

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.

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

Materials *(per group)*

2 250-mL graduated cylinders
100-mL graduated cylinder
isopropyl alcohol
sand
glass stirring rod

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 graduated cylinder to its 200-mL mark with sand.
2. Fill the 100-mL graduated cylinder to the 100-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 line. Observe the volume of water remaining in the 100-mL 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 of isopropyl alcohol into the 250-mL graduated cylinder. **CAUTION:** *Isopropyl alcohol is poisonous and flammable.*
-  5. Fill the 100-mL graduated cylinder to the 100-mL 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
Remaining water	
Water added = total water – remaining water	

DATA TABLE 2

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

Analysis and Conclusions

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

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

- 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.