# Recipe for Volcanoes

## *Overview:*

Students learn some of the physical properties of planets and moons by exploring the features necessary for volcanism to occur.

## *Objectives:*

The student will:
- sketch and label cross-sections and surfaces of planets;
- describe which planets have crusty exteriors;
- investigate how fast objects cool in relation to their size; and
- identify the features necessary for a planet or moon to have volcanism.

## *Materials:*

- *Ola Ka Honua: Volcanoes Alive* interactive DVD
- 1,000 ml beakers
- 1,000 ml flasks
- Hot pads
- Hot plates
- Thermometers
- Timers
- Permanent markers
- Student Worksheet: "Recipe for Volcanoes"
- Student Worksheet: "Cool It"

## *Answers to Student Worksheets:*

Planet Surfaces:
1. Mercury, Venus, Earth, the Moon, Mars, Io, Europa, and Pluto all have a solid surface.
2. Jupiter, Saturn, Uranus, and Neptune all have a gaseous surface.
3. Mercury, Venus, Earth, the Moon, Mars, Io, and Europa.
4. Yes, except for Pluto, or No
5. Answers may vary; Pluto is too far away to have been explored thoroughly.
6. solid; gaseous

Cool It:

Hypothesis: Answers will vary

Data: Answers will vary but should reflect data collected every three minutes.

Analysis of Data: 1. Answers will vary; 2. The small beaker lost the most heat.

Conclusion: Answers will vary but should reflect that the small beaker cooled fastest.

Further Questions:
1. Earth's moon should cool most quickly.
2. Earth and Venus might cool more slowly.
3. Earth, Venus, and possibly Mars, although Mars has not been active for a long time.
4. Mercury and Earth's Moon.
5. Answers may vary, but should indicate that active volcanoes are more likely to exist on larger planets.

 

# Recipe for Volcanoes

## *Activity Procedure:*

1. Ask students what features might be necessary for a planet to have volcanoes. If necessary, ask what they know about volcanoes on Earth (temperature, formation, etc.). Write ideas on the board.
2. Explain that, while many variables help determine whether volcanism occurs, the composition of a planet is one important factor. Invite students to guess whether planets with a solid surface or a gas surface might be more likely to have volcanoes. Have students “vote” for gas or solid and write how many voted for each option on the board.
3. Distribute the *Ola Ka Honua: Volcanoes Alive* interactive DVD and the Student Worksheet: “Recipe for Volcanoes.” Ask students to navigate through Unit 10 of the DVD to complete the worksheet.
4. Once worksheets are complete, review the answers. Remind students that some of the planets and moons on their list of bodies with solid surfaces have active volcanoes; others only have evidence of past volcanism. Point out that not enough is known about Pluto to determine if it has volcanoes.
5. Ask students if they have ideas about why Earth and Venus, for instance, still have active volcanoes, while our Moon does not. Write ideas on the board.
6. Explain that the presence of active volcanoes requires an internal heat source. Tell students that the rocky planets and moons in our solar system were hot early in their history, and have undergone cooling ever since. Some planets cool faster than others.
7. Ask students what factors might determine the rate of cooling? Write ideas on the board. Explain that students will conduct an investigation to determine whether smaller or larger bodies tend to cool faster.
8. Divide students into groups of 3 or 4 and distribute the Student Worksheet: “Cool It.” Ask students to complete the investigation.
9. Discuss the results as a class. If desired, draw the size of Earth, Venus, Mercury, Mars, and Earth’s Moon to scale on the board (diameters: Earth = 12.7 centimeters, Venus = 12.1 centimeters, Mars = 6.7 centimeters, Mercury = 4.9 centimeters, and the Moon = 3.5 centimeters).
10. Remind students that Io and Europa both have evidence of active volcanism (magma volcanoes on Io, and cryovolcanoes on Europa). Explain that the sizes of Io and Europa are very similar to that of Earth’s moon (3.6 centimeters diameter for Io and 3.1 centimeters diameter for Europa, if compared to the sizes for other bodies in # 9).
11. Ask students why these smaller objects might still have active volcanoes. Explain that although these bodies would have cooled long ago under normal circumstances, their proximity to Jupiter and to other moons creates strong gravitational pull in different directions. This pull creates heat. Thus, Europa and Io are heated by tidal heating, which will be addressed in other lessons in this unit.

**Extension Idea:** Small planets cool faster than large ones because small planets have more surface area relative to their volume than do large planets. Thus, small planets lose heat at a faster rate. On completion of the Student Worksheet: “Cool It,” students could calculate the surface area of the water in each beaker and compare the surface area to volume ratio between the large and small volumes of water. The formula for surface area of a cylinder is: 2 pi $r^2$ + 2 pi r h. Students would use this formula to obtain the surface area of the water, and then divide that by the volume of water in the beaker to obtain a surface area to volume ratio.

 

**Name:**____________________________________ **Student Worksheet**

# Recipe for Volcanoes

**Directions:** Look at the *Ola Ka Honua: Volcanoes Alive* DVD and navigate through Unit 10 to complete this worksheet. Sketch a cross section of each planet in the table below. Label sections that are gas, liquid, and solid. Indicate which planets and moons have a solid surface.

**Background Information:** All of the inner planets, Mercury, Venus, Earth, and Mars, have evidence of current or past volcanism. Some of the moons around Saturn and Jupiter also have volcanoes. Why do these moons and planets have volcanoes, while the others do not? The answer lies in the make-up of the planet.

| | Sketch a cross-section. Label the gaseous and/or solid portions. | Describe the surface. Is it solid, liquid, or gas? |
|---|---|---|
| Mercury | | |
| Venus | | |

 

**Name:**______________________________________ **Student Worksheet**

# Recipe for Volcanoes

| | Sketch a cross-section. Label the gaseous and/or solid portions. | Describe the surface. Is it solid, liquid, or gas? |
|---|---|---|
| Earth | | |
| Earth's Moon | | |
| Mars | | |

 

**Name:_______________________________________** **Student Worksheet**

# Recipe for Volcanoes

| | Sketch a cross-section. Label the gaseous and/or solid portions. | Describe the surface. Is it solid, liquid, or gas? |
|---|---|---|
| Jupiter | | |
| Io | | |
| Europa | | |

 

**Name:**______________________________________ **Student Worksheet**

# Recipe for Volcanoes

| | Sketch a cross-section. Label the gaseous and/or solid portions. | Describe the surface. Is it solid, liquid, or gas? |
|---|---|---|
| Saturn | | |
| Uranus | | |
| Neptune | | |

 

**Name:**________________________________________ **Student Worksheet**

# Recipe for Volcanoes

| | Sketch a cross-section. Label the gaseous and/or solid portions. | Describe the surface. Is it solid, liquid, or gas? |
|---|---|---|
| Pluto | | |

1. List all the planets and moons that have a solid surface.

_______________________________________________________________

_______________________________________________________________

2. List all the planets and moons that have a gaseous surface.

_______________________________________________________________

_______________________________________________________________

3. Which planets and moons are known to have active or past volcanoes?

_______________________________________________________________

_______________________________________________________________

4. Does the list of planets and moons in Question 1 match the list in Question 3? ________________

5. Why is little known about Pluto?

_______________________________________________________________

_______________________________________________________________

6. Complete the following sentence: planets with a _________________________ surface are more likely to have volcanoes than planets with a _________________________ surface.

 

**Name:______________________________________** **Student Worksheet**

# Cool It

## *Testable Question:*

Which cools faster in the same conditions, a large volume of water or a small volume of water?

## *Background Information:*

Planets must be hot inside in order to have active volcanoes. Early in the history of our solar system, all of the rocky inner planets were hot. They have cooled at different rates. Could differences in size be responsible for different cooling rates?

## *Hypothesis:*

This activity tests whether a large volume of water or a small volume of water will cool faster. Complete the hypothesis below:

I predict that if a large volume of water and a small volume of water are cooled under the same conditions, then the __________________________________________ volume will cool faster.

## *Materials:*

- 2 1000 milliliter beakers
- 1 1000 milliliter flask
- 2 thermometers
- Timer
- Hot plate
- Hot pads
- Permanent marker

## *Procedure:*

1. Label the two beakers “small” and “large” with a permanent marker. Place these beakers at least two feet away from the hot plate.
2. Heat 800 milliliter of water in the 1000 milliliter flask on a hot plate for about 5 minutes on medium heat. The water should be hot but not at a full boil.
3. Using hot pads, carefully remove the flask.
4. Pour 200 milliliter of water into the beaker labeled “small,” and 600 milliliter of water into the beaker labeled “large.” Use hotpads while pouring.
5. Quickly place a thermometer into each beaker, and record the initial temperature of each volume of water in the “Data” section.
6. Start the timer and take the temperature of the water in each beaker every 3 minutes for twelve minutes. Record in the “Data” section.
7. After 15 minutes, touch the outside of the beakers at the 100 milliliter mark. Observe which beaker feels cooler.

 

**Name:**_______________________________________ **Student Worksheet**

# Cool It

## *Data:*

| Beaker | Initial Temperature | 3 minutes | 6 minutes | 9 minutes | 12 minutes (final) |
|---|---|---|---|---|---|
| Small | | | | | |
| Large | | | | | |

## *Analysis of Data:*

1. Subtract the final temperature from the initial temperature to measure the change in temperature of each volume of water:

   Large: _________ - _________ = _________ Small: _________ - _________ = _________

2. Which beaker lost the most heat? ________________________________________________

## *Conclusion:*

Which beaker cooled the fastest? ____________________________________________________

Was your hypothesis proved or disproved? Explain your answer. ______________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

## *Further Questions:*

1. Earth and Venus are about the same size. The diameter of Mars is about 1/2 that of Earth. The diameter of Mercury is about 1/3 of Earth's diameter, while the diameter of the Moon is about 1/4 that of Earth's.

   Based on this information, which object should cool most quickly? _________________________

2. Based on the information in #1, above, which object might cool more slowly?__________________

3. Which of the objects listed in # 1, above, have active volcanoes? ___________________________

4. Which have evidence of past volcanoes? ______________________________________________

5. How is the size of a planet or moon related to whether or not it has active volcanoes? Use a complete sentence.

   __________________________________________________________________________

   __________________________________________________________________________

 