

2008  
Winning Lesson Plan  
from Grand Junction,  
Colorado

*Viscosity Lab: Kinetic  
Theory as it Applies to  
Magma and Lava*

by Bradley Loucks  
Redlands Middle School

Grade Level:  
Middle School

Duration:  
Two Days

## Overview and Purpose

The Viscosity Lab was one of three lessons that were offered with the intent of demonstrating how heating and cooling of matter (according to kinetic theory) is a direct cause in the phenomena and interrelationship of plate tectonics, volcanoes, earthquakes, and the rock cycle. Heat and its effects are fundamental in understanding a broad scope of scientific principles covered in our 6th grade curriculum and beyond. This concept is appropriate for 6th graders because it is a perfect transitional concept that takes students into the study of science as the study of **Why** instead of **What**. It is a great concept to make this transition because the students can interact with hands-on models that explore possible explanations of what we see on earth and relate them to what we suppose are the conditions beneath the surface of the earth.

Additionally, I intended to accomplish the following:

1. To help students understand and evaluate the advantages and short-comings of scientific models.
2. To create a lab that collected quantitative evidence that heat does effect materials.
3. Development of lab recording and interpretation skills.

These goals are a critical step in understanding the nature of science—in effect the “Rules” of science. Each of these lessons provided a great opportunity to evaluate the validity of the data (as well as the lack of) and the limitations of being able to draw solid conclusions without good data. Even if my students do not grow up to be scientists, I want them to become critical evaluators of scientific “Facts” commonly communicated through popular press, and thoughtfully question the source of the information before drawing popular conclusions.

Otherwise, these process skills become the foundation for forming effective science students who understand that science is a process, requiring research, testing, and reflection.

For each lab, I was looking for each student to identify a direct connection between heat and the outcomes we observed. A hypothesis that the flow rates of honey would increase as temperature increased demonstrates a prior understanding of how heat may effect materials. On question 7, an accurate conceptualization of molecule spacing and speed, based on temperature shows further understanding. The reflection should clearly give an understanding of the relationship between heat and flow as well as a clear relationship between the concept of viscosity and rate of flow. Overall, I am looking for evidence that students are making connections between the **Why** and the **What**.

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## Overview and Purpose (Cont'd)

This selection of lessons proved to be a good use of instructional resources to support my teaching and extend student learning. Another major goal I have is to create an environment where the text is a powerful, integrated resource, rather than an isolated element to their learning. We do a lot of orienteering in the text, showing how publishers organize, emphasize, and summarize concepts. It was my intention to make a clear connection between the material presented in the text and the models presented in the activities. This occurred very well with the Viscosity Lab. If students were to develop an understanding of viscosity based on the reading selection alone, their overall growth would have been all but non-existent, mostly because viscosity is such an awkward concept—less is more. When the lab, along with accompanying role-playing where students were viscous and non-viscous molecules, was completed most students sorted out the relationship between heat, flow, viscosity, and density.

## Context and How This Lesson Is Innovative

The Viscosity Lab was preceded by The Convection and Plate Tectonics Demonstration Lab and Followed by Volcanic Models Lab. These lessons were 3 of 8 that focused on plate tectonics and volcanic activity. Prior to conducting these lessons, the class just completed a unit on properties of matter that emphasized the relationship between heat and density. Featured lessons in the first unit included creating a density lamp out of alcohol and mineral oil and constructing and flying hot air balloons.

The Convection and Plate Tectonics Demonstration Lab was a lesson I found on the internet and adapted to my unit. It involved placing a glass bread pan, filled with cooking oil and thyme, over a heat source allowing two convection currents to develop. I placed two balsa “plates” over the diverging region of the currents and a plate on the edge of the pan so the kids could see the plates move apart and then collide with the plate on the edge. The Volcanic Model Lab used 4 models. The first two, shaking a can of pop and adding *Mentos* to pop I borrowed from other sources and were effective in demonstrating the role of expanding gas in eruptions. Far and away, though, the biggest challenge teaching the concepts related to heat and the geologic activities has been getting the kids to “see” the invisible. So, when I was creating the design for the volcano models I wanted to directly address this issue and give them as much evidence as possible to help even more students “see”.

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Two models specifically demonstrated the relationship. The wax model was very effective because kids saw an eruption directly result from a heat source being applied to the model. It became more obvious that new wax was not being added so the liquid wax that was there must be expanding. The balloon-flour model incorporated a laser level that showed how the balloon expanded as heat was applied. The students also saw cracks form on the cone. Since the balloon was a closed system it also created a better opportunity to see the effects of heat.

The Viscosity Lab is innovative simply because it was designed in response to a need that arose after students struggled with interpreting the text description of rate of flow, viscosity, and types of lava. Students did not get that something high (viscosity) could actually be low (flow) so I created the honey experiment so we could experience it and talk about it more.

## Educational Standards Addressed

The Viscosity Lab directly addresses the following Colorado Standards:

1. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Physical Science: Students know and understand common properties, forms, and changes in matter and energy.
3. Earth and Space Sciences: Students know and understand the processes and interactions Earth's system's and the structure and dynamics of Earth and other objects in space.
4. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

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## Materials

(per group of 2–4 students)

1. (1) 10 x 150 test tube. The test tubes are marked with permanent marker at 1-cm increments from the bottom. Exactly 1 cm of honey is placed in the test tube ahead of time.
2. Water baths. An ice water bath, a room temperature bath, and a boiling water bath. You could choose to use one hot bath for safety concerns.
3. Thermometer that is too wide to fit into the test tube.
4. Stopwatch.
5. Eye protection.

## Procedures

1. This lab is done after reviewing the section on viscosity as it relates to lava flow and type but could be done any time when trying to instruct on kinetic theory.
2. Prepare write up. Include discussion to set the stage for stating the hypothesis. Depending on background of students, help prepare materials list, procedures and data table.
3. Starting with the room temperature bath, have students place the test tube in the bath for two minutes. Record temperature of water.
4. Then conduct the “tip test”. Gently tip the tube on its side on the surface of the desk and measure how many centimeters the honey flows in 10 seconds.
5. Repeat 3 and 4 with the hot water bath and the ice bath.
6. As time allows, repeat trials.
7. Complete write up.

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**Title: Viscosity Lab**

**Purpose:**

**Key Terms:** Rate of flow, viscosity; density, thermal (heat) energy, mechanical energy (motion), physical properties.

**Hypothesis:** Predict the rate of flow for the three temperatures of lava (honey) you tested. Use a complete sentence.

**Materials, Procedure, and Results:**

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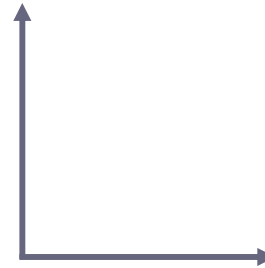
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**Title: Viscosity Lab**

**Analysis:**

1. Create a line graph from the data you collected. It should show the relationship between the temperature of lava (honey) and its rate of flow. Here is a hint. Ask yourself, "Does the rate of flow depend on the temperature or does the temperature depend on the rate of flow?" Remember Y depends on X.



2. What is the definition of viscosity?

3. Write a summary statement that compares the rate of flow of a fluid and its viscosity.

4. Write a summary statement of what you observed about the connection between temperature and the rate of flow of a fluid.

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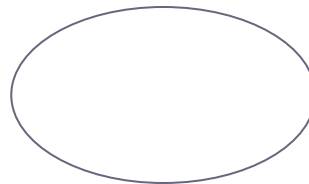
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5. What is the relationship between temperature and viscosity?

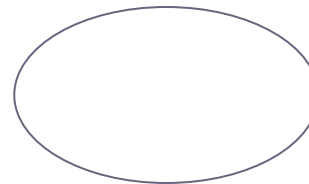
6. Recall the Convection Model Lab. What is the relationship between density and viscosity?

7. Part 1: You are back in your ultra-nano hovering submarine. It is so small that you can travel through and see individual molecules and atoms (we're pretending, remember?) Each ellipse represents your view out of the window of the sub. Draw what the spacing between the lava (honey) molecules would be like for the three temperatures you tested.



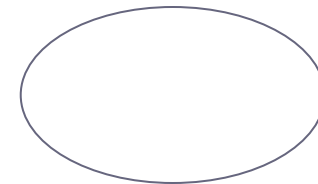
Lowest temperature

\_\_\_\_\_c°



Medium temperature

\_\_\_\_\_c°



Highest temperature

\_\_\_\_\_c°

7. Part 2: While your ultra-nano hovering sub was hovering in place you noticed that the particles were traveling at different speeds depending on the temperature. What did you observe?

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8. Why is viscosity considered to be a physical property of lava?

9. Analyze your hypothesis. Did your prediction match actual outcomes? Explain.

10. Compare your honey to pahoehoe and aa lavas.

**Reflection/Conclusion:** Review section 2 of the chapter. Assume your honey is lava flowing from a quiet eruption on the Big Island of Hawaii. On the shield volcano below, use colors to draw where you would find different temperatures of lava as it flows from the mountain. Also label where the most viscous and least viscous lava would be found. You could also check out sections 3 and 4 for more help.



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### Enrichment Questions (Optional)

1. Go back to your graph of rate of flow. In blue, draw a hypothetical line that shows how the viscosity would change as the rate of flow changed. (2 points)

2. What is the chemical in magma that determines whether a volcano erupts quietly or explosively? (1 point)

3. Explain why low viscosity magma lava results in shield volcanoes.(2 points)

4. Explain why high viscosity magma results in cinder cones. (2 points)

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