CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
J0120

Project Title
How a Solid's Temperature Affects Its Speed Falling through Liquids: Do Sizzling Spheres Sink Swiftly in a Syrupy Soup?

Abstract

Objectives/Goals
My objective was to determine how a solid's temperature affects its speed falling through a liquid. The viscosity of most liquids decreases as the liquid's temperature increases, and Stokes' Law predicts that a solid sphere will fall faster in a less viscous liquid. Therefore, a solid sphere should fall faster through hotter liquids. I hypothesized that if I were to heat the sphere instead of the liquid, the sphere would also fall faster, because it would tend to heat the liquid immediately surrounding it. Likewise, I predicted that colder spheres would fall more slowly. Applications and extensions of my idea and results could improve energy-efficiency of underwater travel, and possibly of air and space travel.

Methods/Materials
For each test, I dropped a sphere into a vertical, cylindrical, liquid-filled tube. After the sphere had fallen 10 cm, I timed the next 50 cm of its descent to find its average speed. Spheres were made of steel, glass, and acrylic and had diameters of 0.6 cm and 1.6 cm. The liquids were water, canola oil, and corn syrup, all at a temperature of 20°C. I heated or cooled the spheres to 0°C, 20°C (the control), 60°C, and 100°C. I compared average speed vs. sphere temperature.

Results
In almost all cases, over the 20° to 100°C range, as I predicted, hotter spheres fell faster! Behavior of cold (0°C) spheres was inconsistent--perhaps their density increased at the cold temperature, counteracting viscosity-related effects. Testing sub-0°C spheres could give a better picture of cold-sphere behavior.

Conclusions/Discussion
All except my 0°C results supported my hypothesis, showing that a sphere's behavior in a liquid is not only affected by the overall viscosity of the liquid, but that it can also be affected by other factors local to the sphere itself (in particular, by heat from the sphere). This idea might be extended to help understand the behavior of underwater vessels or projectiles, possibly improving the energy-efficiency of underwater transportation. Further experiments might even extend my idea to gases: Viscosity of a gas generally increases with temperature, so it may turn out that cold objects move faster than hot objects through gases, an idea that might be used to improve the energy-efficiency of air travel, as well as to understand better the behavior of objects from outer space that heat up on entering the Earth's atmosphere.

Summary Statement
My project demonstrates that the hotter a solid object is, the faster it falls through a liquid, which has possible applications to energy-efficient transportation.

Help Received
This project and hypothesis were my idea, based on my Internet research on viscosity and Stokes' Law. My father helped me design my experiment and find supplies. My tests required an assistant (my father) to time the spheres after I dropped them. My mother helped me paste up the poster.