Freezing (Plaster) – Teacher Notes

Most substances contract when they cool as a result of decreased kinetic energy of their molecules. Less molecule movement means less space is taken up and the material shrinks. Water is anomalous because it shrinks until about 4^{o}C at which point its hydrogen atoms start to line up and bond. Hydrogen bonding creates spaces in crystalline ice. Water expands 9% when it freezes to form ice. This explains why ice floats on water, has decreased density and why a bottle of wine hurriedly placed in the freezer to cool will expand and shatter if forgotten.
In some countries, teachers will take bricks, soak them in water and then freeze to demonstrate how frost wedging can break up rock. When the brick has thawed out it can be easily broken and crumbled because contained water has expanded causing internal cracks. Most WA bricks have very high clay content and are mechanically compressed before baking. As a result they have few pore spaces and will not allow water to penetrate. Unless you have access to hand thrown bricks or old bricks, this activity will not work.
In cold northern countries frost wedging was used to break up rocks in quarries. Thin groves would be cut into the rock and filled with water. Overnight expanding ice would widen and deepen the grooves. The process would be repeated until the crack was sufficiently large.

Teacher demonstration or student activity

This activity demonstrates how freezing water can break rock.
Scientific data for a "fair test" must be:
OBSERVABLE
MEASURABLE
REPEATABLE
Before it is **REPORTABLE**

Materials required:

- 2 clean and empty 1L milk cartons cut in half (only bottom half needed)
- 1 balloon
- A mixing bowl (plastic ice cream carton ideal)
- 1 spoon
- About 12 tablespoonsful of Plaster of Paris (A beautiful white outcrop of gypsum is near Monmatre in Paris – hence the common name).

1. Fill the balloon with water until it is about the size of a ping-pong ball. Tie it off.

HINT Make the water filled balloon just a little smaller than the carton. If it is too small the plaster will be thick enough to withstand the pressure of expansion. Make sure there is no air in the balloon, as it will not expand when cooled.

2. Place the water filled balloon into one carton
3. Place the Plaster of Paris (calcium sulphate, $CaSO_4$) in the bowl and mix in sufficient water until it has the thickness of custard or yoghurt.

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Word equation calcium sulphate + water = hydrated calcium sulphate.
Reactants Product

This is an exothermic (heat releasing) reaction. Since a new substance is created this is a chemical reaction.

4. Drop two tablespoons of plaster into the bottom of the carton. Place the balloon onto this and hold in position with two fingers. Add more plaster until the balloon is just covered. Keep fingers on the balloon until the plaster starts to firm (about 3 minutes) then remove fingers and smooth over with a little of the remaining plaster.

Hint Please do not empty the remaining scrapings down the sink as they will go solid and block the drain. If you wait until the plaster has set in the ice cream container, you can give the container a bit of a wiggle and the hard plaster will crackle off to be dropped into the bin.

5. Leave until the plaster has become hard. It may be necessary to hold down the balloon while the plaster sets
6. Place both half cartons in the freezer overnight. Water in the balloon will have expanded on freezing and have cracked the plaster.
7. Remove and observe

What happened to the plaster blocks? The block with the water filled balloon had cracked

Why was the other block included in the experiment? To act as a control against which change can be measured