Name: _____
Period: _____
Date: _____

Dolphin Divers

This activity involves variations of a fun science toy known as a Cartesian diver. It is thought that the Cartesian diver got its name from a famous mathematician named Rene Descartes. The Cartesian diver does an excellent job of demonstrating scientific principles including buoyancy, density, pressure, and volume. In this activity, you will have an opportunity to examine a typical Cartesian diver. In addition, you will make some modifications to the Cartesian diver to demonstrate a fantastic diving adaptation of the dolphin. Let's get started with a few warm-up questions.

1. What does the term 'density' mean?

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2. What does the term 'buoyancy' mean?

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3. Using the terms from Questions 1 and 2, explain why a quarter sinks but a cork floats.

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Materials:

- Empty plastic soda bottle
- Water
- Cup
- Glass eye dropper
- Wax or clay

Part I: A Typical Cartesian Diver

Procedures:

1. Remove the label from the soda bottle.
2. Fill the soda bottle to the brim with water, leaving no air in the bottle.
3. Put the medicine dropper in a glass of water, and get some water in the dropper by squeezing the rubber bulb. Add enough water to the dropper so that it just barely floats upright. There should still be some air in the dropper!

Dolphin Divers

4. Place the dropper in the soda bottle.
5. Again, make sure the bottle is filled to the brim and screw the cap on the bottle and tighten.
6. Apply pressure to the sides of the bottle, then release the pressure. Carefully observe the dropper and its contents.

Questions

1. What happened to the position of the dropper when you applied pressure to the bottle?

2. Apply pressure to the sides of the bottle again. Make sure to look at both the air and water inside of the dropper, as well as the rubber bulb. Describe what you see.

3. Explain what happened to cause the dropper to sink when you applied pressure. Your answer should include a discussion of density and buoyancy.

Part II: A Dolphin Diver

Dolphins have amazing adaptations that allow them to dive without expending lots of energy. For a long time, scientists thought that dolphins used strong, continuous strokes of their tail to propel them down into the water, and then used these strong strokes again to return to the surface. However, a group of researchers proved this theory wrong by attaching a camera to a dolphin and watching it dive. The camera showed that the dolphin used a few powerful strokes of the tail to get started. The tail then stopped moving, and the dolphin

seemed to just sink towards the bottom. When it was time to return to the surface, the dolphin used a few powerful strokes to begin its ascent, and then the tail stopped moving as the dolphin continued to rise to the surface.

How would you explain these observations?

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Let's make a modified Cartesian diver to help demonstrate what the scientists observed.

Procedures:

1. Make sure the bottle is still filled to the brim with water.
2. Cover the bottom of the dropper with a small piece of wax or clay. Make sure the bottom is completely covered and that there are no holes in the wax or clay.
3. Place the dropper in a glass of water. Again, you will need enough water in the dropper so that the dropper just barely floats upright. You will need to remove either the clay or the rubber bulb in order to adjust the amount of water.
4. Once the dropper is floating properly, place it in the soda bottle.
5. Again, make sure the bottle is filled to the brim and screw the cap on the bottle and tighten.
6. Apply pressure to the sides of the bottle, then release the pressure. Carefully observe the dropper and its contents.

Questions

1. What happened to the position of the dropper when you applied pressure to the bottle?

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   _____

2. Apply pressure to the sides of the bottle again. Make sure to look at both the air and water inside of the dropper, as well as the rubber bulb. Describe what you see.

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Dolphin Divers

3. Unlike Part I, this diver is a closed system. No water is able to enter the dropper, but the dropper still sinks when pressure is applied. Why?

4. Dolphins have a very flexible rib cage. As they dive deeper into the water, the pressure increases. The flexible rib cage allows the lungs to collapse. Which part of your modified Cartesian diver acts like the lungs of a dolphin when pressure is applied?

5. Based on what you observed, explain why a dolphin is able to sink towards the bottom without using its tail to propel it.

6. Why is this modified Cartesian diver a more accurate depiction of a diving dolphin than the one in Part I?

Part III: A Human Diver

Procedures:

1. Remove the dropper from the soda bottle.
2. Make sure the bottle is still filled to the brim with water.
3. Remove the rubber bulb from the top of the dropper. Cover both the top and the bottom of the dropper with small pieces of wax or clay. Make sure the openings are completely covered and that there are no holes in the wax or clay.
4. Place the dropper in a glass of water. Again, you will need enough water in the dropper so that the dropper just barely floats upright. You will need to remove one of the pieces of clay or wax in order to adjust the amount of water.
5. Once the dropper is floating properly, place it in the soda bottle.

Dolphin Divers

6. Again, make sure the bottle is filled to the brim and screw the cap on the bottle and tighten.
7. Apply pressure to the sides of the bottle, then release the pressure. Carefully observe the dropper and its contents.

Questions

1. What happened to the position of the dropper when you applied pressure to the bottle?

2. Apply pressure to the sides of the bottle again. Make sure to look at both the air and water inside of the dropper. Describe what you see.

3. Like in Part II, you have a closed system. However, the results are very different. Explain what is happening this time.

4. This model is a little more like a human diver. What big difference between dolphin anatomy and human anatomy is responsible for the differing results you observed in Parts II and III?

According to this model of the human diver, people would need to swim pretty hard while SCUBA diving in order to move deeper the water! Never fear-- SCUBA divers have equipment that helps them regulate their buoyancy in the water during their dives!