Determination of the relative atomic mass of calcium

Apparatus list

All chemicals should be labelled with the appropriate safety hazard warning label.

Each student will require:

safety spectacles or goggles
access to chemical data or hazard sheets
access to a balance
access to 10, 25 and 50 cm^3 measuring cylinders,
calcium granules
syringe
small vial
2 x lid 2
Apparatus for measuring displacement of water
20 cm^3 of 2.00 mol dm^{-3} hydrochloric acid
phenolphthalein indicator
balance accurate to **at least two** decimal places but one reading to **three** decimal places is preferable
Microtitration apparatus (microburette + syringe etc.)
For the measurement of gas given off, the apparatus should be set up as shown in the diagram.

NB The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

The calcium is unlikely to be pure and it is essential that **the centre carries out control experiments to obtain specimen results**. The specimen results should be used in assessing the accuracy of the candidates' results.

Determination of the relative atomic mass of calcium (Skills I, A and E)

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however your responsibility to follow suitable safety precautions and to organize your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability.

You will first be required to do the experiments (**Skill I**) and then, under supervision, to calculate the results **(Skill A**) and evaluate the experiment (**Skill E**)

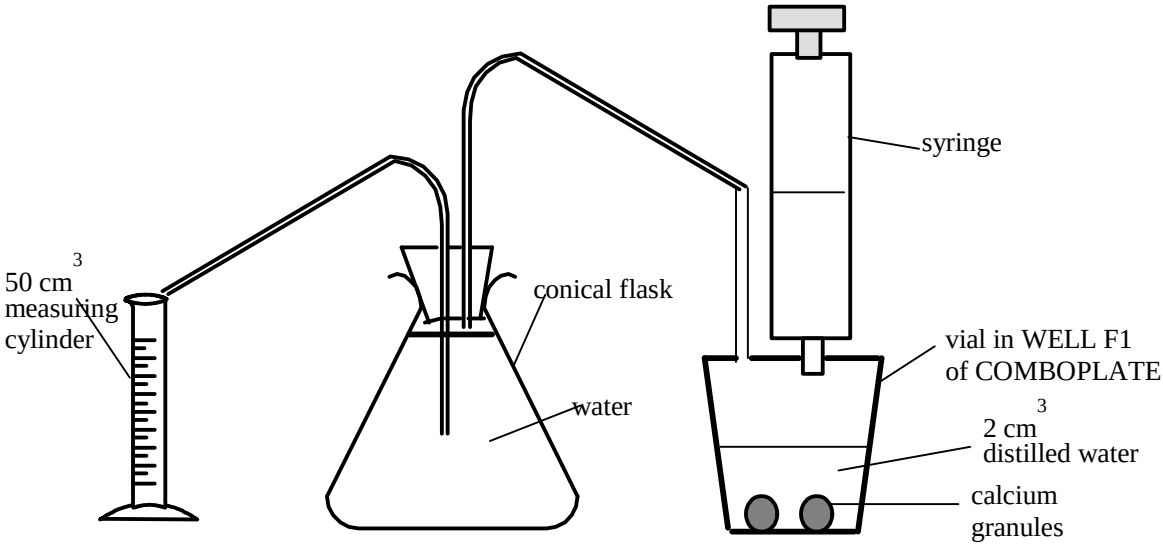
Determination of the relative atomic mass of calcium

Introduction

In this experiment you will determine the relative atomic mass of calcium by two different methods:

- by measuring the volume of hydrogen produced;
- by titrating the calcium hydroxide produced.

Method 1: Procedure



1. Set up the apparatus as shown. **Make sure that the vial for the reaction is completely dry**. **IMPORTANT** – the tube on the conical flask leading from the lid should be the shortened one, otherwise the gas will not displace the water. Also the capacity of the measuring cylinder can be changed for more accurate estimation of the volume of water displaced.

2. Weigh between 0.04-0.06 g of calcium. Record the exact mass of calcium using an appropriate format.

3. Add the distilled water from the syringe.

4. Remove the lid, add the calcium to the vial in Well F1 and then **immediately** replace the lid along with the syringe as shown above.

5. Collect the water displaced by the gas evolved. Record the final volume. Be careful to remove the plastic tubing from the measuring cylinder before making your final measurement.

6. The volume of the tubing from the conical flask to the measuring cylinder can be measured by depressing the syringe from the 2.00cm^3 mark and measuring the volume required to push the water to the very end of the delivery tubing.

KEEP THE SOLUTION IN THE VIAL FOR METHOD 2.

Treatment of results

Assume that 1 mole of gas occupies 24,000 cm^3 at room temperature and pressure.

$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$

Show all of your working clearly

- Calculate the number of moles of hydrogen.
- Deduce the number of moles of calcium.
- Using your values above and the original mass of calcium, calculate the relative atomic mass of calcium.

Method 2: Procedure

1. Remove the lid from the vial in WELL F1.

2. Using either a propette or a wash bottle containing distilled water wash any solid from the lid.

3. Using a micro spatula scrape any white solid off the sides of the vial.

4. Place a bung over the top of the vial and shake the mixture thoroughly to break up any solid present.

5. Using a propette add 2 drops of methyl orange indicator to the mixture in the vial.

6. a) Titrate the mixture in the vial with 2.00 mol dm^{-3} HCl(aq) using the microtitration kit.
   b) Mix regularly using the microspatula.
   c) Note that when the phenolphthalein first changes from red to yellow/orange it is necessary to shake the mixture to make sure that any unreacted solid has reacted.

d) Continue titrating until the methyl orange stays yellow/orange even after vigorous shaking of the mixture.

7. Record your results in an appropriate format.

Treatment of results

$Ca(OH)_2(aq) + 2HCI(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

Show all of your working clearly

- Calculate the number of moles of HCl used in the titration.
- Deduce the number of moles of $Ca(OH)_2$ used in the titration.
- Calculate the number of moles of calcium$_n$present in the solution from Method1.
- Use this result and the original mass of calcium to calculate the relative atomic mass of calcium