BUOYANCY
2nd Grade

OBJECTIVES: Students will:

1. Understand the concept of displacement.
2. Learn that the density of an object will affect its buoyancy.
3. Explore the impact (on buoyancy) of changing the density of the medium by comparing the buoyancy of objects in fresh water vs. salt water.
4. Learn that buoyancy may be increased through the use of floatation.

MATERIALS:

For Introduction:

- Large cylindrical vase (for introduction demonstration)
- 2 Golf balls (1 regular and 1 plastic)
- 2 Forks (1 metal and 1 plastic)
- 1 Bowling Ball
- 1 Basketball
- 9 Mini Ceramic Weight (marshmallow like)
- 1 Mini Marshmallow (1 per class)
- 1 Balloon
- 1 Crown (Burger King or toy version)
- 1 Large Clear Bin (Big enough to fit both Bowling Ball and Basketball)
- 1 Kool-Aid packet
- 5 Sugar packets (any kind of sugar) (add sugar packets into Kool-Aide mixture)
- 2 small plastic water bottles
    - 1 bottle of water will have water inside
    - 1 bottle of water will have 1 packet of Kool-Aide plus 5 sugar packets
- 1 can of Coke
- 1 can of Diet Coke
- 1 graduated cylinder (Use from Lab 1 – Interactions)
- 1 bottle of blue food coloring (Use from Lab 1 – Interactions)
- 1 bottle of oil (Use from Lab 1 – Interactions)
- 2 Plastic Eggs
    - 1 plastic egg (empty inside)
    - 1 plastic egg (8 mini ceramic weights inside)
- OPTIONAL: 2 Mylar Balloons
    - 1 Balloon filled with air
    - 1 Balloon filled with helium with anchor weights at the ends of the strings.

PROCEDURE

Introduction (full group):

Today in Science Action we're going to do some experiments on BUOYANCY. What is buoyancy? (Accept all answers.) *Buoyancy is the force that causes objects to float – it makes objects feel lighter in water than they do in air.*

Show the students an inflated balloon and the water-filled cylindrical vase and ask: *What will happen when I put this balloon in the water?* (It floats)
*What is really happening? The **buoyant force** of the water pushes up on the balloon to make it float. The buoyant force pushing up is greater than the weight of the balloon pushing down, and so the balloon floats!*

*Now we are going to talk about how the concepts of **displacement** and **density** relate to **buoyancy**. How will variations in displacement and density affect the buoyancy of various objects, causing them to either float or sink?*

1. **Displacement:**

*What is **displacement**?* (Accept all answers.) *Two things cannot occupy the same place at the same time - if they try, one or both of them will be displaced.*

Ask for two volunteers and have the children come up and try to occupy the same place at the same time. *Can they do it? No because two things cannot be in the same place at the same time - one or both of them will be displaced. How does this idea relate to buoyancy? If we float an object in water and then push down on that floating object, we can feel the buoyant force pushing up on that object. If you try to overcome the buoyant force you have to move (or displace) the liquid because the liquid and the object can't be in the same place at the same time.*

Demonstrate how displacement affects buoyancy:

Let's see how displacement works. (Use the inflated balloon/water-filled cylindrical vase again.) *What happens when we try to push the balloon under the water? The water rises - see, it is displaced. The balloon pushed the water out of the way, and the water had no place to go but up around the sides of the balloon. We easily see this by observing the water level rise along the sides of the cylindrical vase. When an object rests upon or sinks into water it pushes water out of the way. The water will resist being pushed by pushing back on the object - trying to move the object back out of the water. The more water the object moves out of the way (or displaces) the stronger the push back (or the greater the buoyant force) will be.* (Show this by pushing balloon farther into the vase and letting go.)

2. Density:

*The **density** of an object impacts its buoyancy. What is density?* (How tightly packed an object is …so the more air an object has the less dense it is.)

Demonstrate how density affects the buoyancy of various objects in water:

2 golf balls (one regular and one plastic).
2 marshmallows (one real and one a mini ceramic weight in the shape of a marshmallow).

I have 2 golf balls, a regular one and a toy plastic one. What will happen when I drop both of them into the water? (Demonstrate) *Which one sank and which one floated? Why did the regular golf ball sink?* (It's more dense and "heavy" compared to the water.) *Why did the plastic golf ball float?* (It's light and filled with air so it's less dense and "light" compared to the water - just like the balloon.)
Let's look at two marshmallows. Note that one marshmallow is fluffy and filled with air (I can squeeze some air out) while the other is solid (I can't squeeze it at all). What will happen when I drop them into the water? (Demonstrate) *Which one sank and which one floated? Why did the solid one sink?* (It's more dense and "heavy" compared to the water.) *Why did the fluffy one float?* (It's light and filled with air so it's less dense and "light" compared to the water - just like the balloon again.)

I have a bowling ball and a basketball. What will happen when I drop both of them into the water? (Demonstrate) *Which one sank and which one floated? Why did the bowling ball sink?* (It's more dense and "heavy" compared to water.) *Why did the basketball float?* (It's light and filled with air so it's less dense and "light" compared to water – just like the balloon.)

I have a metal fork and a plastic fork. What will happen when I drop both of them into the water? (Demonstrate) *Which one sank and which one floated? Why did the metal fork sink?* (It's more dense and "heavy" compared to water.) *Why did the plastic fork float?* (It's light and filled with air so it's less dense and "light" compared to water – just like the balloon.)

So in these examples, even though they look the same, the two objects differ in what they are made of and their densities are different, and that affects their ability to float in water.

Demonstrate how density affects the buoyancy of various liquids in water:
What else has different densities? Liquids can also have different densities. The same ideas apply: if a liquid is more dense than water it will sink, but if it is less dense than water it will float! Let's look at some common drinks.

Water and Kool-Aid: *Here we have two bottles - they each have the same volume of liquid in them. One is full of water, and the other is full of Kool-Aid. What will happen*

when I drop them into the water? (Demonstrate) *Which one sank and which one floated? Why did the Kool-Aid sink?* (It's more dense and "heavy" compared to the water because the Kool-Aid contains sugar, which is heavier than water.)

Coke and Diet Coke: *Here we have cans of Coke and Diet Coke - they each have the same volume of liquid in them. One is full of Coke, and the other is full of Diet Coke. What will happen when I drop them into the water?* (Demonstrate) *Which one sank and which one floated? Why did the Coke sink?* (It's more dense and "heavy" compared to the water because the Coke contains sugar, which is heavier than water.)

Can I have a liquid that is less dense than water? (Yes.) *Oil is less dense than water. What do you think will happen with oil? It floats on top! (Do you remember your last Science Action…?)*

Prepare before lab:

- Fill half of graduated cylinder with fresh water.
- Add 1 drop of blue food coloring to fresh water.
- Swirl the graduated cylinder to dissolve the food coloring.
- Fill the top half with cooking oil.
- Allow the two substances (water and oil) to settle.

Demonstrate how density affects the buoyancy of various gases: **(OPTIONAL)**
What else has different densities? Gases can also have different densities. The same ideas apply: if a gas is more dense than air it will sink, but if it is less dense than air it will float! Let's look at a fun example.

Air and helium-filled balloons, both with anchor weights at the ends of their strings: (Hold them by their narrow necks.) *We have two identical balloons, but one is filled with air while the other is filled with helium. What do you think will happen when I release them?* Hold them fairly low to the ground so that there is quite a bit of slack in their strings and then quickly release them. *What happened? Which one sank and which one floated? Why did the air-filled one sink?* (It's more dense and "heavy" compared to the surrounding air due to the additional weight of the balloon itself.) *Why did the helium-filled one float?* (It's filled with helium, which is less dense, and "light" compared to the surrounding air - and so it is able to overcome the additional weight of the balloon itself - and float.)

Summary:

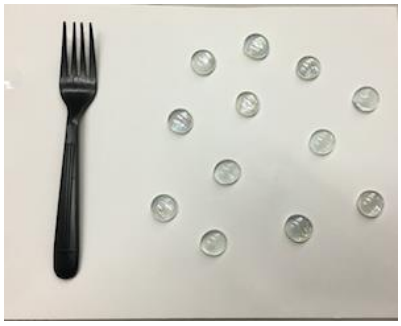
So we have now demonstrated displacement, and how it occurs when an object (a balloon) is placed in a medium (like water).

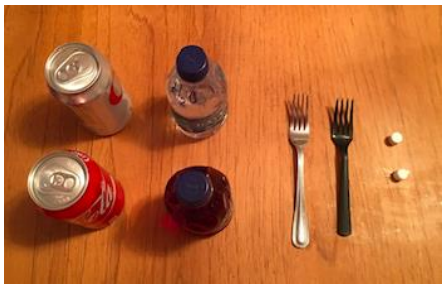
We have also observed that:

- *solid objects, and liquids, (and maybe even gases - if the optional section was performed) - can have different densities*
- *density affects an object's buoyancy*

Today you will get to do your own experiments with buoyancy and further explore the effects of displacement and density on buoyancy.

Break up into groups. Have children with long sleeves roll up their sleeves.





Parent Volunteer Notes for Grade 2 Buoyancy Lab

Note for Parent Volunteers: During this lab you may notice air bubbles on the objects. The air bubbles will help the objects float. Gently tap the objects to release any air bubbles. (This is an example of flotation, discussed in Activity #4.)

NOTES:

- Reserve Auditorium
- Request 6 tables
    - 1 table for Activity 1
    - 1 table for Activity 2
    - 1 table for Activity 3
    - 1 table for Activity 4
    - 1 table for Demonstration
    - 1 table for extra items
- Request usage of Janitorial Closet across from the Auditorium
- Request 1 large rolling trash bin.
- Use towels/rags versus paper towels for water spillage
- Salt Water – Use 4 ½ cups of salt in 1 gallon of water (This will make the real golf ball float)
- Purchase fresh Craisins every year.
- Left over Lentils can be used year after year.
- Use personal bowling ball and basketball

Activity #1: Displacement

Materials:

- 12 red grease pencils
- 1 fish tank or large clear plastic tub
- 1 gallon filled with fresh water
- 1 bowl filled with mini ceramic weights
- 6 clear plastic bins (1 per student in group)
- 6 clear plastic specimen cups (1 per student in group)
- 1 clear plastic specimen cup (1 for parent volunteer lead)
- 6 clear half plastic specimen cups (1 per student in group)
- 1 clear plastic specimen cup (1 for parent volunteer lead)

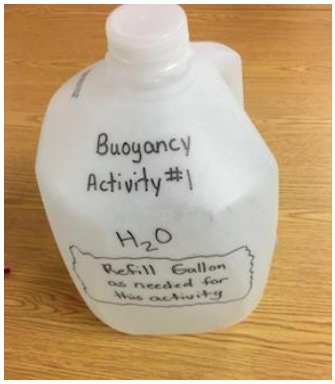
Advance Preparation:

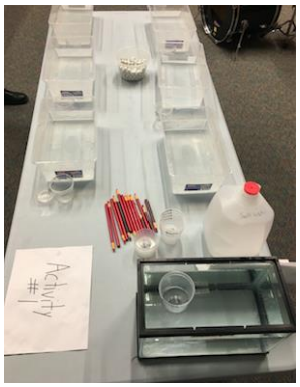
1. Parent Volunteer Only – Prefill the fish tank or large clear plastic tub for the lead parent volunteer.
2. Parent Volunteer ONLY – Prefill the small clear plastic bins that students will use during the activity.

Procedure:

1. *Two objects cannot occupy the same space at the same time.*
2. *In buoyancy this causes **displacement**.*
3. *Will something happen to the water when we add objects to the water container? Let's do some experiments to find out.*
4. Have a large container (Fish Tank or large clear tub) filled with water.
5. **Note:** Parent Volunteer ONLY – Prefill the container before the lab begins to speed up the process.
6. Parent Volunteer ONLY – Take a grease pencil and mark where the water level is on the 4 sides of the container. (This can be done before the lab starts or with each new group that rotates through.
7. Parent Volunteer ONLY – Take 1 clear specimen cup and float it on the water.
8. Parent Volunteer ONLY – Carefully push the cup into the water.
9. Ask students to come up and carefully push the cup into water.
10. Ask the students, "*Can you feel the force required to displace the water?*
11. Ask the students, "*Does the water level change as you apply this force?*
12. Parent Volunteer ONLY – *Now add some weights to the cup.*
13. Ask students, "*Do you see the water level rise?"*
14. Ask students, "*Why does this happen?*"
15. Explain to students: (*When the weights are added to the cup, the combination becomes heavier, and more dense. This allows it to overcome more of the buoyant force, and so it sinks down further, displacing more water. As the water is displaced, it has nowhere in the container to go but "up" and we see this as a rising water level.)*
16. *Remember, two things cannot occupy the same place at the same time – if they try, one or both of them will undergo **displacement**.*

17. Parent Volunteer ONLY – Provide each student with an empty clean/dry specimen cup.
18. Ask the students, "*Will the empty specimen cup float in your clear plastic bin?* (Parent discusses with students about making predictions. Yes, it will float.)
19. Ask the students to place the empty specimen cup into the plastic bin and observe.
20. Discuss the observations with the students.
21. Parent Volunteer ONLY – Distribute 12 mini ceramic weights to each child.
22. Ask the students, "*Do you think the specimen cup will still float if you add the 12 mini ceramic weights?*"
23. Ask the students, "*What happened?*" (It floats)
24. Discuss the results.
25. Parent Volunteer ONLY – Provide each student with an empty clean/dry specimen cup that has been cut horizontally to half its original height.
26. Show the students both halves of this specimen cup so that they can see that this cup was identical to the first specimen cup.
27. *Now let's look at this specimen cup – what's the difference about this cup?* (It is only half the height of the first specimen cup.)
28. Ask the students, "*Do you think that it will still float if we place 12 mini ceramic weights in this one?*"
29. Ask students to place the half cut specimen cut into the clear plastic bin and slowly add the 12 mini ceramic weights into it.
30. Ask the students, "*What happened?*" (It sinks).
31. Ask the students, "*Why did the half cut specimen cup sink while the full size specimen cup floated?*" (As the water in the container is displaced, it rises up the sides of the container and the specimen cup. The water only has to be displaced a little bit, causing a small rise in the water level, for it to pour over the edges of the half cut specimen cup and sink it. Now this cup has weights and water in it whereas before it only had weights and air. It now weighs more than an equivalent volume of water, and so it sinks!)
32. **Note:** Ensure students complete Data Record Sheet.
33. **Note:** Ensure students keep their Data Record Sheet under the table on the floor to prevent it from getting wet and ruined.


Buoyancy
Activity #1
H_2O
Refill Gallon
as needed for
this activity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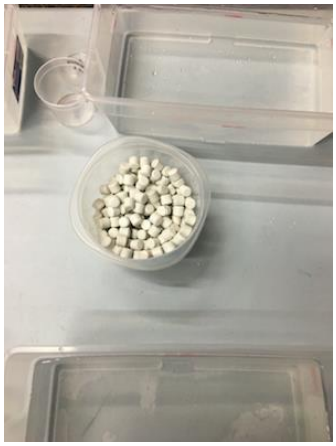


Activity #2: Varying the Density of the Object - Aluminum Foil Boats

Materials:

- 1 large clear plastic tub for lead parent volunteer
- 1 sheet of aluminum paper for lead parent volunteer (1 sheet per group or 4 per class)
- 1 sheet of aluminum paper for each student (average = 150 sheets)
- 1 gallon of fresh water
- 6 small clear plastic bins (1 per student in group)
- 10 small clear plastic specimen cups that include the following: different colored stones, rocks, bottle caps, yarn, pennies, and mini ceramic weights.

Advance Preparation:

1. Parent Volunteer ONLY – Prefill the large clear plastic tub for the lead parent volunteer.
2. Parent Volunteer ONLY – Prefill the small individual clear plastic bins that students will use during the activity.
3. Parent Volunteer ONLY – Organize 10 small clear plastic specimen cups in the center of the table in two rows.

Procedure:

1. Parent Volunteer ONLY – Parent takes one sheet of aluminum foil and asks, *"If I put this in the water, will it sink or float?"*
2. Parent Volunteer ONLY – Parent places the flat sheet of foil on top of the water. The flat sheet of foil floats. *Is this what you predicted?*
3. Parent Volunteer ONLY – *Will the flat sheet of foil hold anything and still float?* (Students make another prediction)
4. Parent Volunteer ONLY – Carefully place items on the flat sheet of foil and observe what happens. (Use yarn, bottle caps, pennies, stones, etc.) Add enough weight so that the boat does eventually sink. Discuss the results.
5. Ask students: *"Do you think that you could reshape the foil so that it could hold weights?"*
6. Parent Volunteer ONLY – Distribute 1 new/dry flat sheet of foil to each student.
7. Ask students to make boats out of the foil. (Each a different shape: round, oval, square, etc.)
8. Ask students to first try floating the boats to make sure they float.
9. Ask the students to predict how many weights their boats will be able to hold.
10. Have students carefully add weights to their boats and compare results.
11. Discuss with students: *Which shaped boat could hold the most weight? Why?* (The boat that displaces the greatest amount of water will be able to support the greatest amount of weight – because the more water you have displaced, the heavier the total amount of water displaced, and it is only when the boat and its contents weigh more than the weight of the water they displace that the boat sinks!)
12. **Note:** Ensure students complete Data Record Sheet.

13. **Note:** Ensure students keep their Data Record Sheet under the table on the floor to prevent it from getting wet and ruined.
14. **Note:** Ensure students dispose of their foil boats in trash bin.







Activity #3: Varying the Density of the Medium - Salt Water

What if instead of changing the density of the object in water, we change the density of the water itself?
Water found in lakes is different from water found in oceans - lakes contain fresh water and oceans contain salt water.
Do you think objects will float the same in both types of water or will they experience different buoyant forces and so behave differently?
Let's do some comparisons to see.

Materials

- 4 Plastic bins
    - 2 plastic containers with fresh water
    - 2 plastic containers with salt water
- 2 Popsicle sticks (use 1 stick in each salt water bin for stirring the salt)
- 2 Gallons of fresh water
- 2 Gallons of salt water
    - NOTE: Prepare salt water before lab. Use 4 ½ cups of salt in 1 gallon of water.
- 3 boxes of salt (1 box of salt = 48 oz.)
- **NOTE**: At the end of each lab remove all mini ceramic weights from inside plastic eggs. Ensure to wash and dry all mini ceramic weights, plastic eggs, golf balls, and plastic golf balls. If all items are not properly washed and dried, they can become damaged and usable for the following year due to the excess salt.
- **NOTE**: After the completion of the Science Action, ensure to wash all items used in this lab with soap and water and dry before storing for the following year.

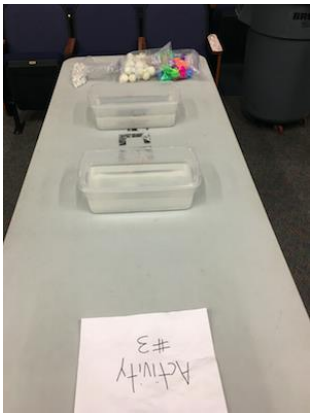
Advance Preparation

1. Parent Volunteer ONLY – Prefill 2 gallons with fresh water from the janitor's closet.
2. Parent Volunteer ONLY – Make salt-water mixture before lab and prefill 2 gallons.
3. Parent Volunteer ONLY – Pour fresh water from the fresh water gallon into 2 plastic containers.
4. Parent Volunteer ONLY – Pour salt-water mixture from the salt-water gallon into 2 plastic containers.
5. Parent Volunteer ONLY – Continually mix salt-water mixture with the popsicle stick.

Procedure:

1. Have students make predictions before adding objects into the 4 plastic containers.
2. Parent Volunteer ONLY – Ensure 2 plastic containers containing fresh water are on one side of the table and 2 plastic containers containing the salt-water mixture are on the other side of the table.

3. Have students place 1 plastic egg in the fresh water container and 1 plastic egg in the salt-water mixture at the same time.
4. Have students observe the results.
5. Have students compare and discuss the results.
6. **Note*:*** *Some objects will sink in regular water, but will float in salt water because salt water has a greater density than regular water.* (Think of it this way: In regular water the egg is more dense than the water and so it sinks. In salt water, the egg is less dense than the water and so it floats!)
7. **Note:** Students can push down on floating objects in salt water to feel the buoyant force pushing back on the objects.
8. **Note:** *Now that everyone has had the opportunity to see that some objects that do not float in regular water will float in salt water. Let's reexamine some of the objects that we used earlier in this lab.*
9. Have students place 1 regular golf ball in the fresh water container and 1 plastic golf ball in the salt-water mixture at the same time.
10. Have the students observe the results.
11. Have students compare and discuss the results.
12. Have students add the mini ceramic weights into the plastic egg to determine how many weights it will take to sink the plastic egg.
13. **Note:** Ensure students complete Data Record Sheet.
14. **Note:** Ensure students keep their Data Record Sheet under the table on the floor to prevent it from getting wet and ruined.



Activity #4: Increasing Buoyancy through Flotation - Dancing Craisins and Lentils

Can an object that sinks be made to float? Let's do an experiment to find out.

Materials:

- 7 up (8 – 2 Liter Bottles)
- 2 Bags of Lentils
- 2 Bags of Craisins
- 7 tall clear cups

Procedure:

1. Parent Volunteer ONLY – Distribute 1 tall clear cup to each student.
2. Parent Volunteer ONLY – Pour 7up (colorless soda) into a dry and clear tall cup.
3. **Note**: Point out the bubbles coming up from the bottom of the cup and explain that, "*the bubbles are carbon dioxide gas released from the liquid."*
4. Ask the students to predict what will happen when you add Craisins to the colorless soda (7up). *"Will they sink or will they float?"*
5. Parent Volunteer ONLY – Distribute between 5 – 10 Craisins to each student.
6. Ask each student to predict what will happen once the Craisins are added into the 7up.
7. Ask each student to drop their Craisins into their own cup.
8. Ask students to make observations.
9. Discuss the observations. (The Craisins first sink, then alternately rise and sink.)
10. **Note**: If the Craisins are not alternatively rising and sinking, make sure the Craisins are fresh and gently tap on the cup to help the process.
11. **Explanation**:
    a. *The Craisins are denser than water so at first they sink to the bottom of the cup.*
    b. *As the tiny bubbles of carbon dioxide gas rise, they are attracted to the rough surface of the Craisins and so attach to the Craisins.*
    c. *Now the Craisins occupy a greater volume (have a greater "size"), but the bubbles don't add much weight, so the overall density of the Craisins has decreased – the Craisins are bigger, but not really heavier so they rise to the top.*
    d. *Once at the top, the bubbles pop, causing the Craisins to return to being denser than the water again, and so they sink once more.*
12. When the action slows down, ask the students to predict what will happen when you add lentils to the water.
13. Parent Volunteer ONLY – Distribute between 5 – 10 Lentils to each student.
14. Ask each student to predict what will happen once the Lentils are added into the 7up with the Craisins.
15. Ask each student to drop their Lentils into their own cup.
16. Ask students to make observations.
17. Discuss the observations.

18. The lentils first sink and then both the Lentils and the Craisins resume alternately floating and sinking.
19. Ask the students, *"Can you think of an occasion when you have behaved like a floating Craisin?" If you have ever worn a set of inflatable floaters or an inner tube while in the water, then you have greatly increased your volume (size) with just a very small increase in weight. So your density becomes less than the density of water – and you float!*
20. Parent Volunteer ONLY – Dump both Craisins and Lentils into black bucket by using your hand or utensil. Keep the 7up liquid.
21. Parent Volunteer ONLY – Refill tall clear cup with 7up as needed (Add 7up after each rotation)
22. **Note:** Ensure students keep their Data Record Sheet under the table on the floor to prevent it from getting wet and ruined.

Conclusion:

Did anyone learn anything new about buoyancy?
Did any of the demonstrations surprise you?
What did you enjoy most about this Science Action?