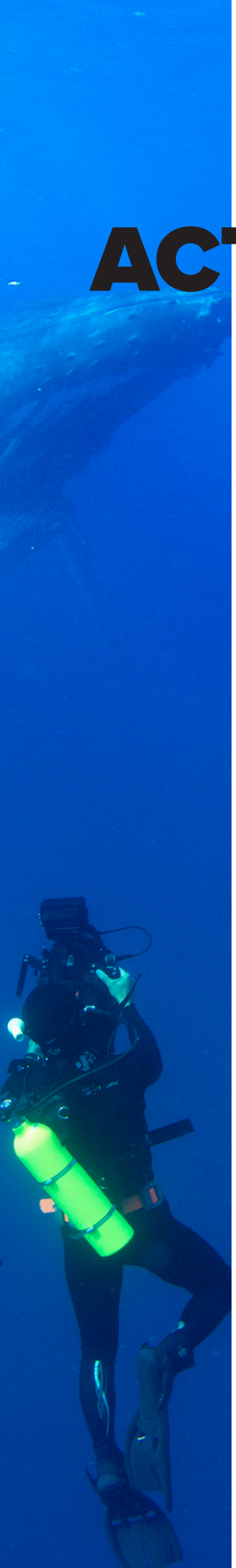


Grades 3–5, 6–8

15 minutes

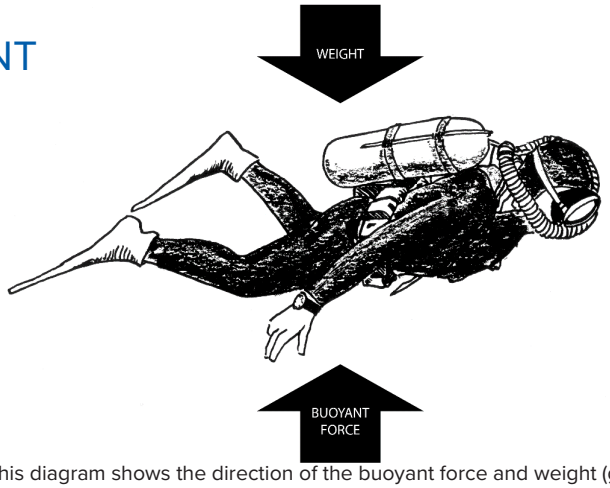
ACTION FIGURE DIVER

DESIGN CHALLENGE

Construct a neutrally buoyant scuba diver who neither sinks to the bottom nor floats on the surface.

SUPPLIES AND EQUIPMENT

- ☐ Plastic action figures (1 per team)
- ☐ Small balloons (bag of 100)
- ☐ Rubber bands (at least 100)
- ☐ Toothpicks (at least 100)
- ☐ Pennies (at least 100)
- ☐ Paper clips (at least 100)
- ☐ Masking tape
- ☐ Buckets



This diagram shows the direction of the buoyant force and weight (gravity) on a diver. Neutral buoyancy depends on balancing these two forces. Public domain image from Pearson Scott Foresman.

GETTING READY

Set up your activity in an area that can get wet. If doing the activity indoors, have a mop or extra towels available.

Adjust your setup depending on your location.

- If working with a small group, divide them into small teams and give each team an action figure, roll of tape, and bucket.
- For a larger event in a public space, plan to have at least two buckets of water and all the materials in an easily accessible location on a table. Be sure to leave workspace for the participants at your table. Have several action figures available, and remove modifications to them when participants leave. Also consider providing a balloon pump so that balloons can be reused.

MacGillivray Freeman's DREAM BIG

INTRODUCTION

Ask questions to get participants thinking about buoyancy. Some examples:

- Think about a time you went swimming: how hard or easy was it to float in the water?
- Why don't fish and other ocean animals float?
- How do scuba divers stay submerged instead of floating to the surface?
- Do you think that you float more easily in some bodies of water than others? Why might that be?

INSTRUCTIONS

Introduce the design challenge: Using the materials provided, modify a plastic action figure to make it neutrally buoyant, so that it neither sinks nor floats. Tell participants that they can use any amount of each material.

Give the following instructions:

Place your action figure in water to determine if it floats (is positively buoyant) or sinks (is negatively buoyant). Think about how the materials provided will affect your diver's buoyancy, and make a plan.

Attach materials to your action figure with masking tape and test your diver in the bucket of water. Does it sink or float? Make adjustments until you achieve neutral buoyancy.

ACTIVITY VARIATIONS

Make a foam packing peanut neutrally buoyant using paper clips.

TROUBLESHOOTING

If participants are having trouble achieving neutral buoyancy, provide a hint.

- If the diver floats, what can you add to make it heavier?
- If the diver sinks, how can you make it lighter? Or, what is something that floats that you can add?

RELEVANT TERMINOLOGY

Buoyancy: An object's ability to float in water or other fluid.

Positively buoyant: An object that is less dense than water and, therefore, floats on the surface.

Negatively buoyant: An object that is denser than water and, therefore, sinks to the bottom.

Neutral buoyancy: An object with density equal to water and, therefore, neither floats on the surface nor sinks fully to the bottom.

GUIDANCE FOR YOUNGER CHILDREN

QUESTIONS TO ASK AFTER THE ACTIVITY

- What materials did you add to make your diver neutrally buoyant? Which materials worked best?
- If your plastic figure had a hollow space in it full of oxygen, what would be different about making it neutrally buoyant?
- How did you think the materials you used would affect your diver, and how did they actually affect it?
- Which of the changes you made seem like ones that real divers might actually use to stay neutrally buoyant?

ENGINEERING CONNECTIONS

When early divers explored the ocean floor, they had to wear a big helmet with a hose that acted like a super long snorkel. It worked to keep them breathing, but it was hard to move around and required them to stay tethered to a boat or raft on the surface of the water. That was the best solution until a French engineer named Émile Gagnan and ocean explorer Jacques Cousteau invented the Self-Contained Underwater Breathing Apparatus, or SCUBA. Scuba allowed people to explore the ocean more easily than older dive suits and helmets.

With his new Scuba gear, it was easy for Cousteau to stay neutrally buoyant and observe the world of the sea. Cousteau captured amazing images of life underwater that had never been seen before. He shared these images with the public through his films and, in doing so, exposed the world to an entirely new universe. It is safe to say that both Cousteau and Gagnan used science and engineering to change how we explore the oceans! Engineers continue to improve SCUBA gear, which has become a very popular recreation around the world.

SCIENCE CONNECTIONS

To remain neutrally buoyant, divers must consider the forces acting on their body. Gravity is constantly pulling down on a diver, while the buoyant force of water is constantly pushing up.

To control their buoyancy, divers need to be heavy enough to overcome the buoyant force. The easiest way is with weight belts. Divers can also use a buoyancy control device. This device has a bladder that can be inflated or deflated to precisely control buoyancy. This works like the swim bladder in most fish!

GUIDANCE FOR OLDER YOUTH AND ADULTS

QUESTIONS TO ASK AFTER THE ACTIVITY

- What materials did you add to make your diver neutrally buoyant?
- What surprised you about the materials you tested in order to make your diver neutrally buoyant? Did any of them behave differently than what you predicted?
- What if the water you used in this activity was salt water? How might salt water change your design?

ENGINEERING CONNECTIONS

An amazing collaboration between science and engineering happened in 1943 during World War II. French engineer Émile Gagnan and famous ocean explorer and filmmaker Jacques Cousteau invented the first SCUBA (Self-Contained Underwater Breathing Apparatus) gear called the Aqua-Lung. The twin-hose underwater breathing apparatus allowed people to explore the ocean more easily than before. As the first diver, Cousteau wore a weighted belt to alter his buoyancy and keep him from continually floating up to the surface. With his new Scuba gear, Cousteau captured amazing images of life underwater that had never been seen before. He shared these images with the public through his films and, in doing so, exposed the world to an entirely new universe. Cousteau and Gagnan utilized the principles of buoyancy to determine the best materials for the Aqua-Lung and the best way to explore the seas.

SCIENCE CONNECTIONS

Buoyancy is all about density. Objects that are denser than water (negatively buoyant) sink; objects that are less dense than water (positively buoyant) float. Objects that neither sink nor float are neutrally buoyant. To remain neutrally buoyant, divers must consider the forces acting on their body. Gravity is constantly pulling down on a diver, while the buoyant force of water is constantly pushing up.

A diver with an air tank is less dense than water. To control their buoyancy, divers manipulate their density to overcome the buoyant force. The easiest way is with weight belts. Divers can also use a buoyancy control device. This device has a bladder that can be inflated or deflated to precisely control buoyancy. This works like the swim bladder in most fish!

MacGillivray Freeman's DREAM BIG

ENGINEERING OUR WORLD

dreambigfilm.com

ACKNOWLEDGMENTS

"Buoyancy Bull's Eye" is based on an activity created by California Academy of Sciences. All rights reserved.
http://www.calacademy.org/educators/lesson-plans/buoyancy-bulls-eye

Supplemental content adapted for *Dream Big* Activities by the Carnegie Science Center.

Find more great activities at DiscoverE.org