**Wind Energy Activity**

## Introduction

**Purpose** To investigate wind energy in relation to alternative energy resources.

**Discussion**

Wind is a (renewable / non-renewable) resource, which is simply air in motion. It is created by uneven heating of land and water or by pressure differences in the atmosphere. Today’s wind machines (also called wind turbines) use blades to collect the wind’s kinetic (moving) energy. The blades turn and are connected to a drive shaft that turns an electric generator to produce electricity.

**Hypothesis**

?

## Materials

 3 speed Electric fan protractors with hole “anemometer”

 Metric rulers with holes masking tape paper strips (1” wide)

 Finishing nails data sheets scissors

**INDOOR Procedures**

A. Building the home-made anemometer (*wind speed indicator*)

1. You will build a home-made wind speed indicator: obtain a protractor and a metric ruler.
2. Place the metric ruler on the desk, flat side up.
3. Align the protractor so that the straight edge of the protractor overlaps the metric ruler and is flush with the edge of the metric ruler (*see diagram below*). Be sure that the protractor is right side up so you can read the protractor numbers.



1. Adjust the protractor on the metric ruler until the protractor is exactly halfway on the metric ruler. To do this, the “90°” line (*also 2 ½ inches on the base of the protractor*) lines up to bisect the hole that is halfway on the metric ruler.
2. Obtain three small pieces of masking tape and tape the protractor to the metric ruler: one piece of tape at each end and one piece of tape directly over the hole at the center of the protractor and metric ruler
3. Obtain one last piece of masking tape and cover the hole at the center of the metric ruler, but on the opposite side of the protractor as before.
4. Obtain a finish nail and carefully poke it through the masking tape at the center hole of the metric ruler and protractor. It does not matter which side you poke the nail through.
5. Lastly, obtain a 1-inch-wide, 4-inch-long strip of paper. Hold the home-made wind speed indicator so that the protractor is hanging **down**. Fold the top ¼” of the paper over so that the paper will hang on the nail. Carefully attach the strip of paper to the finish nail with a small piece of masking tape on the side of the protractor showing the numbers. The paper should be able to blow freely back and forth from the nail pivot**. Do NOT put the sticky side of the tape against the nail**. You need the paper to move freely.
6. Wind Speed Tests (*calibrating the anemometer*)
7. Calibrate the wind speed indicators (anemometers) using a 3-speed fan.
8. Stand at least 5 feet from the fan and no more than 15 feet away from the fan.
9. The protractor should be perpendicular (*at a right angle*) to the fan itself.
10. Fill in the first row of the “**Fan/Wind Speed**” chart on Data Sheet as follows.
11. The piece of paper should hang straight down from the protractor when the fan is off.
12. The protractor’s reading should be “90°”
13. The first row will read, “Fan Speed” 🡪 off; “protractor reading” 🡪 90°; “wind speed” 🡪 0 mph (*miles per hour*)
14. Turn the fan to “low” speed and measure their anemometers.
15. The protractor’s reading should be **GREATER THAN** “90°”. Turn the protractor around if your reading is less than 90°. Take an average protractor reading.
16. The second row will read, “Fan Speed” 🡪 low; “protractor reading” 🡪 ??°; “wind speed” 🡪 5 mph (*miles per hour*)
17. Turn the fan to “medium” speed and allow students to measure their anemometers.
* The third row of the Fan/Wind speed chart will read, “Fan Speed” 🡪 medium; “protractor reading” 🡪 ??°; “wind speed” 🡪 10 mph (*miles per hour*)
1. Turn the fan to “medium” speed and allow students to measure their anemometers.
2. The fourth row of the Fan/Wind speed chart will read, “Fan Speed” 🡪 low; “protractor reading” 🡪 ??°; “wind speed” 🡪 20 mph (*miles per hour*). Plot the points from the “Fan / Wind Speed” chart by using an “X” for each point: The graph is titled: “Wind Speed versus Protractor Reading.”
3. You will then draw one STRAIGHT line using the metric ruler that best represents the points on the graph.
4. Predict the wind speed based on various protractor readings. We will now go outdoors and take actual protractor readings of wind in various locations and elevations.

**Wind Energy Activity Outdoors**

## Materials

* Use the home-made anemometer (*wind energy indicator*)
* Field Compass
* Timer
1. Wind Stations
* You will measure the wind “speed” at five stations that represent different locations and elevations to compare wind speeds:

 Station 1 Middle of a football field

 Station 2 Backside of the bleachers in the stadium

 Station 3 Middle of a school parking lot about 20 feet from the building

 Station 4 Bottom platform level of the bleachers in the stadium

 Station 5 Top of the bleachers in the stadium

5

4

3

Middle of a School Parking Lot

2

Stadium Bleachers

1

Football field

1. Outdoor Wind Speeds
* Note the starting time for wind speed and direction determination.
1. Adjust the homemade anemometer in order to get the maximum wind speed and take a protractor reading (be sure the angle is greater than 90).
2. While watching the homemade anemometer for wind speed, also determine the wind direction using a field compass.

E. Reading A Field Compass (*see picture below for details*)

To determine the compass bearing,

1. Hold the field compass in the palm of your hand at about waist level. Orient the compass so that the “**direction of Travel**” arrow is parallel to your fingers.
2. Rotate the entire compass by turning your body so that the“**direction of Travel**” arrow points in the SAME direction that the wind is blowing.
3. You may need to toss a piece of grass in the air to get the direction.
4. Once you point the “direction of travel” arrow in the direction of the wind, DO NOT move the field compass base. In other words, the direction of travel arrow should not move.
5. Turn ONLY the rotating circle of the compass until the red arrows are aligned (*in the picture below turn the compass counterclockwise*).
6. Then, read the bearing shown on the compass where the “direction of travel” arrow is.



Align the two arrows inside the circular part of the field compass. Normally, these arrows are the color red.

Compass bearing in degrees

Direction of travel arrow

1. Reading the Compass Bearing in degrees
2. Cardinal Directions (N, S, E, W)



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Direction | North | East | South | West |
| Degrees | 0 | 90 | 180 | 270 |

1. Inter-Cardinal Directions (NE, NW, SE, SW)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Direction | NE | SE | SW | NW |
| Degrees | 45 | 135 | 225 | 315 |

Name \_\_\_\_\_ Wind Energy DATA SHEET

Date \_\_\_\_\_ INDOOR Wind Speed Calibration

**CHART: Fan / Wind Speed**

|  |  |  |
| --- | --- | --- |
| **Fan Speed** | **Protractor Reading** | **Wind Speed** |
| Off |  |  |
| Low |  |  |
| Medium |  |  |
| High |  |  |

**GRAPH: “Wind Speed versus Protractor Reading”**

5

10

15

20

25

30

35

0

Wind Speed: Anemometer Reading

Miles per Hour

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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90

180

170

160

150

140

130

120

110

100

Protractor Reading

**QUESTIONS**:

1. According to the graph, as wind speed doubles, what happens to the protractor reading?

2. List some factors that might affect wind speed.

**OUTDOOR Wind Speed DATA SHEET**

QUESTION 1: Predict which station will yield the greatest wind speed and explain why.

QUESTION 2: What is the average compass bearing in degrees of the wind outside the school in the parking lot? \_\_\_\_

To determine the compass bearing, (1) rotate the compass so that the“**direction of travel**” arrow points in the SAME direction that the wind is blowing. You may need to toss a piece of grass in the air to get the direction. (2) turn the rotating circle of the compass until the red arrows are aligned (*in the picture below turn the compass counterclockwise*). Then, read the bearing shown on the compass where the “direction of travel” arrow is.



Align the two arrows inside the circular compass

Compass bearing

Direction of travel arrow

QUESTION 3: What general direction is the bearing of the wind in Question 2? \_\_\_

 *Use cardinal (N, S, E, W) and inter-cardinal points of direction (NE, NW, SW, SE)*

QUESTION 4: Write down the MAXIMUM possible wind speed that the homemade anemometer shows (protractor reading): \_\_\_\_

* *Perform three trials over a period of FIVE minutes at each station. Fill in the chart below for each station*.

**Station 1**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trial #** | **Protractor Reading (greater than 90**°) | **Compass Bearing in degrees** | **General Direction****(N, S, E, W, NE, NW, etc.)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |

QUESTION 5: Did the wind speed change significantly over the three trials as evidenced by the protractor readings?

**Station 2**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trial #** | **Protractor Reading (greater than 90**°) | **Compass Bearing in degrees** | **General Direction****(N, S, E, W, NE, NW, etc.)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |

**Station 3**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trial #** | **Protractor Reading (greater than 90**°) | **Compass Bearing in degrees** | **General Direction****(N, S, E, W, NE, NW, etc.)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |

**Station 4**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trial #** | **Protractor Reading (greater than 90**°) | **Compass Bearing in degrees** | **General Direction****(N, S, E, W, NE, NW, etc.)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |

**Station 5**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trial #** | **Protractor Reading (greater than 90**°) | **Compass Bearing in degrees** | **General Direction****(N, S, E, W, NE, NW, etc.)** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |

QUESTION 6: Which station showed the greatest wind speed?

OUTDOOR Wind Speed Activity Date \_\_\_\_ DATA SHEET

**CLASS CHART** of Outdoor Wind Speed – Fill in information from all the other stations

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Station | Trial | Protractor Reading  | Compass Bearing in degrees  | Wind Direction | AVERAGEReading |
| 1 | 1 |  |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 2 | 1 |  |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 3 | 1 |  |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 | 1 |  |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 5 | 1 |  |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

**GRAPH: “Wind Speed and Elevation”**

1

5

4

3

2

Station #

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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| 0 | 90 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

180

170

160

150

140

130

120

110

100

AVERAGE Protractor Reading

Wind Speed based on page 5 graph