Anemometers: Measuring the Wind

Objectives
Students will:

- Learn about anemometers.
- Learn about engineering design.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Suggested Grade Level
3rd – 12th

Subject Areas
Science, Math, Engineering

Timeline
45 minutes

Standards

- 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

21st Century Essential Skills

- Critical thinking/Problem solving
- Creativity/imagination
- Collaboration and Teamwork

- Carrying out investigations
- Obtaining/evaluating/communicating ideas

Background

Weather patterns are a natural phenomenon that have been observed since the beginning of time. Humans try to predict these trends as a means of forecasting the weather. The study of atmospheric chemistry and physics is called meteorology. This branch of science dates back to the 18th century, where the first anemometer was invented by Leonardo da Vinci. An anemometer is a device that is used for measuring wind speed and is one instrument used in a weather station. The term is derived from the Greek word anemos, meaning wind. Leonardo actually designed two different types of instruments for measuring wind speed. Over time significant break throughs in technology allowed weather forecasting to be more accurate.

The use of a Farmer's Almanac also aided in predicting weather cycles. The Farmer's Almanac is an annual North American Periodical that has been in continuous publication since 1818. It is famous for its long-range weather predictions and astronomical data, along with a variety of trivial content.

Vocabulary

Anemometer, meteorology, almanac

Materials

2 straws
1 toothpick
4 Dixie cups (having different colored cups will help students measure the number of revolutions)
Scotch tape
1 tack
Scissors
1 tiny ball of modeling clay (to act as a stopper)

Students work in teams of "engineers" to design and build their own anemometer out of everyday items. Materials listed is enough for one team.

Lesson

1. Begin by asking the students to identify the types of weather phenomenon that we measure. "What do we measure in terms of weather?" "How do we measure these things?" "In what units do we record these measurements?"

2. Explain that for as long as we have been able to, humans have been keeping track of, measuring, and recording weather events/phenomena so that we can have a better understanding of Earth's processes.
3. Explain to the students that a prime example of this is the Farmer's Almanac. Ask students if they know what this is. "Would this be a 'scientific' method of forecasting weather?"
4. Ask students if they can give examples of why it might be important for us to be able to access information like this. Ask, "What's another name for a Weatherman?" "What does Meteorology mean?"
5. Provide personal examples so kids can relate to what it is that you are saying. I like to give examples of how I have used information like this. (Maybe I tell them that if I take my family to a trip somewhere, it would be nice to know what the weather is going to be like when I get there, OR I decide not to go somewhere because I know that the weather will not cooperate).
6. Explain to the students that when we look to learn more about other planets such as Mars, it is very important to be able to accurately characterize the weather events there. Knowing the patterns of wind events in different regions at micro and macro levels is very important for future human exploration.
7. Show students the weather station from the supply room. Show them all of the components of a weather station but focus on the anemometer. Tell the students to pay particular attention to the attributes of the anemometer. Ask them to note the cups (the direction they're facing), the ease of rotation, quantity, etc.
8. Discuss weather conditions on Mars. Tell the students that they will be doing a design challenge whereby they will design and engineer an anemometer. Explain to the students that currently we are sending robots to Mars, (we have been for quite some time now) and it is important to put instruments, such as anemometers, on these rovers and landers so that we can gain access to recording weather phenomena.
9. Assign student mission: they will be designing the next anemometer to be put aboard the next rover on Mars. Students must devise a way to calculate wind speed. They need to work in a team of three or four to build an anemometer using the supplies provided. Allow time for teams to collaborate, build and test (20 minutes). The top portion must be able freely move without resistance to spin or turn quickly. It is essential to use a straw or pointed object on the top piece so it will pivot or spin.
10. Have a fan (our trusty dusty million-dollar wind tunnel) ready and place somewhere for the students to test their anemometers. If they need to go back to the drawing board for design changes, then have them do so.
11. Record wind speed trials. Students will likely measure the number of revolutions of their anemometer, so you may need to suggest that one of the cups or wind catchers is a different color than the others for easier counting of revolutions.

12. Discuss which attributes of an anemometer were successful and which were not when everyone has completed the lesson. What could be done to improve test results and data collection?
13. Check for understanding and allow them to take anemometers home.

Extensions

1. Challenge students to create a new design to measure weather.
2. Explore the design of a four-cup anemometer versus a three-cup. What are the similarities? Differences? Does cup size effect results?