

Blade Variable: Pitch

Do you know that the air you breathe is actually made up of atoms? When you are running down the street or moving fast on a bike, have you felt wind blowing on your face? What you are feeling is the force of many atoms against your skin.

When wind turbine blades move through the air, they also push against the atoms that make up air. The atoms push back, creating a force that resists or opposes the motion of the turbine blades. The resistance experienced by blades moving through air is called *drag*.

Blade design engineers try to reduce the amount of drag experienced by blades while maximizing the power output of the turbine. One of the ways they do this is by changing the pitch or angle of a blade. In this experiment, you will explore the relationship between blade pitch and wind turbine output.

OBJECTIVES

- Measure the energy generated by a wind turbine using a Vernier Energy Counter.
- Investigate how blade pitch affects energy generation.
- Determine optimal blade pitch for maximum energy generation.

MATERIALS

Vernier Energy Counter
assembled wind turbine setup and fan
Wind Turbine Hub
Blade Pitch Protractor
3 blades
safety goggles

PROCEDURE

? Answer the Pre-Lab Questions.

1. Insert three blades, spaced evenly apart, into the Wind Turbine Hub.
2. Using the Blade Pitch Protractor, adjust the blades so they are set to a pitch of -60° . Tighten the knob of the Wind Turbine Hub so the blades do not move.
3. Attach the hub to the wind turbine setup by firmly pressing the hub onto the drivetrain. Give the blade set a gentle spin to make sure it rotates freely without hitting anything.

Experiment 5

4. If necessary, set up the sensor.
 - a. Connect the red wire from the turbine to the red alligator clip wire.
 - b. Connect the black wire from the turbine to the black alligator clip wire.
 - c. Turn on the Vernier Energy Counter by pressing the Start/Reset button one time.
5. Check the equipment.
 - Position the fan so the center of the fan is in line with the center of the hub of the turbine. The fan should be about 15 cm from the turbine.
 - Make sure that when the fan and the turbine are moving, nothing will be in the way.
6. Put on safety goggles. Turn on the fan to the highest speed setting. **Caution:** Do not stand in the plane of rotation of the wind turbine rotor.
7. Wait 30 seconds or until the Live View number on the Vernier Energy Counter stops increasing.
8. Press the Start/Reset button to start data collection. Data will be collected for 30 seconds.
9. When data collection is complete, turn off the fan and remove the hub from wind turbine setup.
10. Record the total energy generated in the data table.
11. Collect data for four other pitches:
 - a. Plan as a group and decide which four pitches to test.
 - b. Record the pitches in the data table.
 - c. Repeat Steps 2–10 to determine and record the energy generated by the wind turbine for the other pitches.

Name _____

Data Sheet for Experiment **5**

Date _____

Blade Variable: Pitch**PRE-LAB QUESTIONS**

1. What variable will you change in this experiment?
2. List at least three variables that you will keep the same during the experiment.

DATA

Blade pitch (°)	Trial	Energy generated (J)	Average energy generated (J)
-60	1		
	2		
	3		
	1		
	2		
	3		
	1		
	2		
	3		
	1		
	2		
	3		
	1		
	2		
	3		

DATA ANALYSIS

1. Calculate the average energy generated for each blade pitch and record the values in the data table.
2. Use the data in the data table to create a graph of average energy vs. pitch.
3. Which pitch generated the most energy?
4. Why do you think this pitch generated the most energy?
5. Which pitch generated the least energy?
6. Why do you think this pitch generated the least energy?
7. In your own words, explain what drag means.
8. Describe the relationship between blade pitch and energy generation.