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To the Teacher

The science literacy of our citizens may well determine the path our society chooses to follow in the future. In this day of rapidly expanding science technology, diminishing air and water quality, and dwindling natural resources, all adults must participate in science-based decisions. A successful world needs science-literate citizens.

In addressing concepts appropriate for middle years students, the writers point out that even though students at this level are concrete thinkers, they are capable of comprehending some abstract science concepts. For example, they can understand that there should be a relationship between evidence and explanation. Similarly, they can understand that background knowledge and accepted theories help determine the design of current experiments and the interpretation of their data.

Students in this age group have some trouble designing their own scientific investigations. For one thing, it is difficult for them to identify variables and controls in an experiment. For another, they tend to interpret data in a way that agrees with their preconceived ideas. However, these problems are simply due to the level of maturity of the students and can be solved with teacher assistance.

The level of student independence required determines whether an investigation is described as a partial or full inquiry. In partial inquiries, some of the investigation is already planned and outlined for students, and they are asked to complete it. For example, the question to be tested may be stated and an investigation planned. Students then conduct the investigation, gather and analyse the data, and report their findings. In full inquiries, students recognise a question that can be answered through scientific inquiry. From that question, they conduct research, design an investigation, collect evidence, evaluate and interpret that evidence, and report it to others.

Teachers who prefer to omit the partial inquiry exercises and use only the full inquiry investigations may need to review students on the objective being met or on science techniques such as experimental design, data collection and graphing. Remind students to test only one variable and to establish a control.

On the student activity pages of the full inquiry investigations, space is provided for five procedural steps. If more space is needed, students can write on their own paper. The PostLab Questions at the end of each full inquiry help students explain their conclusions.

1

OBJECTIVES

SCIENCE AS INQUIRY

Identify questions that can be answered through scientific inquiry.

Design and conduct a scientific investigation.

Use appropriate tools and techniques to gather, analyse and interpret data.

Develop descriptions, explanations, predictions and models using evidence.

Think critically and logically to make the relationships between evidence and explanations.

Recognise and analyse alternative explanations and predictions.

Communicate scientific procedures and explanations.

Use mathematics in all aspects of scientific inquiry.

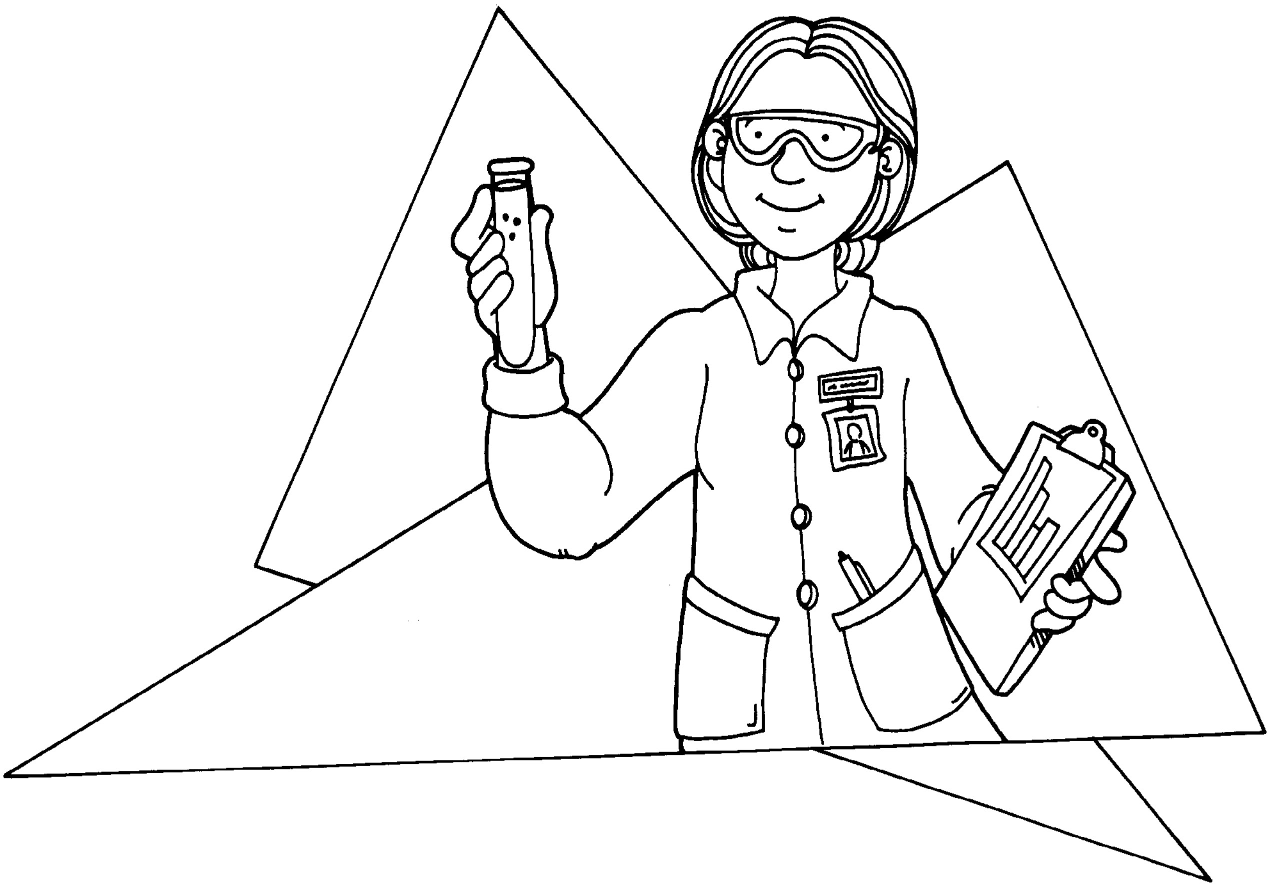
Understandings about scientific inquiry:

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.
- Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories and standards to advance scientific knowledge and understanding.
- Mathematics is important in all aspects of scientific inquiry.
- Technology used to gather data enhances accuracy and allows scientists to analyse and quantify results of investigations.

- Scientific explanations emphasise evidence, have logically consistent arguments and use scientific principles, models and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

- Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence and suggesting alternative explanations for the same observations.

- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.



Dense Food & Are You Dense?

Teacher Information

General Objectives: A substance has characteristic properties, such as density, boiling point and solubility, all of which are independent of the amount of the sample.

Specific Objectives: Students will determine the densities of several materials. Students will compare the densities of 'gold' and 'silver' Australian coins. Students will determine how a change in volume affects the density of marshmallows.

Time Required for *Dense Food:* 50 minutes

Time Required for *Are You Dense?*: This will vary with each student's proposed inquiry, but will require about two hours.

Teaching Strategies: Copy the Background Information for *Dense Food* and *Are You Dense?* and the student activity pages of *Dense Food* for students. Marshmallows were chosen for *Dense Food* because they are easily compressed. Other compressible materials also work well.

To introduce the concept of density, have students compare the density of a mini jam roll or other confectionery to the density of water. Water has a density of 1g/ml (1g/cm^3). If something has a density greater than 1g/ml, it will sink in water. A substance whose density is less than the density of water will float in water. After students predict whether their chosen substance is more or less dense than water, let them place it in water to see if their predictions were correct.

In the partial inquiry lab, *Dense Food*, you may need to review the formula for determining the volume of a cylinder: $V = \pi r^2 h$ ($\pi = 3.14$)

With this formula, students can calculate the density of the mini jam roll and other cylindrical objects. The mass, length, radius and volume of mini jam rolls vary. Table 1 shows some sample measurements.

Table 1. Measurement of Bite-Sized Tootsie Rolls

Jam roll mass	Varies, but average is 80 grams.
Jam roll length	Varies, but average is 6 cm.
Jam roll radius	Varies, but average is 1.5 cm.
Jam roll volume	Varies, but average is 42 ml.
Jam roll density	Varies, but average is 2 g/ml.

In the full inquiry *Are You Dense?* students will need copper wire, copper shot, or some other form of copper. If you use wire, choose a thick gauge so that it will displace a significant amount of water. Cut it into lengths that are several centimetres long, then coil or roll the wire so that it will fit into a graduated cylinder.

Provide at least ten of each Australian circulation coin. The ‘silver’ coins are 75% copper and 25% nickel. The ‘gold’ coins are 92% copper, 6% aluminium and 2% nickel. Copper and nickel have very similar densities (8.96 g/ml and 8.90 g/ml respectively) but aluminium is much lighter at about 2.7 g/ml. However, because the ‘gold’ coins are only 6% aluminium the difference in density between the ‘gold’ and ‘silver’ coins is small (8.58 g/ml for gold and 8.95 g/ml for silver).

In this experiment, students are asked to devise their own experiment to determine the density of several objects: a piece of copper wire, various ‘silver’ and ‘gold’ coins. The appropriate way to determine the volumes of the wire and coins is by water displacement. A five-cent coin has a volume of about .32 ml. This is a difficult volume to read on a graduated cylinder. Encourage students to determine the volume of 10 coins, then divide that volume by 10 to get the volume of one coin. Results should be consistent with all the ‘silver’ coins and both ‘gold’ coins. Although the difference in density between the two coins types is small, with accurate measurement it should still be detectable.