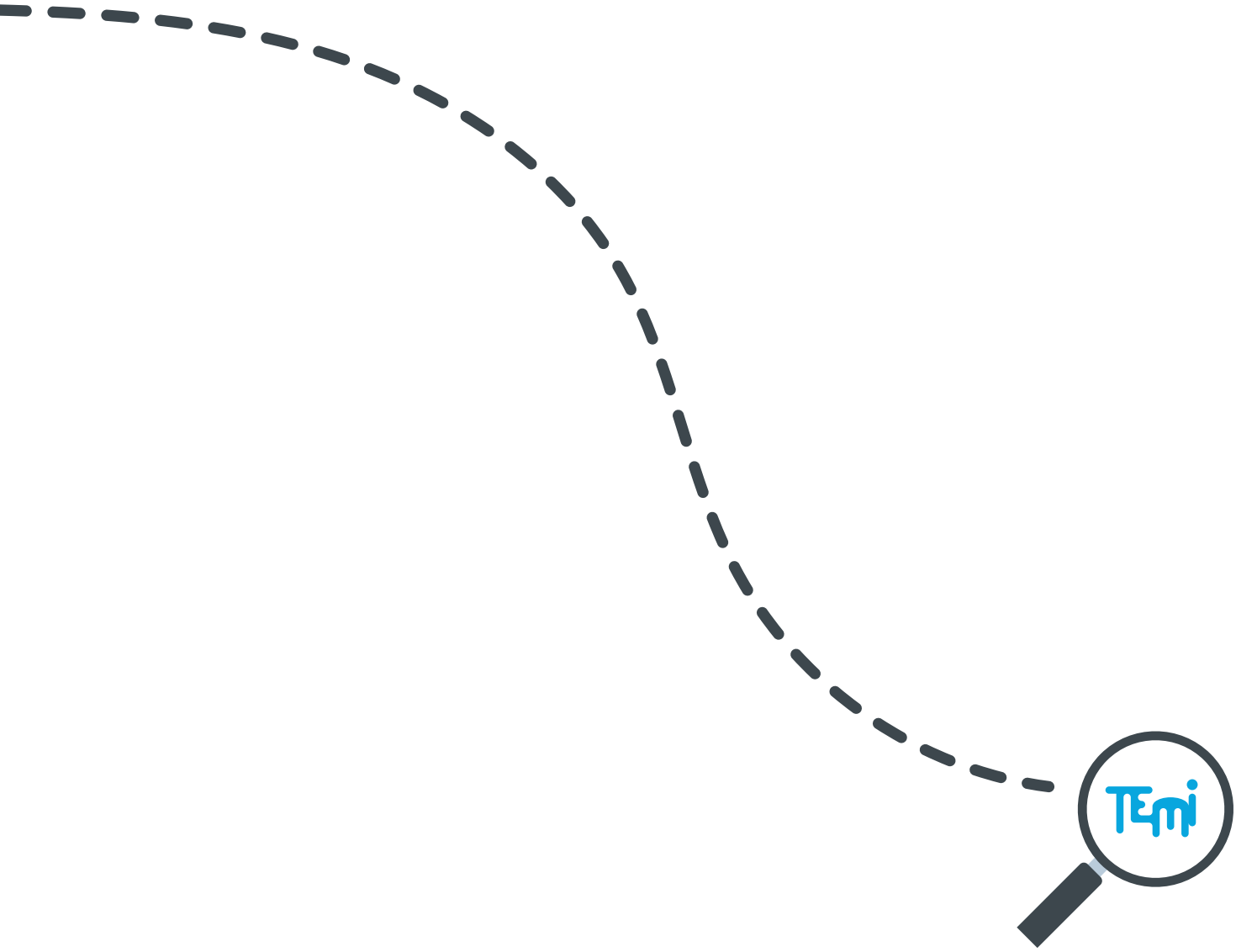
Field trip with ghosts?

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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Field trip with ghosts?

What's the mystery?

A group of students are spending the night in a cabin. After preparing some food, they suddenly hear a strange noise from the kitchen: a can of oil has fallen down from the oven and something or someone has crushed it. Some of the students think that there is a ghost in the cabin.

DOMAIN(S)

Physics, Chemistry.

SUBDOMAIN KEYWORDS

Temperature, force, particles, atom, pressure, gas, phase transition, kinetic energy.

AGE GROUP

13 to **16** years old.

EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation:
One hour.

Approximate time in classroom:
Two hours.

SAFETY/SUPERVISION

Remember safety when working with butane burners.

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

- Butane burners
- Tripod
- Beaker
- Matches
- Soda cans.

LEARNING OBJECTIVES

Think critically about experiments. Learn about atmospheric pressure, balancing forces, the fact that temperature is a measure of particle velocity, and kinetic energy.

Guidance notes for teachers

THE 5E MODEL

Engage

CAPTURE STUDENTS' ATTENTION

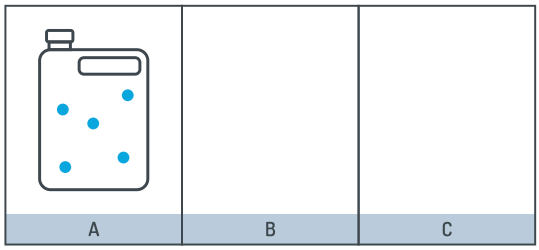
It was an unusually cold autumn day, with frost and snow covering the ground. A group of friends made an overnight trip to a cabin in the woods. When the evening came, and they started to make supper, they discovered that both oil and butter had been left at home. While one of the girls looked around in the cabinets with the hope of finding some butter or oil, the rest of the gang sat down in front of the fireplace in the living room, eating snacks and sandwiches, and telling ghost stories. Suddenly there was a loud scream from the kitchen. The class stormed into the kitchen and found Oda terrified. However, gradually she began to laugh and explained what had happened. She had found a can with some frozen olive oil at the bottom. To get the oil, she had warmed up the can on a hot plate. After a few minutes, the lid on the jug shot off, scaring her.

One of the boys, Fabian, took a cloth and lifted the can away from the hot plate. He put the cap back on the can and they all went back to the living room. When they started telling ghost stories again, there were some strange noises from the kitchen. But now there was no one in there... They walked quietly back towards the kitchen. The oil can was lying on the floor and it looked like someone had stepped on it...Was the cabin haunted? Fabian tried to calm his friends by saying that he knew what had happened! He remembered something from science class and believed that he could convince the rest that there were no ghosts around.

Explore

COLLECT DATA FROM EXPERIMENTS

Task 1: The figure illustrates the gas molecules in the can when it was first found in the kitchen. In B, draw a picture of the collapsed can. In C, draw what would have happened if Fabian had not put the lid on when he removed the can from the hot plate.



Task 2: Go through the following statements in the table in the next page, and give them a score based on their relevance to what happened with the can (0 is not relevant, 5 is very relevant).

Task 3: Show the imploding soda can experiment to the class. Tell the students to work in pairs and hypothesise as to why the can implodes when it is immersed into cold water.

Reason why the lid popped of the can was:	Score	Scientific reasoning
The pressure increased inside the can		
The volume between the gas molecules increased		
The speed of the gas molecules increased		
There were more collisions between the gas molecules and the can		
Hot air rises		
There was a difference in pressure on the inside and outside of the can		
The can gets bigger when heated up		

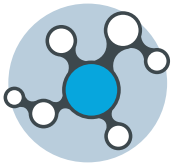
Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

Connect the imploding soda can experiment to the ghost story.

When the girl heated the can with oil, the molecules inside the can started to move faster and faster. Since the space between the molecules increases when the temperature increases (i.e. the pressure increases) the additional force on the weakest point of the can, the lid, caused it to pop off. In this process, gas molecules escaped the can. When the lid was put on again and the can was removed from the stove, the temperature of the molecules inside the can decreased. Due to the fact that the pressure inside the can is lower than the air pressure outside it, the surrounding air pressure caused the can to implode. It is also relevant to discuss the definition of temperature. For some students, it might also be relevant introduce the formula for kinetic energy ($E=1/2mv^2$) and ask them to deduce whether the mass of the gas particles might influence pressure inside the can: would the results be different if some other liquid was present? In other words, GRR can easily be implemented in this mystery.

Relevant concepts to remember: phases, phase transitions, air pressure, implosion, force.



Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

In everyday life, temperature affects phase transitions (gaseous, liquid, and solid). Let the students make a list of such examples. Water is a prominent example. The process of condensation can be introduced. One everyday experience that might be mentioned is that bottles can look deformed during a flight in a jet plane. This mystery can also be extended to geology, since pressure is one of the main reasons causing formation of oil and gas in sedimentary rocks.

Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

During their work, the students can assess their own reasoning. By discussing the students' answers in class, the teacher can uncover misconceptions and explain the principles of the subject. At the end of the lesson, the students can work in pairs and make a quiz with questions from the subject.

Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

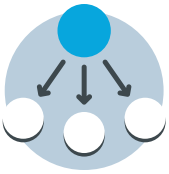
Engage:
Before telling the ghost story to the students, it might be a good idea to bring an already imploded can, which can be tossed in front of the students during the story at the point when the characters hear noises from the kitchen.

Start by dimming the light and perhaps lighting a candle to catch the students' attention. Talk quietly and slow so that everyone can grasp the content. Practise the story beforehand.

Explore:
After the students have gone through the questions, summarise the answers in class. Make sure you go through the concepts of phases, phase transitions, and the speed of molecules with respect to temperature.

Guide the students through the steps of designing the hypothesis based on what is happening with the water molecules when they are heated and what it is causing the can to implode. Instruct the students how to safely handle the butane burner.

Include a short teachers' guide to the main sequence in teaching this mystery and how they should be presented (showmanship).



GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

Setting up the mystery: tell the ghost story to your class.

Demonstrated enquiry (level 0): tell the students to solve the questions shown in the explore phase in pairs. When the answers have been summarised in class, perform the collapsing soda can experiment.

Guided enquiry (level 1): 'We do it'. Ask the students to hypothesise why a heated soda can collapses when it is placed into cold water. The students can make several hypotheses by testing at different temperatures or using cans made of different materials. The students can also calculate the amount of atmospheric pressure, since atmospheric pressure of at least x newtons is needed to deform the can.

Solving the mystery: students are led towards the explanation by using ideas about the particle model and how heat is related to pressure.

Resources

This webpage presents useful insights on atmospheric pressure:
www.livescience.com/39315-atmospheric-pressure.html

The mystery is adapted from the book:
Erduran, S. and Pabuccu, A. (2012). Bonding chemistry and Argument: Teaching and Learning Argumentation through Chemistry Stories, a booklet.

Field trip with ghosts?

STUDENT WORKSHEET

This is a mystery about some powerful features of nature, like pressure, forces, and the effect of temperature on air pressure.

Engage

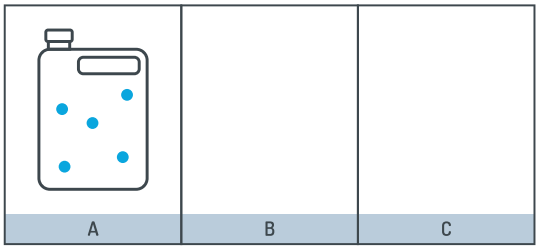
WHAT'S INTERESTING?

Task: Listen to your teacher telling the story about what happened at the cabin. What gave the can a crushed appearance? Do you believe in ghosts?

Explore

WHAT'S HAPPENING?

Task 1: The figure illustrates the gas molecules in the can when first found in the kitchen. In B, draw a model of the collapsed can. In C, draw of what would have happened if Fabian had not put the lid on the can when he removed it from the hot plate.



Task 2: Go through the following statements in the table in the next page, and give them a score based on their relevance to what happened to the can (0 is not relevant, 5 is very relevant).

Task 3: Your teacher will now perform a magic trick.

Work in pairs and hypothesise why the can implodes when immersed in cold water.

Discuss with your partner the following question: in which three forms/phases does water exist?

Explain

WHAT'S CAUSING IT?

Task: Test your hypothesis. Be careful with the butane burner. Discuss the following with your partner:

- What happens to the molecules when they change phase?
- How does the space between the molecules in each phase change with increases to the temperature?

How can you relate this experiment with the setting in the ghost story?

Extend

WHAT'S SIMILAR?

Task: Work together in pairs. Can you think of any substances other than water vapour which might be affected by temperature changes? When the temperature or pressure changes, the substance goes through a phase transition, like during springtime, when ice transforms to water which again transforms to water vapour.

Reason why the lid popped of the can was:	Score	Scientific reasoning
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The speed of the gas molecules increased		
There were more collisions between the gas molecules and the can		
Hot air rises		
There was a difference in pressure on the inside and outside of the can		
The can gets bigger when heated up		

Think of the following materials: rocks, iron, and carbon dioxide. Use the Internet and find the temperatures where these substances experience phase transitions.

Evaluate

WHAT'S MY UNDERSTANDING?

Task: Work in pairs and make a quiz with ten questions from the topic. Solve your quiz and go through them together afterwards. At the end of the lesson, hand them in to your teacher.