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Overview

This Delta Science Module introduces students to the world of measuring.

In Activity 1, students compare the lengths, widths, and heights of various objects. Then they compare the dimensions of similar objects using lengths of ticker tape as a unit of measure.

In Activity 2, students use lengths of string to compare various distances within the classroom and come to appreciate the limitations of string as a measuring tool: Although it can be used to compare one distance with another, it cannot be used to measure actual distance in terms of standard units.

Activity 3 introduces students to nonuniform and uniform units of measure. In the course of their experiments, students come to recognize the need for a unit of measure that is not only uniform but invariable.

In Activity 4, students learn that area is measured in square units and use the formula *length* × *width* = *area* to calculate it. Students also make rectangles of various sizes on geoboards and calculate their areas. They find that rectangles with different dimensions have the same areas if they each include the same number of uniform square units.

Students are introduced to the metric system of measurement in Activity 5. They construct a centimeter ruler on ticker tape and use it to measure the lengths of various objects to the nearest centimeter.

In Activity 6, students are introduced to the millimeter as a standard unit of measure. They measure various objects to the nearest millimeter and the nearest centimeter and come to realize that metric units are related by a factor of ten.

Students explore capacity in Activity 7 and become familiar with two more metric standard units of measure—the liter and the milliliter.

Students discover in Activity 8 that if they know the dimensions of a box, they can calculate its volume. They learn that volume is a cubic measure, and they calculate volume measurements in cubic centimeters.

In Activity 9, students construct a simple balance to compare the weights of various objects or groups of objects. They learn that while they can determine the relative weights of the objects they place on the balance, they cannot express those weights in terms of standard units of measure.

In Activity 10, students use an equal-arm balance to determine the weights of various objects. First they measure weight in uniform, but nonstandard, units of paper clips. Then they weigh each object again, using the international metric standard for weight—the gram.

In Activity 11, students construct a simple thermometer, which they use to measure the relative temperatures of water samples. Their observations lead to an understanding of the principle behind the functioning of a thermometer.

In Activity 12, students continue to measure temperature, this time using a metric thermometer graded in degrees Celsius. They collect temperature data over the course of a week and then graph their data in order to see clearly any trends in the outdoor temperature changes over time.

Students construct their own sand-clock timers in Activity 13. They pour measured amounts of sand into their setups and use a stopwatch to time the emptying of their timers.

Materials List

Qty		Description
1		bag, plastic, reclosable, 15 cm × 15 cm
8		bases, balance
8		beakers, graduated, 800-mL
8		beams, balance
8		beams, pegboard
2		boxes, 2 cm × 5 cm × 8 cm
2		boxes, 2 cm × 5 cm × 20 cm
2		boxes, 2 cm × 8 cm × 10 cm
2		boxes, 2 cm × 13 cm × 13 cm
3		centimeter cubes, p/100
1	c	chart, Indoor and Outdoor Temperatures
1		clay, 0.25 lb
2		containers, 7-oz cup
2		containers, 9-oz cup
2		containers, dish
2		containers, vial
9		cups, foam, 16-oz
50		cups, paper, 6-oz
8	c	cups, paper, cone
32		cups, plastic, 1-oz
1		Drawings to Measure
1	c	food coloring, red, 1 oz
8		fulcrums
8		geoboards
1		Lines and Rectangular Shapes
8		paper clips, large, p/100
8		paper clips, small, p/100
15		paper, construction, 40 cm × 50 cm
3		paper squares, 5 cm × 5 cm, p/112
1		paper squares, 10 cm × 10 cm, p/250
8		pins, balance
1		Rectangular Strips
1		rubber bands, 2 oz
8		rubber stoppers, with tubes
32		rulers, metric
2		sand, fine, 2 lb
16		soufflé cups, balance
4		sponge blocks, p/6
2	c	string, roll
1	c	tape, masking
8		test tubes
8		thermometers, Celsius
1	c	thread
2	c	ticker tape, rolls
8		tongue depressors
8		washers, large
8		washers, small
8		wooden blocks, p/3
1		teacher's guide

Teacher provided items

Qty		
1		chalk
64		crayons
1		electric hot plate
1		hole punch
–	c	ice
1		kettle
–	c	newspaper
–	c	paper towels
32	c	paper, graph
8		pencils
8		pitchers
9		scissors
8		stopwatches
–	c	tape, transparent
2		textbooks
–	c	water, tap

c = consumable item

Activity 4
Area

Objectives

In this activity, students predict and measure the area of different surfaces using uniform square units of measure.

The students

- operationally define *area*
- use squares as uniform units to measure surface area
- use the formula *length* × *width* = *area* to calculate the area of a rectangle

Schedule

About 40 minutes

Vocabulary

area

Materials

For each student

1	Activity Sheet 4, Parts A and B

For each team of four

1	geoboard
1 sht	paper, construction, 40 cm × 50 cm
4	rubber bands

For the class

1 sht	paper, construction, 40 cm × 50 cm
3 pkg	paper squares, 5 cm × 5 cm
1 pkg	paper squares, 10 cm × 10 cm
1 roll	tape, masking

Preparation

1. Make a copy of Activity Sheet 4, Parts A and B, for each student.
2. Four teams will each need 84 small paper squares, and the remaining teams will each need 25 large paper squares.
3. You will need to borrow one large and one small paper square, a rubber band, and a geoboard from one of the teams for demonstration purposes.
4. Each team of four will also need a geoboard, four rubber bands, and a piece of construction paper.

Background Information

Surfaces are two-dimensional. A surface bounded by a line is called an *area*. The measurement of an area is expressed in square units, regardless of its shape, because it is the product of two measurements, one for each of its two dimensions.

The way in which the area of a two-dimensional object is calculated depends upon its shape, or outline. The area of a rectangular or square shape is calculated by multiplying the rectangle's length by its width. The area of a circle is calculated using the formula $area = \pi r^2$, where r equals the radius of the circle. The area of a triangle is calculated by using the formula $area = \frac{1}{2}(base \times height)$.

All results are expressed in terms of square units. Area in the metric system is measured in square centimeters (cm^2), square meters (m^2), or square kilometers (km^2). Large areas of land are measured in hectares. A hectare equals 100 acres or 10,000 square meters. Area in the customary system is measured in square inches ($in.^2$), square feet (ft^2), square yards (yd^2), and acres.

In this activity, students measure area by counting the number of square units needed to cover a rectangular shape. Students learn that different shapes have the same area if they are composed of the same number of square units.

Name _____ Activity Sheet 4, Part A

Area

How many small squares do you think it will take to cover the construction paper? How many large squares do you think it will take?

Answers will vary.

1. Record your results below.

How many small squares did it take to cover the construction paper?

80

How many large squares did it take to cover the construction paper?

20

What is the length of the construction paper in units of small squares?

10 square units

What is the length of the construction paper in units of large squares?

5 square units

What is the width of the construction paper in units of small squares?

8 square units

What is the width of the construction paper in units of large squares?

4 square units

What is the area of the construction paper in units of small squares?

80 square units

What is the area of the construction paper in units of large squares?

20 square units

Name _____ Activity Sheet 4, Part B

Area

2. Make the rectangular shapes described in the chart below on your geoboard and then determine their area. Record your results in the chart.

Rectangle	Length (in square units)	Width (in square units)	Area (in square units)
A	4	2	8
B	10	1	10
C	2	5	10
D	4	3	12

Do you see a relationship between the length and width of each rectangle and its area?

Yes. The length times the width equals the area.

How can you use a rectangle's length and width to calculate its area?

Use the formula *length* × *width* = *area*.

3. Calculate the area of a rectangle with a length of 2 square units and a width of 10 square units.

20 square units

Teaching Suggestions

Additional Information

1

Tape a piece of construction paper (40 cm × 50 cm) to the board. Then hold up a 10-cm paper square and a 5-cm paper square and ask, **Will it take more large squares or more small squares to cover the paper?**

Students should say it will take more small squares.

Give a copy of Activity Sheet 4, Part A, to each student and a piece of construction paper to each team. Distribute 84 small paper squares to each of four teams and 25 large paper squares to each of the remaining teams. Tell students to first predict how many paper squares of each size it will take to cover the construction paper and record their predictions on the activity sheet. Ask, **What uniform unit of measure is each team using?**

Students should say they are using uniform units of small or large squares.

Have each team cover the piece of construction paper with paper squares and count the number of squares used. Tell students to record their results on the activity sheet next to the correct units of measure (small squares or large squares). Tell students to trade squares with another team so that all teams have an opportunity to use both the small and the large squares.

Remind students to record their results with both sets of squares.

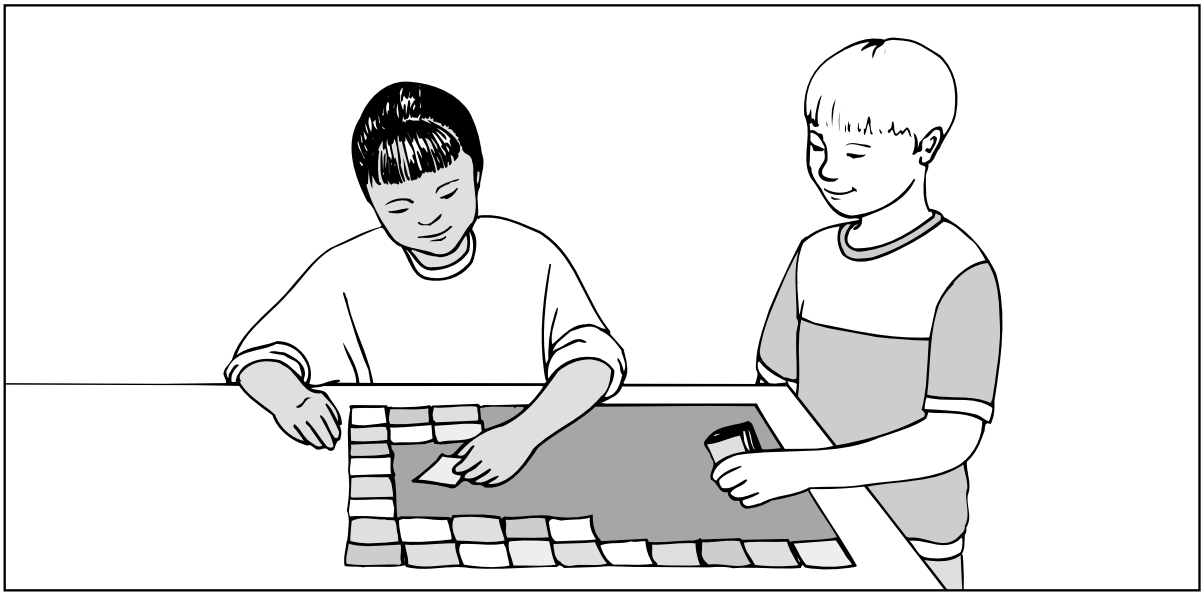

Figure 4-1. Students measure the area of a sheet of paper in uniform square units.

When students have finished write the word *area* on the board. Tell students that they have measured the area of the construction paper in uniform units of paper squares. Ask, **How would you define area?**

2

Answers will vary. Students may say that it is the size of a surface.

Tell students that area is the surface enclosed by a line. Call students' attention to the piece of construction paper taped to the board and point out its outlines and its area.

Ask students, **What is the length of the construction paper in units of small squares? In units of large squares?**

Students should respond that the paper is 10 small square units long and 5 large square units long.

Ask, **What is the width of the construction paper in units of small squares? In units of large squares?**

Students should respond that the paper is 8 small square units wide and 4 large square units wide.

Explain that area is a two-dimensional measurement. Ask, **Which two dimensions does area represent?**

Students should name length and width as the two dimensions.

Hold a class discussion to interpret the data on the activity sheets. Ask, **Can you compare the area measurements you made with small squares with the area measurements you made with large squares?**

Students should say no, because different uniform units—different sizes of squares—were used. Help students relate these results to the results in Activity 3, where different sizes of paper clips were used to measure length.

Make a rectangular shape on a geoboard with a rubber band and hold it up for the class to see. Ask, **How could you measure the area of this shape on the geoboard?**

3

Students should suggest counting the number of squares within the rectangle.

Ask, **What uniform unit of measure should you use?**

Students should say they should use the square units on the geoboard because they are all the same size.

Distribute a geoboard and four rubber bands to each team of students. Tell students to take turns making various square and rectangular shapes. Ask, **Can different shapes have the same area?**

Students should say if different shapes have the same number of squares, their areas are the same.

To reinforce this concept, have each student make a shape on the geoboard and measure its area in squares. Then have another member of the team make a different shape that has the same area (the same number of squares).

4

Distribute a copy of Activity Sheet 4, Part B, to each student. On the board, draw the table in Activity Sheet 4, Part B, listing the length and width of four rectangles. Leave the column headed *Area (in square units)* blank. Instruct students to make each of the rectangles listed in the table on the geoboard. Then tell them to determine the area of each rectangle. Students should record their answers on the activity sheet.

After students have finished determining the area of the rectangles, stimulate a discussion by asking, **Do you see a relationship between the numbers of squares in the length and width of each rectangle and the number of squares in its area?**

Students may notice that the number of squares in the length multiplied by the number of squares in the width equals the number of squares in the area.

Ask, **What can you do with the numerical values for length and width to get the area of a rectangle?**

Students should say that you can multiply the length by the width to get the area.

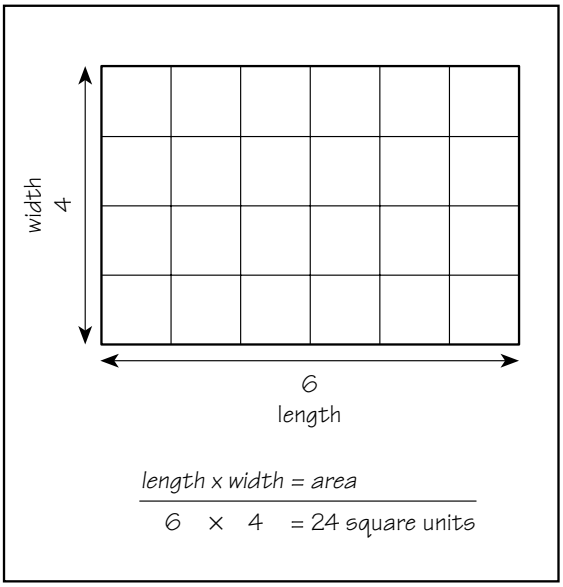

Figure 4-2. The area of a rectangle is calculated by multiplying its length by its width.

Write *length* × *width* = *area* on the board. Tell the class this is the formula for calculating area. Ask, **What is the area of a rectangle with a length of 10 square units and a width of 4 square units?**

Students should say it is 40 square units.

Ask, **How did you come up with that number?**

Students should say that they multiplied the rectangle's length (10) by its width (4).

Encourage students to use the formula *length* × *width* = *area* to complete the activity sheet.

Reinforcement

R

Have students refer to Part B of the activity sheet and calculate the area of a rectangle whose length is twice that of Rectangle A and whose width is twice that of Rectangle B. (8 × 2 = 16)

Cleanup

C

Return the geoboards, the rubber bands, the construction paper, the masking tape, and the paper squares to the kit.

Science at Home

With a paper cutter, measure and cut 2-in. squares of plain or construction paper and give one to each student to take home. Have them measure the length and width of three rectangular surfaces at home—for example, a book cover, a tabletop, or the page of a calendar—to the nearest whole square. Tell them to calculate and record the area of each surface in square units.

Connections

Science Extension

Give each student a sheet of graph paper, and ask students to calculate the area of the sheet. (Count the number of squares for length and for width, and multiply the two numbers.) Then ask them to suggest how they could use the graph paper to figure out the area of their hands. (Trace around the hand with a pencil on the graph paper, then count the number of squares inside the hand outline.) Let students try this. Tell them that if more than half a square is inside the outline, they should count it as one square; if less than half a square is inside, they should not count it. Let students compare their hand areas. (Also see Science and Health below.)

Science and the Arts

Show students, or ask them to find, photographs of mosaics—pictures or designs made with small squares of tile or other materials. Provide an ample supply of small construction paper squares of different colors. (The easiest way to cut a large supply of squares is by using a paper cutter.) Each student can create his or her own mosaic by gluing colored squares on a sheet of black construction paper.

Science and Health

Ask students to name the largest organ (or "specialized body part") in the body. They will probably name the heart, lungs, brain, or liver and will be surprised to learn that the largest organ is the skin. Guide them in identifying the major functions of the skin: protecting the inner parts of the body against drying out and against disease-causing organisms; maintaining a healthy body temperature through evaporation of perspiration; sensing pain, heat, cold, and touch; and eliminating some body wastes in perspiration. Remind students of the method they used to figure out the area of their hands in the Science Extension above, and challenge them to devise a similar way to figure out the surface area of their skin. (Students could trace their body outlines on a large sheet of brown packaging paper ruled into squares or on a large graph sheet made by taping together standard-size sheets of graph paper, count the squares inside the outline, and then multiply by 2 to find the total area for the back and front of the body.)

Science and Math

Have each team measure the length of the classroom in construction-paper lengths and its width in construction-paper widths, then multiply the two numbers to find the area in units of construction paper sheets. Students can then convert these "sheet" units to units of large squares and small squares using the equivalents they recorded on Part A of the activity sheet. For example, a room that is 20 paper-lengths long and 15 paper-widths wide has an area of 300 "sheets." Students found that the sheet has an area of 80 small-square units or 20 large-square units. Thus, the room's area would be 24,000 small-square units or 6,000 large-square units.

Science, Technology, and Society

Ask students to name as many products as they can that are sold based on the area they cover—for example, house paint, wallpaper, carpeting, lawn fertilizer, grass seed, and weed killer. Suggest that volunteers survey such products in stores to find out the area covered by each size package available. Help students use this information to make up and solve realistic word problems involving calculating area and then dividing to determine the number of packages or units that must be purchased.