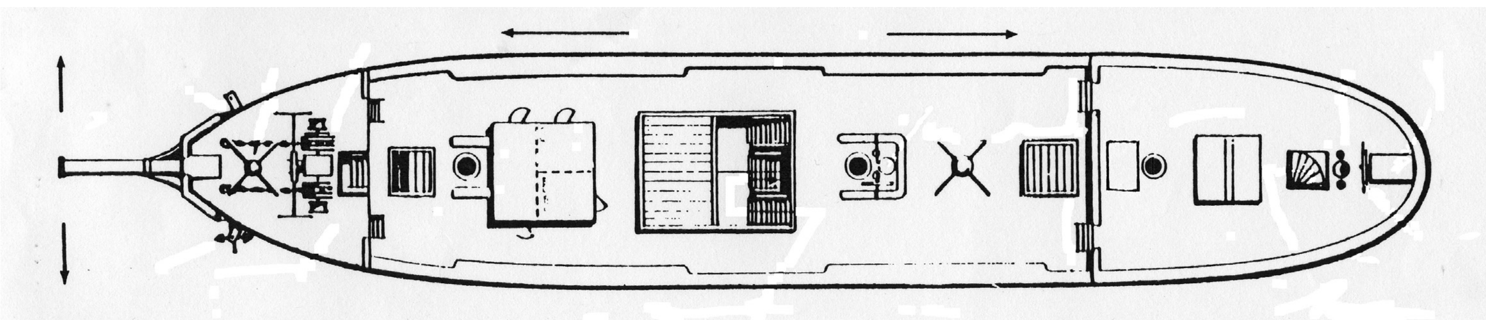
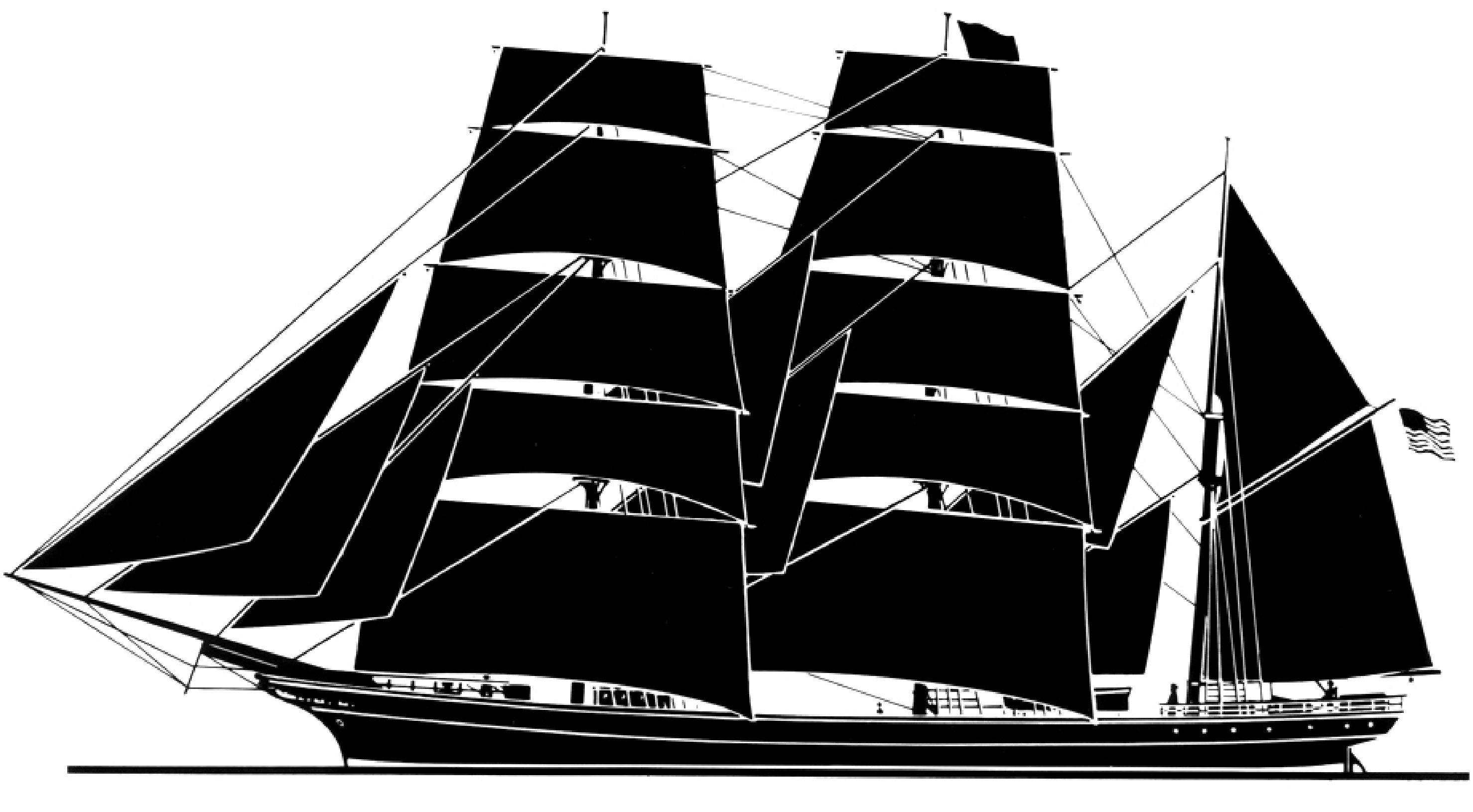
REVIEW

VOCABULARY: Identify or define the following words used above in describing ELISSA.

oakum	jibboom	baggywrinkle	hemp	port	yard	spar
mast	square rigger	anchor	starboard	windlass	running rigging	
barque	aft	ballast	stow	forecastle (fo'c'sle)		
hull	bilge	capstan	bosun	binnacle	standing rigging	
bow	stern	mizzen mast	deck	foremast	galley	pooped
mainmast	hatch	figurehead	hold	watch (2 meanings)		cathead
deckhouse	pinrail	fiferail	bend	hitch	knot (2 meanings)	

THE SHIP: A sailor aboard ELISSA would know the names of her sails and the features of her deck. Can you label them below?





PRE-VISIT ACTIVITIES

1. After sharing information on ships and sailing, have students define the vocabulary words and label the parts of the ship. Use the information and diagrams of ELISSA given above, books such as the ones listed below, and the web. For a fairly detailed seagoing vocabulary guide, for example, see the Texas Seaport Museum web page, http://www.galvestonhistory.org/elissa-glossary_a-l.asp.

2. Discuss the word ballast. Many ships used cargo for ballast. Have students build a sailboat or use a sailboat model in water to demonstrate the need for ballast. This activity can also be done by flying a kite, using the tail as "ballast". Another activity to demonstrate the concept of ballast is by experimenting with corks, small dowel rods (for masts) and small weights in a container. (Also see "Buoyancy Activity" handout).

3. Discuss "How Sails Work:" (see handout). Understand force and air pressure, and how the ship is pulled as well as pushed by the wind.

4. Discuss how much easier it is to lift a heavy object using a pulley system. Using this simple broomstick pulley system to effectively demonstrate why a block and tackle system give such a mechanical advantage (see "Block and Tackle" handout).

5. Discuss the basic understanding of magnetism and how it works as an aid to navigation, (see "Compass" handout).

ELISSA has a variety of "hands-on" activities demonstrating simple machines used on ships, sounds at sea, stability and belaying lines.

POST-VISIT ACTIVITIES

1. Have students complete the ELISSA Word Search (next page) or create one of their own. They may also create another type of word game such as a crossword puzzle using the vocabulary and information gathered.

2. Writing an acrostic poem about ELISSA is a creative way to share learned information.

3. Using the information from ELISSA's Log, have students create a time line. In a creative manner, have them illustrate cargo, destination and date. Place the pictures on a line of water. Students can then chart the voyage on a world map, indicating the date.

4. Discuss how much easier it is to lift heavy objects using a pulley system.

5. Discuss how the compass works and how it is used.

READ

Berenstain, Michael. *The Ship Book.* David McDay, 1978.

Crews, Donald. *Harbor,* Greenwillow, 1982.

Fisher Leonard Everett. *The Shipbuilders.* Watts, 1971.

Gibbons, Gail. *Boat Book.* Holiday House, 1983.

Lasky, Kathryn. *Tall Ships.* Charles Scribner's Sons, 1978.

Macaulay, David. *Ship.* Houghton Mifflin, 1993.

The Visual Dictionary of Ships and Sailing. Dorling Kindersley, 1991.

Activity Guides

BLOCK AND TACKLE

How much easier is it to lift a heavy object using a pulley system? Use this simple broomstick pulley system to effectively demonstrate why the block and tackle pulley system give such a mechanical advantage

Material

2-Broom handles (or dowel rods, PVC pipe),approx. ½ to 1 inch diameter, 3-4 foot long,
Strong, thin, line 25 feet long

Safety Precautions

Please follow normal safety guidelines. Do not jerk on the line. Pull the line gently with an even force.

Procedure

1. Two crew will each serve as broom-handle holders, and the other as the line puller.

2. Have the two broom-handle holders stand about 5 to 6 feet apart and extend their arms to hold the broom handles parallel to the floor at waist level.

3. Securely tie one end of the line to the middle of one of the broom handles.

4. Wrap the line around the middle of the other broom handle and give the bitter end to the line puller.

5. The line puller should stand behind, and slightly to the side of one of the holders, so that the line will be pulled perpendicular to the length of the broom handles. The bitter end side of the line should go under the arms of the broom-handle holder so that the line is pulled parallel to the ground as well.

6. Have the two broom handle holders try as hard as they can to prevent the broom handles from coming together as the line puller tugs on the line.
Can the single line puller draw the two broom handle holders together?
What is the mechanical advantage of this pulley system?

7. Repeat steps 5 and 6 several times. For each new trial, wrap the line around the broom handles a different number of times in a figure 8 fashion.
How much more difficult is it for the holders with each new trial?
How much easier is it for the puller?
What is the mechanical advantage as each new loop is added to the pulley system?
How close are the broom handle holders drawn together compared to the amount of line pulled during each new trial?

Tip: To enhance the effect of mechanical advantage, use two "large" crew members to hold the broom handles and a "small" crew member to pull the line.

Discussion

Pulleys are used extensively when heavy objects need to be lifted, especially in cranes in shipping and construction areas. Pulleys are one of six types of simple machines used to easily change the direction and/or the magnitude of an applied force. (The lever and fulcrum, inclined plane, wheel and axle, wedge, and screw are the five other types of simple machines.)

How does a pulley decrease the amount of force necessary to lift an object? The advantage of a pulley is its ability to change the number of "lines" lifting an object. This gives a lifter a greater mechanical advantage.

Mechanical advantage is a ratio of the output force compared to the input force. The greater the mechanical advantage is for a system, the greater the output force is compared to the input force. The greater the mechanical advantage, the easier it is to do the work. For a block and tackle pulley system, the mechanical advantage is determined by the number of support lines that are lifting the object. Therefore, the more times the line is wrapped around the broom handles, the greater the mechanical advantage is for the puller.

However, a pulley does not give something for nothing. A block and tackle pulley system gives a high mechanical advantage, but the sacrifice is that the applied force must be carried over a longer distance compared to the distance the lifted object actually moves. Ideally, due to the conservation of energy, the work in must be equal to the work out. Work is defined as a force times a distance. Therefore, even though a pulley (or any simple machine) makes it easier to lift a heavy object, the total amount of work necessary to lift the object will be equal. A smaller force will be used over a larger distance in order to lift a heavy object a short distance.

BUOYANCY
(Floating)

A body of water naturally pushes upward. That's the water's buoyancy. You can feel buoyancy when you push the palm of your hand against a water surface. An object floats or sinks depending upon its displacement. Increasing the volume (area that an object occupies) increases the amount of displacement. This increases an objects buoyancy, or ability to float.

Increasing the volume an object occupies increases its surface area, and thus increases the friction it experiences as it moves through the water. Thus, the shape of an object in liquid can serve two purposes. An object designed for speed must have the minimum displacement to decrease the friction, i.e. a speed boat. Conversely, an object designed to carry heavy weights (like ELISSA, when she carried cargo) must be designed for maximum displacement, thus increasing buoyancy and friction.

In other words, every body of water strives to be level. When you place a boat in the water, gravity pulls it down and the water has to move out of the way (becomes displaced). The water is no longer level. So, you have two forces at work against the hull of the boat; the pressure of the water pushing up trying to regain a level plain, and gravity pulling the boat down.
-The hull of every boat is designed to transfer, or spread out the force of the water on which it sits over a large area, thereby decreasing the water pressure force at any particular point. If the pressure of the water pushing on the hull is greater than the force of gravity pulling it down, then the boat floats! Why? There is no longer sufficient water displacement to counteract gravity and the desire for water to maintain a level.

UNDERSTANDING CHANGE IN BUOYANCY
Some water has more buoyancy than other water. Here's how to find out. Plan to take this activity outside. It can get wet and messy.

ITEMS NEEDED:
1. Plasticine clay – 1/3 stick per student (you can purchase plasticine clay at craft stores)

2. A dishpan full of water

3. Pennies

4. Salt

5. Sand or cornstarch

6. A large spoon
Note: You may use aluminum foil instead of clay.

Here's what you do:

1. Give each student one-third stick of clay.

2. Roll the clay into a ball.

3. Drop the ball into the water—IT SINKS!

NOW BUILD A BOAT
1. Shape a boat out of the clay. Boats can be like a raft (flat), sailboat (curved but pointed on the bottom), or bowl (round and curved).

2. Place your boat into the water.

3. Using the pennies, have the students place pennies one at a time onto the boats. Which design floats the longest? Why?

4. Carefully lift the boats out of the water, and remove the coins.

5. Pour 1-2 cups of salt onto the water and stir until the salt dissolves.

6. Now see how many coins the boats can hold. Does adding salt to the water make the boats float better?

7. Again, carefully lift the boats out of the water. Add 1-2 cups sand or cornstarch to the water and stir.

8. See how many coins each boat can carry before it sinks.

THE COMPASS

This activity will help the students gain a basic understanding of magnetism and an understanding of how a compass works and how one is used:

The students will be able to:

1. Identify and read a compass card.

2. Make a simple magnetic compass.

3. Take a bearing with their handmade compass and a real compass in the classroom.

4. Understand the meaning of true North and magnetic North.

Provide definitions or have each student look up, and write definitions for, each of the following words:

1. Magnetize
2. Compass
3. Magnetic North
4. True North
5. Bearing
6. Navigation
7. Poles

Magnetism is the measurable relation of the physical force between two objects of metal, usually iron, or an alloy of iron and other metals, of which one has been previously magnetized. This magnetized metal is commonly referred to as a magnet. The area around the magnet where the force can be detected is called the magnetic field.

Each magnet has separate poles where the magnetic force seems to be concentrated. The opposing poles are termed North and South. The basic law of magnetism is that opposites attract and like poles repel each other.

The earth has magnetic properties that distribute the magnetic poles towards the geographical poles of the earth. The magnetic properties of the earth are distributed unevenly and as a result the poles are not directly parallel with geographical poles, the North and South poles (this is why there is a difference between true North and magnetic North). The magnetic poles are called the North magnetic pole and the South magnetic pole. These poles refer to where the concentration of magnetic force is located.

The compass is a simple device consisting of a magnet, and a way of allowing that magnet to rotate freely. The "north seeking" end of the magnet will reliably point toward the North magnetic pole, thus allowing a direction to be established. For navigation, this direction can be used as a means of finding a location.

The compass card is a non-magnetic disc to which the magnet is attached. It is round and is marked in degrees around its circumference from which the magnet can be read. The card rests on a pivot at its center. It is important to note that as the boat changes direction, the compass card does not change direction (the needle always points to magnetic North).

MAKING A MAGNET

May be done individually, in pairs or in small groups of 3-4 crew members. Here's what you need:

1. A shallow clear dish (Petri dish)

2. Water

3. Magnet

4. Needle

5. Compass card

6. A simple compass to verify accuracy

7. Cork (cut in several pieces)

Here's what you do:

1. Magnetize the needle by passing the needle over a strong magnet for 20 seconds.

2. Fill the dish with water and place the dish on the compass card.

3. Float the slice of cork on the water.

4. Balance the needle on the cork.

5. Move the compass card so the North is lined up with the needle.

6. Use the compass to verify the accuracy of the needle in the dish.

7. Pass the magnet over the dish to change the direction of the needle. What happens? Why? Does the needle return north? Why?

TAKING A BEARING

Here's what you need:
4 student-made compasses

Here's what you do:
1. Place a text book on top of a solid surface.

2. Divide the crew into four groups.

3. Corner off into four areas: A, B, C, D

4. Using the hand-made compasses, have the student take a bearing of the text book from their corner

5. Now have the groups rotate counter-clockwise until each group has taken a bearing from each corner and written it down or logged it.

6. Compare the bearings from each group.

7. Now follow the same procedure using a real compass and compare the results.

Questions:
1. Is the needle in the dish accurate enough for navigation? Why or why not?

2. Is there room for error in navigation, especially on a ship made of iron? Why?

3. How would you verify the accuracy of your compass?

4. What factors affect taking an accurate bearing? You might ask what the heavy iron balls are doing next to ELISSA's magnetic compass below.

ELISSA's binnacle and compass. This is the view that her helmsman worked with. Her courses are now called out in the 360 degree scale marked on the card, but the diamond markings of an older system are easier for the helmsman to read by the dim lights of the candles mounted in the tubes seen at each side.

HOW SAILS WORK

This activity will help the crew gain an understanding of air pressure and how it relates to a sailing vessel. Crew will be able to:

1. Understand the concept of force and air pressure.

2. Understand the concept of air pressure as a force.

3. Understand the meaning of high and low air pressure and how it works.

4. Understand how a sail of a ship is pulled rather than pushed by the wind.

5. Create high and low air pressure systems.

Even though we cannot see air, it is a mass made up of molecules we can feel. Wind is created by differences in air pressure. When the air pressure is even, the air is still. When the air pressure is uneven, the air moves. Air under higher pressure moves towards or is pulled towards air under lower pressure. The amount of difference in pressure will determine the velocity, or strength of the wind and movement of air.

A sailing ship follows the same principles of an airplane wing. The shape of the sail along with the direction the ship is moving in relation to the wind directions determines how air pressure affects the movement of the boat. An airplane wing is shaped to create a wind foil. This wind foil creates a low pressure on top of the wing and high pressure on the bottom of the wing (the air speeds up going over the curve to keep up with the air moving across the flatter bottom half of the wing). This increase in air speed over the top of the wing is what creates the low pressure, causing the lift, allowing the plane to fly!

Sails on a ship follow the same principle. It is a modern sail maker's art to cut the sail with the proper amount of curve creating the desired wind foil shape. Old square rigged ships did not have efficient wind foiled sails- the sails were made to be pushed instead of pulled by the wind. As more was learned about the concept of air pressure and lift, it was soon realized that a sailing vessel could actually sail more efficiently and faster being pulled by wind than being pushed by the wind.

When a strong aerodynamic force is exerted in a sideways direction by the wind, the keel, situated under the boat, prevents the boat from moving sideways by creating a lateral resistance force. These two forces combine to create the resultant force, moving the boat in a forward direction. The interaction of forces is what propels the boat up-wind. Thus the evolution of sail!

EXAMINING THE PUSH AND PULL OF WIND

Materials needed (for each group):

1. Ping pong or small Styrofoam ball

2. Large funnel

3. Alcohol or Purell wipes (to clean the funnel after each crew member use)

Note: If the funnel is too small, and the students have strong lungs, they can usually pop the ball out of the funnel easily. Try this activity first and find funnels that are the right size.

UNDERSTANDING AIR PRESSURE

Materials needed:

1. Two books of equal size

2. One sheet of notebook paper

3. One drinking straw

Procedure:

1. Position the books 10 cm apart on the table.

2. Lay the sheet of paper across the space between the books.

3. Place the end of the straw just under the edge of the paper.

4. Blow as hard as you can through the straw and watch the paper flop down when air is blown under it. Why doesn't the paper blow away?

Before you blew into the straw, the air was pushing on all sides of the paper. As the speed of air increases, the sideways pressure of the air decreases. Forcing a stream of fast-moving air under the paper reduces the upward pressure on the paper. The air pushing down on the paper is greater than the air pushing up, thus the paper is sucked down.

ELISSA WORD SEARCH

ELISSA, ship, sail, hull, bow, stern, deck, por
starboard, mast, yard, line, barque, figurehead
cargo, hold, ballast, squard-rigged, Galveston.

These words are hidden in the puzzle at right-
They may run forward, backward, up, down,
or diagonally. If you look closely, you may
even find some other hidden words.
:

O	T	I	Y	A	B	K	Q	Z	S	A	I	L	F	O	E	P	W	Z	B	J	T	G	I	R	L
Z	Z	K	A	D	O	G	B	A	N	A	N	A	L	L	L	I	N	E	K	Y	T	J	V	X	Y
I	P	O	R	T	S	T	A	R	B	O	A	R	D	D	I	N	K	I	O	L	S	H	A	R	P
P	B	A	D	C	A	T	R	Y	M	T	G	I	R	L	S	E	F	B	J	C	A	U	L	K	O
T	K	C	Q	H	I	Z	Q	T	A	L	R	A	P	H	S	T	E	R	N	A	L	T	E	A	J
F	C	K	P	A	L	S	U	O	S	O	J	I	P	O	A	A	R	H	U	L	L	T	A	C	K
L	E	I	G	A	L	V	E	S	T	O	N	P	L	L	R	P	P	G	L	H	A	M	E	F	O
U	D	F	O	G	F	I	G	U	R	E	H	E	A	D	B	Y	I	Z	C	R	B	O	N	Y	I
G	E	D	W	B	K	C	O	M	E	B	A	C	K	L	J	Z	H	K	Z	A	Z	A	C	E	G
P	O	O	N	M	L	D	E	G	G	I	R	E	R	A	U	Q	S	W	O	B	R	Z	Y	S	U
D	B	Y	E	N	O	W	A	T	E	R	P	S	M	A	R	T	K	I	D	O	N	G	A	N	L
F	U	N	Z	P	F	U	L	L	R	I	G	G	E	D	N	W	O	W	K	M	L	J	O	O	D