

Volcanoes and Earthquakes—Viscosity Lab

Earth Science Essentials
by Russ Colson

Materials: You need a set of measuring cups and a marble. In addition, you will need to get a tall clear glass, a bag of sugar, a timer, a ruler, a spoon or knife for stirring, and water.

Goal: Measure and graph how the viscosity of sugar water changes with composition and use your results to make predictions about experiments you didn't do.

Concept of Viscosity: A viscous material does not 'spring back' when force on it is released. It will deform under even a very low force, with the rate of deformation related to the amount of force applied. More viscous fluids will flow less quickly and a marble will fall through them more slowly. Viscosity in these experiments is proportional to the inverse of the rate of marble drop.

Outline of tasks:

1) Mix sugar and water in several different proportions and measure how long it takes a marble to drop through the liquid. You might want to consider what compositions you want to make. You need a wide enough range of compositions and enough different compositions so you can clearly see the relationship between deformation rate of the liquid and its composition. You need to be able to time how long the marble takes to fall—if it falls too quickly you can't measure precisely and if it falls too slowly you won't have time to wait for it to complete its fall. Another consideration is that sloppy mixing of compositions, or sloppy measurements, results in slop, not science.

2) Choose appropriate units. How will you report the concentration of sugar in your water? Percent by volume? Percent by mass? Fraction by volume? Total sugar divided by total water? Amount of sugar? In general, amount of sugar is a poor unit because the properties of interest, like viscosity, don't depend on the amount of sugar, they depend on the amount of sugar relative to water.

3) Take appropriate measurements. Deformation rate is a—well, it's a *rate*. That means you need to divide a distance by a time. How far does the marble fall in a given amount of time? Or, how long does it take to fall a given distance?

4) Plot an appropriate graph. You are measuring the effect of one variable (composition of sugar water) on another variable (viscosity of the fluid)--independent variable and dependent variable. You need to use an x-y type graph to show the relationship between these two variables—not a pie chart, or a bar graph, or some other kind of figure. By convention, we often plot the independent variable on the x axis and the dependent variable on the y axis.

5) Interpret your results. Does viscosity (as measured by marble-drop-rate) change with composition? Is that change significant given the uncertainty in your measurements? What is your uncertainty and how to you determine it (hint: repetition). In what way does the viscosity change? Does it increase or decrease with increasing sugar concentration? Does the viscosity change linearly with composition or is that change non-linear?

6) Based on your experimental results, predict the composition of sugar water is required for the marble to take 24 hours to fall through 5 inches of sugar water. Show all your work with well-organized math calculations and clear, well-labeled explanations.

Report:

Your report should include pictures of you doing your experiment, your experimental set up and procedures, any problems you encountered and how you solved them, and of course all of the items requested above.

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