

Lesson #3: “Technology to the Rescue”

- actual document
- USGS “Seismometer”
- Student Worksheet #1 “Tide Gauges”
- Student Worksheet #1 Teacher Answer Sheet
- Student Worksheet #2 “DART II System”
- Student Worksheet #2 Teacher Answer Sheet
- Student Worksheet #3 “Society Needs Tsunami Technology”
- Student Worksheet #3 Rubric

LESSON #: 3

TITLE: “Technology to the Rescue”

OVERVIEW:

Students learned in Lesson #1 about waves in general and in Lesson #2 about water waves in particular, with special attention to the powerful nature of tsunamis. In Lesson #3 students learn that human tragedy associated with the 1946 tsunami made society realize a need to develop a tsunami warning system. This need led to technological developments: the modification of seismometers and tide gauges for use in tsunami prediction and the invention of an ocean buoy-tsunami system.

KEY CONCEPTS:

1. Technology can respond to society’s needs.
2. The recognition that society needed a tsunami warning system leads to technological developments.
3. There are 3 devices that are used in tsunami prediction and detection:
 - seismometers
 - tide gauges
 - DART II System of buoys & tsunameters

STANDARD(S)-BENCHMARK(S):

Standard 2: Nature of Science

Benchmark 6.2.2: Explain how the needs of society have influenced the development and use of technologies.

NOAA ocean literacy:

Essential Principle #2: The ocean and life in the ocean shape the features of the Earth.

Fundamental Concept (e): Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

Essential Principle #6: The ocean and humans are inextricably interconnected.

Fundamental Concept (f) Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).

Essential Principle #7: The ocean is largely unexplored.

Fundamental Concept (d) New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, sub-sea observatories and unmanned submersibles.

TEACHER BACKGROUND:

The Pacific Tsunami Warning Center (PTWC) in Ewa Beach is one of two tsunami warning centers operated by the U.S. government's National Oceanic and Atmospheric Administration's (NOAA) National Weather Service. The other one, the West Coast & Alaska Tsunami Warning Center (WC/ATWC), is in Palmer, Alaska, and serves as the primary center for Alaska and both coasts of the U.S. mainland and Canada. Both American tsunami centers are part of international tsunami networks, such as:

- International Tsunami Information Centre (ITIC)
- UNESCO's Intergovernmental Oceanographic Commission (IOC)

The PTWC is not only the tsunami center for the state of Hawai'i; it also monitors and issues bulletins to 26 participating U.S. Territories and other nations around the Pacific Ocean. Additionally, the PTWC is serving as the interim center for the Indian Ocean, South China Sea and the Caribbean Sea, and it's a backup center for WC/ATWC.

The PTWC has the technology and the scientific staff to do three duties:

- monitor earthquakes that could generate a tsunami
- detect a tsunami, if one has been generated, and make predictions as to its size upon reaching coastlines
- issue safety bulletins to civil defense and public information systems (e.g., radio and television.)

The essential technology used to monitor earthquakes and make tsunami predictions are the focus of Lesson #3; civil defense response is dealt with in Lessons #5 and 6.

1. technology to monitor earthquakes that could generate a tsunami

SEISMOMETERS

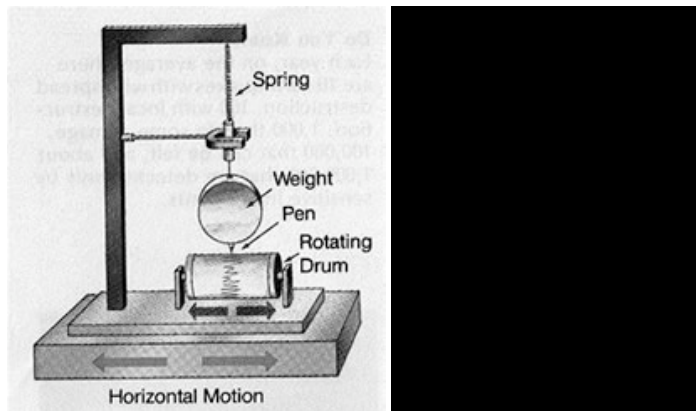
PTWC monitors earthquakes by having satellite access to seismometers all around the world. The terms seismometer, seismograph and seismogram are often used interchangeably; this confusion is found in earthquake information both online and in print. Technically, the seismometer detects the earthquake; the seismograph records the detection; and the seismogram is the written record of the movement. In these lessons the word seismometer will be used to describe both the earthquake detector and recorder, while the word seismogram will be used for the written record.

With seismograms from a minimum of 3 locations, scientists can determine the location of an earthquake. Calculations based on the size of the squiggly line on the seismogram are used to determine the magnitude of the earthquake, and this is given as a Richter Scale number. These numbers are an exponential or logarithmic scale; so each number indicates a quake 10 times as powerful as the next lower number. For

example, a magnitude 7 earthquake is 10 times more powerful than a magnitude 6 quake.

There are plans for building a simple seismometer out of a cardboard box, cup, string, marker pen and other simple materials at both the website *Science Rocks: Seismometer* and VanCleave's *Earthquakes* book listed in the Resources below.

The seismogram graphic used with students in this lesson is simplified. Of course modern seismometers are more complicated; the motion detector components can be located in the field, with electronic transmission of data via satellites to a seismogram located in a lab somewhere else, like the Pacific Tsunami Warning Center.



2. technology to detect a tsunami, if one has been generated, and make predictions as to its size upon reaching coastlines

Tsunami predictions are based on ocean depth and topography data, as well as (a) seismogram indication of the earthquake's magnitude and location, (b) data from tide gauges, and (d) data from tsunameters associated with DART buoys.

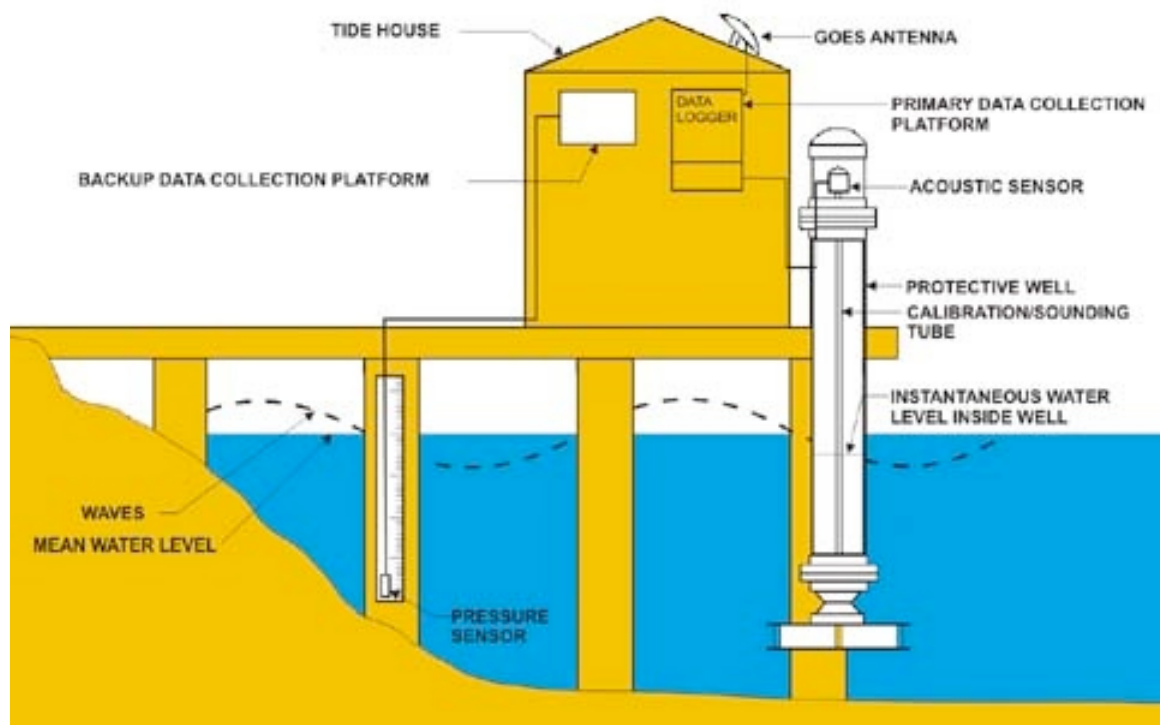
Lesson #3 will teach about these 3 technologies; the goal of Benchmark 6.2.2 is for students to learn "how the needs of society have influenced the development and use of technologies." However, it's important for students to understand that tsunami scientists don't rely solely on technology for tsunami detection and prediction; scientists talk directly with each other as well. Scientists from one country will call/email scientists in other countries. Local scientists in the vicinity of the coast where the earthquake occurred will call law enforcement and civil defense workers in their community -- and even everyday citizen -- to ask if the earthquake was felt and what the ocean looks like. Wherever possible, direct observations are important. It's been reported (Dr. Barbara Keating, personal communication; see Resources below) that at times over half the DART buoys/tsunameters are non-functional; so first-hand observations by people will always be essential.

TIDE GAUGES

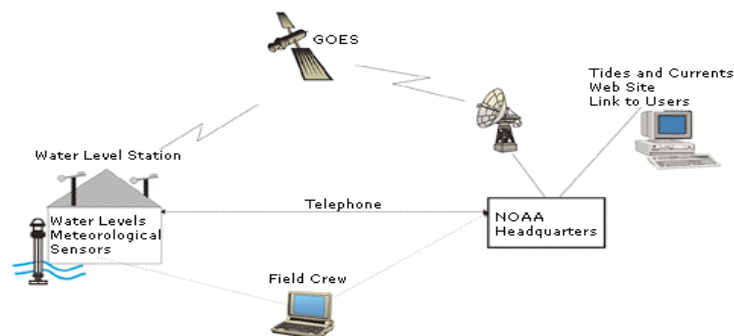
Modern tide gauges have two detection systems:

- a primary system, based on different round-trip travel times for sound waves projected down to sea level (high or low tide) and reflected back, and
- a second, back-up system, based on measuring pressure differences as water height changes between the tides.

A modern tide gauge looks like this:

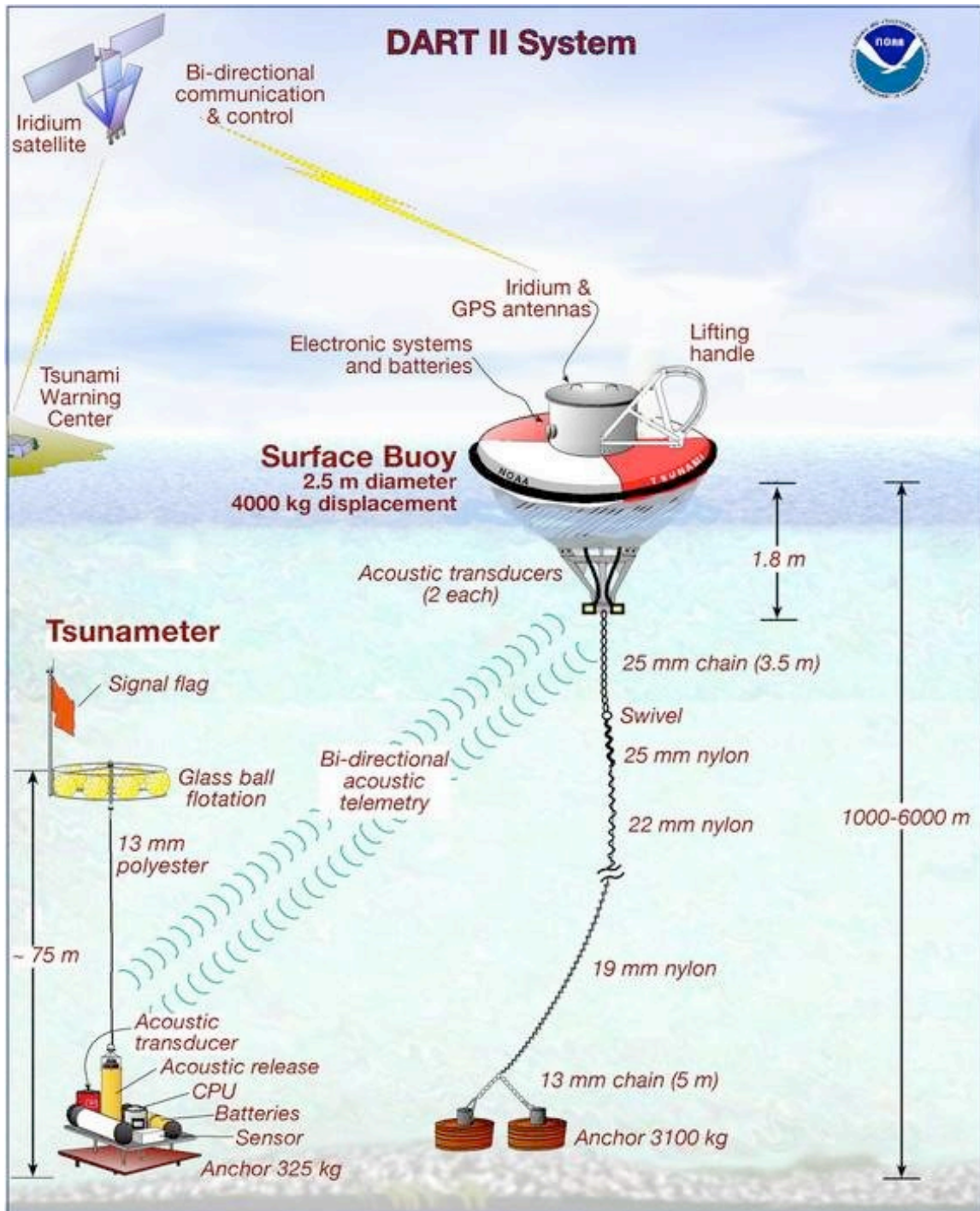


Sea level data is sent by satellites to a lab somewhere else, like the Pacific Tsunami Warning Center:

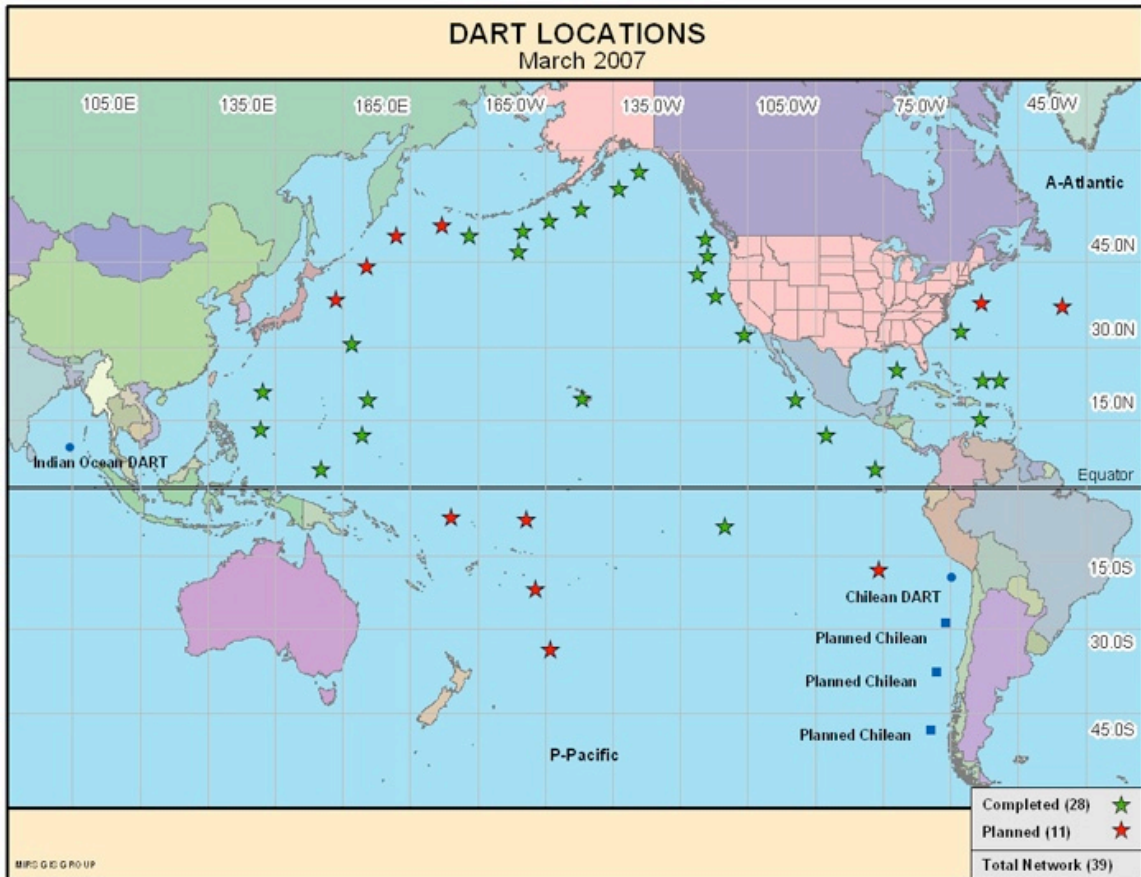


DART II SYSTEM

“DART” stands for Deep-ocean Assessment and Reporting of Tsunamis. This is a system of buoys, located strategically around the world’s oceans, which can alert scientists to the passage of a tsunami. A DART buoy is tethered to an anchor deep (1000-6000m) on the bottom of the ocean. Nearby on the seafloor is a pressure sensor, called a tsunameter (soo-NAHM-ah-tur;) an older name is BPR (Bottom Pressure Recorder. Amazingly, the tsunameter can detect the passage of a tsunami with a wave height as little as 1 cm by the slight change in water pressure that it causes. This information is transmitted by sound waves to the surface buoy, then to a satellite, and finally to the scientists at a tsunami warning center.



DART buoys and tsunameters were in place as early as 2003; as of April 2006, there were 15 buoy-tsunameters in place and there were plans for 24 more:



Another system of tsunami detection involves measurement of the distance between the ocean surface and a satellite. As the long wavelength tsunami, with its crest & trough passes, the satellite detects the change in distance to the sea surface. However, this system is not reliably in place. The technology to repair & maintain geosynchronous satellites is even more expensive than maintaining the open-ocean DART buoys & tsunameters!

Video notes:

1. There's a short, approximately 5 minute, video at the Discovery Education website http://education.discovery.com/player_1.cfm, (see complete citation in Resources below) which shows the PTWC in action and close-ups of a tsunameter. There is a drawback for this video, in that it seems to intermix clips of wind-generated waves and tsunamis, but the ones of tsunamis *are* very dramatic.
2. NOAA's Office of Education's Tsunami Education Resource Kit (TERK) website http://www.oesd.noaa.gov/terk_intro.htm (see complete citation in Resources below) has 4 mini-videos showing the PTWC. There's also footage about DART buoys and their tsunameters (BPRs) being deployed successfully at sea. The drawback is that scientists being interviewed use vocabulary that is a little

advanced for 6th graders. However, it's exciting to see actual buoys going into the ocean from the deck of a ship, and seeing the parts of a tsunameter.

DURATION: roughly 1 class period, or about 45 minutes

VOCABULARY:

- DART buoy = National Oceanic & Atmospheric Administration's Deep-ocean Assessment and Reporting of Tsunamis buoys located strategically around the world's oceans to detect the passage of a tsunamis
- Richter Scale = a mathematical scale used to express the size of an earthquake
- seismogram = the graphic record from a seismometer; a change in the recorded line indicates the occurrence of an earthquake and its comparative size
- seismometer = an instrument that detects earthquakes
- tide gauge = an instrument that continuously records sea level.
- tsunameter = an instrument anchored to the sea floor which can detect the passage of a tsunami by changes in water pressure and transmit the information to the DART buoy overhead.

MATERIALS NEEDED:

- Dudley and Lee's book, "Tsunami!" (See resources below for complete citation.)
- overhead projector & screen
- USGS Science for a Changing World's "Seismometer" 1 transparency for the teacher
- Student Worksheet #1 "Tide Gauges," 1 transparency for the teacher
- Student Worksheet #2 "DART II System," 1 transparency for the teacher
- a pair of blue & red transparency markers for the teacher
- bucket, about 4-5 gallons
- water
- (optional: bicycle pump with a gauge)
- 1 clear, colorless, stiff plastic cup, about 10 oz.
- large (about 12") latex balloon, any color, deflated
- 2, 3" x 5" unlined index cards
- pen
- stapler

per student:

- USGS Science for a Changing World's "Seismometer" graphic

- Student Worksheet #1 “Tide Gauges”
- Student Worksheet #2 “DART II System”
- a pair of blue & red paper markers/crayons/colored pencils
- pencil

PROCEDURE:

1. Before beginning the lesson, prepare this simple pressure gauge:
 - Using a pen, make a scale on one of the index cards, with the lines going across the width of the card. The lines should be about a cm apart.
 - Starting at about the 3rd cm line, number the lines, beginning with zero.
 - Use scissors to cut a hole in the side of the plastic cup; center the hole midway between the bottom and top lip of the cup.
 - Put the deflated balloon into the cup with the balloon’s open end sticking through the cup’s hole.
 - Staple the scaled index card to the outside of the cup, directly across from the hole. Be sure that the zero line is flush with the cup’s lip.
 - Cut a cm-wide strip from the 2nd index card.
 - Staple about 2 cm of one end of the strip to the outside of the cup, halfway between the hole and the scaled index card. The strip will be pointing up.
 - Fold the strip at the cup’s lip so that the strip is horizontal, or parallel to the bottom of the cup.
 - Cut the free, unstapled tip of the strip into a point.

Practice using your pressure gauge by blowing up the balloon. As the balloon increases in size from the pressure of your breath, the strip should point to higher numbers on the index card scale. You’re ready for the teacher demonstration in the section “Tsunami Detection -- DART Buoys!”

2. Also before beginning this lesson, it is advisable to try and find out if one of your students has a relative who survived the 1946, or any other, tsunami. If that’s the case, perhaps the relative could be invited to share his/her experience with the class. Perhaps a student’s family actually lost a relative in the tragedy, in which case, this lesson needs to be approached with even more sensitivity.
3. Review with the students what they learned in Lesson #2 about the difference between “regular” waves and tsunamis. Have categories for comparison, such as these, listed on the white board:
 - Kind of wave? --energy or mechanical? --transverse, longitudinal or “surface?”
 - How deeply does each wave extend into the ocean?
 - Can people dive under the wave?
 - Cause of the wave?

Reiterate to the students that while both waves share some similar characteristics, tsunamis are an entirely different magnitude of experience.

Tsunami Survivor Stories

4. Ask the students if they know when April Fools Day is, and what is commonly done on that day. Of course April Fools occurs on April 1; normally, it's a happy day to tease and joke, but on April 1, 1946 tragedy struck Hilo, and other communities around the state of Hawai'i. As a March 30, 2002 Star Bulletin article said, "An earthquake in the Aleutian Islands triggered a tsunami that killed 159 people: 96 in Hilo, 15 on Kauai, 14 on Maui and nine on Oahu. It was the worst natural disaster in Hawaii's history." (Underlining added for emphasis.)
5. In Dudley and Lee's book entitled *Tsunami!* the first 50 pages document experiences of people who survived the 1946 tsunami. The documentation begins with the incredible loss of a 45-foot lighthouse and its 5-man crew in Alaska and then relocates to experiences from the Big Island. Tell the students they are to imagine being in Hilo on the morning of April 1, 1946, just about the time (7 am) that they'd be heading to school.... Read aloud some of the accounts.
6. Perhaps use the Justin Fujioka CD; the first segment shows video footage of Hilo during the '46 tsunami, and some survivors recount their experiences.
7. After the reading, discuss these true-life experiences with your students:
 - Draw attention to the destruction described in the experiences. This will connect to NOAA's Essential Principles #2, FC (e)...force of waves influence the physical structure and landforms of the coast" and #6, FC (f)...Coastal regions are susceptible to...tsunamis...."
 - Leading into Benchmark 6.2.2, ask students how they would feel, if they had been one of those people, or a relative. If no one thinks of it, perhaps ask the students, "Would you feel angry? Would you be mad that nobody told you the tsunami was coming?"
8. The good news is that we now have the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, O'ahu. The facility was built in 1949 as a result of the loss of life in the 1946 tsunami. This is a perfect example of "how the needs of society have influenced the development and use of technologies," as stated in Benchmark 6.2.2.
9. Tell students that the PTWC has 3 duties:
 - to monitor earthquakes that could generate a tsunami,
 - to make a prediction as to the probability of a tsunami actually being generated by an earthquake, and

- to issue safety bulletins to civil defense and public information systems (e.g., radio and television.)

Tell students, “Let’s learn about the first duties in this lesson: monitoring earthquakes and predicting tsunamis!”

Earthquake Detection

10. Give each student a copy of the USGS Science for a Changing World’s “Seismometer” graphic; use the teacher’s transparency with the overhead projector. Tell students a **seismometer** is the instrument used to detect earthquakes.
11. Explain that the principle of a seismometer is simple. Its base is firmly attached to the Earth, while a heavy weight dangles from it. Attached to the suspended weight is a pen that traces a line on a paper that is mechanically fed through the apparatus. Have them color the seismometer *blue* (everything, but not the paper.)
12. Use the *red* markers to label the paper **seismogram** and color it.
13. Explain to students that normally, the pen line is straight, because there’s no Earth movement. When the Earth moves, as is being shown in the graphic, the seismometer’s base also moves, but the pen does not, because the spring absorbs whatever motion overcomes inertia. The resulting squiggly line on the seismogram shows that an earthquake has occurred.
14. Tell students the size of the squiggly line on the seismogram is used to calculate the Richter Scale magnitude of the earthquake. Seismograms from a minimum of 3 locations around the world are used to pinpoint the location of an earthquake. If an earthquake is a Richter Scale 7 or above, and located close to the surface of the seafloor, it *can* trigger a tsunami. The bigger the quake is, and the closer it is to the surface of the seafloor, the *more likely* a tsunami has been generated. But scientists still don’t know for sure if a tsunami is traveling across an ocean.

Tsunami Detection -- Tide Gauges

15. Once tsunami scientists know from seismometers that a tsunami *could* have been generated, they use more technology to predict if tsunami waves *are actually spreading* from the source of the vibration. One kind of technology they use is a **tide gauge**.
16. Tell students that tide gauges, of course, were originally invented to measure the ocean’s low and high tides each day. (Note: Students in Hawai’i are often unaware of tides, because the tidal difference here is so small, no more than 3’ at the most extreme. But in most other areas, knowing about tides is important for navigation, especially in places where there’s a large tidal difference.)

17. Give each student a copy of Lesson #3 “Technology to the Rescue” Student Worksheet #1 “Tide Gauges.” Using the information given in the Teacher Background above, “talk through the process” with the overhead projector transparency as the students follow along, filling in the labels. Check the Student Worksheet #1 “Tide Gauges” answer sheet for simplified labels.

Tsunami Detection -- DART

18. Tell students that there’s another technology that’s used in tsunami detection and prediction; it’s called the **DART II System**.
19. Teacher demonstration: water pressure:
- Begin by demonstrating how heavy water is. Ask 1-2 student volunteers to fill the 4-5 gallon bucket with water and bring it to you. It would be especially effective if the water source is not too close to you, so that it’s obvious to everyone that the water is heavy.
 - Comment on how heavy the water is. Perhaps have a couple other students heft the bucket.
 - Tell students to imagine how heavy the water would feel if you were at the bottom of the ocean, with 4 kilometers of seawater over your head! The weight of the water would push down on your head; this is called water pressure.
20. Teacher demonstration: changes in pressure can be measured:
- (optional: Use a bicycle pump to show how air pressure is measured on the gauge.)
 - Show students your handmade pressure gauge. Demonstrate that, as you increase pressure by adding air to the balloon, the pointer indicates higher numbers.
21. Tell students that scientists invented a **tsunameter** (soo-NAHM-ah-tur.) (An earlier name of tsunameter was BPR, for Bottom Pressure Recorder.) This is an instrument that is anchored to the bottom of the ocean and can measure the change in water pressure caused by a tsunami’s crest and trough.
22. Give each student a copy of Student Worksheet #2 “DART II System.” Using the information given in the Teacher Background above, “talk through the process” with the overhead projector transparency as the students follow along, filling in the labels. Check the Student Worksheet #2 “DART II System” answer sheet for simplified labels.
23. Show segment 5 of the Justin Fujioka CD, which has footage of a DART buoy being launched from a ship.
24. As of this writing, there’s a wonderful Flash animation of the DART II System at this NOAA website; see the complete citation in Resources below:

http://nctr.pmel.noaa.gov/Dart/Jpg/DART-II_05x.swf

25. Have students individually complete Student Worksheet #3 “Society Needs Tsunami Technology.”

ASSESSMENTS:

Benchmark 6.6.2: Explain how the needs of society have influenced the development and use of technologies -- summative assessment -- Lesson #3 Student Worksheet #3 “Society Needs Tsunami Technology” Science Reflection Rubric

RESOURCES:

- Web:

Altonn, H. (2002). *Tsunami: Scientists say Hawaii’s killer-wave warning system will work -- as long as people listen*. Retrieved March 26, 2007, from Star Bulletin’s Web site: <http://starbulletin.com/2002/03/30/news/story2.html>

Bottom pressure recorder. (n.d.). Retrieved April 9, 2007, from NOAA Deep-ocean Assessment and Reporting of Tsunamis Web site: <http://nctr.pmel.noaa.gov/Dart/gauge.html>

Coloring pages. (2006). Retrieved March 27, 2007, from USGS Science for a Changing World Earthquake Hazards Program’s Web site: <http://earthquake.usgs.gov/learning/kids/coloring/>

DART (Deep-ocean assessment and reporting of tsunamis). Retrieved March 27, 2007, from NOAA Center for Tsunami Research’s Web site: <http://nctr.pmel.noaa.gov/Dart/index.html>

Deep-ocean assessment and reporting of tsunamis (DARTtm). (2006). Retrieved April 4, 2007, from NOAA National Data Buoy Center’s Web site: <http://www.ndbc.noaa.gov/dart/dart.shtml>

Frequently asked questions (FAQ). (2007). Retrieved April 8, 2007, from National Weather Service Pacific Tsunami Warning Center Web site: <http://www.prh.noaa.gov/ptwc/faq.php#29>

Goldman, J. (2004). *NOAA tsunami warning system receives high marks*. Retrieved April 8, 2007, from NOAA Magazine’s Web site: <http://www.magazine.noaa.gov/stories/mag153.htm>

How DART works (Flash animation). (n.d.). Retrieved March 27, 2007, from NOAA's D.A.R.T. II Web site: http://nctr.pmel.noaa.gov/Dart/Jpg/DART-II_05x.swf

How tsunamis are formed. (2006). Retrieved April 7, 2007, from Discovery Education Web site: http://education.discovery.com/player_1.cfm

Merriam-Webster online. Retrieved May 6, 2007, from <http://www.m-w.com/>

Pacific tsunami warning center. (2007). Retrieved March 26, 2007, from NOAA National Weather Service's Web site: <http://www.prh.noaa.gov/ptwc/>

Pacific tsunami warning center real-time sea level data. (2007). Retrieved March 27, 2007, from NOAA National Weather Service West Coast & Alaska Tsunami Warning Center's Web site: <http://wcatwc.arh.noaa.gov/PTWCtide.htm>

Realtime tsunami warning buoy data. (2007). Retrieved March 27, 2007, from NOAA National Data Buoy Center's Web site: <http://www.ndbc.noaa.gov/dart.shtml>

Resources for teachers. (n.d.). Retrieved March 27, 2007, from NOAA's Tsunami Web site: <http://www.tsunami.noaa.gov/teacher-resources.html>

Science rocks: Seismometer. (n.d.). Retrieved March 27, 2007, from WGBH Boston PBSkids' Web site: <http://pbskids.org/zoom/activities/sci/seismometer.html>

The tsunami warning system. (2005). Retrieved March 26, 2007, from the University of Washington Department of Earth and Space Sciences' Web site: <http://www.ess.washington.edu/tsunami/general/warning/warning.html>

Tides and water levels: How are tides measured? - The old system. (n.d.). Retrieved March 27, 2007, from NOAA National Ocean Service Education Discovery Kits' Web site: http://oceanservice.noaa.gov/education/kits/tides/tides10_oldmeasure.html

Tides and water levels: How are tides measured? - The new system. (n.d.). Retrieved March 27, 2007, from NOAA National Ocean Service Education Discovery Kits' Web site: http://oceanservice.noaa.gov/education/kits/tides/tides11_newmeasure.html

Tsunami education resource kit (TERK). (2006). Retrieved April 9, 2007, from NOAA's Office of Education Web site: http://www.oesd.noaa.gov/terk_intro.htm

Tsunami information for kids. (n.d.). Retrieved March 27, 2007, from NOAA's Tsunami Web site: <http://www.tsunami.noaa.gov/kids.html>

Tsunamis. (2007). Retrieved April 4, 2007, from NOAA's Tsunami Website:
<http://www.noaa.gov/tsunamis.html>

Tyson, P. (2005). *Wave of the future: What will it take to be ready for the next major tsunami?* Retrieved April 7, 2007, from Nova's Wave that shook the world Web site: <http://www.pbs.org/wgbh/nova/tsunami/wave.html>

Wald, Lisa. (2006). *The Science of Earthquakes*. Retrieved 27, 2007, from the USGS Science for a Changing World Earthquake Hazards Program's Web site: <http://earthquake.usgs.gov/learning/kids/eqscience.php>

West Coast & Alaska Tsunami Warning Center.(2007). Retrieved March 26, 2007, from NOAA National Weather Service's Web site:
<http://wcatwc.arh.noaa.gov/>

- Print:

Dudley, W. C. & Lee, M. (1998). *Tsunami!* Honolulu: University of Hawai'i Press.

Keating, Dr. Barbara H. University of Hawai'i at Manoa, School of Ocean and Earth Science and Technology. Personal Interview. March 16, 2007.

Smith, C. B. (2006). *Extreme waves*. Washington, DC: John Henry Press.

Tsunami: The great waves. (2005). UNESCO. Pamphlet available from State of Hawaii Coastal Zone Management Program.

VanCleave, J. (1993). *Earthquakes*. New York: John Wiley & Sons, Inc.

- Media:

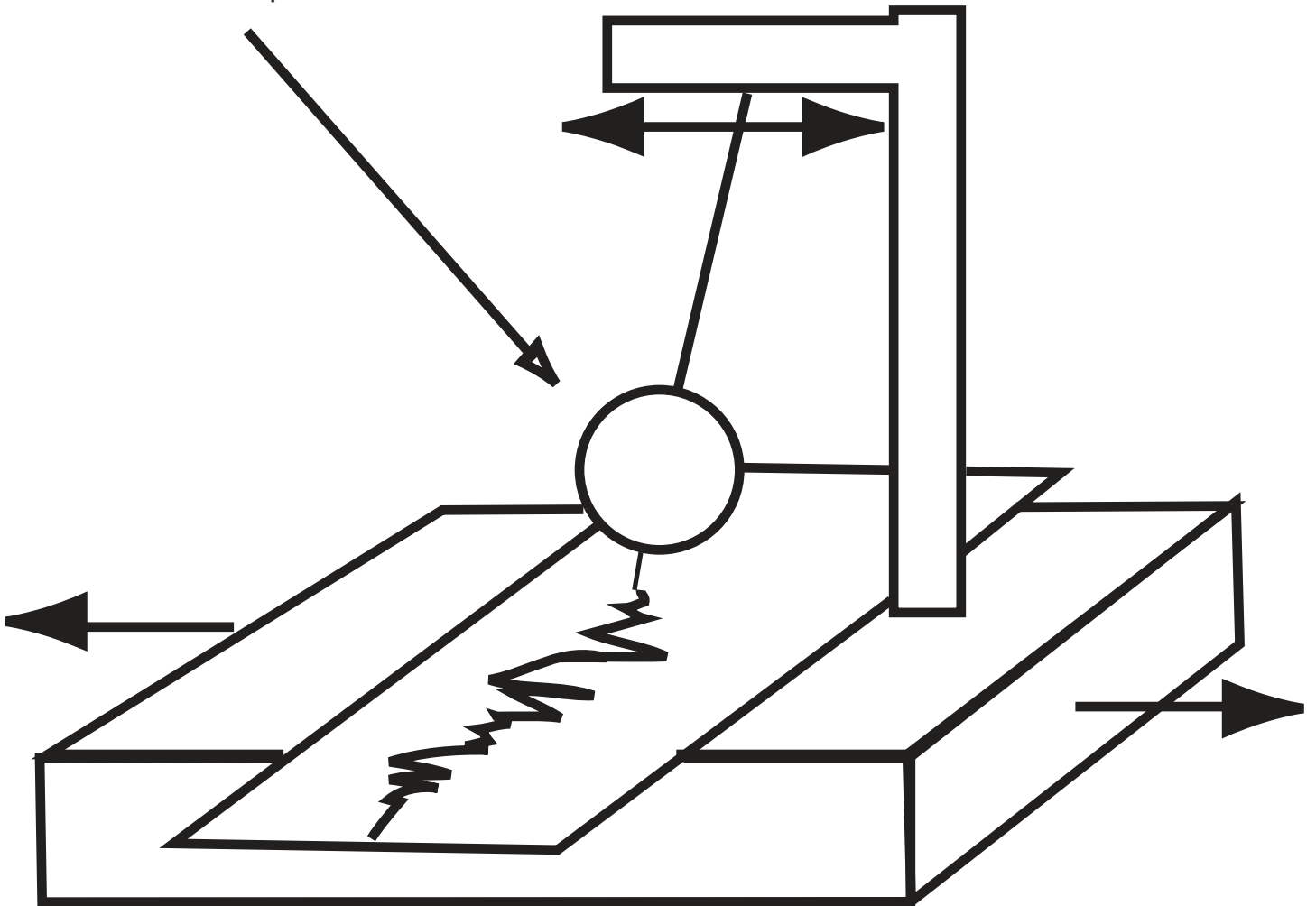
Fujioka, J. (April 2007). *Tsunami information*. KITV channel 4 evening news.

- 1st segment --Tsunami Survivors from Hilo 1946 tsunami (0:00-2:17)
- 2nd segment -- Tsunami Watch and Warning (2:18-4:16)
- 3rd segment -- Tsunami Evacuation Zones Online (4:17-6:06)
- 4th segment -- Big Island Community's Preparedness (6:07-8:18)
- 5th segment – Technology: DART buoys and NOAA weather radios (8:19-10:45)

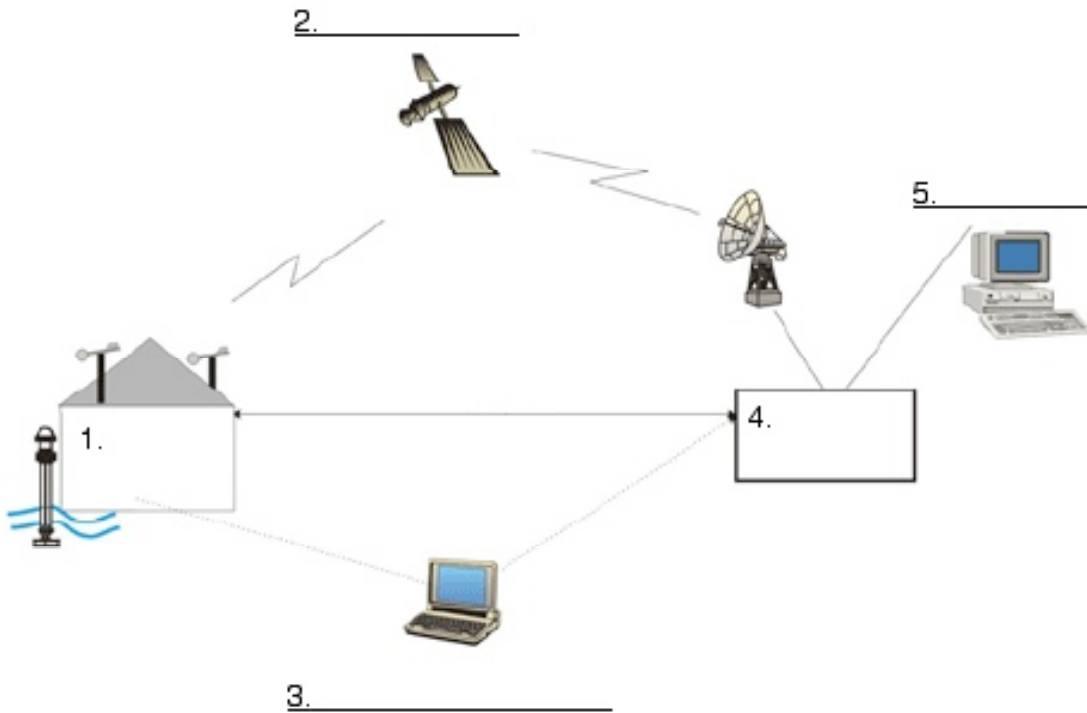
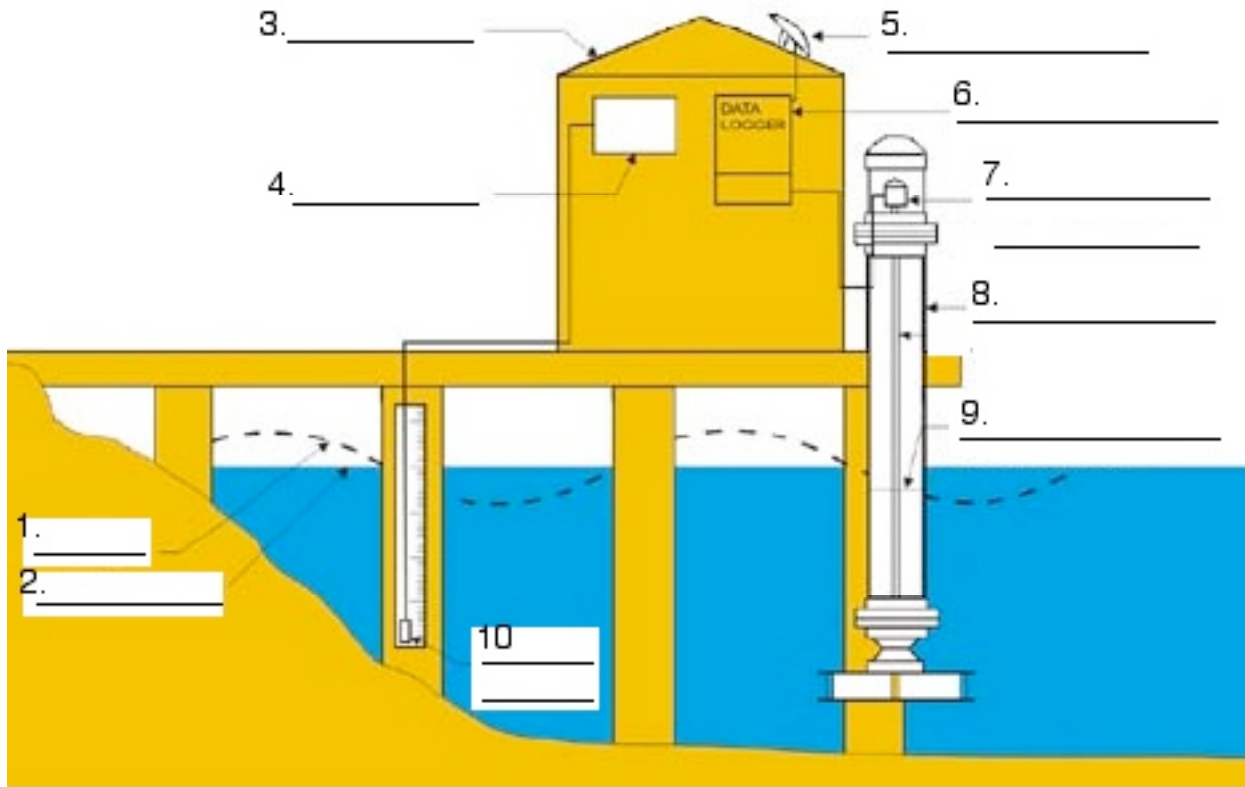
Seismometer

The whole seismometer moves as the earth it is attached to shakes, but the heavy mass does not move because of its inertia.

The recording device measures how far the rest of the seismometer has moved with respect to the mass.



Student Worksheet #1 "Tide Gauges"



Lesson #3

“Technology to the Rescue”

Student Worksheet #1 “Tide Gauges”

TEACHER ANSWER SHEET

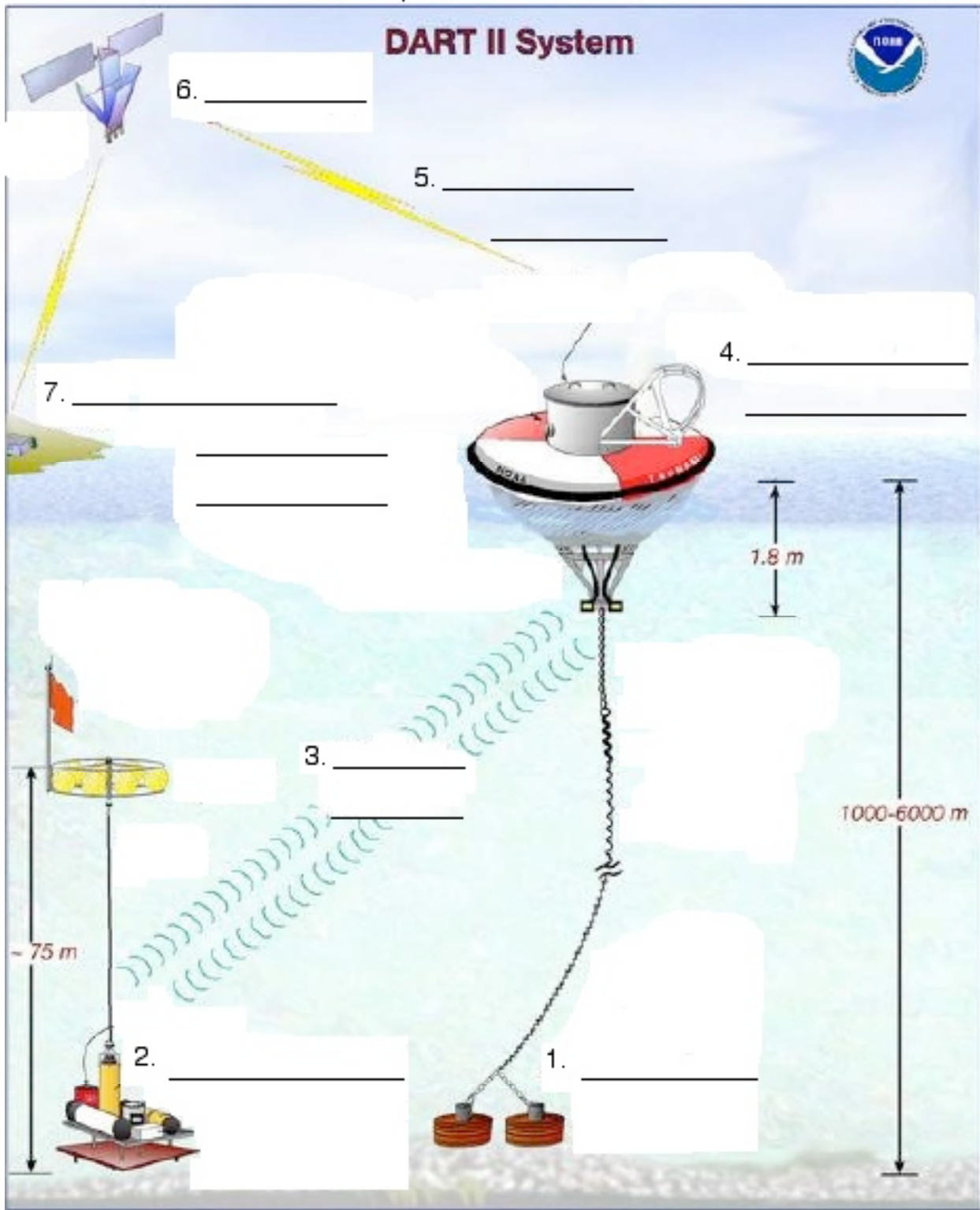
Student name: _____

top picture:

1. waves
2. average water level
3. tide house
4. backup data (sea water height based on pressure differences)
5. satellite antenna
6. data (sea water height based on sound travel time)
7. sound source & receiver
8. protective pipe
9. water level (with no interference from wind waves)
10. pressure sensor

bottom picture:

1. tide house
2. satellite
3. field crew (scientists onsite)
4. NOAA headquarters
5. Pacific Tsunami Center



Lesson #3

“Technology to the Rescue”

Student Worksheet #2 “DART II System”

TEACHER ANSWER SHEET

Student name: _____

1. anchor
2. tsunameter
3. (2-way) sound signal
4. DART buoy
5. (2-way) microwave signal
6. satellite
7. Tsunami Warning Center

Lesson #3
"Technology to the Rescue"

Student name: _____

Student Worksheet #3 "Society Needs Tsunami Technology"

Write a reflection --

Explain how the needs of society influenced the development and use of the tsunami warning system. Be sure to --

- Describe the kind of tragedy that happened in Hilo on April 1, 1946.
- Give details about what happened to some people on this date.
- Explain what the people of Hilo decided they needed, after the tragedy.
- Name and describe the function of the 3 instruments used in tsunami prediction.
- If you can, suggest at least one improvement in any of the instruments.

Lesson #3 Student Worksheet #3 “Society Needs Tsunami Technology” Science Reflection RUBRIC

CATEGORY	Advanced	Proficient	Partially Proficient	Novice
Description of 4/1/46	Identified tragedy as a tsunami composed of several waves; gave 2 or more detailed examples of peoples' experiences, with clear evidence of a personal perception of tragedy.	Identified tragedy as a tsunami composed of several waves; gave 1 detailed example of an experience, with some evidence of a personal perception of tragedy.	Identified tragedy as a "tsunami;" gave at least 1 example of a specific experience.	Identified tragedy as a "tsunami;" general statement about loss of life/property.
Description of Society's Needs	Recognition that tsunami warning system was needed; named and described function of all 3 instruments: seismogram, tide gauge, and DART-tsunami; suggested at least one technological improvement.	Recognition that tsunami warning system was needed; named and described function of at least 2 instruments; suggested one technological improvement.	Recognition that tsunami warning system was needed; named and described function of at least 2 instruments AND suggestion was not related to technology.	Recognition that tsunami warning system was needed; named and described function of 1 instrument AND suggestion was not related to technology.
Writing Skills	Contains 0-1 spelling, grammar, capitalization, punctuation errors.	Contains 2-3 spelling, grammar, capitalization, punctuation errors.	Contains 4-5 spelling, grammar, capitalization, punctuation errors.	Contains 6-7 spelling, grammar, capitalization, punctuation errors.