

Tippy Raft



STEM CONNECTIONS

Science: Principles of Buoyancy

Engineering: Build a Model Raft and Improve Its Design



DURATION

60 minutes



MATERIALS

Name tags

Bricks

Cloth bags (1 bag filled with bricks per pair)

Tippy Raft Build Cards (2 to 3 per ship group)

Plastic bins, filled with water (1 per ship group)

Colored pencils and sharpeners

Comic Strips

SCHEDULE

- Read Story (5 min)
- Activity #1: Tippy Raft Build (20 min)
- Activity #2: Tippy Raft Design Challenge (30 min)
- Comic Strips (5 min)

OBJECTIVE

Students design and test rafts that can carry the greatest load without sinking or capsizing.

ALIGNED STANDARDS

NGSS K-2-ETS-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

NGSS K-2-ETS-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

HABITS OF MIND

Applying Past Knowledge to New Situations • Listening and Understanding with Empathy

21ST CENTURY SKILLS

Flexibility and Adaptability • Information, Media and Technology Literacy

KEY TERMS & CONTENT KNOWLEDGE

Buoyancy: The ability to float in water. Buoyancy can be affected by density, weight, and surface area. These can be altered in today's activities by changing the arrangement and number of bricks used to build the rafts.

Capsize: When a boat or ship is turned on its side or it is upside down (keeling over).

Raft: A flat buoyant structure of timber or other materials fastened together, used as a boat or floating platform.

OVERVIEW

Today students expand on their understanding of buoyancy by building Tippy Rafts. Student pairs will build and improve raft designs by modifying the density and surface area of the rafts. The goal is to build a raft that can carry the greatest load of bricks without sinking or capsizing. At the end of the activity, each ship group presents its best design to the rest of the class.

Note: Activities #1 and #2 may become messy. Have extra paper towels on hand to wipe up spilled water.

Brick prep: Fill one muslin bag full of bricks for each student pair. It will probably won't have the exact parts they need for the Tippy Raft Build - that's okay! During the build, students can come up to the big brick bin to swap out parts they don't need for ones they do. Another option, especially for smaller groups, is to split up the bricks into bins and give one bin to each ship group.

STEP-BY-STEP DIRECTIONS FOR INSTRUCTOR



Whole Group



STORY

The Boatswain drops anchor one mile from the fabled island. Looking through the telescope that is located at the bow of the ship, you see large trees dotting the landscape. Your mouth begins to water. You are starting to feel the effects of scurvy, which results from the lack of vitamin C. You are constantly tired, your gums are bleeding, and you have purple-colored spots on your skin. Regrettably, all of the fruit on the ship has been eaten, or used for buoyancy experiments. You desperately hope that not only will the buried treasure be found on the island, but also orange, mango, and grapefruit trees.

But first the rafts must be built and tested. The ship's barrel maker—called the Cooper—brings empty wooden barrels which once stored food and fresh water up to the deck. Barrels are routinely broken down as they are emptied and sometimes re-purposed. If the barrels are needed again, the Cooper will rebuild them. You hope that in the near future the barrels will contain fresh fruit picked from the island.

The Carpenter brings out hammers, saws, and other various tools. You and the crew get to work taking apart the barrels, which is fairly easy. With a little elbow grease, the metal rings are slipped off, and the barrels open like onions as the wood planks fall onto the deck.

The crew brainstorms how to best build a raft. Everyone has good ideas, especially after the buoyancy experiments. The Carpenter helps choose the best design and the Sea Artist quickly sketches a blueprint that everyone is to follow. Pieces of wood must be shortened and then attached to each other in a box-like fashion. You grab the saw and rub your thumb lightly over the jagged little teeth just to be sure they are sharp. Blimey! The teeth snag your skin and draw blood. You hope that you never end up in the Carpenter's cabin for surgery.

Once the raft is built, it must be tested for buoyancy. Since the area is shark infested, no one dares to volunteer to sit on top of the raft—just in case it does sink. The rafts are lifted overboard and lowered to the water with ropes. You observe the raft as it floats on top of the water and identify some modifications that need to be made. The raft is pulled from the sea and the design is improved. This process is repeated until the crew is confident the raft will not only float, but also carry heavy loads of gold without capsizing. The tippiness of the raft is tested by placing large bricks on top of it.

The Captain reminds everyone that life on the sea can be dangerous and unpredictable. Storms can materialize in an instant with little or no warning, just like the storm that demolished the original ship. Enemies are always lurking, eager to seize any treasures on board the ship. You will have only one chance to retrieve the treasure, so each raft must carry as much gold as possible.



Activity #1: Pairs

TIPPY RAFT BUILD

Distribute Tippy Raft Build Cards, cloth bags with bricks, and bins of water.

Following the Tippy Raft Build Card, students work in pairs to build a raft using bricks and then evaluate its buoyancy. How much cargo can the Tippy Raft hold without sinking or capsizing?



Activity #2: Pairs

TIPPY RAFT DESIGN CHALLENGE

Students work with their partners to modify and improve their designs to maximize the number of bricks that can be carried by the raft.

Students may choose to change the design by changing the number of bricks used to build the raft and/or change the design completely. Modifications may include changing the shape, the density and/or the surface area of the rafts. Due to limited amount of space in the water bin, you may consider limiting the size of the rafts or the number of bricks that can be used.

At the end of the activity, each ship group will choose the best design and present it to the rest of the class.



Group Discussion

TIPPY RAFT DESIGN CHALLENGE, DISCUSSION

- Each ship group built two or three different rafts. Which raft was chosen by the group as the best design?
- Ask each group to describe the raft design. How was the raft made more buoyant? Why was it chosen as the best design?
- How many bricks could the raft carry?
- Looking at the chosen rafts, how are they similar and how are they different? Is there one type of design that seemed to work best?
- What about how the bricks were stacked on the raft. Did any of the groups try changing this? If so, what did they discover?

**Wrap Up: Independent**

COMIC STRIPS

Students record highlights from the day's journey in the fourth box of their comic strip.

CHECK FOR UNDERSTANDING

- How did the raft become more buoyant? Less buoyant?
- What made the raft more or less tippy?
- Why does the pirate ship float rather than sink? What could make the ship sink?

EXTENSIONS

Push students to think even more deeply about buoyancy. How did the clay boats and the brick boats differ? How did the material and shape affect buoyancy? Discuss how the designs of different real-life vessels affect their buoyancy too.

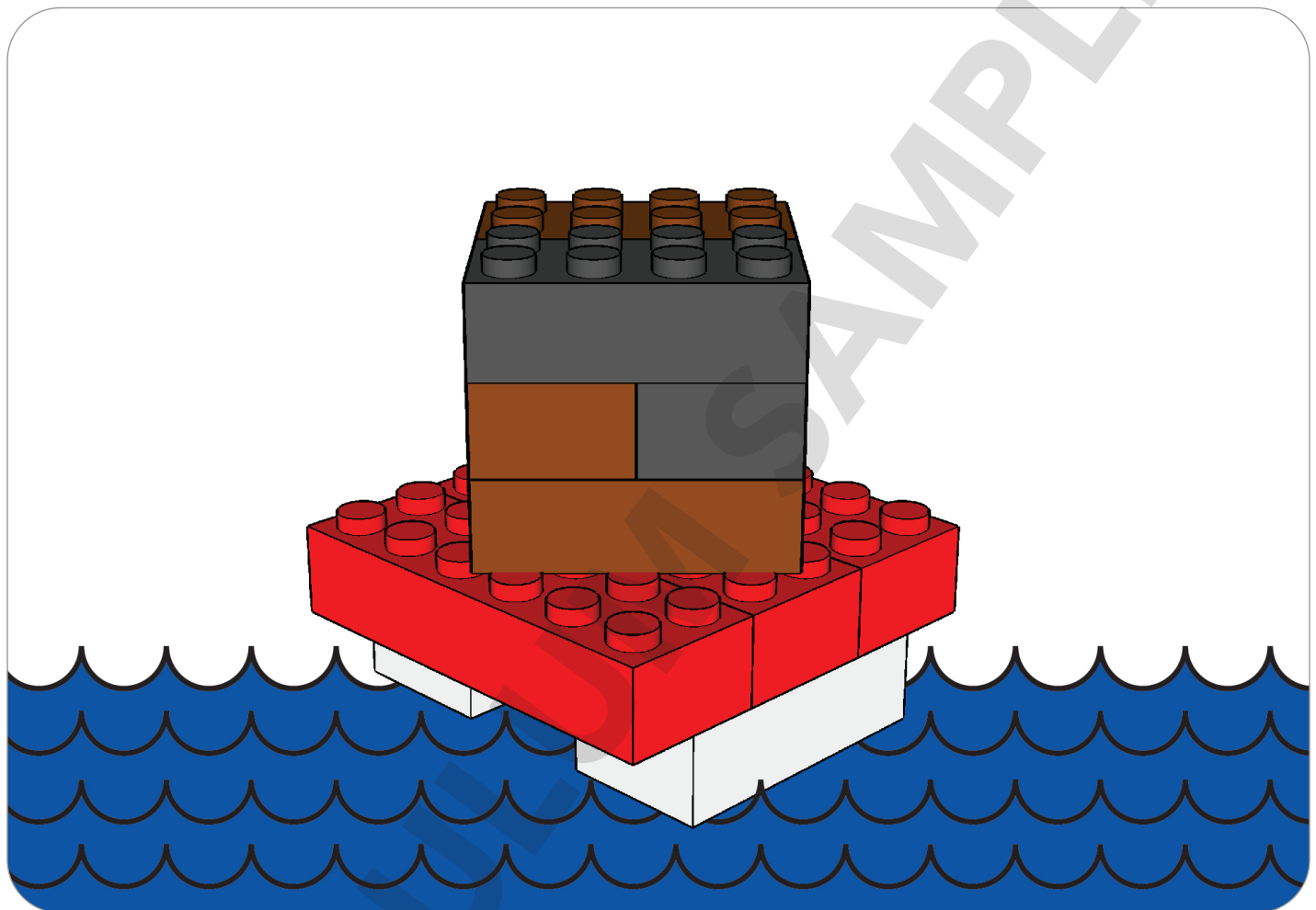
Activity: Clay Submarines

Submarines are pretty cool because they can both sink or float. In order to sink, the submarine fills a closed compartment of its hull with water. This makes it more dense, and it sinks. If submarines want to float, the water is released and replaced with air. Like a balloon, it rises.

Form a ball with the clay. Using a finger, poke a hole through the entire ball and place in water. Allow the hole to become filled with water. Or make a hole in one side and fill with water. Seal the hole and place in water.

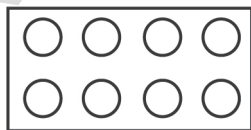
To make the submarine float, close off the openings, making it so water can not enter the inside of the ball. Watch it float!





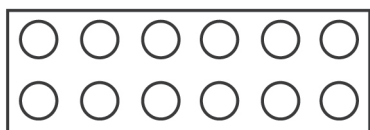
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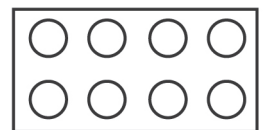
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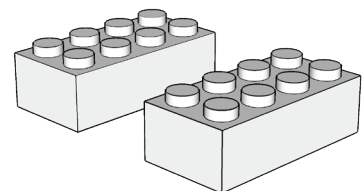


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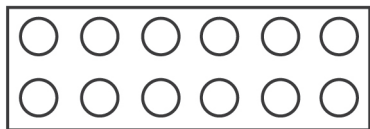
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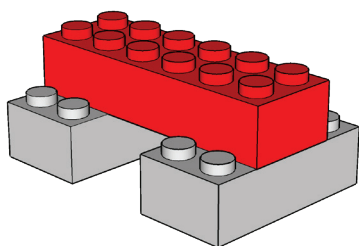
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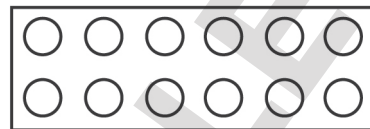
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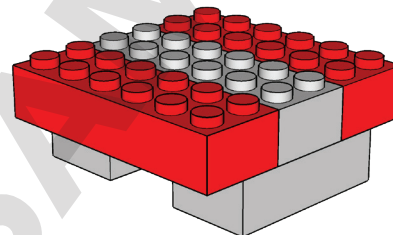
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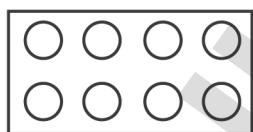


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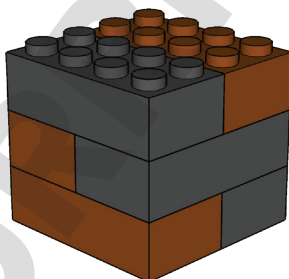


You've built
your tippy raft!

4



x 6



Now you
have cargo.

5

Will your raft
sink or float?

