

## Intriguing ice

**Intriguing ice demonstration:** A demonstration video can be viewed at [rsc.li/36xMyvY](https://rsc.li/36xMyvY). The demonstration video shows what four different liquids look like when they have been frozen. In this investigation, learners can try freezing familiar liquids and are asked to explain what they see using scientific vocabulary.

**Age group:** 7–9

### Learning objectives

- To describe the properties of solids, liquids and gases.
- To understand that materials change state when they are cooled.

Enquiry skills:

- To practise making predictions, observing and recording changes that occur over a period of time, and interpreting and communicating results.

### Background science

Learners are familiar with many liquid mixtures, eg fruit juices, milk, fizzy drinks, honey, syrups, liquid soaps and oils. However, they may not be aware that these liquids consist of a mixture of substances. By comparing what happens when these liquids freeze, learners begin to appreciate that liquids can contain other substances and that these substances might be gases, other liquids or even dissolved solids.

*NOTE: In the English National Curriculum, learners are not usually taught about dissolving until Year 5 (ages 9–10). The focus of this investigation is to explore and explain the freezing process and not to explain dissolving.*

### Prior learning

Learners should be able to compare and group materials according to whether they are solids, liquids or gases.

### Links

Other investigations exploring the properties of solids, liquids and gases include [Biscuit bashing](#) and [Racing liquids](#).

### Key words and definitions

**Solid** – a state in which a substance has a definite volume and shape.

**Liquid** – a state in which a substance flows and takes up the shape of its container.  
Note: even though they can be poured, sugar, salt and flour are all solids.

**Gas** – a state in which a substance expands to fill its container.

**Freezing** – the change of state from a liquid to a solid at a temperature called the freezing point.

**Viscous** – thick and sticky, a liquid that flows slowly.

**Dissolving** – the process of mixing a substance in a liquid until the substance can't be seen.

**Solution** – a uniformly distributed mixture of a liquid with a gas or a solid.

Teachers may wish to hide the meanings/examples on the PowerPoint slide and discuss the learners' ideas first.

### Equipment list

- Access to a freezer
- Plastic beakers
- Spoons
- Water
- Salt
- Sugar
- Food colouring
- Fizzy drink
- A variety of liquids that learners can handle and freeze, eg shampoo, vinegar, cooking oil, fruit juices and honey

Access to freezer – this could be in a staff room, school kitchen or at home. Note that there is no risk to health because none of the liquids that will be frozen are unfit for human consumption.

### Method

#### Optional starter: Odd one out

This activity should initiate a discussion of the properties of solids and liquids.

1. In small groups, provide a beaker of water, a beaker of salt and a beaker containing a ball of play dough or plasticine (or refer to the images on slide 5).
2. Ask the learners to list the similarities and difference between the substances in the beakers.
3. If they get stuck, prompt them to think about the shape of each one, how they move and how they might change.
4. Ask the learners to decide which is the odd one out and why. Encourage a reason for every answer. There is no wrong answer!

### Investigation

Create a 'living model' of a solid, liquid and gas. Learners represent particles:

- solid (rows of learners, left hand on shoulder of person on left, right hand on shoulder of person in front) – learners (particles) create a fixed shape;
- liquid (learners let go of person in front, rows remain linked) – learners (particles) remain closely linked but rows can move, so liquid can flow;
- gas (learners unattached) – full movement is possible.

Show learners the demonstration video or create your own frozen samples to show them.

Ask the learners what other liquids they know and make a list.

*NOTE: learners often list drinks but may not consider other everyday liquids, eg cooking oil, shampoo, toothpaste.*

Discuss/demonstrate how to make solutions containing salt, sugar and food colouring and decide in advance what other liquids you would like learners to explore and how to organise this.

Making a solution:

1. Fill a beaker with water, leaving at least 1 cm space at the top.
2. Add either 1 teaspoon of salt or sugar, or 2–3 drops of food colouring.
3. Stir.

Ask the learners to predict what they think will happen if they put these liquids in the freezer.

Freezing liquids:

4. Along with the solutions created, provide beakers (or, for example, yoghurt pots) and a variety of liquids for learners to create samples, and agree a protocol for accessing a freezer.
5. Freeze the samples. You may decide to check on the liquids at regular time intervals and/or leave overnight.
6. Return samples to learners. They could record their predictions and observations using annotated diagrams, orally or in written form.

Using their observations, ask learners to explain what they think has happened.

### Question prompts

1. Can you think of any liquids found in your kitchen/bathroom at home?
2. How do you know the solid (sugar/salt) has dissolved in the water?  
*You can't see it.*
3. What might affect how quickly a liquid freezes?  
*Possible answers: the volume of liquid, what the beaker is made from, the thickness of the walls of the beaker, the temperature of the freezer, the type of liquid.*
4. Can you describe the substance in the beaker?
5. Does it look similar to its liquid form?
6. Did the liquid freeze?
7. Have you noticed any patterns in how the liquids have frozen?

### FAQs

- 1.** Why didn't the substance (eg oil) freeze?  
*Some liquids harden without forming a crystalline structure, eg glass, oils. Oils consist of molecules in long chains (usually a mixture of sizes and shapes) which make it hard for oil to form a regular crystal structure. Eventually, when the oil is cold enough, the molecules lose the energy they need to move around and the oil will harden, but there is no sharply defined freezing point like there is for water.*
- 2.** How cold is a regular freezer?  
*-18°C*
- 3.** Where has the carbon dioxide in the fizzy drink gone?  
*The carbon dioxide gas bubbles are still present in the middle of the frozen drink because the water in the drink has frozen around the gas bubbles. The holes you see at the edges of the solidified drink are where carbon dioxide gas has escaped into the air.*
- 4.** Will a gas (eg carbon dioxide) freeze?  
*Carbon dioxide is a gas at room temperature and it freezes solid at -78°C. Liquid carbon dioxide does not occur at normal atmospheric pressure. If they get cold enough, other gases can become liquids at normal atmospheric pressure, eg helium at -269°C, oxygen at -219°C.*
- 5.** Is shampoo (or other similar substance) still good to use if it has been frozen?  
*The scents (gases we smell) may be lost during the freezing process. Dissolved preservatives may be pushed into one area, leaving other areas with less preservatives and more likely to grow bacteria.*