



## Assignment Discovery Lesson Plan Junkyard Wars: Wind Machines

### Subject

Physical Science

### Grade level

6 – 12

### Duration

One or two class periods

### Objectives

Students will

- investigate the effect of wind direction on sail angle; and
- compare the tailwind speeds for two sail orientations.

### Materials

- Low-friction toy cars (20-30 cm in length)
- Lightweight, sturdy cardboard or plastic for sails (mat board or foam board work well)
- Duct or masking tape
- Protractor
- Dowel rods (1/4" or similar) for mast and boom (optional)
- Fans

### Procedures

1. Experiment beforehand to determine the best way for students to make the sail and then attach it to the car. You may be able to tape it in place if the sail and car are made of very stiff materials or you may drill a vertical hole in the car slightly smaller than the diameter of the dowel. Glue the dowel in place to act as a mast. If necessary, attach the boom and the sail to the mast with tape.
2. Divide the class into small groups, and tell students that they will be investigating the effect of wind direction on sail angle for maximum speed of a land yacht or sailboat. Have each group create its sail.
3. For the first experiment, tell the groups to set the sail perpendicular to the wheels—it should divide the car front and back. Have them conduct a study measuring the speed of the land yacht at different wind angles, with a tail

wind being 0° and a headwind 180°. They should keep the fan in the same place and measure the time for the land yacht to travel a given distance: a few meters with a large fan or one meter with a small fan.

4. Now have them change the direction of the sail to 45° relative to the wheels and repeat the experiment. Have them test ways to make the land yacht travel into the wind.
5. Then have them compare the tailwind speeds for the two sail orientations.
6. Ask each student to summarize the experiment findings in a short report.

### **Evaluation**

Use the following three-point rubric to evaluate students' work during this lesson.

- **Three points:** Students worked cooperatively during the experiment; were able to determine ways to make the land yacht travel into the wind; thoughtfully and accurately summarized the experiment findings in a written report.
- **Two points:** Students worked somewhat cooperatively during the experiment; needed help determining ways to make the land yacht travel into the wind; somewhat accurately summarized the experiment findings in a written report.
- **One point:** Students did not work cooperatively during the experiment; were unable to determine ways to make the land yacht travel into the wind and did not seek help; did not accurately summarize the experiment findings in a written report.

### **Vocabulary**

#### **boom**

Definition: A long pole or spar attached perpendicularly from the mast that holds and extends the foot of a sail

Context: Use a boom on your sail to increase the amount of area exposed to the fan's wind.

#### **headwind**

Definition: A wind moving in the opposite general direction as a vehicle

Context: Conduct a study measuring the speed of the land yacht at different wind angles, with a tail wind being 0° and a headwind 180°.

#### **mast**

Definition: A long pole or spar that rises vertically from the keel or deck of a ship and supports the sails, boom, and rigging

Context: Position the sail's mast so that it is perpendicular to the wheels

#### **tailwind**

Definition: A wind moving in the same general direction as a vehicle

Context: Conduct a study measuring the speed of the land yacht at different wind angles, with a tail wind being 0° and a headwind 180°.

**Academic Standards**

*The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K–12. To view the standards, visit <http://books.nap.edu>.*

This lesson plan addresses the following science standards for grades 5–8:

- Science as Inquiry: Abilities necessary to do scientific inquiry, Understanding about scientific inquiry
- Physical Science: Motions and forces, Transfer of energy
- Science and Technology: Abilities of technological design, Understandings about science and technology

This lesson plan addresses the following science standards for grades 9–12:

- Science as Inquiry: Abilities necessary to do scientific inquiry, Understanding about scientific inquiry
- Physical Science: Motions and forces, Interactions of energy and matter
- Science and Technology: Abilities of technological design, Understandings about science and technology

**Credit**

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