ELEMENTARY SCIENCE PROGRAM
MATH, SCIENCE & TECHNOLOGY EDUCATION

A Collection of Learning Experiences

BUOYANCY

Updated 6/09

CATTARAUGUS-ALLEGANY BOCES GRADE 3

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BUOYANCY

GRADE 3

Unit Overview

This unit provides students with the opportunity to observe the phenomena of buoyancy. Students will engage in inquiry about why some things sink and some things float. Students will explore properties of materials. Students will plan and construct their own floating containers from clay and compare it to containers already constructed. Students will experiment with their boats and the concept of displacement. Students will also measure the buoyant force in water using fishing bobbers and a rubber band scale that they construct out of K'nex. The science skills emphasized in Buoyancy are collecting data, manipulating, observing and predicting.

Videotapes are included with this kit. Please preview these videos before showing to students. VM 8552 provides an overview for the teacher of a class doing inquiry–based buoyancy tasks. VM 8361 contains 4 modules. Module 1 is on the general topic of Sink and Float. Module 2 is on Displacement. Module 3 is on Boat Shapes. Module 4 is titled What Goes Down Should Come Up.

Scheduling

This unit may take from five to nine weeks to complete depending upon the goals of the teacher and interests of the students. Use of the section included in this manual called More Ideas may extend the time span of this kit.

Materials to be obtained locally: Please make **one** student activity book for **each** student.

- paper towels
- folders
- water
- chart paper
- felt–tip markers
- notebooks
- reference materials (books, magazines)
- metric ruler

Additional objects or materials may be used to extend observations in the learning experience. Salt or sugar may be added to the water to increase its density. Objects that float in pure water will now float higher in the salt or sugar water. Ziploc plastic sandwich bags may be inflated with air to increase their buoyancy in water.

Caution

Remind students to wash their hands after handling any of the materials in the kit.
Small objects should be handled with care. Do not taste any of the liquids. Use caution if liquids are spilled near electrical outlets.

About the Format

Each learning experience is numbered and titled. Under each title is the objective for the learning experience.

Each learning experience lists materials, preparations, evaluation strategy and vocabulary.

The evaluation strategy is for the teacher to use when judging the students' understanding of the learning experience.

Background Information

The learning experiences in the Buoyancy Kit are designed to help students confront some of their "understandings" through scientific inquiry. During the inquiry, it is important to focus students through discussions centered on the question: "Why does anything sink or float?" rather than a specific one of "Why does an individual object sink or float?" The focus should be on sinking versus floating. The phenomenon of buoyancy is the issue. Students often have difficulty realizing that floating can be explained in terms of the weight of the water displaced.

The focus of inquiry should be on student-generated questions or explanations in the student's own language rather than defining them in specialized scientific terms such as density, displacement, etc. These terms will become important as the student develops his or her understanding of scientific concepts. There is much agreement in science literature that an early focus on scientific terms often short circuits the development of student understanding. Specialized language is very important. It facilitates deeper understanding after one has developed ideas in their own terms. Scientific terms should be presented for labeling, consolidating and extending understanding.

The **Properties** of an object are determined by its material and condition.

Gravity affects everything on earth. This includes bodies of air and water and the things in them. Gravity pulls the air or water and the things in them toward the center of the earth. Only the solid surface beneath the air or water prevents them from being drawn farther toward the center of the earth.

In some situations, the buoyant force is able to overcome the force of gravity. The result is that those objects float. We recognize objects such as Styrofoam and wood as being able to overcome the force of gravity when you leave them in water. These materials are less dense than water. The buoyant force of the water on the materials that are less dense than water overcomes the force of gravity.

Mass is a measure of the amount of matter in an object, while the **weight** of an object is a measure of the gravitational pull on the object. Generally, a balance scale of some sort is used to measure mass, and a scale is used to measure weight. Students use a rubber band scale to measure the force of gravity on the object's mass, in Newtons, and that force is the weight of the object. Weight is the result of the effect of gravity on the mass that stretches or compresses a spring. Mass is measured by comparing the gravitational pull on a standard mass. Therefore, some sort of a balance scale is needed to measure mass. Weight will vary with gravitational force, while the mass will remain constant. Therefore, if you measure a weight on earth and then measure the weight on the moon, you would find a difference because the force of gravity is different on the moon. However, if you find the mass on earth or the moon, it will be the same.

Sink or Float: Levels of Explanation

In the past, science curriculum developers have had trouble including explanations for teachers in inquiry–based material. Teachers tend to skip or cut short the student inquiry and just pass the explanations on to students. Teachers are not to "teach" during inquiry activities but rather facilitate student inquiries.

Buoyancy refers to the lifting force that acts on an object in a fluid. If an object floats, the lifting force is greater than the force exerted on the object by gravity. A helium–filled balloon may float in the air (also a fluid) if the buoyant force is greater than the force of gravity.

Three alternative conceptualizations of why objects sink or float are presented below.

Displacement: An object floats if it displaces an amount of liquid equal to its own weight (otherwise it sinks).

In order for an object to be submerged in a liquid, the object must push aside or displace some of the liquid it is contained in. This is called displacement. The volume of an object can be determined by displacement. Let's say that 10 mL of liquid is placed in a graduated cylinder. If an object is dropped into the cylinder, the water level appears to go up, even though no more water was added to the cylinder. This is due to the fact that the object has "displaced" or pushed aside some of the liquid when it was put into the container. If the object is submerged, it will displace the object's volume. Therefore, if there was 10 mL of liquid before the object was placed in the fluid, and the measurement of the liquid in the cylinder is 14 mL after the object is placed in the fluid, then subtracting 10 mL from 14 mL would equal how much space the object took up in the cylinder. Since the definition of volume is "the amount of space taken up by an

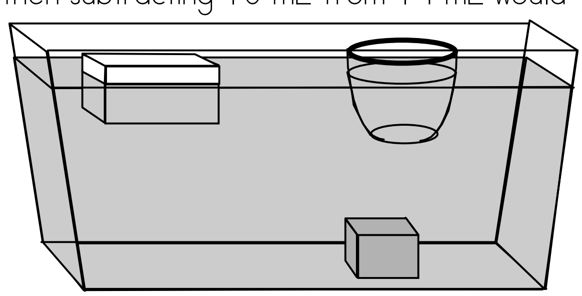


Figure 1

object," it can be concluded that the volume of the object placed in the fluid is 4 mL.

- The block of wood floats because the water *displaced* by the portion of the block in the water equals the total weight of the block.
- The metal cube sinks because the "cube" of water it *displaced* weighs less than the cube of metal.
- The empty glass cup floats because its weight is less than the weight of the water it *displaced*, that is, the water that occupied the space which the cup presently takes up in the water.

<u>Density:</u> An object floats because it is less dense than the liquid it is in.

<u>Density</u> is the measure of the "compactness" of a material. It is the ratio of mass to volume for any material. It is usually measured in grams per cubic centimeter and tells how much matter is packed into a given space. Density is not a simple comparison of the "heaviness" or lightness" of materials. It is instead, a comparison of the "heaviness" or "lightness" of the same volume (mass per unit volume).

The density of a material is determined by the masses of the atoms in the material and the amount of space between the atoms. Gases have a low density not only because the atom making up the gases have a small mass, but also because there is a large amount of space between the atoms. The heavy metals like gold, lead and uranium are very dense because the atoms they are composed of are massive and spaced closely together.

Water has a density of 1 gram per cubic centimeter (1 g/ cm^3) at 3.98 degrees Celsius, and water is the standard for comparing the density of materials. Materials with a density greater than 1 gram per cubic centimeter are denser than water and will sink; materials with a density that is less will float in water. Lead has a density of 11.3 grams per cubic centimeter (11.3 g/cm^3) that tells us it is more than 11 times as dense as water. It also means that 100 grams of lead would have 11 times less volume than 100 grams of water (atoms in lead are much more closely packed together, so they take up less space.)

The density of an object equals its mass divided by its volume ($D = M/V$)

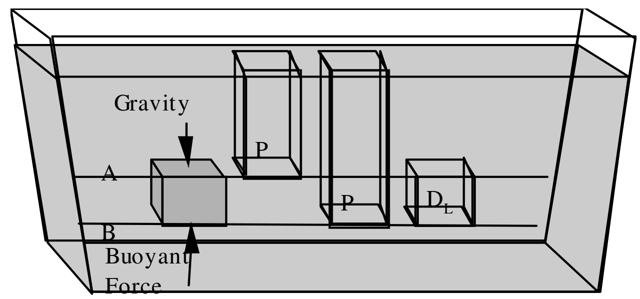
- The block of wood floats because wood is less dense than water. The mass of the volume of water displaced by the floating block of wood is equal to the total mass of the block of wood. Alternatively, the volume of water that has the same mass as the block would occupy less volume than the block of wood.
- The metal cube sinks because the metal in it is denser than water. For equal volumes of metal and water, the metal's mass is more than the mass of the water. Alternatively, for equal mass of metal and water, the water would have the greater volume.
- The glass cup containing only air floats in water if its average density is less than that of water. The density of the glass alone is greater than that of water but in

calculating the total density of the cup, its total mass is divided by the volume that includes the space inside the cup.

- Salt water vs. fresh water – salt water is denser than the fresh water because of the mass of the salt that has been dissolved in it. The greater density of salt water increases the buoyancy on objects placed in it. Liquids with a greater density have a greater internal pressure and therefore push upon objects with a greater buoyant force.

<u>Buoyant Force</u> An object floats because the buoyant force of the liquid upward on the object is equal to or greater than the pull of gravity downward on the object. An object will sink if the upward buoyant force on it is less than the downward force of gravity.

Buoyant force is the net upward force on the object due to the <u>difference</u> in pressure of the liquid at the level of the top and bottom of the object, level A and B in Figure 2. This <u>difference</u> in pressure is due to the <u>difference</u> in the weight of liquid directly above each of the two levels, P_A and P_B. That means that it is equivalent to the weight of the liquid between the two levels (D_L). This more complex explanation clarifies the two explanations above that are based on displacement and density respectively.



Fiaure 2

- If the buoyant force is the same as the weight of the liquid between the two levels, it is the same as the weight of the liquid *displaced* by the object (D_L).
- Only if the *density* of the object is greater than that of the liquid displaced (D_L), will the object weigh more than this equivalent volume of liquid and thus sink.
- As an object is lowered into the liquid, until it is completely below the surface, P_A is zero, and the buoyant force increases only as P_B increases. If the object does not float, once it is beneath the surface, P_A and P_B both change but their <u>difference</u>, the buoyant force, remains constant regardless of the depth of the object and the buoyant force is less than the force of gravity on the object.

<u>Archimedes' Principle</u>

A buoyant force is an upward force exerted on an object by a fluid in which the object is immersed. When an object is placed into a liquid, the object displaces some of the liquid. The volume of the liquid that is displaced is equal to the volume of the object. <u>The amount of buoyant force is equal to the weight of the displaced fluid</u>. Archimedes concluded that an object in a fluid is acted on by a force equal to the weight of the fluid displacing the object. This statement describes Archimedes Principle.

*In Learning Experience 7, students are using a rubber band scale to measure the weight of an object. Normally a spring scale would be used to measure weight. However, a spring scale uses the Newton as the unit in which to measure weight. Since the concept of a Newton is not a concept third graders need to be familiar with, we created a rubber band scale that students can use that is similar to a spring scale. Students are measuring the distance between the green, blue and gray connectors in centimeters to see how far the rubber band is stretching when an object is pulling on it. It should be stressed to students that centimeters is not a measurement of weight. A centimeter is a measurement of length. We are measuring (the length) of the stretch of the rubber band.

Learning Experience 1: Sink or Float

Objective: Students will use their background knowledge to make predictions about why some things sink or float.

Materials:

For the class:
Chart paper*
Felt-tip markers*
Notebooks*
Folders*

For the teacher:
Video – "Sink or Float" (15 min.)
*provided by teacher

Preparation:

The informational video "Sink or Float" (15 min.) should be viewed by the teacher before beginning the unit.

This video gives background information that may be helpful while teaching this unit. Each student should obtain a notebook and a folder with pockets to hold the activity sheets for this unit. Create a KWHL chart to post in the classroom.

Evaluation Strategy:

Students will use their background knowledge to create ideas about why some objects sink and why some objects float.

Vocabulary:

sink
float

Learning Activities:

Session 1:

Using the KWHL Strategy, students will explore their knowledge about buoyancy and then expand on it throughout the unit. Brainstorm what all the students already **know** about buoyancy. Ask students to brainstorm words or ideas that come to mind when they say "sink" or "float." Record their ideas on a class size K-W-H-L chart. Ask students what more they would like to know about concerning buoyancy and record their ideas under the **"want to know"** column. Now that the students have decided what they want to know, they need to think about **"how they are going to find out"** the answers to the questions they have. After the hands–on activities, maintaining journals and discussion, students can then record information into the **"what we learned and still want to learn"** column. This process can also be done in cooperative groups where students gather information in small groups then share their ideas with the class.

Learning Experience 2: Clay Boats

Objective: Students will design three different clay boats and test how the design relates to the amount of cargo it will hold.

Materials:

For each pair of students:
2 Buoyancy Student Activity Books
Modeling Clay
4-liter container
30 ceramic cylinders
Paper towels*
Water*

For the class:
25 ceramic cylinders
Balance stand
Pin for balance
2 baskets for balance
Balance base
Balance arm
*provided by teacher

Preparation:

The double-pan balance needs to be assembled and should be used to measure the same amount of clay for each pair of students. The amount of clay needs to be equal to 25 ceramic cylinders for each pair. Since each student uses the same amount of clay, the creation of a "fair test" for Learning Experience #3 is possible.

Use room temperature water in the 4-liter containers when trying to get the clay to float to keep it from flaking. During the discussion questions, students should explain that the shape of the clay affects its buoyancy. A ball of clay will not float. When the shape of the clay is changed into a boat, it will float. Special shape is why boats made of steel, aluminum and fiberglass float.

Evaluation Strategy:

Students will explain how the design of a boat made of clay relates to the amount of cargo it will hold.

Vocabulary:

shape	optimize	cargo
ceramic	fair test	design
cylinder	vertical	

Learning Activities:

Session 1:

As a teacher demonstration, roll a small piece of clay into a ball. Have students predict what will happen to the ball of clay when it is placed on the water. Place the ball of clay into one of the 4-liter containers. Discuss the results.

Distribute a piece of clay equal to 25 ceramic cylinders to each pair of students. Students are to mold their clay into different shapes in order to get the clay to float in their 4-liter containers filled with water.

Discussion Questions:

- How does the shape of a boat affect how much it will hold?
- Discuss which shape boat will hold the most objects.
- How does the weight of an object affect the number of objects a boat can hold without sinking?
- What did you do to make your clay float?
- Which shape(s) would float?
- Which shape(s) sank?

Students will begin to see that the clay shaped in a "boat" design is what allows the clay to float most efficiently.

Students are to complete their activity sheet for Learning Experience #2 in the Buoyancy Student Activity Book. In this activity, student pairs are to design a boat out of clay and draw a picture of the boat on the activity sheet. Students will then place their boat in water in their 4-liter container and place the ceramic cylinders inside the boat to see how many cylinders their design will hold before it sinks and record the amount on their activity sheet.

Students are to create two more boat designs out of the clay. The goal is that the boats will hold more cylinders for each attempt.

Discussion Questions:

- How can a clay boat be made to hold more ceramic cylinders?
- Students could redesign their boats according to suggestions from other students.

Activity Sheet for Learning Experience #2 Name______________________________

CLAY BOATS

In order for an object to be submerged in a liquid, the object must push aside or displace some of the liquid it is contained in. That is why the level of the water in a bathtub rises when you get in! You do not absorb, or soak up, the water you displace it, or push it away.

Draw your three best boat designs.	Mass of cargo
1.	____ # of ceramic cylinders held by the boat without sinking
2.	____ # of ceramic cylinders held by the boat without sinking
3.	____ # of ceramic cylinders held by the boat without sinking

What boat design out of the three your group has created held the most cargo?

____

Why does this boat design hold more cargo than the other two designs?

____

____

If you could create one more boat design what would it look like and why would you create it that way?

Learning Experience 3: Plastic Cup Boats v. Clay Boats

Objective: Students will compare the number of ceramic cylinders that their boat can support to that of a plastic cup and redesign their boat to hold the same or greater amounts of ceramic cylinders.

Materials:

For each pair of students:
2 Buoyancy Student Activity Books
4–liter container
Clay
30 ceramic cylinders
3.5 oz. sundae plastic cup
Paper towels*
Water*
*provided by teacher

For the class:
Video–"Buoyancy" – Module 3 (25 min.)

Preparation:

Students should use the same clay as in Learning Experience #2. The plastic cup acts as a model so students can get some ideas of how they can optimize their boat design for a final time. Prepare the video so students can watch module 3 of the video "Buoyancy" on boat shapes. Students need the boats they optimized in Learning Experience #6.

Evaluation Strategy:

Students will optimize their clay boat designs to hold the same amount or more ceramic cylinders than the plastic cup.

Vocabulary:

compare
contrast
optimize

Learning Activities:

Session 1:

Float the plastic cup in the 4–liter container filled with water, and add ceramic cylinders to the plastic cup until it sinks. (It takes approximately 26 cylinders to sink the cup.)

Discussion Questions:

- How does the plastic cup compare to a boat?
- How does the plastic cup sit on the water?

Compare the plastic cup to the boat you have created.

Student pairs are to create a clay boat that will hold the same amount of or more ceramic cylinders than the plastic cup. Students may begin to take notice of the width of the bottom of the boat and the height of the sides. Compare and discuss the results. Record all results on the observation sheet for Learning Experience #3.

Challenge students to see whose boat will hold the most ceramic cylinders.

Discussion Questions:

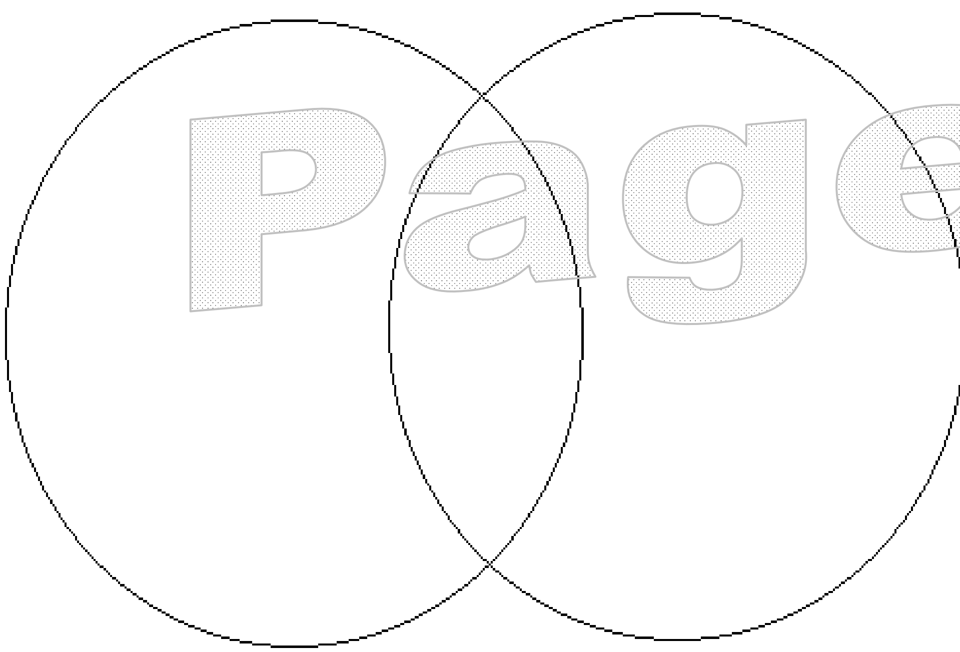
- How is the boat you created in this learning experience different or the same as the boat designs in the last learning experience?
- How can the clay boat be made to hold more ceramic cylinders?
- Did the plastic cup's design influence your boat's design? How?

Watch module 3 of the video "Buoyancy." This part of the video discusses boat shapes and why they float. Discuss how the information in the video applies to the boats they created with clay.

Student Observation Sheet for Learning Experience #3 Name ____________________

Observations for the Cup	Observations for the Boat
Shape:	Shape:
Height:	Height:
Width at Base:	Width at Base:
Number of cylinders held:	Number of cylinders held:
Other Observations:	Other Observations:

Cup Boat



Learning Experience 4: Measuring Mass

Objective: Students will observe a teacher demonstration of finding the mass of the cylinders using the balance and compute how many grams their boat designs could hold.

Materials:

For each student:
Buoyancy Student Activity Book

For the class:
Ceramic cylinders
Balance stand
Pin for balance
2 baskets for balance
Balance base
Balance arm
Gram cubes

Preparation:

The balance scale will need to be assembled for this learning experience. Read background information on mass on Page 3. Students will also need to be familiar with plotting data points on a line graph. This learning experience could be done in small groups as students are completing their research independently in Learning Experience #5.

Evaluation Strategy:

Students will describe the pattern found in the data and determine how much mass their boats could hold.

Vocabulary:

mass
balance
horizontal

Learning Activities:

Session 1:

Remind students of how the balance was used to measure the clay for their boats. Students can describe how the 25 cylinders were placed in one basket and the clay was placed in the other basket. When the beam was horizontal, it showed that the objects in both baskets were equal in mass. This explanation offers a review for students on how the balance scale works.

Discuss with students the definition of mass. Place the balance scale in an area of the room where everyone in the class can see it.

Explain to students that we are going to determine the mass of the ceramic cylinders – then we can determine how much mass our boats could hold up.

Place one ceramic cylinder in one basket – place gram cubes, one at a time, in the other basket until the balance beam is horizontal.

Students can then record on the chart in the activity sheet for Learning Experience #4 how many gram cubes equals one ceramic cylinder. Complete the same activity for two, three, four and five ceramic cylinders.

Students should begin to see that if one ceramic cylinder equals 6 grams and if you multiply the number of ceramic cylinders by 6 it should give you the number of grams. If the results on the chart are not exact for multiple cylinders (example: one cylinder = 6 grams and two cylinders = 13 grams instead of 12), you may want to discuss with the students the accuracy of the balance and why the results may not be exact. **An approximate mass in grams is sufficient for this learning experience.**

Discussion Questions:

- Do you notice any patterns in the number of grams every time we added a ceramic cylinder? Explain.
- If we create a line graph showing the data we collected, what do you think it would look like? Why?
- Create a line graph based on the data collected in your chart. (Students should see that due to the pattern of numbers (each cylinder = approximately 6 grams) the line on the graph will be a straight line.
- How many grams do six cylinders equal? Seven? Ten?

Extension: For more practice using the double-pan balance and graphing, have students create a double line graph. One, estimating how many grams the cylinders might equal AND one line showing the mass found for 4, 8, 12, 16, 20, 24, 28, 32, 36, 40.

Activity Sheet for Learning Experience #4 Name________________________________

MEASURING MASS

Record the mass of each number of ceramic cylinders in the chart below.

Ceramic Cylinders	Grams
1	
2	
3	
4	
5	

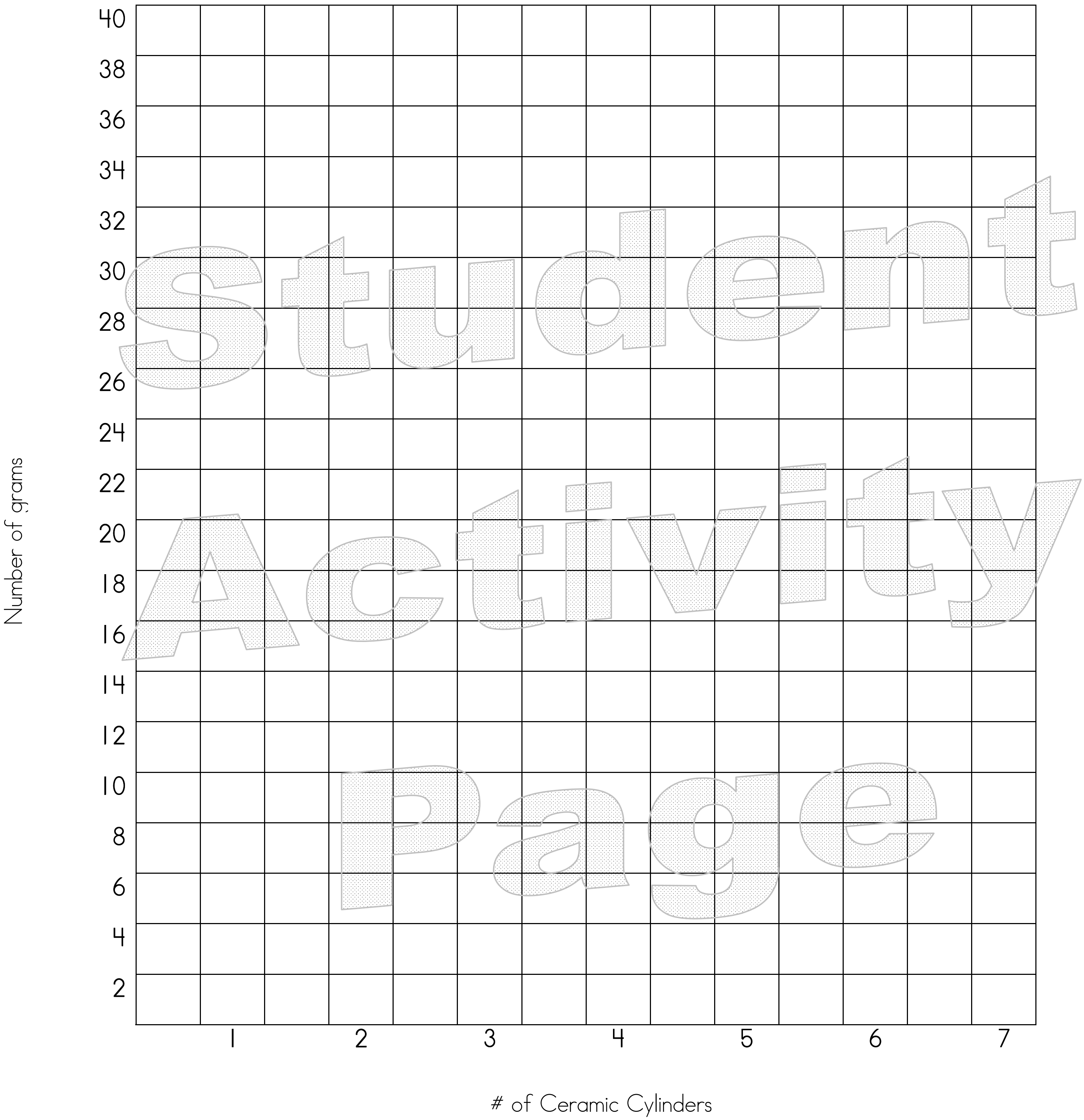
Create a line graph based on the data in the chart above on page 2 of this activity sheet.

Look back to your activity sheet for Learning Experience #2. You created a chart showing your three best boat designs and how many ceramic cylinders they would hold. Let's figure how many grams each boat would hold.

Boat design	Mass of cargo in ceramic cylinders	Mass of cargo in grams
#1		
#2		
#3		

Activity Sheet for Learning Experience #4 Page 2

Measuring Mass of the Ceramic Cylinders



Learning Experience 5: What Makes a Good Boat?

Objective: Students will research different types of boats and compare and contrast their appearance, function and design of those boats with the ones they created.

Materials:

For each student:

Buoyancy Student Activity Book
Reference materials (library books, magazines)*
*provided by teacher

Preparation:

Research materials will need to be prepared/collected before class. Decide if each research team is to research a different boat or if several teams are going to research the same boat. This learning experience will take more than one class period to complete.

Evaluation Strategy:

Students will research information on different types of boats and explain the differences between the boats researched.

Vocabulary:

research
propulsion
hull
structure
materials

(Other vocabulary will come from the reference materials students use for research.)

Learning Activities:

Session 1:

Ask students to brainstorm the names of different types of boats. List ideas they suggest on the chalkboard. A sample list of boats: speed boat, barge, sail boat, ocean liner, freighter, tug boat, canoe, kayak, schooner, row boat, paddle boat (steam wheeler), peddle boat, catamaran and submarine. Provide access to the library and other information resources. Students are to complete the activity sheet in Learning Experience #5 in the Buoyancy Student Activity Book. Students can orally present the information found in their research or use the chart as a graphic organizer from which they can write their information in paragraph or report form. Also, students can use each other's research to compare and contrast the different boats.

Discussion Questions:

- What are some of the shapes of the different boats we researched?
- What materials seem to be used to construct the various boats we researched?
- Which boats seem to be used most for carrying cargo? How do you know?
- Which boats seem to be used most for carrying people? How do you know?
- Which boats seem to be the fastest? How do you know?
- After completing the research on boats, how would you change your clay boat? Why would you make this change?

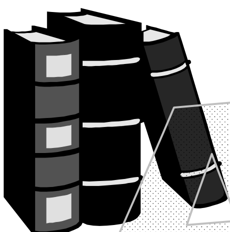
Students can redesign boats according to what they found in their research and suggestions made by other students.

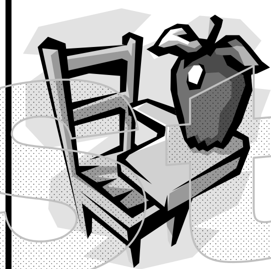
Activity Sheet for Learning Experience #5 Name____________________

WHAT MAKES A GOOD BOAT?

Use the research materials provided to fill out the chart below on your type of boat.

The boat I am researching is: ____

1. History of the boat. Who developed the boat <u>or</u> how was it developed? Where was this boat developed? What was the boat used for <u>or</u> why was it developed? 	____ ____ ____ ____ ____ ____ ____ ____ ____
2. Describe the boat. What does it look like? 	____ ____ ____ ____ ____ ____ ____

3. What is the boat made of? (Materials it is made of) 	
4. How does it move? (Propulsion) 	

Draw a picture of your boat in the box below. Try to fill most of the box with the picture of the boat, not the water it floats on, so you can easily share your picture with the class.

*Be sure to label any special features of your boat.

Learning Experience 6: Displacement

Objective: Students will observe and record changes in water level when various objects are put in the tank demonstrating the relationship between volume (size) and displacement.

Materials:

For each pair of students:

Boat constructed in Learning Experience #2
9 oz clear plastic tumbler
Glass ball
Nylon plastic ball
30 ceramic cylinders
4-liter container
Water*
*provided by teacher

For the class:

Video–"Buoyancy"– Module 2 (25 min.)
Balance stand
Pin for balance
2 baskets for balance
Balance base
Balance arm
Gram cubes
Masking tape

Preparation:

Prepare video to module 2 for use in this learning experience. Read background information on displacement on Page 3. The 9 oz. plastic tumbler needs to be saved for use in Learning Experience #9.

Evaluation Strategy:

Students will observe the displacement of water in their container and explain the concept of displacement from their observations.

Vocabulary:

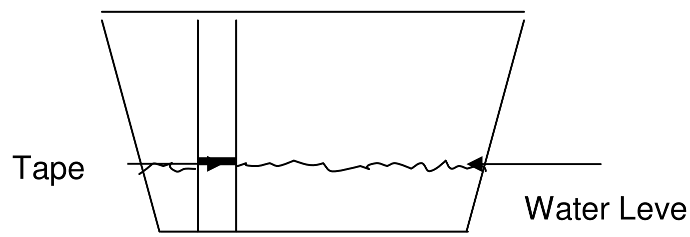
displacement
vertical

Learning Activities:

Session 1:

Students should view the video "Buoyancy" module 2 which discusses the concept of displacement. Discuss the information in the video as a class. Students may think of situations in which they have observed first hand when an object displaced a liquid. Discuss those previous observations.

Student pairs should fill their 4–liter containers half full of water. A piece of tape should be attached vertically to the outside of the container.



Students should draw a line on the piece of tape showing where the water level is with nothing in the water.

Discussion Questions:

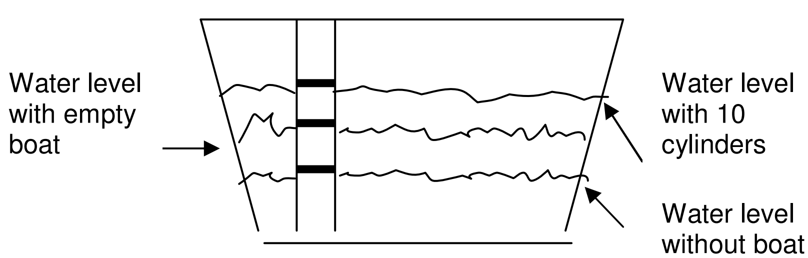
- Predict what will happen to the water line when you place your boat in the water. Explain your prediction.

Student should then place their boat in the water and mark on the tape where the water level is now located after the boat is placed in the water

Discussion Questions:

- What did you notice happened to the water level?
- Why do you think this occurred?
  (Students should begin to see that the boat took up some of the space in water or displaced some water, therefore, the level of liquid rises in the container. The liquid that was once where the boat was must go somewhere else in the container so it appears as if the water level rises.)
- What would happen if we took the boat out of the water?
  (You may want to try this with the students so they can see the process in reverse.)

Students should place their boat in the water and add 10 ceramic cylinders to the boat and mark the location of the water level on the tape. Students should mark the water level on the tape after 10 more cylinders have been added to their boat. Students should take a close look at their results.



Discussion Questions:

- What has happened to the water level when we added 10 cylinders to the boat?
- Why do you think this is happening?
  (As the cylinders are being added to the boat, the boat is becoming heavier and sinking deeper in the water. Therefore, it is taking up more space in the water. The water level, again, rises as the boat displaces more water.)

Session 2:

Assemble the balance, and place it in a location where students can observe results. Explain to the students that they are going to be given two balls made of different materials. Before they receive them, they are going to find the mass of each of the two balls. Place each ball, one at a time, in one basket and gram cubes in the other basket until the balance arm is horizontal. Count the number of grams in the basket and that is equal to the mass of the ball. (Nylon plastic ball = approx. 10g; glass ball = approx. 20g.) Ask students to fill a 9 oz clear, plastic tumbler half way with water. Place a piece of tape on the side of the tumbler and mark the water level on the piece of tape. Students are going to place two different balls, all the same volume but made of different materials (nylon plastic and glass), in the 9 oz clear plastic tumbler. On chart paper or on the chalkboard, write the names of the two different balls in order by gram mass. Distribute the two balls to each pair of students. They are to observe the two different balls carefully and make a prediction of what they think will happen to the water level when each ball is placed in the tumbler of water. Discuss their predictions for each ball. Students are to then drop the ball that has the least mass in their 9 oz clear, plastic tumbler filled with water and mark the water level with the ball in it.

Discussion Questions:

- What happened to the water level?
- Why did this occur? (Students should recognize from the previous session that the ball displaces some of the water in the tumbler so the water level rises.)
- Predict what will happen if you take the ball that has the least mass out and place the ball with the greater mass in the water. Discuss predictions.
- Students are to take the nylon plastic ball out and replace it with the glass ball.
- What happened when you put the ball with the greater mass into the water? (Students should indicate that the water level did not rise above the second line drawn.)
- Why do you think this happened? (The rise in water level is related to the volume of the object under water, not the mass of the object. Volume is the amount of space an object takes up. The two balls are equal in volume.
- What would happen if we measured the amount of displacement of the glass ball we are now using and then put a larger glass ball in the water? (The water level would then rise higher due to the fact that when the larger glass ball takes up more space, the volume rises.)

Learning Experience 7: Measuring Buoyant Force

Objective: Students will use a K'nex rubber band scale to measure the buoyant force on objects of different sizes and describe the relationship between size and the level of buoyant force.

Materials:

For each pair of students:

2 Buoyancy Student Activity Books
Fishing bobber (medium 4.5 cm or
1 ¾)
Fishing bobber (large 5 cm or 2")
K'nex rubber band scale (to be assembled by students)
Direction card
Rubberbands (#16)
Fishing line (45 cm)
Suction cup with hook
4-liter container
3.5 oz sundae plastic cup
Metric ruler*
Water*
Paper towels*

For the class:

Video–"Buoyancy" – Module 1 (25 min.)
Balance stand
Pin for balance
2 baskets for balance
Balance base
Balance arm
*provided by teacher

Preparation:

Read background information on buoyant force on pages 5 and 6. Students may need to be instructed on how to push down on the top of the bobber to make the hook on the bobber come out in order to attach the string. The rubber band scales will need to be assembled using the K'nex pieces before beginning this learning experience. Direction cards are provided for students in the kit.

Evaluation Strategy:

Students will explain the comparison between size and the amount of buoyant force that keeps an object afloat.

Vocabulary:

buoyancy
force
gravity
bobber
trials
level

Learning Activities:

Session 1:

This learning experience provides students with a chance to measure the buoyant force by using a K'nex rubber band scale and a string to pull a fishing bobber underwater. What students are actually measuring with the K'nex rubber band scale is the upward buoyant force minus the downward force of gravity (the weight of the bobber). However, the bobber's weight is insignificant to the buoyant force, so what the students measure is nearly equal to the buoyant force.

Ask students to fill their 4-liter containers halfway with water and place the plastic cup on the surface of the water. Students already know that this cup floats but now ask the students to use their finger to gently push down on the cup in the water.

Discussion Questions:

- What do you feel when you push down on the cup with your finger? (They are feeling the buoyant force that is pushing up on the cup that allows it to float.)
- If you used a smaller cup, do you think the "force" would feel greater or less than the force you are feeling now?
- What if it was a larger cup? Would the force feel less than or greater than the force you feel now? Explain your answers.

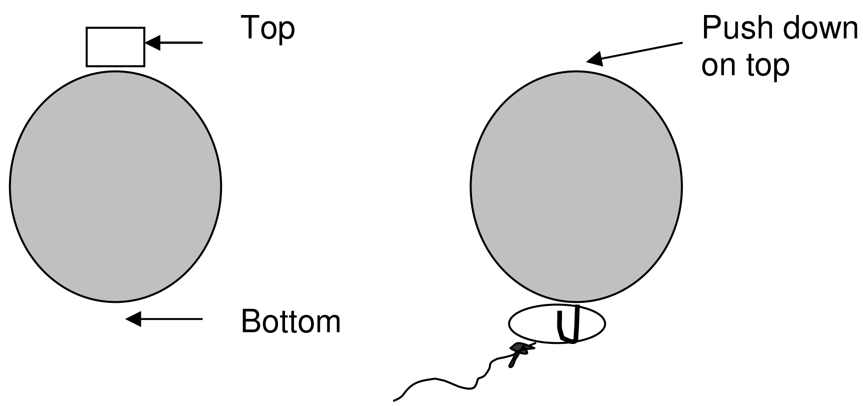
Students should begin this learning experience by noting the size difference of the two bobbers. The two bobbers could be placed in the double-pan balance to determine which has the greater mass based on size.

Discussion Questions:

- If we were to measure the buoyant force of each bobber, which fishing bobber do you think has the greater buoyant force acting on it? Give reasons for your predictions.

Be sure students place the K'nex rubber band scale flat on the table so nothing is pulling down on it. Move the green or blue connector so it is right across or level with the gray connector. This shows where there is no force pulling on the rubber band.

Students are to complete the activity sheet for Learning Experience #7 in the Buoyancy Student Activity Book. This activity sheet provides the directions for setting up the materials. Students may need to be taken through the directions step-by-step to be sure of correct setup.



Discussion Questions:

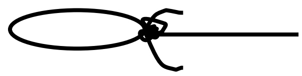
- What effect does size have on the amount of buoyant force? (Students should discover that the larger the bobber, the greater the upward force of the water.)
- Can we measure the buoyant force of other objects using these materials? Give some suggestions.

Students can view the video "Buoyancy" module 1 as a review for this learning experience.

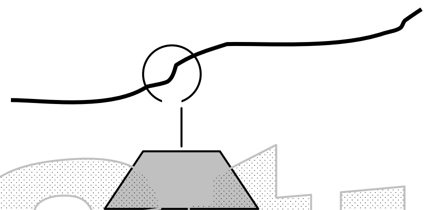
Activity Sheet for Learning Experience #7 Name____________________

MEASURING BUOYANT FORCE

Directions for set up of activity.

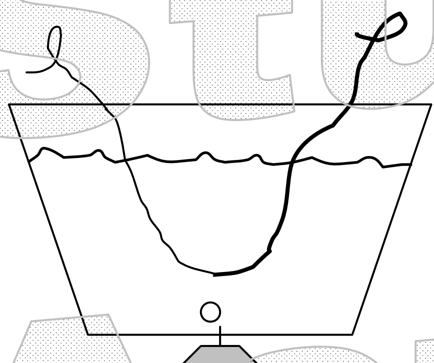


1. Place the rubber band scale flat on the table so nothing is pulling down on it. Move the green or (blue) connector so it is right across or level with the gray connector. Where the green connector is located shows the point where there is no force pulling on the rubber band.



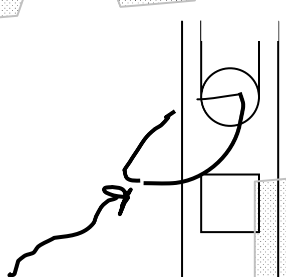
2. Tie a loop on one end of the fishing wire.

3. Thread the string through the hook in the suction cup.

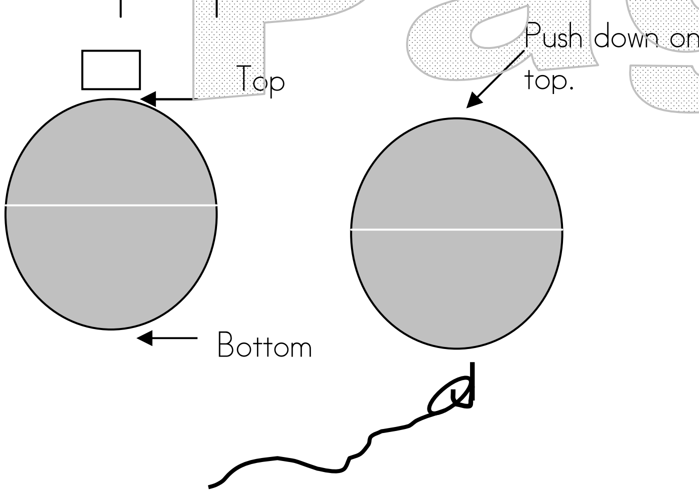


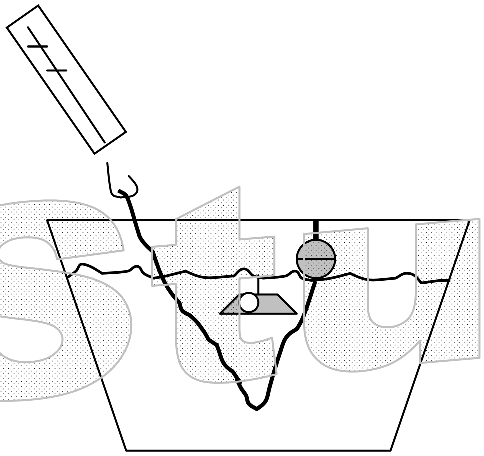
4. Suction the cup to the bottom of the container filled with water.

5. Tie the other end of the string to the bottom of the Knex rubberband scale (orange Knex piece).



6. Attach the loop that was tied on the other end of the string to the fishing bobber. (Start with the smaller bobber.) Push down on the top of the bobber to make the hook on the bottom of the bobber come out.





7. Use the rubberband scale to pull the bobber slowly under water. You will notice that the gray connector has moved downward from the green (or blue) connector due to the force that is needed to pull the bobber under water.

8. Move the tan connector so that it is across from where the gray connector is after the bobber is pulled under water.

9. Measure the distance in millimeters between the green (or blue) connector and the tan connector. You will need your partner to help you! The greater the distance between the two connectors, the greater the force needed to pull the bobber underwater.

10. Repeat Step 7 several times and record your results on the chart below.

11. When you have completed all your trials with the medium bobber, switch to the large bobber. Record your results on the chart.

Size of Bobber	Floating Force of Fishing Bobbers		
	Trial 1	Trial 2	Trial 3
Medium (4.5 cm or 1 ¾")	mm.	mm.	mm.
Large (5 cm or 2")	mm.	mm.	mm.

12. Which bobber has the greatest buoyant force pushing against it?

____

____

13. Why do you believe this bobber has the greatest buoyant force pushing against it?

____

____

____

Learning Experience 8: Weight of an Object in Water

Objective: Students will predict, observe and explain the change in the apparent weight of objects when they are out of water, partially submerged and submerged as it relates back to buoyant force.

Materials:

For each pair of students:
2 Buoyancy Student Activity Books
K'nex rubber band scale
Rubber bands #16
White plastic jar weight w/eyehook
Piece of fishing line (24 cm)
4-liter container
Water*
Paper towels*
*provided by teacher

Preparation:

K'nex rubber band scale needs to be assembled for this learning experience. The white plastic jar weights filled with iron filings have been sealed shut. Students should not attempt to open them or take the eyehook out of the lid.

Evaluation Strategy:

Student pairs will use their K'nex rubber band scales to observe the difference in weight between an object that is out of the water, partially submerged in water and completely submerged in water and explain the results.

Vocabulary:

submerged
detach
attach
weight

Learning Activities:

Session 1:

Students are to complete the activity sheet for Learning Experience #8 in the Buoyancy Student Activity Book.

Students will notice that by placing the white plastic jar weight filled with iron filings in water, it seems to weigh less than when it is above water. This is due to the buoyant force pushing upward on the object that counters the downward force of its weight.

Discussion Questions:

- Use the questions on the activity sheet as a basis for discussion.
- What happens if you lightly grip the jar as it is being submerged? What does the jar appear to do? (Students may feel the jar begin to feel weightless or feel like it's being pulled out of their hand due to the buoyant force. Students may want to use their K'nex rubber band scales to measure weight of other objects both in and out of water. Students should notice that the more the object is submerged in the water, the less it appears to weigh.)

If students connect these results with the results in Learning Experience #7, they should explain that the buoyant force is pushing up on the object so it counteracts the downward force of the weight. So it appears the object weighs less, however, the weight has actually remained constant.

Students may recall when they were swimming in water, they may have picked someone or something up and it appeared to be much lighter than if they tried to pick that same person or thing up outside of the water.

Activity Sheet for Learning Experience #8 Name____________________

WEIGHT OF AN OBJECT IN WATER

1. Lay the Knex rubber band scale on the desk so there is no force acting on it, and move the green connector so it is right across from the gray connector. This indicates where there is no force acting on the rubber band.

2. Attach one end of a line to the end of the rubber band scale and the other end to the eye hook on the top of the white plastic jar weight filled with iron filings.

3. Move the tan connector to where the gray connector falls.

4. Measure the distance in millimeters between the green and tan connector at this time. You will need your partner to help you. This is showing how far the rubber band is stretching with the jar filled with iron filings attached to it. The farther the rubber band stretches the heavier the object.

5. Record the distance in the "out of water" column on the chart below.

	Out of Water	Partially Submerged	Submerged
Jar filled with iron filings	mm.	mm.	mm.

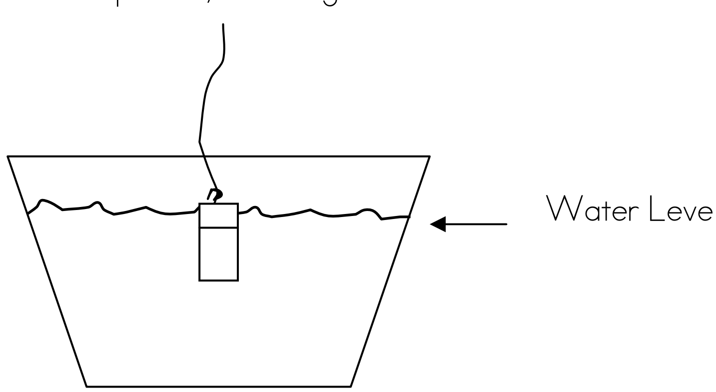
7. Predict what will happen to the weight of the object (the stretch of the rubber band) when it is placed halfway in water and explain your prediction?

____

____

____

8. Place the white plastic jar weight filled with iron filings that is attached to the Knex rubber band scale in the water so it is partially submerged.

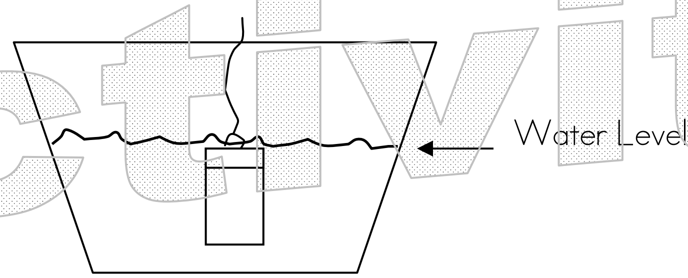


9. Move the tan connector so that it is across from the gray connector.

10. Measure the distance in millimeters between the green and tan connectors and record the distance on the chart in the "partially submerged" column.

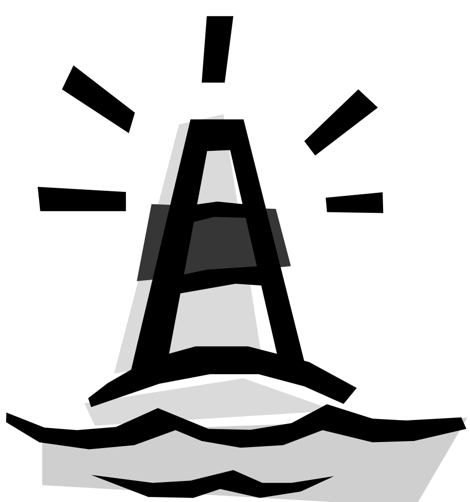
11. Predict what will happen to the weight of the object (stretch of the rubber band) when the ball is placed completely underwater and explain your prediction.

12. Place the jar filled with iron filings that is attached to the Knex rubber band scale in the water so it is completely submerged. Be sure its not touching the bottom!



13. Move the tan connector so that it is across from the gray connector.

14. Measure the distance in millimeters between the green and tan connector and record the distance on the chart in the "submerged" column.



15. Graph the results from the completed chart.

Choose a color for each item in the key and create a bar graph from the data in the chart.

Key

☐ Out of Water

☐ Partially Submerged

☐

Stretch of rubber band in millimeters

10			
9			
8			
7			
6			
5			
4			
3			
2			
1			
0			
	Out of Water	Partially Submerged	Submerged

Jar Filled With Iron Filings

16. Compare the results on the graph. What do you notice about the weight of the object as it is submerged in the water? (Remember: the greater the distance between the green and tan connectors = the greatest weight.)

____

____

17. Why do you think these results occurred? (Hint: Think back to Learning Experience #7)

____

____

18. Have you ever had a real life experience like this? Have you ever been able to pick something up in water and you were not able to outside of the water? Explain.

Learning Experience 9: Salt Water vs. Fresh Water

Objective: Students will demonstrate an understanding of why certain objects sink in fresh water and float in salt water.

Materials:

For each pair of students:

2 Buoyancy Student Activity Books
Glass ball
Nylon plastic ball
Two 9 oz, clear plastic tumblers
Popsicle stick
Water*
Paper towels*
*provided by teacher

For the class:

Two 9 oz, clear plastic tumblers
2 gram cubes
Canning salt
Measuring cup
Medicine cup
Balance stand
Pin for balance
2 baskets for balance
Square base
Balance arm
Teaspoon

Preparation:

Prepare the salt water for the teacher demonstration ahead of class so students do not see the salt being added to the water. If the salt completely dissolves, the salt water will appear clear due to the kind of salt provided. Read background information on salt water on Page 5.

Safety:

Concentrated salt water can sting if it comes in contact with cuts or sensitive skin. Students should wash hands with fresh water after working with the salt water.

Evaluation Strategy:

Students will explain the difference between fresh water and salt water in relation to their density.

Vocabulary:
density

Learning Activities:
Session 1:
Fill one 9 oz., clear plastic tumbler with 100 cc of very warm water. Fill another tumbler with 100 cc of water and then add 20 cc of salt and stir to create a salt water solution. Place a gram cube in each tumbler. One cube should sink to the bottom of the tumbler and the other cube should be floating. Place the tumblers in front of the class and brainstorm with students why this is occurring.

Discussion Questions:
- Why is one gram cube floating in water and the other sinking?
  (Students may think that the cubes are different in some way. Stress that they are exactly the same. Students may think something is in the water. Get them thinking about what it might be and why that would affect the cube the way that it is. If students still are not thinking that salt may be the factor, ask students to think about what it is like to swim in the ocean vs. a swimming pool. They should then conclude that it is easier to float in the ocean than in a pool and realize that the salt is the additive that causes the difference.)

Students are to now try this out on their own using the two different balls they are already familiar with: glass and nylon plastic. They should fill two 9 oz., clear plastic tumblers with 100 cc of very warm water. Use the medicine cup to measure 20 cc of salt. Add the salt to one of the tumblers of water, and students can stir the salt with their popsicle stick.

Students can then complete the activity sheet for Learning Experience #9 in the Buoyancy Student Activity Book.

Use the results of this learning experience as a basis for discussion.

Extension:
Prepare an extra cup of salt water, and leave it in the room uncovered for several weeks. After the water has evaporated, students will be able to see the teaspoon of salt still in the tumbler. This helps the students understand that the salt remains in water even if it can not be seen after it dissolves and that the salt makes salt water heavier than fresh water.
Use the balance and gram cubes to find the mass of the fresh water and the mass of the salt water. The mass of the salt water should be more due to the added salt.

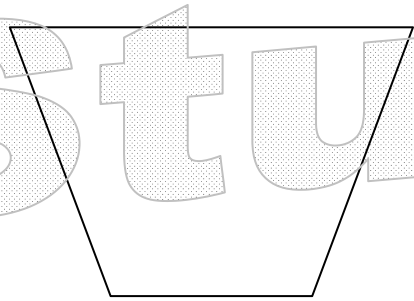
Activity Sheet for Learning Experience #9 Name______________________

FRESH WATER VS. SALT WATER

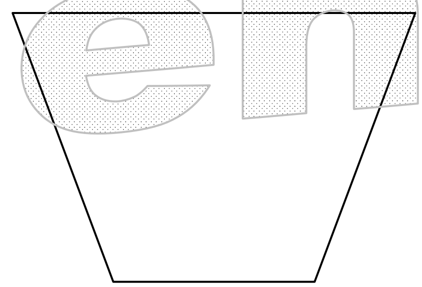
Place each of the balls in the fresh water and draw the results in the cup labeled "fresh water." Do the same for the cup labeled "salt water."

Glass Ball

1.



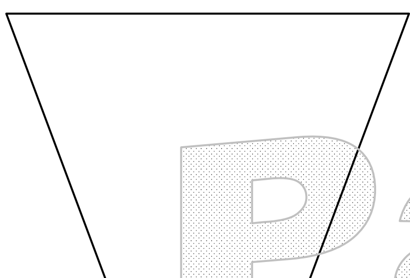
FRESH WATER



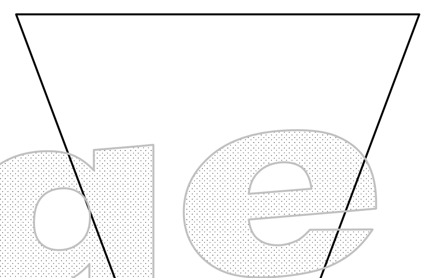
SALT WATER

Nylon Plastic

2.



FRESH WATER



SALT WATER

3. Describe what happened when you placed the different balls into the fresh water then in the salt water. Be sure to include information about each ball you tried.

4. How does the salt change the water when it is added?

5. Explain why the nylon plastic ball is able to float in salt water and not in fresh water?

Learning Experience 10: Submarine – Sink then Float

Objective: Students will determine the number of ceramic cylinders it takes to make a plastic jar partially submerge and fully submerge in water and compare how this concept is similar to a submarine.

Materials:

For each pair of students:
4–liter container
Clear plastic jar w/lid
Ceramic cylinders
Water*
*provided by teacher

For the class:
Video–"Buoyancy" – Module 4 (25 min.)

Preparation:

Prepare video to module 4 for use in this learning experience.

Vocabulary:

submarine
submerge

Learning Activities:

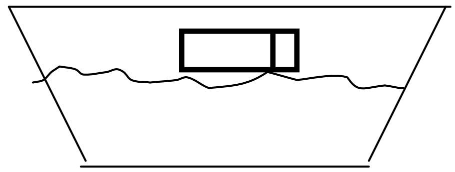
Session 1:

Begin the learning experience by brainstorming with students how they think a submarine is able to sink under water then come back up to the surface based on what they have learned about buoyancy. Create a list on the chalkboard of their ideas.

Watch module 4 – What Goes Up Must Come Down on the video "Buoyancy". Discuss with students their thoughts of how a submarine works compared to what they learned in the video.

Explain to students that they are going to use a plastic jar as their submarine and ceramic cylinders as the water that is pumped into the submarine to recreate the scenario of a submarine sinking and floating.

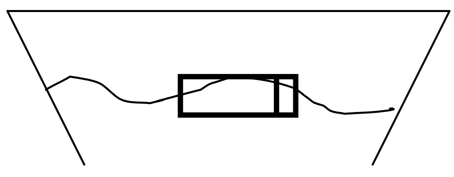
Students should fill their 4–liter container halfway with water, and place their plastic jar on the surface of the water (on its side).



Discussion Questions:

- If this plastic jar was a real submarine, based on what you learned from the video, why is it able to float?
- How can we get it to sink?

Students are to place their ceramic cylinders inside the plastic jar and get the plastic jar to partially submerge in the water.

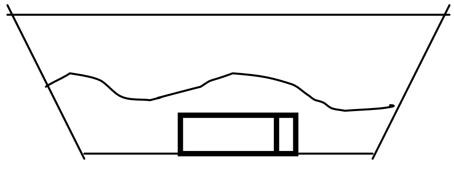


Approximately 15-20 ceramic cylinders will get it to submerge itself halfway in the water. The ceramic cylinders need to be distributed somewhat evenly in the jar or one end of the jar will tip downward.

Discussion Questions:

- Predict how many ceramic cylinders it will take to get the "submarine" to partially submerge.
- How many ceramic cylinders can we place in the plastic jar to get it to partially submerge?
- How many grams of ceramic cylinders does that equal? (Think back to Learning Experience #4.)
- If this plastic jar was a real submarine, based on what you learned from the video, why is it able to partially submerge underwater?

Add more ceramic cylinders to the plastic jar and get it to completely submerge underwater.



Approximately 47 ceramic cylinders will get plastic jar to sink to the bottom of the container. If students are interested in getting the plastic jar to submerge itself without touching the bottom, they will need to break up the mass of one of the ceramic cylinders. It takes approximately 45 ceramic cylinders and 3–4 gram cubes to get the plastic jar to submerge in the water without touching the bottom. Remind students that distributing the cylinders in the jar evenly will allow the jar to float horizontally without one end of the jar pointing farther downward.

Discussion Questions:

- Predict how many ceramic cylinders it will take to get the “submarine” to completely submerge.
- How many ceramic cylinders does it take to get the plastic jar to sink to the bottom?
- How many grams is this?
- Can we get the jar to completely submerge without touching the bottom with the ceramic cylinders? If not, what can we do?
- If this plastic jar was a real submarine, based on the video, how is it able to sink?
- If we wanted to get it to float again, what can we do? What did the submarine in the video do?

Name: ______________________ Date: _________

Buoyancy Student Assessment

Directions: Read the question carefully, and answer based on your knowledge about buoyancy. Circle the correct answer.

1.) What unit of measurement would you use when using your double-pan balance?

a.) Centimeters
b.) Grams
c.) Miles
d.) Liters

2.) If I tell my teacher that I think my boat will hold 10 grams, I am making a:

a.) Boat
b.) Note
c.) Prediction
d.) Fair test

3.) In order to have a fair test between two boats, I need to make sure that I:

a.) Have 3 boats.
b.) Have 2 jugs of water.
c.) Keep all the conditions the same for both boats.
d.) Make a prediction.

4.) How important is the shape of a boat in making it float?

a.) Not important at all
b.) Very important
c.) A little important

5.) When a boat is placed in the water, and the water level rises, this is called:

a.) Displacement
b.) Fair Test
c.) Density
d.) Balance

6.) What pulls a clay ball to the bottom of the water tank?

a.) Water
b.) Gravity
c.) Electricity
d.) Air

7.) Does something heavy always sink?

a.) Yes
b.) No

8.) What is the force called that pushes upward on a boat?

a.) Electricity
b.) Water
c.) Gravity
d.) Buoyancy

9.) When a boat is under water it is:

a.) Floating
b.) Submerged
c.) Heavy
d.) Full of air

10.) If you placed your boat in a container filled with saltwater, the boat would:

a.) Sink to the bottom.
b.) Sink down into the saltwater more than in fresh water.
c.) Float higher up in the saltwater than in fresh water.
d.) Float in the same place as it would in fresh water.

11.) If you want to measure the length of something very small you would use which unit?

a.) Kilometers
b.) Miles
c.) Liters
d.) Millimeters

12.) If any object is denser than water it will:

a.) Float
b.) Sink

13.) In science what does **mm** mean?

a.) Measurement
b.) Volume
c.) Chocolate
d.) Millimeter

14.) When you place a boat into a water container, the water level:

a.) Decreases
b.) Increases
c.) Stays the same

15.) How does the density of air compare to the density of water?

a.) Air is more dense
b.) Air is less dense
c.) Water is less dense
d.) Both are the same

16.) What is mass?

a.) The height of an object.
b.) The length of an object.
c.) The amount of matter in an object.
d.) The level of water in a jug.

17.) Would it be easier to lift a stone in water than on land?

a.) Yes
b.) No
c.) The same

18.) When I place a ruler flat on my desk, it is ________________ to the desk:

a.) Vertical
b.) Uneven
c.) Horizontal

19.) When I place a pencil on my desk sitting on the eraser head straight up, the pencil is _____________ to the desk.

a.) Vertical
b.) Uneven
c.) Horizontal

20.) You have two pieces of clay. Follow the directions below.

Make two boats out of the clay, and draw a picture of each boat. Make sure they are different.

Boat 1

Boat 2

21.) Make a prediction on which boat will hold more weight (gram cubes).

____

____

22.) Give three reasons for your prediction.

1.____

2.____

3.____

23.) Test your boats three times each. Add gram cubes to your two boats one at a time and record your data.

Look at your results (Data).

Was your data different than your prediction? (Explain and give details in your answer— **yes or no** is **not** an acceptable answer)

____

____

____

If you could make one change to your boats what would it be?

Change to Boat A
Change to Boat B

Buoyancy Student Assessment Key

1. B
2. C
3. C
4. B
5. A
6. B
7. B
8. D
9. B
10. C
11. D
12. B
13. D
14. B
15. B
16. C
17. A
18. C
19. A
20. Answers will vary
21. Answers will vary
22. Answers will vary
23. Answers will vary

MORE IDEAS

Language Arts

- Have students investigate (in the library) the concept of buoyancy in whales and report to the rest of the class.
- Write stories and poems about boats.
- Read stories and poems about boats.
- Give a presentation comparing a hot air balloon to a floating ship.
- Write a friendly letter to a friend describing the learning experiences you have been doing in the Buoyancy Kit.
- Research how fish change their density to swim different depths. Compare this to how a person floats and swims in water.

Book suggestions:

Ballard, Robert D. Exploring the Titanic
Donnelly, Judy. The Titanic Lost and Found
Gibbons, Gail. Sunken Treasure
Allen, Pamela. Who Sank the Boat?
Cole, Johanna. The Magic School Bus at the Waterworks
Say, Allen. A River Dream
Locker, Thomas. Where the River Begins
Aui, Don Bolognese. Abigail Takes the Wheel
Lincoln, Margaret et al. Amazing Boats
Orr, Wendy & Kim Gamble. Arabella
Dyson, George. Baidarka: The Kayak
Kentley, Eric. Boat (Eyewitness Books)
Trumbauer, Lisa. Sink or Float

Art

- Have students construct boats at home as a culminating activity. Write a paragraph describing: materials used, construction of boats, purpose or use of boats, description and special features of boat, name of boat and why that name was chosen. Obtain a large plastic wading pool for testing the boats and experimenting with large loads.
- Build a boat that "floats" underwater, simulating a submarine.
- Design your own dream boat.

Social Studies

- Research types of boats used in various countries from past to present. Identify shapes, purposes and sizes. Make scale models for display.
- Explain the role of ships in history.
- Research the role submarines played in our nation's defense.
- Find out where the Great Salt Lake is and why it's named that.

Math

- Measure the mass of various objects using the balance.
- Compare the weight of various objects using the K'nex rubber band scale.

Science

- Explore objects that both sink and float depending on how the objects are placed in water. See if students can find objects that both sink and float depending on how the objects are placed in the water.
- Students may design boats from other materials available.
- Students may want to make bigger boats by using more clay.
- Teacher may want to discuss and display flotation devices.

Health

- Discuss the human body's ability to float.

INQUIRY AND PROCESS SKILLS

Classifying	Arranging or distributing objects, events or information in classes according to some method or system.
Communication	Giving oral and written explanations or graphic representations of observations.
Creating Models	Displaying information by means of graphic illustrations or other multi–sensory representations.
Formulating Hypotheses	Constructing a proposition or assumption of what is thought likely to be true based on reasoning, which serves as a tentative, testable theory.
Gathering & Organizing	Collecting information about objects and events which show a specific situation.
Generalizing	Drawing general conclusions from information.
Identifying Variables	Recognizing the characteristics of objects or events which are constant or change under different conditions.
Inferring	Making a statement or conclusion based on reasoning or prior experience to explain an observation.
Interpreting Data	Analyzing information that has been collected and organized by describing apparent patterns or relationships in the information.
Making Decisions	Choosing an alternative from among several and basing the judgment on defendable reasons.
Manipulating Materials	Handling or treating materials, equipment or procedures skillfully and effectively.
Measuring	Making quantitative observations by comparing to a standard.
Observing	Becoming aware of an object or even by using any of the senses to identify properties.
Predicting	Making a forecast or estimate of what future events or conditions may occur.

GLOSSARY

Attach:	to fasten or join.
Balance:	an instrument for determining mass by the equilibrium weights suspended from opposite ends of a horizontal bar.
Bobber:	a float for a fishing line.
Buoyancy:	An upwards force acting on all objects in fluids, whether they are floating or submerged.
Ceramic:	of products made of clay and similar materials.
Compare:	to examine for similarities and differences.
Contrast:	to compare to show differences.
Cylinder:	a solid that has two parallel circles of the same size and shape as bases and one curved surface.
Density:	the ratio of mass of an object to its volume (D=M/V)
Detach:	to unfasten and separate.
Displacement:	an object pushes aside (displaces) amount of liquid in a container by taking up the space the liquid once held.
Fair Test:	to conduct a scientific test where there are specific items that remain constant.
Float:	objects that are less dense than water that overcome the force of gravity.
Force:	an influence on a body or system producing a change in movement or shape.
Gravity:	the force of attraction by which objects fall toward the center of the earth.
Horizontal:	parallel to floor or table.

Hull: the watertight frame of a vessel/boat.

Level: a horizontal position or condition.

Mass: the amount of matter in an object (grams).

Materials: the items needed to make or do something.

Optimize: the best or most favorable condition for obtaining a given result.

Propulsion: the act of being driven forward or onward.

Research: an inquiry into a subject to discover or check facts.

Shape: to give form to.

Sink: objects that are denser than water that are forced down by gravity.

Structure: the manner in which something is constructed.

Submarine: a warship designed to operate under the sea.

Submerge: to sink below the surface of any liquid or to cover with a liquid.

Trials: the act of trying or testing.

Vertical: an upright position – at approximate right angles to the plan of the horizon.

Weight: the measure of gravitational pull on an object.

TEACHER REFERENCES

Ardley, Neil. The Science Book of Water. HBJ–Gulliver, NY 1991

Englehart, Derde & Matthew VanZomeren. Sink & Float (Inquiry Science Series). 1999

Gibson, Gary. Making Things Float & Sink (Science for Fun). 1995

Langley, Andrew. How Do Submarines Dive? Derrydal Books

National Science Resource Center. Floating & Sinking. 1995

Media Net

Please use the BOCES MediaNet Web site to check out the media (books, models, movies, Distance Learning opportunities, etc.) available on this science topic at http://medianet.caboces.org. Call the media library to order media materials and to check on new materials that are available. The number to be reached is (716)376-8212.

Digital Resources

Please visit our Web site at www.mstkits.org to access links to Web sites and other digital resources that correlate with this science topic.

Major Science Concepts To Be Addressed

Objects and events have distinctive properties.

The properties of an object are determined by its material and its condition.

A kind of material may be divided into smaller parts or changed in shape without changing the properties of the materials.

For example:	Molding clay
For example:	The shape of the object
	The position of the object
	The weight of the object
	The type of material in the object

Energy and material have forms and properties.

Objects have properties determined by the forms, amounts and properties of the materials of which they are made.

Properties of a material can be affected by the shape of the material.

For example:	Buoyancy of aluminum foil shaped like a boat
	Structural strength – flexibility of aluminum foil pleated.