active divers

Experiment 1

Setup

- Take two plastic cups and fill them with water from each of the two bottles, one with salt water (approximately as much salt as ocean water!) and one with fresh water. The water in both bottles has been sitting out here for a while and has room temperature – which is fairly warm!
- We now have two different water masses in the two cups: Let's call them WF for "warm and fresh", and WS for "warm and salty". It might be a good idea to mark which cup contains which!
- Take a plastic cup with two ice cubes in it.

Experiment

- Place one ice cube into each of your cups with water
- Observe the ice cubes melting
- We now have a third water mass: Let's call it CF for "cold and fresh"
- Observe what happens with the melt water in the two cups!

Question

Imagine if all three water masses were in the same cup, which would be the correct order of water masses from top to bottom?

- WS->CF->WF? Then the first digit for your code is 5
- WF->CF->WS? Then the first digit for your code is 9
- CF->WF->WS? Then the first digit for your code is 7

How this relates to Boalt (where it suddenly gets cold when we dive down!)

In Boalt, as in most lakes, we find a seasonal thermocline, i.e. a depth at which the temperature rapidly changes between the surface that has been warmed during spring and summer, and the bottom that is still at the same temperature that it was cooled down to during winter.

When the sun warms the water surface in the spring and summer, the warm water floats on top of cold water. The longer the sun shines on the lake, the warmer and thicker the warm surface layer gets, but it is still floating on top of the old, cold winter water. The border between the two layers is the thermocline that we feel when we dive down.

In fall and winter, as the surface water cools, it will sink down through the warm surface layer like the meltwater from the ice cube sank through the warm freshwater in the cup, and form a cold layer at the bottom that gets thicker and thicker, until it reaches the surface and the lake eventually freezes.

Since the cold water is denser than the warm water, the thermocline is also a pycnocline, meaning a depth layer where the density rapidly changes. Many small particles are denser than the warm water in the surface and sink down, but get trapped above the denser cold water, since they are less dense than that. Hence, they collect at the pycnocline and form a "foggy" layer.

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Experiment 2

Setup

- Take an empty PET bottle and fill it with water all the way to the top
- Take one of the plastic cups with the three objects in them
- !! When you touch the objects, make sure to do so very carefully and not to press them between fingers! !!

Experiment

Practice "diving"

- Carefully place the pink object (open side down!) into the bottle and close the lid
- Press the bottle so hard that it starts sinking
- Ease up a bit and watch it raise again
- Can you find the right pressure, so it just hovers in the middle of the bottle, without raising or sinking?

Real experiment

- Take the other two objects and carefully place them in the bottle together with the pink object
- Press the bottle again

How this relates to freefall

When we press the bottle, we increase the pressure in it. This can be seen as simulating diving down in the water, where the pressure is higher. In the top 10 or so meters, we are positively buoyant, i.e. thanks to the air in our lungs, we will float up to the surface by ourselves. But as the pressure increases, air in the lungs is being compressed and the volume thus decreases. At a level of neutral buoyancy, our body weighs exactly as much as the water it is displacing, so it is neither floating up nor down. Below that level, the lungs are compressed a bit more, our body becomes denser than the surrounding water and sinks.

In the experiment, we see that objects float, hover, or sink, depending on pressure. So if they were at the depth corresponding to that pressure, they would be positively, neutrally, or negatively buoyant there, too, the last one meaning they would go into freefall.

Question

Which is the correct order in which the objects sink (first to last)?

- Pink->Green->Yellow? Then the second digit for your code is 5
- Yellow->Pink ->Green? Then the second digit for your code is 7
- Green->Yellow->Pink? Then the second digit for your code is 9

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Experiment 3

Setup

- Get the materials!
- Fill one tray with water
- Place the water-filled tray on top of a closed box
- Put the empty tray open-side-up on the table
- Lean the cutting board against the tower

Experiment

Practice flow around an object

- Take up the cutting board
- Place the paper towel with the cut out drop shape on the grey side of the cutting board, such that the fold hangs over the edge of the cutting board
- Carefully place the cutting board in its position, such that the short end of the paper towel hangs in the water
- As the water starts slowly flowing across the edge and then down the slope, dye starts to bleed from the colored dots
- “Recharge” the dye flows as soon as they become hard to see by placing a dot directly into the dye flow
- When the water has reached the bottom of the paper towel, take the paper towel off the cutting board and place it on a flat surface to dry

Experiment

- Cut digit-shaped holes in paper towels
- Mark the top edge with dots every 0.5cm
- Run the experiment like you did in the test
- Dry the cutting board and repeat with the next shape
- Compare the resulting patterns. Which look like the best stream lines for fastest gliding?

How this relates to streamlined shapes

In this experiment, we are visualizing streamlines by “marking” the path that water takes around the cut-outs in the paper towels.

The closer streamlines fall together, the faster the water flows in that region. Water moving quickly and undisturbed around our bodies is what we want when gliding. When streamlines become far apart or wide, it means that water is flowing slowly, and there is possibly some turbulence that we cannot resolve with our method. Turbulence slows down our gliding and should therefore be avoided.

The nicer the streamlines flow around an object, the more “streamlined” the object is, meaning the better it glides through water (or air).

Question

Which digit wins in freefall?

- 0? Then the third and last digit for your code is 0
- 1? Then the third and last digit for your code is 1
- 2? Then the third and last digit for your code is 2