the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Title Waves and Tides on the Move

Grade Level	5th	**Subject**	Ocean Movements and Hydroelectric Power

Objective(s):

The students will analyze how waves and tides can move objects from one place to another by researching tide tables and making observations of areas where tides can be found. The students will complete an activity observing how waves can move different types of materials. The students will also research moon phase calendars to determine when high and low tides often occur. Using this information, the student will also research the different energy sources on the CEED dashboard. They will also compare this to wind speeds in Virginia Beach. The students will then design a tool that will convert hydro-electrical power (from tides and waves) to electricity if the CEED building was located at the beach.

SOL Addressed:

5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations.

5.6 The student will investigate and understand characteristics of the ocean environment.

4.9 The student will investigate and understand important Virginia natural resources.

4.8 The student will investigate and understand the relationships among Earth, the moon, and the sun.

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nature of science by planning and conducting investigations

Common Core Standards:

4-PS3-3.	**Ask questions and predict outcomes about the changes in energy that occur when objects collide.**
4-ESS3-1.	**Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.**
4-PS3-4.	**Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.***
4-PS4-1.	**Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.**
4-PS3-2.	**Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.**
5-ESS2-2.	**Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.**

Materials Needed Per Class of 30 **and** **Prior Knowledge**	**30 clear liter bottles** **30 fishing bobbers (small enough to fit into the bottle)** **30 tablespoons of glitter** **90 small stones (three per student)** **400 mL of water per student** **400 mL of vegetable oil per student** **Blue food coloring- a few drops per bottle** **30 student laptops** **Activeboard** **Internet connection for the following websites:** **http://education.nationalgeographic.com/education/multimedia/interactive/wave-simulator/?ar_a=1** **http://www.freetech4teachers.com/2014/03/how-tides-work-three-explanations.html#.UzdAlPldWSo** **http://www.surf-forecast.com/breaks/Virginia-Beach/tides/latest** **http://www.moonconnection.com/moon_phases_calendar.phtml**
Ways to differentiate this lesson plan	• **EXTENSION** for Higher Level Learner- The students can analyze and graph the differences between wind speeds at the CEED building and compare to wind speeds in Virginia Beach. Students may also research the Smith Mountain Lake damn to gather information about their production of energy. • **MODIFICATIONS** – Students may need additional help when gathering information. To do so, they may need to work in groups. The analyzing of certain graphs may need clarification or may need for a teacher to walk through what the information is showing. Students may also need further direction when navigating the sites and graphs.
Introduction/ Anticipatory Set	**Anticipatory Set:** The students will share any prior knowledge they have on waves or tides. The teacher may want to share a personal experience of when they had their towels on the sand and went for a walk. When they got back, their towels were wet. What made that happen? **Questions to ask students:** • Who here has been to the beach? • Think, Pair, Share with a partner, how does the water move at the beach? • How many of you that have been to the beach, have noticed that at some times in the day, the water is high and other times, the water is farther away?
	Introduction: The class will discuss that there are many motions in the ocean such as waves, tides, and currents. The students will discuss that waves can be powerful enough to knock down sandcastles and even people. Teacher may say- What if there was a way to harness this energy? Today, you will discover how waves can make things move. In the following days, you will discover how tides occur and when they are their highest and lowest. At the end of this series of lessons, you will be an inventor of a new tool that will use waves and tides to produce a new form of renewable energy.

Guided Practice	Day 1 Students will be guided through the creation of their waves in a bottle. For one liter bottles, add 400 milliliters of water with blue food coloring already added, 400 milliliters of oil, teaspoon of glitter, five to six small stones, and fishing bobbers. The students or teacher will add the items to the bottles using a funnel. The teacher will have the students create waves within their bottles by simulating the waves using the webstie http://education.nationalgeographic.com/education/multimedia/interactive/wave-simulator/?ar_a=1. The students will draw conclusions about how waves can move different types of materials and will record their observations in writing and by drawing how the items reacted to the waves. Day 2 The teacher will ask the students about their prior knowledge of tides. Students or the teacher can share their experiences with tides. Students will watch the short introduction to tides using one or more of the videos onhttp://www.freetech4teachers.com/2014/03/how-tides-work-three-explanations.html#.UzdAlPldWSo. In their groups, students will share their own summaries of how tides work. The teacher will ask the students to share their ideas and will ask the students to record these summaries in their notes.	
Independent Practice	Day 3 The teacher will ask students to share their summaries on tides that they recorded the day before to refresh their ideas they had gathered on tides. The teacher will then show different pictures from the webcam of Rudee's inlet at Virginia Beach (or beach of choice) at different points in the day. Using the student laptops, the students will work in partnerships or teams to analyze the graphs and how the tides work. The students will also discover at what points tides are at their highest/lowest using the graph at http://www.surf-forecast.com/breaks/Virginia-Beach/tides/latest or the beach location of choice. Students will also compare these with the moon phase calendar athttp://www.moonconnection.com/moon_phases_calendar.phtml. The teacher may want to print this calendar or allow the students to use the website. Students will use this information to answer the discussion questions. As a class, the students will share the information gathered from the websites that they recorded on their discussion question worksheet.	

	Day 4 Students will give a quick review as a class to summarize the tools at the CEED center and how they produce energy through renewable energy sources. The teacher may want to pull the website up to refresh their memories. Students will use the information gathered from their previous activities on waves and tides to design their own energy-producing machine. They will describe how the waves and tides can create energy production through their machine and will draw what their machine would look like and will label each part.
Closure (Summary of Lesson)	Day 5 The students will pretend the CEED building has moved to the beach and will describe how their machine will fit into their building. The students will share their tools as a class and explain how tides and waves can be used to harness energy in their examples. The other students will give suggestions or comments for modification on the other students' tools.
CEED Building Application/ Sensor Data	The students can compare data collection from other tidal energy sources to give them estimates on the energy-production of current uses of tidal energy. They can analyze how much energy production is gathered from these sources to the energy production gathered at the CEED center. http://dashboard.intellergy.us/ceed/index.php The website can compare the different types of renewable energy sources to their designed tool.
Assessment	Students will be graded based on their understanding of tides and energy transfer from hydropower to electricity shown in their final design of the energy tool. The students can be assessed by their participation in discussion and their completion of the discussion questions in written form. The students will also be assessed using their design of their wave/tidal-powered machine. Their score will be based on their understanding of tides and waves, as well as completion of the activity, including their written description and drawing.

Wave Discussion Questions:

Describe how the following objects were moved in the water:

Bobbers-

Glitter-

Stones-

List some items found in the ocean that might compare to these.

Bobbers-

Glitter-

Stones-

Draw a picture of how the items looked while creating waves:

Bobbers glitter stones

When did the items move the most? Why?

When did the items move the least? Why?

How does this compare to how things move in the ocean?

Tidal Analysis Discussion Questions

Analyze the graph on the following website:
http://www.surf-forecast.com/breaks/Virginia-Beach/tides/latest

What times in each day are the tides the highest? lowest?

Explain why tides are higher at certain times in the day, compared to others.

Explain what might happen to these tides when there are severe storms.

Are there certain times in the month when the tides are stronger? What makes this happen?

Draw a picture of how the earth, sun, and moon would align during the highest tides and lowest tides.
Highest tides Lowest tides

What moon phases can be observed during a neap tide? _____

What moon phases can be observed during a spring tide? _____

INQUIRY LEARNING RESEARCH PROCESS GUIDELINES

The following table is just one guideline to use for developing your own inquiry materials. The seven steps in the Learning Research Process include not only how people learn but also how research is conducted. The heart of the design, the three-stage learning cycle of exploration, concept invention or formation, and application is embedded in the middle. In addition to these three stages, this design takes into account that learners need to be motivated to spend the time required for understanding complex subjects and that learners need to build this new knowledge onto prior knowledge. These are similar to the 5E and 7E learning models.

The Learning-Research Process

Steps in the Learning-Research Process	7E Equivalent	Component of the Activity
1. Identify a need to learn.	Engage	An issue that excites and interests is presented. An answer to the question *Why?* is given. Learning objectives and success criteria are defined.
2. Connect to prior understandings.	Elicit	A question or issue is raised, and student explanations or predictions are sought. Prerequisite material and understanding is identified.
3. Explore	Explore	A model or task is provided, and resource material is identified. Students explore the model or task in response to critical-thinking questions.
4. Concept invention, introduction, and formation	Explain	Critical-thinking questions lead to the identification of concepts, and understanding is developed.
5. Practice applying knowledge.		Skill exercises involved straightforward application of the knowledge.
6. Apply knowledge in new contexts.	Elaborate and Extend	Problems and extended problems require synthesis and transference of concepts.
7. Reflect on the process	Evaluate	Problem solutions and answers to questions are validated and integrated with concepts. Learning and performance are assess

Hanson, D. (2006). POGIL Instructor's Guide to Process-Oriented Guided-Inquiry Learning. Lisle, IL: Pacific Crest