



WATER WORKS:

Adventures in Density

Students conduct investigations to discover how different temperatures and pressure and salt affect the density of water, relate water molecule compactness to density of water and relate their discoveries to literary adventures.

Adapted from “Project Wet”

Activity time – After Station Set-up:
30-40 minutes

Grades: 4 – 6

Water Words:

Density, mass, volume, molecules, molecular bonds and salinity

Materials - Teacher Demo:

- 2 clear plastic cups
- ¼ cup oil
- ¼ cup water
- Copy of density diagram
- Copies of Activity Sheet (1 per group)
- Copies of Reading - 1 copy per student

Activities:

- Very hot water – Thermos
- Very cold water
- Red and blue food color
- Clear plastic cup
- Straws – for dropper
- Colored ice cubes (need to make)
- ½ -1 cup salt

Background

Water is one of the few substances on Earth that can be naturally found in all three states: solid, liquid, and gas. One difference of each of the three states is **density**. The number of particles (mass) within a certain space (volume) determines the density of a substance. The density of water can be influenced by a variety of factors, and many aspects of water density play important roles in life on Earth.

Water Density Concepts

Review each factor of density with the class:

Temperature affects the density of water.

- ◆ Heating speeds up the movement of water molecules causing them to bounce off each other and move apart. Therefore, there are less molecules within a certain space and warm water is less dense than cold water.
- ◆ As water cools the molecules lose their heat energy and move slower. They move closer together becoming denser.
- ◆ This temperature difference causes warm water to rise and cold water to sink. Since cold water has more molecules closer together, they can support the less dense warm water.
- ◆ When cold water turns to ice something unique happens. The molecular bonds between water molecules spread out and become arranged in a lattice pattern. This means the molecules are more spread out and the cold water becomes less dense than liquid water. This is why ice floats.

Dissolving substances in water changes the density of water.

If you dissolve salt in water, you have salt and water molecules occupying the same space which increases the density.

Pressure also increases the density.

- ◆ When you apply pressure, you decrease the space between molecules allowing for more molecules to occupy the same amount space.
- ◆ At different depths in a lake, you will encounter different temperatures and pressures. Also, the weight of the molecules from above press down on the molecules below. As the depth of water increases the density increases.
- ◆ You will encounter less sunlight as you go deeper in a lake which causes lower water temperatures.
- ◆ A large body of water like Lake Michigan contains many density levels. Each level provides a different habitat where you can find different plants and animals. People that fish and harvest food from lakes and oceans drop their nets or fishing lines at a specific depth (density) for specific food.
- ◆ Lake Michigan and other temperate climate lakes benefit in another way from water density through a process called turnover. As surface water cools in fall it becomes denser. Water has its greatest density at 39° F, below this temperature it begins to freeze.
- ◆ As stated earlier, ice crystals arrange themselves in a lattice pattern and causes ice to float. Ice acts as an insulator and prevents deeper water from freezing. This allows many types of wildlife and plants to survive the winter. As the temperature rises in spring the ice melts. The surface water is still colder than the lower levels and has a greater density, and so the colder water sinks and circulates oxygen and nutrients to lower depths.

Getting Started – Teacher Demo:

Take a plastic cup and fill with 1/3 cup water and 1/3 cup oil on top of the water. Ask, “Which weighs more, a pound of lead or a pound of feathers?” Of course, the answer is they both weigh the same. However, lead is denser.

Ask if they know the definition of density. Show students the **Density Diagram**. Ask them to decide which box represents lead, the denser material. Help students understand that density is related to the compactness of the particles or molecules. Show students the cup with the layers of water and oil. Tell them they both contain equal amounts of liquid. Ask them to explain what happened to the liquids and which diagram best illustrates water and oil.

Getting Wet:

#1 Density Activities: Setup stations and cut out a copy of each activity attached. Place an activity card at each station. There are five stations; three stations deal with temperature effects on density and the other two deal with salinity. Have students work in groups and rotate through the stations, or if time is limited, have each group perform one activity and then have a sharing time where each group explains what they did, what happened and why. **Students can enter results in their Water Log if used.**

NOTE: Temperature Station 1 can be done as a teacher demonstration if there is concern about the students working with hot water.

#2 Light Reading: Complete the literature exercise. Copy and hand-out copies of the 3 *Heavy and Light Reading* attached.

Answers to Heavy & Light Reading:

1. The Iceberg Hermit: Ice floats, as the molecules expand and become less dense, so it acts like a platform for the wildlife to rest.
2. The Adventures of Huckleberry Finn: It's easier to float on salt water because it is denser and will hold the weight of the floating object.
3. Old Man and The Sea: The deeper the water the colder water. Therefore, the water at the surface is less dense – warm water is less dense than cold water.

Wrap up:

Have students summarize the results of their activities. Challenge each group to brainstorm ways to alter the experiments. For example, if they floated fresh water on salt water, how would heating one change the results? They can write these up and present them to other groups. If time allows, students can try out their ideas, or do one as a demonstration.

Assessment:

Have students:

- Demonstrate the relationship of water temperature and salinity to of density.
- Cite examples of different densities of water in literature.
- Have students cite situations in their lives that have involved different densities of water, such as ice skating, feeling colder water on the bottom of a lake while swimming or floating in salt water in the ocean.

Adventures in Density

Action Card

Temperature Station #1

1. Get two clear plastic cups. Label one, "Hot" and the other, "Cold". Pour cold and hot water in the appropriate cups.
2. Put a drop of red food coloring in hot water.
3. Predict what you think will happen when you pour one liquid over the other.
4. Gently tilt the cups towards each other until the cups touch.
5. Slowly pour the hot water over the cold.
6. Look at the cup from the side. Draw what you see and label the picture with the cold and hot water.

Which liquid is denser?

Why did you answer the way you did?

Hint: How does heat energy affect the movement of water molecules? Think about the movement of boiling water to cool water. Do molecules stay closer together when they move slowly or when they move quicker?

Adventures in Density

Action Card

Temperature Station 2:

1. Get two clear plastic cups. Label one, "Hot", and the other, "Cold". Pour cold and hot water in the appropriate cups.
2. Add blue food coloring to the cold water. Put a straw in the cold blue water and position your finger over the opening to plug it. Using the straw as a dropper, lift the straw out of the water. Water should stay in the straw.
3. Put the straw on the inside edge of the cup of hot water.
4. Predict what will happen when you release your finger on the straw.
5. Slowly release the cold blue water.

Where does the cold water go?

Why did this happen?

Draw and label what you observe.

Adventures in Density

Action Card

Temperature Station 3:

1. Float a colored ice cube in a clear plastic cup of warm water.
2. Look from the side. What happens?

Even though the ice is colder than liquid water it floats. How does the density of ice compare to liquid water?

Draw what you observe.

Adventures in Density

Action Card

Salinity Station 1:

1. Fill two plastic cups with cool water. While stirring, add salt to one of the cups until no more salt will dissolve.
2. Predict whether a hard-boiled egg will sink or float in your solution.
3. Place a hard-boiled egg in each cup. The egg should float in the salt water. If not add more salt.

Why does the egg float in salt water?

How does adding salt affect the density of water?

Adventures in Density

Action Card

Salinity Station 2:

1. Fill two plastic cups with cool water. While stirring, add salt to one of the cups until no more salt will dissolve.
2. Add a drop of food coloring to the fresh water. (water with no salt added)
3. Try to float the fresh water on top of the salt water. Gently tilt the cups towards each other till the cups touch. Slowly pour the fresh water over the salt water.

Look at the cups from the side.

Explain what happened and why.

Draw a picture of your observations.

Adventures in Density

Heavy and Light Reading

Relate what you have learned from your experiments to the following excerpts from the following selections, pay special attention to words or phrases in bold.

The Iceberg Hermit by Arthur Roth

Summary:

Allan Gordon was shipwrecked on an iceberg where he lived for two years. He finally made contact with the native people and lived with them for an additional five years, until a Dutch whaling ship found him. Allan Gordon observed the following about the Arctic wilderness that surrounded him.

Excerpt:

...there was plenty of wildlife. He often saw seals sleeping on pans of **ice**. Small herds of walrus sometimes **used the iceberg as a resting platform**, between dives to the sea floor after clams and other shellfish. Birds of all descriptions flew over and often **landed briefly on his ice island**. On several occasions Allan spotted the high feather of mist that came from a sounding whale, and once he even saw the long twisting horn of a narwhal.

Explain how the wildlife observed by Allan Gordon depended on density.

The Adventures of Huckleberry Finn by Mark Twain

Summary:

This famous story recounts the adventures of a young boy and a runaway slave on a raft floating down the Mississippi River.

Excerpt:

.....It's lovely to live on a **raft**.....Once or twice a night we would see a steamboat slipping along in the dark....and by and by her waves would get to us, a long time after she was gone, and **joggle the raft** a bit.....

Would it be easier to float a raft on salt water or fresh water?

***The Old Man and the Sea* by Ernest Hemingway**

Summary:

An old Cuban fisherman struggles to catch a giant marlin and is pulled far out into the ocean.

Excerpt:

They sat on the Terrace and many of the fishermen made fun of the old man and he was not angry. Others, of the older fishermen, looked at him and were sad. But they did not show it and they spoke politely about the **current and the depths they had drifted their lines at** and the steady good weather and of what they had seen....

This far out, he (the marlin) must be huge in this month, he thought. Eat them (sardines), fish. Eat them. Please eat them. How fresh they are and you **down there six hundred feet in that cold water in the dark**. Make another turn in the dark and come back and eat them.

How would the density of water near the surface of the ocean compare to water at greater depths?

STATION LABELS

Adventures in Density
Temperature
Station 1

Adventures in Density
Temperature
Station 2

Adventures in Density Temperature Station 3

Adventures in Density Salinity Station 1

Adventures in Density Salinity Station 2