IMHOTEP'S LEGACY ACADEMY

7.9 Making Things Float & Making a Hydrometer

Grade 7 Activity Plan

Reviews and Updates

7.9 Making Things Float

Objectives:

1. To demonstrate how density and displacement affect whether things float or sink
2. To illustrate how cohesion and surface tension cause certain things to float
3. To create a hydrometer to test and compare the densities of oil, water, saltwater, and alcohol
4. To apply knowledge of the relative densities of common household liquids in order to layer liquids on top of each other

Keywords/concepts: density, buoyancy, displacement, cohesion, surface tension, mass, volume

Take-home product: hydrometer, liquid pyramid

Segment	Details
African Proverb and Cultural Relevance (5 min.)	"No one tests the depth of a river with both feet." **Ashanti of Ghana**
Pre-test (5 min.)	Show of hands who can swim. Why is it possible for you to stay afloat in water?
Background (10 min.)	Explain the concepts of displacement and density to explain why some things float while others sink.
Activity 1 (5 min.)	Place a can of coke and diet coke in water to see which is less dense. Have students try to explain results.
Activity 2 (10 min.)	Challenge students to create out of clay a shape that will float in water and one that will sink. Explain buoyancy.
Activity 3 (10 min.)	Float a needle on top of water to demonstrate another interesting property of liquids: cohesion.
Activity 4 (20 min.)	Use oil and water to demonstrate different densities of liquids. Make a hydrometer using straw and clay and test the density of three different solutions namely: water, salt water, and cooking oil.
Activity 5 (10 min.)	Based on known density of different liquids make a floating pyramid out of water, glycerol, syrup, and alcohol.
Post-test (15 min.)	http://www.pbs.org/wgbh/nova/lasalle/buoyquestion.html Three brainteasers with multiple choice answers. Can be tough but engage the students. Students should learn from trying because the site explains answers very well, which should be relayed by the mentor.

Suggested interpretation of the proverb: No one will jump into a river not knowing its depth, for fear of drowning. In this activity, you will learn what it is that causes things to float or sink, and hopefully by the end you will understand what to do in order to float rather than drown. This proverb suggests that when trying something new, you should play it safe. You wouldn't dive into a pool if you've never swum, you wouldn't get married to someone you met yesterday, and you would not invest all your life savings into an activity you're not sure you like. Try new things, but don't dive in all at once. Better safe than sorry.

BACKGROUND INFORMATION

Density: the ratio of the mass of a substance to its volume. The greater the mass per given volume, the greater the density. Lead, for example, has a greater density than aluminum because a given volume of lead weighs more—that is, has a greater mass—than an equal volume of aluminum. The density of a material depends not only on its composition, but also on its temperature and, especially in the case of gases, on pressure. Density is commonly expressed in such units as pounds per cubic foot, grams per cubic centimeter, and grams per liter.

In general, when a substance changes from a gas into a liquid, or from a liquid into a solid, its density increases. A notable exception is water; its density decreases when it changes from a liquid into a solid.

If one places a copper ball in a pail of water it will sink, whereas a wooden ball will float. Whether or not a given object will sink or float in a fluid is determined by the **buoyant force** on the object. The buoyant force is essentially caused by the difference between the pressure at the top of the object, which pushes it downward, and the pressure at the bottom, which pushes it upward. Since the pressure at the bottom is always greater than at the top, every object submerged in a fluid necessarily feels an upward buoyant force. Of course, objects also feel a downward force due to gravity, and the difference between the gravitational force and buoyant force on a submerged object determines whether that object will sink, or rise to the surface. If the weight is greater than the buoyant force, the object sinks, and vice versa. This explains why wood and styrofoam float on water, whereas concrete and steel sink. It also explains why it is nonetheless possible to make boats out of steel or even concrete. As long as there are portions of the boat below the surface of the water that are hollow (i.e. contain air), the effective density of the boat can be less than that of water even though the real density of the material is greater.

The cohesive forces between liquid molecules are responsible for the phenomenon known as **surface tension**. The molecules at the surface do not have other like molecules on all sides of them and consequently they cohere more strongly to those directly associated with them on the surface. This forms a surface "film" which makes it more difficult to move an object through the surface than to move it when it is completely submersed.

Activity 1: Density Demo

Purpose: To demonstrate how density affects whether things float or sink

Item	**Quantity (for mentor)**
Water	1L
Can of Coke	1
Can of Diet Coke	1
Large Deep Container	1

Procedure:

1. Fill a large, deep container with water.
2. Place a can of diet coke and coke in the bottom of the bucket. Let go, and see which one floats.

Expected Results: The Diet coke is supposed to float and the regular coke is supposed to sink

Activity 2: Understanding Buoyancy

Purpose: To demonstrate how displacement affects whether things float or sink

Suggested format: Students may work individually or in pairs

Item	**Quantity (10 students)**
Clay	3 jars or 3 113g bags
Water	750mL
Beaker (250 mL)	5
Rocks	50

Procedure:

1. Fill a container about ¾ with water.
2. Obtain 2 pieces of clay.
3. Have students form a piece of clay they feel will sink and one that will float (you should expect figures shaped like a ball and another with tall sides like a boat)
4. Test both objects.
5. Drop a penny in the object that is floating. Does it sink deeper in the water?
6. Add more pennies until the object sinks. Why did it sink?

The science:
For something to float, it needs to either be less dense than water or displace enough water to support its weight with the up-thrust (buoyancy).

Additional Resources:
Buoyancy simulation for kids http://www.ciese.org/buildit/sims/buoyancy.html

Activity 3: Can a Paper Clip Float on Water?

Adapted from: https://sciencebob.com/make-a-paperclip-float/

Purpose: To illustrate how cohesion and surface tension cause certain things to float

Item	**Quantity (10 students)**
250mL Beaker	5
Water	1L
Paper clip	5
Small piece of paper (a little wider and longer than your paperclip)	5
Toothpick	5

Procedure:

1. Fill the beaker with water.
2. Now hold the paper clip over the beaker and drop it into the water. What happens?
3. Float the small piece of paper on top of the water.
4. Carefully place the paper clip horizontally on top of the paper .
5. Use the toothpick to slowly push the entire paper into the water. What happens?
6. Now push the paper clip with the toothpick. What happens?

The science: Surprisingly, the paper clip floats when you place it in with paper towel, not because of buoyancy, but because of cohesion and surface tension. The surface tension of the water at the top of the drinking glass forms an invisible film that is able to support the paper clip.

Activity 4: Measuring Density using a Hydrometer

Adapted from: http://www.ecawa.asn.au/home/jfuller/liquids/hydrometers.htm

Purpose: To create a hydrometer to test and compare the densities of oil, water, saltwater, and alcohol

Suggested format: Students will work in groups of 2 or 3

Item	**Quantity (10 students)**
Cooking Oil	350mL
Rubbing alcohol	300mL
Water	200mL
Salt	9 Tbsp
Stirring Rod	1
Beaker (500 mL)	1
Drinking Straws	10
Plasticine	100g
Small nails	20
Graduated cylinder	12

Procedure:

1. Fill a beaker with **200mL of water**, and pour a layer (~50mL) of **cooking oil** over the top.
2. **Stir** them together vigorously, and observe how the oil still floats to the top.
3. Ask students to **infer** what this means about the density of oil and water.
4. Ask students to **guess** out of water, salt water, oil and alcohol, which one will be the least dense liquid? Now test their hypotheses using a hydrometer.
5. Hand out the **drinking straws**. Roll a small piece of **plasticine** around the bottom of the straw.
   NOTE: If the plasticine doesn't work then **mentors** should use a hot glue gun to seal the bottom of the draw
6. Put **two small nails** into each straw.
7. Using a ruler, **mark a scale** on the drinking straw. Place a mark every 2 millimetres. Make every 5th mark darker.
8. For each group of students, have **4 graduated cylinders**: one with water, one with salt water, one with alcohol, and the last with cooking oil.
9. To **calibrate the hydrometer**, lower it into a graduated cylinder with 100 ml of water in it. The density of water is 1.0 gram/ml. If the hydrometer sinks to the bottom, remove one nail, if it floats to the top, add one nail. Once the hydrometer is neither too high nor too low, mark the line it reaches as 1. The hydrometer has been calibrated.
10. Now have students **test oil, alcohol, and saltwater** (100mL each). The lower in the solution the hydrometer goes, the higher the density of that solution.

Activity 5: Liquid Pyramid

Purpose: To apply knowledge of the relative densities of common household liquids in order to layer liquids on top of each other

Item	**Quantity (10 students)**
Glycerol	300mL
Cooking Oil	300mL
Water	300mL
Syrup	300mL
Small Mason Jars	10
Food colouring	3 colours
Graduated Cylinder	1
Honey	300mL
Dish soap	300mL

Procedure:

1. Colour water and alcohol with food colouring.
2. Into a mason jar, pour 30mL of 4 of these items: glycerol, syrup, water, oil, dish soap, honey, or alcohol.
3. Encourage experimentation: pouring a less dense liquid, then something denser, swirl container and see if layers reform the same.

Post-Test

Online activity at http://www.pbs.org/wgbh/nova/lasalle/buoyquestion.html. These three buoyancy brainteasers can be shown on a projector, printed off and handed out by mentor, or conveyed by hand on the board.