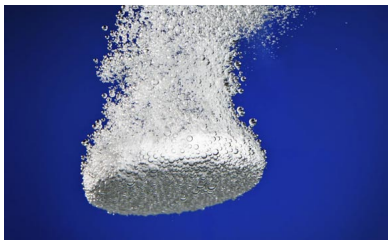
Lesson 4



Suggested Timeline

45 minutes

Materials

- 6 effervescent tablets (such as Alka-Seltzer®)
- clear plastic cup
- thermometer
- timer
- waste bowl
- disposable coffee cups (for hot water)
- hot water
- ice
- room temperature water
- small hammers (or other tool to crush tablets)

Prep

1. Students should have a system of how to take notes from a presentation (Cornell, interactive notebook, etc.)
2. Make copies of the Effervescent Antacid Weathering
3. Prepare trays/bins of materials for each group and have a table set up in an area with easy access to the hot water, room temperature water, and ice.

Effervescent Antacid Weathering

Summary

In this inquiry-based lesson, students investigate how different factors affect the rate of chemical weathering. The dissolution of common effervescent antacid tablets are used as a model for chemical weathering. During the first part, students run four tests to determine how temperature affects the rate of dissolution. They are given three different temperatures of water (hot, room temperature, and ice) and then decide on a fourth temperature, building their reasoning and inquiry skills. After testing, students complete a C-E-R response based on their results.

In part two, students engage in more inquiry to design two more tests to make the effervescent antacid tablet dissolve even faster.

Objective

- To engage students by giving them the freedom to create different tests
- To collect data using scientific instruments
- To use evidence collected to explain how temperature and other factors affect the rate of dissolution.

Teacher Background Knowledge

This activity primarily investigates chemical weather and the factors that may affect the rate of weathering. There are two types of weathering processes: chemical and physical weathering. *Physical weathering (*also known as *mechanical weathering)* is the result of physical forces that break rock into smaller and smaller pieces without changing the rock's mineral composition. *Chemical weathering* involves the chemical transformation of minerals and commonly results in the dissolution of minerals in a rock. Generally, chemical reactions occur more rapidly at higher temperatures. Thus it is clear that chemical weathering of rocks and minerals is more intense in warmer environments (low latitudes) than in colder environments (high latitudes). In addition, chemical weathering is generally enhanced in wet environments. The physical weathering of rocks increases the rate of chemical weathering by increasing the surface area on which chemical reactions occur. This is analogous to the more rapid dissolution of granulated sugar in a cup of coffee relative to a single large rock sugar crystal.

Lesson 4 Effervescent Antacid Weathering

Standards [12]

NGSS Performance Expectations: *This lesson supports students in **progressing toward** the NGSS Performance Expectation.*
MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]
Assessment Boundaries: *Assessment is limited to the interactions of two systems at a time.*

In this lesson…

Science and Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concepts
Planning and Carrying Out Investigations Students will plan an investigation that analyzes the effects of temperature on dissolution rates. Students will individually and collaboratively consider the different variables. Students will have the opportunity to revise their experimental design to try to increase the rates of dissolution. Quantitative and qualitative data will be collected to serve as evidence for constructing their explanations.	**ESS2.A: Earth's Materials and Systems** The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. **ESS2.C: The Roles of Water in Earth's Surface Processes** Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.	**Stability and Change** Students examine changes in one part of a system and relate it to how chemical weathering occurs at different rates depending on different climates. **System and System Models** Students create a model of different environments using different temperature ranges of hot water and then observe how the effervescent antacid tablet is "chemically weathered".

In this lesson…

CCSS Mathematics	CCSS English-Language Arts
CCSS.MATH.CONTENT.6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.	CCSS.ELA-LITERACY.RI.6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

[1] NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, D.C.: The National Academies Press.

[2] National Governors Association Center for Best Practices, Council of Chief State School Officers Title: Common Core State Standards (insert specific content area if you are using only one) Publisher: National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C. Copyright Date: 2010

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Prior Knowledge

In grades 3-5, students learned that water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around. Students have also learned that most of Earth's water is in the ocean and much of the Earth's fresh water is in glaciers or underground.

In the previous lessons, students have learned about mechanical weathering and the role of weathering and erosion when forming mountains and landscapes. Students have also learned about the different types of weathering and had a small introduction to chemical weathering using a flavored hard candy.

Lesson

PART 1

1. Pose the following questions to the class: "Will water temperature affect how fast an effervescent table will dissolve?" and "How does the temperature of water affect how fast an effervescent tablet will dissolve?"
2. Instruct students to select their prediction on their worksheet and explain their thinking.
3. Divide students into groups of 4.
4. Explain the rules for creating the testing procedures for part one and point out where materials are.
5. Check with groups as they make their procedures to make sure they are gathering data that answers the presented question. After checking with groups, allow them to get materials and perform the 4 tests.
6. Instruct students to carefully watch for when the tablet disappears and not when the water stops fizzing. It is important that students measure the amount of time that it takes for the tablet to dissolve the same way each time in order to get good results.
7. Students will find that the dissolution rate is clearly a function of temperature where the warmer the water, the shorter the time it takes for the tablet to dissolve.
8. As groups of students finish each test they should record their data and observations, pour each completed test into their waste bowl, then proceed with the next test.
9. After students have finished the four tests, have them answer the analysis question.

PART 2

10. Instruct groups that have finished testing to brainstorm additional ways to make the effervescent tablets dissolve even faster.
11. Once these groups have discussed more ideas, give them 2 more tablets and have them complete two more tests
12. In the best case, students will want to break up the tablet to see if that changes the dissolution rate. The teacher may need to guide students to this experiment. The tablet may be crushed by gently tapping it with a hammer while the tablet is inside the packet or in a small plastic bag (or wrapped in paper).
13. Ideally, students will perform a controlled experiment where one tablet is whole, the second is crushed and the temperature of the water is the same in both trials. In this way, students can compare the effect of crushing the tablet (with water temperature being equal).
14. Students will find that a crushed tablet will dissolve more rapidly (almost instantaneously) that a whole tablet due to the increase in the surface area in the crushed tablet.

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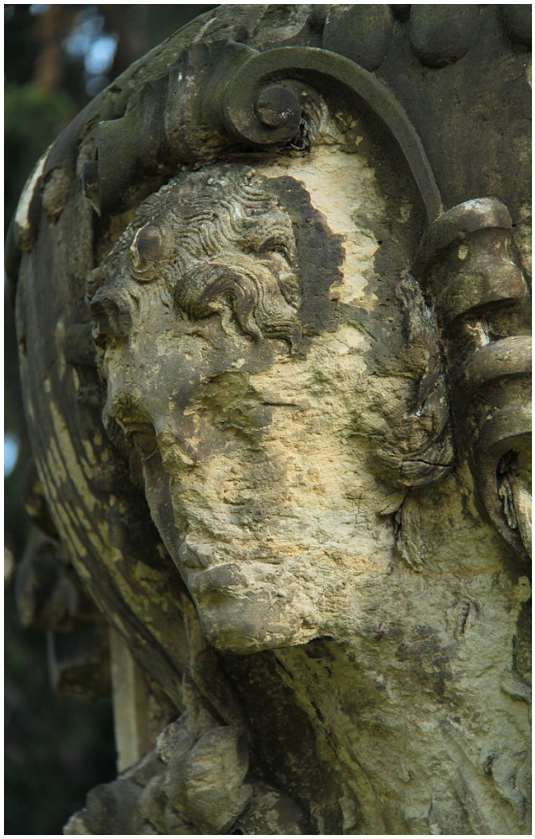
Potential Pitfalls

Students are asked to create 4 tests in part 1 but they are only given three different types of water (hot, room temperature, and ice). This is done to push students to think about different ways they can test their question. Remind students that temperature is a continuum and they need to create a temperature of water they haven't tested before.

In order to get good consistent results, students must agree to when they will stop timing the dissolution of the tablet. The tablet will disappear before the fizzing of the solution ends. Students must closely observe the tablet and measure the time it takes for it to disappear.

After creating and observing this model activity, students may conclude that chemical weathering is a rapid process since the tablets dissolve so quickly. It should be reinforced to students that the tablets are only a model for the weathering of rock and that real rocks are affected by chemical reactions at a much slower rate. Make sure that students understand the relative timeframes for geologic change as they relate to weathering of rock.

If some groups finish early, they can use the extra time to brainstorm about how to test other factors that will affect the amount of time it takes for a tablet to dissolve.



Weathering of statue in Dresden, Germany
Source: Wikimedia Commons User Slick