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# INTRODUCTION

Scientific inquiry lies at the heart of education in science. It is an endeavour that is critical for students to learn and use as they discover their world. While definitions of "the scientific method" vary widely, it is generally understood to be a group of practices for investigating phenomena that follow processes of inquiry based on gathering measurable evidence, measuring, experimenting, forming and testing hypotheses, and drawing conclusions (and in many cases, posing further questions). The scientific method is not (and should not be taught as) a rigid set of steps. Instead, it is intended as a flexible vehicle to focus on productive inquiry.

To meet the latest science education curriculum expectations, students need extensive experience with the inquiry processes, incorporating science practices, disciplinary core ideas, and concepts that can be applied to all scientific disciplines as a whole. Students must learn to ask relevant questions, develop hypotheses, test models and make evidence-based arguments.

*Teaching the Scientific Method* introduces scientific inquiry with "Opening Demonstrations" to spark students' interest in science principles and processes. These are followed by strategies focused on varying skills and processes of scientific inquiry. The book offers ready-to-use experience and practice with:

- following directions
- stating problems
- researching
- forming hypotheses
- designing an experiment
- using materials and equipment
- collecting, measuring, and recording data
- summarising and recording outcomes

The activities in this book engage students in active learning. It is organised in a manner that makes daily or weekly lesson plans easy to develop, offering a variety of such strategies as individual assignments, group activities, in-class and at-home projects, hands-on activities, review and study guides, and assessments. Use these to help students explore and develop the components of scientific inquiry as they experiment, participate in science projects and succeed on tests so that you can enjoy watching them grow in understanding their world!

# Demonstrations

Demonstrations, especially at the beginning of the year, are an effective way to motivate students and grab their attention. After the demonstration, lead a discussion about the scientific concept behind it. Using these at the beginning of the year will help you gauge student understanding and prior knowledge; they will also break the ice and help students feel comfortable. If used later in the year, these demonstrations will provide a refreshing break from the routine for both teachers and students.

## CAN CRUSH

### Materials:

empty soft drink cans, a pair of tongs, a hot plate, a small amount of water, a medium to large bowl of ice water

### Procedure:

1. Turn the hot plate on high.
2. Put a couple of tablespoons of water in the can, and set it on the burner.
3. When most or all of the water has boiled out of the can, use the tongs to quickly flip the can upside down and plunge it into the ice water. The greater the temperature difference, the larger the "BOOM".

### Science behind the demonstration:

When molecules are heated, they move quickly and spread out. Heating the can enables the air molecules to escape from the can. Flipping the can upside down in the ice water prevents more air molecules from moving into the can. When the can is cooled down quickly, the molecules of the can, and any air that is left, will rapidly slow their movement and contract. Since there is now more air on the outside of the can than on the inside, the pressure of the outside air crushes the can.




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# Writing the Problem

The problem is the first step of the scientific method. It is a testable question and should be written in question form. Only one variable at a time should be tested so that the results can be easily clarified. You may also wish to teach the concepts of research, demonstrations and models at this time, emphasising how they differ from testable problems.

## Definitions:

**Test** – An attempt to solve a problem through experimentation. This is also called an experiment or an investigation. To verify results, an actual test should be conducted at least three times or should contain at least three samples of items to test (see "Examples of Testable Problems", page 19). A test shows why and how something works or reacts the way it does.

**Research** – Information about an idea obtained through observations, surveys, the internet, books or other sources to answer a question. Asking someone which brand of deodorant works best is research, not a test. Setting up the experiment and having individuals try different kinds of deodorant is a test.

**Demonstration** – A demonstration uses an example or illustrates a series of steps to show how something works. It does not explain why it works. A test attempts to show both.

**Model** – A model is closely related to the demonstration. Emphasising the pattern or makeup of the object in question, a model shows its design, but does not explain why it works the way it does. Models can be used in demonstrations and tests; to be classified as a test, however, it must provide for experimentation and measurable results.

> **Note:** *The difference in a model and demonstration may be difficult to distinguish. A model usually shows the makeup, while a demonstration shows a process. Whenever you have a demonstration, it can also be categorised as a model. You may wish to teach these two concepts as one.*




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# Conducting Research

Research may give students an idea for an experiment or allow students to better understand the content of an experiment by helping them form a hypothesis. Learning to conduct research in the middle years prepares students for the requirements of later education. To familiarise students with the process of research, have them investigate ideas using books, the internet or surveys. The students also learn how to pick out key words in a "problem" to research.

## Ideas for Research:

1. Surveys that reveal popularity or effectiveness of products (best tasting, etc.)
2. Surveys that reveal beliefs about ideas
3. Information about products from manufacturers (usually can be found on commercials or on the packaging)
4. Information that gives details about materials used in the experiment. For example: What is acetone? What are its uses?

Before they begin investigating, discuss the concept of "key words" with your students so that they know how to spot key words in the problem they want to research. Some examples follow.

**Problem:** What causes mould to grow on bread?

**Key Words:** mould and bread

**Problem:** If I exercise strenuously for 15 minutes per day, how long will it take to lower my resting heart rate by 3 beats per minute?

**Key Words:** exercise and resting heart rate

## TEST, RESEARCH, DEMONSTRATION OR MODEL?

### Materials:

Copy and use the handout on page 21 for this activity.

### Procedure:

1. Students may work in groups or individually to complete the task.
2. They must identify each as a test, research, demonstration or model.





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