Investigation and Experimentation

9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
   a. Plan and conduct a scientific investigation to test a hypothesis.
   b. Evaluate the accuracy and reproducibility of data.
   c. Distinguish between variable and controlled parameters in a test.
   d. Recognize the slope of the linear graph as the constant in the relationship y□kx and apply this principle in interpreting graphs constructed from data.

The scientific method is a series of steps that scientists use to answer questions and solve problems. Any information you gather through your senses is an observation. Observations often lead to questions or problems. A hypothesis is a possible explanation or answer to a question. A good hypothesis is testable. After you test a hypothesis, you should analyze your results and draw conclusions about whether tour hypothesis was supported. Communicating your finding(data) allows others to certify your results or continue to investigate your problem. A scientific theory is the result of many investigations and many hypotheses that have been supported over time. Scientific models are representatives of objects or systems. Models make difficult concepts easier to understand. Models can represent things too small to see or too large to observe directly. Models can be used to test hypotheses and illustrate theories.

Definitions to know:

_____: a series of steps that scientists use to answer questions and solve problems

_____: a possible explanation or answer to a question

_____: any information that results from experimentation

_____: any use of the senses to gather information

_____: the amount of surface an object has

_____: the amount of matter in a given space; mass per unit volume (density = mass/volume)

_____: the amount of space that something occupies or the amount of space that something contains

_____; the amount of matter that something is made of; does not change with the objects location

_____: the basic unit of length in the SI system

_____: the measure of how hot (or cold) something is

_____: the part of a controlled experiment that contains all of the same variable and constants as the experimental group but the independent variable is NOT changed

_____: any factor in a scientific investigation that can have more than one value. In an experiment it is what is being tested AND measured

_____: a number describing how steep a plotted line on a graph is; equal to the rise divided by the run.

Column A	Column B
___ **3.** I told my classmates that Kaboing! shoes do not help you jump higher and that regular sneakers work better.	**a.** Ask a question.
___ **4.** I wanted to know, "Will wearing Kaboing! shoes help me jump higher?"	**b.** Form a hypothesis.
___ **5.** I jumped five times in a pair of Kaboing! shoes and recorded the height each time. After resting for 5 minutes, I repeated the test wearing my sneakers.	**c.** Test the hypothesis.
___ **6.** I thought I'd jump higher in Kaboing! shoes than in my sneakers.	**d.** Analyze the results.
___ **7.** I jumped higher in my sneakers than I did in Kaboing! shoes. Kaboing! shoes do not help me jump higher.	**e.** Draw conclusions.
___ **8.** The average height for the five jumps in Kaboing! shoes was 35.5 cm. The average height for the five jumps in my sneakers was 36 cm. On average, I jumped half a centimeter higher in my sneakers than I did in Kaboing! shoes.	**f.** Communicate the results.

Math in science:

1. a cereal box has a mass of 340g. its dimensions are 27cm x 19cm x 6 cm. what is the volume of the box?

2. Each of two cement building blocks has a volume of 2.5L. The mass of block A is 5kg, and the mass of block B is 7kg. find the difference in the densities of the two blocks (density = mass / volume)

Variables & Controls:

3. Imagine that you are conducting an experiment in which you are testing the effects of the height of a ramp on the speed at which a toy car goes down the ramp. What is the variable in this experiment? What factors must be controlled?

Part 2: Calculating Area

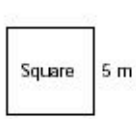
Now that you know how to find the perimeter of the garden, you are ready to plan what to grow. How much planting soil will you need? How many plants will fit in the garden? To answer these questions, you will need to know the area of the garden. **Area** (*A*) is the number of square units needed to cover the surface of a figure. The equations below will help you find the area of some common figures.

EQUATIONS: Area of a square = side × side

Area of a rectangle = length × width

Area of a triangle = $\frac{1}{2}$ × base × height

SAMPLE PROBLEMS: Find the area (*A*) of each of the following figures:



A = side × side

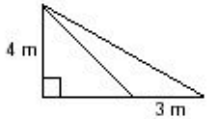
$A = 5\text{ m} \times 5\text{ m}$

$A = \mathbf{25\ m^2}$

A = length × width

$A = 9\text{ cm} \times 3\text{ cm}$

$A = \mathbf{27\ cm^2}$



$A = \frac{1}{2} \times$ base × height

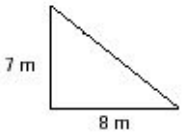
$A = \frac{1}{2} \times 3\text{ m} \times 4\text{ m}$

$A = \mathbf{6\ m^2}$

Area Alert!

3. Find the area of each figure below. *Hint:* When finding the area of irregular figures, first divide the figures up into triangles, squares, and rectangles and then add their individual areas.

a.

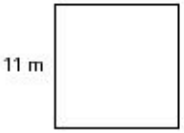


$A =$ _____

b.

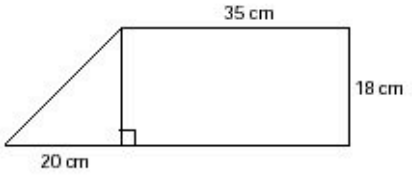
$A =$ _____

c.



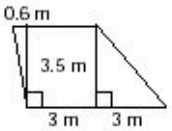
$A =$ _____

d.



$A =$ _____

e.



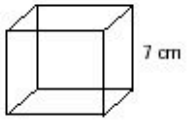
$A =$ _____

Finding Volume

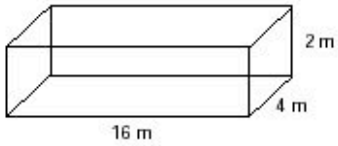
Volume (V) is the amount of space something occupies. It is expressed in cubic units, such as cubic meters (m^3) and cubic centimeters (cm^3). Use the equations for volume below to calculate the volume of cubes and prisms.

EQUATIONS: Volume of a cube = side × side × side
Volume of a prism = area of base × height

SAMPLE PROBLEMS: Find the volume (V) of the solids.



V = side × side × side
V = 7 cm × 7 cm × 7 cm
V = **343 cm³**

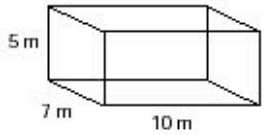


V = area of base × height
V = (length × width) × height
V = (16 m × 4 m) × 2 m
V = 64 m² × 2 m
V = **128 m³**

Turn Up the Volume!

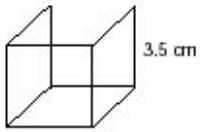
1. Find the volume of the solids.

a.



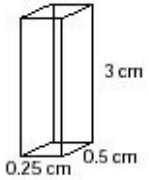
V = _____

b.



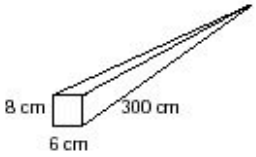
V = _____

c.



V = _____

d.



V = _____

Challenge Yourself!

2. A rectangular-shaped swimming pool is 50 m long and 2.5 m deep and holds 2500 m^3 of water. What is the width of the pool?

What Is a Ratio?

Imagine that you are planning a science experiment for your class and you want to make sure you have enough beakers for everyone. What do you do? Well, you could simply count the total number of beakers you have and compare it with the number of students in your class. You may not have realized it, but you just made a ratio! A **ratio** is a comparison between numbers, and can be written in words (3 to 7), as a fraction (3/7), or with a colon (3:7).

PROCEDURE: To find the ratio between two quantities, show the two quantities as a fraction, and then reduce. The result is the ratio.

SAMPLE PROBLEM: Find the ratio of thermometers to students if you have 36 thermometers and 48 students in your class.

Step 1: Make the ratio. $\frac{36 \text{ thermometers}}{48 \text{ students}}$

Step 2: Reduce. $\frac{36}{48} = \frac{36 \div 12}{48 \div 12} = \frac{3}{4}$

The ratio of thermometers to students is 3 to 4, $\frac{3}{4}$, or 3:4.

Wildflower Research Results

Field	Average number of flowers (per 10 m²)	Number of species	Species currently flowering
1	51	12	9
2	17	11	7
3	22	22	20

Analyze Your Data!

1. What is the ratio between the currently flowering species and the total number of species of flowers in Field 1?

_____

2. What is the ratio between the number of species currently flowering in Field 1 and Field 2 and the number of species currently flowering in Field 3?

_____

3. What is the ratio between the number of species currently flowering and the total number of flowers in all three fields?

_____

Objective

You've read about the scientific method. Now you will have a chance to put it to use by performing an experiment and by designing a new experiment. In this activity you will place one candle in ice water and one in hot tap water. You will observe any changes that occur. Then you will design a similar experiment using the scientific method.

Know the Score!

As you work through the activity, keep in mind that you will be earning a grade for the following:

- how well you work with the materials and equipment (30%)
- how well you state your observations (40%)
- how well you analyze and explain your observations (30%)

Ask a Question

How does temperature affect the expansion and contraction of solid matter?

MATERIALS

- sandpaper
- 2 new, nontapered wax candles (about 20 cm long)
- 2 dishes (25 cm deep)
- hot water and ice water
- 2 metal spoons

Make Observations

1. Use the sandpaper to sand the ends of the candles so that they are exactly the same length.
2. Fill each dish about 5 cm deep with water. Use ice water in one dish and hot tap water in the other dish.
3. Place one candle in the dish containing hot water and one candle in the dish containing cold water. Place a spoon on top of each candle to keep the candle from floating. Leave the candles in the water for 10 minutes.

Form a Hypothesis

4. How do you think the hot water and ice water will affect the candles?

Test the Hypotheses

5. Remove the candles from their dishes. Describe any differences you see in the candles.

Draw Conclusions

6. What does the difference in the two candles tell you about the relationship between heat and the size of an object?

7. Based on your answers to the questions above, explain why there is a need for expansion joints in train tracks, bridges, buildings, etc.

Use the scientific method to answer the following questions.

8. Are bicycle tires less likely to need additional air on a hot summer day or on a cool fall day? Formulate a hypothesis. Keep in mind that materials expand when heated.

9. How might you test your hypothesis?

10. From what you learned in this activity, give an explanation that supports your hypothesis.