Wind Energy

Introduction

Demand for alternative energy sources has led to a dramatic increase in the use of wind energy over the past decade. The design, construction, and use of wind turbines involve a wide range of career fields including mechanical, electrical, structural, civil, and computer engineering, computer programming, manufacturing, utility grid management, meteorology, environmental impact studies, and transportation logistics. How do windmills and wind turbines work?

Opportunities for Inquiry and Engineering Design

Constructing a windmill ties together principles and concepts from forces and motion, energy, work, and power. Students engage in essential science and engineering practices as they develop and use a model windmill to carry out investigations.

- Take away the step-by-step procedure! Give students the materials and challenge them to create a hand-held windmill that will lift a 3- to 4-gram hex nut with the fan provided. Guide students to design the windmill through a series of leading questions. Given the purpose of the windmill, will they need a rotor (blades and hub) that provides less torque and more speed or more torque with less speed? How will they design the shaft so it turns freely? What are ways to reduce friction of the rotor?
- Introduce the lab by demonstrating the three-blade pinwheel constructed according to the directions. As students observe the windmill lifting the hex nut, ask them what variables will influence the experimental data. Choose the independent and dependent variables for the experiment and describe the variables that should be kept constant during the experiment. Students may then develop a written procedure, construct a windmill, and test the chosen variable.
- Discuss how wind turbines are used to generate electricity. Ask students to draw a diagram to show how they would modify their windmills to produce electricity to light a bulb.
- Demonstrate how electrical energy can be transferred to mechanical energy by attaching a pinwheel to the shaft of a small DC motor (Flinn Catalog No. AP6041). Attach the leads of the motor to a 1.5-V battery to spin the blades. Explain that a generator is like a motor in reverse—mechanical energy spinning the motor shaft can produce electrical energy. Challenge students to design a wind turbine that will fit onto the shaft of a DC motor and transfer mechanical energy to electrical energy. Provide 1.5-V DC motors, wire, and LEDs or multimeters for students to test their designs.

Alignment to the NGSS

Disciplinary Core Ideas: Grades 6–8

Physical Science
- MS-PS2 Motion and Stability: Forces and Interactions
  - PS2.A: Forces and Motion
- MS-PS3 Energy
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer
  - PS3.C: Relationship between Energy and Forces
  - ETS1.A: Defining and Delimiting an Engineering Problem
  - ETS1.B: Developing Possible Solutions

Earth and Space Science
- MS-ESS3 Earth and Human Activity
  - ESS3.A: Natural Resources
  - ESS3.C: Human Impacts on Earth Systems

Disciplinary Core Ideas: Grades 9–12

Physical Science
- HS-PS2 Motion and Stability: Forces and Interactions
  - PS2.A: Forces and Motion
- HS-PS3 Energy

© 2017 Flinn Scientific, Inc. All Rights Reserved.

Publication No. 11228
021617

PS3.A: Definitions of Energy
PS3.B: Conservation of Energy and Energy Transfer
Earth and Space Science
HS- ESS3 Earth and Human Activity
ESS3.A: Natural Resources
ESS3.C: Human Impacts on Earth Systems

Engineering, Technology, and Applications of Science Performance Expectations

Students who demonstrate understanding can:

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Science and Engineering Practices

Asking questions and defining problems

Developing and using models

Planning and carrying out investigations

Analyzing and interpreting data

Using mathematics and computational thinking

Constructing explanations and designing solutions

Engaging in argument from evidence

Obtaining, evaluating, and communicating information

Crosscutting Concepts

Patterns

Cause and Effect

Scale, Proportion, and Quantity

Systems and System Models

Structure and Function

The *Wind Energy Student Laboratory Kit* is available from Flinn Scientific, Inc.

Catalog No.	Description
AP7512	Wind Energy Student Laboratory Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

© 2017 Flinn Scientific, Inc. All Rights Reserved.