Buoyancy Bull's-eye

GRADE LEVELS	6th-8th ; California Content Standards for 8th
SUBJECTS	Physical Sciences, Investigation and Experimentation
DURATION	Preparation: 10 minutes Activity: 40 minutes
SETTING	Classroom

Objectives

In this activity, students will:

1. learn how organisms float, sink, or hover in water.
2. construct a neutrally buoyant scuba diver.

Materials

small action figures (one per student)
small rubber balloons (bag of 100)
rubber bands (box of 100)
tooth picks (box of 100)
pennies (at least 100)
masking tape (one roll per group)
paperclips (box of 100)
buckets (one per group)
water from the faucet
Buoyancy Bull's-Eye Worksheet (one per student)

Vocabulary

- buoyancy: the ability to float
- buoyant force: the upward force exerted by a fluid on a submerged object
- density: mass per unit volume

Teacher Background

Scuba diving is an excellent hobby for underwater naturalists. Along the California coast, scuba divers can see kelp forests, sea otters, many species of fish, sea lions, and a variety of invertebrates such as octopuses, crabs and urchins. With the aid of specialized equipment, divers can prolong their visit below the surface for a lot longer than they can hold their breath! Expert divers have set records exploring ocean depths of approximately 1000 feet (305 meters), but, ost scuba divers swim closer to shore where the water is shallower.

Scuba diving requires training as well as specialized equipment, called SCUBA (Self-Contained Underwater Breathing Apparatus) gear, which includes one or two oxygen tanks strapped to the back of the diver and a regulator that fits into the mouth and controls the flow of air. It is essential for divers to be able to breathe underwater, but they also need to be neutrally buoyant to prevent floating to the surface or sinking to the bottom. What makes divers sink or float depends on a combination of the density of their bodies, the density of the diving equipment they wear, and the density of sea water.

Water has a natural force that pushes up towards the surface. This is called the buoyant force. The buoyant force comes from the pressure exerted on the object by the fluid. Pressure increases as depth increases, so the pressure on the bottom of an object is always greater than the force on the top resulting in a net upward force.

The net upward buoyancy force is equal to the weight of fluid displaced by an object. This force enables an object to float or at least seem lighter. If the weight of an object is less than the weight of the displaced fluid when fully submerged, the object has an average density that is less than the fluid and has a buoyancy that is greater than its own weight which results in the object tending to rise. If the object has exactly the same density as the fluid, then its buoyancy equals its weight and the object will remain submerged in the fluid, but will neither sink nor float. An object with a higher average density than the fluid has less buoyancy than weight and it will sink.

Other forces act on a floating body in the ocean, such as drag (due to the density of the fluid), thrust (if the body pushes the water away), and weight (which pushes the body down toward the ocean floor).

The net weight of a scuba diver can be altered by decreasing or increasing density using air or solid weights. Scuba divers can change their density by adding or releasing air from a buoyancy compensator, or BC, a vest that holds air. Solid weights help the diver to stay underwater by increasing their net weight.

The density of tap water is 1 g/cm^3. The water off the coast of Northern California is cold and varies from 50 to 60 degrees Fahrenheit. Cold water can dissolve more salt than warm water. High salinity and low temperatures make the water more dense. Therefore, the physical properties of water off the California coast require divers to wear a thicker wetsuit (to stay warm) and more weights (to add net weight) than they might need to wear when diving in warmer waters in the tropics.

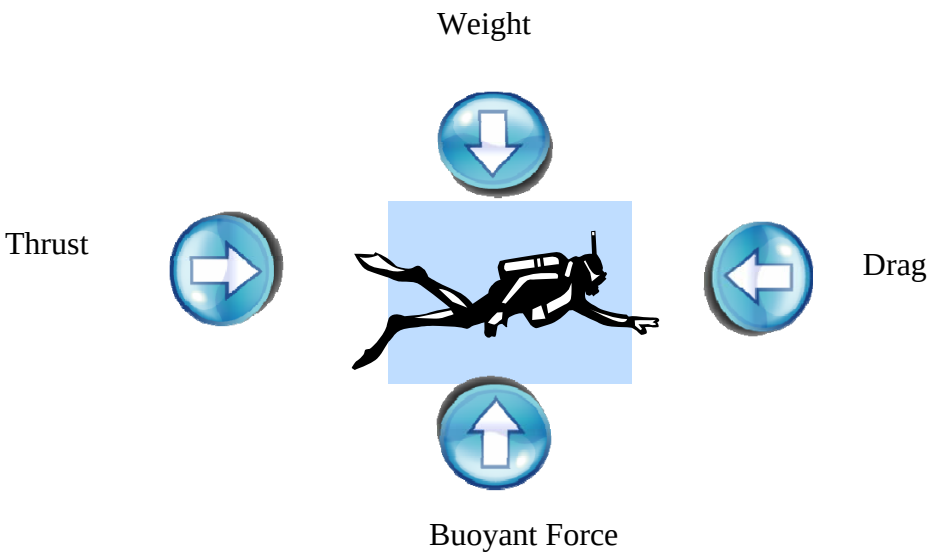
Activity

Preparation

1. Collect materials (rubber balloons, rubber bands, toothpicks, pennies, and paperclips) and place them in small separate bowls at each group's table.
2. Fill large buckets half full with tap water.

Introduction

While showing images of scuba divers, compare the buoyancies of divers and marine animals, such as plankton, fish, and jellyfish. Explain how buoyant animals can stay afloat in the ocean (e.g. bony fish have swim bladders in their abdomens that help them control buoyancy). Contrast these creatures with sea stars or sea urchins which are found on the sea floor. Introduce the forces acting on a body in the ocean.



Lastly, explain to the students the importance of balancing these forces to maintain neutral buoyancy. For example, if the weight is too heavy, the scuba diver would sink to the bottom. If the buoyant force is too great, the scuba diver will rise to the surface. If there is a current in the water pushing against the scuba diver, it would be more difficult to swim in place. In this activity, students will experiment with neutral buoyancy and try to balance these forces. Inform the students that they will be adding materials such as balloons, rubber bands, toothpicks, pennies, etc., to make the figure remain neutrally buoyant in a bucket of water. The figure must not float to the top or sink to the bottom.

Procedure

1. Distribute one plastic figure to each student.
2. Separate students into groups of five.
3. Allow students to use as much of the materials provided as needed to make the figure neutrally buoyant. They can use rubber bands or masking tape to attach the materials to the figure.
4. Tell the students to take turns testing the figure's buoyancy in the bucket of water provided to each group.
5. Have the students complete the Buoyancy Bulls-Eye worksheet during and after their experimenting.

Wrap-Up

- What are the benefits to being neutrally buoyant? *(not sinking to the bottom or floating to the top, being able to swim over the ocean floor away from the turbulent ocean waves and to have a good view of ocean life)*
- What forces are acting on a body in water? *(buoyant force, weight, drag, and thrust)*
- What type of equipment is used to control the buoyancy of a scuba diver? *(Buoyancy Compensator (BC))*

Correlated California Content Standards

Grade Eight

Physical Sciences

8c. Students know the buoyant force on an object in a fluid is an upward force equal to the weight of the fluid the object has displaced.

8d. Students know how to predict whether an object will float or sink.

Investigation and Experimentation

9a. Plan and conduct a scientific investigation to test a hypothesis.