# Racing liquids

**Racing liquids demonstration:** A demonstration video can be viewed at rsc.li/3xESWxf

The investigation allows learners to explore the difference in viscosity of different liquids.

**Age group:** 7–9, 9–11

## Learning objectives

- To understand that viscosity is a measure of a liquid's resistance to flow.
- To recognise viscosity as a useful property of liquids.
- To understand that liquids can be ordered by their viscosity.

Enquiry skills:

- Be able to set up a comparative test to consider how different types of liquid flow at different speeds.
- To recognise that a comparative/fair test has variables which can be changed and controlled.
- To record observations and explain what has been found.

## Background science

Learners are exposed to liquids frequently in their everyday lives. They will already be aware of the flow of liquids. This investigation invites them to think about how to test and measure this flow.

Viscosity is a measure of how much a liquid resists changing shape or flowing. Learners may already have noticed how some liquids are difficult to pour from containers (eg ketchup from a bottle). They will have experienced squeezing toothpaste from a tube (but may not have considered this to be a liquid before). This can be broadened to think about larger quantities of liquids such as sewage flowing through pipes.

## Prior learning

Learners should know that force (a push or a pull) on an object can change its shape or movement.

They should understand that friction occurs when materials rub against each other to oppose motion.

Learners should have been introduced to comparative or fair testing. They should be aware of what can be changed (the 'variables') and whether this might make a difference to the outcome.

They should understand that changing one variable (the independent variable) may have an effect on another (the dependent variable).

## Links

Other investigations exploring the properties of solids, liquids and gases include Biscuit bashing and Intriguing ice.

## Key words and definitions

**Viscosity** – a measure of a liquid's resistance to flow (the runniness or flow of a liquid).

**Resistance** – in this context is 'fighting back' against flowing.

**Friction** – a force that acts to slow down (oppose) movement.

In a simple example, water has a low viscosity, as it is 'thin'. Honey, on the other hand has a high viscosity, as it is 'thick'.

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

## Equipment list

- A selection of household liquids. Ideally these will be similar in colour (eg yellow). You should place 100–150 ml (approx. ¼ of a small cup) of each liquid in plastic cups in preparation for the investigation. Examples might include:
  - Syrup/treacle
  - Liquid soap
  - Vinegar
  - Tomato ketchup
  - Brown/other sauces
  - Hair conditioner
  - Water (you could colour this to be more similar in colour to the other liquids used)
  - Shampoo
  - Cooking Oil
  - Gravy
  - Cocoa
- Clear plastic cups. Tape these together with a measured amount of liquid in the bottom cup. Ensure that they are well sealed so that liquid cannot escape.

## Method

Begin by asking the learners what they know about liquids and their properties. Record and display their responses.

Introduce the word *viscosity* and explain that this is how easily a liquid flows. The learners are going to 'race' liquids to find out which flows the slowest. Before explaining the method, discuss with the class the aim (finding out which liquid flows fastest/slowest) and how you can keep this as fair a test as possible. Invite learners to consider the following points:

- How will you start the race?
- How many times will you carry out the test?
- How will you record your findings?
- What will you change and what will you keep the same?
- Can you order your liquids by viscosity?

You should guide the learners to think about variables – anything that could be changed in the experiment that might affect the outcome. It is useful to start by asking learners to identify *everything* that they think could be **changed** (eg shape/size of the cups, type of liquid, volume of liquid, temperature of the liquid) and *everything* that could be **measured** (eg how quickly the liquid flows, how far the liquid flows in a given time).

In this experiment, learners will **change** the type of liquid – this is the **independent** variable.

Learners will measure the time it takes for all the liquid to travel from one cup to the other – this is the **dependent** variable.

All other variables [the amount (volume) of liquid, the size/shape of the cups, the temperature of the liquids] must be **controlled** (ie must remain the same each time). This makes it a fair test.

Older learners should be introduced to these terms, but it is more important that they understand the process than remember the names of the variables!

Younger learners should be introduced, simply, to the term variable as anything that can be changed and shown how these are changed, measured, and controlled.

You should decide in advance whether you have time (and enough equipment) for each group to repeat their tests more than once, or whether you want each group to test the same liquids and then share their results. Talk to the learners about the importance of repeating a fair test to see whether results are consistent. If they will be repeating the test more than once, they should consider the time they should leave between tests. Why do they think this is important? If necessary, show them how some liquids 'stick' to the container as they are poured.

**Method**

Group learners in fours and provide each group with a selection of four liquids to test, in taped cups. (You may decide to leave out water as learners know that it has the lowest viscosity or is the thinnest liquid.)

1. Each learner will race the three others. First, learner 1 races 2, while 3 races 4.
2. They simply upend their cup at the same time and observe closely until all of the liquid has flowed from one container to the other. They should record which liquid was faster and which was slower.
3. Next, learner 1 races learner 3, while 2 races 4. Again they record the faster and slower liquids.
4. Finally, learner 1 race learner 4, while 2 races 3. They record these final results.

5. The group should be able to arrange the liquids in order of viscosity from lowest (fastest) to highest (slowest).

If all groups have the same liquids then the results should all be identical. If not, encourage learners to consider what they need to do to order all the liquids in the class.

It is helpful to put a time limit on the activity and to give learners a countdown towards a time when they need to have their results ready to share with the class.

## Question prompts

1. Can you explain what is happening in the races?
   *Different liquids flow differently according to their viscosity.*
2. Why do you think each liquid behaves differently?
   *Teachers will need to encourage learners to give reasons why liquids are more viscous than others. For younger learners, it could be enough for them to share their understanding that some liquids are thicker than others and find it more difficult to move. For older learners, it may be appropriate to explore their ideas about friction between surfaces and to introduce the idea that there is friction inside some liquids, or even that there are forces between the particles of a liquid.*
3. How much of a fair test were our races?
   *Learners can be encouraged to reflect on issues such as start times, how much the cups were tipped up, differences between individuals or groups, and amount of liquid used.*
4. Which is our independent variable (what are we changing)?
   *The type of liquid.*
5. Which variables are we keeping the same (controlled)?
   *Amount of liquid, size and shape of container.*
6. What is the dependent variable (what are we measuring)?
   *The rate/speed of liquid flow.*
7. Can you order the liquids by their viscosity?
   *Thicker liquids will generally be more viscous than thinner ones.*
8. Can you think of other liquids we could test with similar viscosity to those we have looked at?

**Extension**

9. Can you think why some liquids flow more quickly than others?

   *Liquids are all made up of particles or molecules. 'Cohesive force' between the particles or molecules of the same type causes them to be attracted to each other. This creates 'internal friction' within the liquid – learners will know that friction slows movement.*

   *A liquid with high viscosity will have high cohesive forces and a low flow rate, eg honey, whereas water, which has low viscosity, will have weak cohesive forces, and therefore flow faster than honey.*

## FAQs

1. Do all liquids flow?
   *Yes – this is why they are classified as liquids.*
2. Even very thick liquids?
   *Yes, they just move more slowly because their viscosity is high.*
3. Why do some liquids travel more slowly than others?
   *Because their particles are held together more tightly – this creates friction within the liquid itself and we know that friction slows down movement.*
4. What happens if you warm the liquids?
   *We could test them to find out!*
5. Can we time how long it takes for them to flow?
   *Yes, we could time a selection of thicker liquids; those with low viscosity would possibly flow too fast for us to measure them accurately.*
6. Can we change how we test liquids so that we can measure them more easily?
   *Yes, we could pour them down a sloping surface and compare their movement.*

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