



Cartesian Divers

Discover how fish rise and fall using a special air pouch in their stomach. Demonstrate these principles of buoyancy as you control whether a ketchup packet “Cartesian diver” sinks or floats!

TEKS:

SCI 4.5 A: The student is expected to measure, compare, and contrast physical properties of matter, including mass, volume, states (solid, liquid, and gas), temperature, magnetism, and the ability to sink or float.

SCI 5.5 A: The student is expected to classify matter based on measurable, testable, and observable physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating using water as a reference point), solubility in water, and the ability to conduct or insulate thermal energy or electric energy.

Materials:

- Bowl (any size)
- Empty plastic water bottle (any size is fine, although a 1L bottle works best)
- Hot glue
- Ketchup packets (or any type of condiment packet that is [this shape](#))
- Permanent markers
- Water

Experiment/How To:

1. First, test to see if your ketchup packets float by placing them in a bowl of water. You want to make sure to use a ketchup packet that floats for all of the next steps.
2. Transform your ketchup packet into a fish! Make small folds on two corners of the packet and hot glue into place. Gently squeeze the center of the packet and hot glue in place. Your ketchup packet should look like a fish! Decorate your fish with permanent markers. (Safety: An adult should assist when using the hot glue gun.)

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3. Drop your ketchup packet fish into the empty plastic bottle. Be careful that the packet doesn't explode!
4. Fill the bottle with water all the way to the brim and screw on the lid.
5. Now, squeeze the sides of the bottle. Your ketchup packet fish should dive to the bottom. When you release your hands, the fish should float back to the top!
6. Experiment with multiple fish or different sized bottles.
7. What fun games can you play with your diving fish? Try using permanent markers to draw special "targets" on the side of your bottle for your diving fish to hit. Or, mark different "diving levels" on the outside of the bottle, and challenge your family members to keep the fish at a certain level for 5, 10, or even 30 seconds!

STEM Connection:

The rising and falling ketchup packets you made are known as "Cartesian divers," named after the French scientist who invented them, Rene Descartes. He used similar divers to help demonstrate different laws of physics and buoyancy. Let's learn about some of them now!

Ketchup packets feel pretty heavy, so why do some of them float? When ketchup packets are sealed at a factory, an air bubble gets trapped inside the packet. This air bubble makes the ketchup packet float because air is lighter than water. And the bigger the trapped air bubble, the more the packet floats! When this floating ketchup packet is added to a sealed bottle filled with water, at first it stays floating at the top. However, when the sides of the bottle are squeezed, the packet suddenly sinks to the bottom. Why does this happen?

Gases are easy to compress. When you squeeze the sides of the bottle, an increase in pressure makes the little air bubble inside of the ketchup packet even smaller. This results in a heavier ketchup packet, causing it to sink to the bottom. However, when you release the sides of the bottle, the compressed air bubble is able to expand again and causes the packet to float back to the top! Fish use a similar principle to rise and sink as they swim. Many fish have a pouch of air inside of them called a "swim bladder." They are able to add or remove air from this pouch to help them move around in the water. If a fish wants to rise, it increases the amount of air in its swim bladder, and if it wants to sink, it releases air.

Career:

Physicists study the natural world, from the tiniest subatomic particles to the largest galaxies. They do experiments to discover the laws of nature. They study what things are made of (matter) and how things behave. They also learn about energy, studying how it changes from one form to another.

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Resources:

<https://www.steamsational.com/diving-fish-science-experiment/>

<https://www.stevespanglerscience.com/lab/experiments/density-divers/>

<http://coe.fit.edu/dmes/ocean.php>

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