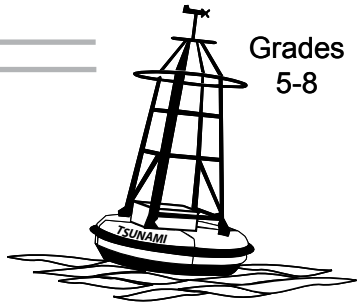
How the Mighty Fall



Grades 5-8

Overview:

Slope failure is the second most common cause of tsunamis, and slope failure triggers vary greatly. In this lesson, students develop, refine, and present investigations of slope failure. (NOTE: This lesson will require more than one class period and includes a brief segment on measuring accurately with a protractor.)

Targeted Alaska Grade Level Expectations:

Science

[7] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct simple repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings.

[8] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings.

[7] SD2.2 The student demonstrates an understanding of the forces that shape Earth by describing how the movement of the tectonic plates results in both slow changes (e.g., formation of mountains, ocean floors, and basins) and short-term events (e.g., volcanic eruptions, seismic waves, and earthquakes) on the surface.

[6] SD2.3 The student demonstrates an understanding of the forces that shape Earth by describing how the surface can change rapidly as a result of geological activities (i.e., earthquakes, tsunamis, volcanoes, floods, landslides, avalanches).

[5] SE2.1 The student demonstrates an understanding that solving problems involves different ways of thinking, perspectives, and curiosity by investigating a problem or project over a specified period of time and identifying the tools and processes used in that project.

[6-7] SE2.2 The student demonstrates an understanding that solving problems involves different ways of thinking by comparing the student's work to the work of peers in order to identify multiple paths that can be used to investigate a question or problem.

[8] SE2.2 The student demonstrates an understanding that solving problems involves different ways of thinking by comparing the student's work to the work of peers in order to identify multiple paths that can be used to investigate and evaluate potential solutions to a question or problem.

Math

[7] MEA-5 The student demonstrates understanding of measurement techniques by accurately measuring a given angle using a protractor to the nearest plus or minus 2 degrees

Objectives:

The student will:

- measure angles;
- plan and carry out an investigation of variables in slope failure;
- present investigation to peers; and
- suggest ways to improve investigations.

Materials:

- Butcher paper or newspaper
- Foam board (8 ½" x 11") (one for each individual or group)
- Protractors
- Water
- Sand
- Soil
- Gravel (optional)
- Trays
- Styrofoam bowls
- Scissors
- Graduated cylinders
- Beakers
- Scale
- Digital camera (optional)
- VISUAL AID: "Augustine Tsunami"
- STUDENT INFORMATION SHEET: "Slope Failure and Tsunamis"
- STUDENT WORKSHEET: "Measuring Angles"
- STUDENT WORKSHEET: "How the Mighty Fall"
- STUDENT WORKSHEET: "Slope Journal"

Science Basics:

Slope failure is a potential tsunami trigger and is the second most common cause of tsunamis. Landslides, rockfalls, avalanches and slumps are all examples of slope failure and occur above and below water. There are many causes of slope failure, see the tables below.

Above Water Slope Failure

	Natural Triggers	**Human Triggers**
Removal of Support	erosion at the base of a slope by streams, waves, glaciers	excavation at the base of a slope or excavation on a hillside
Removal of Vegetation	forest fires	clearing trees, removing plants
Addition of Moisture	rainfall or snowmelt	sewage or runoff disposal, broken water pipes, improper grading
Addition of Weight	heavy snowfall, volcanic ash, landslides	placement of fill
Oversteepening	magma buildup within volcanoes	placing fill at an angle that exceeds its stability
Vibrations	earthquakes, thunder	blasting, operation of heavy equipment

Submarine Slope Failure

Natural Triggers	**Human Triggers**
extreme low tide earthquake	construction

Slope failure is responsible for many tsunamis in Alaska's history. The triggers for these landslides vary from earthquakes, volcanic activity, and human activity.

Activity Preparation:

Display materials for carrying out investigations. Bowls are for containing water, soil, sand or gravel. It may also be helpful to consider students carrying out investigations outdoors.

Activity Procedure:

1. Explain students will learn about slope failure and its potential to trigger tsunamis.
2. Distribute STUDENT INFORMATION SHEET: “Slope Failure and Tsunamis” and review the information as a class.
3. Display VISUAL AID: “Augustine Tsunami” and discuss the information displayed on it.
4. If practice in measuring angles is necessary, distribute STUDENT WORKSHEET: “Measuring Angles,” and explain this skill will be necessary in carrying out an investigation on slope failure. After students complete the worksheet, review as a class.
5. Explain that students will now apply knowledge and skills to investigate slope failure. (NOTE: Adapt this lesson so that it is more appropriate for your students. For some classes it may be necessary to carry out the following investigation as a class.) Distribute STUDENT WORKSHEET: “How the Mighty Fall.” This activity may be completed by individuals or by groups. Review all sections. Explain the foam board is the slope surface. Review all the materials available for use. Water may be added or slope materials (sand, soil, gravel) may be mixed but careful attention should be paid in describing how materials are mixed. Scissors may be used to poke small holes in the bottom of a bowl to sprinkle water on a slope. Tools available to collect quantifiable data include: protractors, graduated cylinders, beakers, and a scale. Draw the following example of a data table on the board. Explain this is an example and that depending on the investigation, tables may need to change to fit the needs for data. When discussing the analysis of data, emphasize that students need quantifiable data in order to construct a graph. This needs to be a consideration in planning the procedure. Also emphasize that procedures should address how only one variable will be tested and how other variables will remain constant.

	Trials			
	1	2	3	

6. Explain that students will present investigations twice to other students. The first presentation will be to gather information on how to improve their plans for the investigation. The second presentation will be after the investigation has been completed to compare and discuss investigations.
7. Allow time for students to plan and complete STUDENT WORKSHEET: “How the Mighty Fall” up to the “STOP” sign. Then, students share their plans. Encourage student feedback on how to strengthen the presenters’ investigations. Distribute STUDENT WORKSHEET: “Slope Journal,” and tell students to complete the first section.
8. Students conduct investigations and complete STUDENT WORKSHEET: “How the Mighty Fall.”
9. Students present full investigations and results for peer feedback and complete STUDENT WORKSHEET: “Slope Journal.”

Extension Idea:

- Incorporate digital pictures of procedures and materials in PowerPoint presentations of investigations.
- Research areas around the community that may have potential for slope failure.

Answers:

STUDENT WORKSHEET: "Measuring Angles"

1. 51°
2. 56°
3. 68°
4. 10°
5. 111°
6. 27°
7. 34°
8. 101°
9. 40°
10. 67°

STUDENT WORKSHEET: "How the Mighty Fall"

Hypothesis: Answers will vary, but should be a clear prediction related to the testable question. Variables should be marked accordingly with "C" for variables that are constants, "T" for variables that will be tested, and "X" for variables that do not apply.

Materials: The materials list should include all appropriate tools and resources necessary to carry out the investigation.

Procedure: Answer should clearly describe all necessary steps, including how constant variables will remain the same throughout each trial.

Data: All necessary data should be recorded, including data from at least three trials.

Analysis of Data: A graph should represent quantitative data and include a title, a labeled x-axis and y-axis.

Conclusion: The conclusion should be written in complete sentences, compare the results of the investigation to the hypothesis, and include possible ways to improve the experiment.

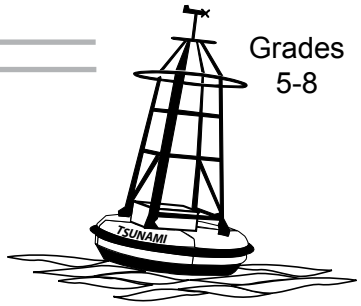
STUDENT WORKSHEET: "Slope Journal"

Answers will vary, but responses should display the student's reflection, or insight gained, from peer review toward the improvement of the investigation.

Slope Failure and Tsunamis

Student Information Sheet

Grades 5-8



A possible tsunami trigger is slope failure. Landslides, rockfalls, avalanches and slumps are all examples of slope failure. Landslides can occur above and below water. Landslides are the second most common cause of tsunamis. The causes of slope failure are many. Examine the tables below.

Above Water Slope Failure

	Natural Triggers	Human Triggers
Removal of Support	erosion at the base of a slope by streams, waves, glaciers	excavation at the base of a slope or excavation on a hillside
Removal of Vegetation	forest fires	clearing trees, removing plants
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Slope failure is responsible for many tsunamis in Alaska's history.

Earthquake-generated landslide
Lituya Bay, Alaska is the site of many past tsunamis. The most dramatic happened on July 10, 1958, when a magnitude 7.9 earthquake triggered an enormous landslide at the head of the bay. This landslide then triggered a tsunami that reached 525 meters in height! Two people died in this event.

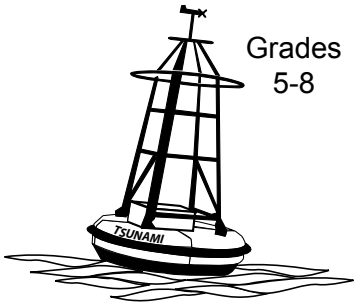
Volcano-generated landslide
The flanks, or sides, of volcanoes can become steeper as magma builds up inside. In 1883, Mt. Augustine volcano in the Cook Inlet experienced slope failure that was powerful enough to generate a tsunami. The maximum water height for this tsunami was 9.14 meters. It reached communities across the inlet, such as Homer and Nanwalek. It even reached Kodiak.

Human-generated landslide
On April 11, 1994, construction in the Skagway harbor triggered a landslide, which in turn triggered a tsunami wave 11 meters tall. The wave caused $21 million in property damage and killed one person.

Slope failure across the ocean
In 1975, Kilauea, on the Hawaiian Islands, produced a volcano-generated earthquake with a magnitude of 7.2. This caused a submarine landslide that triggered a tsunami. Although 2 people died from the tsunami in Halape, Hawaii where the maximum water height reached 7.9 meters, the maximum tsunami height was only 10 centimeters when it reached Sitka, Alaska and 5 centimeters when it reached Yakutat, Alaska.

Name:_____

Grades 5-8

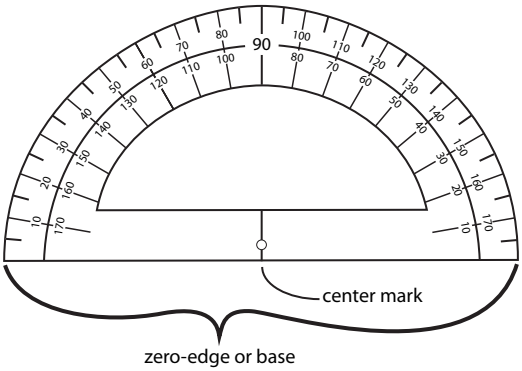


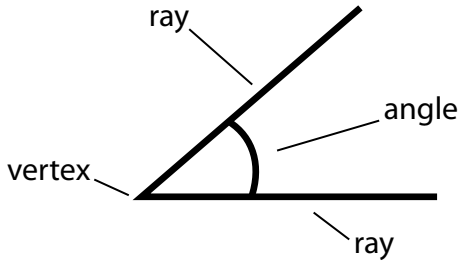
Student Worksheet

Measuring Angles

To measure slope:

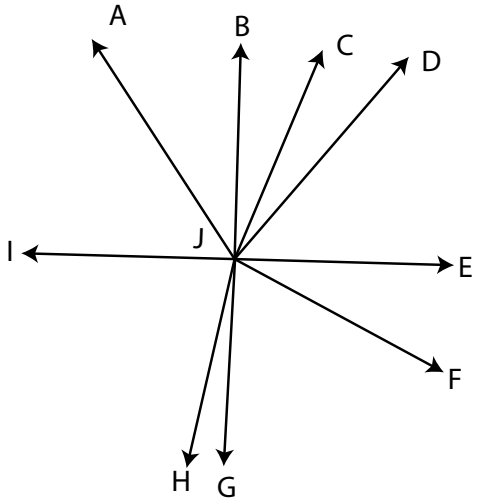
A. Place the center mark on the vertex of the angle and place the base or zero-edge along one ray of an angle.





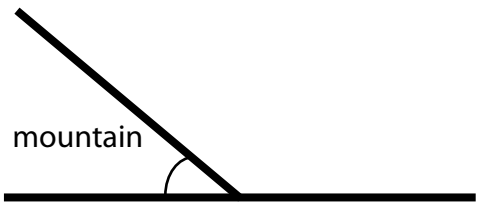
B. Read the measure of the angle where the other ray crosses the protractor. Start reading the angle of the protractor from the zero that the first ray is on.

1. <EJD _____
2. <AJI _____
3. <EJC _____
4. <GJH _____
5. <IJC _____
6. <EJF _____
7. <AJB _____
8. <HJA _____

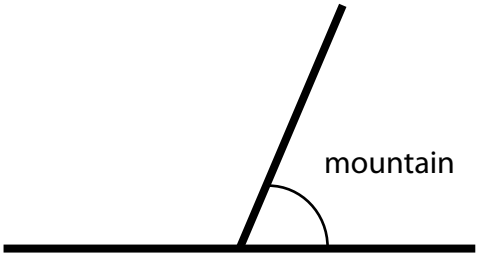


What is the slope of each mountain below ?

9. _____



10. _____



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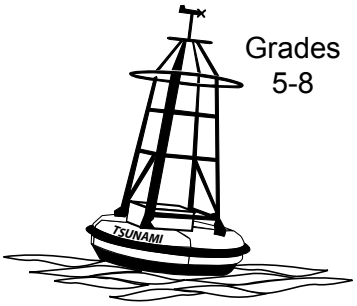
Grades 5-8



Student Worksheet

How the Mighty Fall (page 1 of 3)

In this activity, you will investigate slope failure. It is important to think through the steps before carrying out your investigation.

Testable Question:

Choose a mechanism of slope failure and a corresponding testable question to investigate, OR add a question of your own after approval from your teacher.

(✓)		
	Removal of Support	How much material has to be removed before slope failure occurs?
	Addition of Moisture	How much moisture needs to be added before slope failure occurs?
	Oversteepening	How does the composition of slope material contribute to slope failure?

Hypothesis:

Write a clear statement of your prediction.

_____

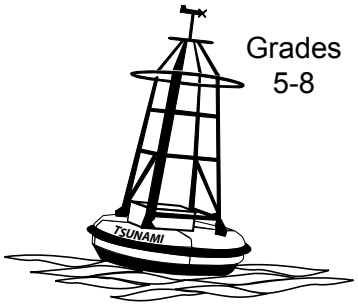
_____

Variables are factors that could change in an experiment. A variable that is kept from changing the outcome of an experiment is called a constant. There are several possible variables. It is important to consider them before planning out your investigation and to determine how you will keep certain variables constant. Before each variable, write “C” for variables that should remain constant, “T” for variables that will be tested, and “X” for variables that do not apply to your investigation. Add more variables if necessary. Make sure to note how constant variables will remain the same for each trial in the procedure.

_____ angle of slope	_____ amount of material	_____ type of material
_____ amount of water	_____ _____	_____ _____

Name:_____

Grades 5-8



Student Worksheet

How the Mighty Fall (page 2 of 3)

Experiment:

Materials:

Foam board, protractor,

Procedure:

1. Place butcher paper or newspaper on the work surface.
2.

Data:

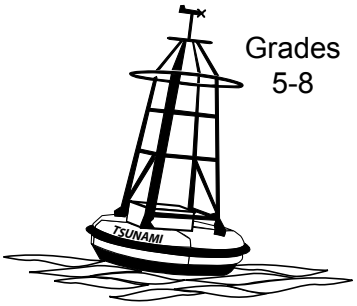
Make a table to record the types of data needed to test the hypothesis. Make sure to include at least three trials per test.

Name:_____

Grades 5-8

Student Worksheet

How the Mighty Fall (page 3 of 3)



Analysis of Data:

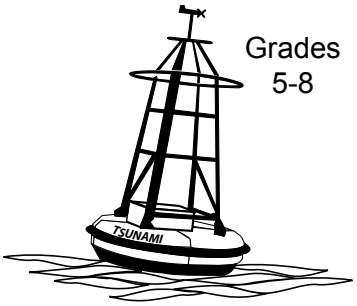
Create a graph using the data. Make sure it includes a title, labeled x-axis, and labeled y-axis.

Conclusion:

Does the data support the hypothesis? If data doesn't support the hypothesis, what is a possible reason? How could you improve this experiment? Write your conclusion in complete sentences.

Name:_____

Grades 5-8



Student Worksheet

Slope Journal

The goal of this journal is to show how you have used feedback from your peers to strengthen your investigation before you carry out the procedure and after the entire investigation.

After the Planning Presentation…

I (we) decided to change _____ because _____

After the Final Presentation…

Consider the following:

- Were your observations as detailed as possible?
- Did you use the best available tools to make measurements?
- Are there other ways to communicate your procedure or results?
- Is there anything you would change?
- Did other questions arise from your experiment?