Saving Lives With Air!

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Purpose

I am making a density tower to test which objects will float or sink. In my second experiment, I will be testing how well 3 types of plastics float in water when weight is applied. I am interested in the concept of designing a snowmobile that would float if it broke through the ice.

Hypothesis

In my first experiment, I think that the bolt, copper tube, battery, and coins will sink and the ping pong ball, flat Lego piece, and wooden spool will float in the density tower. I think that the cardboard tube, tomato, and ear plugs will sink half way down. In the second experiment, I think the plastic cardboard material with airspace inside will hold more weight than the single layer plastic sheets with the honey comb shapes (airspaces) on the exterior.

Variables

Independent variable (changed)- For the density tower, this would be the objects dropped into the tower (ping

pong ball, tomato, bolt, battery, crayon, wooden spool, cardboard tube, plastic Lego pieces, copper tube, rubber ear plugs, mini light bulb). For the floating experiment, this would be the amount of weight added to sheets of plastic.

Dependent variable (measured)- For the density tower, I would measure at what liquid level the objects float at. For the floating experiment, I am recording whether the plastic sheets stayed floating.

Controlled variable (stays the same)- For the tower experiment, these things are the same: jar, liquid tower, temperature of liquids and other objects (room temperature), person doing the tests, and technique of putting the liquids in the jar with turkey baster. For the floating experiment, these things stayed the same: weights (each weight 141 grams), temperature of bath water, amount of water in tub, and plastic boards used for each trial.

Materials

For the density tower: dyed water, milk, honey, canola oil, dishwashing detergent, 1 liter glass jar, ping pong

ball, cherry tomato, bolt, turkey baster, copper tube, plastic Lego piece, rubber ear plugs, wooden spool, battery, crayon, measuring cup, tiny light bulb, twoony, quarter, dime, penny. Materials for the floating experiment: plastic cardboard (has air spaces in the middle) and 2 plastic boards with honey comb shaped design (little air spaces where water contacts the plastic), 4 full Play Doh containers, packing tape to seal the edges of the plastic carboard, tub of water.

Background Information

The Particle Theory tells us that particles in solids are tightly packed together, held by the attractive forces between particles. Liquids have a little more space between the particles, so liquids are less dense than solids. Comparing densities of liquids allows us to determine which substances will float on top of other substances.

To calculate the density of a substance, you divide the mass of the substance by its volume. Ex: If the mass of an object is 12 g and the volume is 4 cm, then the density would be 3 g/cm^2 (12/4 = 3). Source: Alexander, Glegg, Hammill, Hirsch, Ritter, Williams (2000). *Science and Technology 8*. Scarborough: Nelson.

pg. 102-106.

Definitions

Gravity- the force that attracts a body toward the center of the earth or toward any other physical body having mass.

Mass- the amount of matter in an object. Mass stays constant and is measured in grams or kilograms.

Volume- is a measure of the amount of space occupied by matter. Measured in cubic meters (m), liters (L), cm, or ml.

Density- The density of a substance is related to it's mass (how much matter there is) and its volume (how much space it takes up). Measured in gm/cm.

Hydrometer- instrument which is used for measuring the relative density of a liquid.

Specific gravity- the ratio of the density of a substance to the density of a standard, usually water for a liquid or solid, and air for gas. The density of water at 4.0 C is $1g/cm^2$. Source: www.softschools.com

Buoyancy- the force that causes objects to float.

According to the principle of Archimedes, when a solid is placed in a fluid (a liquid or a gas), it is subject to an upward force equal in magnitude to the weight of the fluid it has displaced. So the object will rise or sink depending on whether it weighs less or more than the fluid it displaces. The object will rise or sink depending on whether it is less or more dense than the fluid it displaces. Buoyancy depends on gravity because buoyancy is a result of the weights of various substances. Three types of buoyancy are positive, negative, and neutral. **Positive buoyancy** happens when an object is lighter than the fluid it displaces. The object will float because of the buoyant force is greater than the object's weight. (ex- floating ping pong ball). **Negative buoyancy** happens when an object is denser than the fluid it displaces. The object will sink because its weight is greater than the buoyant force. (example steel bolt sinking to bottom of the jar). **Neutral buoyancy** occurs when an object's weight is equal to the fluid it displaces. (ex- tomato floating in the middle of the density tower). See lab book for diagram.

https://sciencing.com/three-typesbouyancy-10036718.html.

Method

For the Density Tower:

1. Using your turkey baster and glass measuring cup, pour in 175 ml of the following in this order: liquid honey, milk, dish detergent, colored water, and lastly canola oil. Pour liquids in against the wall of the jar so they go in gently to not disrupt the delicate liquid layers.

2. Start dropping in your objects and record what level they sunk to. I started dropping in the objects that I guessed to be the least dense so that I didn't disrupt the levels right away.

For the Floating Experiment:

1. Cut the 3 types of plastic boards to same size. Fill bath tub 3/4 full of water. Place board #1 in water and start adding weights on it.

2. Repeat process with board #2 and #3. Do 2 more trials. Record observations

Observations:

For the Density Tower:

These things floated in the oil level: ping pong ball, wooden spool, cardboard tube.

These things stayed in the middle: tomato was in between the water and detergent layer, dime stayed on top of the detergent, ear plugs (yellow part) stayed in the oil level and the cord went into the milk level, flat Lego piece and mini light bulb were in the water level.

These things sank: steel bolt, steel screw driver bit, AA battery, copper tube, twoony, quarter, penny, white plastic piece.

For Floating Experiment:

Each weight is 141 grams.

Trials	#1	#2	#3
Board #1 White Honey Comb with exterior airspaces	2 weights	1 weight	0 weights
Board #2 Heavier Yellow Comb with exterior airspaces	3 weights	2 weights	1 weight
Board #3 Plastic Cardboard with Interior airspaces	3 weights	3 weights	3 weights

Conclusion:

For Density Tower: The objects made of different types of metal sank. The objects that were air filled or had holes that contained air stayed on top of the oil (ping pong ball, cardboard tube). The objects that contained water or were light weight plastic generally stayed in the middle. I think the light bulb would have floated if there was no metal on it. It would be simpler to test objects made of only one type of material (twoony, light bulb, battery made of several substances). Next time, if I used the same jar, I would not test so many things because the jar got pretty full which made it hard to tell which level something truly sunk to (ex-dime).

For the Floating Experiment: Sheets #1 and #2 with no airspaces inside (the honey comb imprinted plastic sheet with airspaces on the outside) showed less buoyancy when weight is applied. These sheets might have done better in the first trial compared to second and third trial because the air spaces wouldn't have water in them yet. #3 plastic sheet was able to consistently hold 3 weights for each trial showing that the air filled spaces on the inside of the plastic sheet improved buoyancy.

Application:

The idea of a snowmobile staying on top of either water or a moving avalanche could save lives. I noticed that my research on Densities of Common Substances (found in my lab book) shows that while aluminum is more dense than water (2.7 g/cm^2), aluminum is significantly less dense than steel or copper. So, if a person could design a snowmobile made of double walled aluminum and or plastic with an air space between the two layers, the entire frame and the hood could remain buoyant. The frame and hood could act as a life raft for the rider. The ping pong ball that was filled with air shows that air is the key to buoyancy since the density of air is .0013 g/cm^2 which is significantly lower than the density of water (1 gram/cm^2 at 4 C).

Information for Density Tower diagram for Lab Book:

Although water molecules crowd closely together, each one has low mass, so water's density is low. When substances dissolve in water, their molecules squeeze in between the water molecules, increasing the solution's density.