



Schooner Adventure

Water and Energy

Keeping Things Afloat: Investigating Sinking and Floating

I. Why Do Things Float?

What Sinks, What Floats?

- Predict and test whether various objects placed in water will sink or float

Moving Waterlines

- Observe the waterlines on floating objects as weight is increased
- Observe and measure the displacement of water

A Naked Scientist Discovered How Things Float.

- Demonstrate Archimedes' Principle: volume of water as heavy as an object must be displaced for the object to float.

Buoyancy

- Observe that water gives an upward push

II. What Factors Affect Floating?

Same Size, Same Shape

- Test the buoyancy of objects made of different materials but having the same shape and size.

Different Size, Same Shape

- Investigate whether objects of the same material and shape but of different sizes float or sink

Same Size, Different Shape

- Discover that by changing the shape of an object they can change its buoyancy

Floating Metal

- Determine what factors contribute to the ability of a metal object to float

Bubbles and Buoyancy

- Compare the buoyancy of an object submerged in plain water with its buoyancy in bubbling water

Fresh and Salty

- Experiment with floating an object in two different liquids, fresh water and salt water

Density is the factor

- Compare changing mass and keeping volume constant with changing volume and keeping mass constant

III. Keeping Boats Afloat

Loading a Boat

- Compare the capacities of different boats

Boats of All Shapes

- Formulate hypotheses about how to maximize a boat's capacity
- Design boats of different shapes and determine their capacities

Boats of All Sizes

- Predict how size affects capacity
- Create boats of different sizes but of the same shape and material.

Boats of Different Materials

- Compare the weight capacities of clay and foam boats of the same inside size and outside shape

Keeping Things Afloat: Investigating Sinking and Floating

Learning Goals

- Students will make predictions and carry out experiments to test their predictions.
- Students will identify important properties that may affect an object's ability to sink or float.
- Students will design specific experiments to determine the effect of changing the mass or volume of an object on that object's ability to float or sink.
- Students will come to their own working definition and mathematical relationship for why an object floats or sinks
- Students will be introduced to the concept of buoyancy and density.

Background Information

I. Why Do Things Float?

- A. Objects sink or float due to mass and volume*
- B. Greek mathematician Archimedes discovered displacement = volume of water as heavy as an object must be displaced for the object to float.*
- C. Buoyancy = water's upward push*

II. What Factors Affect Floating?

- A. Size*
- B. Shape*
- C. Bubbles in water*
- D. Non-buoyant objects can be made to float*
- E. Different liquids have different degrees of buoyancy*
- F. Density of an object and the liquid are factors in ability to float*

III. Keeping Boats Afloat

- A. capacities of boats vary due to:*
 - 1. Shape*
 - 2. Size*
 - 3. Construction materials*

I. Why Do Things Float?

What Sinks, What Floats?

Objectives:

- Predict and test whether various objects placed in water will sink or float
- Introduce the concept of buoyancy
- Practice categorizing a variety of objects according to observable characteristics.

Materials:

- large tub of water about 1/2 full for the teacher demonstration
- bucket, or bowl of water about 1/2 full for each group
- different items for each group that are made of a variety of different materials, such as: wood, metal, plastic, aluminum foil, apples, oranges, plastic bottles, toy blocks, paper, bathtub toys, plastic forks, rubber balls, soda-bottle caps, pencils, erasers, sponges
- What Sinks, What Floats? chart

Procedure:

1. Enter item in column 1.
2. Predict whether it will sink or float and record prediction in column 2.
3. Place the item in the water and observe what happens.
4. Record their results in column 3.
5. Repeat the procedure and record the results in column 4.
6. Place the items that sank in one pile and the items that floated in another pile.

Inquiry Discussion:

1. How many of your predictions were correct?
2. Did your predictions get better, worse, or stay the same?
3. Look at the pile of objects that sank. Describe them. Do they have anything in common with one another?
4. Look at the pile of objects that floated. Describe them. Do they have anything in common with one another?

(Compare the results for each group. Did everybody get the same results? If any of the results were different, ask students to replicate their trial.)

Further Inquiry:

1. Does it matter how deep the water is?
2. Does it matter how much water there is?

Have the students suggest different things to try and give them an opportunity to test their ideas.

Name _____

What Sinks, What Floats?

Guess whether each object will sink or float when you put it in water. Circle your guess. Put the object in the water. Circle **float** or **sink** to show what happens. Put the object in the water again. Circle **float** or **sink** to show what happens the second time.

OBJECT	PREDICTION	1st TRY	2nd TRY
	float sink	float sink	float sink
	float sink	float sink	float sink
	float sink	float sink	float sink
	float sink	float sink	float sink
	float sink	float sink	float sink
	float sink	float sink	float sink
	float sink	float sink	float sink

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I. Why Do Things Float?

Moving Waterlines

Objectives:

- Observe the waterlines on floating objects as weight is increased
- Observe the displacement of water

Materials:

- Styrofoam bowl “boats”
- clear container of water
- pennies

Procedure

1. Mark the level of water on side of container
2. Set the Styrofoam bowl “boats”, open side up, on the surface of the water.
3. How much of the boat is above the surface of the water?
4. Did the water level change?
5. Add coins in the boat one at a time. Make an effort to distribute the coins evenly in the bottom of the boat.
6. How much of the boat is above the surface after adding each penny?
7. What happened to the water level?
8. Continue to add coins until the boat sinks.

Inquiry Discussion:

1. What relationship do you see between the water levels and the amount of pennies in the boat?
2. Why do you think the water level changes?

Sum It Up!

Before any coins are added, the boat floats with most of the boat above the water line. With each addition of a coin, the boat sinks lower into the water. When the weight of the boat becomes more than the weight of the water the boat can displace, the boat sinks.

I. Why Do Things Float?

More Moving Waterlines

Objective:

- Observe and measure the displacement of water as objects are put in

Materials:

- clear cups
- water
- markers
- objects
- rulers

Procedure:

1. Give pairs of students a clear cup of water and small items that sink or float. Remind them that when an object is placed in water, the level will rise.
2. Have them predict how much they think the water will rise for each item. Students should mark the original water level and draw their predictions on the side of the cup. They can use different colors of marker to distinguish their own predictions.
3. Then have them drop different items into the cup, make observations, and record their data. Encourage them to measure with a ruler to see how much the water rose.

Inquiry Discussion:

1. What is the relationship between the object submerged and the amount of water displaced?
2. Does this relationship ever change?

I. Why Do Things Float?

A Naked Scientist Discovered How Things Float.

Objective:

- Demonstrate Archimedes' Principle: volume of water as heavy as the object must be displaced for the object to float.

Materials:

- Archimede's story
- container filled to top with water
- larger empty conatiner
- objects to submerge
- scale (if available)

Procedure:

1. Read story of Archimedes' discovery

Older Version:

The Greek mathematician Archimedes was getting into a tub for a bath when he observed that the water spilled over the sides. He realized that there was a relationship between his weight and the amount of water displaced (pushed aside). He realized that the amount of water displaced (pushed aside) by his body was equal to the volume of his body. While floating in the tub, he also realized that all objects "lose" weight when placed in water. Furthermore, the amount of weight an object apparently loses when placed in water is equal to the weight of the water the object displaces. He was so excited that it is said he ran naked through the streets yelling "Eureka!" His joy was because he had discovered a means of determining the densities of things based on their weight and weight loss in water. This technique was needed to determine whether the king's crown was made of pure gold. Archimedes discovered that the crown was not made of pure gold but was a mixture of gold and silver.

Archimedes experimented further and described what is now called Archimedes' Principle: a volume of water as heavy as a particular object must be displaced for the object to float.

Younger Version:

Mr. Archimedes' Bath by Pamela Allen

2. Place filled container in empty container
3. Carefully drop one object in the water.
4. Observe how much water overflowed.
5. If scale is available – measure and compare weight of displaced water with weight of object.
6. Replace water and repeat with various objects.

I. Why Do Things Float?

Buoyancy

Objective:

- Observe that water gives an upward push

Materials:

- clear glass
- piece of foam
- container of water

Procedure:

1. Put foam against opening of upside-down glass
2. Try keeping foam attached while holding in air
3. What do you need to keep the foam in place?
4. While holding foam in place, force glass down in water, then let go.

Inquiry Discussion:

1. What happened to foam piece?
2. What is keeping the foam in its place?

Sum It up:

Water gives an upward push which is holding the foam in place when under water. This push is called buoyancy.

II. What Factors Affect Floating?

Same Size, Same Shape

Objective:

- Test the buoyancy of objects made of different materials but having the same shape and size
- infer that the type of material an object is made of is one of the factors that determine whether it will sink or float
- begin listing on a class chart the factors that determine whether an object will sink or float

Materials:

- tub of water
- different types of objects same size and shape (wood, foam, Styrofoam, clay)

Procedure:

1. Students experiment to determine whether the type of material of which an object is made affects its buoyancy in water.
2. What types of material float?
3. As a class, begin to list of the factors that influence buoyancy.

Inquiry Discussion:

1. How does the type of material affect buoyancy?

Different Size, Same Shape

Objective:

- Investigate whether objects of the same material and shape but of different sizes float or sink
- observe that size does not affect the buoyancy of an object
- confirm the importance of material as a factor affecting an object's buoyancy

Materials:

- tub of water
- cubes of the same shape and the same material (wood, foam, Styrofoam, clay) but of different sizes

Procedure:

1. Students compare cubes of the same shape and the same material but of different sizes.

Inquiry Discussion:

1. How does size affect the buoyancy of an object?

II. What Factors Affect Floating?

Same Size, Different Shape

Objective:

- Discover that by changing the shape of an object they can change its buoyancy

Materials:

- tub of water
- modeling clay

Procedure:

1. Weigh out equal amounts of clay and mold them into various shapes that will float in water
2. Does changing the shape of an object change its buoyancy?
3. What shapes floated, What shapes sank?

Inquiry Discussion:

1. How does shape affect buoyancy?

Floating Metal

Objective:

- experiment with a metal object to see if they can make it float
- determine what factors contribute to the ability of a metal object to float

Materials:

- tub of water
- paper clips

Procedure:

1. Carefully position a paper clip flat on the surface of water so it floats, supported by the water's surface tension.

Inquiry Discussion:

1. What positions worked best for floating?

II. What Factors Affect Floating?

Bubbles and Buoyancy

Objective:

- Compare the buoyancy of an object submerged in plain water with its buoyancy in bubbling water

Materials:

- tub of water
- tub of soda (carbonated) water
- balls of clay

Procedure:

1. What differences do you see between the 2 tubs of water? Observe bubbles rising to the surface of carbonated water
2. Do things float differently in the different types of water?
3. What happens to the balls of clay when dropped in the tubs? Observe that the balls of clay sink to the bottom in both but that gas bubbles in the carbonated water eventually adhere to the clay balls and lift them to the surface.

Inquiry Discussion:

1. How do bubbles in the water increase buoyancy?

Fresh and Salty

Objective:

- experiment with floating an object in two different liquids, fresh water and salt water
- observe that the buoyancy of an object is different in different liquids
- Students learn that different liquids have different degrees of buoyancy and that salt water exerts more buoyant force on an object than does plain water.

Materials:

- salt
- water
- 2 clear glasses
- egg

Procedure:

4. Fill glasses with water
5. Put 2 T of salt in one glass, stir until dissolved
6. Put egg in plain water. What happens?
7. Put egg in salt water. What happens?

Inquiry Discussion:

1. What are the constants and variables?
2. Which liquid has more density?
3. How does liquid density affect buoyancy?

II. What Factors Affect Floating?

Dense Liquids

Objective:

- identify that object density can affect buoyancy

Materials Needed

- clear cups
- one cup of colored water
- one cup of light corn syrup
- one cup of cooking oil (like vegetable oil or corn oil)
- food coloring (to be added to water)
- nickel
- grapes
- Lego(tm) piece
- one large clear container

Procedure:

1. Predict if grape will sink or float in syrup? in water? in oil?
2. Drop one grape into the cup of water, one grape into the cup of corn syrup, and one grape into the cup of cooking oil.
3. In which liquid does the grape float and in which does it sink?
4. Next, try dropping a Lego(tm) piece and a nickel. Will they float on the syrup, will they float on the water, or will they float on the oil? Or will they just sink?
5. Then, combine the cups of syrup, water and oil into the large clear container. What happens?

Inquiry Discussion:

1. What difference in density exists among the different liquids?
2. How can you tell?

Summing it Up.

Density is one of the things that makes things float. The three liquids float on top of one another because they have different densities. The syrup is the densest. The oil is the least dense. The water's density is in between the syrup and oil.

All three liquids take up the same amount of space in the container. But the denser one, the syrup, is heavier. That's why the water floats on the syrup. The oil is less heavy than the water. That's why the oil floats on the water.

II. What Factors Affect Floating?

Sinking Soda

Objective:

- identify that object density can affect buoyancy

Materials:

- cans of regular soda and diet soda
- large bowl or tank of water

Procedure:

1. Have students predict which will sink and float. Have students explain their predictions.
2. Then drop both cans in a large bowl or tank of water.
3. What happens?
4. Why?

Inquiry Discussion:

1. Which liquid is denser?
2. How did this affect its buoyancy?

II. What Factors Affect Floating?

Density is the Factor

Objective:

- Compare changing mass and keeping volume constant with changing volume and keeping mass constant

Materials:

- tub of water
- film canisters
- pennies
- scale if available

Procedure:

Change mass and keep volume constant—

1. Using one canister, start with zero pennies in it and see if it floats.
2. Add one penny to the inside of the canister each time, thereby increasing the mass of the system while leaving the volume constant. (measure increasing mass on scale)
3. How many pennies did you need to sink the canister? (answer: about 12-14).

Change volume and keep mass constant—

1. Using a set number of pennies that would sink one film canister, attach a second canister to the first to increase the volume but keep the mass the same. Tips: To attach two canisters together, take the lid off of the second one and force the bottom of the first canister into the mouth of the second.
2. *If available, have students use a balance to figure out how much mass they are adding with the second canister (about 1 penny-worth) and then remove pennies to accommodate the mass of the canister.
3. How many canisters did you add to the volume to get the pennies to float?

Inquiry:

1. After they have completed both experiments, predict how many film canisters they would need to use to float 50 pennies. After making a prediction, they test it by performing the experiment

III. Keeping Boats Afloat

Loading a Boat

Objective:

- Compare the capacities of different boats

Materials:

- tub of water
- clay
- pennies

Procedure:

1. Make clay boats and load them with various weights
2. What is the maximum amount of cargo their boats can hold?
3. Compare the capacities of different teams' boats – What differences allowed for different capacities?

Inquiry Discussion:

1. What factors will work best for larger capacities? Why?

Sink the Ship

Objective:

- Observe factors that can sink a boat

Materials:

- tub of water
- toy boat

Procedure:

1. Float a toy boat in a clear tub filled with water.
2. Have students find ways to sink the ship in the tank.
3. Waterlog the ship by tipping it over and filling it with water.
4. Why does the boat sink when it tips over?

Inquiry Discussion:

1. What factors will cause a boat to sink? Why?

Sum It Up:

Explain that air inside the ship helps the boat float, but when it tips over, the air escapes. Thus, the boat sinks.

III. Keeping Boats Afloat

Boats of All Shapes

Objective:

- Formulate hypotheses about how to maximize a boat's capacity
- Design boats of different shapes and determine their capacities

Materials:

- tub of water

Procedure:

1. Formulate hypotheses about how to maximize a boat's capacity
2. Design boats of different shapes and determine their capacities
3. Start a Good Boat chart that lists the factors that determine what makes a good boat
4. Determine what makes a "good boat"—that is, a boat that will carry the maximum cargo without sinking.
5. They construct clay boats of different shapes and load them to their maximum capacities. In doing so, students discover which aspects of boat design are most critical.

Inquiry Discussion:

1. Which shape works best? Why?

Boats of All Sizes

Objective:

- Predict how size affects capacity
- Create boats of different sizes but of the same shape and material

Materials:

- tub of water

Procedure:

1. predict how size affects capacity
2. create boats of different sizes but of the same shape and material
3. conclude that the larger the boat, the larger its capacity
4. add *large size* to the Good Boat chart as a factor affecting capacity
5. Students compare the capacities of boats of different sizes. They use the same material (clay) and a standard shape, but this time each team creates three boats of increasing sizes and tests them with various weights of cargo. Students conclude that the larger the boat, the greater its weight capacity.

Inquiry Discussion:

1. Is there a size that works best?

III. Keeping Boats Afloat

Boats of Different Materials

Objective:

- Compare the weight capacities of clay and foam boats of the same inside size and outside shape
- Students determine the effect of the type of material on the capacity of a boat.

Materials:

- tub of water
- modeling clay
- Styrofoam cups
- scissors

Procedure:

1. construct a clay boat of the same inside size as a foam-cup boat
2. compare the weight capacities of clay and foam boats of the same inside size and outside shape
3. conclude that a boat should be made of a buoyant material if it is to carry the maximum cargo for its size and shape.
4. add *buoyant material* to the Good Boat chart as a factor affecting capacity

Inquiry Discussion:

1. Is there a material that works best?

Boat Float

Objective:

- experiment with different types of construction material to create the best boat

Materials:

- various building materials and tools

Procedure:

1. Have your child make boats out of different materials, such as toothpicks, cork, paper, craft sticks, fabric, and clay.
2. Have him or her make predictions about which boat will sink or float and write them down.
3. Then have him or her try out their boats in a tub.
4. Which boat floats?
5. Which boat sinks?
6. Encourage your child to explain what happened.
7. Then have him or her think of ways to make a sinking boat float and vice versa.
8. Allow your child to experiment using different shapes and adding weight to the boats.

III. Keeping Boats Afloat

A Cargo Contest

Objectives:

- construct their boats with maximum capacity as their goal, within a size limit

Materials:

- wide selection of boat-building materials

Procedure:

1. design and make boats out of any materials they choose
2. compare their boats in terms of weight capacity
3. make drawings of their “ideal” boats
4. compare their boats and discuss the qualities that distinguish the boats that can carry the most cargo.

**INQUIRY BASED SCIENCE
WATER & ENERGY: SINKING AND FLOATING**

Grades PreK–2

- Ask questions about objects, organisms, and events in the environment.
- Tell about *why and what would happen if?*
- Make predictions based on observed patterns.
- Name and use simple equipment and tools (e.g., rulers, meter sticks, thermometers, hand lenses, and balances) to gather data and extend the senses.
- Record observations and data with pictures, numbers, or written statements.
- Discuss observations with others.

Grades 3–5

- Ask questions and make predictions that can be tested.
- Select and use appropriate tools and technology (e.g., calculators, computers, balances, scales, meter sticks, graduated cylinders) in order to extend observations.
- Keep accurate records while conducting simple investigations or experiments.
- Conduct multiple trials to test a prediction. Compare the result of an investigation or experiment with the prediction.
- Recognize simple patterns in data and use data to create a reasonable explanation for the results of an investigation or experiment.
- Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

Grades 6–8

- Formulate a testable hypothesis.
- Design and conduct an experiment specifying variables to be changed, controlled, and measured.
- Select appropriate tools and technology (e.g., calculators, computers, thermometers, meter sticks, balances, graduated cylinders, and microscopes), and make quantitative observations.
- Present and explain data and findings using multiple representations, including tables, graphs, mathematical and physical models, and demonstrations.
- Draw conclusions based on data or evidence presented in tables or graphs, and make inferences based on patterns or trends in the data.
- Communicate procedures and results using appropriate science and technology terminology.
- Offer explanations of procedures, and critique and revise them.

Massachusetts Frameworks Covered

STRAND: PHYSICAL SCIENCES (CHEMISTRY)

Broad Topic	Content of Each Learning Standard		
	PreK–2	Grades 3–5	Grades 6–8
Properties of Materials and Matter	1. Observable properties of objects include size, shape, color, weight, and texture.	1. Properties of objects and materials.	2. Volume and mass are distinct components of density. 3. Appropriate tools and use of significant digits are needed to measure volume and mass. 4. Mass is conserved in a closed system.
Forms of Energy		4. Basic forms of energy, which cause motion or create change. 5. Energy can be transferred from one form to another.	13. Kinetic energy is transformed into potential energy & vice versa. 14. Temperature change results from adding or taking away heat energy from a system. 16. Heat moves in predictable ways, from warmer to cooler objects until reaching equilibrium.

STRAND: TECHNOLOGY/ENGINEERING

Broad Topic	Content of Each Learning Standard		
	PreK–2	Grades 3–5	Grades 6–8
Transportation			6.1 Transportation systems and devices that operate on or in land, air, water, and space. 6.2 Possible solutions to transportation problems, using the universal systems model.