

Draggin' Boats

Students design and build dragon boats using milk cartons. The boats may be tested at the "Boat Hulls" water tank of the *Engineer It!* exhibit.

Grade Levels	Science Topics	Key Science Skills
K–6 (7–8 with optional extensions)	Buoyancy Design technology Scientific inquiry Velocity Mass Variables	Observing Predicting Interpreting data Making models Measuring Hypothesizing Controlling variables

Time Required

Advance Preparation	30–60 minutes (rinsing milk cartons)
Set Up	5 minutes
Activity	30–50 minutes
Clean-up	5 minutes

What you'll need

- School lunch milk cartons
- Bleach
- Paper clips or ornament hangers
- Scissors
- Waterproof heavy tape (duct, gaffer's, etc.)
- Pipe cleaners
- Wallpaper water tray (long narrow plastic tub for wetting wallpaper available in paint and décor departments or at home builders supply stores)
- Drinking straw
- String
- Small metal weight (nuts & bolts, old keys, etc.)
- Screwdriver or other pointed instrument

Optional Extensions

- Decorations: permanent markers, yarn, googly eyes, paper, Popsicle sticks, sequins, felt, etc. for dragon's head and flags.
- Waterproof glue
- Stopwatch or watch with a second hand

- Meter stick or yardstick

Do this first!

Prepare the milk cartons

1. Have students collect school lunch milk cartons in advance (3 per student or student group).
2. Make a dilute bleach solution by adding one capful (about one tablespoon) of bleach to a gallon of water in a large mixing bowl.
3. Rinse school lunch milk cartons under running water.
4. Dip milk cartons in the bleach solution.
5. Rinse milk cartons under running water to remove the bleach.
6. Allow to air dry.

Prepare the classroom testing tank

1. Use a Phillips head screwdriver or other pointed instrument to punch a centered hole in one end of the plastic wallpaper tub near the upper lip (above the water line).

CAUTION: Hold the tub over wood or the ground to absorb the impact of the screwdriver.

2. Cut a drinking straw to about 1 1/2 inches. Insert the straw into the hole in the plastic tub. The straw will prevent the hole's rough edges from slowing the string when testing. Tape the straw in place if necessary to keep it from sliding.
3. Cut a piece of string a little longer than the length of the wallpaper water tray. Thread the string through the straw
4. Attach a weight to the end of the string outside the tub. You may use a large nut/bolt, old keys, or other metal objects of a similar weight.
5. Tie a fixed loop at the other end of the string. This will attach to the hook on the front of the boat.

Paper clip hooks

Paper clip hooks that attach the boat to the string for testing may be made in advance. See Student Procedure: "Create a Dragon Boat, Step 3."

Student handouts

Copy one worksheet per student from Handout Master section.

Getting Ready

1. Place supplies (student worksheets, three milk cartons, a long strip of tape, and four pipe cleaners) at each group or individual workstation.
2. Place the classroom testing tank on a table. The weight on the string should hang freely over the table's edge.
3. Add water to the tank until the water is within two inches of the top.

Why do this?

Overview of Dragon Boats

Legend says that many centuries ago, on the fifth day of the fifth lunar month, Chu Yuan, a very wise and respected government official, drowned in the Mi Luo River. When the local people discovered that Chu Yuan had drowned, they went out in boats to search for him. When they could not find him, the people threw rice into the river so the fish would eat the rice instead of Chu Yuan. This happened many centuries ago, but each year people in China, Taiwan, and other countries around the world remember Chu Yuan and celebrate Chinese culture by having dragon boat races and eating "Tsong Tze" (sticky rice cakes wrapped in leaves and tied with colorful strings). Today, people around the world race Dragon Boats.

What is a dragon boat?

Dragon boats are boats that look like dragons. They are made of three parts: a head, a body, and a tail. The dragon head is in the front of the boat. The body is in the middle of the boat. The tail is at the end of the boat. The paddlers sit in the body of the boat. Dragon boats may have between 10 and 22 paddlers. During the race, the drummer, near the head of the boat, beats a drum so the paddlers will row together to the drummer's rhythm. Near the tail of the boat is a helmsman (see vocabulary in "Explanation" section). He or she uses a rudder (see vocabulary) to help steer the dragon boat. Near the head of the dragon boat is a flag catcher. The flag catcher usually leans over the head of the dragon boat to grab the flag at the end of the race. The first team to complete the course and catch the flag wins the race.

What to do

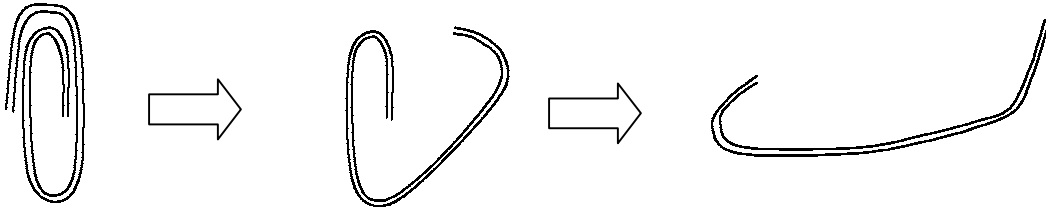
Create a Dragon Boat

1. Draw a picture of your dragon boat design on your worksheet.

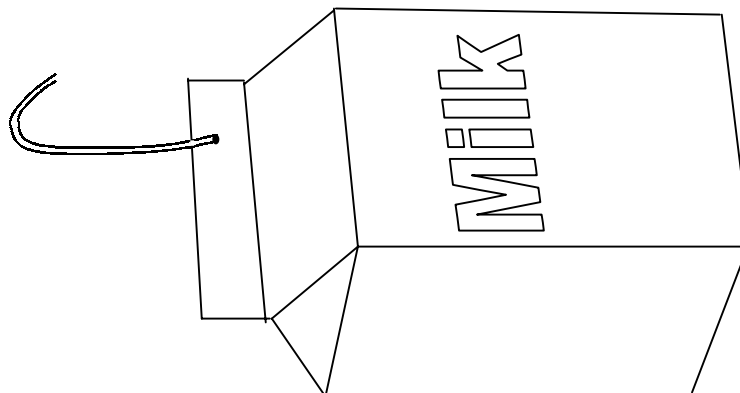
2. Build your dragon boat.

- You may use up to three milk cartons per boat.
- Make a head, a body and a tail for your dragon boat.
- You may cut the milk cartons.
- Be sure to leave room for the paddlers.
- Use pieces of heavy tape to connect the pieces of your boat.
- The boat must be waterproof.

3. Make a hook for your boat by bending a paper clip or ornament hanger.



4. A hook needs to be attached to the front of the boat. The hook should be taped to the top half of the boat so that it will be above the waterline when the boat is placed in the water. The string for testing your boat will attach here.



Test your boat in your classroom

1. Be careful not to spill water onto the floor.
2. Pull the string from the water tank. Attach the looped end to the hook on your boat.
3. Put your boat in the water and let go.
4. Record the time it took for your boat to travel the length of the tank.
5. Record your observations.

Test your boat at the *Engineer It!* Exhibit

1. Pull the string from the water tank. Attach it to the hook.
2. Put your boat in the water and let go!
3. Record the time it took your boat to travel across the water tank.

What's happening?

Have students record and compare different designs and their results.

Let's say you are going to design and make a dragon boat. What design elements do you think are important?

(For example, boat hull shape, weight, craftsmanship; see Explanation section.)

Which design elements do you think are important for a *fast* boat?

**Does the shape of a boat's hull affect how it goes through the water?
How?**

What are different ways to design a Dragon Boat using milk cartons?

Have students come up with as many different designs as they can and make predictions about which design characteristics will be most important. Students may write, draw or tell their plans.

Have students (individually or as a class) describe possible design elements. Include these elements in a chart. Rate which elements will have the most impact on speed (e.g., a boat with a flat hull will go fastest).

How did the results vary with the design of the boat?

What design element(s) seemed to make the boat go fast?

What design element(s) seemed to slow the boat down?

Did you make any changes while making your boat? What happened?

If you could change the design of your boat, what would you do?

How would this change affect the boat's performance? What is your hypothesis?

More stuff to do!

- A. Calculate the average velocity of the boats. One student releases the boat while the other measures the time (see Cross Curricular Integration: Math).
Velocity = Distance Covered ÷ Time
- B. Depending on boat size, dragon boats have crews of 12 or 24 people. Mark the waterline for your empty boat with a permanent marking pen. Add objects

(marbles, erasers, or clay) to the boat for a “crew.” Mark the waterline. Now retest your boat. How does the added weight change your results?

- C.** Investigate whether boats will float at different levels in saltwater and fresh water. To make saltwater, add a tablespoon of salt to every cup of water. Stir until dissolved. Using a permanent marking pen, mark the waterline for your boat in a container of fresh water. Now place the boat in the container of saltwater and mark the waterline. What do you observe?

Explanation

Boat terms

Bow	The front of the boat.
Helmsman	The person who is steering the boat.
Hull	The main structural body of the boat. The part that keeps the water out of the boat.
Rudder	A flat surface attached behind or underneath the stern, used to control the direction the boat is traveling.
Stern	The back part of the boat.

The shape of a boat's hull can affect the speed at which the boat travels. The streamlined shape of Dragon Boats helps them go through the water quickly. Dragon Boat racing is popular around the world. There are two types of dragon boats: Chinese and Taiwanese. Chinese dragon boats have larger heads than Taiwanese boats.

Milk carton boats that have flat hulls tend to skim over the top of the water, moving faster than boats with bow-shaped hulls. Elements that produce drag (either in the bow or the stern) tend to make boats slow down. “Fixed rudders” (the pointy ridge of a closed carton) tend to provide stability only when enough mass weighs down the boat in the water. Keep in mind that results may vary.

Scientific Inquiry

This activity allows students to practice their scientific inquiry process skills. In classroom scientific inquiry, students are scientists. They are observing, discovering, asking questions, testing, and drawing conclusions about their boats.

“Draggin’ Boats” allows students to explore a boat’s design elements using the materials provided. They will use their background knowledge to create a dragon

boat that they think will perform well in the testing tank. After building and testing their boats, they may have new ideas about how to improve their boats. At this point, a more formal scientific inquiry may take place.

The following table describes a simplified version of the steps of scientific inquiry, along with examples of each step from the “Draggin’ Boats” activity.

Scientific Inquiry	Student action
Use background knowledge and observations to form a testable question: What are you changing and what are you measuring?	Student uses knowledge of boats and first design experience to ask: “If I make my boat longer, will it go faster?” (The length is changing, time is measured.)
Design an experiment to answer the question	Student plans to build a boat with the same original design, but make it longer than her first one. She may make a third boat even longer.
Collect data, using tables, graphs, pictures, etc., to represent the data	Student makes a table to record her data from the three boats. She times the three boats in the testing tank. She may repeat each trial and average her results.
Use collected data to answer the original question	Student summarizes results and uses data to answer her question.
Suggest further experiments or testable questions	If the results are unexpected (length didn’t seem to affect speed), she may suggest another testable question, such as “Will a boat with a flat hull go faster than one with a curved hull?”

How does it all fit in?

MATH Test the speed of your boat several times and calculate its average speed. Calculate a class average (see Optional Extension A).

Hypothesize and predict which of the design elements will affect the speed the most. Test and record the data. Make a chart that includes your predictions and the results. Explain your results.

CULTURAL STUDIES Read a story about how dragon boat races began, from *Red eggs and dragon boats: celebrating Chinese festivals*, by Carol Stepanchuk.

ART Glue yarn, googley-eyes, pipe cleaners, etc., to the front of the cartons and create dragon heads for the boats.

Study several examples of Chinese writing/art. Copy a Chinese character (or create your own symbol) for your boat. Put this character on a flag for your boat or draw it on your boat with permanent ink.

Create paper dragons, Chinese lanterns, or multi-colored braided bracelets. See *Working with Paper* and *Red eggs and dragon boats: celebrating Chinese festivals*.

LANGUAGE ARTS Research the cultural history of dragon boat races. Imagine that this is part of your heritage. How would you describe the meaning of dragon boats to future generations?

Describe the structural and cultural differences / similarities between the Chinese and Taiwanese dragon boats.

As a class, prepare and eat “*Tsung Tze*” (sticky rice cakes). See *Red eggs and dragon boats: celebrating Chinese festivals*.

MUSIC Make drums to beat a rhythm for rowing a dragon boat.

DESIGN TECH Study other types of boats. Try designing, building, and testing ocean liners, barges, or catamarans. How do they compare with the dragon boats?

References

Moiz, Azra. *Cultures of the World—Taiwan*. New York: Marshall Cavendish Corporation, 1995.

General information about Taiwan on a range of topics including geography, economy, art, festivals. Many colorful photos of people and what life is like in Taiwan.

Rotner, Shelley. *Boats Afloat*. New York: Orchard Books, 1998.

Large colorful photographs and simple text present many different types of boats and their uses. Children are shown using boats in a safe manner. The engaging photos may appeal to many ages (pre-K to adult).

Portland-Kaohsiung Sister City Association, Portland, OR

Graham, Ian. *Boats, ships, submarines, and other floating machines*. New York: Kingfisher Books, 1993.

Text, illustrations, and diagrams examine different kinds of boats and how they work. Includes simple experiments and activities.

Stepanchuk, Carol. *Red eggs and dragon boats: celebrating Chinese festivals*. Berkeley, Calif.: Pacific View Press, c1994.

This is a book about the celebration of Chinese festivals. Most of the Chinese festivals are based on the lunar calendar. It includes festivals such as the Chinese lunar New Year, Clear Brightness festival, Full-month red egg and ginger party, Dragon Boat festival and Moon festival.

Working with Paper. New York: Franklin Watts, 1971.

Pictures and simple instructions for paper projects, including a dragon, and Chinese lanterns.

Goldstein, Peggy. *Lo'ng is a Dragon*. Berkeley, CA: Pacific View Press, 1991.

Black-and-red drawings show how Chinese characters have changed over time, from pictures to ancient characters to modern characters. Guides to pronunciation and how to draw the characters are included.

Williams, C. A. S. (Charles Alfred Speed). *Encyclopedia of Chinese symbolism and art motives*. Intro. By Kazimitsu W. Kato. New York: Julian Press, 1960 [i.e. 1961].

An alphabetical compendium of legends and beliefs as reflected in the manners and customs of the Chinese throughout history. A re-issue of the work originally titled *Outlines of Chinese symbolism and art motives* published [1931] revised 1932." Includes bibliographies.

Handout

Draw a picture of your boat. Label the parts.

Test your boat in the water tank and record observations.

Describe what happened.

Observations

Was your boat fast or slow?

Did it go straight or curve?

Did it sink or float?

Would a change make your boat go faster or better? Try changing your boat and retesting (draw new boat and record observations on back).

Supplies Worksheet

Instructions: Copy this worksheet and calculate the supplies you already have and what you still need. Then copy your completed worksheet to give to a teacher aid or a parent helper to gather the supplies designated in the right-hand "Supplies Needed" column.

No. of students: _____ **No. of groups:** _____

Supplies	Amount Needed	Supplies on Hand	Supplies Needed
Clean milk cartons	1-3/group		
Paper clips or ornament hangers	1/group		
Scissors	1/student		
Heavy tape (duct, gaffer's, etc.)	Up to 2 ft./boat		
Decorations: pipe cleaners, permanent markers, yarn, googly eyes, paper, popsicle sticks, sequins, felt, etc., for dragon's head and flags.	4 pipe cleaners/group		
Glue			