Teacher Resource Bank

GCE Chemistry

PSA11: A2 Inorganic Chemistry

- Investigate the chemistry of copper compounds

A2 Inorganic Chemistry

PSA11 Investigate the chemistry of copper compounds

Technical Sheet

Investigate the chemistry of copper compounds

Whenever possible, students should work individually.
If it is essential to work in a pair or in a small group, because of the availability of apparatus, supervisors must be satisfied that they are able to assess the contribution from each student to the practical activity.

Requirements

- copper(II) sulfate solution
- copper(I) oxide powder
- copper(II) oxide powder
- copper powder
- concentrated hydrochloric acid
- dilute sulfuric acid
- sodium carbonate solution
- sodium hydroxide solution
- concentrated (880) ammonia solution
- 1,6-diaminohexane solution (aqueous)

- Two 250 cm^3 beakers
- Test tubes
- Teat pipettes
- Bunsen burner

The concentrations of the dilute solutions in these reactions need to be sufficient to ensure that an obvious reaction takes place. In practice, this is likely to mean 1 mol dm^{-3} for most solutions.

The method refers to test tubes, but Centres may choose to use boiling tubes.

Centres are expected to carry out and be responsible for their own safety risk assessments.

A2 Inorganic Chemistry

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Student Sheet

Investigate the chemistry of copper compounds.

Introduction

Copper is found in small amounts in nature as the free metal, but more commonly in minerals such as copper pyrites and malachite. The separated metal is purified by electrolysis.

Copper forms compounds in which its oxidation state is +1 by the loss of its single 4s electron to leave a filled 3d sub-level. However, the copper(I) ion is unstable in aqueous solution and disproportionates (by simultaneous oxidation and reduction of the copper(I) ion) to aqueous copper(II) ions and copper metal i.e copper(0).

Copper forms the copper(II) ion with an oxidation state of +2 and in aqueous solution it is this hydrated ion which is the more stable and gives rise to the familiar coloured complex.

This series of experiments explores some of the chemistry of copper compounds.

It is the responsibility of the student to carry out and be responsible for their own safety risk assessment before carrying out this experiment. Wear safety glasses at all times. Assume that all of the reagents and liquids are toxic, corrosive and flammable.

Experiment

For each of the following test tube experiments, you should make a neat record of your observations, which should include what is seen before, during and after any reaction that has taken place.

You are advised to prepare a Table to record your observations before carrying out any practical work.

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Part 1 - The reaction of alkaline solutions with Cu(II) ions in aqueous solution.

Place approximately 1 cm^3 of copper(II) sulfate solution into three separate test tubes and label them Tube 1, Tube 2 and Tube 3.

a) Add sodium carbonate solution to Tube 1, dropwise with shaking until in excess.
b) Add sodium hydroxide solution to Tube 2, dropwise with shaking until in excess.
c) **Working in a fume cupboard**, add concentrated ammonia solution to Tube 3, dropwise until in excess. **Do not remove this test tube from the fume cupboard until it has been rinsed thoroughly.**

Part 2 - Cu(II) to Cu(I)

a) Place 10 drops of copper(II) sulfate solution in a test tube and add concentrated hydrochloric acid dropwise **with care** and with shaking until in excess (no further colour change will occur).
b) Add one **small** spatula measure of copper powder to this solution and boil it gently for five minutes.
c) Slowly pour the resultant solution into approximately 50 cm^3 of water in a beaker.
d) Place a small volume of the solution containing the suspended white solid into a test tube and **working in a fume cupboard, quickly** add a similar volume of concentrated ammonia solution. Leave the tube to stand for several minutes and then shake it gently. **Do not remove the tube from the fume cupboard** until it has been rinsed thoroughly.

Part 3 - Ligand Substitution

a) Place 10 drops of copper(II) sulfate solution in a test tube and add an excess of concentrated hydrochloric acid to the tube. Pour the contents of the tube into approximately 50 cm^3 of water in a beaker.
b) Place 10 drops of copper(II) sulfate solution in a test tube and add an excess of 1,6-diaminohexane solution to the tube.

Part 4 - Cu(I) to Cu(II)

a) Place one small spatula measure of copper(I) oxide in a test tube and add approximately 3 cm^3 of dilute sulfuric acid. Warm the contents of the tube carefully.
b) Repeat the experiment with copper(II) oxide and dilute sulfuric acid and compare your results with those from part 4(a).

Teacher Notes and Marking Guidance

The specific marking guidance in the specification is as follows

2 marks: All experiments are carried out competently.
The quantities of reagents are appropriate.
All experiments are carried out safely and with due care.
Nearly all of the observations are correct.

1 mark: One of the areas of the task is performed poorly.
The quantities of reagents are inappropriate **OR**
Some of the experiments are carried out in a careless manner **OR**
Only some of the observations are correct.

0 marks: At least two of the areas of the task are performed poorly.
The quantities of reagents are inappropriate.
Many of the experiments are carried out in a careless manner.
Few of the observations are correct.

Guidance for Teachers

Teachers are expected to exercise professional judgement in assessing the competence of their candidates in following the instructions.

Candidates should have been given guidance in the correct use of equipment and this guidance **can continue during the practical session** for which this PSA forms a part.

If, however, the guidance required is fundamental or frequent, then the student should **not** be awarded 2 marks.

Judgement of 2 marks, 1 mark or 0 marks will depend on whether the candidate

- collects sensible quantities of reagents for each test,
- carries out each test tube reaction with care and with due regard to safety,
- is able to make and record correct observations.
  N.B. For 2 marks "Nearly all of the observations are correct" should be interpreted as two-thirds or more are correct. Correct observations will vary depending on reagents and teachers should either carry out the experiment themselves or make sensible judgements about the acceptable responses.

Student performance should **not** be judged on the basis of their ability to explain the observations or to write the formula of any copper-containing reactants and

products or to write balanced chemical equations. This aspect of their study is an appropriate extension of the practical activity rather than a measure of their practical competence.

It is important to remember when marking these practical exercises that PSA is about student competence and that for a student to score full marks on this exercise **perfection is neither expected nor required**.