet (MSDS). Consult your teacher for details.

Pay special attention when handling corrosive concentrated ammonia solution and inflammable ethanol.

Perform the experiment in a well-ventilated fumehood.

Materials and Apparatus Available

For preparatory work:

Copper(II) sulphate(VI) pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)



Concentrated ammonia solution



Ethanol



Deionised water

Filter paper

Beaker

Filtering flask/suction flask

Büchner funnel

Spatula

* Special items may be provided upon request.

For chemical tests:

All common glassware, chemicals and apparatus in laboratory are available on request in advance.

Questions for Further Thought

1. Describe the differences when dilute and concentrated hydrochloric acids are added to a CuSO_4 solution, respectively.
2. When a large excess of AgNO_3 is added to the following solutions: Na_2CuCl_4 , $[\text{Cu}(\text{NH}_3)_3\text{Cl}]\text{Cl}$, $\text{Cu}(\text{NH}_3)_2\text{Cl}_2$, $\text{Cu}(\text{NH}_3)_4\text{Cl}_2$, which one will produce the largest amount of AgCl solid? Explain briefly.
3. Draw all the possible isomers for the complex $\text{Cu}(\text{H}_2\text{O})(\text{NH}_3)\text{Cl}_2$.



Photos of the experiment are available at <http://www.chem.cuhk.edu.hk/ssc.htm>.

Reference

R. H. Petrucci and W. S. Harwood, *General Chemistry: Principles and Modern Applications*, 7th Ed., Prentice Hall, New Jersey, 1997, pp. 864 - 895.
