

Investigating Space Between Particles in Matter

Background Information

If you have ever seen water drain through beach sand, you know that there are spaces between the grains of sand. Because the grains of sand are relatively small and separate, you can pour sand almost as if it was a liquid. There are also spaces between the tiny particles that make up all matter.

In this investigation, you will first measure the volume of the space between grains of sand by filling a container with sand and water. Then, you will measure the volume of the space between the particles in a liquid by mixing two liquids together.

Problem

How much space is there between grains of sand or between particles in liquids?

Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

- 1. Using Analogies** Why is there space between marbles in a bowl? What factors might determine how much space there is between particles in a solid or liquid?

- 2. Predicting** What do you expect to happen to the height of the material in the beaker when you begin to add water to the sand? Explain your answer.

Name _____

Class _____

Date _____

3. **Predicting** In the investigation, you will mix ~~100~~⁵⁰ mL of water with ~~50~~¹⁰⁰ mL of isopropyl alcohol. Predict whether the volume of this mixture will be less than, equal to, or more than ~~200~~¹⁰⁰ mL. Explain your answer.
- _____
- _____
- _____
- _____
- _____

Materials (per group)~~2 250-mL graduated cylinders~~~~100-mL graduated cylinder~~

isopropyl alcohol

sand

glass stirring rod

2 - 100 mL cylinders
50 mL cylinder

Safety

Put on safety goggles and a lab apron. Be careful to avoid breakage when working with glassware. Always use caution when working with laboratory chemicals, as they may irritate the skin or stain skin or clothing. Never taste any chemicals unless instructed to do so. Keep alcohol away from any open flame. Wash your hands thoroughly after carrying out this investigation. Note all safety alert symbols next to the steps in the Procedure and review the meaning of each symbol by referring to the Safety Symbols on page xiii.

Procedure

1. Fill a ~~250-mL~~^{100 mL} graduated cylinder to its ~~200-mL~~^{75 mL} mark with sand.
2. Fill the ~~100-mL~~^{50 mL} graduated cylinder to the ~~100-mL~~^{50 mL} mark with water. Slowly pour a little water into the graduated cylinder containing the sand. Continue pouring until the level of the water in the sand reaches the ~~200-mL~~¹⁰⁰ line. Observe the volume of water remaining in the ~~100-mL~~⁵⁰ graduated cylinder. Record this volume in Data Table 1.
3. Calculate the volume of water added to the sand by subtracting the volume of water remaining in the graduated cylinder from the total volume of water. Record your result in Data Table 1.
4. Pour ~~100-mL~~⁵⁰ of isopropyl alcohol into the ~~250-mL~~¹⁰⁰ graduated cylinder. **CAUTION:** Isopropyl alcohol is poisonous and flammable.
5. Fill the ~~100-mL~~⁵⁰ graduated cylinder to the ~~100-mL~~⁵⁰ mark with water. Slowly pour the water into the graduated cylinder containing the isopropyl alcohol. Use the glass stirring rod to mix the two liquids. Observe the volume of the mixture. Record this volume in Data Table 2.

6. Subtract the volume of the alcohol-water mixture from the total volume of alcohol and water. Record this difference in Data Table 2. Wash your hands thoroughly after completing the investigation.

Observations

DATA TABLE 1

Material	Volume (mL)
Total water	100 50
Remaining water	
Water added = total water – remaining water	

DATA TABLE 2

Material	Volume (mL)
Alcohol	100 50
Water	100 50
Mixture	
Volume change = mixture – (alcohol + water)	

Analysis and Conclusions

1. **Analyzing Data** What was the total volume of the space between the grains of sand?

2. **Drawing Conclusions** Based on this investigation, how do you know that there is space between the particles in alcohol or water?

3. **Formulating Hypotheses** Why did the total volume of water and alcohol decrease when the liquids were mixed together?

Go Further

If the distances between the particles of a material change, will the volume of the material change? Design an experiment to determine the percentage change in volume that occurs when materials such as water, paraffin, or shortening change from solid to liquid or from liquid to solid. When your teacher has approved your experiment, perform it under your teacher's supervision, using all necessary safety procedures. Report your observations and conclusions.

Rubric for major labs

Physical Science Major Labs Rubric

	Beginner 1	Developing 2	Accomplished 3	Advanced 4
Data Chart	Data is inaccurate and/or represented poorly. No units are used, hard to follow, messy.	Data is accurate but something is not labeled (title of chart/ heading of columns/ units)	Easy to follow Missing units on some entries. Title present.	All data entered. Used units and title. Easy to follow. Neat and organized. Professional looking.
Question 1-3, pre lab questions	Not a sentence. Vague answer, did not explain your answer	Wrote a sentence, but did not explain your answer or your explanation is not appropriate.	Wrote a good sentence and attempted to explain the answer but your explanation did not fully explain your answer.	High school level sentence, explanation fully explains your point.
Analysis and conclusion questions.	Not a sentence. Vague answer, did not explain your answer	Wrote a sentence, but did not explain your answer or your explanation is not appropriate.	Wrote a good sentence and attempted to explain the answer but your explanation did not fully explain your answer.	High school level sentence, explanation fully explains your point. You used your data to explain your answer.
Mechanics	Many errors in spelling, punctuation and/ or grammar. Not in sentence format	5-10 noticeable errors in spelling, punctuation and/ or grammar. Did echo the question.	1-4 noticeable errors in spelling, punctuation and/ or grammar. Did echo the question.	No errors in spelling, punctuation and/ or grammar. Did echo the question.