

# Penny Crystal Structure

**Overview:**What in the world is going on when water freezes? Something is happening to those little H<sub>2</sub>O molecules, but what??? You'll find out today using pennies and a ruler.

**What to Learn:**You will learn what atoms and molecules are up to in their little microscopic world as they go from a liquid to a solid. You will also see what happens when a solid breaks. (Have you ever chipped off a piece of ice? Then you already know what cleavage is!)

## Materials

- 50 pennies
- ruler

## Experiment

1. Lay about 20-50 pennies on the table so that they are all sitting flat on the table. Now, use the ruler to push the pennies toward one another until there is one big glob of pennies on the table, all touching one another. Don't push so hard that they pile on top of one another.
2. Take a look at the pennies. Do you notice anything? You may notice that the pennies form patterns. How could that happen? You just shoved them together you didn't lay them out in any order. Taadaa! That's what often happens when solids form.
3. Now, place your ruler on the right hand side of your penny blob so that it's touching the bottom half of your pennies.
4. Slowly push the ruler to the left and watch the pennies.
5. You may have noticed that the penny "crystal" split in quite a straight line. This is called cleavage. Since crystals form patterns, they will tend to break in pretty much the same way you saw your pennies break

## Reading

Imagine a bunch of folks all stuck to one another by big rubber bands. Each person can wiggle and jiggle but they can't really move anywhere. Atoms in a solid are the same way. Each atom can wiggle and jiggle, but they are stuck together. In science, we say that the molecules have strong bonds between them. Bonds are a way of describing how atoms and molecules are stuck together.

There's nothing physical that actually holds them together (like a tiny rope or something). Like the Earth and Moon are stuck together by gravity forces, atoms and molecules are held together by nuclear and

electromagnetic forces. Since the atoms and molecules are so close together, they will often form crystals.

The molecules are pulled so close to one another that they will form patterns, also known as matrices. These patterns are very dependent on the shape of the molecule, so different molecules have a tendency to form different shaped crystals. Salt has a tendency to form a cube shape. Go take a look... and you'll find that they are like little blocks!

Water has a tendency to form triangle or hexagon shapes, which is why snowflakes have six sides. The pennies in this experiment also form a hexagon shape. Solids don't always form crystals, but they are more common than one may think. A solid that's not in a crystalline form is called amorphous.

In this experiment, the penny "crystal" will split in quite a straight line. This is called cleavage. Since crystals form similar patterns, they will tend to break in the same way the pennies break.

Break an ice cube and take a look. You may see many straight sections. This is because the ice molecules "cleave" according to how they formed. The reason you can write with a pencil is due to this concept. The pencil is formed of graphite crystal. The graphite crystal cleaves fairly easily and allows your students to write down their amazing physics discoveries!

### Exercises

1. Explain what happened when you pushed the pennies together.
2. Draw a diagram of the structure your pennies formed.
3. You observed how the pennies broke into a straight line when pushed around with a ruler. What is this called? Do you think all crystals break into a perfectly straight line? Why or why not?
4. Are atoms closer together in a liquid or a solid?
5. You learned that many solids form into crystalline shapes but that some don't. What are these called?

### Answers to Exercises

1. Explain what happened when you pushed the pennies together. (They formed a pattern)
2. Draw a diagram of the structure your pennies formed. (answers will vary but should show a roughly hexagonal pattern)