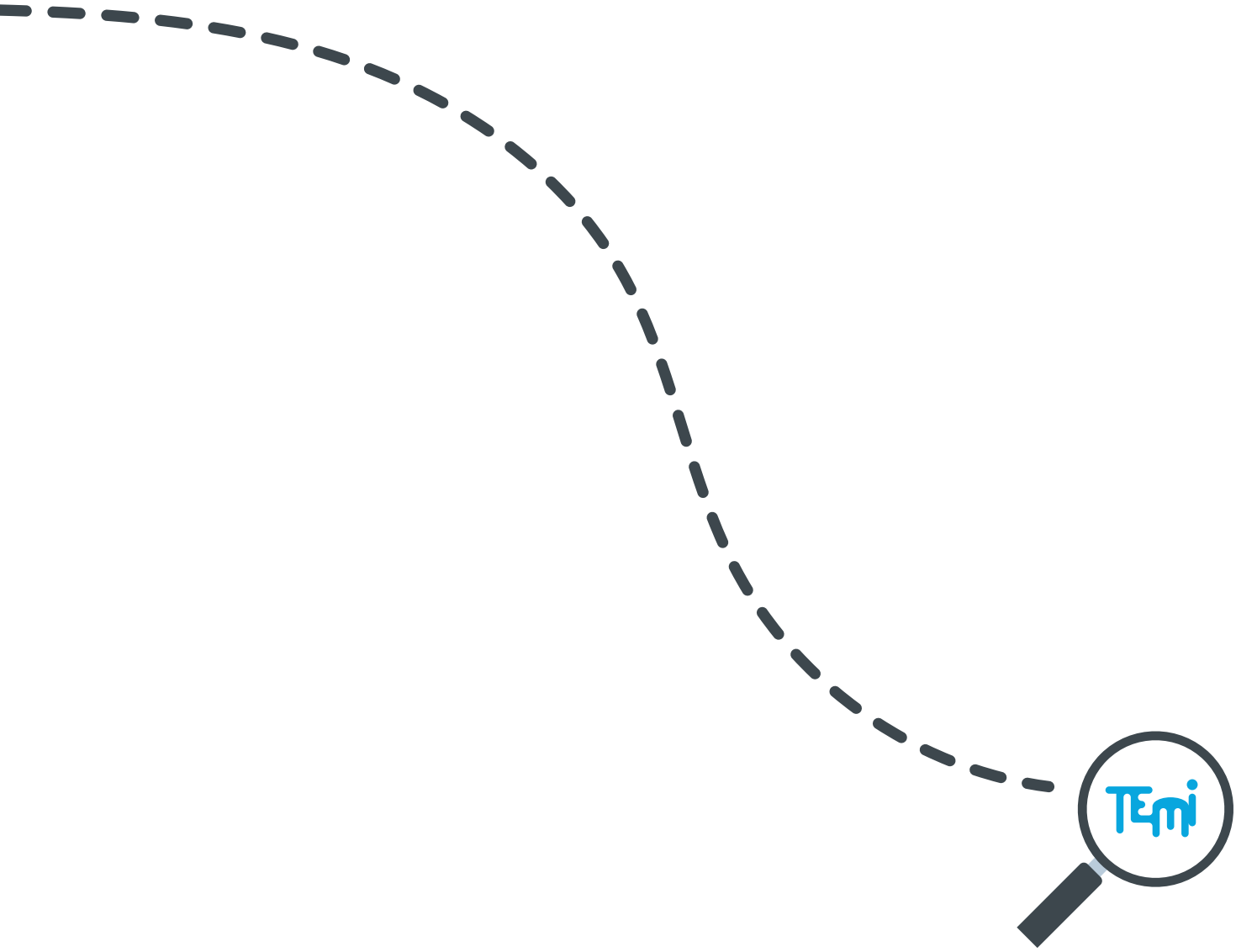
Grit on the streets

CLASSROOM SCIENCE ACTIVITY TO
SUPPORT STUDENT ENQUIRY-BASED LEARNING



This classroom-tested teaching plan uses the four innovations of the TEMI project, as detailed in the Teaching the TEMI Way (TEMI, 2015).

You should read this companion book to get the most from your teaching. The **TEMI** techniques used in this teaching plan are: **1)** productive science mysteries, **2)** the **5E model** for engaged learning, **3)** the use of presentation skills to engage your students, and **4)** the apprenticeship model for learning through gradual release of responsibility. You might also wish to use the hypothesiser lifeline sheet (available on the **TEMI** website) to help your students document their ideas and discoveries as they work.

To know more about **TEMI** and find more resources **www.teachingmysteries.eu**

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teachingmysteries.eu

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Grit on the streets

What's the mystery?

A common misconception is that gritting the sidewalk causes the temperature to increase and thus melt the ice. However, it is actually the other way around. Adding salt to a water-ice mixture lowers the freezing point of the solution, causing the ice to become liquid even though the temperature is below 0°C. This is the reason why we put grit on the streets and one of the reasons why ice rarely forms in oceans in temperate climates.

DOMAIN(S)

Chemistry.

SUBDOMAIN KEYWORDS

Phase transitions, salt, water, freezing point, boiling point, condensation.

AGE GROUP

14 to **15** years old.

EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation:
30 min.

Approximate time in classroom:
One hour.

SAFETY/SUPERVISION

Supervision is recommended.

Disclaimer: the authors of this teaching material will not be held responsible for any injury or damage to persons or properties that might occur in its use.

PREPARATION AND LIST OF MATERIALS

The night before: fill milk cartons with water and put them in the freezer.

Equipment:
- Hammer
- Towel
- Thermometer
- 1kg salt (NaCl)
- Large 400 ml beakers
- Butane burners
- Tripods
- Matches.

LEARNING OBJECTIVES

Revision of phase transitions and the concepts of condensation and chemical bonds. The students should have prior knowledge about the particle model before starting this activity.

Guidance notes for teachers

THE 5E MODEL

Engage

CAPTURE STUDENTS' ATTENTION

The teacher tells a story about how in winter, when it gets cold, we tend to put grit on roads and pavements so that they do not freeze and get icy. The teacher acts as if he/she is curious about what happens when we do this and asks the students whether they have ever wondered about this. The teacher presents ice lollies made of frozen water and drizzles salt on one of them. He or she then asks the students if they believe that the temperature of the ice lolly with the salt will increase or decrease, causing it to melt faster. The teacher then says that the class will look at some characteristics of salt water and conduct a few experiments.

The teacher also asks the students to discuss in pairs what actually happens to the particles in the water when it freezes as well as the different phases in which water and other substances can exist. He or she tells the students that they are going to find out more about the properties of substances and how they might change in different conditions. The aim here is to activate the students' prior knowledge about the particle model.

Explore

COLLECT DATA FROM EXPERIMENTS

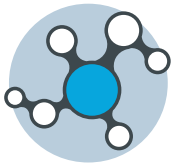
The teacher tells the students to discuss and write down a Hypothesiser Lifeline for an experiment (presenting them with the hypothesiser lifeline) and to test if salt increases or decreases a mixture's freezing point and boiling point. In this section, we recommend that you explain/revise what happens to the particles in a substance when the freezing or boiling point is reached.

The students should also find out how cold the mixture can get by adding salt to the solution while measuring the temperature. At the end of the lesson, you can maintain the students' interest by making ice cream by putting a plastic bag filled with lemonade into the ice-salt solution.

Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

Adding salt to the ice will lower the freezing point of the solution. This is the reason why we put grit on the streets and why the salt is inefficient when the temperature goes below 15°C. Some substances have the ability to lower or elevate their freezing or boiling point in a solution/mixture. Ask the students to think about this the next time they take their dog for a walk on a gritted icy street.



Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

We have now seen how the freezing point of a mixture can change if we add something to it. What happens to the boiling point? Is it the same as for water, 100°C? Why would it increase or decrease? Tell the students to test this and to try to sort out whether the salt becomes gaseous along with the water when the solution boils. Is it possible to make fresh water from salt water? How can you test this? Use the hypothesiser lifeline.

Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

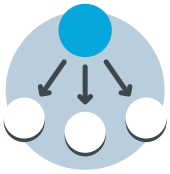
During the experiment, a conversation between teacher and students can take place. In pairs, the students explain the hypothesis, present the observed results, and the credibility of the hypothesis while using academic argumentation. Possible questions for discussion between the students might be: what happens on a molecular level when we add salt to the water and why can this affect the boiling temperature of the now heavier solution? Several YouTube movies have good animations of this.

THE 5E MODEL

Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

Curiosity is a key ingredient in this mystery. To attract more attention from the students, one could colour the ice-lollies with various colours. One could also present some fun facts about how much salt we actually use on gritting the streets and who came up with the idea. You could also ask the students to discuss why seawater freezes slower than freshwater. In the extend section, one could also involve crystal making and geology by letting the students make their own salt crystals.



GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

This mystery begins as a structured enquiry (level 1). The students will have to think critically to design an experiment with a few selected variables. The degree of independence increases in the extend section, where the students will have to explore whether it is possible to produce freshwater from saltwater. Using the Hypothesiser Lifeline throughout the mystery is recommended.

Resources

This web site explains why the oceans do not freeze and offers a classroom activity: www.education.com/science-fair/article/why-doesnt-the-ocean-freeze/

Read more about the desalination of salt water at this web page: http://adventure.howstuffworks.com/survival/wilderness/convert-salt-water1.htm

Grit on the streets

STUDENT WORKSHEET

You have now heard from your teacher that it is a good idea to put salt on an icy pavement to make the ice melt. Why do we actually do this? Does the temperature of the ice increase, thereby causing it to melt? In this mystery, you will design an experiment to see what happens to the temperature when we add salt to ice.

Engage

WHAT'S INTERESTING?

Task: Discuss with your group what you think happens with the temperature of the ice when we put grit on the streets in order to make the ice melt. Do you remember the temperature in which water freezes to ice and what happens to the water particles?

Explore

WHAT'S HAPPENING?

Task: Work together in pairs. Write a hypothesis using the hypothesiser lifeline about what you think will happen when you add salt to an ice mixture. Describe an experiment where you test your hypothesis.

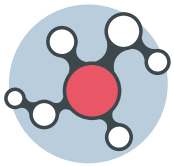
Test your experiment.

How warm/cold does the mixture get when you add salt?

Explain

WHAT'S CAUSING IT?

Task: What happened to the temperature of the ice mixture when you added the salt? How does this relate to the concept of the freezing point? What happens to the weight of the solution when you add the salt?



Extend

WHAT'S SIMILAR?

Task: We have now seen how the freezing point of a mixture can change if we add something to it. However, what happens to the boiling point? Is it the same as for water (100°C)? Why would it increase or decrease? Discuss this with your group and write down your thoughts. Try boiling the salt water to see if the boiling point has changed.

Even though oceans cover 71 per cent of the Earth's surface, the world is running out of drinking water. Can you think of a way of turning salt water into fresh water?

Does the salt evaporate as well as the water?

Use the hypothesiser lifeline to design a new experiment to test this.

Evaluate

WHAT'S MY UNDERSTANDING?

Task: Discuss with your group:

Why did the ice and salt mixture remain in a liquid state, even though the temperature was below 0°C?

What happens with the salt and water molecules when salt water boils?

Write down two things you learnt from this mystery and one thing you would like to learn more about.