

Lesson 8

AIR PRESSURE

GOALS:

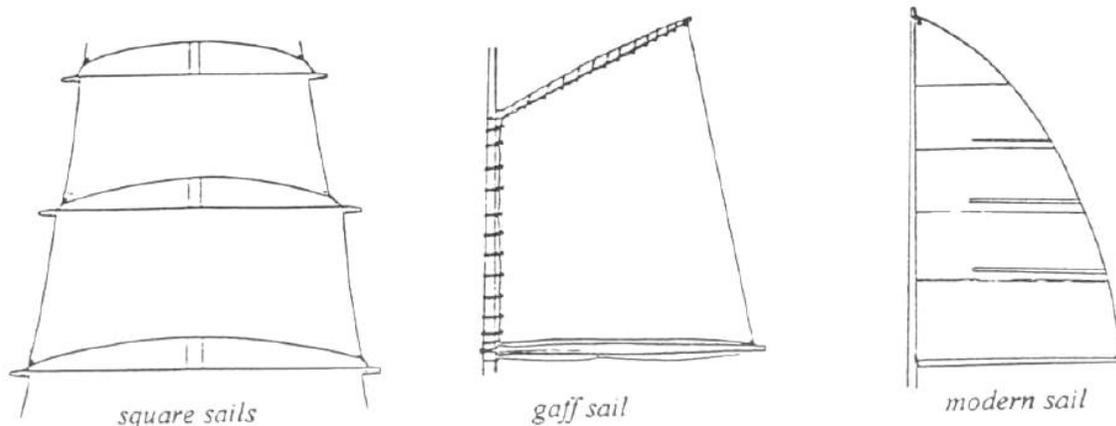
- › Students will gain an understanding of air pressure and how it relates to a sailing vessel.

CONCEPT AND BACKGROUND:

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. If the air pressure is even the air is still, if 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 speed) 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 direction determines how air pressure affects the movement of the boat. An airplane wing is shaped to create a wind foil, which creates a low pressure on top of the wing and a 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 (more pressure on the bottom of the wing than the top) which is what allows the planes to fly!

A sail on a boat follows the same principles. Modern sail maker's make an art out of cutting a sail to form the proper amount of curve, ultimately 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 the knowledge about the concept of air pressure and lift increased, the realization that sailing vessels were more efficient and faster being pulled by wind rather than being pushed was made. Thus, the evolution of sailing occurred!



BEHAVIORAL OBJECTIVE:

The students will be able to:

- a. Understanding the meaning of high and low air pressure and how it works.
- b. Understanding how the sail of a ship is pulled rather than pushed by the wind.
- c. Create high and low air pressure systems in the classroom:
 - Causing a piece of paper to be pulled downward with low pressure.
 - Making a ping pong ball float in mid air by creating unequal air pressure.

VOCABULARY:

1. air pressure
2. low pressure
3. high pressure
4. lift
5. wind foil
6. velocity

STRATEGY: Discovery

Activity One: Paper Flop*

Materials: Two books of equal size
One sheet of notebook paper
One drinking straw
Ruler

Methodology

- Position the books 10cm apart on a table
- Lay the sheet of paper across the space between the books
- Place the end of the straw just under the edge of the paper

Challenge: 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?

Activity Two: Floating Ball*

Materials: Small funnel
Table tennis ball (ping pong ball)

Methodology

- Turn the funnel upside down
- Hold the ping pong ball in the funnel with your finger
- Start blowing hard into the narrow end of the funnel
- Remove your finger from the ball as you continue to blow down into the funnel

Challenge: Make the ball float inside the funnel by creating low air pressure over the top of the ball. Why doesn't the ball fall to the ground?

The fast moving air over the top of the ball creates the low pressure. The air under the ball is not moving, therefore is creating more pressure up against the bottom of the ball. When the air flows faster over the top of the ball than below (like an airplane wing), there is an upward push on the ball called a lift.

*Activities created by Janice VanCleave's *PHYSICS for Every Kid*.

Lesson 9

FLOAT A BOAT

GOALS:

- › Students will understand the concept of displacement in water and buoyancy as well as how other forces (gravity and friction) relate.
- › Students will comprehend how these concepts affect an object's ability to float and move through the water.

CONCEPT AND BACKGROUND:

Why does a ship float whereas another object made of the same material as the ship sink? The answer can be summarized in one word –buoyancy. Buoyancy is the ability of a substance to float.

An object floats or sinks depending upon its displacement. Increasing the volume (area that an object occupies) increases the amount of displacement. This increases the buoyancy, or ability to float. Increasing the volume an object occupies increases its surface area, which increases the friction it experiences as it moves through the water. The shape of an object in liquid serves two purposes: (1) speed –an object designed for speed must have the minimum displacement possible to decrease the friction (i.e. a speed boat), (2) weight –an object designed to carry a heavy weight (a cargo vessel, like the *Pilgrim*) must be designed to maximize displacement, thereby increasing buoyancy and friction.

In other words, all bodies of water always strive to be level. When a boat is placed in water, gravity pulls it down and the water has to move out of the way, becoming displaced. The water is no longer level and there are two forces working 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 hulls of boats are designed to transfer the force of the water underneath it over a larger area, which decreases the 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, the boat will float! If a sea worthy boat hull is broken down, compacted together, and placed in water it will sink. Why? –there is no longer sufficient water displacement to counteract gravity and the desire for water to maintain a level plain.

BEHAVIORAL OBJECTIVE:

The students will be able to:

- a. Describe the concept of displacement.
- b. Describe the concept of buoyancy.
- c. Distinguish between objects that will and will not float.
- d. Design a hull that will maximize its ability to hold cargo.
- e. Design a hull that will maximize its speed by minimizing friction.

VOCABULARY: