STEM

ACTIVITY BOOK

Hands-on STEM activities connecting key science skills of curiosity, observation, method, practice, and fun. Online book and 10 min how-to videos for each experiment.

In partnership

How-to videos

Salinity: Ocean Layers

https://zoom.us/rec/share/N2cR-ddLUGI85jAJERjEiN_7IgDPAISXQluLeEI7-CZKggAPw0Jd91d0ebTWHw_D.r4AM2jn9rH5kWlvX

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Ocean currents

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Compass

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Cartesian Diver

https://zoom.us/rec/share/HNwHmhLbmCwA83Uso6iHmi4yytVr-1u5yBBfvgQ8kqO-TZnXNbfmXjrt5ILl_A.LVq-aA2p1oaqNXzE

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Diving Bells

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Submarine Aircraft Carrier

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OCEAN LAYERS

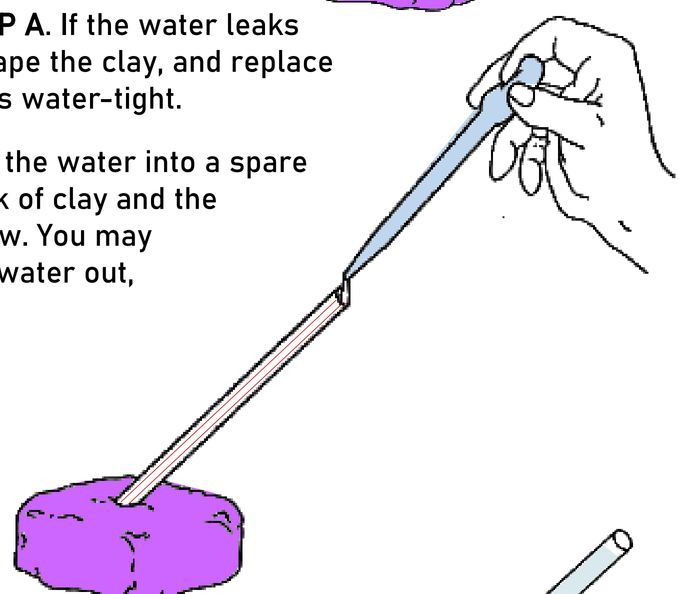
Materials

- Modeling Clay
- 3 Cups
- Straw (clear)
- Salt (canning or pickling is best)
- Food Coloring (3 colors)
- 3 Spoons or stir sticks
- Eye Dropper
- Water

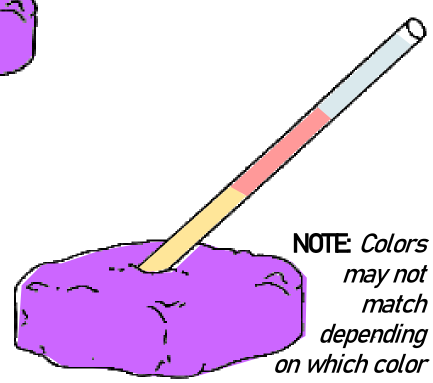
PROCEDURE

1. Use a marker to label your cups A, B, and C.
2. Fill each cup 3/4 full with warm water and add one drop of food coloring (different colors) into each cup.
3. Use a stir stick to stir **CUP A** until the color is totally dissolved.
4. Measure 1 spoon full of salt and add it to **CUP B**. Use a different stir stick to stir until the color and salt are completely dissolved.
5. Measure 2 spoons full of salt and add it to **CUP C**. Use a different stir stick to stir until the color and salt are completely dissolved.
6. Form a mound with your modeling clay and stick the straw into the clay at an angle as shown. (NOTE: *Do not stick the straw all the way through the clay. If the straw comes out through the bottom of the clay, remove the straw, reshape the clay, and replace the straw.*)

7. Test the straw for leaks by filling it with water from **CUP A**. If the water leaks out of the bottom of the straw, remove the straw, reshape the clay, and replace the straw. Test for leaks again. Repeat until the straw is water-tight.
8. When you are sure that the straw is not leaking, empty the water into a spare cup or sink by picking up the entire assembly (the block of clay and the straw) and tipping it so the water drains out of the straw. You may need to shake the straw several times to get all of the water out, but do not remove the straw from the clay.
9. Add a small amount of each **solution** to the straw using the eyedropper. Fill about 1/3 of the straw with each solution. You might need to put a piece of paper behind the straw to observe more clearly.



10. Explore how the salt water, brackish water, and freshwater interact by adding a bit of each solution to the straw as described in step 5. Empty your straw and try adding your liquids in different orders.
11. If you saw 3 distinct layers, what conclusions can you draw about the relative saltiness of the 3 layers. If you *did not* see 3 distinct layers, write a hypothesis about the relative saltiness of each of the colored solutions.
12. Empty the contents of the straw and change the order in which you fill the straw to test your hypothesis.
13. If you *did not* see 3 distinct layers, continue revising your hypothesis and testing it.



NOTE: *Colors may not match depending on which color went in each solution.*

So What's Happening?

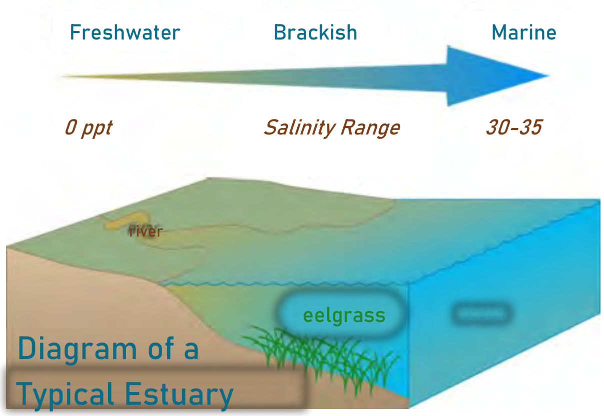


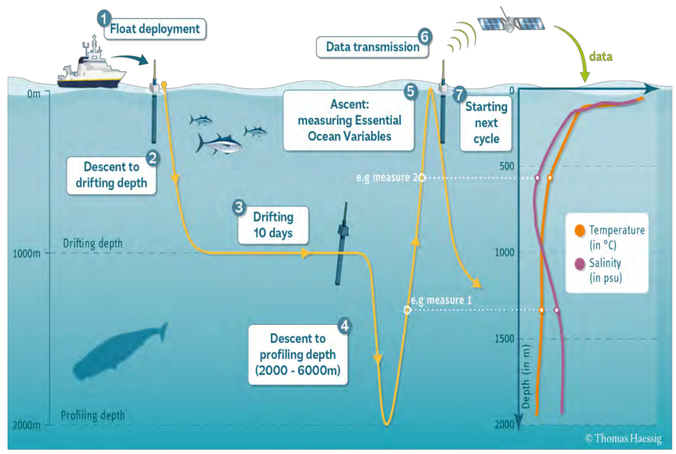
Diagram of a Typical Estuary

Ocean water is not the same everywhere. In some places, the water is colder or deeper than in other places. Some parts are denser or contain differing amounts of dissolved salts than other parts. All these things affect the way ocean water behaves.

Although water is the most abundant substance on Earth's surface, very little of it is pure water. Many elements other than hydrogen and oxygen — the only two elements in pure water — are found in Earth's water. Tap water, for example, contains chemicals used to disinfect the water and to prevent bacterial growth. Ocean water has many other elements in it, such as dissolved salts and other materials.

Water has different properties depending on the environment in which it is found. Water in streams and rivers has few dissolved salts and is called FRESHWATER. Water found in the ocean is called SALT WATER because it contains a lot of dissolved salt. In areas where rivers flow into oceans — called estuaries — brackish water is found. BRACKISH means that the water has a higher concentration of salts than river water, but a lower concentration of salts than the open ocean.

How do we know that estuaries and oceans are layered? The oceans are layered in some cases because densities differ among water masses. The densest water mass will be on the bottom, and the least dense water mass will be on the surface. Seawater density is a result of TEMPERATURE and SALINITY (lowest temperature and highest salinity correspond to the highest density). Traditionally, seawater density, and hence ocean layers, are measured using a CTD reading, which stands for conductivity (a measure of salinity), temperature, and depth. More modern methods consist of detecting density interfaces between two layers using a high-frequency signal generated from a boat, ship, or undersea drone.



Naval Meteorology & Oceanography Command

The **Naval Meteorology and Oceanography Command** (or **CNMOC**, serves as the operational arm of the Naval Oceanography Program. CNMOC is focused on providing critical environmental knowledge to the warfighting disciplines of Anti-Submarine Warfare; Naval Special Warfare; Mine Warfare; Intelligence, Surveillance and Reconnaissance; and Fleet Operations, as well as to the support areas of Maritime Operations, Aviation Operations, Navigation, Precise Time, and Astrometry

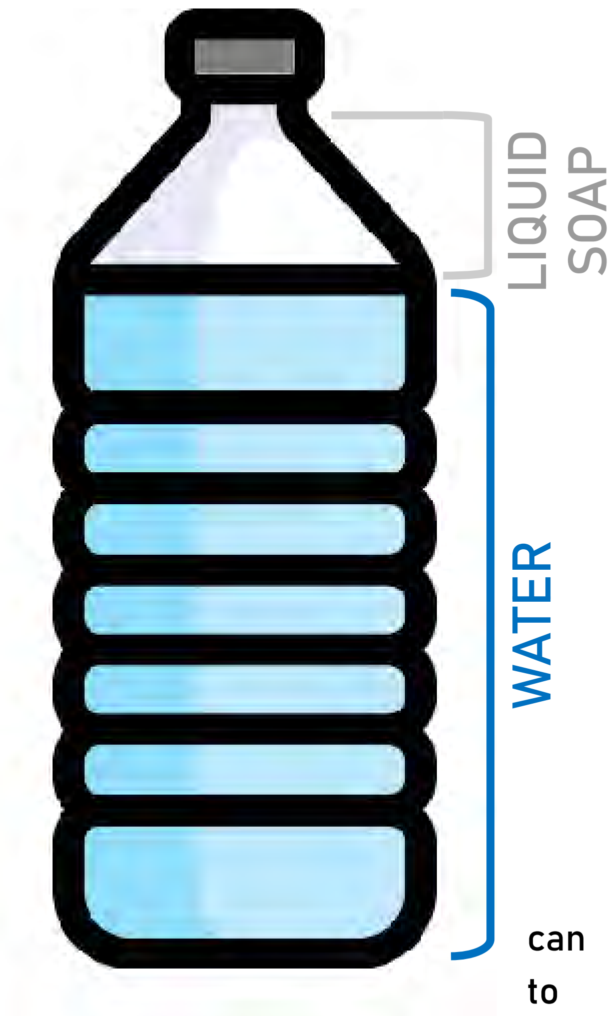
OCEAN CURRENTS

Materials

- Water Bottle
- Liquid hand soap (opaque white)
- Funnel
- Pitcher
- Food Coloring (optional)

An ocean current is a continuous, directed movement of seawater generated by forces like breaking waves, wind, temperature, and salinity differences. Currents are also influenced by the rotation of the Earth called the Coriolis effect. This causes currents to flow clockwise in the northern hemisphere and counter clockwise in the southern hemisphere.

PROCEDURE



1. Drink, or pour out about 1/4 of the water in your bottle.

2. WITH AN ADULT: Put the funnel into the mouth of the water bottle.

3. WITH AN ADULT: CAREFULLY pour liquid hand soap in until the bottle is totally filled up. The soap is more dense than both the oil and water, so it will sink to the bottom.

4. OPTIONAL: Add a drop or two of food coloring and glitter to your bottle.

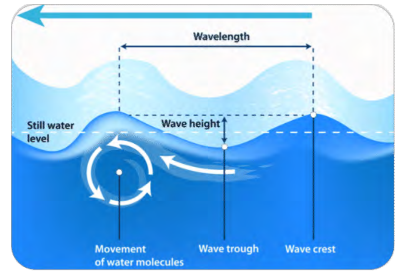
5. Securely cap your bottle.

6. GENTLY tilt your bottle end to end until the soap and the water mix. When it is mixed, you can see the currents swirl through what appears to be still water.

So What's Happening?

If you've ever visited an ocean shore, then you know that ocean water is always moving. Waves ripple through the water, the water slowly rises and falls because of tides. You may see signs warning of currents that flow close to shore. What causes all these ocean motions? Different types of motions have different causes.

Most ocean waves are caused by winds. A wave is the transfer of energy through matter. A wave that travels across miles of ocean is traveling energy, not water. Ocean waves transfer energy from wind through water. The energy of a wave may travel for thousands of miles. The water itself moves very little. The image (right) shows how water molecules move when a wave goes by.



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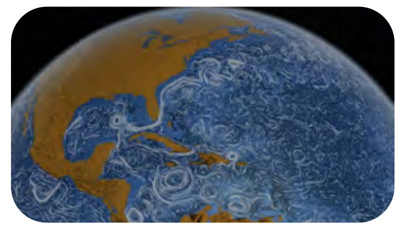
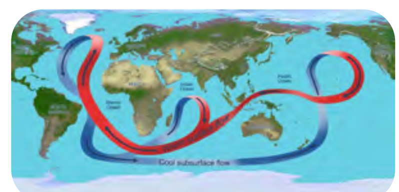


Surface currents

Surface currents are usually caused by wind and found in the top 1,000ft of the ocean—making up about 10% of all the water in the ocean. Currents don't necessarily travel in the same direction as waves.



Deep-water currents

Deep-water currents make up the other 90% of the ocean. They are driven by density and forces of gravity. The change in density is caused by temperature changes and salinity (salt content) levels.

Navy Quartermasters

QUARTERMASTERS (QM) navigate the open seas to keep our Navy mission on course. Specializing in maps, charts and oceanography, QMs work up in the ship's pilot house, watching the sun rise and set each day. Every Sailor relies on the QM's expertise to keep them safe and operational. A Quartermaster becomes the ship's human GPS, keeping it on track to reach its destination.

Quartermasters (QM) stand watch as assistants to Officers of the Deck and Navigators. They serve as Helmsman and perform ship control, navigation and bridge watch duties.

COMPASS

<u>Materials</u>

- Cork
- Magnet
- Needle or Pin (1-2")
- Marker
- Cup
- Water

<u>PROCEDURE</u>

1. To magnetize the needle: Stroke the South (S) side of a magnet along the needle 20 times in ONE DIRECTION ONLY. * **DO NOT RUB THE MAGNET BACK-AND-FORTH**

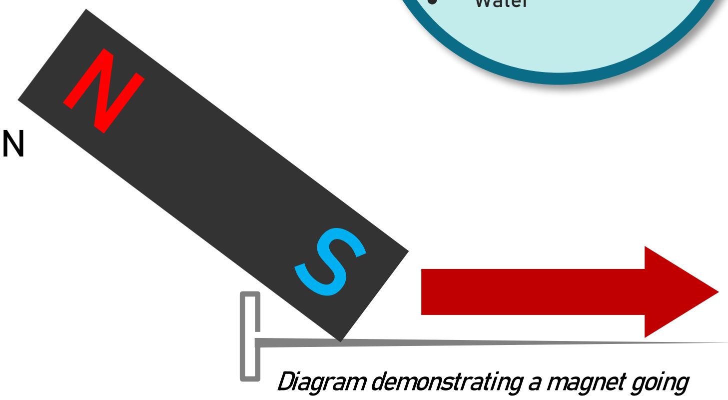
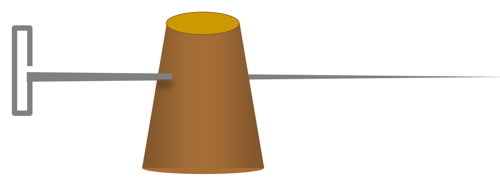


Diagram demonstrating a magnet going along the needle in ONE DIRECTION ONLY.

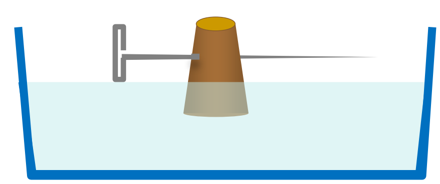
2. **WITH AN ADULT** Push the needle through the end of the cork so that the needle is sticking out both ends of the cork evenly. **<u>BE CAREFUL!</u>**



3. Fill the cup half-way with water and float the cork on the surface of the water.

4. Place the whole "compass" on a flat surface and watch as your needle tries to align itself with the magnetic fields. The needle should point toward the nearest magnetic pole (north).

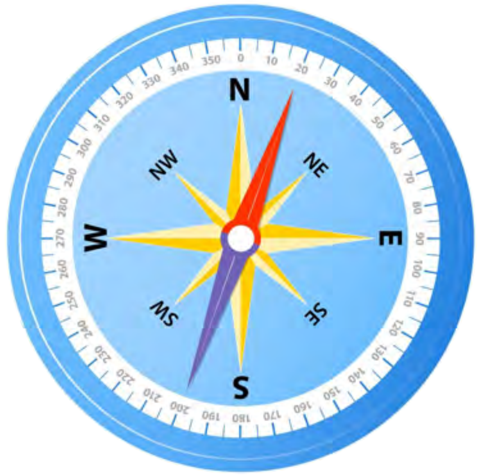
5. Compare your compass with a real compass or compass app. Do they match?



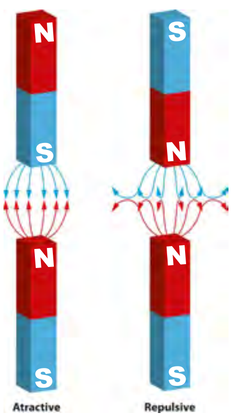
WARNING:

Needles are sharp, be careful and get an adult's help with this activity!

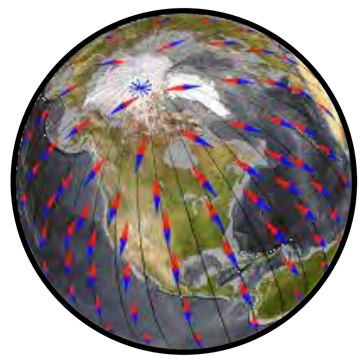
So What's Happening?



A **COMPASS** is a tool for finding direction. A simple compass is a magnetic needle mounted on a pivot, or short pin. The needle, which can spin freely, always points north.



A compass works because Earth is a huge **MAGNET**. A magnet has two main centers of force, called **POLES**—one at each end. Lines of magnetic force connect these poles. Bits of metal near a magnet always arrange themselves along these lines. A compass needle acts like these bits of metal. It points north because it lines up with Earth's lines of magnetic force.



Earth's magnetic poles are not the same as the geographic North and South poles. The geographic poles are located at the very top and bottom of a globe. The magnetic poles are nearby but not at exactly the same places. A compass points to the magnetic North Pole, not the geographic North Pole. Therefore, a compass user has to make adjustments to find true north.

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Submarines and Neutral Buoyancy

It's **Ballast**! Like yellow pool floats for a swimmer's arms, submarines can change the amount of air in submarine ballast tanks to sink or float at will.

Make Your Own Floating and Sinking Sub!

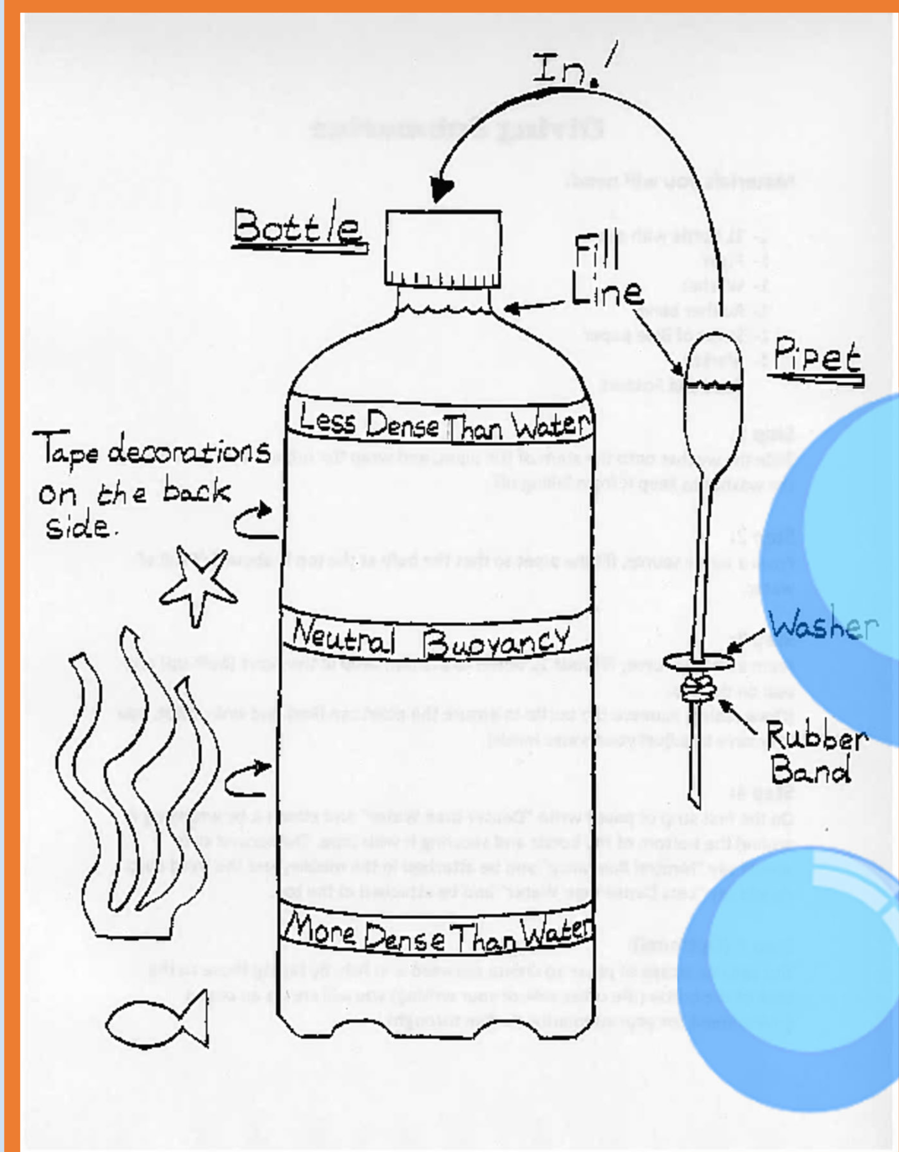
1. Slide the washer onto the stem of the pipet, and secure it in place with the rubber band.
2. Fill the pipet with water so the bulb at the top is about 2/3 full.
3. Fill the 1L bottle to the top, and insert the pipet, checking to see that it just barely floats, and screw the cap on tightly. (If the pipet doesn't float, remove it from the bottle and squeeze out a drop of water before returning it to the bottle.)
4. On one strip of paper, use the marker to write "Less Dense than Water". Write "Neutral Buoyancy" on the second strip of paper, and "More Dense than Water" on the third.
5. Tape the three strips of paper to you bottle as shown in the illustration.
6. Optional: Draw or tape decorations to the back of the bottle to create an ocean environment for your submarine!

Materials

- 1L bottle with cap
- 1 pipet or eye dropper
- 1 rubber band
- 1 washer
- 3 strips of paper
- 1 marker
- tape

Test it !

Squeeze the completed bottle to make the pipet sink or float. The harder you squeeze, the more compressed and dense the air becomes! Can you squeeze the bottle to make the pipet sink, or squeeze just hard enough to achieve neutral buoyancy?



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www.navalunderseamuseum.org

Diving Bell Submariner!

Diving Bells and **Submarine Rescue Chambers** are built to bring air and space under the sea. This keeps sailors dry, with air to breath, as they explore underwater, or escape a sunken vessel.

Test Your Own Diving Bell!

1. Color the sailors on this page and cut them out.
2. Tape one of your sailors to the inside bottom of a cup. This cup is your sailor's diving bell.
3. Hold the cup upside down. With the rim of the cup touching the water first, can you fully submerge your diving bell cup, and take it out of the water again without your sailor getting wet?
4. Try the experiment again with your second sailor!

Materials

1 cup

1 basin of water

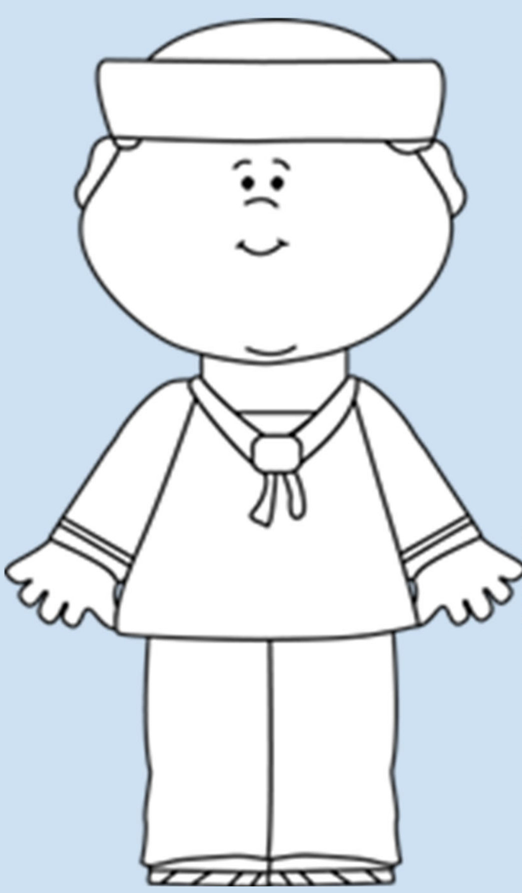
washable markers

tape

What Happened?

Why didn't the air escape the diving bell?

In order for the air to escape the diving bell, it would have to push past the water to move under the rim of the bell. Because air is less dense than water, it cannot push past to escape, and remains inside the bell!



Color and cut out the sailors for your experiment!

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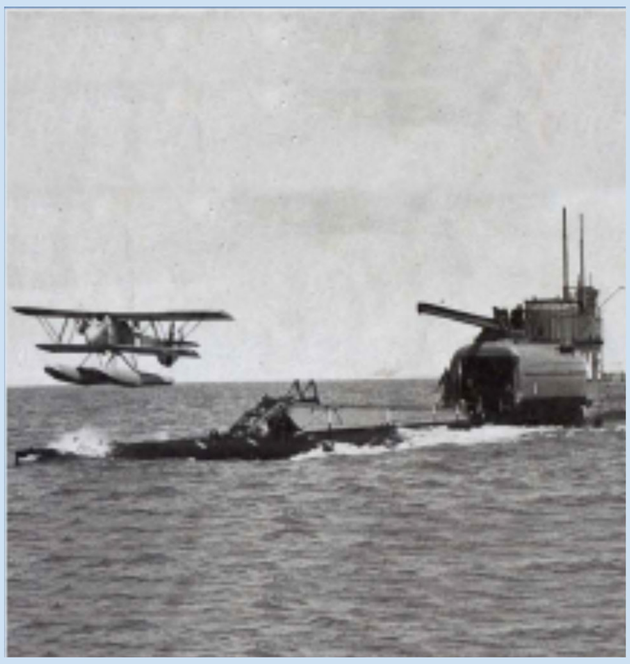
Submarine Aircraft Carriers

From WWI through WWII, several different nations experimented with submarine aircraft carriers. These are submarines equipped with fixed-wing aircraft, usually used for reconnaissance missions. The planes were typically small, and could either be attached to the deck of the submarine, or even folded up and stored inside the sub!



Challenges

Issues that prevented the planes from being widely used included the amount of time the sub would have to be exposed, and the inability of the planes to land directly on the submarine.

Try This!

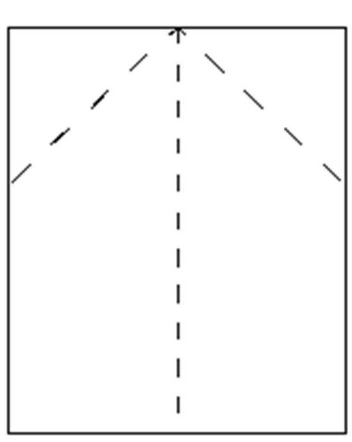
Can you build and land "The Eagle" on the deck of a submarine? What if the deck isn't right in front of you? Can you alter your plane to control its flight direction?

Materials:

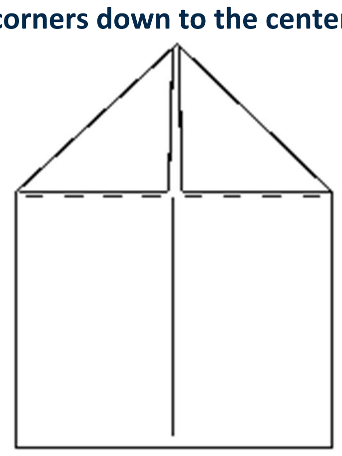
All you will need for this folding plane is a sheet of paper, and a designated landing strip!

The EAGLE

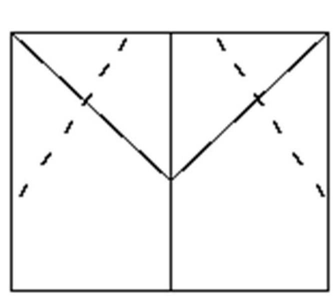
This is a very stable plane. It can fly straight with little adjustment. Try curving the elevators up or down for curves and loops



Fold an 8.5 x 11 inch sheet of paper in half lengthwise and open back up. Fold the top corners down to the center.

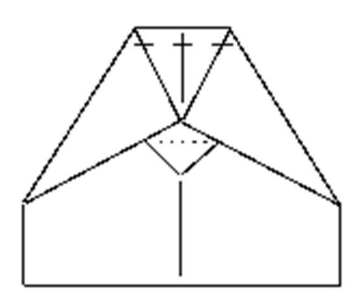


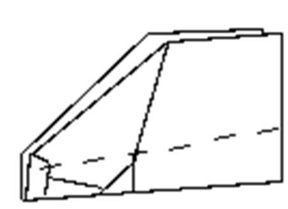
Fold the top down.



Fold the top corners in to the middle.

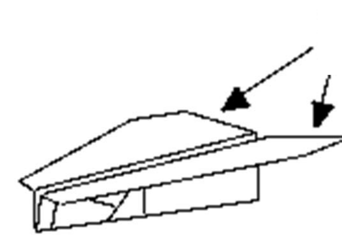
Fold the little point up. Fold the top 0.5 inch down. Fold the airplane in half away from you.





Fold the wings out at an angle as shown.

Bend elevators up slightly for better performance



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