11-14s / 14-16s LESSON 3 (flexible)

HOW CAN WE GENERATE THE MOST FIZZ?

This lesson offers a fun and flexible way to review and explore acids, alkalis, soluble bases and neutralisation. Use the ideas below to adapt your delivery for upper KS3/CfE 3rd level or KS4/CfE 4th level students.

In the lesson students review their understanding of acids, alkalis, soluble bases and neutralisation. They use an online interactive experiment to measure and mix the ingredients for fizzing bath bombs – everyday toiletries that rely on the neutralisation of a carbonate or hydrogen carbonate base to release carbon dioxide.

Students use the interactive tool to identify the optimum ingredient mix for maximum fizz, thinking of the balance of ingredients for complete neutralisation.

You can optionally extend this lesson to include a practical activity to make and test mini bath bombs!

TOPIC AREAS

- Acids, bases, alkalis and neutralisation
- pH and indicators
- Practical skills
- Applications of science

LEARNING OUTCOMES

Students will be able to:

- Explain neutralisation and recall that the products of a neutralisation reaction are a salt and water.
- Identify that when the reaction is with a carbonate or hydrogen carbonate, carbon dioxide is also formed.
- Complete a 'virtual' practical activity to make and test a bath bomb, to measure the volume of carbon dioxide released and measure the pH of the remaining 'bath water'.

Older and more able students may also be able to:

- Complete a word equation for the neutralisation reaction taking place.
- Carry out a mini bath bomb practical.

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RESOURCES

FROM THIS PROGRAMME

11-14s / 14-16s flexible lesson 3: activity sheet 1 (one per student)

11-14s / 14-16s flexible lesson 3: PPT presentation

Students will need access to ICT facilities with an internet connection, ideally one computer per pair.

FROM YOUR LAB

We recommend you demonstrate the reaction that happens when a full sized bath bomb is dropped into a water container. Bath bombs are available from many shops selling toiletries and cosmetics. However, you do not need any lab equipment if using the online interactive experiment only.

If you want to extend this lesson to carry out your own mini bath bomb experiment you will also need the following:

Per pair of students:

- Citric acid, 5g
- Sodium bicarbonate, 5g
- Electronic scales (accurate to 0.1g)
- Disposable gloves
- Conical flask
- Bung and delivery tube
- Water trough
- Beehive shelf
- Gas jar

(Set up detailed on activity sheet)

PPE as required by your school, eg eye protection.

PREPARATION

You will need to book ICT facilities so each pair of students can use the online interactive experiment. We recommend you try the online activity yourself to become familiar with how it works.

If carrying out a demonstration, you will need one bath bomb to demonstrate to students, and a suitable water container in which to drop it, preferably one with clear sides. You may also want to use indicator strips or UI solution to test the final pH of the water once the bath bomb has dissolved. Try testing this first – with some bath bombs the reactants may naturally buffer leading to no significant change in pH.

Students should be familiar with acids, alkalis, bases and neutralisation. Adapt the content and your delivery to suit the age and ability of your students.

SAFETY

There are no safety considerations for the core lesson, which uses an online interactive experiment.

If students are going to make real bath bombs as an extension activity we recommend students wear eye protection. Follow your school's risk assessment and safety procedures for this activity.

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STARTER

1. If carrying out a demonstration with a full-sized bath bomb, hold it up so that students can see. Explain that it's mainly a mixture of two chemicals: citric acid and sodium bicarbonate (you may want to write these on your whiteboard and emphasise the underlined words). Ask if students can recognise what two types of chemicals these are. The first should be easy – an acid – while students should also recognise that a carbonate is a form of base (and since it's soluble in water, it's an alkali).
2. Ask students to work in pairs to review what they can recall about the reaction between acids and bases.
3. Students should recognise that this is a neutralisation reaction, to form a salt and water (and because the alkali is a carbonate, carbon dioxide as well). Show **slide 1**.
4. Older students should recall that the acid releases H+ ions while the alkali releases OH- ions. These join to form water and the 'leftover' halves of their molecules react to form the salt and water. Show **slide 2**.
5. Challenge older or more able students to complete the word equation for this:

   Citric acid + sodium bicarbonate ⟶ sodium citrate + carbon dioxide + water
6. Ask students why no reaction takes place when the bath bomb is made? The answer is that the ions need to be mobile in solution so they can combine to form new compounds. While a tiny amount of water is sometimes added to help bath bombs bind together, the bombs are essentially dry, so no reaction can take place.
7. If carrying out a demonstration, release the bath bomb so that students can see the reaction take place. Ask students to suggest what can happen when the reaction is unbalanced. That is, there is more of one reactant than another (eg more citric acid than sodium bicarbonate, or vice versa). What could students test to see if there is any of one reactant left over? The answer is that they could test the water using universal indicator or indicator strips. You can test the water and identify the final pH – the plenary addresses why it ends up as it does. Note that the reactants may naturally buffer leading to no significant change in pH.

MAIN ACTIVITY

1. Show **slide 3** and discuss.
2. Show **slide 4**. Brief students that they are going to complete an interactive experiment online, to make and test bath bomb recipes to find the one with the most fizz. Explain that this is an important product quality consumers enjoy, along with the fragrance and colour of the bomb.
3. Ask students to suggest how they might measure the 'fizz' scientifically, to compare each bath bomb formula.
   - They could capture the carbon dioxide released, for example in an upturned measuring cylinder full of water.
   - They could measure the volume of gas by finding out how much water is displaced, for example reading the starting and finishing level of the water surface along the scale on the measuring cylinder.
4. Show **slide 5 (animated)**. Review the interactive tool and the main steps students should take:
   - Select an ingredient formula.
   - Measure each ingredient – students will only be able to move to the next screen when their measurements are accurate.
   - Mould the bath bomb.
   - Begin the reaction.
   - Test the pH level of the solution left after the reaction has taken place.
5. Students complete the interactive experiment. Depending on time, students can repeat for different formulae to generate a results chart, or complete one formula per pair and share results.

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PLENARY

1. Explore the results as a class using **slide 6** to help you. Which mixture generated the most fizz, and did all students obtain the same results?
2. Help students identify that to obtain the greatest amount of fizz, the greatest amount of sodium bicarbonate must react to release carbon dioxide (this should have happened with the 1:1 ratio mixture).
3. Optionally, if your pre-lesson test showed a good pH change, discuss the final pH of the water.
   - Normally water would be around pH7 (neutral).
   - All the final pH readings were acidic but two were almost neutral – see if students can spot that this indicates all the citric acid was used up in those reactions.
   - In the other three reactions the excess citric acid made the water more acidic.
   - Emphasise that this would be the case for real bath bombs but in a large volume of water this effect may not be noticeable due to buffering and the dilution factor.

DIFFERENTIATION IDEAS

EASIER

Less able students can 'prepare and test' one bath bomb formula using the online interactive experiment. Tailor your use of theory to suit the class.

MORE CHALLENGING

More able students can 'prepare and test' several or all bath bomb formulae using the online interactive experiment. Tailor your use of theory to suit the class.

Students could complete the practical and try a real experiment to capture and measure the carbon dioxide they release.

EXTENSION IDEAS

Students can test mini bath bombs by combining the ingredients listed in resources, using the suggested ratios and weights in the table below. These are equivalent to the figures in the online interactive, but scaled down to a tenth of the amount. Use **activity sheet 2** if carrying out the practical experiment.

Students can add their mini bath bombs to water to see how well they work and could experiment with capturing and measuring the carbon dioxide given off, as in the online interactive tool. Students can make and test one sample, or a range, dependent on their ability.

They'll need to carefully measure out the correct amounts, and then mix them together thoroughly, being careful to keep the mixture completely dry (or the reaction will begin).

The samples can then be measured using a conical flask and gas jar, as per the diagram on **activity sheets 1 and 2**. This will only work for small samples as a whole bath bomb will produce several litres of carbon dioxide.

FORMULA	RATIO	SODIUM BICARBONATE (g)	CITRIC ACID (g)	CARBON DIOXIDE (cm3)	SAMPLE RESULTS (pH)
A	2:1	3.4	1.6	252	6.58
B	1:1	2.5	2.5	304	5.72
C	1:2	1.6	3.4	204	3.84
D	4:1	4.0	1.0	130	6.95
E	1:4	1.0	4.0	100	3.08