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Lesson title
Dynamic Earth

Grade level
3–5

Subject area
Weather

Duration
One class period

Objectives
Students will understand the following:

1. A tidal wave, or *tsunami*, is a huge, destructive wave caused by a certain type of earthquake.

Materials
The following materials will be required for each group:

- Clear plastic box
- Water
- Rubber mallet

Procedure

1. Review with your students what they have learned about tidal waves, or *tsunamis*. They should understand that a tsunami is a gigantic sea wave that can wash away an entire town in just a few seconds. They should also know that tsunamis can be caused by a certain type of earthquake.
2. Tell students they are going to do a demonstration to show how earthquakes affect sea waves. Students will work in teams of 2 or 3.
3. Direct each team to fill a clear plastic box halfway with water and place the box on a sturdy tabletop.
4. Have a student from each team lightly strike the tabletop with a rubber mallet on the table's front edge. Team members should observe the water and draw pictures of the waves they see in the box.
5. Instruct students to repeat the procedure 2 more times, lightly striking the table on its top, then on one of the side edges of the tabletop. Each time, students should observe the waves in the box and draw what they see, labeling their drawings "front," "top," and "side," according to where the table was struck with the mallet.

6. Tell students that the 3 directions in which earthquake waves vibrate determine how large the resulting sea waves will be. The front strike produces a P (primary) wave, the side strike produces an S (secondary) wave, and the top strike produces an L (surface) wave. L waves cause the most damage and set up tsunamis.
7. Students can work in pairs to further demonstrate the 3 types of waves by using a Slinky® toy. Direct students to do the following:
   - Stretch the spring to about 6 to 10 times its compressed size, with one student holding each end.
   - One student will be the “holder,” and the other will be the “operator.” The holder should hold the spring still, while the operator moves the spring as directed.
   - To create a P wave, the operator pushes the spring directly toward the holder.
   - To create an S wave, the operator waves the spring from side to side.
   - To create an L wave, the operator lifts the spring up and snaps it down.
8. Students can observe that the L wave is the biggest of the 3.

Adaptations

Rather than have students work independently, set up the experiment for them and demonstrate the different kinds of waves. Invite volunteers to try using the mallet themselves. Younger children may not be able to make the conceptual connection between the action of the Slinky® toy and different types of waves; you might want to omit this part of the procedure.

Discussion questions

1. Imagine you are making a movie about tsunamis. Explain how you would show the effects of a tsunami without putting anyone in danger. Would you choose to build a model or draw a picture? Talk about how a tsunami gets started and what people can do to be safe when it approaches.
2. A tsunami can cause a lot of damage very quickly. Sometimes people have little time to escape before their houses get flooded. Have you ever been in a flood or do you know someone who has? How much time do people have to escape from a flood? What can they take with them? Where could people go to be safe from the rising floodwaters? If a family’s home gets flooded, should they move back to the same place after the water goes down or choose a new place to live?
3. Talk about your personal experience with weather disasters, especially hurricanes. Do you know someone who has been through a hurricane evacuation? Where do people go when they are forced to leave their homes? What could happen if a family tried to “weather the storm” and not follow the warnings to evacuate their home?
4. You are the Hurricane Team for Severe Emergencies and Other Critical Stuff for Beachlandia, USA. There is a category 4 hurricane approaching fast. You have 6 hours to evacuate all the residents and tourists. Explain to a really stubborn resident (your teacher), who lives on the beachfront why evacuation is necessary.
5. You live in Tornado Alley and you’re riding in the car for a family trip. Suddenly, to your horror, you see a tornado in the distance. You’re near a highway overpass,

a drainage ditch with a large concrete pipe running under the highway, and an abandoned tool shed. Which would you pick for shelter (or would you stay in your car)? Explain your choice.

6. Explain what a tornado is in your own words. What sights and sounds would you encounter if you could get close to a tornado? Why do tornado hunters risk their lives to get close enough to study them?
7. Most people have heard the story of Benjamin Franklin's electricity experiment, which involved flying a kite in a thunderstorm in Philadelphia. Tell the class what you know about this legendary American and his story. Explain what you think happened during this experiment and discuss how it helped him understand more about lightning.
8. Have you ever been in a blackout during a thunderstorm? Have you ever been rained out at a picnic and looked for shelter from lightning? Think about the last time you were in a thunderstorm. What memories do you have of it? Explain how lightning makes you feel when you see it flash.

Evaluation

You can evaluate groups on their drawings using the following 3-point rubric:

- **Three points:** Three wave types represented, carefully drawn, clearly and correctly labeled.
- **Two points:** Three wave types represented, drawings acceptable, labeling unclear or incorrect.
- **One point:** Fewer than 3 wave types represented, carelessly drawn, labeling unclear or incorrect.

Extension

When the Wind Blows, the House Will Rock!

Hurricanes can destroy houses by blowing their roofs off, but improper construction can be to blame. Have your students work in teams of 3 to build houses made only of index cards, using tape only to anchor the bottom to a tabletop. Have students use drinking straws to simulate hurricanes of different strengths. To simulate a force 1 hurricane, a student should put a straw in his or her mouth and the other end 2 feet from the house, and then blow on the house to see if it will hold up. A force 2 hurricane will require 2 group members to blow on the house. Groups should continue up to force 4.

After each trial, each group should make a list of damages and then make modifications to the house. On the last modification, they may use one inch of tape (but no more) placed anywhere on the card house. How many houses in your class were able to stand up to the level 4 hurricane test? Talk about the features of the houses still standing and compare their construction to those that fell.

Count the Strikes

During a thunderstorm, have students count the number of lightning strikes they see. Remind them to observe from a safe location. They should take note of the time of day and separately record how many cloud-to-ground and cloud-to-cloud strikes they observe in a 10-minute period. Were there more cloud-to-ground or cloud-to-cloud strikes?

Suggested readings

Science Crafts for Kids: 50 Fantastic Things to Invent and Create
Gwen Diehn and Terry Krautwurst. New York: Sterling Publishing Co., 1994.

The Earth Atlas
Susanna Van Rose. Illustrated by Richard Bonson. London: Dorling Kindersley, 1994.

Hurricanes
Sally Lee. New York: Franklin Watts, 1993.

Hurricanes: Earth's Mightiest Storms
Patricia Lauber. New York: Scholastic Press, 1996.

Storm Warning: Tornadoes and Hurricanes
Jonathan D. Kahl. Minneapolis: Lerner Publications Co., 1993.

Tornado!
Jules Archer. New York: Crestwood House, 1991.

Thunderbolt: Learning about Lightning
Jonathan D. Kahl. Minneapolis: Lerner Publications Co., 1993.

How the Weather Works
Michael Allaby. Pleasantville, NY: The Reader's Digest Association, Inc., 1995.

Web links

Welcome to Tsunami!
This site covers the mechanisms of tsunami generation and propagation, the impact of tsunamis on humankind, and the Tsunami Warning System.
http://www.geophys.washington.edu/tsunami/welcome.html

Hurricanes and Typhoons
Want to see some great satellite images of hurricanes and typhoons? This site has them.
http://www.ngdc.noaa.gov/dmsp/hurricanes/hurricanes.html

The Tornado Project Online
This site contains information about tornado myths, tornado oddities, personal experiences, tornado chasing, tornado safety, and tornadoes in the past as well as more recent tornadoes.
http://www.tornadoproject.com/

Electricity Misconceptions
This thought-provoking site takes a look at some of our fundamental notions about electricity. It even has a few things to say about Ben Franklin's famous lightning experiment.
http://www.eskimo.com/~billb/miscon/eleca.html - franklins

Vocabulary

tsunami
Definition: A large wave caused by an earthquake, underwater landslide, volcanic eruption (explosion), or impact from a large space rock called a meteorite.
Context: A tsunami is a gigantic wall of water that can stretch as far as the eye can see and can travel thousands of miles before it crashes into land.

battlements
Definition: Walls built to protect a town from a dangerous ocean wave.
Context: The giant concrete battlements, or walls, are designed to keep the sea out.

eye
Definition: An area like a hole in the center of a hurricane marked by only light winds or complete calm with no rain.
Context: There is only one area that remains calm. It's the spot where competing up and down air drafts cancel each other out. This is the eye of the storm.

evacuate
Definition: To withdraw from a place in an organized way, especially for protection.
Context: These are the guys who will decide whether or not people need to "head for the hills" and evacuate.

tornado alley
Definition: A portion of the United States, stretching roughly from Texas to Nebraska and Iowa, which receives the most tornadoes annually.
Context: In America there is even a place called tornado alley.

Doppler Radar
Definition: A radar system that utilizes the Doppler effect for measuring wind velocity. Note: the Doppler effect can tell us whether something is moving toward or away from us. Scientists know a tornado is forming when they spot a particular shape on the radar screen.
Context: This is what a storm looks like on Doppler Radar.

condense
Definition: To convert water from the vapor state to the liquid state.
Context: When pockets of air are warmed up by the sun, they rise. The higher the pocket gets, the cooler it gets. This process causes the water vapor in the air to condense onto dust particles and turn back into the water droplets, which form clouds.

lightning rod
Definition: A grounded metallic rod set up on a structure (like a building) to protect it from lightning.
Context: But how do you protect buildings? With a device that's over 200 years old. It's called a lightning rod.

current
Definition: A flow of electricity.
Context: So a huge current rips through the air balancing out the electric charges.

Academic standards
Grade level
K–2

Subject area
Science

Standard
Understands motion and the principles that explain it.

Benchmark
Knows that things move in many different ways (e.g., straight line, zigzag, vibration, circular motion).

Grade level
K–2

Subject area
Science

Standard
Understands the nature of scientific inquiry.

Benchmark
Knows that learning can come from careful observations and simple experiments.

Grade level
3–5

Subject area
Science

Standard
Understands the nature of scientific knowledge.

Benchmark
Knows that air is a substance that surrounds us, takes up space, and moves around us as wind.

Benchmark
Knows that although the same scientific investigation may give slightly different results when it is carried out by different persons, or at different times or places, the general evidence collected from the investigation should be replicable by others.

Grade level
K–2

Subject area
Science

Standard
Understands basic features of the Earth.

Benchmark
Knows that short-term weather conditions (e.g., temperature, rain, and snow) can change daily, and weather patterns change over the seasons.

Grade level
3–5

Subject area
Science

Standard
Understands basic features of the Earth.

Benchmark
Knows that short-term weather conditions (e.g., temperature, rain, and snow) can change daily, and weather patterns change over the seasons.

Grade level
3–5

Subject area
Science

Standard
Understands basic features of the Earth.

Benchmark
Knows that clouds and fog are made of tiny droplets of water.

Grade level
3–5

Subject area
Science

Standard
Understands energy types, sources, conversions, and their relationship to heat and temperature.

Benchmarks
Knows the organization of a simple electrical circuit (e.g., battery or generator, wire, a complete loop through which the electrical current can pass).

Grade level
3–5

Subject area
Science

Standard
Understands the nature of scientific knowledge.

Benchmark
Knows that although the same scientific investigation may give slightly different results when it is carried out by different persons, or at different times or places, the general evidence collected from the investigation should be replicable by others.

Credit
Frank Weisel, science teacher, Tilden Middle School, Rockville, Maryland

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