Creating Science – Growing Crystals

*How do rocks get made? Here's one way - **#CreatingScienceGrowingCrystals***

Suggested outcomes

(NOTE: This is by no means an exhaustive list of possible outcomes, neither is it intended that ONLY these outcomes can or should be met. Science is a deeply interrelated activity; all outcomes, when appropriate, should be integrated.)

Science understanding

- Earth and space science 4: Earth's surface changes over time as a result of natural processes and human activity.
- Earth and space science 8: Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales.

Science inquiry skills

- Processing and analysing data and information 5: Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Science as a human endeavour

- Nature and development of science 3: Science involves making predictions and describing patterns and relationships (ACSHE050)

Science vocabulary words

Tier 3 (Specialised vocabulary)

- Igneous: meaning "born from fire", this refers to rocks that formed from heat, such as solidified lava.
- Crystal: a material made out of similar 'building blocks'. It usually has a shape that relates directly to the shape of the atomic building blocks.
- Amorphous crystal: instead of having the building blocks set down neatly, they're connected in haphazard, random shapes.
- Saturated. A solution with so much of something dissolved in it that no more will dissolve in. For example, saturated solution of salt in water will still have salt crystals sitting around at the bottom.

Warning

- Boiling hot water is used in the preparation of these crystals, please be careful.

Preparation

- You'll need glass or ceramic cups for every participant – the kind of cup you don't mind not using for a few months and can handle becoming permanently stained.
- This activity uses metal salts for making crystals. Copper sulphate is fairly cheap at your average gardening department, but sodium chloride (aka table salt) is cheaper

Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the students' questions can and should guide student learning, more material is presented for your convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

Children at this age must be aware of the dangers of boiling water and kept away at all times.

Crystals take a long time to grow – sometimes months. This will be a struggle for some kids.

Middle:

This activity is fairly well suited to this age group, though some of the more abstract concepts will require assistance with visualisation.

Teen:

This can be an excellent activity for teens who are prepared to check up on an activity for months on end. The opportunity to add small amounts of crystal making liquid can help extend the challenge and will, in a cool, dry, and stable condition, produce crystals as large as most coins.

Engage

- ⇨ Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

Demonstrate some large rocks, especially crystals.

Ask students - why are some crystals are larger than others?

Explore

One answer is that the size of a crystal depends on what it is made out of.

But another reason is that it depends on the amount of time the crystal had to form.

Try the 'grow your own crystal' activity from the book.

- ⇨ Encourage and validate student explanations of this phenomenon. You may like to ask students to write or draw their explanation personally to avoid embarrassment to students unfamiliar with this material. Remember, 'I don't know' is a valid explanation in science – it is the beginning of learning new things!

Explain

Explain: Crystals, like Lego structures, are built of many, many repeating units.

If those units don't have much time to be laid down, they end up all higgledy piggledy, much like a bucket load of Legos tossed onto the floor. Even after many years, they won't hold together too well.

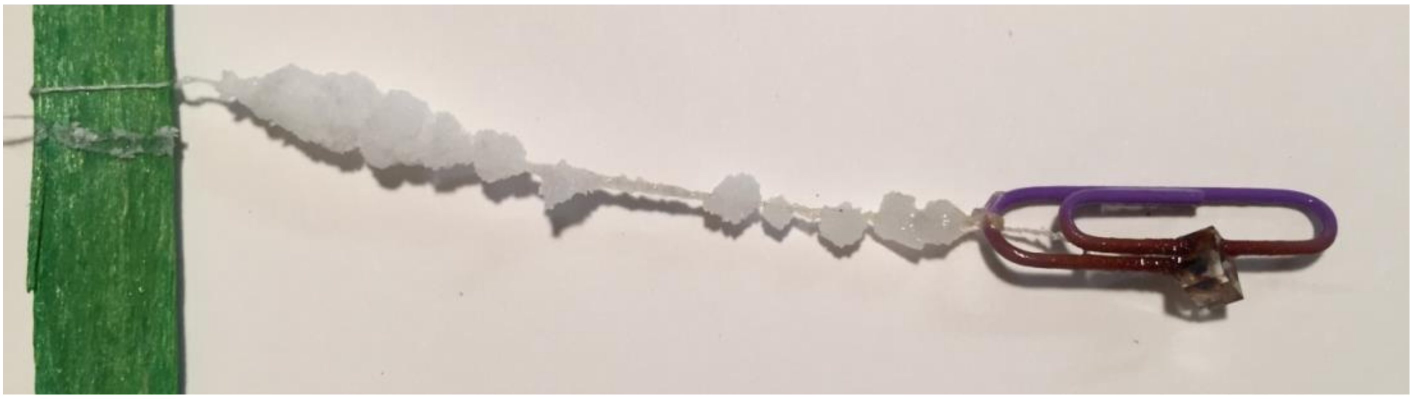
But if you have time to place them carefully, one at a time, in an exact order, you will end up with a very large and strong structure.

This is essentially what happens when crystals form.

Every crystal is made out of one or more repeating units. In the case of table salt, it's made of sodium and chlorine atoms. At first they are floating freely in the water, but as the water slowly evaporates, the atoms have a chance to click together – and these two atoms work together well.

If the water evaporates quickly, as it does on the string, you'll see the irregular crystals forming.

Yet deep down in the water the concentration of sodium and the chlorine atoms slowly increases as the water slowly evaporates. This means there's plenty of time for the hundreds of millions of atoms to pack together in their preferred shape – a nice cube. This cube keeps adding on layers and layers of sodium and the chlorine atoms until it is large enough to see.



Irregular crystals due to fast formation ^ regular crystal due to slow formation ^

Elaborate

- ⇨ Ask students if they can design new ways to test this explanation. Is it really sufficient? Can they think of further or better explanations, and the experiments needed to test them?

So how do you grow bigger crystals?

Start with a 'seed' – a nicely shaped crystal of the kind you want to grow.

You can add small amounts of super saturated water each week to the crystal growing solution.

You need a cool, dry, stable place.

- Cool so that it doesn't heat up so much the crystal begins to dissolve. It can happen, especially if you put boiling water in the crystal solution again.
- Dry, because added moisture will lower the concentration of metal ions in your solution and might dissolve your growing crystal. The drier, the better. Air conditioning often helps with this.
- Stable because, believe it or not, simply banging the table can make bits of your crystal fall off. Stirring the crystal too often might stop it forming at all!

Igneous rocks

All the information regarding how crystals form helps us understand the formation of *igneous rocks* – the first rocks of all, 'born from fire', which means they turn from being a liquid, into being a solid rock. When a volcano leaks magma, the gasses explode out, chemically changing the material so that we now call it lava. As the lava cools it can form a wide variety of shapes and colours depending on its materials, the surrounding environment, and how long it takes to cool.

You can also experience crystal-growing of the igneous kind when you cook toffy.

Quartz

Amethyst, chalcedony, rose quartz, citrine, agate, jasper, and many more are all made up of silicon dioxide – or quartz, which is the most common material on earth, and it makes up the majority of the mantle. When quartz has the right conditions to cool slowly it can form a bewildering array of fantastic crystals.

Mind you, silicone dioxide is also glass. But it hasn't had time to form nice strong crystal structures, so it has the amorphous structure that leads to amorphous shapes.


amorphous amethyst 'glass'


amethyst crystal – millions of years in the making

Life

Many other substances can form crystals. In fact, so many of them, that in a certain sense everything in the dirt not alive is a tiny crystal, and many living things are able to produce crystals. (https://en.wikipedia.org/wiki/Crystal). Scientists use the shape of the crystal to help them guess at the size and shape of the originating materials.

Water

Water can form crystals too – a fun fact for making snowflakes. Water, for instance, is presumed to have a tetrahedral shape because it forms hexagonal structures.

But there is an interesting side effect of crystals forming in water, and it all has to do with cryogenics. When water freezes quickly it makes small crystals, but if it freezes too slowly the crystals can be large enough to grow right out of a cell and cause it to, essentially, pop. If this happens too much it will kill any creatures that experiences cryogenic freezing. So what to do when we want to freeze people for 200 years so they can populate another planet? At the moment we simply can't, though ideas apart from snap freezing include injecting the blood with some sort of anti-freeze that resists the formation of large crystals. But cryogenics remains very much at the frontier of science for now.

Evaluate

- ⇨ Review with students what they felt they learnt from this lesson. Did they have any questions at the start that they feel were answered?

Success criteria

- ⇨ Review the Learning Intentions of this lesson with students. Was it met?

At the end of each class, review the learning objective and see how we did. Ask:

- ⇨ Did you achieve your learning goal?
- ⇨ What did You learn?
- ⇨ What worked to help you achieve it?
- ⇨ What might you do better next time?
- ⇨ (If needed) where can you go for extra help or information?

Assessment

Prior learning:

Take time to focus on planned content material during the engage phase, for example, are students demonstrating correct technique in preparing the experiment?

Formative:

Do students understand the reason for the cool, dry, stable environment to grow crystals?

Summative:

Help students consider ways they can communicate their new understanding to others, just as scientists need to do. Study your favourite crystal and prepare a report on it, including the theories regarding how it forms in the earth.

So what?

Igneous rocks are 'born from fire'. We don't know who came up with this idea, but it comes from the Latin word for fire.

Crystals form as things cool slowly. We can guess the shape of the atoms and molecules by the shape of the general crystal.

Creating science

Science understanding

As we learned about crystals we were learning that that;

- Earth and space science 4: Earth's surface changes over time as a result of natural processes and human activity.
- Earth and space science 8: Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales.

Science inquiry skills

As we compared irregular crystals on our string to the regular crystals we grew under the water, we used atomic theory to understand and explain our observations, helping us know that we can;

- Processing and analysing data and information 5: Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Science as a human endeavour

Using atomic theory of crystal growth we saw how;

- Nature and development of science 3: Science involves making predictions and describing patterns and relationships (ACSHE050)

Tips from the Masters to make it work:

Crystals are tricky! They require time, patience, and precision!

Saturated copper sulphate solution left to dry in a plate for a week – look at all those copper sulphate crystals! These can be used as 'seeds' to try and make bigger crystals in another super saturated solution.

Bottles don’t need these thin necks, but the set-up of the string is right on point.