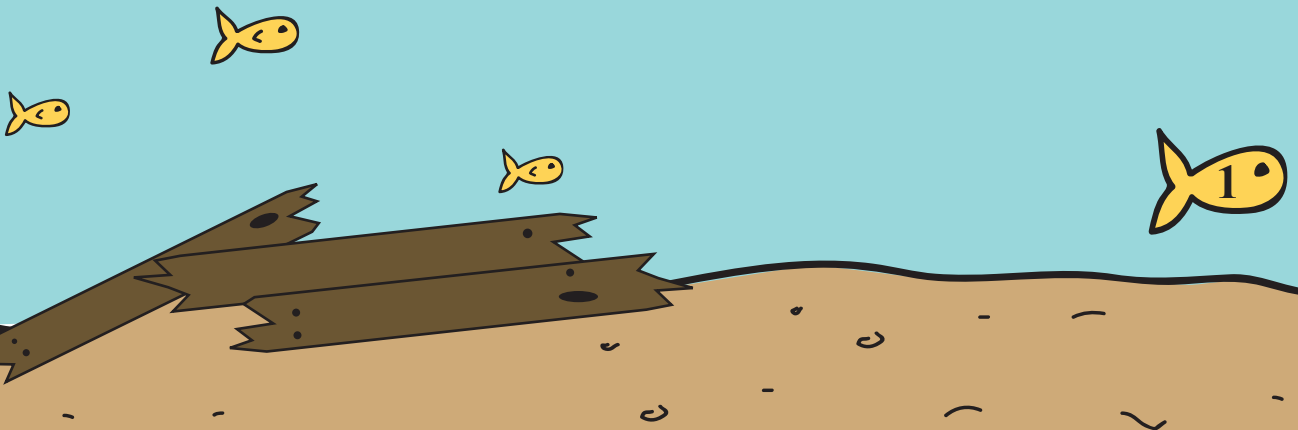


Working a Ship Activity



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Working a Ship: Aboard the Western Hope of Alpena



Captain's Notes



Overview

In this activity, students will learn about the mechanics of pulley systems and how they were used aboard ships. Students will lift heavy objects without and then with the help of a block and tackle and experience how much they help. Using the accessible block and tackle aboard the Western Hope adds a more authentic shipboard atmosphere to the activity. Older students will learn about and make some calculations about work ratios and mechanical advantage/purchase. Younger students will learn the concepts more exclusively with hands-on activities.

Difficulty/Grade Level

Easy-Moderate/Elementary-Middle School

Suggested Group Size

About 10 students at a time. Two presenters can accommodate 15

Time

20-30 minutes

Sails and Rigging

The sails that controlled the ships and the rigging, and spars that controlled the sails, could be very complicated and very heavy to lift. Large, square-rigged ships had hundreds of blocks, many huge sails, and miles of line aboard. The largest sail on the USS Constitution weighed over 1/2 ton! These ships needed many men to sail. On the Great Lakes, sailing ships called "schooners" had fewer sails and much less rigging. A large schooner only needed a crew of 6-8 to operate. On all ships, though, blocks and tackle were essential.



Objectives

- Identify several important parts of a ship and shipboard terms.
- Lift objects with and without the help of a block and tackle system.
- Describe how the block and tackle system works and how the advantage is "purchased" and how the work is distributed.
- Calculate ratios of different block systems and variables such as weight and length of line.

Skills and Strategies

- Scientifically describing a simple machine
- Connecting a scientific concept with practical uses
- Describing how science impacts history

Materials

- Diagram showing important parts of a ship and shipboard terms
- Small demonstration block and tackle
- Heavy duty and portable block and tackle system
- Western Hope of Alpena exhibit with accessible block and tackle on the starboard side
- Weight that can be attached to the block heavy enough so students can barely or not at all lift it
- How it Works handout with example problems

Preperation

1. Rig the portable block and tackle to the davit line made off to both pins on the Western Hope's starboard quarter so it can be used for tug-of-war.
2. Rig the weight to the accessible block on the starboard side of the Western Hope.
3. Set up the small demonstration block and tackle and the explanatory diagram in the stern on the wheel box.



Procedures

1. Introduce the *Western Hope* and her desperate situation, caught in a late season storm trying to enter Thunder Bay for shelter.
2. Review the "Parts of a Ship" vocabulary using the diagram and the surroundings of the *Western Hope*. Have younger students interact by playing a game. "Everyone touch the _____. Everyone go to the _____ side" etc.
3. Explain the need to lift very heavy spars, sails, and cargo on a ship. Have students count how many blocks they can find on the *Western Hope* (15; don't forget the ones in the yawl boat! There is also a 16th at the top of the mast but it is painted black and not supposed to be seen.)
4. With the demonstration block and tackle system, have the students look at the weights (all the same) and at the systems. Ask them to guess which system will be easier to pull.
5. Next, have the students try all the systems and determine which weight feels the lightest. Have them try to figure out why they feel different.
6. Go over the "How it Works" concepts, explaining the mechanics of the block and tackle. Ask older students to figure out some examples of ratios, apparant weight, and length of line in different purchase systems. See "Example Problems."
7. Next, have each student try to lift the weight attached to the *Western Hope's* block without using the block and tackle. Then, have each student pull on the line to lift it.
8. Finally, have the students divide into groups of three. Using the system set up on deck, have the smallest play tug-of-war against the other two using the end with the extra purchase. Before the first group begins, ask the students to guess who they think will win.

Discussion

What type of ship is the *Western Hope*? How does it move through the water? *The Western Hope is a sailing ship and it uses the wind to move through the water.*

How did sailors lift the extremely heavy spars and sails? *Sailors use block and tackle systems (pulleys). Point to some blocks.*

How did block and tackle technology make operating a ship less expensive? *With block and tackle technology, less manpower was needed so less sailors needed to work and be paid. Also, it took less time loading and unloading a ship's cargo, so a ship could carry more cargo in less time, allowing it to make more money.*

What has replaced block and tackle technology on cargo-carrying ships today? *Ships use cranes and lifting systems powered by motors to load and unload cargo today. Sailing ships are not used to carry cargo anymore so raising and lowering sails is no longer an issue. Sailing ships do carry passengers, though, a type of cargo, and still do use block and tackle systems.*

How could you use a block and tackle in your life?

Answers will vary.

Reeling It In

Explain that this simple machine made it possible for ships to sail all over the world, bringing many of our ancestors to America. This machine makes it possible for small people to do the work of giants!

Vessel Vocabulary

Block and Tackle: pulley system on a boat

Bow: the front of a boat

Stern: the back of a boat

Port: the left side or direction on a boat looking forward

Starboard: the right side or direction on a boat looking forward

Forward: the direction toward the front of the boat

Aft: the direction toward the back of the boat

Mast: the tall vertical pole on a boat which supports the spars and sails

Spar: the horizontal poles which are attached to the mast upon which the sails hang

Sail: a large piece of fabric attached to the mast and spars of a boat that responds to the wind forcing a boat through the water

Example Problem Answers:

1. 100 lbs.; 40 ft.
2. 3; 20 ft.



Western Hope Layout



**Starboard block and tackle
with weight attached**



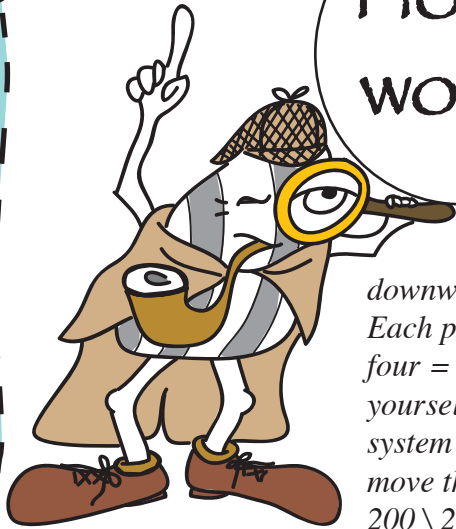
Tug of war on the starboard quarter of the *Western Hope*



Working a Ship



How it works



The block and tackle system gives mechanical advantage by distributing the weight or load of the object along the length of the line. This weight distribution is what allows you to more easily lift the object. You are not lifting all the weight at the same time, so it takes less force to move the object. If you have a 200 pound barrel rigged to a double purchase system (four parts to the fall; four lines leading downward to the object being lifted), you are only lifting 50 pounds at a time. Each part of the fall is holding a fourth of the weight (divide 200 pounds by four = 50), therefore if you can lift fifty pounds you can lift the heavy barrel by yourself. If however you have a 200 pound barrel rigged to a single purchase system (two parts to the fall) you have to be able to lift 100 pounds in order to move the barrel by yourself. (Divide the weight by each part of the fall - $200 \div 2 = 100$).

Although the force needed to move an object is decreased, you have to 'purchase' the advantage by applying the force over a greater distance. When raising sail or cargo, although the block and tackle system decreases the force needed to move the object up, it increases the amount of line that must be pulled through the blocks. Since "you can't get something for nothing", you have to 'purchase' the ease of your efforts by having to pull more line. Example: A schooner uses a double purchase system when raising their Main Sail (at the throat). This gives a 4 to 1 advantage, but this means you must pull four feet of line for every one foot the barrel or chair is raised.

Example Problems (answers on bottom of pg. 3)

1. Aboard the *Western Hope*, you are trying to lift a 400 lb. anchor from the hold to put on deck. You are using a double purchase system (four parts to the fall) and you need to lift the anchor 10 feet to swing it to the deck. How much weight do you need to be able to lift to do the work on your own and how much rope will you have to pull through the blocks?
2. You pull 60 feet of line through a block and tackle system. You are lifting a 150 lb. barrel full of sugar onto a schooner bound for Lake Michigan. It feels like you are lifting 50 lbs. How many 'parts to the fall' are there in your system. In other words, how many lines lead down to the block attached to the barrel? How high did you lift the barrel? On the back of this sheet of paper, draw a diagram of what your system would look like.

