Sushi Soy Sauce Diver

Get your science juices flowing at the local Sushi restaurant or take away.

Many science teachers and experimenters are familiar with the tomato sauce bag Cartesian Diver. In another science snippet we provide directions for the preparation of such a ketchup (tomato sauce) bag diver.

Since publishing the Ketchup Bag Diver notes we were informed by two creative Lab Technicians, *Jenny Kelly* & *Julie Stallwood* of *Ivanhoe Grammar School in Melbourne* that there is another "take away" source for density science: The local sushi shop. In Australia most sushi shops supply their traditional soy sauce in small plastic fish-shaped containers. These make excellent cartesian divers in the classroom as they have clear walls and screw-on caps.

So we'll try this one today.

How to do it:

Components

★ Clear, plastic 1.5 l soft drink bottle
★ Fish shaped plastic soy sauce containers from the Sushi Shop
★ Brass or stainless steel flat washers. The zinc plated ones rust easily. We used the 3/16″ size.
★ Plastic cups (2)
★ Food colouring
★ Plastic pipet

Putting it together

With the ketchup diver we had to be very particular in our choice of a ketchup bag, the good news is that all fish soy containers with tight sealing lids will do the job.

1. Get rid of the soy sauce and rinse the fish well.
2. Add water and a few drops of food colouring to a cup. We use black as it shows up better inside the fish.
3. Suck the diluted food colouring into the fish - as full as possible.
4. Add three brass washers to the screw neck of the fish. Screw the lid on.
5. Fill another cup with water. Place the fish in the water, head first. It will probably go to the bottom of the cup. Take it out, dry it, unscrew the lid and squeeze a few drops of dyed water from it. Screw the lid on and try to float it in the water.
6. The object is to **barely** float the fish.
7. Repeat this action until the fish barely floats in the water in the cup.
8. Now transfer the fish to the bottle, fill it right to the brim with water and seal it tightly.
9. The fish should float at the top. Squeeze the bottle and make the fish dive!

Notes

★ If you only use one washer then the little ones in the class will need to squeeze much harder to make the fish dive as it will have less air in it.
★ The students should be able to see the movement of the dyed water in the fish as it moves up and down. As for the air in the fish: When the pressure goes up, the volume goes down . . .
★ If the fish does not dive: Its density is too low. Add more dyed water to it with a pipet.
★ If the fish stays at the bottom: Its density is too high. Remove a few drops of water from it.
★ If you have stored the bottle, first release the air from the bottle, fill it to the brim with water and seal it again.

Extensions

✦ Change the number of washers.
✦ Increase the water's density: Dissolve sugar or salt in the water.
✦ Study the temperature effect: Place the bottle in the fridge and then in the sun.

- ✦ Make a density column diver. Layer several liquids with differing densities inside the bottle. Try the following: corn syrup, dishwashing liquid, water, vegetable oil and rubbing alcohol (order of decreasing density). Drop in divers with different buoyancies. A diver will choose its location according to its density and that of the liquid.
- ✦ Find out how all of this relates to the functioning of a submarine. (It uses water and compressed air to facilitate the dive and surface motion.)
- ✦ Look up Boyle's Gas Law and explain how the air in the diver obeys this Law. (When the pressure goes up, the volume goes down . . .)

The Science of the Diving Fish

This is a Cartesian Diver and **two principles** apply here:

The first is about the **density** of the two objects: water & fish.

Density is simply a result of an object's spread of mass:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

An object that is less dense than water, such as a log, can float in water. An object that is more dense, such as a rock, will sink.

Initially with the fish barely floating, the fish's density is just a little bit lower than that of the water.

When we squeeze the bottle, pressure is exerted on the water and this is transfered to the fish. The fish's body is flexible and thus its volume decreases (the mass stays constant) and consequently its density increases and it dives.

Likewise, if we release the squeeze, the fish's air volume increases and the density decreases. This causes the fish to surface.

The fish is essentially a **barometer**, indicating the outside pressure on the bottle.

But there is a second principle too which is basically just an extension of the above:

More than 2000 years ago, Archimedes found that an object weighs less in water than in air because of the upwards thrust of the water, called **buoyancy.** This partly supports the object. He simply found that a boat will float *when the weight of water that it displaces equals the weight of the ship (**Archimedes' principle**).*

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