TO DETERMINE THE PERCENTAGE BY MASS OF CALCIUM CARBONATE IN AN EGG SHELL

INTRODUCTION:
The aim of this practical is to determine the percentage by mass of calcium carbonate in an egg shell but could in fact be used to determine the amount of calcium carbonate in other samples such as limestone rock or sea shells.

In addition to the stated aim of determining the percentage of calcium carbonate in the shell you are also introduced to the technique of ‘back titration’. Calcium carbonate reacts with hydrochloric acid but it is difficult to determine exactly when all the solid calcium carbonate has reacted to one drop of standard hydrochloric acid solution if it is titrated directly. In this experiment a known amount of excess acid is added to the sample to ensure that all the calcium carbonate has reacted. The excess acid is then diluted and made up to a known volume. Aliquots of this diluted excess acid solution are then titrated with a standard solution of sodium hydroxide.

ENVIRONMENTAL CARE: Because the samples are natural materials and the acids used mainly react to form either calcium chloride or sodium chloride there are no particular environmental issues and the waste can be disposed of down the sink. To save on distilled water this practical uses smaller amounts than more traditional titration experiments.

SAFETY: There are no particular safety hazards except for the usual need for care when handling glassware and 1.0 mol dm$^{-3}$ strength acids.

PROCEDURE:
Carefully wash the shell of an egg to remove any dirt and organic matter attached to it. Dry the shell either in an oven or by using hot air from a hair dryer. Grind the shell into small pieces and weigh accurately about 0.6 g of the shell into a conical flask. Using a graduated pipette add 20.0 cm$^3$ of 1.00 mol dm$^{-3}$ hydrochloric acid solution. Add the acid slowly and swirl the flask to prevent any small amount of liquid escaping from the flask with the carbon dioxide that is produced. Once the reaction has completely finished add about 20 cm$^3$ of distilled water and transfer all the contents of the flask to a 100 cm$^3$ volumetric flask. Use more distilled water to ensure all the contents have been transferred and to make the final volume to exactly 100 cm$^3$. Take 10.0 cm$^3$ aliquots of this solution and titrate them with standard 0.100 mol dm$^{-3}$ sodium hydroxide solution using phenolphthalein as an indicator.

Record all your data in an appropriate way.

CALCULATION:
1. Calculate the amount (in mol) of hydrochloric acid present initially in 20.0 cm$^3$ of 1.00 mol dm$^{-3}$ HCl(aq).
2. Calculate the amount of sodium hydroxide (in mol) present in the volume of 0.100 mol dm$^{-3}$ NaOH(aq) used for the titration.
3. Determine the amount (in mol) of unreacted HCl(aq) present in the 10.0 cm$^3$ sample.
4. Determine the amount (in mol) of unreacted HCl(aq) present in the 100 cm$^3$ solution.
5. Determine the amount (in mol) of HCl(aq) that reacted with the egg shell.
6. Calculate the amount (in mol) of calcium carbonate present in the egg shell.
7. Calculate the mass of calcium carbonate present in the egg shell.
8. Determine the percentage by mass of calcium carbonate in the egg shell.
9. Determine the total percentage uncertainty associated with your result.

DISCUSSION: What assumption(s) have you made about the composition of the egg shell that could have a serious effect on your result if the assumption(s) is/are not true?