STEM gems

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CRYSTAL SNOWFLAKES

big IDEAS

THE CRUNCH OF FRESH SNOW UNDERFOOT, the crackle of chestnuts roasting on an open fire, and the smell of eggnog all signal that it's time for a little winter STEM activity. If you find that real snowflakes are pretty, but melt too quickly, than this is a great activity for you. This activity will allow you to use some simple science to grow permanent glittering crystal snowflakes.

WHAT IS A CRYSTAL?

Crystals come in all shapes and sizes, from sugar and salt to emeralds and diamonds. A crystal is a solid substance that has a natural symmetrical pattern of faces and angles caused by an orderly, repetitive arrangement of the atoms in the substance. All crystals have a specific shape because the atoms that they are made from can only fit together in a special pattern. It is this pattern that gives each type of crystal its shape. Crystals are defined by having straight edges, clean angles, clearly defined surfaces, a particular hardness, and a predictable shape. The shape of a crystal can help scientists identify what the crystal is.

WHAT IS A SNOWFLAKE?

Snowflakes are really snow crystals. Snow crystals are not simply frozen raindrops; that is called sleet. Snow crystals are special and form when water vapor in the air freezes directly into ice without first becoming water. Snow crystals grow as more vapor condenses and form very ornate patterns as they grow. Due to the way water molecules fit together, snow crystals always start with six corners, so snow crystals always have six arms and hexagonal symmetry. Each snow crystal is different from all others because, as it forms, it experiences different temperatures and humidity levels tumbling through the clouds, causing the vapor to freeze in different patterns.

WHAT IS BORAX?

Borax, also known as sodium borate or sodium tetraborate, is a mineral and a salt of boric acid. Powdered borax is white, consisting of soft, colorless crystals that dissolve easily in water. Borax first came into common use in the late 19th century when Francis Marion Smith's Pacific Coast Borax Company began to market and popularize a large variety of applications under the 20 Mule Team® Borax trademark, named for the method by which borax was originally hauled out of California and Nevada deserts in large enough quantities to make it cheap and commonly available. Borax has a wide variety of uses. It is a component of many detergents, cosmetics, and enamel glazes.

SCIENCE talk

CRYSTAL
A solid whose atoms are arranged in an ordered, repeating pattern.

CRYSTALLIZATION
To cause to form crystals.

EVAPORATE
To change from a liquid into a gas.

MINERAL
A mineral is a naturally occurring inorganic solid with a definite chemical composition and a regular repeated crystal structure.

SYMMETRICAL
Something that is exactly the same on both sides when split by an axis.

engage

What is a crystal? *A solid with a definite symmetrical shape.*

What is a snowflake? *Ice crystals that form high in the clouds when water freezes.*

Who has taken a close look at a single snowflake? Describe what you saw. *Children's choice.*

What shape are snowflakes? How are they formed? *Snowflakes are ice crystals that form high in the sky. Snowflakes grow into amazing patterns. Each snowflake is different from all others because the slightly different conditions it experiences as it freezes causes the crystal to grow in different ways. Even though all snowflakes are different, each one is hexagonal with six arms or sides.*

What are some of the rules we should have when working with chemicals? *Explain the following Chemistry Safety Rules and ask for additional ideas. Note: contrary to youth development practices, two of these rules are stated in negative terms to communicate explicit safety expectations.* ***(1)*** *Do not eat or drink any chemicals at any time.* ***(2)*** *Do not touch or smell any chemicals at any time.* ***(3)*** *Listen carefully and follow all directions.* ***(4)*** *Use both hands for stirring and pouring and keep mixing containers flat on the table while mixing.* ***(5)*** *Ask to have things passed instead of reaching across others.* ***(6)*** *Wash hands before and after any experiment.* ***(7)*** *Keep paper towels nearby to clean up spills.*

what YOU WILL NEED & before YOU BEGIN

FOR EVERY CHILD:

- **12-oz wide mouth Mason jar or coffee cup**
- **1 pencil or pen**
- **3-inch piece of string**
- **1 white pipe cleaner cut into three equal pieces**

FOR THE GROUP:

- **Paper towels**
- **Magnifying glasses** *(optional)*
- **Water** *(to be boiled)*
- **Heat source**
- **Pan**
- **Mixing spoon**
- **Box of borax**
- **Masking tape**
- **1-Tablespoon measuring spoon**
- **1-cup measuring cup**
- **Scissors**

- Cut each white pipe cleaner into three equal-size pieces.
- Make the borax solution. Begin by boiling enough water in a pan to give each child one cup. Carefully add borax to the water one tablespoon at a time. You should add three tablespoons of borax for every cup of water. Stir the solution thoroughly to dissolve as much of the borax as possible and let the solution cool before allowing children to experiment with it.
- Pour the cooled borax solution into the Mason jars or cups, one per child. Place the jars where they can sit undisturbed. A lid to a storage box makes a great temporary tray.

EXPLORE & EXPERIMENT

1. **Share with children that snowflakes are hard to see individually because they clump together and melt if you try to catch them.** Explain to children that they are going to make a permanent crystal snowflake that will never melt and can be hung as a winter decoration.

2. **Provide each child with three pieces of pipe cleaner.** Have each child make a snowflake with the pipe cleaner pieces. Instruct children to begin by stacking two of the three pipe cleaner pieces on top of one another to form a cross and bending the pieces around one another to join together. Then have children lay the last pipe cleaner piece on top of the cross to create a six-sided star and twist around the other two to hold the cross together. Assist children as needed.

3. **Have each child gather a piece of string and pencil or pen** and tie one end of the string to the middle of the pencil and the other end to the pipe cleaner snowflake.

4. **Invite each child to tear a small piece of masking tape,** write his or her initials on it and adhere it to his or her pencil.

5. **Provide each child with a jar of borax solution.** Have children submerge their pipe cleaner snowflakes into the solution. Encourage children to wind the string around their pencils so that the snowflakes are centered in the jars, but not touching the bottom or the sides. If the arms of the snowflakes touch the sides of the jar, trim the arms to make sure they all hang freely. Instruct children to rest the pencils on top of the jars to hold the snowflakes in the solution. Have children cover the top of the jars with a piece of paper towel to keep dust out.

6. **Allow the jars to sit undisturbed for a period of time.** Crystals will start to grow on the pipe cleaners after about an hour. The rate of growth will depend on the heat and humidity of the room as well as how saturated your borax solution is. Results will appear after about an hour, but the snowflakes can be left for up to 24 hours. The longer the snowflakes are left in the solution, the thicker the layer of crystals.

7. **When ready, invite children to retrieve their crystal snowflakes.** Have children remove their snowflakes from the solution and place on a piece of paper towel to dry.

8. **Encourage children to examine their crystal snowflakes.** Ask children to share their observations. Explain that the crystals grew because the solution was made from borax dissolved in hot water. Borax was added to the hot water until the solution was saturated and no more borax could fit among the water molecules. Hot water can hold more borax crystals than cold water because, when water is heated, its molecules move farther apart, making room for more of the borax crystals to dissolve. As the solution cooled, the water molecules moved closer together again and the borax was pushed back out of the solution. This borax stuck to the pipe cleaner and new borax crystals began to grow. As the water cooled and evaporated, more borax came out of the solution and added to the growing crystals. Like all crystals, borax forms a specific shape because of the way its atoms fit together and layer one on top of each other.

9. **Explain to children that the borax crystals are safe to handle.** They are not poisonous, but they are not edible and should not be ingested. Handle the crystals with the same precautions as a strong soap. Have children wash their hands

after handling them and warn them to keep the snowflakes away from younger children.

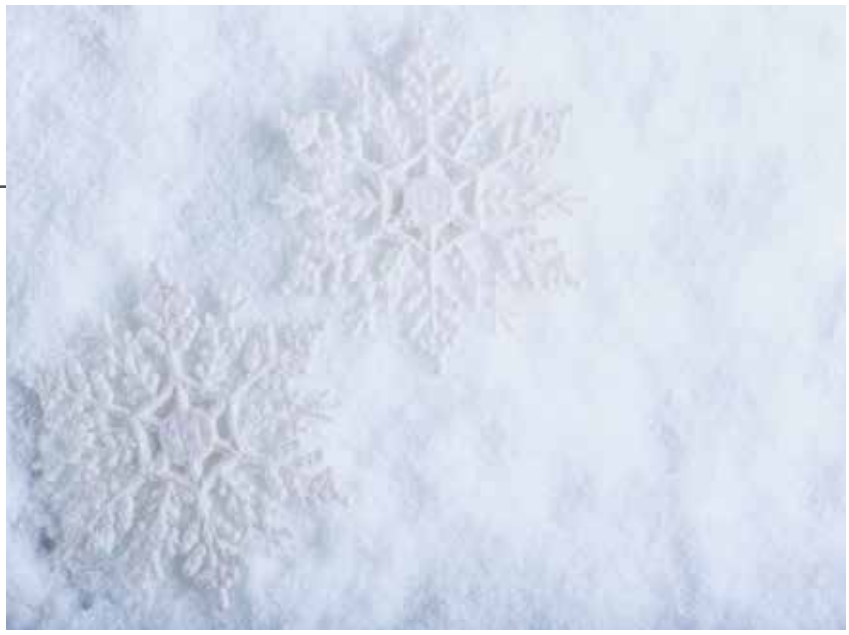
Provide several magnifying glasses and invite children to take turns examining their crystals using the magnifiers. Have children describe their crystals. What color are they? What shape are they? Are they hard or soft, shiny or dull? The shape of a borax crystal can be hard to describe, but children will definitely be able to see flat sides and a symmetrical shape. Geologists classify borax crystals as monoclinic, meaning that crystals form along three axes. All axes are unequal in length and two of the axes are perpendicular to one another.

Ask children to describe how each crystal snowflake is the same and different and why they are each different. The snowflakes are all slightly different because everyone's starting pipe cleaners had a little different length and shape, and just like snowflakes, the conditions in each jar were slightly different, causing the crystals to grow at different rates.

Invite children to display the wintery, crystal snowflakes after completing the experiment. Create a display by tying a loop on the end of the strings and hanging them in a window or other available display space.

make THE CONNECTION

USING BOOKS FROM THE LIBRARY OR A ROCK COLLECTION, HAVE CHILDREN EXAMINE AND RESEARCH OTHER TYPES OF CRYSTALS. Everything from quartz and garnets to salt and sugar are examples of naturally occurring crystals that can be found in our everyday lives.



EXTEND & EVALUATE

Repeat the experiment with children using sugar or salt solutions. As with the borax, make a saturated solution by dissolving sugar or salt into hot water. Only an adult should make the saturated salt or sugar solution. Salt and sugar dissolve a lot more readily than borax, so you will need about two cups of salt or sugar for every one cup of hot water. The crystals will also take longer to grow and you will need at least 24 hours to grow good crystals that can be examined.

Ask the children to predict what they expect will happen before beginning the experiment. Will the crystals grow at the same rate as the borax crystals? What color will they be? What shape will they be? How will they be the same as the borax crystals? How will they be different than the borax crystals? Children can start the experiment and check on it for changes over a period of time. When finished, have children contrast and compare the salt and sugar crystals with each other and the borax crystals. The salt crystals will be cubic in shape, while the sugar crystals will form with 12 sides. Have the children draw the crystals they made and highlight the differences and similarities.