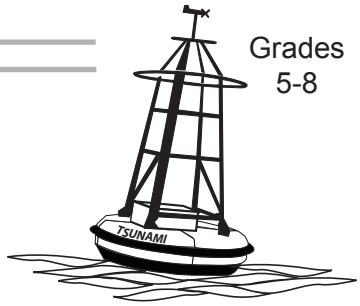
DART II System

Grades 5-8



Overview:

Students simulate the transfer of signals in a DART II system after viewing a multimedia file that illustrates the process. Students then view *The wave that shook the world,* and consider the role that the DART II system plays in tsunami warning capabilities.

Targeted Alaska Grade Level Expectations:

Science

[5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[6] SB4.3 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by making waves move through a variety of media.

[6] SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by describing the various effects of an innovation on a global level.

[7] SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by recognizing the effects of a past scientific discovery, invention, or scientific breakthrough (e.g., DDT, internal combustion engine).

Writing

[5] 2.1.2 The student writes about a topic by using paragraph form: indents or uses paragraph breaks (L).

[6] 2.1.2 The student writes about a topic by using paragraph form: indents or uses paragraph breaks, and places paragraph breaks appropriately (L).

[7-8] 3.1.2. The student writes about a topic by writing in paragraphs that include relevant details and evidence that support the main idea of the paragraph and thesis statement.

Objectives:

The student will:

- act out the operation of the DART II system;
- describe the components and operation of a DART II system in paragraph form; and
- write a description of the impact of the DART II system on society.

Materials:

- Tennis balls (five per group)
- Beach ball (one per group)
- DVD: Williams, M., Acaster, L., Williams, A., McMaster, J., & Galusha, G. (2005). *Wave that shook the world.* [S. Burlington, Vt.]: WGBH Video.
- VIDEO FILE: “DART II”
- VISUAL AID: “DART II System”
- STUDENT WORKSHEET: “DART II System”

Whole Picture:

DART stands for Deep ocean Assessment and Reporting of Tsunamis. DART is a real-time tsunami monitoring system developed by the Pacific Marine Environmental Laboratory of the National Oceanic and Atmospheric Administration in Seattle, Washington. DART systems are strategically placed around the Pacific, Atlantic and Indian Oceans to supply data for tsunami forecasting.

A DART® system consists of a tsunameter anchored to the sea floor and a nearby surface buoy. View the VISUAL AID: "DART II System" that accompanies this lesson for visual reference. Unlike waves caused by wind, tsunamis and tides reach all the way to the ocean bottom. This makes it possible for the tsunameter to register changes in pressure as tides and tsunamis pass over it, even registering tsunamis as small as 1 centimeter in height. In the open ocean, the amplitude of a tsunami wave is very small (a few centimeters) compared to tides, which are about 1 meter high. This information, coupled with the predictable nature of tides, facilitates the process of filtering data to isolate the tsunami's frequency. Tsunameters transmit data through an acoustic signal to a nearby surface buoy. The buoy is equipped with a GPS unit and an Iridium antenna that sends and receives a radio signal to an Iridium satellite. The satellite relays the signal to four centers in the United States:

- West Coast/Alaska Tsunami Warning Center in Palmer, Alaska;
- Pacific Tsunami Warning Center in Hawaii;
- Pacific Marine Environmental Laboratory in Seattle, Washington; and
- National Data Buoy Center in Mississippi.

The DART II system also supports bi-directional communication in such a way that Tsunami Warning centers may request data from tsunameters.

In the DART II system, data is transmitted using sound (acoustic) waves and radio waves. A wave's properties are influenced by the medium through which it propagates. Acoustic signals are used to transmit data in the ocean between the tsunameter and the surface buoy. Sound travels at about 1500 meters per second (m/s) in salt water that is free of air bubbles or suspended sediment. Additional factors that affect the speed of sound in seawater are pressure (influenced by depth), temperature (a change of 1 °C ~ 4 m/s), and salinity. Radio signals are used to transmit data between the surface buoy, Iridium satellite, and the tsunami warning centers. Radio waves travel at the speed of light, approximately 300,000,000 m/s.

A tsunami warning system did not exist in the Indian Ocean prior to the Indian Ocean Tsunami of 2004. After the mainshock of the December 26, 2004 earthquake was recorded, the Pacific Tsunami Warning Center and the Pacific Marine Environmental Laboratory were able to determine that a potentially disastrous tsunami will develop from this large earthquake, but the warning could not be delivered to the coastal areas in the Indian Ocean. Recognizing the need for communicating tsunami warnings to populations around the Indian Ocean, the U.S. Agency for International Development funded the creation of the U.S. Indian Ocean Tsunami Warning System (IOTWS) in cooperation with other countries and U.S. agencies.

Activity Procedure:

1. Explain students will learn about technology used to gather information about tsunamis: the DART II system.
2. Explain DART systems are only one component of a tsunami warning system. Display VISUAL AID: "DART II System" and use the information from the *Whole Picture* section to describe the components and signal transmission. Access and display the VIDEO FILE: "DART II System."

3. Act out the process of communicating data through the transmission of acoustic and radio signals used by the DART II system.

   For the Tsunami mode, one student acts as the tsunameter on the ocean floor. Upon detection of pressure change, the student sends a signal by tossing the beach ball to a student acting as the surface buoy. Upon receiving the signal from the tsunameter, the student acting as a surface buoy sends a signal (a tennis ball) to the student acting as the iridium satellite. The Iridium satellite, then sends a signal (tennis ball) to each of the four students representing the US tsunami warning centers.

   For Request mode, reverse the process of signal transmission starting with the tsunami warning centers.

Critical Thinking: Think-Pair-Share. Pose a question or task. Allow time for thinking of a response, and then ask students to share their ideas with a partner. Call on students to share their responses, or their partner's responses, with the rest of the class. Pose the following questions: 1. Why is a beach ball used between the tsunameter and buoy, and tennis balls for all other transmissions? (*The beach ball represents the acoustic signal, which is slower than the radio signals represented by the tennis balls. The acoustic signals travel at the speed of sound and the radio signals travel at the speed of light.)* 2. Calculate the time it would take for an acoustic signal to travel from the tsunameter to the surface buoy at a distance of 6000 meters. Refer to the VISUAL AID: "DART II System" for reference. *(The speed of sound is about 1500 m/s in salt water, so it would take about 4 seconds for the acoustic signal to travel 6000 meters.)*

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4. View the DVD, *Tsunami: The wave that shook the world.* While viewing the movie, ask students to consider the impact of a technological innovation, like the DART II system, has on society.
5. Distribute STUDENT WORKSHEET: "DART II System" for student completion.

Extension Idea:

- View the map of DART buoys at the National Data Buoy Center website at http://www.ndbc.noaa.gov/. Determine the location of the closest DART buoy to your community.

Answers:

1. *Answers will vary but should reflect the description of the components and operation of the DART II System from Whole Picture section of this lesson.*
2. *Answers will vary, but should reflect information from the Whole Picture section of this lesson and the DVD: The wave that shook the world*

Lesson Information Sources:

National Data Buoy Center. National Oceanic and Atmospheric Administration. http://www.ndbc.noaa.gov/

NOAA Center for Tsunami Research. Pacific Maine Environmental Laboratory. *DART®: Deep-ocean assessment and reporting of tsunamis.* http://nctr.pmel.noaa.gov/Dart/index.html

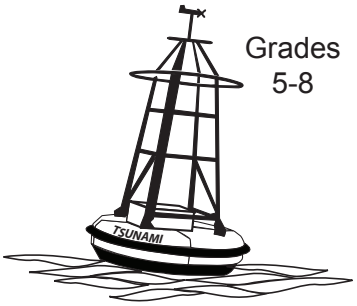
US Agency for International Development. *US IOWTC Program Summary*. http://apps.develebridge.net/usiotws/pageaahome.html

Williams, M., Acaster, L., Williams, A., McMaster, J., & Galusha, G. (2005). *Wave that shook the world.* [S. Burlington, Vt.]: WGBH Video.

Name:_____

DART II System

Student Worksheet



Grades 5-8

1. Use paragraph form to describe the components and operation of a DART II system. Continue on the back of this sheet if necessary.

2. After viewing the DVD: *The wave that shook the world,* describe the impact a technological innovation, like the DART II system, has on society. Continue on the back of this sheet if necessary.