Finding the empirical formula by displacement Transcript

The empirical formula of a compound is its simplest possible formula.

It gives the proportions of the elements present, not the actual numbers or arrangement of atoms.

An empirical formula is identified from the mole ratio of the elements in a compound.

This experiment uses a displacement reaction for determining the empirical formula of copper chloride. Empirical means by experiment.

First, the mass of an empty beaker is recorded.

Then one gram of copper chloride is added to the beaker and the mass is recorded again.

25 centimetres cubed of water is measured into a measuring cylinder and added to the beaker.

The mixture is gently stirred with a glass rod until all the solid dissolves, forming a blue-green solution.

The mass of a zinc piece is recorded and (using tweezers) is carefully added to the beaker. The zinc is used to displace the copper in the reaction.

At this point the tweezers are rinsed with distilled water in to the beaker.

This is to ensure that you don't remove any copper ions from the solution with the tweezers.

In order to remove any copper produced the zinc should be scraped with the glass rod.

The reaction has stopped when no more copper forms on the zinc.

Once the reaction has stopped, five to ten drops of hydrochloric acid are added to the beaker.

Using tweezers, the zinc is carefully removed from the beaker.

Scrape the zinc piece with the glass rod until no more copper is present.

The zinc piece is dried with a paper towel.

Then its mass is recorded.

The liquid from the beaker is carefully decanted into a large waste beaker.

The copper that has been produced should be kept.

The copper is now rinsed with ten centimetres cubed of distilled water and stirred.

Rinsing with water removes any zinc chloride present.

Next, the copper is rinsed with ten centimetres cubed of propan-2-ol. This is repeated two more times.

Next, an evaporating dish is wiped clean and its mass is recorded.

The copper is carefully transferred to the evaporating dish using a glass rod.

A small amount of isopropyl alcohol can be used to ensure that all the copper is transferred. This is repeated until all the copper is transferred.

Next, a hot water bath using a beaker is set up and the evaporating dish is placed on it.

When the copper appears almost dry, it is stirred. When it appears completely dry the dish is removed from the water bath and left to cool.

Once cooled, the mass of the evaporating dish containing the copper is recorded.

The evaporating dish is placed back on the hot water bath for another five minutes.

Again the dish is removed from the heat and left to cool and its mass is recorded again.

This process is repeated until a constant mass within the range of 0.04 grams is reached for three heating's. This constant mass is used for the calculations to determine the empirical formula for copper chloride.

First, to find the mass of copper in the anhydrous copper chloride the mass of the empty evaporating dish is subtracted from the constant mass of the evaporating dish containing the copper.

Now the mass of chloride needs to be found.

This is done in two steps.

First the mass of the empty beaker is subtracted from the mass of the beaker containing the anhydrous copper chloride.

Then the mass of the copper produced (calculated earlier) is subtracted from the mass of the anhydrous copper chloride.

This gives the mass of chloride.

The mass of copper and the mass of chloride need to be converted into moles.

To convert the mass of copper in to moles, this important relationship is used.

The mass of copper is divided by its molar mass; 64. The molar mass for any element or compound can be found from the Periodic Table.

Now the mass of chloride is converted into moles using the molar mass for chlorine, 35.5.

The number of moles are now compared by the simplest possible ratio.

This is found by dividing the number of moles for each element by the smallest number of moles. The ratio of copper to chloride is found to be 1 to 2.

Therefore, from experimental evidence, the empirical formula for copper chloride is $CuCl_2$.

Here the empirical formula has been calculated from a displacement reaction.

The relationship between mass, moles and molar mass has been used. This is an important relationship to remember.