EXPLORATION: THEN AND NOW

Grade level: 6-8

Subject Area: Social Studies

Objective: The students will be able to explore how sail size affects kite ability to fly.

Related CBC Objective: Apply basic map and globe skills including cardinal and intermediate directions, determining distance using scale, interpreting map projections, interpreting legends and symbols.

Sunshine State Standards: (SS.B1.3.1) (SS.B.1.3.3) (SS.B.2.3.9)

Description of activity:

1. Build background/set purpose by reading the information about solar sails provided in the handout. Discuss.
2. Assign students to groups of three or more.
3. Assign students to groups of three or more.
4. Have students group construct three kites utilizing standard size paper (8- by 11-inches).
5. Students will predict which kite will fly the best and record their answers in their journals.
6. Students will evaluate each kite for time spent in the air, stability, and control using the "Flight Rating Chart."

Assessment:

1. Evaluate class/students charts for new information learned during these activities.
2. Assess students' journal responses.
3. Ask students to apply what they learned about transportation to future exploration. Have them plan to explore an unknown world; options may include another planet, a moon, the center of earth, or an area beneath the ocean. Ask them to design a vehicle that is capable of making the trip and then describe the propulsion and navigation systems needed. Have students make presentations to their classmates.

Extension:

1. Have students design experiments to test different types of propellants.
2. Assess students' journal responses
3. Ask students to apply what they have learned about transpiration to future exploration. Have them plan to explore an unknown world; options may include another plant, a moon, the center.

Activity Three: Exploring Sail Size

Ships of the 17th century were rigged with large, rectangular- or triangular-shaped sails to catch the wind and propel the ship forward. The stronger the wind, the faster the boat moved. The *Godspeed* sported sails with an area of about 225 square meters (2,422 square feet).

With only trade winds and ocean currents to propel ships, explorers were at the mercy of the weather and the water. If conditions were unfavorable, a ship simply dropped anchor and waited. The first fleet to Jamestown, for instance, anchored off the coast of Kent for 6 weeks until the wind blew in the right direction to enable the ships to sail down the English Channel.

Today, NASA is investigating the possibility of using solar sails to propel spacecraft of the future. Riding on the light from the Sun, solar sails may be used to deliver payloads to a variety of locations in our solar system. Just as the sailing ships of past centuries opened up new frontiers for affordable transport and exploration, solar sails offer revolutionary capabilities for in-space propulsion, transport, and exploration of Earth, the Sun, the planets, and even interstellar space.

A common misconception is that solar sails are pushed by the solar wind the same way sailboats are propelled by the wind on Earth. This is not exactly so. The density of solar-wind particles is so small that their combined pressure is much less than the pressure resulting from even a gentle breeze on Earth. The propulsive force for a solar sail comes from the pressure of the light particles from the Sun or from lasers. A solar sail is a very large mirror that reflects light. As the photons of light strike the sail and bounce off, they gently push the sail along by transferring momentum to the sail. Over time, the solar sail spacecraft constantly accelerates and achieves an ever-greater velocity. To perform at maximum efficiency, solar sails must have a large area to collect as much sunlight as possible and must be lightweight, durable, and temperature-resistant.

1. Assign students to groups of three or more.
2. Prepare kite tails in advance by cutting plastic trash bags into strips 2 centimeters by 200 centimeters. Each group needs three kite tails.
3. Have each student group construct three kites according to the following directions:

For the first kite:

a. Fold a standard size sheet of paper (8- by 11-inches) in half so the sheet is now 8- by 5-inches. See Diagram 1.

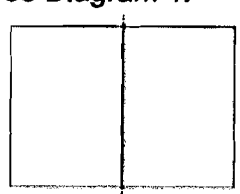

Diagram 1

b. Open the sheet. Starting at the fold, measure 3.5 centimeters along the top on one side and mark point "A."
c. At the bottom, starting from the fold line, measure 9 centimeters and mark point "B."
d. Draw line segment "AB."
e. Repeat the process to mark the reflection of line segment "AB" on the other side of the fold. Label this "A'" and "B'" (A prime and B prime) and draw the line segment. See Diagram 2.

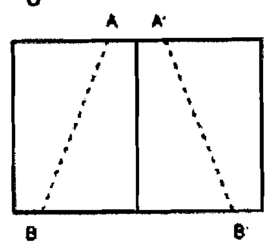

Diagram 2

f. Fold the paper in half once more, then fold back along the segments "AB" and "A'B'," forming the kite shape shown in Diagram 3.

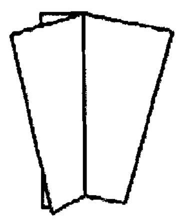
Diagram 3

g. Flip the kite over to the back and fold the flap back and forth several times until it stands perpendicular to the kite sails.

Teaching Suggestion: *If the kite flap is not perpendicular, it acts as a rudder and the kite spins in circles.*

h. Flip the kite over to the front and place a piece of tape firmly along the fold line where "AB" meets "A'B'."
i. Place a skewer stick across the top of the kite sails at the widest point and tape them down, firmly, along the entire length of the stick. Cut any excess stick from the pointed end. See Diagram 4.

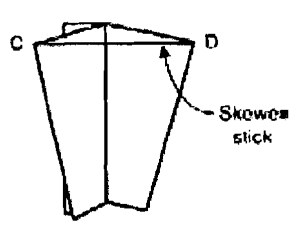

Diagram 4

b. What was the relationship between the surface area of the kites and their flight ratings?

c. What are the advantages and disadvantages of relying on sails for propulsion?

d. Compare solar sails to ship sails. How are they the same? How are they different?

Teaching Suggestion: *To extend this activity, ask students to attach their kites to a simple boat. Place the boats in a small wading pool and use a box fan for wind. Ask the students: Did the kites perform the same way on the water as they did in the air? What modifications could be made to the sails to make them more effective?*

10. Add any new information students have learned about propulsion to the class and student charts.