

*Exploring Surface Area*

**Overview:**

In this lesson we will discuss how to describe the amount of space and object takes up and review the definitions of area, volume, and surface area. Understanding the amount of surface area on an object is important to material scientists since the surface of a material can affect the rate of reactions and other material properties such as conduction of electricity, emission of light

**Essential Question:**

What is surface area and what material properties are affected by surface area?

**Vocabulary:**

Colloquial description of vocab.

* Volume – the amount of space an object occupies
* Surface area – the amount of outermost part of a material
* Defects – a change from the normal pattern in a crystal

**Background:**

Surface area can play an important part in both material properties and reaction kinetics. In this lesson, we want students to learn (1) the difference between surface area and volume (2) how to increase surface area and (3) why surface area is important to how fast a reaction occurs. Additionally, we want students to understand that surfaces can have a large amounts of defects which can prevent the materials from performing well.

## Research Connection:

Surface area can play an important role chemical reactions and material properties. For reactions, having a larger surface area increases the amount of space available for the reaction to occur. Additionally, materials with large amounts of defects on the surface of the material can lose their properties such as conduction of light emission.

## NGSS Standards:

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| --- | --- |
| Standard Number | Standard text |
| MS-PS1-2 | Analyze and interpret data on the properties of substances before and after the substance interact to determine if a chemical reaction has occurred. |

## Materials:

* Alka-seltzer tablets
* Plastic cups
* Mortar and pestle
* ballons

## Procedure:

First, review with students how last week they demonstrated how the thickness of materials can affect how it interacts with its surroundings – i.e. nail polish can separate light into different colors. Similarly, the amount of surface area can change properties of materials.

We want to teach students the difference between surface area and volume and that the same volume of material can have different surface areas. A good way to demonstrate this is to have the students stand and form a square as shown below with the students represented with “X”.

 X X X X X

X X X X X

X X X X X

X X X X X

X X X X X

The students have now created an object with a certain volume. To draw a connection between volume and amount of material, determine the total number of students and say that this represents the “volume” of our objects.

Next, we want to figure out the surface area of our object. Have the students raise their hand if they are on the outside of the square. These students represent the surface are of the object.

To show that we change the surface area of an object without changing the volume of an object, we want to rearrange the students into a rectangle.

 X X X X X X X X X X

X X X X X X X X X X

X X X X X X X X X X

Another way to change the surface area is to split an object into smaller pieces. The overall amount of the object remains the same, but the amount of the object on the surface increases. You can show this by having the students break into smaller rectangles.

We have now demonstrated the difference between surface area and volume and how you can change the surface area without changing the volume of a material.

Now, we want to explore the affects of surface area on the rate of reactions. We will do this by having the students observe the differences in how quickly an alka-seltzer tablet dissolves when it is crushed vs when it is whole. Before beginning the experiment, we want students to consider the scientific method – (1) Ask a question (2) construct a hypothesis (3) test with an experiment (4) analyze data (5) determine a conclusion.

The question for this experiment is – **Does the surface area affect how quickly the alka-seltzer tablet dissolves?**

To test this, students will have two cups in front of them. One cup will have a crushed tablet (done beforehand by volunteers using mortar and pestle) and the other tablet will have a whole tablet.

Ask the students the following questions:

1. What factors could affect how quickly the tablets dissolve? **Let the students brainstorm, but help them along if needed – they should be able to come up with temperature, amount of water, and surface area.**
2. Which tablet has the most surface area? **Crushed tablet**
3. How do we control the other factors mentioned?  **Same water source, keep the level of water the same between the two cups.**
4. What do they think will happen when they add water?  **Bubbles will form as the tablet dissolves**
5. How can you tell which is reacting faster? **Time how long it takes to dissolve, how many bubbles are released.**
6. Which tablet do they think will dissolve faster and why?

Once the students have designed their experiment and come up with their hypothesis, allow them to add water to cups and observe their reactions. Engage with the students as they observe and have them explain how the experiment is proving or disproving their hypothesis.

Once the tablets are dissolve, have the students discuss their results and talk about how surface area can affect the rate of reactions by allowing more sites for the reaction to occur. This can be tied into electrode materials, catalysts, or other research interests.

For the second part of the lesson, we want students to understand that the surface of a material is a place that allows for a lot of material **defects**. A defect is any change in the pattern of a material, and we can demonstrate defects by having the students form into the square again.

X X X X X

X X X X X

X X X X X

X X X X X

X X X X X

Once the students are in a square, have on of the student from the center try to move out of the square without touching anyone else (the students might have to pack closer together for this). This should be hard for someone inside but easy for someone on the outside of the square. Explain to the students that one type of defect is having a missing piece.

Another type of defect is when a piece is out of place, this can be demonstrated by having a few students step out of their normal place.

To demonstrate how these defects impact the properties of the material, we are going to simulate conduction by passing a balloon through the material. However, if the student not in the normal position then they can not pass the balloon. Have the students repeat this exercise with different amounts of “defects” to show that as the amount of defects increases, the conduction decreases.

## Discussion

## How does surface area impact the rate of reactions?

## How can you increase surface area on a material?

1. What happens if the surface of a material has defects? Describe some types of defects in a material?
2. What are other applications where surface area is important?