A1. Some reactions between acids and alkalis

Looking at sodium hydrogencarbonate and citric acid
Pupils investigate solubility, acidity and neutralisation.

Task 1
Citric acid is far more soluble than sodium hydrogencarbonate. It is likely that all of the citric acid will dissolve in the water. About 6g of sodium hydrogencarbonate can be expected to dissolve.

Task 2
Citric acid has a pH of <5.

Sodium hydrogencarbonate has a pH of >7.

When the two are mixed effervescence occurs. Pupils may suggest that this could be because a gas/carbon dioxide (because a carbonate has been used) is being produced. This can be tested for using limewater which goes from clear to cloudy. By mixing the volumes suggested on the pupil sheet, it should be possible to see that neutralisation occurs when acids are added to alkalis.

The equation for this reaction is:

citric acid + sodium hydrogencarbonate ⟶ carbon dioxide + sodium citrate + water

How much acid is present in drinks?
Pupils investigate acidity and carry out a titration.

Task 1
All of the suggested foods are acidic to some extent except for water. The inclusion of the juice from fresh fruit is to show that many natural foods are highly acidic. Fresh milk may not give an acidic pH; but with time the production of lactic acid by bacteria causes milk to 'sour' resulting in a solution with pH <7.

Task 2
Pupils carry out a titration to determine accurately the concentration of an acid in a fizzy drink.

SAFTEY NOTE: DO NOT ALLOW PIPETTING BY MOUTH

Hints for the teacher:

- Some of the soft drinks which the students will wish to test contain a range of acidulants, companies such as Britvic will often quote on labels total acidity, as an expression of citric acid.
- Make sure the drinks supplied do contain mainly citric acid rather than other acids such as malic acid, which is found in apple drinks.
- The correct use of burettes is quite a difficult skill and pupils will need guidance if this is the first time that they carry out a titration. If this is the case they should be allowed to practice using the equipment. How to read the burette correctly with respect to the meniscus and the scale must also be explained.
- The end point is taken when the pink colour just remains in the solution.

The standard citric acid solution should take between 7 and 8 cm^3 to be neutralised by the sodium hydroxide. Other results will depend on the drinks tested.

KS4
science
- some prior knowledge about acids and alkalis is desirable.

Timing - 2 or 3 sessions of 40 - 50 minutes to cover all the activities

Two pupil activity sheets A1 accompany this activity

Requirements
Task 1 (per group)
- *30 g citric acid powder*
- *30 g sodium hydrogencarbonate powder*
- *2x50 cm^3 water in small beakers*
- *stirring rods (or access to magnetic stirrer)*

Task 2
- *equal concentrations (4.0 g in 100 cm^3) of citric acid solution & sodium hydrogencarbonate solution*
- *Universal indicator & chart*
- *measuring cylinders*
- *small beakers*
- *apparatus for testing for gases such as carbon dioxide and oxygen*

Task 1
- *Universal indicator & chart*
- *samples of water, cola, fizzy lemonade, blackcurrant juice, orange squash, milk, freshly squeezed juice from oranges/lemons/other fruits*

Task 2
- *250 cm^3 conical flasks*
- *10 cm^3 measuring cylinders/pipettes*
- *distilled water*
- *phenolphthalein indicator solution*
- *burettes*
- *funnels to assist filling of burette*
- *various small beakers*
- *0.1M sodium hydroxide solution*
- *Solution 1: citric acid solution of 7 g/dm^3*
  samples of fizzy drinks; Tango, lemonade, 7Up and limeade all work well; coloured solutions can be used

SOME REACTIONS BETWEEN ACIDS AND ALKALIS

pupil activity A1

The reactions between acids and alkalis are very important reactions in everyday life as well as in both food technology and science lessons.

acid + alkali ⟶ a salt + water

Sometimes other substances are produced depending on the nature of the acids and alkalis which take part in the reaction.

Looking at sodium hydrogencarbonate and citric acid

Sodium hydrogencarbonate (an alkali) and citric acid are often found in food products.

Task 1

You are given 30 g each of citric acid and sodium hydrogencarbonate. You are given 2 beakers each containing 50 cm^3 of water.

Find out how much of each substance you can dissolve in the water. This will compare the *solubility* of the two substances. Do **not** heat the water.

Comment on your findings.

Task 2

You are given solutions of citric acid and sodium hydrogencarbonate. Use Universal indicator to find the **pH** of each solution.

Mix 10 cm^3 of the citric acid solution with 20 cm^3 of the sodium hydrogencarbonate solution. What happens? Use Universal indicator to find the pH of the resulting solution. What gas do you think might be produced when the two are mixed? Devise how you could test for this gas. Write a word equation for the reaction between these two substances.

Present your results in a suitable way.

Explain your findings.

How much acid is present in drinks?

The use of artificial sweeteners in soft drinks has helped to reduce the amount of sugar we eat. This has also reduced the amount of tooth decay. Tooth decay is caused by the production of acids by bacteria in plaque.

Tooth decay should not be confused with tooth erosion. The acids found in many of the foods and drinks we eat can cause the loss of tooth enamel. This is known as erosion. The frequent exposure of teeth to any acidic food or drink may cause this chemical erosion.

Task 1

Use Universal indicator to find out the pH of a range of drinks. Make sure you test tap water, cola, fizzy lemonade, blackcurrant juice, orange squash, milk and freshly squeezed orange or lemon juice.

Present your results in a suitable way.

SOME REACTIONS BETWEEN ACIDS AND ALKALIS

Task 2

The acid that is used in most fizzy drinks is citric acid. It is quite easy to determine the acidity of drinks using a technique called **titration**.

You are given a number of solutions. Find how much citric acid is in each.

SAFETY - REMEMBER TO WEAR GOGGLES
PHENOLPHTHALEIN SOLUTION IS FLAMMABLE AND HARMFUL
SODIUM HYDROXIDE SOLUTION IS AN IRRITANT

Method

1. Measure accurately 10 cm^3 of solution 1 into a conical flask.
2. Add about 15 cm^3 of distilled water to the flask.
3. Add 5 drops of phenolphthalein to the flask. Swirl the flask carefully to mix the contents of the flask.
4. Fill the burette to a convenient point with sodium hydroxide solution. Sodium hydroxide solution is an alkali. (Your teacher will show you how to use a burette properly.)
5. Slowly and carefully add the sodium hydroxide solution to the flask. Swirl the flask carefully after each addition.
6. Keep adding the sodium hydroxide until the pink colour just remains after swirling. Carefully read from the burette how much alkali you added.
7. Repeat the titration (steps 1 - 6) another 2 times. You will then be able to work out, from the three* readings, an average volume of sodium hydroxide added.
8. You can find out the total acidity of the solution using the following equation. The amount of acidity will be expressed as the amount of citric acid:
   amount of citric acid = 0.64 x volume of sodium hydroxide g per dm^3.
9. If there is time, repeat the titration using another drink in place of solution 1.
10. Write up your investigation.
    Present your results in a suitable way.
    Comment on your results.
11. If your teeth are in contact with acidic foods, not just fizzy drinks, tooth erosion may occur. Think of any advice you could give to individuals who like to drink acidic drinks so that the effects of the acid are minimised.

Phenolphthalein is an indicator. It is colourless in acids. It will change to pink in alkalis.

You will notice that a pink colour appears when the sodium hydroxide is first added to the flask. This disappears when you swirl the flask as the alkali reacts with the acid.

*Do not include the reading from the first titration if this was much larger than the second two.