Titration transcript

Water is essential for life and most of us get our water from a water tap. However, the quality and properties of water varies around the world, and one property is its hardness.

Hard water is caused by the presence of naturally occurring calcium and magnesium salts in water.

A tell tail sign of hard water is the build-up of limescale around taps and leaking pipes, which if left unchecked can reduce the flow of water and damage pipework

The hardness of water can be measured using a **complexometric titration**. This is a volumetric analysis in which the formation of a coloured complex is used to indicate the end point of a titration.

In this experiment, you will investigate the hardness of water samples taken from rivers around the world. This video will show you how to use a virtual chemistry laboratory to measure the total hardness of these river samples by following the chemical reaction of calcium and magnesium metal ions with EDTA.

In this experiment, you will determine the hardness of water using the **chelating agent** EDTA. This reacts and captures calcium and magnesium metal ions forming a metal complex. This complex is formed in a controlled 1:1 mole ratio, or in other words – one mole of metal ions reacts with one mole of EDTA forming one mole of the metal-EDTA complex. Ammonia **buffer** is used to maintain a pH of 10, ensuring EDTA doesn’t react with any other metal ions in solution.

The end point detection of this complexometric titration is determined by adding a few drops of the **indicator** Eriochrome Black T to the sample. The solution will change colour when there is an excess of EDTA added to the sample, an excess that arises because there are no unchelated calcium and magnesium ions left in the solution.

On the bench you have all the glassware and reagents needed for this experiment.

There is a:

* A burette
* EDTA solution
* De-ionised water
* A 50 ml measuring cylinder
* A conical flask
* A standard solution of calcium carbonate of a known concentration
* A river water sample bottle
* Ammonia buffer
* The indicator Eriochrome Black T
* And a set of Volumetric pipettes of varying sizes.

There is help text available throughout the experiment with detailed instructions on each step of the procedure. It is very important when carrying out this virtual titration that you select items in the order given in the instructions.

Your first task, Task 1, is to determine the exact concentration of EDTA by reacting it with a standard solution of calcium carbonate of a known concentration, in this case the concentration is 0.01 moles per litre. This process is called **standardisation**.

To begin, you will fill the burette with EDTA solution by clicking on the burette and on the EDTA solution.

And when the ‘Next’ button appears, click on it to go on to the next step of the experiment.

Your next task is to prepare the sample. For this you will need the conical flask, the standard solution, the 10 ml volumetric pipette, the deionised water and the 50 ml measuring cylinder.

Once again, once you have selected the required items, click on next to go to the next stage of the experiment.

To complete the sample preparation, click on the ammonia buffer solution, the 2 ml pipette and finally select the indicator. Remember the indicator will change the colour of the sample at the end point of the reaction.

Once again, click on next to advance to the next stage of the experiment,

Once you have selected all the glassware and solutions needed for this experiment you will move onto the actual titration. The burette containing the EDTA has been clamped to a retort stand above the conical flask containing the prepared sample for analysis. To allow you to read easily the volume of EDTA used during your titration, a zoom in view of the burette graduated scale is displayed on the right-hand side of the screen.

The sample in the conical flask must be thoroughly mixed as you add the EDTA solution. On the bench you have a magnetic stirrer that produces a rotating magnetic field so the white magnetic stirring bar immersed in the solution will spin, mixing the solution in the conical flask. Switch on the magnetic stirrer by pressing the green button on the front panel of the stirrer. A zoom in view of the solution in the conical flask will be displayed on the left-hand side of the screen. In the laboratory, if you don’t have a magnetic stirrer, you can instead mix the contents of the conical flask by swirling it by hand.

The indicator added to the solution at pH 10 gives a pink/red colour depending on the concentration of calcium and magnesium ions in the sample. The solution will turn blue when the EDTA has reacted with all calcium and magnesium ions present. Click on the ‘Example’ button to see the colour you will observe just before and just after end point of the titration.

Once you have recorded the initial burette reading, you can open the burette tap by clicking on the rotation button. You can increase the rate of flow with further clicks. By tapping on the rotation button below you can decrease the rate of flow and with further clicks, eventually stop it.

Follow the chemical reaction and determine the end point of the titration by observing the colour change of the solution shown. If you are uncertain about the colour change, you can always click on the example.

Stop the flow when you think you have reached the end point.

Remember to record the final burette reading. For your calculations, you will need to know the total volume of EDTA used in each titration.

When you have completed a titration, you can return to the start and set up another titration by clicking on ‘Next trial’.

It is good practice to do a ‘rough’ titration first to estimate the approximate volume of EDTA required and then carry out the titration more carefully, adding EDTA very slowly as you approach the estimated end point. At the end point the last of the pinkish tinge disappears and a blue color is left. The standardisation of the EDTA solution should be repeated at least twice.

When you have completed a titration, click on the ‘Next trial’ to set up your next titration.

Once you have completed the standardisation process, you’re ready to move onto Task 2. Here you will determine the hardness of a river water sample using your standardised EDTA solution from Task 1. You have a choice of river water samples from around the world, including

* The Avon river in the United Kingdom
* The Tejo river in Spain and Portugal
* The river Seine in France
* The river Rhine in Germany
* The St. Lawrence river in Canada
* The Yellow river in China
* The Kathajodi river in India
* The Orange river in South Africa
* The Arkansas river in the United States of America
* And finally, the Rio Grande in Mexico.

Once you have selected your river water sample, you will use the same titration procedure; but with one important difference – you will use a larger volume for the river water sample, 50.00 ml, instead of the smaller 10.00 ml of standard solution used for standardisation process.