Activity 40: The Scoop on Slope (y=mx+b)

Maine Geological Survey

Objectives:

Students will construct a slope measuring device, measure a series of slopes, and relate the concept to physical structures around them.

Time:

This activity is designed to last one 45 minute period, with students working groups of three.

Background:

What do a mud slide, an avalanche, or an extreme erosion event all have in common? All are common tragedies in the newspaper or on television. They also have one physical character in common, and that is the concept of slope. Slope may be defined as a measurement of the steepness of a surface. Students may also have definitions of "rise over run" and "vertical drop over horizontal distance" depending on their math experiences. The measurement of slope is a common practice with engineers, surveyors, foresters, housing contractors, architects, and numerous other professionals. It is also found in laws and established standards for road construction, building access ramps, mining, and many environmental factors.

In this exercise students will construct a simple slope measuring device (clinometer) and measure a series of slopes within their own school's area. Professionals may measure slope in a number of different units. Two units are used in this activity and will be compared later in the exercise.

Materials:

Each student will need pens and their notebook. Each group of three students will need the following:

- A soda straw
- A piece of stiff cardboard
- String
- Paper and white glue
- Masking tape
- A small weight (quarter-ounce lead barrel sinkers work well)
- Copies of clinometers (see attached sheet)
- Scissors

Procedure:

Have students glue model A or B from Figure 3 to the piece of cardboard and cut out around the outside margin. Using the tape, attach approximately 12 inches of string to point X on the clinometer you have selected to work with. Attach the small weight to the end of the string; the string must swing freely from point X. Using two or three pieces of tape, attach a soda straw along the straight edge of the scale. This will be your sight. See Figure 1 for steps 2, 3, and 4.

Have students select three slopes around the school grounds. One of the groups will act as a target; this person stands at the top of the slope. Another student sights through the clinometer at the nose of the target student (see Figure 1). The third partner reads and records the position of the string as it crosses the scale. Students should swap jobs so all have a turn using the clinometer. See data table on student pages.

Follow-Up:

Have the students describe some of the variables that will affect the accuracy of their measurements (e.g., a four-foot student viewer using a six-foot student target).

Determine and discuss how slope is applied to:

- The crown of a road
- Switchbacks on steep mountain roads
- A flight of stairs
- Mudslides in California
- Rain runoff on your lawn
- The entry ramp at the grocery store
- Erosion in a plowed farm field
- Building a railroad

Have students locate a copy of your town or city building codes for house lots or roads and determine if there is any reference to slope in the standards. If there are references, have students discuss why they are there.

Slope may be measured in degrees, but engineers use percent slope for their unit of measurement. If students used different units to measure slopes, have them compare these measurements and try to mathematically relate % slope to slope in degrees.

References:

Activity developed by James H. Barden, in conjunction with the 1991 CREST intern program.

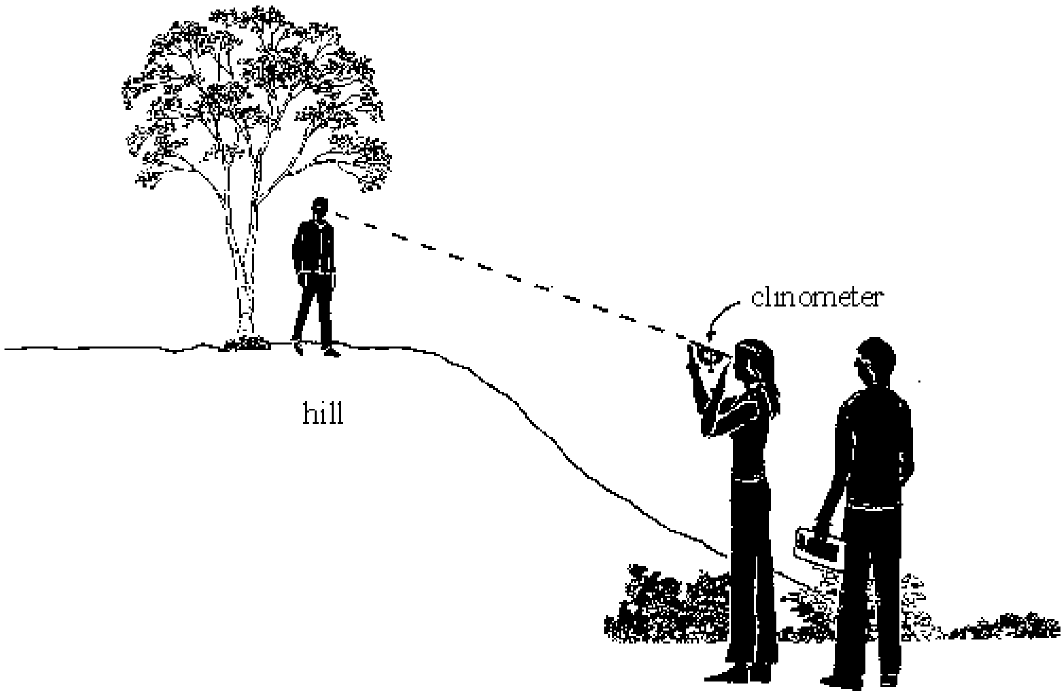


Figure 1. Using a hand-held clinometer to measure slope.

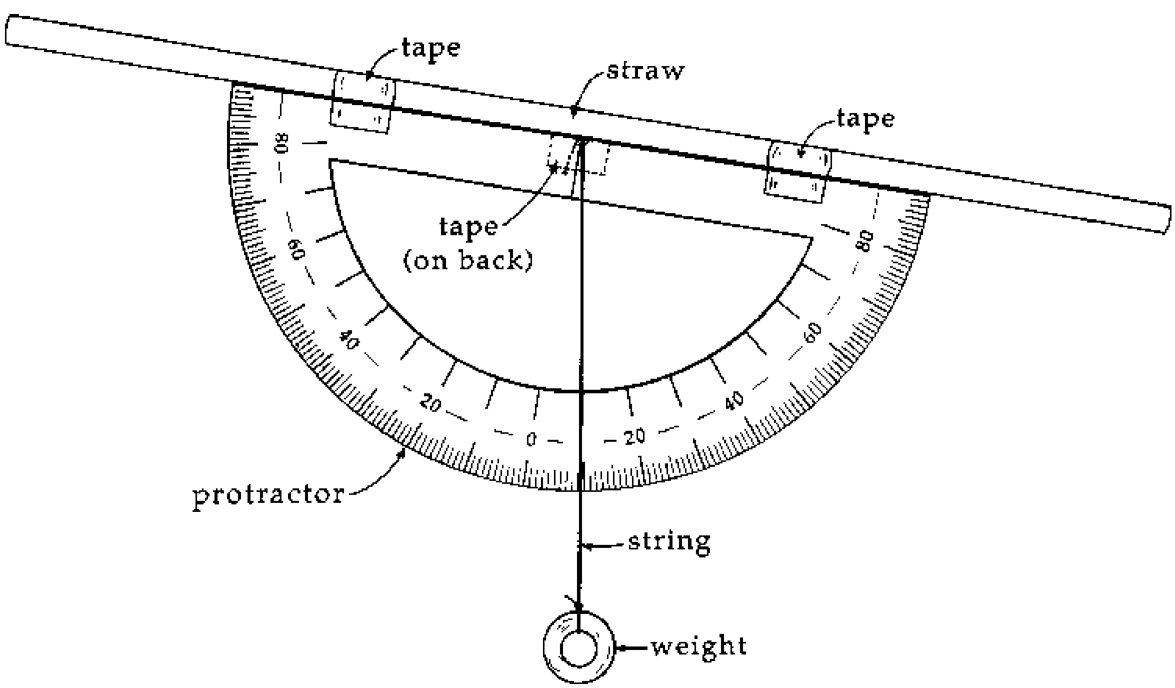
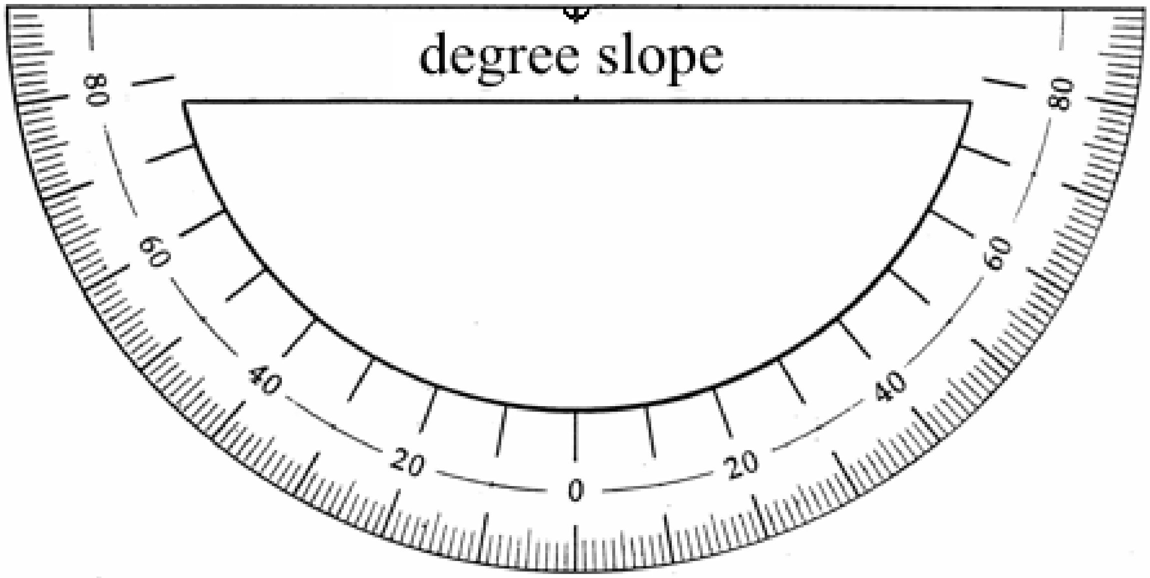


Figure 2. Diagram of finished clinometer with attached weight.

Model A.



Model B.

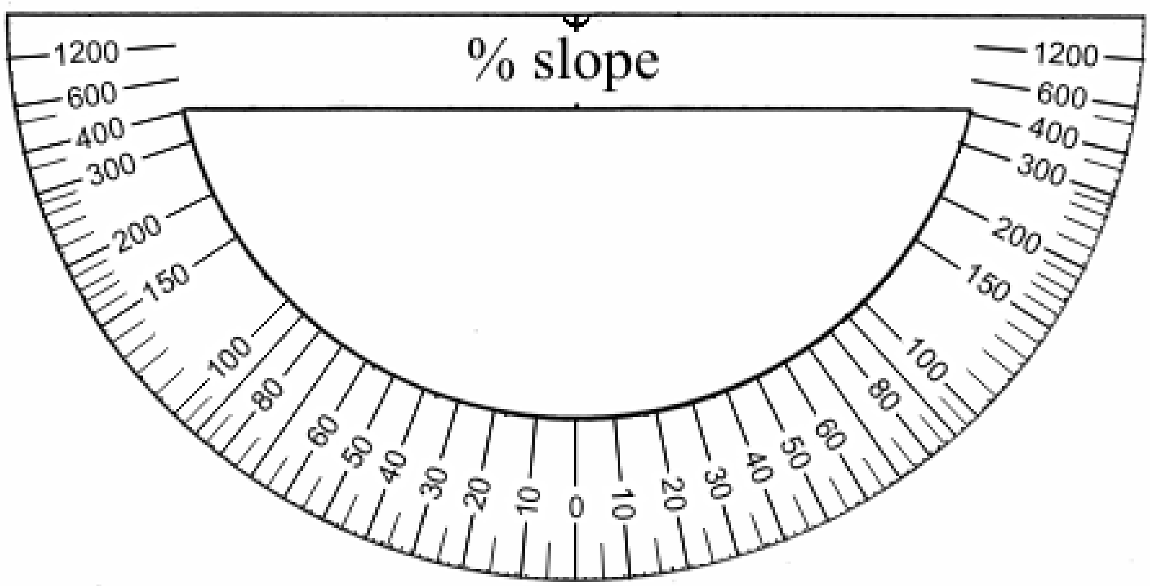


Figure 3. Glue model A or B to cardboard and cut around the shape.

Name___________________________

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Student Sheet

Purpose:

To construct a device to measure slope and use this device to find out the slope of structures in your immediate school environment.

Materials:

For this activity you will work in groups of three. Each group will need the following: a soda straw, a piece of stiff cardboard, a piece of string 1 foot long, paper, white glue, masking tape, a small weight, a paper copy of the clinometers (Figure 3), a diagram of the finished product (Figure 2), and scissors. Each student will need a pen and notebook.

Procedure:

A device which measures a slope is called a clinometer. The following steps apply to the construction of the clinometers you will use in this exercise.

1. Glue EITHER model A or B from Figure 3 onto a piece of stiff cardboard and cut out around the outside margin.
2. Using tape, attach approximately 12 inches of string to point X on the clinometer model you have chosen to work with.
3. Attach the weight to the end of the string; the weight and string must swing freely.

4. Using two or three pieces of tape, attach the soda straw carefully along the straight edge of your scale. This will be your sight. See Figure 2 for steps 2, 3, and 4.

The next steps apply to using your clinometer to take slope readings.

5. With your partners, select three sloped areas around the school ground to measure.
6. With one of the partners as a target at the top of the slope, a second partner sights through the straw at the NOSE of the target partner (see Figure 1). The sighting partner needs to hold the clinometer very steady.
7. The third partner reads and records the position of the string as it crosses the scale.
8. Partners switch positions and allow all members of the group to measure the same object.
9. Complete the attached data table; fill in the name/location of each slope.

Measured in (circle one): PERCENT DEGREES

Observer	Slope #1	Slope #2	Slope #3
1:			
2:			
3:			
Average			

Questions:

1. List and explain some of the factors that will affect the accuracy of your clinometer. Be specific.

2. What pieces of equipment could you add to your clinometer that would increase the accuracy of this method? (Hint- look up the term stadia rod.)

3. Determine the mathematical relationship between percent slope and degree of slope.