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Educational Product

Educators	Grades 3–5

EG-2004-11-17-LARC

The NASA Sci Files™

The Case of the Ocean Odyssey

An Educator Guide with Activities in Mathematics, Science, and Technology

Illustrated by: René H. Peniza Jr.

The Case of the Ocean Odyssey educator guide is available in electronic format .
A PDF version of the educator guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site:
http://scifiles.larc.nasa.gov

www.swe.org

www.sbo.hampton.k12.va.us

www.buschgardens.com

www.cnu.edu

The NASA Science Files™ is produced by the NASA Center for Distance Learning, a component of the Office of Education at NASA's Langley Research Center, Hampton, VA. The NASA Center for Distance Learning is operated under cooperative agreement NCC-1-02039 with Christopher Newport University, Newport News, VA.

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Production of the NASA SCI Files™ is made possible by the generous support provided by the Society of Women Engineers (SWE); Busch Gardens, Williamsburg; Hampton City Public Schools; and the NASA Langley Research Center's Aerospace Vehicle Systems Technology Program Office.

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The NASA Sci Files™

Program Overview

The tree house detectives are eager to help clean up their community beach but are surprised when they arrive to find a beach full of tennis shoes and oil globs. Curious as to how the tennis shoes and oil ended up on their beach, the detectives set out to solve their next case, *The Case of the Ocean Odyssey*.

After listening to a KSNN™ report, the tree house detectives are convinced that the shoes were in a container that fell off a cargo ship near the Virginia coast. Bianca cautiously reminds the detectives not to jump to conclusions, so they meet Dr. Eileen Hofmann from Old Dominion University at the wave pool in Water Country USA, Williamsburg, Virginia. Dr. Hofmann explains how tides are created and uses Jacob as a human guinea pig to demonstrate how water particles move within waves. This new knowledge sparks the detectives to visit Dr. D on the *Maury*, a research vessel operated by Tidewater Community College in Norfolk, Virginia. Dr. D helps the detectives understand how oceans became salty and demonstrates density differences in salinity.

Realizing that there are many different kinds of currents in the ocean, the detectives visit Dr. Chris Martens in Key Largo, Florida. Dr. Martens has just surfaced from the Aquarius, an underwater research laboratory operated by the National Oceanic and Atmospheric Administration (NOAA) and NASA. Dr. Martens explains that differences in salinity and temperature can create density currents. He also describes upwellings and thermohaline circulation, the global conveyor belt of our oceans. Next, Dr. Textbook gives some historical information about the Gulf Stream, which motivates the detectives to learn more about surface currents. Bianca sets off to visit Dr. David Adamec at NASA Goddard Space Flight Center in Greenbelt, Maryland. Dr. Adamec helps Bianca understand how the Coriolis effect, wind, and topography affect surface currents in the ocean. He also explains the importance of oceans to our climate and why NASA uses various instruments and tools to learn more about oceans. Meanwhile, back at Water Country USA, Dr. D, Catherine, and RJ conduct an experiment to measure the speed of the Hubba Hubba Highway. They also discover that the swift moving current is too much for even really strong swimmers!

While in Houston, Texas, oil country, Jacob sets out to learn more about oil—black gold, Texas Tea. He visits Paul Bernhard in the Wiess Energy Hall at the Houston Museum of Natural Science who explains how oil was formed millions of years ago. Curious as to how oil is found and extracted from the ground, Mr. Bernhard suggests that Jacob visit Mr. Kent Wells at the Ocean Star, an offshore drilling rig and museum. Mr. Wells explains how a well is drilled and how production is completed once oil is found. Mr. Wells also tells Jacob some interesting facts about oil, which spurs the tree house detectives into action. Kali visits Ms. Jennifer Miselis at the Virginia Institute of Marine Science (VIMS), who describes ocean floor topography and gives them another clue to the mystery.

The tree house detectives think they are getting close to solving the case but become concerned over the environmental impact that the oil has on their community and wildlife. They dial-up a NASA SCI Files™ Kids' Club at Key Largo School in Key Largo, Florida, where Mrs. Ann Dunn's class is conducting an experiment to learn more about cleaning up an oil spill. After discovering that cleaning up oil is not so easy, RJ goes to NASA Wallops Flight Facility, located on Virginia's Eastern Shore, to talk with Ms. Sue Fields and Dr. John Moisan. Ms. Fields explains the environmental impact of oil and why it is so important to contain an oil spill before it reaches land. Dr. Moisan helps the detectives put the final pieces together to solve the mystery as he explains coastal currents. Finally, it is off to Dr. D's lab, where the tree house detectives wrap it up and get confirmation on their hypothesis. Another case solved!

National Science Standards (Grades K-4)

STANDARD	SEGMENT 1	2	3	4
Unifying Concepts and Processes	1	2	3	4
Systems, orders, and organization	◆	◆	◆	◆
Evidence, models, and explanations	◆	◆	◆	◆
Change, constancy, and measurement	◆	◆	◆	◆
Evolution and equilibrium	◆		◆	
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	◆	◆	◆	◆
Understandings about scientific inquiry	◆	◆	◆	◆
Physical Science (B)				
Properties of objects and materials	◆	◆		◆
Position and motion of objects	◆	◆		◆
Light, heat, electricity, and magnetism		◆		
Earth and Space Science (D)				
Properties of earth materials				◆
Objects in the sky	◆	◆	◆	◆
Changes in earth and sky	◆	◆	◆	◆
Science and Technology (E)				
Abilities of technological design	◆	◆	◆	◆
Understandings about science and technology	◆	◆	◆	◆
Science in Personal and Social Perspectives (F)				
Types of resources	◆	◆	◆	◆
Changes in environment	◆	◆	◆	◆
History and Nature of Science (G)				
Science as a human endeavor	◆	◆	◆	◆

National Science Standards (Grades 5–8)

STANDARD	SEGMENT 1	2	3	4
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Systems, order, and organization	◆	◆	◆	◆
Evidence, models, and explanations	◆	◆	◆	◆
Change, constancy, and measurement	◆	◆	◆	◆
Evolution and equilibrium	◆		◆	
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	◆	◆	◆	◆
Understandings about scientific inquiry	◆	◆	◆	◆
Physical Science (B)				
Properties and changes of properties in matter	◆	◆	◆	◆
Motion and forces	◆	◆		
Transfer of energy	◆	◆	◆	
Earth and Space Science (D)				
Structure of the earth system	◆	◆	◆	◆
Earth's history	◆	◆	◆	◆
Earth in the solar system	◆			
Science and Technology (E)				
Abilities of technological design	◆	◆	◆	◆
Understanding about science and technology	◆	◆	◆	◆
Science in Personal and Social Perspectives (F)				
Populations, resources, and environments	◆		◆	◆
Natural hazards	◆		◆	◆
Risks and benefits			◆	◆
Science and technology in society			◆	◆
History and Nature of Science (G)				
Science as a human endeavor	◆	◆	◆	◆
Nature of science	◆	◆	◆	◆
History of science	◆	◆	◆	◆

National Mathematics Standards for Grades 3–5

STANDARD	SEGMENT 1	2	3	4
Number and Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	◆	◆		
Understand meanings of operations and how they relate to one another.	◆	◆		
Compute fluently and make reasonable estimates.	◆	◆		
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols.		◆		
Use mathematical models to represent and understand quantitative relationships.		◆		
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	◆	◆	◆	◆
Apply appropriate techniques, tools, and formulas to determine measurements.	◆	◆	◆	◆
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	◆	◆	◆	◆
Develop and evaluate inferences and predictions that are based on data.		◆	◆	◆
Understand and apply basic concepts of probability.		◆		
Problem Solving				
Build new mathematical knowledge through problem solving.	◆	◆	◆	◆
Solve problems that arise in mathematics and in other contexts.	◆	◆	◆	◆
Apply and adapt a variety of appropriate strategies to solve problems.	◆	◆	◆	◆
Monitor and reflect on the process of mathematical problem solving.	◆	◆	◆	◆

National Mathematics Standards for Grades 3-5

STANDARD	SEGMENT			
Communication	1	2	3	4
Organize and consolidate mathematical thinking through communication.	◆			
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.	◆			
Analyze and evaluate the mathematical thinking and strategies of others.	◆			
Use the language of mathematics to express mathematical ideas precisely.	◆			

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT			
Basic Operations and Concepts	1	2	3	4
Use keyboards and other common input and output devices efficiently and effectively.	◆	◆	◆	◆
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	◆	◆	◆	◆
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.				◆
Discuss basic issues related to responsible use of technology and information and describe personal consequences of inappropriate use.				◆
Technology Productivity Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	◆	◆	◆	◆
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	◆	◆	◆	◆
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	◆	◆	◆	◆
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	◆	◆	◆	◆

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT 1	2	3	4
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	◆	◆	◆	◆
Use technology resources for problem solving, self-directed learning, and extended learning activities.	◆	◆	◆	◆
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	◆	◆	◆	◆
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	◆	◆	◆	◆
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	◆	◆	◆	◆
Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.	◆	◆	◆	◆

International Technology Education Association Standards for Technological Literacy Grades 3-5

STANDARD	SEGMENT 1	2	3	4
The Nature of Technology				
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	◆	◆	◆	◆
Standard 2: Students will develop an understanding of the core concepts of technology.	◆	◆	◆	◆
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	◆	◆	◆	◆
Technology and Society				
Standard 5: Students will develop an understanding of the effects of technology on the environment.	◆	◆	◆	◆
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	◆	◆	◆	◆
Standard 7: Students will develop an understanding of the influence of technology on history.		◆		
The Designed World				
Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.			◆	◆

National Geography Standards

STANDARD	SEGMENT			
The geographically informed person knows and understands:	**1**	**2**	**3**	**4**
The World in Spatial Terms				
How to use maps and other graphic representations, tools, and technologies to acquire process and report information from a spatial perspective		◆	◆	◆
Places and Regions				
The physical and human characteristics of places	◆	◆	◆	◆
Physical Systems				
The physical process that shape the patterns of Earth's surface		◆	◆	
Environment and Society				
How human actions modify the physical environment			◆	◆
The changes that occur in the meaning, use, distribution, and importance of resources			◆	◆
The Uses of Geography				
How to apply geography to interpret the past		◆		
How to apply geography to interpret the present and plan for the future			◆	◆

The NASA SCI Files™

The Case of the Ocean Odyssey

Segment 1

The tree house detectives head to the beach for a fun-filled "Clean the Bay Day" where they volunteer to clean the shoreline of their local beach. While combing the beach for trash, the detectives find an unusual kind of beach debris—tennis shoes and oil globs. Curious as to where so many tennis shoes could have come from and why there is oil on them and the beach, the detectives decide this is their next case. When I.M. Lissening reports that a cargo ship lost a container at sea off the Virginia coast, the detectives conclude that the morning tides brought in the shoes and oil. However, they remember that it's not always wise to jump to conclusions and agree that they need to do a little more research. They contact Dr. Eileen Hofmann at Old Dominion University to learn more about tides. Dr. Hofmann agrees to meet them at the Wave Pool in Water Country USA (Williamsburg, Virginia) where Jacob, bobbing in the waves, becomes a human experiment. Next, the tree house detectives head to the boat docks to meet Dr. D on the research vehicle, *Matthew F. Maury*, Tidewater Community College's research boat, to learn that oceans are not as simple as they thought.

Objectives

Students will

- learn about buoyancy
- determine why certain items float
- calculate the rate at which items sink
- understand tides and tidal bulges
- read and interpret tide tables
- demonstrate the circular movement of waves

Vocabulary

basin—a low area that contains an ocean

buoyancy—the tendency of a liquid or gas to cause less dense objects to float or rise to the surface

cargo container—a receptacle for holding or carrying freight; usually transported by ship, airplane, truck, or train

current—the part of a fluid body moving consistently in the same direction; the swiftest part of a stream

gravitational force—an attractive force that exists between all objects

oil—a liquid formed as ancient plants and animals decay; burned as a fossil fuel and used to make lubricants and plastics

salinity—a measure of the amount of solids (mostly salts) dissolved in seawater

tide—the periodic change in the surface level of the oceans caused by the gravitational forces of the Sun and Moon on the Earth

wave—a series of ripples moving across the surface of a liquid, especially a large, raised ridge of water moving across the surface of the sea

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 1 of *The Case of the Ocean Odyssey*, read the program overview to the students. List and discuss questions and preconceptions that students may have about how oceans are formed, the tides and currents in oceans, and what causes ocean waves.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the Problem-Based Learning tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log and Rubric—Students' printable log with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method and Flowchart—Chart that describes the scientific method process
3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. They can be printed ahead of time from the **Educators** area of the web site in the **Activities/ Worksheet** section under **Worksheets** for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.
4. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. You can print them by selecting **Educators** on the web site in the **Activities/Worksheet** section under **Worksheets** for the current episode.

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Ocean Odyssey* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about the oceans of the world. Have the students conduct research on the difference between currents, tides, and waves. Brainstorm ideas about how the tennis shoes may have ended up on the beach. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide them with the information needed.
4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools** section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
5. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. For related activities from previous programs, download the **Educator Guide**. On the NASA SCI Files™ home page, select **Educators**. Click on **Episodes** in the menu bar at the top. Scroll down to the 2003–2004 Season and click on *The Case of the Disappearing Dirt*. In the green box, click on **Download the Educator Guide**.

   a. In the Educator Guide you will find

      a. **Segment 4** – *Riding the Waves*

   Close the PDF window to return to the Educators Activities page. Click on Episodes in the menu bar at the top. Scroll down to the 2003–2004 Season and click on *The Case of the Wacky Water Cycle*. In the green box, click on **Download the Educator Guide**.

   b. In the Educator Guide you will find

      a. **Segment 1** – *Around and Around It Goes (water cycle)*

      b. **Segment 1** – *A Cycling We Will Go (water cycle)*

      c. **Segment 1** – *Water, Water Everywhere (usable water on Earth)*

7. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the 2004–2005 Season and click on *Lost at Sea*.
8. To begin the PBL activity, read the scenario *(Here's the Situation)* to the students.
   - Read and discuss the various roles involved in the investigation.
   - Print the criteria for the investigation and distribute.
   - Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. The **Research Rack** is also located in the **Tree House**.
9. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
10. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.
11. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Careers

cargo transport engineer
customs officer
marine chemist
marine engineer
oceanographer
ship captain

Resources *(additional resources located on web site)*

Books

Baker, Lucy and Jason Page: *Oceans*. Creative Publishing International, 2000, ISBN: 1587284596.

Berger, Melvin and Gilda Berger: *What Makes an Ocean Wave?: Questions and Answers about Oceans*. Scholastic, Inc., 2001, ISBN: 0439148820.

Demas, Corinne: *Disappearing Island*. Simon and Schuster, 1999, ISBN: 068980539X.

Ganeri, Anita: *Oceans*. Houghton Mifflin Company, 2002, ISBN: 0753454653.

Herman, G.: *Creeping Tide*. Kane Press, 2003, ISBN: 1575651289.

Jacobs, Marian: *Why Does the Ocean Have Tides?* Rosen Publishing Group, 2003, ISBN: 082395272X.

MacQuitty, Miranda: *Eyewitness: Ocean*. DK Publishing, Inc., 2000, ISBN: 0789460343.

Mason, Adrienne: *Oceans: Looking at Beaches and Coral Reefs, Tides and Currents, Seaweeds and Other Ocean Wonders*. Kids Can Press, 1997, ISBN: 1550741470.

Norris, Paul: *Aquaman's Guide to the Ocean*. DK Publishing, Inc., 2004, ISBN: 0756602300.

Simon, Seymour: *Oceans*. Morrow, William, and Co., 1997, ISBN: 0688154786.

Video

BBC: *Tidal Seas/Coasts*
Grades 6–8

Discovery Channel: *Understanding Oceans*
Grades 6–12

Web Sites

Tide and Current Predictor
Find the current prediction of tidal heights and current speeds for various locations around the world.
http://tbone.biol.sc.edu/tide/sitesel.html

National Oceanic and Atmospheric Administration (NOAA)
Visit NOAA's main web site to learn about oceans, fisheries, charting and navigation, weather, hurricane tracking, climates, and much more. There are also great educational resources for both teachers and students.
http://www.noaa.gov/

NOAA – About Water Levels, Tides, and Currents
On this NOAA web site, you can learn about what makes tides, the history of tidal analysis and prediction, tide-predicting machines, how and why we measure water levels, and the challenges of measuring water currents.
http://co-ops.nos.noaa.gov/about2.html#ABOUT

NOAA's National Ocean Service – Tides and Currents
Learn all about tides, tidal and storm surges, and water levels.
http://www.nos.noaa.gov/topics/navops/ports/welcome.html

Lunar Tides
The tides at a given place in the Earth's oceans occur about an hour later each day. Since the Moon passes overhead about an hour later each day, it was long suspected that the Moon was associated with tides. Visit this web site to learn more about lunar tides.
http://csep10.phys.utk.edu/astr161/lect/time/tides.html

Why Tides?
This web site has a great animation of the gravitational action of the Sun and Moon on the Earth's oceans and tides.
http://www.sfgate.com/getoutside/1996/jun/tides.html

Rip Tides
This web site contains information on rip tides, including an audio and graphic explanation of rip tides and safety information on what to do if you are caught in a rip tide.
http://ww2010.atmos.uiuc.edu/%28Gh%29/guides/mtr/hurr/damg/rip.rxml

Water on the Move
The Oceans Alive! web site has some great information about currents, wind and waves, and tides.
http://www.mos.org/oceans/motion/index.html

Why Is the Ocean Salty?
Visit this site to learn how salty the ocean is, the origin of the sea, sources of the salt in the ocean, and many other facts about the salt in the ocean.
http://www.palomar.edu/oceanography/salty_ocean.htm

NASA Jet Propulsion Laboratory Ocean Game
This NASA web site contains all the information and materials needed to make a board game to learn about continents, oceans, and ocean currents. You can download everything you need for the game from this site.
http://sealevel.jpl.nasa.gov/education/jason-1-game.html

Eco-Pro Ocean Home
This web site has a wealth of information on oceans as well as many links to other ocean related web sites.
http://www.eco-pros.com/oceanhome.htm

Activities and Worksheets

Boats Afloat

Segment 1

Purpose

To learn what buoyancy is

To determine characteristics that make an object buoyant

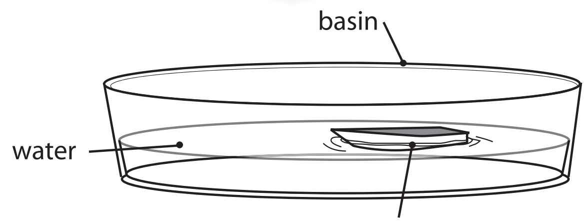
Materials

various lightweight materials (i.e., foam trays, cups, straws, paper plates, toothpicks)
various weighted materials (i.e., pennies, rocks, paper clips)
large basin, sink, or inflatable pool
tap water
scale
science journal

Background

Some objects, when placed in water, will float, while others will sink. Some objects neither float nor sink. The objects' ability to float or sink is a function of buoyancy. We call objects that float, positively buoyant. Objects that sink are called negatively buoyant. Objects that neither float nor sink are called neutrally buoyant. A Greek mathematician named Archimedes defined the principle of buoyancy: *Any object, wholly or partly immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object.* This statement is known as Archimedes' principle. Think about what happens when you take a bath. When you fill the bathtub half full with water and then get in, the water level rises. The weight of your body displaces the water. Saltwater is heavier, or denser, than freshwater, so objects in saltwater tend to float more easily than they do in freshwater. Objects of greater density than the fluid will sink, while objects of lesser density will float. Shape and position also factor into whether or not an object will float. A steel boat turned on its end will not float; however, the same steel boat will float when turned horizontally.

Procedure



1. Fill your basin, sink, or pool 1/2 full with water.
2. Survey the lightweight materials available to you.
3. In your science journal, draw a design of a boat to float in the water by using only the available materials.
4. Following your design, build your boat.
5. Place your boat in the water and see if it floats.
6. If necessary, modify your boat design until it floats.
7. Record your observations and design changes in your science journal.
8. Using paper clips, pennies, or other objects, add weight to the boat by adding one object at a time. Continue until the boat no longer floats.
9. Retrieve the objects from the water and dry them.
10. Weigh the objects on a scale to determine the amount of weight your boat could hold before sinking. (Don't include the last object that sank the boat.)
11. Record your findings in your science journal.
12. Using different materials, repeat steps 2–11.

Boats Afloat

Segment 1

Conclusion

1. What types of materials were more buoyant? Why?
2. What shape of boat was more buoyant? Why?
3. Did one boat hold more weight than the other boat? Why?
4. What do you think would happen if you added salt to the water?

Extension

1. Repeat the experiment with saltwater. Add salt to the water in the basin and repeat the steps. Did it make a difference? Explain the difference between saltwater and freshwater buoyancy?
2. Fill two jars 1/2 full with water. The mouth of the jar should be large enough for an egg to fit. Label one jar "freshwater" and the other jar "saltwater." Add 120 mL salt to the "saltwater" container and stir. Place an uncooked egg in each jar and observe. Is there a difference between salt- and freshwater density? How do you know?

Going Up or Going Down?

Segment 1

Purpose

To determine which items float and which items sink

To understand buoyancy

Background

Have you ever wondered why heavy objects such as large trees float while lightweight objects such as a small grain of sand sinks? When scientists want to know if an object will sink or float, they find out its density. The density of a substance is the weight of a standard amount of the substance. The amount that scientists usually use is the cubic centimeter cubed (cm^3). A cm^3 is a cube that is 1 cm long by 1 cm wide by 1 cm deep. To find out if an object will sink or float in water, you have to compare the weight of the object to the weight of an equal amount of water. If a cm^3 of a substance weighs less than a cm^3 of water, the substance will float.

Materials

Per Group

pencil
masking tape
metric ruler
2 tea light candles
modeling clay
water
1 cup
table
large basin
science journal

Procedure

1. Tape a pencil to a table. See diagram 1.
2. Roll 2 small pieces of tape, sticky side out, and stick one on each end of the ruler. See diagram 2.
3. Remove the candles from their metal containers.
4. Place the empty metal containers on the rolled-up pieces of tape.
5. Place the ruler on the pencil so that it is as evenly balanced as possible. See diagram 3.
6. The number directly above the pencil in the center is your balance point. Record the balance point in your science journal.
7. Being careful not to move the ruler from its balance point, replace one of the candles in its metal container.
8. Slowly fill the empty metal container with water.
9. Which is heavier—the wax or an equal volume of water?
10. Predict whether or not the wax will float in water.
11. Fill a large basin with water.
12. Test your prediction by placing the candle in the basin of water. Record your observations in your science journal.
13. Remove the water and candle from the metal containers.
14. Fill one metal container with clay.
15. Reset your ruler on the balance point.
16. Slowly fill the empty container with water.
17. Which is heavier—the clay or an equal volume of water?
18. Predict whether or not the clay will float in water.
19. Test your prediction by placing the clay in the basin of water. Record your observations.

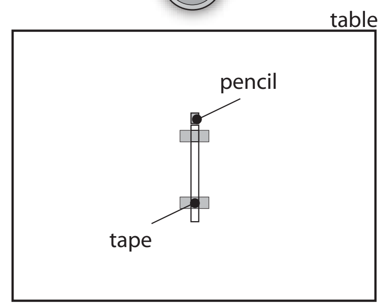


Diagram 1

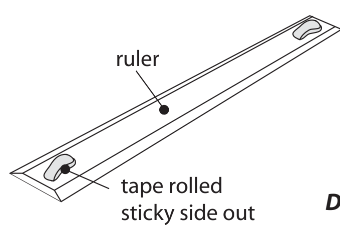


Diagram 2

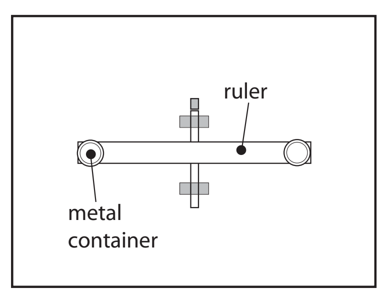


Diagram 3

Going Up or Going Down?

Segment 1

Conclusion

1. Did the wax float? The clay? Why or why not?
2. What do you think would happen if you changed the shape of the wax or clay?
3. What do you think would happen if you used saltwater instead of freshwater?
4. Why did you have to have an equal amount of water to compare the weights?

Extension

1. Test other items to see if they will float in water. Try changing the shape of some items if possible. Did it make a difference? Add salt to the water. Repeat the activity with saltwater. Does it change the result?
2. Fill 2 clear cups with water. Add salt to one cup until it will no longer dissolve. Label the cups "saltwater" and "freshwater." Have an adult cut a carrot into slices. Place a carrot slice in each cup. What did you observe? Why do you think it happened? What does this experiment tell you about the density of fresh- and saltwater? About the buoyancy of a carrot?
3. Compare other liquids such as vegetable oil, water, and corn syrup. Which liquid is the heaviest? Place equal amounts of the three liquids in a glass jar with the liquid you think is the heaviest on the bottom and observe. Optional: Use food coloring to differentiate between the layers.

Ahoy! Container Overboard

Segment 1

Purpose

To calculate the speed of a moving object

Background

Each year, manufacturers around the world ship more than 100 million containers of cargo, each the size of a semi-truck across the world's oceans and seas. Each year more than 10,000 cargo containers fall overboard and are lost on the high seas. Storms are often to blame. Most dry containers are steel boxes that weigh between two and four tons. These containers are built to be weatherproof but not watertight. If the containers are empty, they sink quickly as the water fills the inside of the box. Most cargo containers have small openings or distortions that allow seawater to enter at a very slow rate (about 11 kg per hour). The containers will eventually become deadweight, or completely waterlogged, so they will no longer float. If the containers are full, they may float for a while. Air trapped in the cargo container may hold a container on the surface of the water until the cargo becomes waterlogged. Marine insurance companies estimate that a 7-meter container would take some 57 days to reach the waterlogged weight necessary to sink it. A 14-meter container could float for some 183 days. The speed at which the container sinks depends on the shape and content of the boxes. The formula to calculate speed is simple: Speed = Distance ÷ Time

Materials

2-liter soda bottle
scissors
metric ruler
tape
watch or clock with a second hand
peanuts in shell
tap water

Procedure

1. Remove the label from the soda bottle.
2. With the help of an adult, carefully cut the top off the soda bottle approximately 10 cm from the opening.
3. Tape a metric ruler to the outside of the bottle so that the zero is at the bottom of the bottle and the ruler is touching the table. See diagram 1.
4. Fill the bottle with water so that the water level is about 3–5 cm below the top. Try to make the water level line even with a whole number on the ruler.
5. In the chart, write your prediction for the speed at which a whole peanut will fall.
6. Remove a whole peanut from the shell and place it on the surface of the water.
7. Use a stopwatch or clock with a second hand to time the peanut as it sinks. Record the time in the chart.
8. Measure the distance that the peanut fell and record the distance in the chart.
9. Use the formula and calculate the speed. Remember that the speed of the peanut = distance the peanut sinks ÷ the time it took the peanut to sink to that distance.
10. Repeat this experiment at least two more times and find the average speed for a whole peanut.
11. Predict whether a half-peanut will sink faster or slower than a whole peanut and record your prediction in the chart.
12. Remove a second peanut from the shell and split the peanut into two halves.
13. Place the half-peanut on the surface of the water.
14. Repeat steps 7–10.
15. Predict what you think the speed might be for 1/4 of a peanut.
16. Repeat steps 6–10.
17. Try an even smaller piece and calculate its speed.

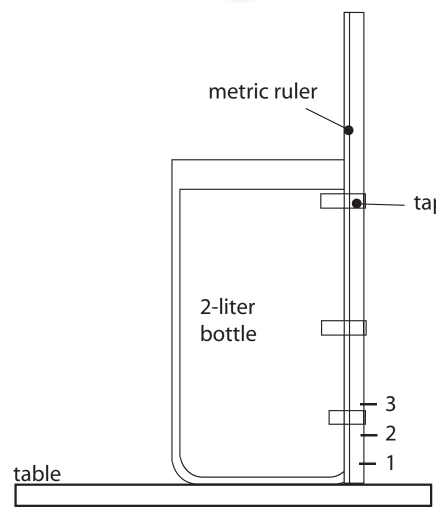


Diagram 1

Ahoy! Container Overboard

Segment 1

Chart

Peanut	Prediction	Distance	Time	Speed	Average speed
Whole					
Trial 1					
Trial 2					
Trial 3					
Half					
Trial 1					
Trial 2					
Trial 3					
1/4					
Trial 1					
Trial 2					
Trial 3					
Other					
Trial 1					
Trial 2					
Trial 3					

Conclusion

1. What is deadweight?
2. Why would cargo managers calculate the speed of a sinking object?
3. Based on the calculations you made, do you think a larger cargo box or a smaller cargo box would float longer?
4. What other factors might affect the speed at which the cargo box sinks?

Extension

Find out more about lost cargo containers and the insurance companies who must pay for them. The news of containers lost overboard is seldom publicized. Concern over dangers of lost containers to smaller craft and passenger ships has led the International Marine Organization to call for mandatory reporting of all cargo losses within a specific amount of time. Because most lost containers will eventually sink, are they a safety issue? Consider this issue from the perspectives of different people involved in the cargo transportation business. Would the cargo company view the loss of the container the same way that the company who sent it or should receive it would? Choose a role and decide what your reaction to the loss would be. Present the different points of view to a mock committee of the International Marine Organization.

Suggested roles: ship owner, exporter, importer, insurer, cruise ship captain, commercial fisherman, or pleasure boat owner

Tidying Up the Tides

Segment 1

Purpose

To read and interpret tide tables

Background

Ocean tides are affected most by the pull of the Moon on Earth. The Moon's gravity pulls the ocean water towards it, causing a bulge on each side of the Earth. These bulges are where the high tides occur, and the areas without the bulges are where the low tides occur. Most coastal areas on Earth experience two high and two low tides each day. However, some areas, such as the Gulf of Mexico, only experience one high and one low tide per day. Tide researchers gather tide data and can even predict future tides. Knowing when high and low tides will occur in an area is extremely important to the people who live along the coast and to ocean going vessels that have to navigate through the waters.

Materials

Tide Table, page 25
Tide Graph, page 26
pencil
highlighter

Procedure

1. Use the Tide Table to plot a graph of tide data.
2. Choose a date in July 2004.
3. Highlight the date you chose on the worksheet.
4. Copy the data from this date onto the top of your Tide Graph worksheet.
5. Plot the data onto the graph.
6. Connect the points (coordinates).
7. Find the range of tides for July 2004 by taking the highest tide and subtracting the lowest tide. Record your answer on the worksheet.
8. Find the mean of tides by taking all the tide values in feet and adding them together. Divide the answer by the number of tides. Record your answer.
9. Find the median of tides by sorting the tides in ascending order. If the list is odd, the middle number is the median. If the list is even, add the 2 middle numbers together and divide by 2. Record your answer.
10. Find the mode by looking to see the most frequently occurring tide value. Record your answer.

Conclusion

1. What was the highest tide value? The lowest?
2. What did your graph look like after you connected the points (coordinates)?
3. What do the range, mean, median, and mode tell you about the tides for July 2004 in Wallops Island, Virginia?
4. Why would a Navy aircraft carrier be concerned with the tides in an area it travels through?

Extensions

1. Use the Internet to find a tide table for Wallops Island, Virginia for a different month. Find the range, mean, median, and mode of the tides for that month. Compare the data to the data from July 2004. Is there a difference? Why or why not?
2. In areas where there is a large difference between the water level of high and low tides, tides can be used to generate electricity. Research how tidal energy is being tapped and create a report by using posters, PowerPoint, or other forms of media to explain the process and its benefits and drawbacks. Be sure to include whether tapping tidal energy is beneficial or harmful to the environment.

Tidying Up the Tides

Tide Table

*Next Day – The tide appeared early the next morning; there will only be 3 tides for that date

Tide Table - Wallops Island, Virginia 2004

Date	1st *Tide AM*	Feet	2nd *Tide AM* (except when noted)	Feet	3rd *Tide PM*	Feet	4th *Tide PM*	Feet
1	1:08	-0.1	6:54	3.3	12:57	-0.3	7:29	5.0
2	2:03	-0.2	7:50	3.4	1:52	-0.4	8:24	5.1
3	2:56	-0.3	8:45	3.4	2:46	-0.4	9:19	5.0
4	3:48	-0.3	9:40	3.5	3:41	-0.3	10:12	4.8
5	4:40	-0.2	10:35	3.5	4:37	-0.3	11:04	4.5
6	5:32	-0.1	11:29	3.5	5:35	-0.1	11:54	4.1
7	6:23	0.0	12:23 PM	3.4	6:35	0.1	*Next day*	
8	12:45	3.7	7:13	0.1	1:20	3.4	7:36	0.3
9	1:38	3.4	8:01	0.1	2:19	3.4	8:38	0.3
10	2:33	3.0	8:49	0.2	3:18	3.5	9:40	0.5
11	3:29	2.8	9:36	0.3	4:12	3.6	10:42	0.5
12	4:23	2.7	10:23	0.3	5:02	3.7	11:39	0.5
13	5:13	2.7	11:11	0.3	5:48	3.8	*Next day*	
14	12:27	0.4	5:59	2.7	11:57	0.3	6:31	3.9
15	1:09	0.4	6:43	2.8	12:42	0.2	7:14	4.1
16	1:47	0.3	7:27	2.9	1:25	0.2	7:56	4.1
17	2:24	0.3	8:09	3.0	2:06	0.1	8:37	4.2
18	3:01	0.3	8:51	3.1	2:46	0.1	9:17	4.2
19	3:38	0.3	9:33	3.2	3:27	0.1	9:57	4.2
20	4:16	0.3	10:14	3.3	4:10	0.2	10:35	4.1
21	4:55	0.3	10:56	3.4	4:55	0.3	11:14	4.0
22	5:35	0.3	11:39	3.5	5:45	0.3	11:56	3.8
23	6:17	0.3	12:26	3.6	6:40	0.4	*Next day*	
24	12:41	3.6	7:03	0.2	1:18	3.8	7:38	0.4
25	1:34	3.4	7:52	0.2	2:16	3.9	8:41	0.4
26	2:33	3.2	8:45	0.1	3:18	4.1	9:46	0.3
27	3:36	3.1	9:42	0.1	4:21	4.4	10:52	0.3
28	4:39	3.1	10:43	0.0	5:22	4.6	11:56	0.1
29	5:40	3.2	11:44	-0.1	6:20	4.8	*Next day*	
30	12:55	0.0	6:38	3.3	12:43	-0.3	7:16	4.9
31	1:49	-0.1	7:34	3.5	1:40	-0.3	8:10	4.9

Range = highest tide – lowest tide = ________________

Mean = all tide values in feet/the number of tides = _________________

Median = sort the tide values in feet in ascending order; if the list is odd, the middle number is the median; if the list is even, add the 2 middle numbers together and divide by 2 = _________________

Mode = the most frequently occurring tide value in feet = _______________

Tidying Up the Tides

Tide Graph

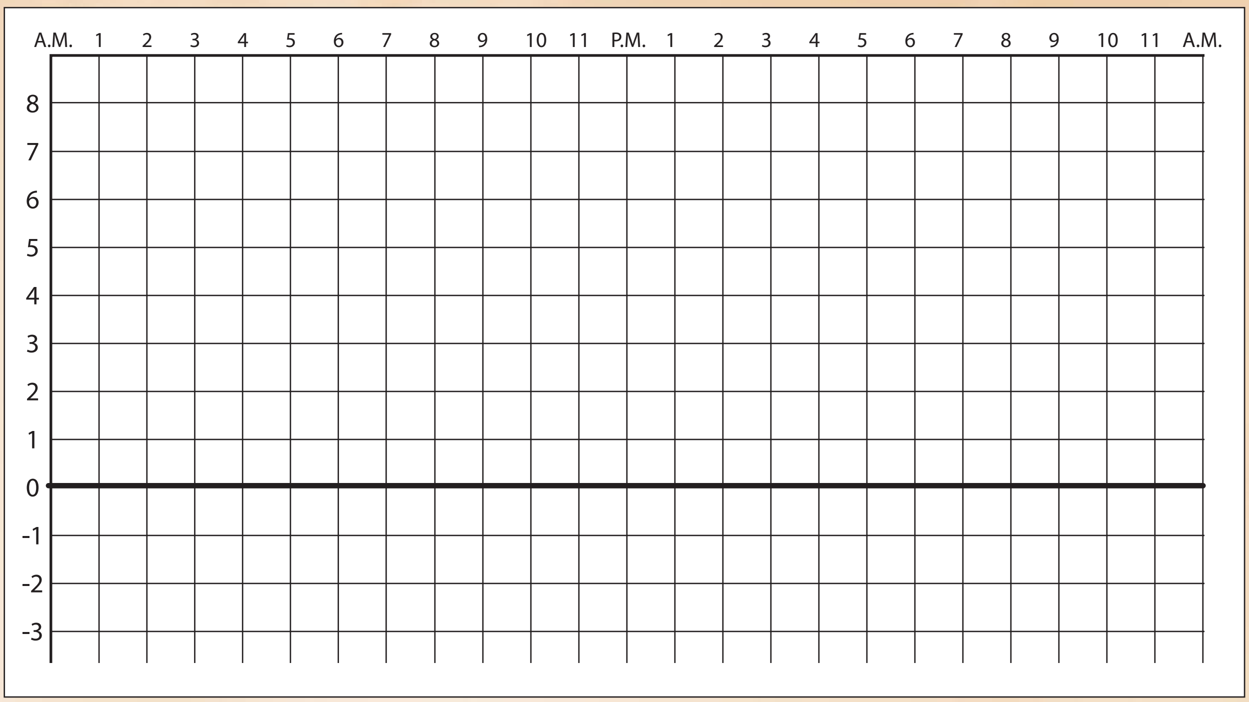
____
month *day* *year*

First Tide **Feet** **Second Tide** **Feet** **Third Tide** **Feet** **Last Tide** **Feet**

____

TIME

12 .... **A.M.** .... **12** .... **A.M.** **12**
(noon)



Wave on Wave

Segment 1

Purpose

To demonstrate the circular movement of waves

Background

Waves are movements in which water alternately rises and falls. When you watch a wave, it looks like the water moves forward, but it doesn't. The water actually stays in about the same place. An object floating on the water will rise and fall as a wave passes, but the object will not move forward. Each particle of water in a wave moves around in a circle. Energy moves forward while water particles remain in the same place.

Materials

clear drinking glass
deeper clear glass jar
clear carbonated soda or seltzer water
4–5 raisins
science journal

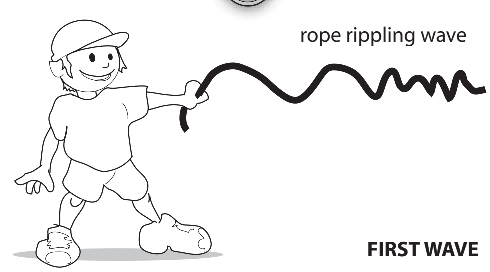
First Wave

To demonstrate how waves transfer energy but not water particles hold a 2-meter rope in your hand and flip your wrist to start a wave moving down the length of the rope. Notice that the wave moves across the entire length of the rope, but note that the rope did not move any distance. It is still in your hand.

Second Wave

To demonstrate how water particles move in a circular motion, try the following experiment.

NOTE: *The energy that causes waves is called a disturbing force. Wind blowing across the ocean's surface provides the disturbing force for wind waves. Other forces, such as gravitational pull, change because of atmospheric pressure, or earthquakes may also cause waves of different sizes. In the following activity, the disturbing force is created by the release of carbon dioxide gas bubbles. The bubbles collect around the raisin, acting like tiny balloons to raise it to the surface. As the bubbles reach the surface and are released into the air, the raisins once again fall to the bottom of the glass.*



FIRST WAVE

Procedure

1. Pour the carbonated soda into the clear drinking glass.
2. Put the raisins in the glass.
3. Observe the motion of the raisins as they rise, spin, and fall to the bottom of the glass.
4. In your science journal, record your observations and draw a diagram of the raisins by using arrows to show direction.
5. Repeat steps 1–4 using a deeper glass jar.
6. Compare the movement of the raisins in the two containers.

Conclusion

1. What kind of movement can you observe in this activity?
2. How is this movement like the movement of the waves in the ocean?
3. What can the tree house detectives learn from this activity?

Extension

Fill a clear plastic storage box or a glass baking dish with water. Float a cork or other object in the center of the container. Along the sides and bottom of the container, use masking tape to mark the approximate location of the cork. Use a spoon to gently make waves in the container and observe what happens to the cork. Did the cork move to the edge of the container? Explain why or why not.

Answer Key

Segment 1

Boats Afloat

1. Answers will vary.
2. Answers will vary.
3. Answers will vary.
4. More objects should be able to float.

Going Up or Going Down?

1. The wax should float because it is lighter than the water. The clay should sink because it is heavier than the water.
2. Answers will vary.
3. More objects should be able to float.
4. To compare density, the objects must be of equal quantity.

Ahoy! Container Overboard

1. Deadweight is anything that is completely waterlogged and can no longer float.
2. Cargo managers calculate the speed of a sinking object to decide whether or not they should retrieve the lost cargo.
3. Answers will vary.
4. Answers will vary.

Tidying Up the Tides

1. The highest tide value is 5.1. The lowest tide value is –0.4.
2. The graph should have resembled a wave.
3. The range, mean, median, and mode can tell you about the changes in the tide during a month.
4. Answers will vary.

Wave on Wave

1. The raisins move in a circular motion. They move up and then sink back down.
2. Water in waves moves in a circular motion.
3. The tree house detectives can learn that waves did not bring the tennis shoes to the beach.

On the Web

Dancing with the Tides

1. Low tide is in a line with the Earth, perpendicular to the bulge line.
2. The Earth's gravity prevents the bulging water from escaping into space.
3. The tidal bulges are a result of the Moon's gravitational pull and the Earth's rotation.