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Laboratory—Viscosity of Liquids Teacher's Notes

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Focus question

How does the viscosity of a liquid affect the motion of an object moving in the liquid?

Essential materials

- Water
- Baby oil (or some other easily obtainable light oil)
- Clear or light colored shampoo
- Clear plastic bottle about 444 mL (15 oz) or slightly larger in capacity , with tightly fitting cap
- Small wooden or plastic block about 2.54 cm (1 in) in height
- Stopwatch that measures to 0.1 or 0.01 seconds
- Glass marble small enough to fit through the mouth of the bottle
- Permanent marking pen
- Chart to record your results

Main ideas and background information

- *Viscosity* is the property of a fluid that causes it to resist flowing. Thick liquids such as oil and shampoo are more *viscous* than water.
- A viscous liquid resists the motion of an object moving in it. The more viscous a liquid is, the more it will resist the movement of an object. Thus an object can move more freely in a liquid of low viscosity, such as water, but moves more slowly in a liquid of higher viscosity, such as oil or shampoo.

Procedural tips

- Be sure to have students draw the lines all the way around the bottle. They will need to have their eyes level with each line when making their time measurements, and this will help them to do so. Note how the camera is positioned in the photographs for step 7 for the top and the bottom line.
- When students attempt to measure the time it takes for the marble to drop in water (step 4), help them to realize that they are measuring what is essentially their reaction time. The marble drops so quickly in such a non viscous liquid that it is not possible to measure the time by hand with a stopwatch.
- For the ramp in step 5, place the bottle cap on a small object to make a ramp with an angle of no more than about 10° or so. This will be enough to ensure a reasonably slow rolling speed for the marble. (*Note*: Galileo used a similar technique to “dilute” the acceleration that is due to gravity. The description of his ramps is found on pages 178 and 179 of his book, *Two New Sciences*.)

- For the most consistent results, students should make sure that the marble is in the same starting position in step 6 before lowering the end of the bottle in step 7. If the starting position is a centimeter or two above the first line, it will help the timer to start the stopwatch more consistently as the marble reaches the first line.
- In step 10, allow as much water as possible to drain from the bottle before adding the marble and oil.
- In optional step 11, the contrast with the more viscous shampoo will be dramatic, especially if students replicate the ramp measurement.

Safety considerations

- This investigation should be supervised, especially the filling of the bottles.
- No horseplay allowed.
- It is a good idea to have a material safety data sheet (MSDS) on hand for each material, whether they are hazardous or not. You can obtain an MSDS for shampoo from a number of sources. Here is one example.
- Dispose of the shampoo properly if you do not reuse it. (See section 13 of the shampoo MSDS.) Confirm with your custodian or building administrator that it is permitted to pour the shampoo down a waste drain a little at a time, followed by a rinse of water.

Discussion

1. How was the time it took for the marble to roll down the ramp in water different from the time needed for the marble in oil? (It took a longer time for the marble to roll down in oil than it did in water.)
2. What is your explanation for this difference? (The oil is more viscous than the water. The water does not hold the marble back as much.)
3. Looking at your data, what do you think might happen if the angle of the ramp had been steeper? Less steep? (For a steeper angle, the marble would roll faster and the rolling times would be shorter. For a less steep angle, the times would be longer.)
4. How might this activity be useful in your everyday life? (For example, students might notice a difference in the force required to stir various liquids.)

Assessment

Are students able to describe how the viscosity of a liquid affects the motion of an object moving in the liquid? (A liquid with a low viscosity, such as water, does not resist the motion of an object moving in it very much. A liquid with a higher viscosity, such as oil or shampoo, resists the motion of an object moving in it to a greater extent.)

Extensions and further investigations

- Have students repeat the experiment using
    - other liquids
    - a marble of a different size
    - a bottle of a different size (with a different rolling distance)
    - different ramp angles
- Before the students carry out each additional experiment, challenge them to predict what they think will happen and why. Then have them compare the results with their predictions and develop possible explanations for any discrepancies.

Glossary/vocabulary

viscosity
viscous

Resource links

Hawai'i Space Grant College, Hawai'i Institute of Geophysics and Planetology, University of Hawai'i
A good general treatment of viscosity, with some additional information about the viscosity of volcanic lava.

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Related Links

SEED Science Center

Viscosity Explorer (Virtual Experiment)

Try this interactive exeriment to see how viscosity varies from liquid to liquid and how temperature affects viscosity.

Viscosity of Liquids

Different liquids have different properties. One of these properties is viscosity, the liquid's resistance to flowing. Water, milk, and fruit juice are comparatively thin and flow more easily than thicker, more viscous liquids such as honey, corn syrup, shampoo, or liquid soap.

Viscosity of Liquids II

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Viscosity and Temperature

Temperature affects the viscosity of most liquids. This experiment focuses on the viscosity of shampoo in a bottle as it is heated and cooled.

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Properties of Liquids