

1.2 The Effect of Temperature on Viscosity

EXPLORE

Earlier in this Big Idea, you thought about different fluids and what would happen if their viscosity changed. What might cause a fluid's viscosity to change? Think back to the last activity, The Bubble Test. As you held the tube in your hand, the liquid may have heated up a little. Was there a change in the time it took for the bubble to rise between the first, second, and third trials?

Temperature is one factor that can have a big effect on viscosity. Look at the photos below. What will happen to the viscosity of these liquids?



Table syrup poured on hot pancakes



Flowing lava reaching the ocean



Olive oil put into a refrigerator



Room-temperature engine oil put into a hot engine

DEVELOP

The Ramp Method

reSEARCH

Chocolate-dipped ice-cream cones are a great treat on a summer day.

- What is added to chocolate to change its viscosity to allow it to be thin enough to dip into, but viscous enough to stick to the ice cream?

The ramp method of testing viscosity involves pouring a measured volume, say 15 mL, of a fluid down a ramp and timing how long it takes to get to the bottom. By pouring the same volume of another fluid and timing it, you can compare the viscosities of different fluids. You can also investigate the effect of temperature on viscosity by testing the same fluid several times.

A car owner will use oil with a different viscosity, depending on the season. Oil is used as a lubricant for vehicle engines. Its viscosity is important, as it must be thin enough to flow through the engine, and thick enough to coat engine parts. The Society of Automotive Engineers (SAE) assigns all motor oils a viscosity number between 5 and 50. In the next activity, you will use the ramp method to design your own test to find out what the numbers on a motor oil mean, and which motor-oil grade is best to use in each season.

What Oil Should You Use?

In this activity, you will use the ramp method to determine what the grades given to motor oil mean, and the effect of temperature on the viscosity of motor oil.

- You will investigate four different grades of motor oil.



10W30 is a common multi-grade oil used in Canada.

- Design a fair test that will allow you to collect evidence to answer the questions:

CAUTION!

Environmental safety: Consider the environment when choosing the volume of oil to be used in your fair test.

- 1 What do the numbers on a sample of motor oil tell us about its viscosity?

- 2 How does temperature affect the viscosity of different motor oil grades?

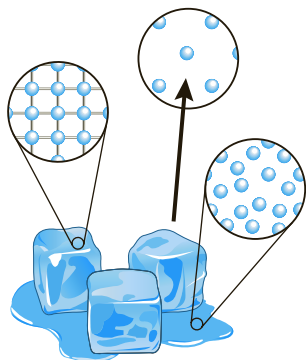
- 3 What type of motor oil would be useful in the summer in Saskatchewan? in the winter?

- Look at the labels for the oils you are investigating. What safety information do you need to be aware of?
- Use a temperature probe or thermometer to measure the temperature of the oils being investigated. Be sure to think about both cold and warm temperatures.
- Have your teacher approve your procedure.
- Carry out your test. Create a written, visual, or digital summary explaining your results, including:
 - the safety precautions you needed to take during this activity;
 - the type of motor oil you would recommend for summer and winter driving, and what criteria you used to determine this;
 - what the numbers on a label describing the grade of motor oil mean.

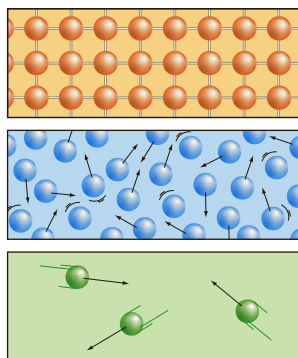
Understanding Viscosity and Temperature

Your Problem Solver activity may have shown how a change in temperature can affect the viscosity of a fluid. The Particle Theory can help to explain the effect of temperature on fluid viscosity.

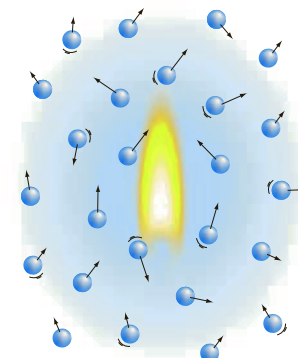
As temperature increases, the viscosity of a liquid decreases. Particles at higher temperatures move with more energy. Particles are able to move out of the way and make room for other particles to pass, allowing the liquid to flow more easily. The opposite is also true. As temperature decreases, the viscosity of a liquid increases. Particles at lower temperatures move with less energy. The spaces between particles get smaller, making less room for other particles to pass. This causes the liquid to flow less easily.



- 1 All matter is made of tiny particles. Different substances are made of different particles.



- 2 The tiny particles of matter are always moving and vibrating.



- 3 Adding heat to matter makes the particles move around faster and vibrate faster.

infoBIT

Soft-Serve Ice Cream

Soft ice cream is something we take for granted, but it has not always existed! A soft-serve ice-cream formula was invented in 1938. The first Dairy Queen in Canada opened in Melville, Saskatchewan, in 1953.

Temperature changes can greatly affect manufactured devices. Look back at the Problem Solver: *What Oil Should You Use?* In colder weather, motor vehicle engines cannot function well if an oil becomes too viscous. Therefore, when the weather is cold, an oil with a low viscosity is used. As the temperature drops, the oil's viscosity remains low enough to allow it to flow through the engine. During warm weather, a higher viscosity oil is used. As the temperature increases, the oil's viscosity remains high enough to allow it to still coat the engine properly. Thin oil is less effective as a lubricant. Manufacturers add chemicals called viscosity modifiers to motor oil to change the oil's characteristics. Some of these modifiers help to improve fuel economy or oil performance in extreme temperatures.

COMMUNICATE

- 1 Look at other students' summaries of the results of their motor oil ramp tests.
 - a) Do your results agree with the others?
 - b) Are there differences? Why do you think differences might occur?
- 2 In a fair test, you have to keep most variables the same so that you can see what the effect of one variable is.
 - a) What things did you keep the same for each test?
 - b) What did you change during the tests?

- 3 How does temperature affect the viscosity of a liquid?
- 4 You are given three samples of the same shampoo at three different temperatures: 35°C, 50°C, and 75°C.
 - a) Which sample would have the highest viscosity? Which sample would have the lowest viscosity?
 - b) Support your answer with ideas from your Problem Solver activity.
- 5 What safety precautions are needed when you work with liquid materials in a science lab?

1.3 Check Your Progress

- 1 What is a fluid? Make a list of all the words related to fluids in this Big Idea. Use those words to create a concept map illustrating your understanding of fluids. Save your concept map for future use, as you will add to it after you complete each Big Idea.
- 2 Use the Particle Theory of Matter to explain what viscosity is and why temperature affects viscosity.
- 3 Describe two methods used to test viscosity.
- 4 When you pour cereal into a bowl for breakfast, the cereal takes the shape of the bowl. Is cereal a fluid? Explain your answer.
- 5 Give some examples of how an understanding of viscosity benefits people.
- 6
 - a) How are the Hazardous Household Product Symbols and WHMIS symbols the same and different? Use a table similar to the one below to help you organize your thinking.
 - b) What is the importance of having both systems?

	Hazardous Household Product Symbols	WHMIS Symbols
Ways the two symbol systems are different		
Ways the two symbol systems are the same		