**ACTIVITY: Racing marbles**

**Activity idea**

In this activity, students compare the viscosity of common household substances by measuring how fast marbles move through the liquids.

By the end of this activity, students should be able to:

* set up and carry out a test, keeping variables constant
* use a graph to communicate their results
* apply their understandings about viscosity to everyday situations.

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**Introduction/background**

In this activity, students work in small groups to compare the physical property of viscosity of a range of household substances by timing how long it takes a marble to race through each liquid. Results are recorded in a table, and students then represent these results by drawing a bar graph. The substances are then ranked according to their viscosity – from low to high viscosity.

Viscosity refers to a liquid’s resistance to flow. It can be thought of as the frictioninside a liquid or the thickness of a liquid. The more viscous a substance, the thicker it is and the slower it flows, whereas a low-viscosity solution is thin and will flow more easily or allow objects to travel through it more quickly.

In the 1700s, Sir Isaac Newton (1642–1727) made discoveries in the areas of motion, gravity and mathematics. He also described the properties of fluids by stating that the ideal fluid has a constant viscosity (resistance to flow) at a given temperature. He observed that temperature affects a fluid’s viscosity – if the fluid is heated, it tends to become less viscous, and if it is cooled, it tends to become more viscous.

Although the definitions can get complex, liquids that pour and behave like water and oil are called Newtonian fluids.

However, we now know that there are some liquids that that do not fit Newton’s model of viscosity as their viscosity can be affected by pressure and stress. These are called non-Newtonian fluids.

Viscosity is an important property of liquids, which people who work in science often need to measure and change:

* Engineers who are involved in transporting oil though pipelines from offshore or over land need to ensure that the highly viscous crude oil continues to flow through the pipelines throughout a variety of conditions, such as temperature changes.
* Motor oil commercials often mention viscosity. Viscosity in oil changes with temperature, so motor oils must be at the right viscosity in both hot and cold weather. If oil is not viscous enough, it will not lubricate the engine enough, friction then heats the engine and this may cause damage. If the oil is too viscous, it is difficult for the engine parts to move.
* Keeping blood viscosity within a correct range is important for doctors to prevent blood clots developing in patients whose blood has high viscosity or prevent bleeding and bruising in patients whose blood has low viscosity.
* Volcanologists monitor viscosity of magma or molten rock within a volcano because this will determine the kind of eruption. A thin and fluid magma with low viscosity erupts gently, forming gentle mountain slopes, whereas a highly viscous magma can erupt explosively and form steeper mountain slopes.
* Viscosity is important in making products such as hair shampoos – low viscosity would be inconvenient for users.
* Viscosity is also important in food products. Different sauces have their different viscosities. For example, a spaghetti sauce would not be useful if it was as fluid as water. (Try pouring hot fudge sauce onto very cold ice cream and see the fudge sauce get thicker as it is chilled by the ice cream.)

**What you need**

* Tall thin glasses or jars of the same size
* Felt-tipped pen
* Glass marbles of the same size
* Stopwatch
* Sieve
* Bowl
* Common household liquids, for example, golden syrup, honey, olive oil, milk, fresh water, glycerine, shampoo (clear), detergent (clear)
* Copies of the marble time chart

**What to do**

1. As a class, discuss the concept of viscosity and explain that they will be carrying out a test to compare the viscosity of a range of household substances by timing how long it takes a marble to race through the liquids. Show the liquids to the students and get them to predict which liquids will be most/least viscous.
2. Divide the class into small groups or pairs and get them to set up their equipment. Ask them to choose four of the liquids they would like to test or allocate these to them. If you have enough glasses/jars, groups could have one for each of their different liquids. If not, they will need to clean the glass/jar between testing each liquid.
3. Have students measure and mark a line with a felt-tipped pen about 2cm from the top of the glass/jar and fill the glass/jar to the 2cm line with a test liquid.
4. Explain the experiment:

* For each test liquid, hold the marble level with the top of the glass.
* Drop the marble into the liquid and use a stopwatch to time how long it takes the marble to reach the bottom.
* Record the time under Trial 1 in the marble time chart.
* Retrieve the marble by pouring the liquid with the marble in it into a sieve sitting over a bowl.
* Wash and dry the marble and repeat the process twice more. Remind students that they must use exactly the same procedure each time (e.g. the height of the marble when it is dropped, coordinating starting the stopwatch with the dropping of the marble).

1. Once all liquids have been tested three times, have the groups calculate the average time taken for the marble to reach the bottom of the glass/jar in each test liquid and draw a bar graph to show this.
2. Ask each group to arrange their test liquids in order of their viscosity and display these along with the graph. Get students to look at other groups’ displays.

**Discussion questions**

* Why did we need to conduct each test three times and work out an average time?
* Why do you think viscosity would be important to an engineer transporting oil from offshore pipelines?
* Why might a volcanologist (a person who studies volcanoes) have an interest in viscosity?
* Why might the viscosity of hair shampoo be important?
* Can you think of other ways in which the viscosity of liquids might be important?

**Extension idea**

Students could plan an investigation to see whether temperature affects the viscosity of honey or golden syrup.

**Marble time chart**

Group names: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Test liquid** | **Time to reach the bottom (in seconds)** | | | |
| **Trial 1** | **Trial 2** | **Trial 3** | **Average time** |
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