Sailing With the Wind

Goal: Demonstrate that you understand the effect of wind direction on sail angle and speed

Role: Yachting Club

Audience: Sailing Enthusiasts

Situation: Sail Design Competition

Product: Sail to move land yacht or sailboat

Standard:

SP1 Students will analyze the relationships between force, mass, gravity, and the motion of objects.

a. Calculate average velocity, instantaneous velocity, and acceleration in a given frame of reference
b. Compare and Contrast scalar and vector quantities.
c. Compare graphically and algebraically the relationships among position, velocity, acceleration, and time.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

a. Develop and use systematic procedures for recording and organizing information.
b. Use technology to produce tables and graphs.
c. Use technology to develop, test, and revise experimental or mathematical models.
d. Develop procedures for solving scientific problems.
e. Collect, organize and record appropriate data.
f. Graphically compare and analyze data points and/or summary statistics.
g. Develop reasonable conclusions based on data collected.

5. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

a. Trace the source on any large disparity between estimated and calculated answers to problems.
b. Consider possible effects of measurement errors on calculations.
c. Recognize the relationship between accuracy and precision.
d. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.
e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.

SCSh6. Students will communicate scientific investigations and information clearly.

a. Write clear, coherent laboratory reports related to scientific investigations.
b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data
c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
d. Participate in group discussions of scientific investigation and current scientific issues.

The Nature of Science

SCSh7. Students will analyze how scientific knowledge is developed.

Students will recognize that:

a. The universe is a vast single system in which the basic principles are the same everywhere.
b. Universal principles are discovered through observation and experimental verification.
c. From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Major shifts in scientific views typically occur after the observation of a new phenomenon or an insightful interpretation of existing data by an individual or research group.
d. Hypotheses often cause scientists to develop new experiments that produce additional data.
e. Testing, revising, and occasionally rejecting new and old theories never ends.

SCSh8. Students will understand important features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

a. Scientific investigators control the conditions of their experiments in order to produce valuable data.

b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyses, and interpretations.

c. Scientists use practices such as peer review and publication to reinforce the integrity of scientific activity and reporting.

d. The merit of a new theory is judged by how well scientific data are explained by the new theory.

e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.

f. Science disciplines and traditions differ from one another in what is studied, techniques used, and outcomes sought.

SCSh9. Students will enhance reading in all curriculum areas by:

a. Reading in All Curriculum Areas

- Read a minimum of 25 grade-level appropriate books per year from a variety of subject disciplines and participate in discussions related to curricular learning in all areas
- Read both informational and fictional texts in a variety of genres and modes of discourse
- Read technical texts related to various subject areas

b. Discussing books

- Discuss messages and themes from books in all subject areas.
- Respond to a variety of texts in multiple modes of discourse.
- Relate messages and themes from one subject area to messages and themes in another area.
- Evaluate the merit of texts in every subject discipline.
- Examine author's purpose in writing.
- Recognize the features of disciplinary texts.

c. Building vocabulary knowledge
- Demonstrate an understanding of contextual vocabulary in various subjects.
- Use content vocabulary in writing and speaking.
- Explore understanding of new words found in subject area texts.

d. Establishing context
- Explore life experiences related to subject area content.
- Discuss in both writing and speaking how certain words are subject area related.
- Determine strategies for finding content and contextual meaning for unknown words.

Rubric for Sailing With the Wind

	Beginning	Accomplished	Exemplary	Self-Evaluation	Teacher Evaluation
Function	Sailboat does not move a distance in the direction predicted	Sailboat moves a distance in direction predicted, but motion is not constant	Sailboat moves in direction predicted and motion is constant		
Plan and Technical Drawing	Plan shows incorrect measurements, is not to scale, or is drawn or labeled inaccurately	Plan provides clear measurements and labeling for most components	Plan is neat with clear measurements; labeling and scale are correct for all components		
Construction	Construction appears careless or haphazard. Many details need refinement for an efficient or attractive sail.	Fairly careful construction and accurately followed plans, but 2-3 details need refinement for an attractive and efficient sail.	Great care taken in construction; the sail is neat, attractive, and follows plans accurately.		
Personal Responsibility	• Tardy or significant time wasted • Careless with equipment or	• Some contribution to group understanding • Mostly	• Contributes to group understanding though questions or		

	does not handle equipment at all • Does not follow safety procedures • Cleans up insufficiently • Unprepared for lab	receptive to ideas and opinions of others • Creates some distractions	explanations • Makes sure everyone in group understands • Receptive to ideas and opinions of others • Makes effort to reduce group distractions		
Group Dynamics and Interactions	• Does not contribute to group • Minimal or negative interactions • Creates or encourages unrelated activities or discussions	• Some contribution to group understanding • Mostly receptive to ideas and opinions of others • Creates some distractions	• Contributes to group understanding through questions or explanations • Makes sure everyone in group understands • Receptive to ideas and opinions of others • Makes effort to reduce group distractions		

Student Commentary:

Teacher Commentary:

Teacher notes:

Suggested materials per lab group: low-friction toy car, 20-30 cm in length, lightweight, sturdy cardboard or plastic for a sail (mat board or foam board may be used), duct or masking tape, protractor, ¼ or similar dowel rods for mast and boom. Alternately, you may allow students to use their imaginations for materials to use for the sail. To compare sails, students should use the same low-friction toy car which you provide. You should also provide fans and cones for a land-yacht course.

Math integration: Students can make a graph of velocity (on the vertical axis) vs. wind angle (on the horizontal axis) for each sail position. They should try to determine the function (equation) that describes each curve.

Advanced students: See http://www.pbs.org/safarchive/4_class/45_pguides/pguide_405/4545_ss.html for a project that involves design of a land yacht that can be steered directly or by radio control to run a course that you design.