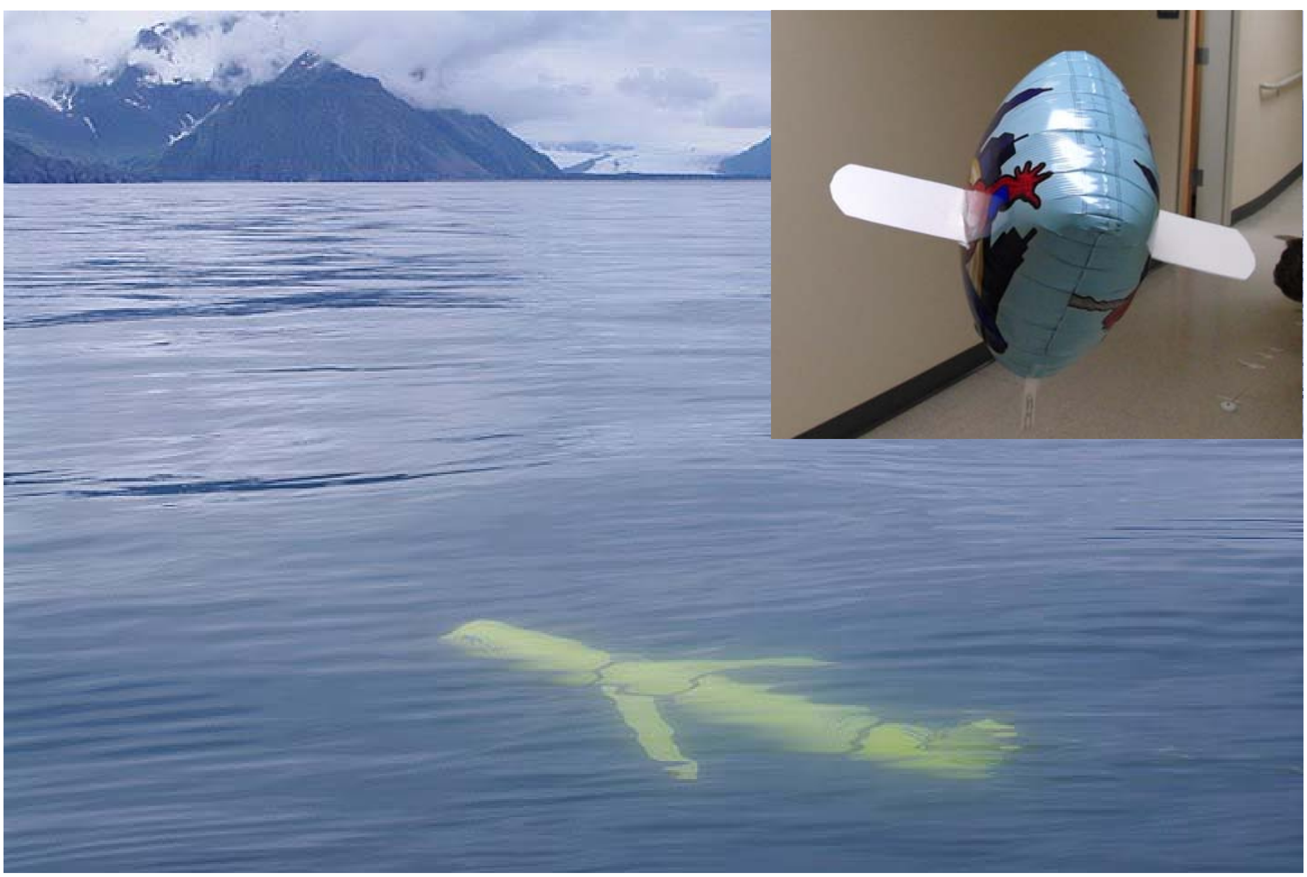
Name ___________________________________ Date _________________

Helium Balloon Glider Mission 1

Your mission is to design and create a Helium Balloon Glider that simulates the flight patterns of a commercial underwater glider. The second challenge of the mission will be to fly your balloon glider for maximum distance.

YOU NEED:

Rectangular Foil Helium Balloon
Paper Clips
Large Styrofoam Plates or Other Light-Weight Wing Materials
Scissors, Cellophane Tape, Paper Clips

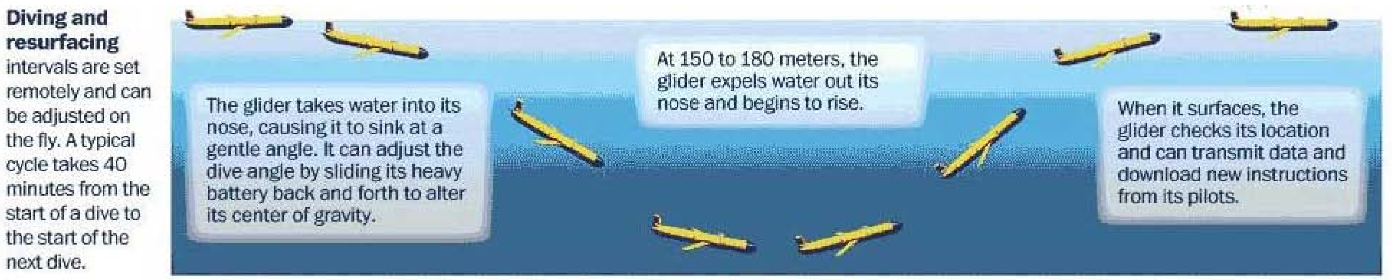


Gliders in Alaska

BACKGROUND:

An underwater glider is a non-tethered or autonomous robot that has no propeller and uses very little energy. It uses its wings to "fly" through the water propelling itself forward by long slow dives followed by extended glides to the surface. By changing its buoyancy, it repeats this up-and-down pattern over and over again and travels forward.

To change buoyancy, a glider changes its density. A glider can change density by a number of different ways. One is to mechanically draw in a small amount of water becoming more dense (heavier per unit volume) causing it to sink or expel water becoming less dense (lighter per unit volume) causing it to rise.



SOURCE: Rutgers University Coastal Ocean Observation Laboratory | Bonnie Berkowitz, Patterson Clark and Laris Karklis/The Washington Post - December 15, 2009

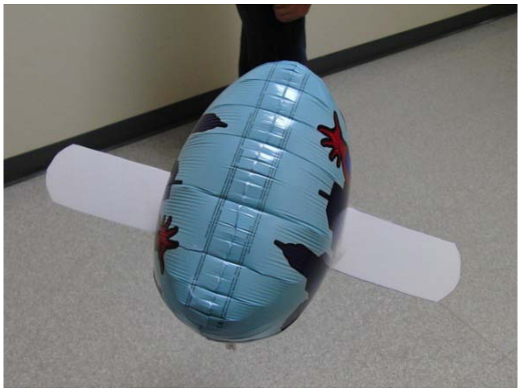
Slocum Glider Dive and Resurface Cycle

In order to change buoyancy on a Helium Balloon Glider, weight is physically added to increase density or physically removed to decrease density. As the balloon glider sinks and rises, its wings give it forward motion. A graph of its sink/rise cycle roughly mirrors that of the underwater glider's sink/rise cycle illustrated above.

INSTRUCTIONS:

On graph paper, design wings for your balloon glider. Trace the designs onto a large Styrofoam plates or other light-weight wing materials. Use scissors to cut-out the wings and then attach them to each side of the balloon with cellophane tape. Use small struts to stabilize and help support them.

From scrap materials, make a one by three inch nose section. Attach the nose to the bottom corner of the balloon. Use a small strut to stabilize the nose. Carefully attach paper clips to the end of the nose section until



your balloon glider hovers or is neutrally buoyant. This will also tilt the glider downward.

To create a descending or sinking glider, add a small amount of weight to the nose until your balloon slowly glides towards the floor. The wings should provide lift that will move it forward as it descends.

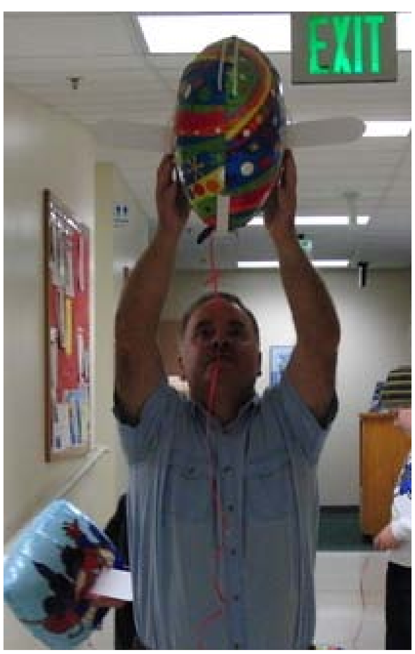
To create an ascending or rising glider, remove a small amount of weight from the nose until the glider floats towards the ceiling and slowly glides forward.

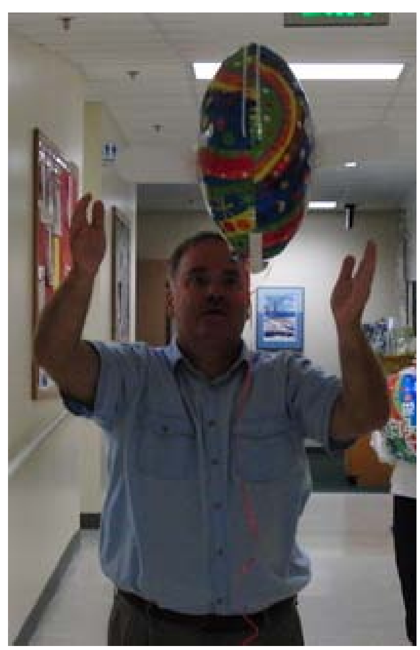
CHALLENGE:

The mission challenge is for your balloon glider to reach the greatest forward travel distance possible with one sink and rise cycle:

Descending Glide
Indoors in an open room or hallway, release you balloon glider from a consistent, designated height. This is a motionless release with no forward push. Record the maximum distance in centimeters that it travels forward before reaching the floor. Record three trials in the chart below under **Downward Glide** and average your results.

Ascending Glide
From a designated starting line release your Helium Balloon Glider from the ground. Record the maximum distance in centimeters that it travels forward before reaching the ceiling. Record three trials in the chart below under **Upward Glide** and average your results.





Descending Glide Release

Add the averages for the Downward and Upward Glides to calculate the average distance for one sink and rise cycle. Record the combined average total in space provided in the chart below.

Mission Data:

(Results)

Trials	Downward Glide (Distance in cm)	Upward Glide (Distance in cm)
1		
2		
3		
Totals		
Averages		
Sum of Downward and Upward Glide Averages		

QUESTIONS:

1. Of all the balloon glider designs, which one seemed to produce the best distances? Why did it work better?

2. How would you redesign your balloon glider for greater distances? (On separate sheet of paper, draw a diagram of improvements and label.)

3. Does increasing the speed of the balloon glider’s descent or ascent affect distances? Explain.

4. What problems did you encounter during this mission? How did you try to correct them?

EXTENSION:

For each exercise below, use graph paper to illustrate new glider designs. Label wings, struts, and any new structures. Control variables and just test for one new design change at a time.

Create a data chart to record results of tests for downward and upward glides as well as distance covered in one sink and rise cycle. Describe how the new design worked compared to the original and how it could be improved.

1. Given what you know about which balloon gliders produced the longest distances, design a new set of wings for your glider. (You can imagine using any type of materials that are readily available.) Build and test your new wings.

2. See the **Animals that Fly** slides and find a truly unique design feature that could be adapted to your balloon glider. Create and test your bio-inspired design on the balloon glider.

3. Will a larger balloon glider fly better then a small one? Combine two or more balloons and add the wings from a small balloon glider. After testing and recording results, try bigger wings.

Illustrations & Photos:
Page 1 Large Photo: http://www.ims.uaf.edu/artlab/projects/glider_nitrate.html#thumb
Page 1 Small Photo: Bob Vieth - http://stemak.org/photos
Page 2 Illustration: http://rucool.marine.rutgers.edu/atlantic/downloads/wp_121509_print.jpg
Page 2 Photo: Bob Vieth - http://stemak.org/photos
Page 3 Photos: Bob Vieth - http://stemak.org/photos

(From http://stemak.org/photos)

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Teachers' Notes

This is an activity related to construction of an Underwater Bottle Glider. The activity is best done inside without the influence of air currents. Rectangular prism shaped helium balloons seem to work best. Ten inch Styrofoam plates work fine for wings, struts, and nose pieces.

With the instructions as written the balloon glider will be going backwards when weight is removed from the nose. To make the analogy to a real glider's motion more precise, both a nose and tail piece could be placed on the balloon. To change pitch, weight should be shifted from the nose for sinking to the tail for rising with some mass removed to decrease weight.

For the **Mission Data** results, students can be asked to put their combined averages on the board and then instructed to calculate the mean, medium, median and range for the data. Students could also use the data to create a box-and-whisker graph.

An additional method for finding the maximum distance covered in one sink/rise cycle is to allow students to combine their best Downward Glide with their best Upward Glide.

To allow for equal distances for both upward and downward glides, release balloons half way between the ceiling and the floor or if the downward glide is released two feet from the ceiling, release the upward glide two feet from the floor.

A very interesting extension to the Animals that Fly slides and bio-inspired engineering is the development of a monocopter from studying the flight of maple seeds. See summary and videos at http://www.physorg.com/news/2011-01-robotic-tree-helicopter-video.html.