

Name: \_\_\_\_\_

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## **12.001 Lab 5 part 1**

### **due: March 19**

### **Section 1: Volcano simulation**

As we discussed in lecture, in order for a volcano to erupt there must be volatiles in the magma. Therefore it follows that volcanic eruptions are fundamentally gas-driven phenomena. Most explosive eruptions are driven by the depressurization of volatiles (primarily  $\text{H}_2\text{O}$  and/or  $\text{CO}_2$ ) dissolved in magma as it ascends. During an eruption, the gas exsolves (comes out of solution) and its volume expands rapidly, causing the magma & bubble aggregate to rise faster. When the volume fraction of bubbles exceeds about 80%, the magma fragments explosively and is carried by a gas stream (e.g., Sparks, 1978).

#### **Goals:**

- 1) Visualize how a gas-driven volcanic eruption might occur.**
- 2) Compare a small-scale analog model of a volcanic eruption to actual full-scale events.**
- 3) Collect data and make observations of a physical experiment.**

#### **Simulation:**

The first part of our volcano simulation is a hands-on exercise that involves a bottle of diet Coke and a handful of Mentos (mint flavor). With these two materials, your group will create your own erupting volcano. Before you start, make sure you read the following instructions and are ready to make the appropriate observations (see the questions listed after the instructions):

- 1) Divide up into a group of 3 or 4 and grab 1 bottle of diet Coke, a pack of Mentos, and a sheet of scrap paper (to use as a funnel).
- 2) Your group will need to collect the following data from your volcanic eruption:
  - a) the maximum height of your eruption column
  - b) the number of Mentos dropped into the bottle, and
  - c) some visual observations of your eruption and eruption column.
- 3) To measure the maximum height, you should conduct your simulation next to a tree or light pole (i.e., something you can mark and measure the height on) so that you can accurately estimate how high the column goes. There will be a tape measure on hand so that you can then measure the maximum height after the eruption occurs.
- 4) Your TA will give you some pointers on successfully erupting your volcano, but your group should discuss how the experiment will proceed (i.e., what each person is responsible for), before you head outside.
  - a) First, *slowly* uncap the bottle (so as to keep as much  $\text{CO}_2$  in solution as possible).
  - b) Decide how many Mentos you want to use (between 2 and 8).
  - c) Take your funnel (paper) and line up the Mentos in the funnel so that they will smoothly slide into the bottle as quickly as possible.
  - d) Before you drop the Mentos into the bottle, make sure that at least one member of

- you group will be able to accurately estimate (within a foot or 6 inches) the maximum height of your eruption column.
- e) Now, drop your chosen # of Mentos into the bottle using the paper funnel. The eruption will begin immediately.
  - f) Record the # of Mentos that actually dropped into the bottle (this may be different from the intended number; the Mentos that went in should still be in there) and the maximum eruption column height (in feet + inches).

### Observations:

How tall was the eruption column?

How wide was the eruption column? (Did it stay the same width as the bottle opening?)

What was the texture of the eruption column?

About how long did the eruption last?

What was the approximate volume of ejected material?

How does the height of your eruption column compare with the height of other groups' eruption columns? Did they use more or fewer Mentos?

### Calculations

- a) Using the estimated maximum eruption column height from the simulation, calculate the initial eruption velocity ( $v$ ). You can calculate this by thinking about the energy of the system: the kinetic energy of a parcel of material at the beginning of the eruption ( $KE = \frac{1}{2}mv^2$ ) is equal to its potential energy as it reaches its maximum height ( $PE = mgh$ ), where  $v$  is the initial eruption velocity (m/s),  $g$  is gravitational acceleration ( $9.8 \text{ m/s}^2$ ), and  $h$  is the maximum eruption column height (meters). Show your work, and pay attention to units.

- b) Now that you have initial eruption velocities your “volcano”, let’s compare these values to some real volcanoes and their eruption velocities.

Kilauea Iki Fire Fountain, Kilauea (1959) – lava reached 177 meters

Heimaey Volcano, Iceland (1973) – ash and steam cloud reached 2 km

Pinatubo Volcano, Philippines (1991) – ash cloud reached 34 km

To make your comparison easier, fill in the simple table below that includes the volcano name, maximum column height (m or km), and initial eruption velocity. Then, look up the volcanoes online; use any available online information plus the data available here to determine what style of eruption each volcano produced.

<b>Volcano name</b>	<b>Height of eruption column</b>	<b>Velocity of ejected material</b>	<b>Eruption style</b>
Coke bottle			n/a
Kilauea			
Iceland			
Philippines			

## Questions

- 1.** In the simulation the driving mechanism is gas. What gas is used?
- 2.** How does the gas form in the eruption? How does that drive the eruption?  
(Refer to your observations)
- 3.** How did the gas behavior in question 2 affect how the eruption sounded and behaved?