

# Measuring Slope for Rain Gardens

## Activity Overview

Students measure the slope and calculate percent slope for their rain garden project.

## Objectives

### Students will:

1. Measure and calculate degree of slope using simple tools
2. Use math concepts in problem-solving a real-world situation
3. Understand how the percent slope, i.e., steepness of a slope, affects the construction of a rain garden

## Subjects Covered

Science and Math

## Grades

3 through 12

## Activity Time

1-2 hours

## Season

Spring or Fall

## Materials

For each team of 4 students - 1 Line level\*, 15 feet of string, 2 wooden stakes, 1 ruler, clipboard and field sheet

## State Standards

Math

Use reasoning abilities (A.4.1, A.8.1, A.12.1)

Connect mathematical learning with other subjects (A.4.3)

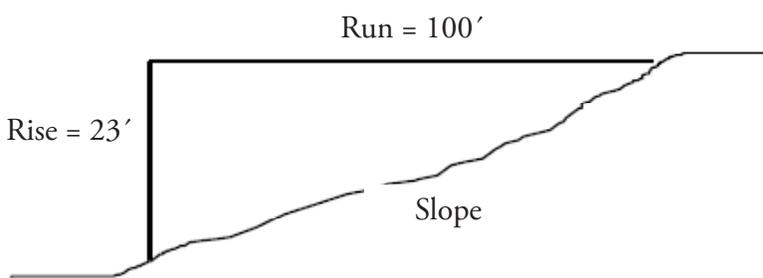
Use vocabulary, symbols, notation (A.4.4)

Explain solutions to problems (A.4.5)

Analyze non-routine problems (A.8.3)

## Background

Slope is the change in elevation between two points. It is expressed as a percent change in elevation per unit of distance. When planning a rain garden the percent slope of the garden space determines the depth of the rain garden and how deep to dig your garden. The goal is to keep the garden level so that water spreads out and does not puddle. When digging your garden, you will cut soil from the upper slope and fill in the lower slope to create a flat bottom. To determine how much cut and fill is necessary, you calculate the depth of the garden based on the slope. Generally the greater the slope the deeper the garden will need to be dug. A slope less than 4% equals a 3 – 5 inch deep garden, 5 – 7% slope equals a 6 – 7 inch deep garden, and 8 – 12% slope equals an 8 inch deep garden. If the slope is more than 12%, it's best to talk to a professional landscaper or find a different site.



The easiest way to determine the percent slope of an area is to measure the change in height (elevation over a measured distance), then calculate the percentage of slope. Use the following formula to determine slope:

$$\text{Rise} \div \text{Run} \times 100 = \text{Slope \%}$$

OR

$$(\text{Change in elevation (rise)} \div \text{horizontal distance (run)}) \times 100 = \text{slope \%}$$

$$23' \div 100' \times 100 = 23\%$$

## Pre-Activity Preparation

For each team:

- Make two 20 inch stakes
- Cut a piece of string about 10 feet long plus 6 inches for tying the string to the stakes. It is helpful to use a nylon-type string that is less prone to knotting. Mark the string at 10 feet (120 inches). You may mark the string in 10 inch intervals for easier measuring. Tie the string to one of the stakes and wrap the string around the stake. Make a loop at the other end of the string that will slip over the second stake.
- Assemble a measuring tool packet with stakes, string, line level, ruler, clipboard, field sheet and a pencil.

## Measuring Slope for Rain Gardens (cont.)

Math (cont.)

Explain mathematical concepts, procedures, & ideas (A.8.5)

Analyze non-routine problems & arrive at solutions (A.12.3)

Organize work & present mathematical procedures & results (A.12.5)

Represent & explain whole numbers, decimals, & fractions (B.4.1)

Read, write, & order whole numbers, fractions, & decimals (B.4.3)

Select & use appropriate computational procedures (B.4.5)

Read, represent, & interpret rational numbers (B.8.1)

Generate & explain equivalencies among fractions, decimals, percents (B.8.3)

Apply proportional thinking (B.8.5)

Use appropriate computational procedures with rational numbers (B.8.7)

Use complex counting procedures (B.12.1)

Compare real numbers (B.12.2)

Create & critically evaluate numerical arguments (B.12.5)

Routinely assess the acceptable limits of error (B.12.6)

Describe simple two- & three-dimensional figures (C.4.1)

Identify & use relationships among figures (C.4.3)

Use coordinate systems to find map locations (C.4.4)

Describe complex two- & three-dimensional figures (C.8.1)

figures (C.8.2)

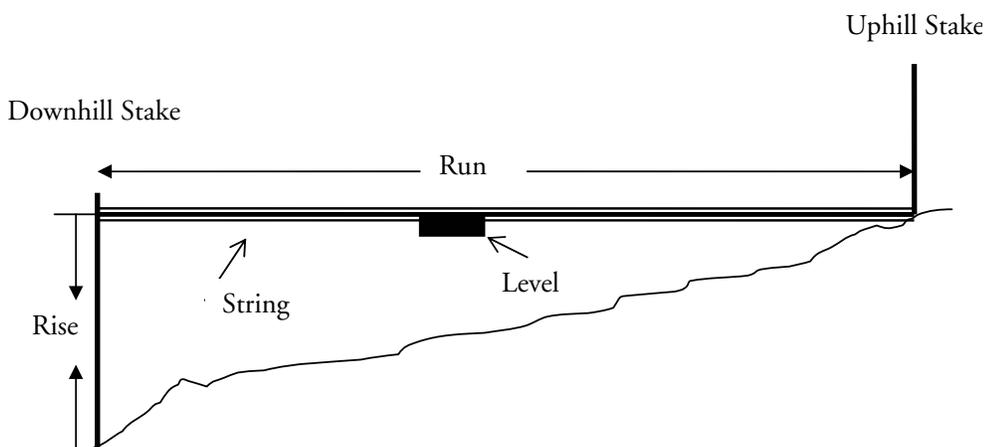
Identify & draw two- & three-dimensional shapes (C.8.3)

### Activity Description

1. Form teams of 5 students each, and hand out measuring tool packets. Each student has a different role. One student holds the uphill stake, another holds the downhill stake. One student records the data, and 2 students pull and level the string. All students calculate the numbers.
2. Practice measuring slope in the classroom following the instructions below. Go out to proposed rain garden site.
3. Select measuring sites in and around the proposed rain garden. Not all students will be able to measure the slope in the rain garden. Locate other sites for comparison, especially if different slopes are evident. Another option is to have all students practice in different spots, then measure the rain garden as a group, in which students take turns doing and describing each step.
4. Record measurements on the field sheets.
5. Return to the classroom to calculate slope and determine depth of rain garden using the field sheet.

### Directions for measuring the slope

1. Hold the stake with the string attached at the uphill end of the measuring site. Push the string down to the bottom of the uphill stake.
2. Place the second stake at the downhill end.
3. Run the string to the downhill stake. You may need to move the stake to meet the string. The distance between the stakes is 10 feet or 120 inches. Write this number as the run on the field sheet.
4. Loop the string around the downhill stake.
5. Attach the line level to the string. It should hang down. Slide the string up or down on the downhill stake until the line level indicates the string is horizontal and level.
6. Measure the height in inches on the downhill stake between the string and ground. Write this number as the rise on the field sheet.



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## Measuring Slope for Rain Gardens (cont.)

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Math (cont.)

Use geometric models to solve problems (C.12.2)

Recognize & describe measurable attributes & units (D.4.1)

Demonstrate understanding of measurement (D.4.2)

Read & interpret measuring instruments (D.4.3)

Determine measurements by using standard tools (D.4.4)

Demonstrate understanding of measurement facts, principles, techniques (D.8.2)

Determine measurement directly by using standard units (D.8.3)

Determine measurement indirectly (D.8.4)

Select & use tools to determine measurements directly (D.12.2)

Determine measurement indirectly (D.12.3)

Work with data in real-world situations (E.4.1, E.8.1, E.12.1)

Describe a set of data (E.4.2)

Use graphs, tables, or charts (E.4.3)  
cal investigations (E.8.2)

Analyze information from organized & displayed data (E.8.3)

Use results of data analysis (E.8.4)

Work with data in real-world situations (E.12.1)

### Extensions

- Measure a slope at three places along a line, and plot the results on a graph.
- See Earth Partnership for Schools activity “Topography: Measuring Slope” for additional information about the relationship among slope, soil, vegetation and human uses. This activity also provides an alternative technique for measuring slope.

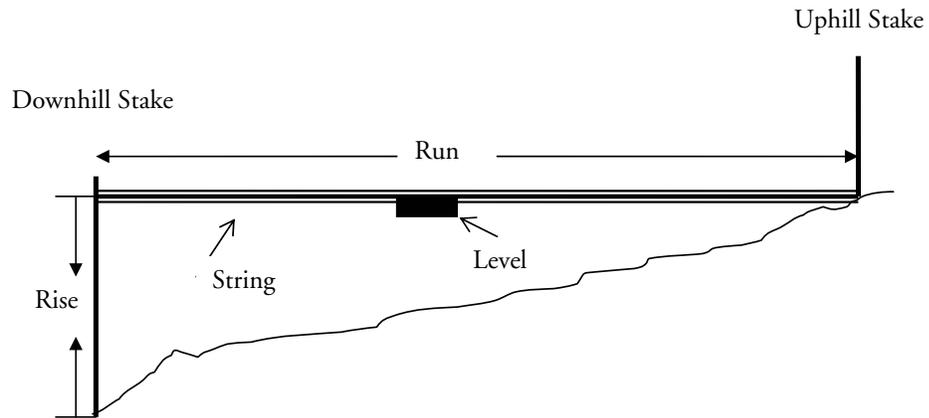
### Additional Resources

- ...*Soil erosion: The work of uncontrolled water*. Agriculture Information Bulletin #260, Soil Conservation Service, U.S. Department of Agriculture.
- ...*Teaching soil and water conservation*. Program Bulletin #341, Soil Conservation Service, U.S. Department of Agriculture.
- Line Levels are available at hardware stores for about \$1 to \$2.

### Assessments

- Describe the steps to accurately measure the slope on your schoolyard.
- If you had to dig a rain garden by hand, identify what kind of slope you would prefer to minimize your work, and why.

# Measuring Slope for Rain Gardens - Field Sheet



## Slope Formula

Rise (change in elevation) ÷ Run (horizontal distance) x 100 = slope %

## Rain Garden Depth

- < 4% slope = 3" – 5" deep garden
- 5 – 7% slope = 6" – 7" deep garden
- 8 – 12% slope = 8" deep garden

Location	Rise	Run	% Slope	Rain Garden Depth
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				