



## REACTION RATES

### LESSON DESCRIPTION

A whole antacid tablet and a crushed tablet are added to separate beakers of water so that their relative reaction rates can be compared.

### OBJECTIVES

Students will

- Discover conditions that make a reaction proceed faster or slower
- Demonstrate how increasing the surface area of a chemical increases its reaction rate

### NASA SUMMER OF INNOVATION UNIT

*Physical Science*

### GRADE LEVELS

4–6

### CONNECTION TO CURRICULUM

*Science*

### TEACHER PREPARATION TIME

10 minutes

### LESSON TIME NEEDED

1 hour

*Complexity: Basic*

## NATIONAL STANDARDS

### National Science Education Standards (NSTA)

*Physical Science*

- Properties and changes in properties of matter

*Science and Technology*

- Abilities of technological design
- Understanding science and technology

## MANAGEMENT

This activity is an ideal way for safely showing how the burning rate of rocket propellants is increased without having the students use fire. However, you may choose to demonstrate a model rocket launch prior to the activity in order to give students an experiential point of reference. Another option is to use a model rocket launch after this lesson to reinforce concepts.

The materials list calls for rock salt, table salt, and magnifying glasses. Use these materials with students as a way to demonstrate how the difference in surface area will affect their solubility in water.

A similar activity can be tried with small pieces of hard candy. Take two pieces of candy and crush one. Then give the whole candy piece to one student and the crushed candy to another student to dissolve in their mouths.

Demonstrate the same effect by trying to ignite a thick piece of wood with a match. Next, cut the wood with a sharp knife to make shavings. Then, try to ignite the shavings. Caution: Be sure to exercise proper safety precautions with fire.

## CONTENT RESEARCH

In water, a sugar cube dissolves in water at a much slower rate than if the same cube is first crushed. The crushed cube has a greater surface area—more parts of the sugar are in contact with the water. In a fireplace, wood chips burn faster than a pile of logs. In both of these cases, the smaller pieces, with their increased surface area, allow the particles that are reacting to come in contact with each other more often. This increases the collision frequency.

Another factor that influences reaction rate is the concentration of the reactants. An increase in concentration means an increase in the number of particles in the reaction. This results in an increase in the collision frequency. If a chemist wants to increase the rate of a reaction, an increase in the concentration of one or more of the reactants will do the trick.

Altering collision frequency and efficiency can also be accomplished through temperature changes. According to the kinetic theory, particles move faster at higher temperatures and slower at lower temperatures. The faster motion of the particles increases the energy of the particles and increases the probability that particles will collide. As a result, the reaction rate increases.

Catalysts play an important role in many chemical reactions. A catalyst is a substance that speeds up a reaction without being permanently changed itself. The catalyst lowers the action energy of the reaction. Many commercial reactions make use of catalysts, because the catalysts can be recovered, regenerated, and reused. You are probably familiar with the term catalytic converter, a device used in automobiles to improve the efficiency of unleaded gasoline engine's combustion exhaust. The catalyst in this converter is platinum.

This activity demonstrates how increasing the surface area of an antacid tablet by crushing it into a powder increases the rate in which it dissolves in water. This is a similar situation to the way the thrust of a rocket is increased by increasing the burning surface of its propellants. Increasing the burning surface increases its burning rate since more fuel becomes exposed to oxygen. In solid rockets, a hollow core extending the length of the propellant will permit more propellant to burn at a time. This increases the acceleration of the gases produced as they leave the rocket engine. Liquid propellants are sprayed into the combustion chamber of a liquid propellant rocket to increase their surface area. Smaller droplets react more quickly than do large ones, increasing the acceleration of the escaping gases.

### Key Concepts:

- The rate of a chemical reaction is the speed with which reactants are converted to products.
- Collision theory is used to explain why chemical reactions occur at different rates.
- Collision theory states that in order for a reaction to proceed, the reactant particles must collide.
- The more collisions there are per unit of time, the faster the reaction will be.

### Misconceptions:

Understanding the factors that influence the rate of a chemical reaction is a fairly complex, but completely logical, affair. Students readily accept the idea that molecules must collide if a reaction is to occur. However, many students have the misconception that every collision leads to the formation of product, when the truth of the matter is that many collisions do not go anywhere. A huge

## MATERIALS

- Antacid tablets (two per test)
- Two beakers (or glass or plastic jars)
- Tweezers or forceps
- Scrap paper
- Watch or clock with second hand
- Small block of wood
- Rock salt
- Table salt
- Water

percentage of molecules within a sample may collide without ever turning into products. When creating a mental picture of a successful collision, students must envision molecules that possess both proper orientation and a sufficient amount of energy. (Courtesy of [http://www.algebra-lab.org/activities/activity.aspx?file=Science\\_RateOfReactions.xml](http://www.algebra-lab.org/activities/activity.aspx?file=Science_RateOfReactions.xml))

## LESSON ACTIVITIES

Students explore factors affecting reaction rates.

<http://exploration.grc.nasa.gov/education/rocket/TRCRocket/antacid2.html>

## ADDITIONAL RESOURCES

This educational wall sheet illustrating Newton's Third Law of Motion is the third of a set of four that was developed by the Sonoma State University Education and Public Outreach group for the Swift mission. <http://teachspacescience.org/graphics/pdf/10000798.pdf>

## DISCUSSION QUESTIONS

What is the definition of rate of reaction? *Rate of reaction is defined as how fast reactants are used up or products appear.*

Let students examine rock salt and table salt using magnifying glasses. Then ask what will happen when they are each mixed with water? *The different types of salt have differences in their surface areas that affect their solubility in water.*

Which one will dissolve first in the water? *The table salt will dissolve first.*

Why is there a different time taken for the salt to dissolve? *This is because the smaller granules of table salt provide more surface area for the reaction.*

How could this happen? *When the surface area of the substance increases, the rate of reaction also increases.*

## ASSESSMENT ACTIVITIES

In order to determine whether or not students are achieving the learning goals for the activity, the teacher should monitor progress in the lab to see what kind of results students are obtaining. Also, students will turn in their collected data in a lab writeup, where they will summarize their findings.

## ENRICHMENT

Consider using the following activities to enrich the concepts taught in this lesson.

Students can discover in the "Part B: It's Alive!" activity that chemical makeup of substances play a role in their reaction rates.

<http://ares.jsc.nasa.gov/education/websites/astrobiologyeducation/Data/lookingLife.PDF>

Students make slime to explore the concept of combining substances to form new substances.

<http://astroventure.arc.nasa.gov/teachers/pdf/AV-Atmoslesson-4.pdf>