



### Overview

**Age Range:**

10-14

**Lesson Time:**

45 Minutes (including 1 video)

**Equipment Needed:**

Computer

Projector

**Topics Covered:**

- Geology
- Chemistry
- Biology (life in extremes)
- Astronomy (Mars surface conditions)

### Activity Outline

Understand super-saturated salt solutions and how they can affect the habitability of another planetary body.

### Learning Outcomes

After completing this activity, pupils will:

- Understand how crystallisation works.
- Be able to explain how we get saturated and super-saturated solutions.
- Be able to reason how saturated salt solutions affect habitability.

## Background Material:

**Slide 1 - Introduction**

In this lesson we will be delving into how saturated brine solutions affect the habitability of Mars.

**Slide 2 - Objectives**

Can be seen above in Learning Outcomes.

**Slide 3 – Introduction to Saturation**

In order to understand this, we must first clarify some terms. Firstly, can anybody give a brief explanation of what is meant by a saturated solution?

(Take answers)

Saturation is the point in which the maximum amount of a compound has been dissolved into a solution. For

example, 357g of sodium chloride (or table salt) can be dissolved into 1 litre of water before hitting its point of saturation at a concentration of approximately 26.3%. Of course, saturation points are affected by many factors including pressure and temperature.

#### Slide 4 – Super-Saturation

The example that was just given assumes the water temperature to be 20°C, which is around room temperature. However, by heating the water, this will allow more of a given substance to be dissolved thereby forming a supersaturate.

At 100°C water will be able to dissolve 390g of salt, a 33g increase from our 20°C example.

#### Slide 5 – Puna Plateau, Argentina

Now that we have a bit of an understanding of how these mechanisms function, we can turn our attention to Mars. It is believed that there was a point in the history of Mars where it would have had saturated brine lakes. In order to study if these lakes would have been viable for early martian life, analogue sites here on Earth are used.

One such analogue site is Laguna Negra, a shallow lake which lies on the Puna Plateau in [Northern Argentina](#). This environment is saturated with calcium chloride salts. This presents a very harsh environment for life.

#### Slide 6 – How habitable do you think Laguna Negra might be?

Discuss in your groups if you believe that there is indeed life within the Laguna Negra.

(Allow time to discuss)

(Take answers)

The presence of microbial life has indeed been detected within the Laguna Negra; these life forms are halophilic, thriving in salt rich environments.

#### Slide 7 – Crystallisation

Metallic salts such as calcium chloride and sodium chloride are often found in a crystalline form. Crystallisation is the (natural or artificial) process by which a solid forms where the atoms or molecules are highly organised into a structure known as a crystal. Some of the ways by which crystals form are

precipitating from a solution, freezing, or more rarely deposition directly from a gas.

Here we have a diagram depicting the molecular structure of a salt crystal. Their highly organised structure leads to crystalline compounds being comparatively strong. For example, both graphite found within pencils and diamonds are structures of pure carbon and yet graphite can be crushed between your fingertips and diamonds are one of the hardest substances in the natural world. This is due to their molecular arrangement.

**Slide 9 – What does crystallisation look like?**

Supersaturates can very easily lead to crystals forming as they leave the solution.

Here we have a video of a sodium acetate supersaturated solution being poured out:

<https://youtu.be/bdhcRrP31LM>

Video background information: Sodium acetate is an ionic compound consisting of Sodium cations,  $\text{Na}^{(+)}$ , and acetate ions,  $\text{C}_2\text{H}_3\text{O}_2^{(-)}$ . Like most acetates, it exhibits high solubility in water: 76g dissolves in 100ml at  $0^\circ\text{C}$ . The solubility, however, increases substantially at higher temperature. The precipitation of a solid from a solution results in decrease in the disorder of the system. That is, in the solution the ions move freely in random directions and therefore exhibit high disorder. When the ions combine to form solid crystallites, their freedom of motion becomes restricted. Scientists describe this as a decrease in the entropy, or disorder, of the system. The laws of thermodynamics stipulate that for a process exhibiting a decrease in entropy to occur spontaneously, such as the precipitation of a solid from a solution, the process must also liberate heat. Consequently, the introduction of a solid crystallite of sodium acetate will warm itself as the sodium acetate precipitates from solution.

**Slide 10 – What happened? Why?**

Please discuss in your groups what you observe in this video, why do you think this happened?

(Allow time to discuss)

(Take answers)

**Slide 13 - Review**

From this lesson, students should be able to answer the following questions:

- Can you explain the mechanism of crystallisation?
- How do we get saturated and supersaturated solutions?
- How do saturated salt solutions affect habitability?