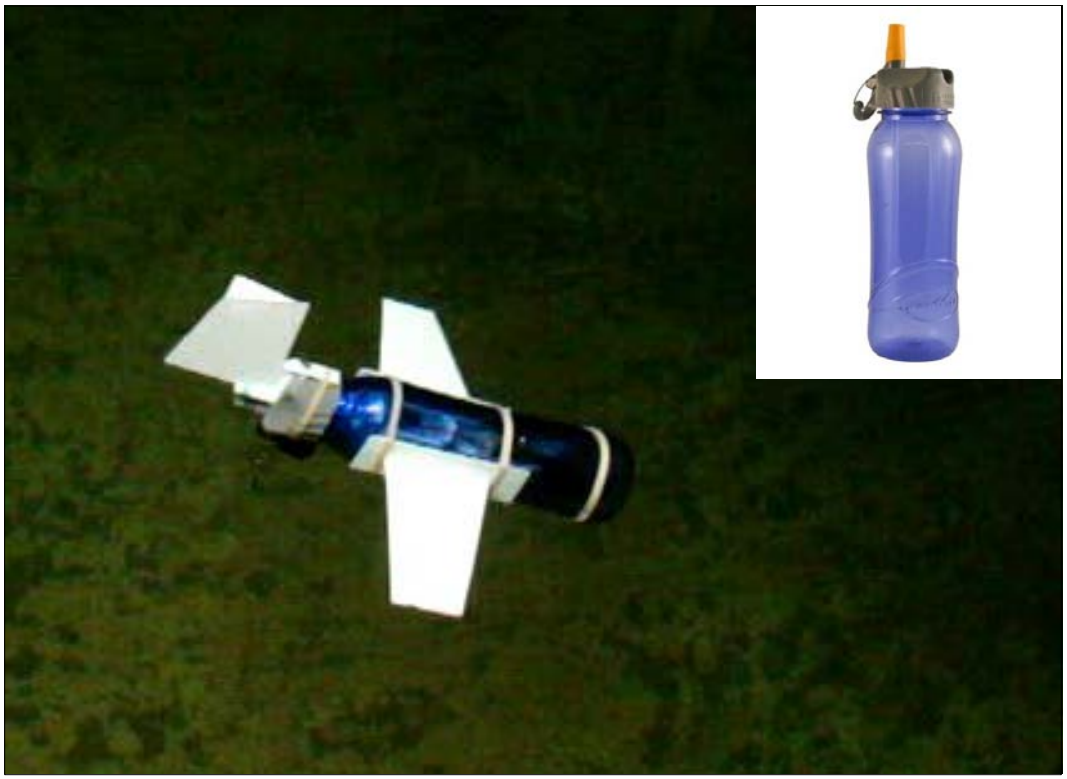
Name _____ Date _____

SeaGlide One Cycle Glide Mission 2

Your mission is to design and create wings and a rudder for your bottle glider and then fly it underwater for one sink/rise cycle. The challenge will be to cover the maximum distance possible in one cycle.

YOU NEED:

One Nathan BPA Free Flip Straw Bottle 700 ml (glider body)
1/16" and 1/8" Polystyrene Sheet (wings and rudder)
Alka-Seltzer
Moveable Rudder Hardware
Assorted Ballast Weights and Washers
Scissors, Glue, and Foam Mounting Double-Sided Tape
Aquarium or other testing tank



Underwater Bottle Glider

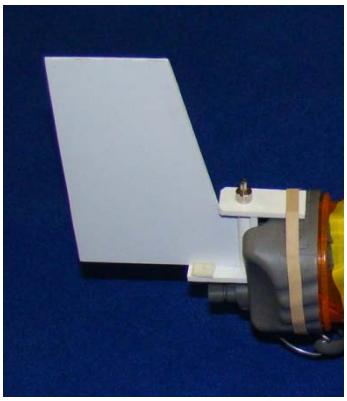
INSTRUCTIONS:

Use your knowledge about wing designs from Mission 1 to draw wings for the bottle glider on graph paper. (A glider wing template is also available.) Trace your plans onto 1/16" polystyrene and use scissors to carefully cutout the tracing.

Each wing will need a base support that will hold the wing and serve as a means of attachment to the bottle. Design and create the wing base supports or use the template.

Carefully cut a slot in each base support for the wings. Glue the wings into place perpendicular to the base supports. Attach wings to the bottle with rubber bands. Foam Mounting Double-Sided Tape stuck on the base supports will cushion them against the bottle. Leave the plastic backing on the exposed side.

Design a moveable rudder for the bottle. (A rudder template is also available.) Trace your plans on to 1/16" polystyrene and use scissors to carefully cutout the tracing. If you use the rudder template, use 1/8" polystyrene to create a rudder base support as illustrated on the plans.



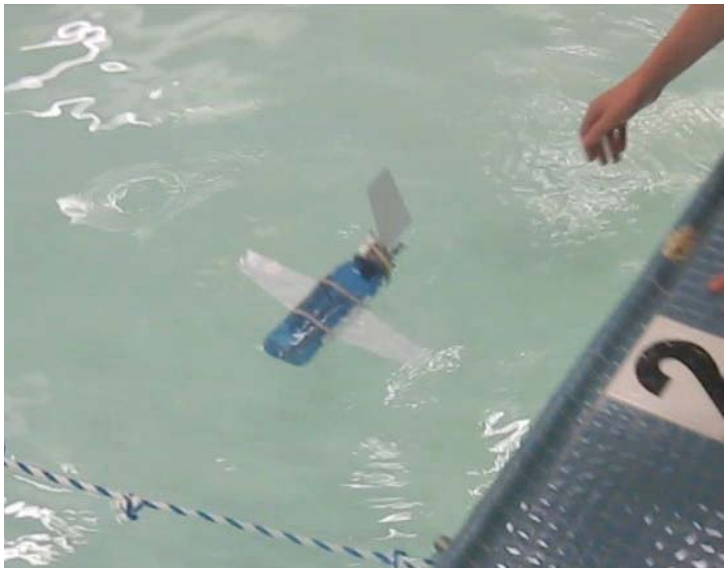
Use 1/4" diameter polystyrene tubing (3.8 cm long) for creating a hinge. Carefully cut a slot in the polystyrene tubing to accommodate the rudder. Glue the rudder into the slot in the tubing. Attach the rudder to the base support using a 1/8" brass rod (5.7 cm long) and 1/8" shaft collars.

The rudder can be attached to the bottle top with a rubber band. Foam Mounting Double-Sided Tape stuck on the rudder mount will cushion it against the bottle. Leave the plastic backing on the exposed side.

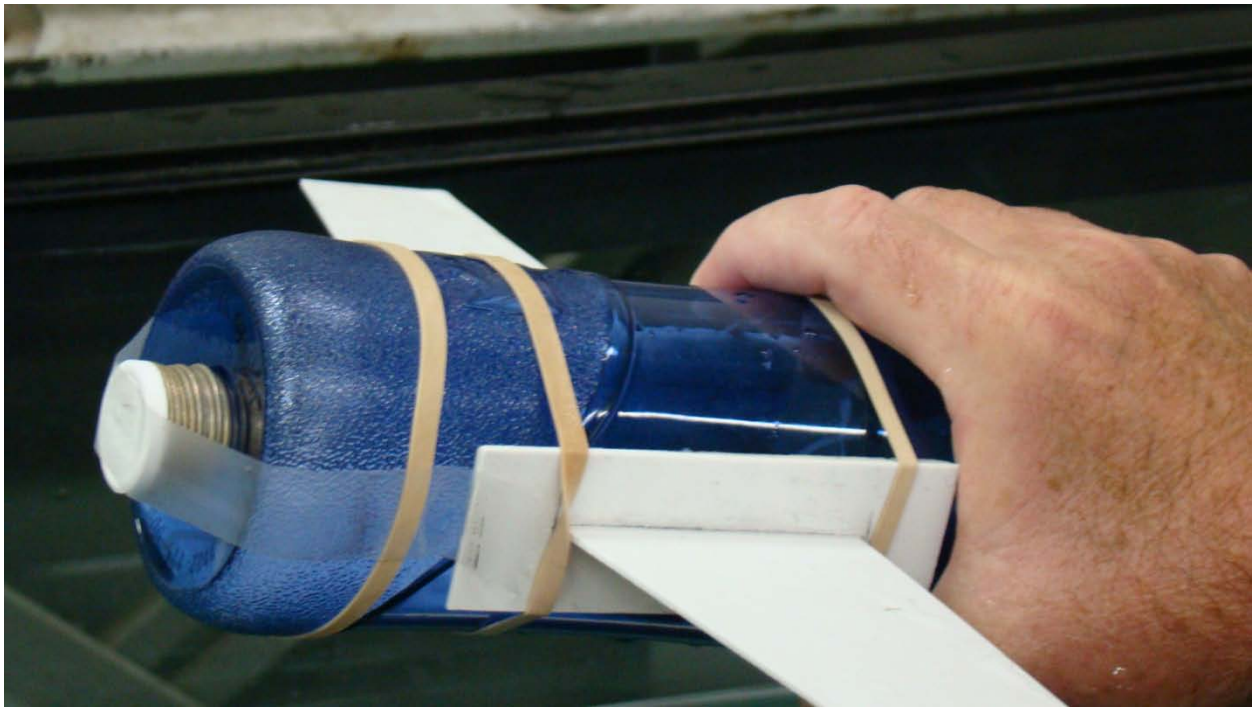
In water with the wings and rudder attached, determine how much ballast (weight) will be required inside the bottle to allow it to barely float or hover near the surface. Record your results below. The location of the ballast inside the bottle is important. The bottle should hover at the surface in slightly nose (bow) up position.

Add washers under the rubber band near the front of the bottle. The bottle glider should tilt nose down and begin to sink. As it descends, it should glide forward. To complete the sink/rise cycle, remove the washers. The bottle should pitch upward and glide to the surface.

Adjust wings and rudder for the option forward motion both for descending and ascending glides.



To accomplish one sink/rise cycle hands-free, you'll need an automatic way to release the washers at the bottom of a dive. One way is to tape an Alka-Seltzer tablet (or tablet section) and washers together on the front of the bottle. (See below.)



With the right number of washers and correct tablet size, the glider will pitch downward and glide towards the bottom. When the tablet dissolves, the washers will drop off causing the glider to pitch upward and fly to the surface.

CHALLENGE:

The mission challenge is to fly your underwater bottle glider for one fully cycle covering as much distance as possible. Complete three trials and record your results in the chart below. Average the trials and record the results.

Mission Data:

Ballast needed in sealed glider to hover near the surface: _____

Trials	One Cycle Glide (Distance in cm)
1	
2	
3	
Totals	
Average	

NOTES - PROBLEMS ENCOUNTERED AND SOLUTIONS TRIED:

QUESTIONS:

1. Given a water bottle with a right circular cylinder shape and a diameter of 7.0cm with a height of 21.5cm, what is the volume of the bottle? Use pi=3.14 and round to the nearest hundredth. (Show formula used and calculations below.)

2. Assuming that the above water bottle is sealed and its thickness is negligible, how many cubic centimeters of water will it displace if completely submerged? Explain.

3. Approximately how many grams of ballast would you add to get this bottle to barely float? Explain.

4. Does it make a difference if ballast is added to the inside or outside of the bottle? Explain.

EXTENSION:

Use 3D printed wing brackets with wing mounts (see below), to make testing new wing designs easier. Use your knowledge about wing designs from Mission 1 to draw wings for the bottle glider on graph paper. Trace your plans onto 1/16" polystyrene and use scissors to carefully cutout the tracing.

Wing Brackets

SeaGlide One Cycle Glide Mission 2

Teachers' Notes

The best bottle we've found for the glider project is the Nathan BPA Free Flip Straw Bottle 700 ml in colors clear or translucent orange or violet. (See below.) The bottle is reliably waterproof and allows for visual access to the inside operation of the buoyancy engine when it is added later.

An alternative approach would be to have students bring their own bottles or provide one-time use bottles such as 400 ml Simply Lemonade bottles. These would be used for this activity only.

For cutting styrene plastic: Under supervision, a box cutter can be used instead of scissors. Cut lines can be scored and then the styrene can be snapped in two. A Dremel tool works well for cutting the 1/16" slot in the wing base support. Super or crazy glue can be used to bond the wings into the base support. Use eye protection and other precautions as needed. Depending on the situation an adult may need to operate the Dremel tool. A Dremel tool is also useful for cutting a 1/16" slot in the ¼" diameter polystyrene tubing for the moveable rudder.

One or two layers of electrical tape around part C of the rudder mount design will stabilize the rudder so it can move but will stay in place once adjusted.

For a good discussion of buoyancy see:
http://www-personal.umich.edu/~lpt/archimedes.htm.

For testing tanks, we've used a variety of waterproof enclosures: 60 gal aquarium, swimming pool, 100 gallon horse trough, and a fish tote.

Questions:

1.

$V = \pi r^2 h$

$V = (3.14)(3.5)^2(21.5)$

V=826.9975…

V=827.00 cubic centimeters

2. 827cubic centimeter of water

3. Slightly less than 827grams, one cubic centimeter of water ~ one gram

4. Yes, if ballast is added to outside, the shape of the bottle changes and more water is displaced. Therefore, buoyancy increases and more weight may be needed to reach the “barely floating” state.

RESOURCES

Nathan BPA Free Flip Straw Bottle 700ml: http://www.amazon.com/gp/product/B001KZATUK/ref=s9_simh_gw_p200_d18_g200_i1?pf_rd_m=ATVPDKIKX0DER&pf_rd_s=center-2&pf_rd_r=0HP3XXBN8EQHX5SQ1VQK&pf_rd_t=101&pf_rd_p=470938631&pf_rd_i=507846.