What is stuff made of? Exploring matter, atoms and elements

Learning objectives

1 Recall that matter is made from atoms

2 Compare the size of atoms with small objects that we can see and other objects which are too small to see with the naked eye

3 Describe that atoms are the smallest parts of an element and that they retain the properties of that element using observations from a demonstration

4 Make deductions about the nature of atoms from a series of observations

Success criteria

LO1 and LO2 are assessed through the 'it's a small world' section of the resource. LO3 is assessed through the observation and explanation of these observations from the 'atomic paper clips' demonstration. Finally, LO4 is achieved through deductions from observations of an investigation entitled 'tasty particles'.

Introduction

This resource introduces learners to the idea that all matter is made from tiny particles called atoms. It begins by connecting the concept of matter to learners' everyday experiences, encouraging them to recognise that everything around them is made up of matter.

The resource then develops the idea that matter is made from atoms, the extremely small building blocks that make up everything in the universe. Because atoms are far too small to see with the naked eye, learners are supported to think about their scale through comparisons with familiar, visible objects as well as other entities that cannot be seen directly but are known to exist. Learners are also introduced to the concept of elements as different types of atoms, each with their own properties.

Through these activities, learners will develop an appreciation of the tiny scale of atoms and begin to build a conceptual understanding of how different atoms combine to form the wide range of materials found in the world around them.

Scaffolding

There are two versions of the student worksheet: scaffolded (✪) and unscaffolded (✪✪). The scaffolded sheet offers more support to allow learners to access the questions.

For example, learners are asked to choose from a series of prepopulated answers or to fill in gaps in questions that require longer answers. Some questions have more information to aid learners' understanding.

Technician notes

Read our standard health and safety guidance (rsc.li/3zyJLkx) and carry out a risk assessment before running any live practical.

Equipment

Introduction teacher demonstration

- 1 kg bag of rice

Atomic paperclips teacher demonstration

- A pile of paper clips – approximately 100 small ones
- A sheet of aluminium foil

Tasty water class practical

- Plastic drinking cup with rings marked at about 1/3 and 2/3 of the way up the side (1 per group)
- Drinking straws (3–4 per group depending on group size – one per learner)
- Dropping pipette (1 per group)
- Lemon juice (20 drops per group)
- Sugar (1 teaspoon per group)
- Access to a source of drinking water

Safety and hazards

- The class practical should be completed in a classroom that is not a laboratory. There should be no drinking in a science laboratory.
- Each group may designate a single 'taster' if they do not wish to taste from the same cup. Each individual 'taster' should have their own straw.

Method

For the 'Atomic paper clips' demonstration

Time required: 10 minutes

1. Place the pile of paper clips and the aluminium side by side.
2. Start with the paper clips.
3. Divide the paper clip pile roughly in half, making two smaller piles.
4. Repeat the division until there are two paper clips, and then, finally, only one paper clip.
5. The single paper clip represents an atom.
6. Now split the paper clip into two pieces. Invite learners to think up names for these, such as 'hook' and 'centre'.
7. Now pick up the aluminium sheet.
8. Tear the sheet into two halves.
9. Repeat the tearing until the pieces cannot be torn into any smaller pieces.
10. Ask learners to answer the questions on the Powerpoint slides, or on the worksheet, as you are doing the demonstration.

For the 'Tasty water' class practical

The method is also given on the student worksheet.

1. Taste the water
   - Fill the cup with water to 1 cm from the top.
   - Use the straw to taste the water in the three sections of the cup – above the top mark, between the two marks and below the bottom mark.
   - Write down what it tastes like at each level.
   - Refill the cup.
2. Add lemon juice
   - Add about 10 drops of lemon juice to the water.
   - Taste the water again at the three levels.
   - Write down what it tastes like at each level.
   - Keep the water for the next step.
3. Add sugar
   - Add one teaspoon of sugar to the water.
   - Don't stir. Let the sugar settle.
   - Taste the water again at the three levels.
   - Write down what it tastes like at each level.
   - Keep for the next step.
4. Wait and taste again
   - Wait for 2 minutes.
   - After waiting, taste the water at the three levels.
   - Write down what it tastes like at each level.
   - If you can, wait even longer and taste again.

Teaching sequence and notes

Introduction and demonstration (slide 3)

Introduce the topic and the purpose of the session, using a 1 kg bag of rice. Ask learners to guess how many grains of rice there are in the bag. After a few suggestions, give a clue – that there are about 1000 grains in 25 g. (1 million grains would be 25 kg, so 1 kg is 1 million ÷ 25 = 40,000.) Say that rice grains are 'small' and ask, 'How much smaller are atoms?'

Activity 1: It's a small world! (slide 5)

Then ask learners to answer the questions in the 'it's a small world' section of the worksheet. After a couple of minutes, invite learners to share their responses to question 1 before giving them the actual answer (the number of hydrogen atoms in 1 cm is 1.35×10^6). Again, give learners time to answer question 3 before displaying the completed table (slide 7). They need this to be able to answer the rest of the questions.

Activity 2: Atomic paperclips (Slide 8)

Introduce the next activity, which allows learners to find out more about what atoms are like. Carry out the demonstration 'Atomic paper clips' and then give learners time to complete the questions related to the demonstration (slide 9). Allow learners to peer- or self-assess their answers. While they are doing this, reinforce the idea that atoms are very small and retain the property of the element, but the subatomic particles do not.

Activity 3: Tasty particles (slide 10)

Introduce the next activity 'Tasty particles', which enables learners to find out more about how particles behave. Set the scene by telling learners that they are going to add sugar and lemon juice to water to see how the taste changes. Give each learner the worksheet 'Tasty particles' and give each group a set of equipment.

After the practical, allow learners time to complete the follow-up questions (slide 13). When learners are peer- or self-assessing their answers, reinforce the idea that particles can move through water and that not all particles are the same.

Answers to follow-up questions

It's a small world!

1. About 1.35×10^6 (over 1 million) hydrogen atoms would be alongside each other in 1 cm.
2. This tells you that atoms are incredibly small.
3.

Small object	Can it be seen with the naked eye?	Approximate size
Red ant	Yes	~3 mm
Pin head	Yes	~1–2 mm
Poppy seed	Yes	~1 mm
Grain of sand	Yes	~0.5 mm
Grain of table salt	Yes	~0.3 mm
Dust mite	Barely visible	~0.3 mm (300 µm)
Human hair (diameter)	Barely visible	~17–181 µm
Human egg cell	No	~100 µm
Pollen grain	No	~30–100 µm
Skin cell	No	~30 µm
Red blood cell	No	~8 µm
Bacterium	No	~2 µm
Mitochondrion	No	~1 µm
Virus	No	~100 nm
Ribosome	No	~20–30 nm
DNA (width)	No	~2 nm
Water molecule	No	~0.3 nm
Atom	No	~0.2 nm

4. Grain of table salt. About 0.3 mm.
5. Our eyes are not sensitive enough.
6. Atoms.
7. They are very small.

Atomic paper clips

1. One paper clip.
2. Yes, because it can still perform the same function.
3. Names for the paperclip might be hook and centre. Parts of an atom are proton, neutron and electron.
4. No, the paper clip is not useable. A broken-up atom would not be useable as an atom.
5. An atom of aluminium.
6. We cannot use our hands to tear pieces that small.
7. Yes, because it will still consist of metal atoms.
8. We need to use a very powerful microscope.
9. Yes, into subatomic particles.
10. No, because they are no longer metal atoms.

Tasty particles

1. They have different tastes so must be different particles.
2. Particles are able to move in water.
3. Matter is made of atoms which are too small to be seen with the naked eye. Atoms are the smallest parts of elements. An atom retains the property of the element. Particles can move.