

## The Space Between

### Abstract

To address a common misconception that between molecules there is “air” or between the nucleus and electrons of an atom there is “air” students create an infographic about the space between after seeing demonstrations and having a discussion

### Learning Objectives

- Describe the composition of atoms in terms of subatomic particles and the space between them
- Explain the difference between a vacuum and air.
- Describe the composition of the universe in terms of atoms and space.
- Create an infographic about the space between atoms in interatomic and subatomic levels.

### Logistics

#### Time Required

- Class time: 120 - 200 minutes
- Prep time: 20 - 30 minutes

#### Materials

Student handouts, high purity methanol (anhydrous), water, long glass tube with stoppers on each end, food coloring, 1 L beaker, round objects of various size, sand, molecule cut-outs, student computers/netbooks/tablets for infographic creation

Great Space simulation:

[http://joshworth.com/dev/pixelspace/pixelspace\\_solarsystem.html](http://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html)

Glass demonstration tube ~\$15/ea

<http://www.flinnsci.com/store/Scripts/prodView.asp?idproduct=19463>

Methanol (anhydrous)~6/500mL

<http://www.flinnsci.com/store/Scripts/prodView.asp?idproduct=19938>

#### Appropriate For

- 9<sup>th</sup>-12<sup>th</sup> grade students

### Student Instructions

- After watching your teacher's demonstration, come up with an explanation for the decreased volume with your partner and be prepared to share and discuss. You may use the molecule papers to help form your explanation.
- After the class discussion, how did your ideas change? What really happened?
- Use your textbook, resources and the internet to gather information about the space between atoms and molecules, the space between the nucleus and electrons, and the space between objects in space.
- Create an infographic synthesizing and organizing the information you gathered.

## Teacher Recommendations

This is a guided inquiry activity where students attempt to explain a phenomena that seems to counter their previous knowledge of the conservation of matter. This activity helps them understand that between molecules is nothing, just space. Often students mistakenly believe that there is “air” between molecules, but air is made of molecules! The first part of the lesson is done as a demonstration, paired discussion, then whole class discussion. After this, students conduct research to create a digital infographic about the space that exists between planets, atoms, and subatomic particles.

Even as students are discussing in their pairs, roam the room to listen in on conversations. If they are completely lost, ask them some questions to guide their thinking such as, “are there any attractions between the molecules?” or “what are the differences between the types of molecules?” If you have a document camera, you can show how the water molecules fit in the spaces between the methanol molecules, or you may want to show the diagram included in the answer key.

If students have computer/Internet access, you can assign finishing the infographic as homework. If access is only available at school, plan to use more class time to work on the infographic.

## Assessment

The format of this lesson allows you to constantly monitor the student learning process. Students discussing in pairs will also help each other form concepts and ideas about how the demonstration worked. The final assessment for this activity is the creation of a digital infographic. A rubric is included in the student handout.

## Answer Key

The answer key at the end is an example of how a student might answer the question. You may want more or less depth in student responses depending on time and the age group you are working with.

# The Space Between

Name \_\_\_\_\_ Date \_\_\_\_\_ Per \_\_\_\_\_

After the demonstration:

After watching your teacher's demonstration, come up with an explanation for the decreased volume with your partner and be prepared to share and discuss. You may use the molecule papers to help form your explanation.

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After the class discussion:

1 How did your ideas change?

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2 What really happened?

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Task:

- 1 Use your textbook, resources and the internet to gather information about the space between atoms and molecules, the space between the nucleus and electrons, and the space between objects in space
- 2 Create an infographic synthesizing and organizing the information you gathered

Research:

Remember to analyze the validity and credibility of your research when you use the Internet. Cite your sources. Only use images that are made by you or copyright free and credited

Specification sheet for *The Space Between* Infographic

Features to include on infographic	Present, Missing, or Needs Improvement
Shows creativity	
Tells a story	
The information flows in an organized manner	
The information is clear and concise	
Uses charts, graphs, and statistics to present numerical information	
Addresses: What is the relative distance between nucleus and electrons in an atom?	
Addresses: What is in between molecules of air?	
Addresses: What is outer space really made of?	
All information and images contribute to the message of the infographic	
Uses and cites multiple credible sources	
The title stands out and fits the contents and message	
The text can be read easily and contrasts with the background	
Images are clear, relevant, original or copyright free, and credited	
Fonts, shapes, and colors are consistent throughout	

Infographic tools

Glogster: <http://glogster.com>

Infogram: <http://infogram>

Piktochart Infographics:

<http://piktochart.com>

## Answers and Teacher Notes

### Demonstration:

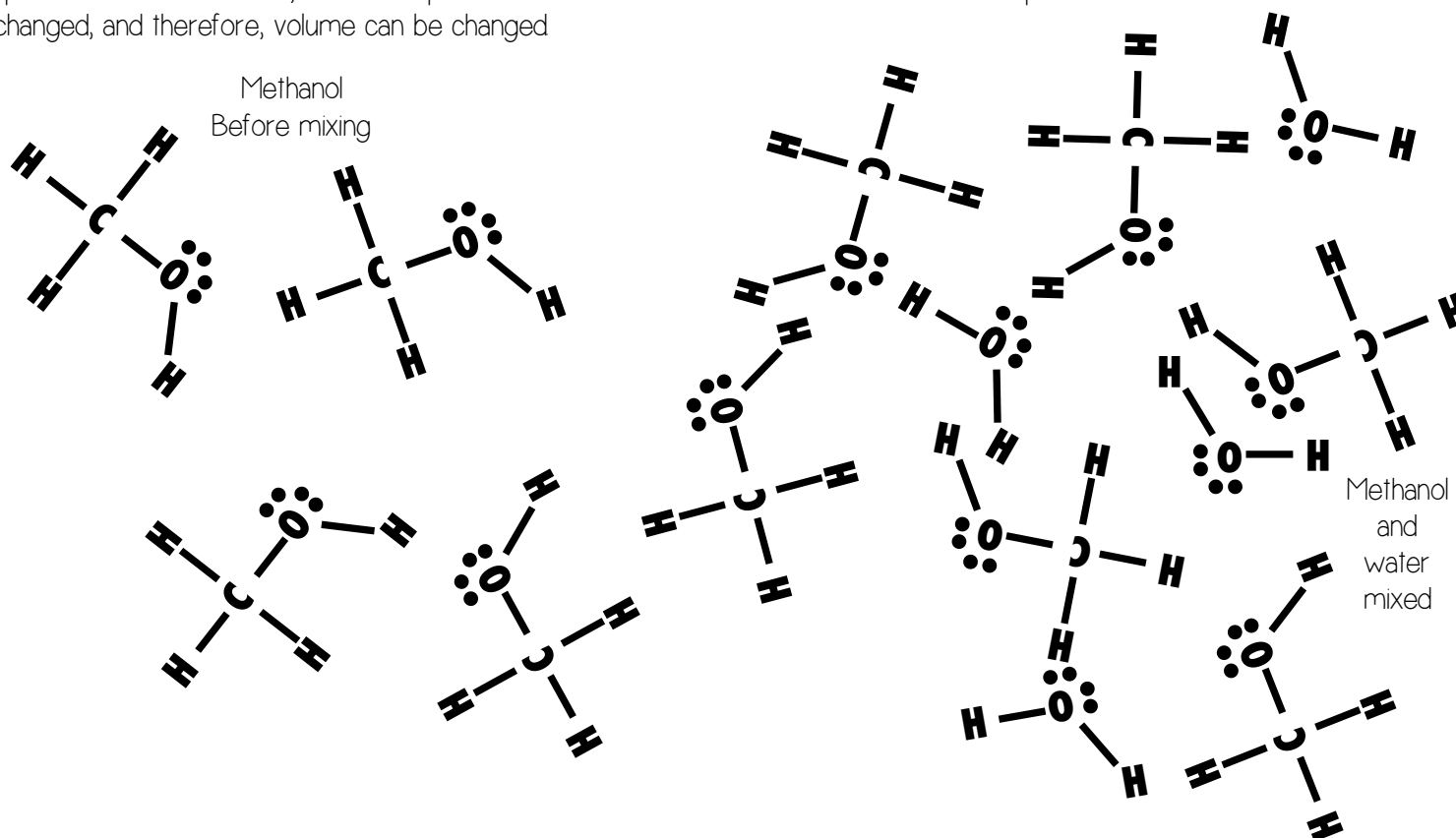
In front of the class, fill the demonstration tube half way with colored water. (the color just makes it easier for the class to see). Then tilt the glass tube and slowly pour the methanol in, avoiding mixing as much as possible, until the liquid is an inch or two from the top. Put a stopper on the top of the tube and have a student mark the top of the liquid line with a sharpie. Make sure it's easy to see around the room. Now tilt the tube upside down and back to mix the liquids. During this time, explain that you are mixing the two liquids together, and assure them that alcohol and water won't make a chemical reaction. Rubbing alcohol, wine, and spirits are all mixtures of water and alcohol. Keep mixing until you can see a clear drop in liquid level from the original line. You may see bubbling, but this does not indicate a reaction. This is just methanol vapor forming from the movement and to compensate for the lower pressure created by the increased volume of the space between the liquid and the stopper in the demonstration tube. Walk around and show students the different, lower height of the liquid in the tube, and have them come up with an explanation with their partner. They can use the methanol and water molecule cut outs if that helps them come up with an explanation.

### Class Discussion:

Now students have come up with some explanation of the event. Have groups share out their ideas, defend them, and have other groups argue against or for them. Make sure to refrain from saying "right" or "good" but instead, say "thank you" if the group needs acknowledgment. As the class discussion is coming to either consensus or isn't moving forward, do the following quick model: put large balls (ping pong balls, or super balls) in the beaker. Ask the class if it is full. Now put smaller balls (marbles) in the jar and see that they fit in the spaces. Ask the class if it is full. Now add sand to the jar. Ask the class if it is full. Now add water. The idea here is that smaller items can fit in the spaces of larger items. Ask the class to look at their molecule papers and decide which will act like ping-pong balls, and which acts as marbles. See if each pair can come up with the correct model of what is really happening. Show the molecules on the board, or show the pictures below as an explanation of what's really happening.

### What's happening?

When water and methanol mix, water is able to fit in the spaces between methanol molecules. There was nothing there, but now water molecules are there. Volume is not conserved the way mass is conserved, because there is so much empty space between molecules, subatomic particles and even the universe. Those distances in space can be changed, and therefore, volume can be changed.



Leading to the research:

Students will now research the actual amounts of space that exist between subatomic particles, molecules and objects in space. They will compile their research into an infographic. You may choose to have them work alone or in teams based on time and student age. Show some examples of infographics to get ideas flowing. Students can build their own from scratch using Microsoft Word, PowerPoint, Excel, Adobe Photoshop or Illustrator; or they can use infographic website tools like Piktochart. This creates an opportunity for them to combine their artistic abilities with storytelling and science.

Paper molecules (print these for students to cut out and use as models)

