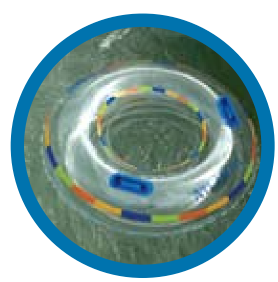
AQUAVENTURE

teacher resources
and activities



ATLANTIS
PARADISE ISLAND, BAHAMAS™

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message to our teacher partners

Atlantis, Paradise Island, strives to inspire students to learn more about the aquatic world that surrounds them in The Bahamas. Through the interactive, interdisciplinary activities in the classroom and at Atlantis, we endeavor to help students develop an understanding of the ocean and a desire to help conserve it and its wildlife. Aquaventure provides students with a thrilling and inspirational opportunity to learn about water and its physical properties as well as the importance of water safety at Atlantis and at the beach. Through students' visits to Atlantis, we hope to open up their minds to the physical sciences and help facilitate their critical-thinking and problem-solving skills. This knowledge should lead many on the path to future careers in the sciences. We are a resource for you. Please contact us if you have any questions as you prepare your students for their Aquaventure.

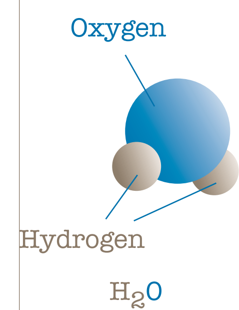
program goal and objectives

goal: Students will develop an understanding of water and its properties.

objectives: Upon completion of the Aquaventure unit, students will be able to:

- State the chemical composition of water.
- Draw a picture of a water molecule.
- List the three properties of water.
- Define capillary action.
- Define cohesion.
- Define surface tension.
- List the three states of water.
- Compare and contrast evaporation, sublimation, condensation, and frost formation.
- Determine distances traveled through different routes at Aquaventure.
- Define buoyancy and determine if an object is buoyant in freshwater and seawater.
- Measure the velocity of a moving object.
- Convert gallons to liters and feet to meters.
- Explain how osmosis works.

what is water?

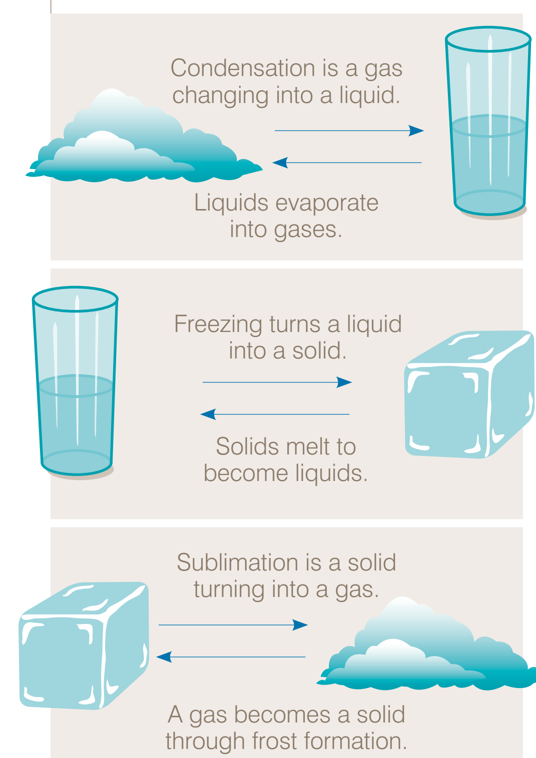


Water is a necessary part of all life on Earth. It is composed of two atoms of hydrogen and one atom of oxygen—you might have heard people call it H_2O. Water covers 71% of our planet. There is very little freshwater on the Earth—only 0.6% is found in rivers, lakes, and streams. The rest of the water is either seawater, which makes up 97% of all water, or in ice caps and glaciers, which make up the remaining 2.4% of the world's water.

Your body is also mostly water, in fact, about 75%. Adults' bodies are 50-65% water.

Water has three states

You can find water in three different states: gas, liquid, and solid. When you boil water it evaporates and becomes a gas. When the gas cools and condenses it changes into a liquid. When the liquid is frozen it becomes a solid or ice. When the solid or ice melts it becomes a liquid. And if water turns directly from a solid to a gas the process is called *sublimation*, and when it changes from a gas to a solid it is called *frost formation*.



Water has a lot of unique properties. Most liquids become smaller, or contract, when they become a solid. Water contracts until it reaches 4°C, and then it expands until it becomes a solid. If water worked like other liquids, ice would sink to the bottom of your glass, the bottom of a pond would freeze before the top, and icebergs would not exist.

You Experiment!

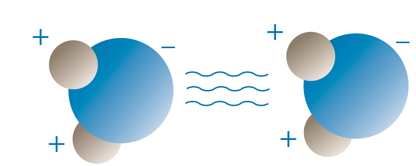
1. Dry your hand with a towel. Feel it carefully: Is it wet or dry?
2. Place your hand about one inch in front of your mouth. Slowly breathe out eight times (do not blow).
3. Feel your palm: Is it wet or dry?
4. Your palm should feel moist. Why? Repeat this experiment with a mirror in front of your mouth. What do you see now?

Adhesion and cohesion

Water molecules attract each other in a process called *cohesion*. When water is attracted to other materials, this is called *adhesion*. At the oxygen end of water there is a negative charge. The hydrogen atom end has a positive charge. That means the hydrogens of one water molecule are attracted to the oxygen from other water molecules. This attractive force is what gives water its cohesive and adhesive properties.

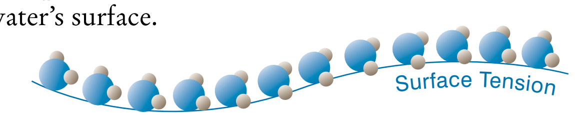
Opposites do attract!

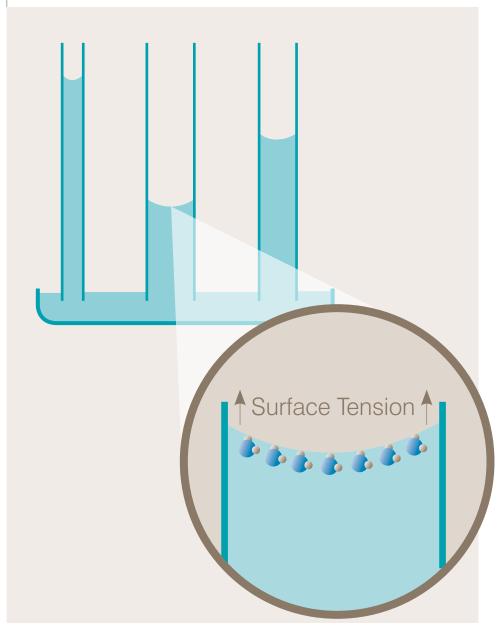
The negative charge of an oxygen atom attracts to the positive charge of the hydrogen atom.



Surface tension

Have you ever noticed that some insects look like they are walking on water? Believe it or not, they are! It is surface tension that allows them to perform this feat. Surface tension is the term we use for the joining of water molecules at the water's surface.





q: Why does the water rise higher in the thinner tube?

a: Weight will determine how high the water rises, so it will rise higher in the thinner tube.

You Experiment!

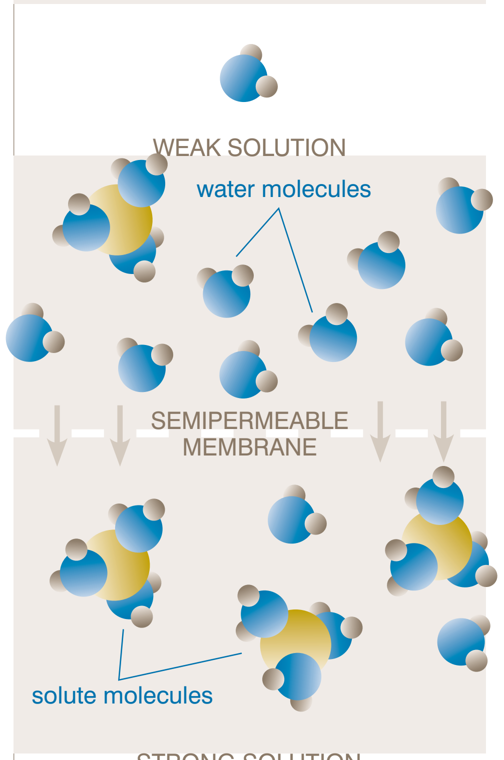
1. Gather a small cup of water, a piece of wax paper, and a paper clip.
2. Place a small drop of water onto a piece of wax paper. Examine it carefully. What shape is it? Why do you think it is this shape? What is happening? Each molecule in the water drop is attracted to the other water molecules in the drop. This causes the water to pull itself into a shape with the smallest amount of surface area, a bead (sphere). All the water molecules on the surface of the bead are "holding" each other together and creating surface tension.
3. Next take a cup of water and place a paper clip on the surface. Surface tension helps float the paper clip.

Capillary action

What is capillary action? It's the movement of water molecules along the surface of a solid caused by the attraction of molecules of the liquid to the molecules of the solid.

You Experiment!

1. Collect a small cup of water, a thin clear straw, and a thick clear straw.
2. Lower the thin straw into the water.
3. What do you see? The water "climbs" up the straw. The water molecules are attracted to the straw molecules. When a water molecule moves closer to a straw molecule, other water molecules that are attracted to each other also move up the straw. It is like the molecules are playing piggyback!
4. Lower the straw into the water. Does the water rise higher in the thin or thick straw? You should see the water rise higher in the thinner straw.



Diffusion and osmosis

Diffusion is the movement of molecules from a region in which they are highly concentrated to a region in which they are less concentrated. It depends on the motion of the molecules and continues until the system in which the molecules are found reaches a state of *equilibrium*, which means that the concentrations are equal throughout the system. Osmosis is a special case of diffusion. *Osmosis* is the movement of water through a semipermeable membrane, such as a cell wall. In this case, a large molecule like starch is dissolved in water. The starch molecule is too large to pass through the pores in the cell membrane, so it cannot diffuse from one side of the membrane to the other. However, the water molecules can, and do, pass through the membrane. Hence the membrane is said to be *semipermeable*, since it allows some molecules to pass through.

During the process of osmosis, water moves from the area of weak concentration of solutes, such as starch, to the strong concentration of solutes until equilibrium is met. The large molecules cannot cross the membrane because they are too large, so more water moves to the side with the higher concentration of solutes, which allows equilibrium to be met.

water on the move

objective: Students will observe osmosis in action and be able to state the effect of four different substances on a membrane.

Introduction

The membrane of a chicken egg has many similarities to the membrane surrounding animal cells. In this experiment we are going to look at how water moves across a membrane.

Supplies

- Corn syrup
- Eggs: four large for each student team
- Foil or plastic wrap
- Food coloring: blue or black
- Glasses: four for each team (preferably wider rather than taller)
- Grease pen or masking tape and marker for each team
- Molasses
- Paper
- Pen
- Tape measure (or a piece of string and ruler) for each team
- Toothpicks
- Vinegar: white
- Water
- Data table: one per student

step 1

1. Label each glass with a grease pencil or on a piece of tape with the student team's name and the numbers one through four.
2. Place each egg in a separate dish.
3. Pour vinegar into each glass until it covers each egg.
4. Cover each glass with foil or plastic wrap.
5. Place glasses in a refrigerator for 24 hours.

step 2

1. Describe the condition of the eggs.
2. The vinegar should have dissolved the egg's shell, leaving only the inner membrane. Assure students that they can proceed even if some shell remains.
3. Pour the vinegar out of each glass, rinse out each glass, and very lightly rinse each egg with water.
4. Measure the widest part of each egg with a tape measure or a piece of string. To use string, wrap it around the egg once and mark the length with a marker, then place it on a ruler to determine the length.
5. Record the length around each egg on the data table.
6. Cover one egg with water, one with water and a drop of food color, one with molasses, and one with corn syrup.
7. Cover the eggs with foil or plastic wrap and place in the refrigerator for 24 hours.
8. Have the students make predictions about what will happen with each egg and record on data sheet.
9. Be prepared to uncover the results in 24 hours!

step 3

1. Carefully remove the eggs from each of the four containers and rinse them gently with water.
2. Measure the eggs around the widest part using the tape measure or string and ruler.
3. Record the measurements on the table.
4. Place the eggs back into each of the dishes.
5. Use a toothpick to pop the membrane of each egg.
6. Record what was inside each egg.

Questions for review

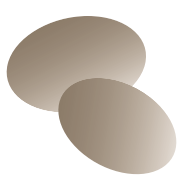
1. What substances caused the width of the egg to increase? Why did the egg expand?
2. What substances caused the width of the egg to decrease? Why did the egg decrease in size?
3. Did any eggs remain the same size?
4. How did the results compare with your predictions?

Data Table

	substance	prediction	width before	width after	what was inside the egg?	other observations
EGG 1						
EGG 2						
EGG 3						
EGG 4						

Experiment results

Water was the substance that was able to move through the egg membrane because of the small size of the molecule. The food-color molecule is also very small, so it may have passed across the membrane, too.



If the egg was smaller in size in the molasses and corn syrup, then the water moved out of the egg through the membrane. This would be due to the lower concentration of water outside of the egg in the molasses and corn syrup than inside of the egg.

If the egg increased in size, then water moved into the egg. Just like in the molasses and corn syrup cases, the water moved from an area of lower concentration to higher concentration; however, the lower concentration of water was inside the egg in the plain water and food-colored water dishes. As you can imagine, if too much water rushes into the egg due to osmosis, this could cause the egg membrane to pop! Occasionally, this happens to cells in our bodies, too!

the freshwater and seawater challenge

objective: Students will learn the three states of water and compare and contrast the differences between seawater and freshwater.

Master supply list: One set for each student group.
Note: This activity can be done as a demonstration.

NOTES ON USING ALCOHOL AND DRY ICE: Alcohol may be used as a liquid in the experiment for comparison. Make sure that the alcohol is in a closed container and do not let it splash. ALCOHOL IS FLAMMABLE. Isopropyl alcohol works nicely because it contains water. When the water in the alcohol freezes, it should sink. There are numerous stores that sell dry ice as either chunks or cubes. Ask the salespeople at the store for the best way to handle the dry ice. If you cannot find or do not wish to use dry ice, you can use a salt-ice mixture.

Supply list for all activities

- Distilled water
- Seawater (if seawater is unavailable, check the pet store for “Instant Ocean” mix)
- Isopropyl alcohol (optional)
- Hot plate
- 3 flasks, each with a rubber stopper that holds a thermometer
- 3 thermometers that can measure from -10° to 110° C
- 3 large test tubes, each with a one-hole fitted stopper
- 3 Pyrex beakers
- Dry ice chunks
- Bucket of ice water
- Stopwatch
- Gloves
- Graph paper

station 1 Boiling Hot!

You'll need:

- Distilled water at room temperature
- Seawater (if seawater is not available, check the pet store for “Instant Ocean” mix) at room temperature
- Isopropyl alcohol (optional) at room temperature
- Hot plate
- 3 flasks, each with a rubber stopper that holds a thermometer
- 3 thermometers that can measure from -10° to 110° C
- Stopwatch
- Graph paper

1. You will be comparing the differences between seawater, a type of saltwater, and distilled water, a type of freshwater. If you were to boil both, which type of water do you believe would boil first?
2. Pour equal amounts of room-temperature distilled water, seawater, and alcohol into a flask. Place a stopper on top on the flask and insert the thermometer.
3. Record the temperature of the distilled water, seawater, and alcohol in the flasks. Turn on the hot plate.
4. Place the flask with the distilled water on the hot plate. Check and record the temperature of the water every 30 seconds. When the water begins bubbling and the temperature levels off, the water is boiling. Keep recording the temperature for 3 minutes after you see bubbles. Plot and graph your data. What is the boiling point of distilled water? How long did it take the distilled water to reach the boiling point?
5. Repeat the experiment with seawater. Record the thermometer reading every 30 seconds. Plot and graph your data. What is the boiling point of seawater? How long did it take the seawater to reach the boiling point?
6. Optional: Repeat the experiment with alcohol. Record the thermometer reading every 30 seconds. Plot and graph your data. What is the boiling point of alcohol? How long did it take the alcohol to reach the boiling point?
7. Compare the results of the three experiments. Use your graphs. Are there any differences in the boiling points? How do you explain these differences?

Experiment results

The boiling point of a liquid is the temperature at which it turns to gas. Water, when heated, evaporates and boils slowly compared to other liquids. This means that the heat of vaporization, or the amount of heat needed to turn a liquid to a gas, is high, the highest of all common liquids. Because of the high heat of vaporization, water evaporates slowly and absorbs a lot of heat. Water's high heat of vaporization gives it a high boiling point (100° C). This is why much of Earth's water is in liquid form.

Lesson extension

Have students think about evaporation from the ocean surface in comparison to evaporation from the surface of a freshwater blue hole. How would these processes differ? Which evaporates more readily? Then have the students look at a map of surface salinity of the oceans. Is the pattern they see consistent with how much sunlight reaches different parts of the Earth? Does the pattern of salinity coincide with that of sea surface temperature? What other factors might affect sea surface salinity? Think about the surface temperatures of other planets and moons in our solar system. Are any others able to host liquid water? How does their surface temperature affect each planet or the moon's ability to support life as we know it?

station 2
The Freeze Is On!

You'll need:
- Distilled water at room temperature
- Seawater at room temperature (if seawater is not available, check the pet store for "Instant Ocean" mix)
- Isopropyl alcohol at room temperature
- 3 thermometers that can measure from -10° C to 110° C
- 3 large test tubes, each with a one-hole fitted stopper
- 3 Pyrex beakers
- Dry ice chunks
- Gloves
- Graph paper

1. You will explore the freezing point of water, including the differences between seawater and freshwater. For pure water, the freezing point is defined as 0° C, but have you ever measured it? How can we measure it? Can we put the thermometer in a solid chunk of ice or in chopped ice? What is the temperature of ice? Which will freeze more slowly, seawater or freshwater? Why?
2. Fill one test tube with distilled water, the second with seawater, and the third with alcohol, all at room temperature. Insert the thermometer through each rubber stopper and cap the test tubes. Make sure that the thermometer is suspended in the water. Record the temperature of each test tube.
3. Using tongs or heavy gloves, fill the bottom of three Pyrex beakers with chunks of dry ice. DO NOT TOUCH THE DRY ICE WITH YOUR BARE HANDS! Place each test tube in a beaker of dry ice.
4. Record the temperatures every 30 seconds until they level off. Observe the test tube of alcohol. What happens to the water that is in the alcohol? Compare it to the freezing point of the seawater and of the freshwater. Does the ice float or sink?
5. Plot and graph your data. Compare the information on the three graphs. What is the freezing point of freshwater? Seawater?

Lesson extension

The fact that water ice is lighter than liquid water has key implications for Earth. Can your students think of why this property is so important? Have them think about the implications this has for ocean life and life in our blue holes and rivers. Another interesting property to consider is that when ice is formed it gives off heat. How might this affect our oceans, blue holes, and rivers? Can they think of other ways this helps humankind? For example, how might farmers use this knowledge when protecting their crops from freezing air temperatures?

station 3
The Heat Is On!

You'll need:
- Hot plate
- 2 flasks (same size)
- 2 thermometers
- Bucket of ice water
- Stopwatch

1. You will examine water's ability to store heat. Water has a higher heat capacity than almost any other liquid. This means that it takes a lot of heat to significantly change water's temperature. We can measure and compare the heat capacities of water and air. Based on your experience, which will heat and cool more slowly: water or air? Why?
2. Fill one flask with water and leave one flask empty. This flask is filled with air. Insert thermometers through rubber stoppers and cap the flasks.
3. Record the temperature in each flask at room temperature. Place both flasks on top of the hot plate and start the stopwatch. Record the time it takes for the water to reach 33° C. Also record the temperature of the empty flask at that instant. Is the temperature in the flask of air higher or lower than the temperature of the flask of water?
4. Remove both flasks from the heat and place them in ice water. Record the time it takes for each flask to reach its original room temperature. Which flask took longer to reach its original room temperature? Record your observations.

Lesson results

Water, when heated, evaporates slowly in comparison to other liquids. This means that the heat of vaporization is high—the highest of all common liquids. Water also has a high *latent heat of fusion*. Latent heat of fusion refers to the amount of heat gained or lost when a substance changes from a solid to a liquid, or from a liquid to a solid. When ice is formed, large quantities of heat are given off. Liquid water also has an extremely high *heat capacity*, the amount of heat required to raise its temperature between the freezing and boiling points. The high values of the heat capacity, heat of vaporization, and latent heat of fusion mean that it takes more heat to cause a change in the temperature in water than in most other substances. This makes water a strong buffer against both rising and falling temperatures.

Lesson extension

Water covers about 71% of Earth's surface, so its ability to store heat strongly affects our climate. Have your students look at an image of night-to-day mean surface temperature difference. About how much does the ocean temperature change from day to night? Do land areas experience greater or lesser differences in temperature from day to night? How does this affect the climate of coastal regions? What would happen if our oceans only covered 25% of Earth's surface? Would the day-to-night temperature difference on land masses be more or less extreme? How does the lack of liquid water oceans affect day-to-night temperature differences on some of the other planets and moons in our solar system?

math mysteries

Aquaventure contains massive amounts of water, fabulous filtration systems, and acres of action. Following is data you will need to solve the math puzzles below.

Facts for figuring

1. The Aquaventure river holds 2 million gallons of water.
2. About 83 million gallons of water pass through the wave generator each 8-hour operating day.
3. The wave generator system dumps 43,000 gallons into the river in about 3 seconds.
4. The river filtration system filters all of the water in the river in 1.66 hours.
5. The Power Tower is 71 feet high.
6. The wave generator building is 35 feet high. The water drops about 14 feet from the tank inside the building to the river below to create the wave effect.
7. The total length of the river is 3,420 feet.
8. The large slide conveyor is 232 feet long. The river-to-river conveyors are both 120 feet long. The slope of the conveyors is 15° and they travel at about 60 feet per minute.
9. The Abyss Slide is 237 feet long.
10. The slides all have specific volumes of water going through them. They are as follows:

- Abyss Slide = 300 GPM
- Falls Slide = 5,325 GPM
- Dark Slide = 5,300 GPM
- Surge Slide = 3,800 GPM

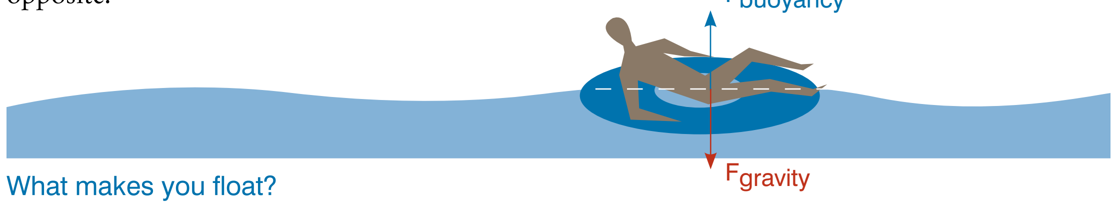
Metric Conservation Chart

unit	when you know	multiply by	to find	unit
LENGTH				
in.	inches	25.4	millimeters	mm
ft.	feet	0.305	meters	m
yd.	yards	0.914	meters	m
mi.	miles	1.61	kilometers	km
VOLUME				
fl. oz.	fluid ounces	29.57	milliliters	ml
gal.	gallons	3.785	liters	l
$ft.^3$	cubic feet	0.028	cubic meters	m^3
$yd.^3$	cubic yards	0.765	cubic meters	m^3
MASS				
oz.	ounces	28.35	grams	g
lb.	pounds	0.454	kilograms	kg

you and your inner tube

The physics of Aquaventure

When you are sitting in your inner tube, the gravitational force and buoyancy force are equal and opposite.



What makes you float?

Take a close look at something floating in the water. What you will notice is that part of the object is actually under the water! When you place an item in the water, it starts sinking. If the water that is displaced by the object doesn't weigh more than the object, the object will keep pushing water away—and sink!

When you are sitting in an inner tube, you are buoyant. Buoyancy is an upward force created as the still water pushes up on the inner tube. The water exerts its force on every part of the inner tube that it touches, yet the buoyant force acts as if it were one force pushing up on the inner tube at the center of buoyancy, which is the center of mass of the water displaced by the inner tube.

key concept

Objects that are heavier or more dense than the same amount of water will sink. Density is a measure of how much mass is present in a given volume. For an object to float it must be less dense then the amount of water it is in.

What is gravity?

Gravity is the attractive force in all things. Gravity is a force that pulls on every atom in you and your inner tube, yet it acts as if it were one force acting on your center of mass. In most people, their center of mass is located in the middle of their body, just behind their belly button.

What is net force?

You are in one of the large pools at Aquaventure and not moving. You are staying in one place, you are not accelerating. At this point, the sum of all the forces on you is zero, and this is called the *net force*. No acceleration means no net force.

What is potential and kinetic energy?

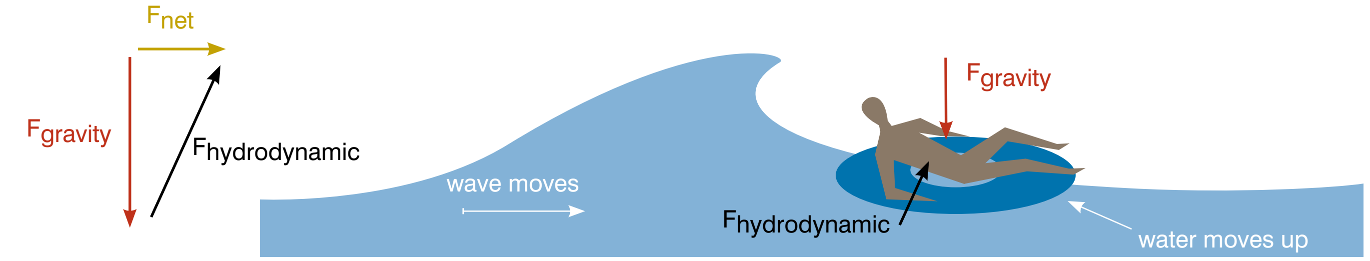
The purpose of the conveyor belt at Aquaventure is to create a store of potential energy. As you get higher up in the air on the belt, gravity can pull you down a greater distance. You experience this phenomenon almost every day while driving a car or riding a bike. You build up potential energy as you go up a hill, and when you go down the hill this energy is released as *kinetic energy*. The energy of motion takes you down the hill.

When you start barreling down a slide at Aquaventure, gravity takes control and all the potential energy you have built up while going up the conveyor belt changes to kinetic energy. Gravity applies a constant downward force on you in the inner tube.

Your river ride begins

As the wave reaches you in your inner tube, the surface of the water begins to tip at an angle. Think about that—liquid water sloping at an angle! This can only happen because the water is in motion. You can see the water move in a wave by watching bits of foam accelerate up the front of the wave. As the water rises under you, you find yourself on a slippery slope. Gravity is pulling you down that slope, buoyancy pushes you up, and new forces—hydrodynamic forces from the interaction of moving water with the inner tube—push you forward.

As you move just ahead of the crest of a wave, you can slide down the front of the wave. You feel acceleration as gravity pulls you down the wave, and the wave pushes you forward and up.



As you catch the wave, the water pushes the inner tube forward. At last the net force is not zero! The net force accelerates you to the speed of the wave and beyond. You enjoy the rush of acceleration as tons of moving water push you along faster and faster.

As you are moving down the river in the rapids, *velocity* describes how quickly you and your inner tube are changing positions. The higher the velocity, the quicker you are traveling between two locations. Phrases like "how fast" and "how quickly" are used to describe velocity. Often the word "speed" is substituted for the word "velocity" in common usage. However, technically the two are different. Velocity is actually speed with direction. For example, 60 mph, west, is a velocity. "West" is the direction and "60 mph" is the speed. The units of velocity are in the form of:

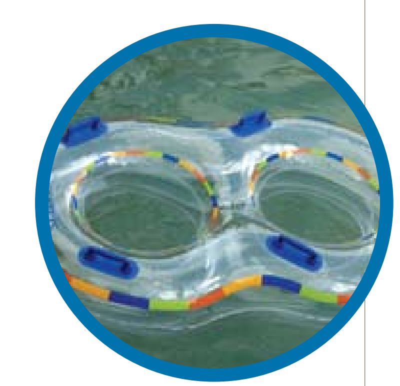
$$\text{Velocity} = \frac{\text{Units of Distance}}{\text{Units of Time}}$$

Example: $\frac{\text{meter}}{\text{second}}$ or $\frac{\text{mile}}{\text{hour}}$

In certain areas of the rapids, you accelerate. Acceleration describes how quickly you and your inner tube are changing your velocity. Phrases like "slow down," "speed up," "change speed," and "change velocity" are used to describe accelerations. The units of acceleration are in the form of:

$$\text{Acceleration} = \frac{\text{Units of Distance}}{\text{Units of Time}^2} = \frac{\text{Units of Velocity}}{\text{Units of Time}}$$

Example: $\frac{\text{meter}}{\text{second}^2}$ or $\frac{\text{mile}}{\text{hour}^2}$



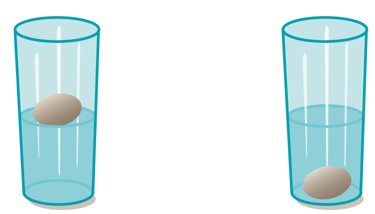
float or sink

objective: Students will compare and contrast the density of freshwater and saltwater and its effects on the buoyancy of an object.

Supplies
- Two eggs per team
- Two glasses per team
- Salt

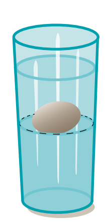
step 1
1. Mix plenty of salt (about 10 heaping teaspoons) into half a glass of water.
2. Fill half of the second glass with freshwater (no salt added to this glass).
3. Try floating an egg in each glass.

Experiment results
You will find that the egg will float in saltwater but not in freshwater. This is because the egg is less dense than saltwater but more dense than freshwater. Since saltwater is more dense than freshwater, it is also easier to float in the sea. The Dead Sea, which is actually a big inland lake bordered by Jordan and Israel, is the world's second most saline body of water, and its upper layers are more than ten times more saline than the Mediterranean Sea. Everyone floats in the Dead Sea, and in fact, you can read a paper while lying on your back with no difficulty!



step 2
1. Fill one glass half full of freshwater.
2. Fill one glass half full of very salty water (such as from the original egg-floating experiment).
3. Very carefully pour the freshwater into the saltwater. Try not to let the liquids mix.
4. Gently lower the egg into the water that is half saltwater and half freshwater.

Experiment results
The egg should float on saltwater and sink in freshwater. The result looks like the egg is suspended in the middle of the glass.



am I dense?

objective: Students will explore the concepts of density, mass, and volume.

Supplies
- Beaker
- Graduated cylinder
- Balance scale (can be shared among groups using a station)
- 3 different objects of different densities that will fit inside graduated cylinder (marble, paper clip, pencil, aluminum foil ball)
- Work sheet (one for each student)
- Graph paper (one for each student)
- Water
- Calculator (optional)

1. Using the three objects, engage the students in a discussion of density, mass, and volume. It is important that the objects chosen be small enough to fit into the graduated cylinder and be of varying densities. Glass marbles and lead fishing weights work well. The use of common everyday objects will assist in engaging the students in the discussion. For example, why do lead fishing weights sink? Does the color of the object affect density?
2. Students should create a hypothesis by ranking the objects in order from greatest to lowest density on their data sheet.
3. Explain how to measure volume. Take the volume measurement of water in the cylinder before and after the object is placed in it. Have the students calculate the volume of each object.
4. Explain how to use the triple beam balance scale. Then have the students calculate the mass, or weight, of each object.
5. With the volume and mass measurements for each object, have the students calculate the density of each object.
6. Have students create a bar chart displaying each object on the X axis and density on the Y axis.
7. Lead a discussion on the results. What was the most dense object? The least dense? Were your results what students expected, based on their hypothesis?

am I dense? data sheet

1. Which object do you think has the greatest density? Why?

2. Which object might have the least density? Why?

Hypothesis
The order in terms of highest to lowest density for each object is:

1. ______________________
2. ______________________
3. ______________________

Testing the hypothesis
Use the following table to record the data you collect in the experiment.

Data Table

object	mass (g)	volume (ml)	density	notes
		total final volume minus initial volume	total mass divided by the volume of the object (g/ml)	

Analyze your results
Using the data you collected, create a bar chart of the density of each object.

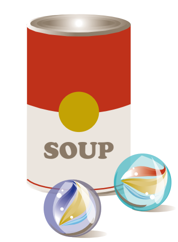
Experimental results
Was your hypothesis correct? If not, what might have happened that you did not expect?

accelerating!

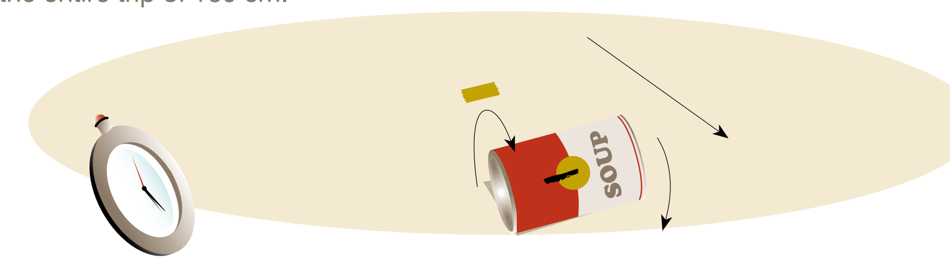
objective: Students will be able to define and show an example of acceleration as well as make predictions on whether different objects have different rates of acceleration.

Supplies
- Table (at least 2 meters in length)
- Masking tape
- Tape measure
- Two identical soup cans (labeled one and two) and two large identical marbles (labeled one and two) or another round object
- Stopwatch
- Permanent marker

step 1



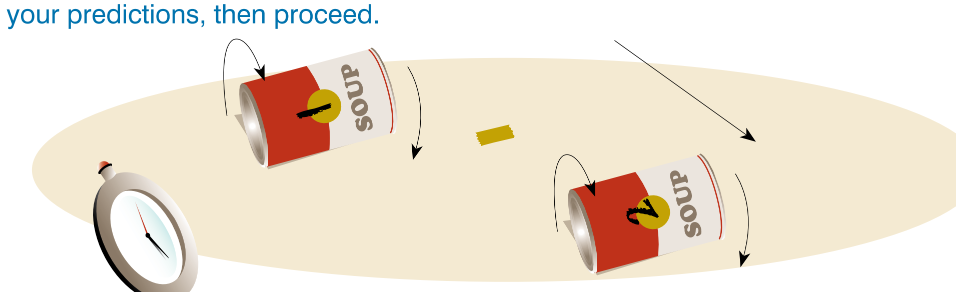
1. Place two identical books under the legs of the table to elevate one end of it.
2. Place a 10-cm length of masking tape at least 50 cm from one end and parallel to the end of the table. Place two more 10-cm pieces of tape on the table so that each piece is 80 cm from the next.
3. Start with the cans. Release one of the cans from the piece of tape nearest the end of the table and use the stopwatch to time how long it takes to roll the first 80 cm. Record the result on your data sheet.
4. Repeat this measurement a total of 5 times and calculate an average value for the time. Predict: How long do you think it will take the can to roll the next 80 cm?
5. Test your prediction. To do this, release the can from rest at the same tape at the high end and time how long it takes to roll from the second piece of tape to the third. Run a total of 5 trials and take an average. What do you conclude? How can you use the results of this activity to define accelerated motion?
6. Use your data to determine the average velocity for the first 80 cm, the second 80 cm, and for the entire trip of 160 cm.



step 2

1. Using the elevated table, predict what you think will happen if 1) Both cans are released at the same time at the same height, and if 2) The cans are released simultaneously, with one of the cans being 10 cm below and in line with the first one.

Make your predictions, then proceed.



2. Test your prediction. One person should release both cans so that they can be released at the same time, first with both of the cans at the same marker and then with one can 10 cm ahead of the other. What happened? Is this what you predicted? Discuss any differences between your prediction and what actually happened.
3. What do you think will happen to the distance between two cans if they are arranged again with one can 10 cm ahead of the other and the lower can is released about 2 seconds before the higher can?
4. Test your prediction. What happened? Discuss whether both cans had the same acceleration or different accelerations.
5. Repeat the experiment using marbles. Will the results of the marbles be the same as the cans or different? Make your predictions and repeat the experiment.

Data Table

	can 1	can 2	both cans 1	both cans 2	marble 1	marble 2
1st 80 cm trial 1						
1st 80 cm trial 2						
1st 80 cm trial 3						
1st 80 cm trial 4						
1st 80 cm trial 5						
average velocity						
2nd 80 cm trial 1						
2nd 80 cm trial 2						
2nd 80 cm trial 3						
2nd 80 cm trial 4						
2nd 80 cm trial 5						
average velocity						
160 cm trial 1						
160 cm trial 2						
160 cm trial 3						
160 cm trial 4						
160 cm trial 5						
average velocity						
160/150 cm trial 1						
160/150 cm trial 2						
160/150 cm trial 3						
160/150 cm trial 4						
160/150 cm trial 5						
average velocity						

math mysteries challenge

1. During an 8-hour day of operation, 83 million gallons of water go through the wave generator at Aquaventure. During a week, how many gallons of water move through the wave generator? How many liters of water move through the wave generator?

2. The length of the river at Aquaventure is 3,420 feet. If you rode the river five times in a day, how many miles would you have traveled? How many kilometers would you have traveled?

3. Following is a list of waterslides and the number of gallons per minute that flow down each slide.

   a. Abyss Slide = 300 gallons per minute
   b. Surge Slide = 3,800 gallons per minute
   c. Falls Slide = 5,325 gallons per minute
   d. Dark Slide = 5,300 gallons per minute

   Which slide would have 1,824,000 gallons flow down it in a day?

4. To generate a wave, 43,000 gallons of water are dumped in three seconds. If a wave is generated every five minutes, how many gallons of water would be dumped in an hour?

5. There are 2 million gallons of water at Aquaventure. If the maintenance staff discovered that they lost 100,000 gallons a day for three days, how much water would be left in the river?

6. All the water at Aquaventure is filtered in 1.66 hours. How much water is filtered per minute?

7. The long slide conveyor is 232 feet long. How many times would you need to ride this conveyor to travel a mile on it?

8. You travel the same river-to-river conveyor six times—it is 120 feet long. Also during your day you go up the long slide conveyor three times and go around the river six times. How many miles did you travel during the day? How many kilometers?

9. If the large slide conveyor travels at 60 feet a minute, how many seconds does it take to get from the bottom to the top of the conveyor?

10. If you were to empty 600,000 gallons of water from the river at Aquaventure to clean the system and then decided to add only 500,000 gallons back into the system, how many gallons of water would be in Aquaventure?

11. If there was a lifeguard every 120 feet at Aquaventure, how many lifeguards would be needed to staff the area each day?

12. There are many inner tubes throughout the Aquaventure complex. What system would you use to determine how many inner tubes are located at the facility?

Postvisit activity

Use the Aquaventure statistics to write three math challenges. Exchange your challenges with another class member's challenges and solve them.

math mysteries answers

1. 7 x 83 million gallons = 581 million gallons per week; 581 million gallons x 3.785 liters/gallon = 2,199 million liters
2. 3,420 feet x 5 times = 17,100 feet; 17,100 feet x 0.305 meters/feet = 5,212 meters. 1 mile = 5,280 feet = 1,690.3 meters. You traveled 3.2 miles and 5.21 kilometers.
3. There are 480 minutes during 8 hours of operation; 1,824,000/480 = 3,800, the answer is "b"
4. One hour is 12 x 5 minutes; 12 waves makes 43,000 gallons x 12 = 516,000 gallons per hour
5. 3 x 100,000 gallons = 300,000 gallons lost, out of 2 million, leaves 1,700,000 gallons left in the river
6. 2 million gallons/1.66 hours x 1.66 hours/100 minutes = 20,000 gallons per minute
7. 5,280 feet/1 mile; 1 ride/232 feet x 5,280 feet/mile = 22.76 rides per mile, or 23 rides
8. (6 river-to-river rides x 120 feet) + (3 long slide conveyer rides x 232 feet) + (6 river circuits x 3,420 feet) = 720 feet + 696 feet + 20,520 feet = 21,936 feet; 21,936 feet x miles/5,280 feet = 4.15 miles; 4.15 miles x 1.61 kilometers/mile = 6.67 kilometers
9. 232 feet/1 ride (1 minute/60 feet) x (60 seconds/1 minute) = 232/60 x 60 = 232 seconds per ride
10. 2,000,000 gallons – 600,000 gallons + 500,000 gallons = 1,900,000 gallons
11. 3,420 feet x (1 lifeguard/120 feet) = 28.5, or 29 lifeguards
12. There are a myriad of ways that the inner tubes can be inventoried. One method would be having each of the lifeguards on staff gather the inner tubes in their area and then turn in their number to one lifeguard who could then determine the total.

vocabulary

Acceleration: A change in velocity.

Adhesion: The attraction of water molecules to other materials.

Buoyancy: Capacity to remain afloat in a liquid.

Capillary action: The movement of water along the surface of a solid caused by the attraction of the molecules of the liquid to the molecules of the solid.

Cohesion: The attraction of water molecules to one another.

Condensation: The process of reducing a gas or vapor to a liquid.

Density: The relative heaviness of objects, measured in units of mass, or weight, per units of volume.

Equilibrium: A condition in which all influences acting upon a system are canceled by others, resulting in a stable, balanced, or unchanging system.

Evaporation: The process of changing a liquid to a gas or vapor.

Frost formation: A gas is changed directly to a solid.

Gravity: The force that attracts a body to the center of the Earth or toward any other physical body having mass.

Heat capacity: Heat energy required to increase the temperature of an object by a certain temperate interval.

Heat of vaporization: Amount of heat needed to turn a liquid into a gas.

Hypothesis: A tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation.

Kinetic energy: The energy possessed by a body because of its motion.

Latent heat of fusion: Heat gained or released when water changes phase from liquid to solid or solid to liquid.

Mass: Measure of the quantity of matter in an object.

Net force: The directional total of all forces acting on an object.

Osmosis: The tendency of a fluid, usually water, to pass through a semipermeable membrane into a solution where the solvent concentration is higher, thus equalizing the concentrations of materials on either side of the membrane.

Potential energy: The energy an object has from its position, rather than its motion. An object held in a person's hand has potential energy, which turns into kinetic energy when dropped.

Sublimation: A change directly from the solid to the gaseous state without becoming liquid.

Surface tension: The joining of water molecules at the surface of the water.

Velocity: A body's speed and whose direction is the body's direction of motion.

Volume: The amount of space occupied by a three-dimensional object.

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