

P 5 Analysing water of crystallisation

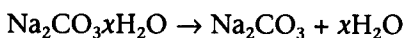
My business supplies washing soda to local laundrettes and hotels. We can't afford to keep the washing soda in our warehouse for long before delivery since the soda can effloresce. That's why we regularly analyse samples for water content. There's also a use-by date on every container for the benefit of our customers.



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Background information

Washing soda is a hydrated form of sodium carbonate. It is a cheap alkali and water softener. It can also be used for cleaning grease and unblocking drains. Washing soda, when new, consists of clear colourless crystals with a formula $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. However, the crystals show efflorescence and lose water to the atmosphere. If they are left for a long time they turn to a white powder, $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$. The sample you have been given will show signs of some efflorescence and should contain between one and ten molecules of water of crystallisation. When these crystals are heated the following change takes place:



Task

You must find the number of molecules of water of crystallisation in a sample of washing soda. Heat a weighed sample of washing soda and drive off all the water of crystallisation. On cooling, record the mass of anhydrous sodium carbonate. From your results, find the number of molecules of water of crystallisation in your original sample.

Make sure that you list all relevant safety precautions before you start the experiment.

Instructions sheet

- 1 Weigh the crucible. If the crucible is dirty add a little dilute nitric acid to loosen impurities. Rinse the crucible and dry by heating it for a few minutes, to constant weight.
- 2 Add a sensible amount of washing soda crystals (say 0.5 g – 5 g). Errors are too great using a small mass, while it is very difficult to remove all of the water from a large bulk of the hydrated salt.
- 3 Reweigh the crucible and salt.
- 4 Heat the crucible strongly. There is no need to use a lid since the solid product is not a low density powder, and is unlikely to be carried out of the crucible by vapour fumes.
- 5 Stir the solid with a small spatula from time to time. This ensures that all of the hydrated salt is dehydrated.
- 6 Allow the crucible to cool and weigh.
- 7 Repeat steps 4 to 6 until the weight of the crucible and its contents is constant.

Sample results

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Complete the following:

mass of crucible =

mass of crucible + washing soda crystals =

mass of washing soda crystals =

mass of crucible + dehydrated salt =

mass of anhydrous sodium carbonate =

mass of water in hydrated salt =

Calculate the number of moles of the two products present using the equation:

$$\text{moles of Na}_2\text{CO}_3 = \frac{\text{mass of Na}_2\text{CO}_3}{M_r(\text{Na}_2\text{CO}_3)}$$

$$\text{moles of H}_2\text{O} = \frac{\text{mass of H}_2\text{O}}{M_r(\text{H}_2\text{O})}$$

Now, convert these numbers of moles to a simple ratio (try dividing each number by the smaller number).

Ratio of Na_2CO_3 : H_2O

1 :

Does the number have to be a whole number?

Write down the formula of the hydrated sodium carbonate.