LET'S DO IT!

ISBN 978-1-847003-60-7

Teacher Edition

Science Is A Verb!

Part 7

Teacher Edition

Contents

Introduction to the lab manual:

This lab manual provides structure for teachers who wish to engage students in hands-on interactive learning but also provides support for teachers who are more comfortable with enquiry based learning. If you are a teacher who is taking his or her first "dive" into hands-on Science, the background material is designed to provide enough structure to help support the organisation of the lab and its materials. Most of the materials are commonly found in local supermarkets and department stores at a nominal cost. A few materials, like scales and hand microscopes can be found on-line. The lab sheets can be given to students so they follow step-by-step or they can be told a general structure to follow.

The critical portion of any lab is to have a thorough discussion of the results and their thinking after the experiment is completed. It is suggested that you take as much time as the experiment to have this discussion with students. The real learning occurs not from the hands-on experiment, but from a deep discussion of the experiment, while making connections to the concept they are learning. For this reason, it is suggested that the students do the experiment FIRST and then have the students learn the concepts. They will have a better understanding of the concept if they first conduct an experiment, gain the experience and then discuss a new concept.

Even without a strong Science background, get into the habit of asking questions. The process of asking questions and being inquisitive will generate more excitement for students and will engage them in a deeper way of learning Science. "I don't know" is as important to learning as having all the answers. Together you can learn Science and discover the major ideas that Scientists' research.

If you are an experienced teacher, the Teacher Guided Questions to Enquiry are designed to provide prompts for students. These questions are not intended to be assessment questions, but ones that will engage students in the general direction of the benchmark. The teacher may select one or two, but not all of them, to have students start on an open enquiry approach to learning. The students will engage in their own experiment, create their own procedures and make conclusions from their data. For this reason, there are no answers to those questions. They are open ended and can be used to formulate interesting experiments for advanced students. The slight variation in some of the questions in each of the labs is designed to provide a sufficient number of prompts at various levels of Bloom's Taxonomy to engage students.

Throughout the year, encourage questioning, student dialogue and the scientific process. There is no one exact scientific method as is often suggested. The process of learning about the world and universe, drawing conclusions from facts and building these facts into strong scientific theories is the work of Science. Science is always growing, stretching and expanding its knowledge base. It is about challenging well-supported ideas to discover weakness. This is exactly what students should be encouraged to do! And in the end, Science is not something to study, it is something to do!

Science is a VERB!

Science is a Verb

Density and Buoyancy

WHY DO YOU FEEL LIGHTER IN A SWIMMING POOL?

Description: Students will explore Archimedes principle by measuring the weight of objects in and out of water and compare the difference in the measurements.

Student Materials (per group):
- Spring Scale (with Newtons)
- Cup
- Pie Pan
- Object (that will fit in a cup and will sink – golf ball

Additional Teacher Materials:
- String
- Tape

Background and Misconceptions:

Archimedes was an advisor to King Hiero II of Sicily. He was posed a problem to determine if a crown that was created for the king was real. His solution came while he was sitting in the bath tub. He noticed that he felt lighter when he was in the tub and the weight of the water that his body displaced was equal to the decrease in his own weight. When he used this idea to determine if the crown was a fake, he measured the weight of the crown. He then put in an equal weight of pure gold into a bucket of water and filled it to the top. He figured that if the crown was not made out of gold, when it was placed into the bucket, if it were made out of something like silver or other cheaper metals, it would have a greater upward force on it – it would be more buoyant. So he removed the gold, placed the crown into the bucket, and this time the water overflowed. He concluded that the crown was not real!

Archimedes had discovered a fundamental principal that all fluids exert an upward force on objects. (A fluid is classified as both a liquid and a gas, so while Archimedes' Principle is usually taught as applied to liquids like water, it applies also to objects in the atmosphere). When a brick is placed into a container of water its weight decreases. The amount of decrease in the weight is equal to the WEIGHT of the water displaced. While the brick may weight 30 newtons in the air, when it is submerged into a container

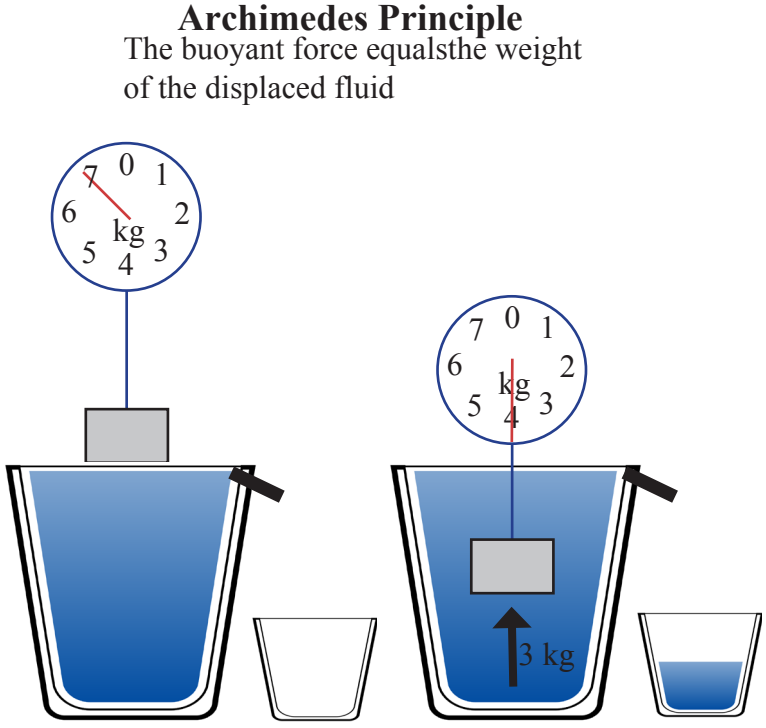
of water, its weight may now be 20 newtons. This means that the volume of the brick displaces an amount that equals 10 newtons. Remember that students may confuse VOLUME and WEIGHT in this case. When the brick is in water, it displaces a great deal more weight than while the brick is in the air. The air is also providing an upward buoyant force, but the weight of air displaced is much less than water because water has a much higher density.

Archimedes' principle is also the reason why ships float. (It can also be explained in terms of density). When the ship is in water, it displaces an amount of water that is equal to its volume. If the amount of water displaced is equal to the weight of the ship, it floats! The ship will partially sink into the water until the amount of water displaced is equal to the weight of the ship.

In general:

- If an object is submerged in the water, the buoyant force is equal to the VOLUME of the object.
- If an object is floating on the water, the buoyant force is equal to the WEIGHT of the object.

If you were to float on an inflatable raft in a pool and measure the water level, you would find that if you fell off the raft and were completely submerged in the pool, the water level would drop!
The buoyant force is greater when you float in water as possible to being completely submerged in water.



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Density and Buoyancy

Teacher Guided Questions to Enquiry:

Use these questions to get the students started on their own enquiry!

1. How do ships float?
2. What happens to the force on your body when you are submerged in a swimming pool?
3. Why do you feel lighter when you are swimming in a pool?

Additional Hints:

- If the object that is being used can not be attached to the spring scale easily, tie or tape a piece of string to the object.
- The must be dense enough to sink in water and small enough to fit in the cup. Use objects like a golf ball, a rock, or a rock that has about 50 - 100 mL volume.
- If students are using a scale that lacks units of newtons, show students how to calculate the weight using F=ma ($a = 9.8\ m/s^2$)

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Density and Buoyancy

WHY DO YOU FEEL LIGHTER IN A SWIMMING POOL?

TEACHER ANSWER KEY

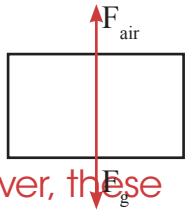
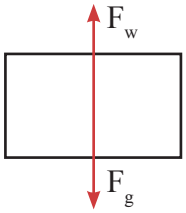
Description: When you swim in a pool, it is easy to notice that you feel lighter. The water is providing a force that causes you to be suspended in the water. This force is called a buoyant force and was first discovered and explained by Archimedes.

In this experiment you are going to explore Archimedes Principle.

Materials: Spring Scale (N), Object, Cup, Digital scale, Pie Pan

Procedures:

1. In this lab, you will be placing an object on a spring scale. The spring scale can measure the weight pulling the object down and the net force acting on the object. Below, draw your prediction of the force diagram of an object hanging from a spring scale. Label the gravity pulling the object down and the tension acting on the object from the scale.
2. Then draw this same object immersed in a container of water. Again, label the force of the spring scale, gravity and the buoyancy force acting on the object.

PREDICTION of force diagram OUT of WATER. DRAW TO SCALE	PREDICTION of force diagram IN of WATER. DRAW TO SCALE.
 Students answers. However, these arrows should be larger than the prediction in water to the left.	

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WHY DO YOU FEEL LIGHTER IN A SWIMMING POOL?

3. Record the force acting on the object out of water using the spring scale.
4. Weigh the empty water collection container with the spring scale.
5. Place a cup into a pie pan. Fill the cup all the way to the top.
6. Slowly immerse the object in the water. Watch as the force measurement changes.
7. When the object is fully immersed in water, record the final net force measurement on the spring scale
8. Remove the scale and water cup. Weigh the water that overflowed into the pie pan. (Remember to subtract the weight of the pie pan!)
9. Record all data in the table.
10. Collect information from at least three other groups in the classroom.

<table>
<tr><td>Net force (on spring scale) before immersing in water</td><td>Net force (on spring scale) when fully immersed in water</td><td>Change in net force acting on the object</td><td>Group 2 Force:</td><td></td></tr>
<tr><td colspan="3" rowspan="2">10 Newtons
8 Newtons
2 Newtons</td><td>Group 3 Force:</td><td></td></tr>
<tr><td>Group 4 Force:</td><td></td></tr>
</table>

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WHY DO YOU FEEL LIGHTER IN A SWIMMING POOL?

Observations- How did the net force acting on the object change as you lowered it into water?

The force decreased.

Weight of empty container (m x 9.8 m/s^2)	Weight of container with water (m x 9.8 m/s^2)	Weight of water that spilled out (m x 9.8 m/s^2)	Group 2 Force:	
.25 newtons	2.25 newtons	2 newtons	Group 3 Force:	
			Group 4 Force:	

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WHY DO YOU FEEL LIGHTER IN A SWIMMING POOL?

Questions:

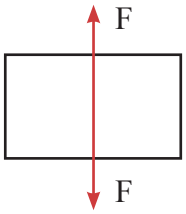
1. Look at the weight of the water that spilled out and the change in net force. What do you notice about these values?

They are the same. The amount that the force decreased equals the weight of the water.

2. Describe what you think is going on with the forces as you lower the object into the water.

The water is providing an upward buoyant force on the object causing it to pull down on the scale with less force.

3. Draw a diagram of the buoyant force acting on an object.



4. Based on the results of this experiment how would you explain the idea that Archimedes discovered?

The buoyant force of an object in water is equal to the weight of water displaced by the object.