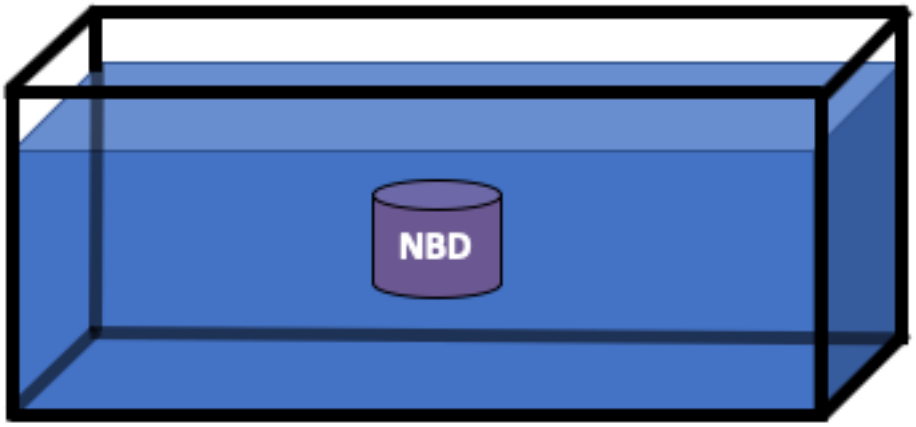
Make a Device that Neither Sinks nor Floats

Boats are able to float on water because they are less dense than water. Iron, on the other hand, sinks because it is more dense than water. Density is defined as the mass of the object divided by the volume of space the object occupies. What happens when something has the *same* density as water? In this activity, you'll construct a device that neither sinks nor floats in water: it is called a **neutrally buoyant device** or **NBD**.

Two or more people, or groups, can compete to see who can build the most effective NBD. Rules for individuals or groups are below.



Competition vessel with a contestant's neutrally buoyant device (NBD).

Your Goal:

Design and then build a neutrally buoyant device. Your NBD must:

- Use at least three different types of materials.
- Be waterproof.
- Remain under water for at least 30 seconds such that:
    - No part of it is above the surface of the water.
    - No part of it touches the bottom of the water-filled testing container.

Suggested Materials List:
The NBD can be made primarily with materials found around the house that would be either recycled or used for a different purpose afterwards.

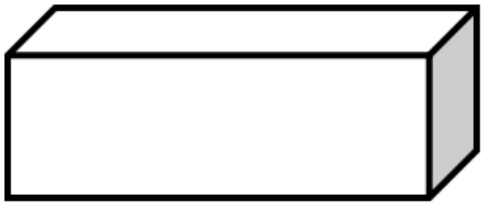
- Tupperware containers
- Plastic eggs
- Plastic bags
- Rubber bands
- Toothpicks
- Dirt or sand
- Paper clips
- Hot glue**
- Packing peanuts
- Waterproof glue** (Gorilla Glue, Super Glue, Flex Glue, Silicone Glue, Goop)
- Plastic bottles
- Nails, Screws, Washers, Bolts
- Bubble wrap
- Anything else that is safe to use and can be recycled!
- A timer that can measure 30 seconds

****Note:** *It is strongly recommended that young children be supervised when handling the waterproof glue and that parents/guardians handle the hot glue to prevent injuries.*

Neutral Buoyancy Trials:

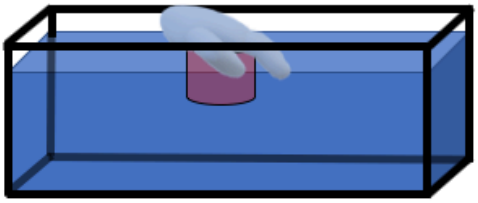
- First, choose a vessel that will hold the water for the trials. The NBD must fit within the vessel without touching the bottom or coming within three inches of the top. A fish tank or fishbowl is ideal because the contestants can easily see both the bottom of the bowl and surface of the water. Alternate vessels include very large Tupperware containers, empty peanut butter jars, mixing bowls, and salad spinner bowls.
- Next, fill the vessel with water leaving about 3 inches from the top. For the best results, allow the water to reach room-temperature before beginning the trials.
- Lastly, obtain a time-keeping device that can measure 30 seconds (kitchen timer, smartphone, watch) that can be used to keep track of the duration the NBD is neutrally buoyant during the trials.

Diagram with Instructions

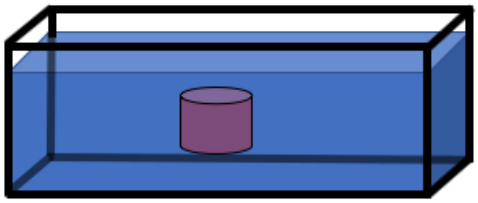


1. Choose a vessel to be filled with water. One with transparent sides is optimal. The vessel must be about 4 inches taller than the NBD.

2. Add water to the vessel, but not so much that it will overflow when you place the NBD into the water.



3. Have your timer ready. Gently lower the NBD into the water until it is entirely submerged.



4. When the NBD is below the surface of the water, but not touching the bottom of the vessel, let it go and immediately start the timer.

- Each team has two attempts for their device to remain neutrally buoyant for at least 30 seconds. If no device is neutrally buoyant for 30 seconds, modify each device and try again.

Learning Objectives:

- Concept: *Neutral Buoyancy*—while sinking (negative buoyancy) and floating (positive buoyancy) are likely not new concepts, neutral buoyancy is the third type of buoyancy. SCUBA divers utilize neutral buoyancy to avoid disturbing aquatic life while they are exploring a lake or an ocean.
- Concept: *Density*—the density of a neutrally buoyant object is equal to the density of the liquid the object is in. Density is calculated by weighing the object and then finding its volume and dividing the two values.

$$Density = mass \div volume$$

- Measuring the *volume of irregular shapes*—the water in the vessel will be displaced by the same volume of the neutral buoyancy device. In a chemistry lab, the volume of an irregularly shaped object is measured by placing the object in water and measuring the volume of water it displaces. You can do this with a measuring cup: put water in the cup and read the volume; then add the irregularly shaped object and read the new volume. The difference is the volume of the object. (This works for objects that are neutrally buoyant or that sink, but not for objects that float. Why?)

- *Density of water*—the density of water changes depending on its temperature! Proof: ice-cubes (cold, solid water) float in a glass of room-temperature liquid water. Another way to test this is to remove your NBD from the water, replace the water with hotter or colder water, and see if your device is still neutrally buoyant.

Troubleshooting:

- *If the device starts off neutrally buoyant but then begins to sink…*
  Leak alert! The NBD probably is not watertight. Check for cracks or areas where water can seep into the inside of the device and seal off entry points for water.
- *If the device immediately begins to float…*
  The device is not dense enough. Add additional mass. For the best results, use a material that can be added in highly controlled increments—a little at a time. Sand or dirt is ideal.
- *If the device immediately begins to sink…*
  The device is too dense. Remove some mass. This is easier if you used some sand or dirt as ballast from the start.