Mini Wind Turbine Lab Activity

Name: _____ Set: _____ Date: _____

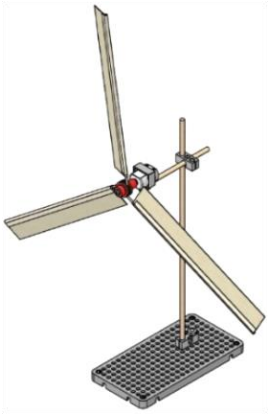
Perfect for Grades: 5+
Difficulty: Intermediate

Download Documents at **teachergeek.com**

The Lab

This lab can begin after you build the example mini wind turbine. During this lab, you will research rotor configurations and the effect they have on turbine voltage output. At the end of the lab you will devise and run your own experiment.

For use with TeacherGeek Mini Wind Turbine Activity: 1823-12 (single) or 1823-13 (10 pack)



TeacherGeek Components

1. You'll need the Mini Wind Turbine you built from the TeacherGeek Build Guide. https://teachergeek.com/blogs/projects/mini-wind-turbine
2. Seven **Skewer** Sticks

TeacherGeek Tools You'll Need

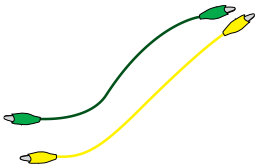
Easy to Share in Groups

Multi-Cutter

Screwdriver

Pliers

Digital Multimeter



Alligator Clip Leads

*Tools available at **teachergeek.com***

Materials You Supply

Tape

Recycling Materials
(for blades)

Fan
(for testing)

Safety Goggles

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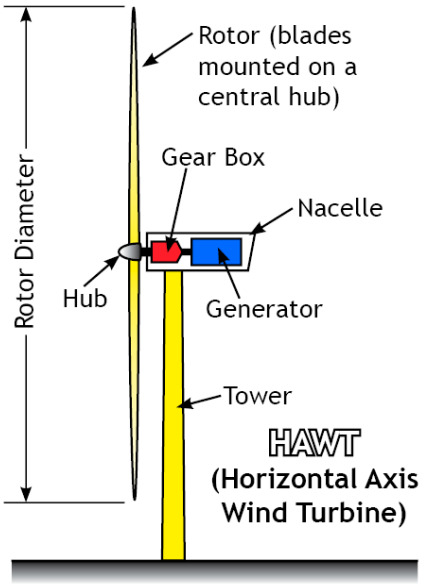
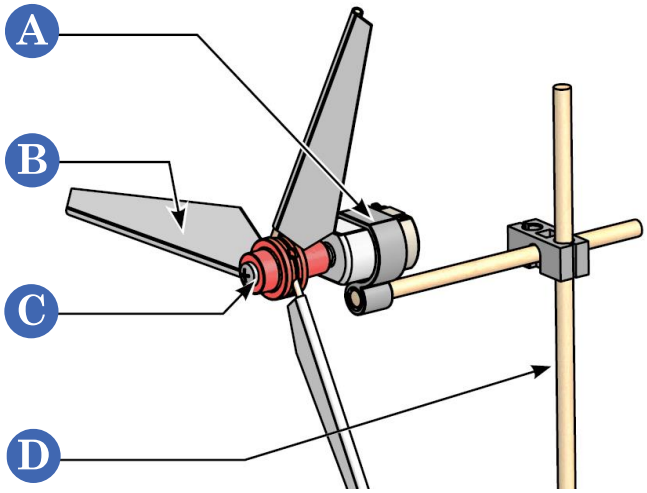




1. Write the names of the components diagramed above:

A _____

B _____

C _____

D _____

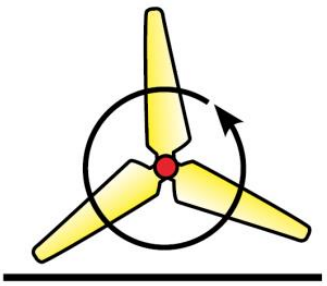
2. Which of the following components is your turbine missing?
(hub, tower, gear box, rotor, generator)

_____

Mini Wind Turbine Lab Activity

What is RPM?

RPM = Revolutions per Minute
*(the **number** of times something **rotates in a minute**)*

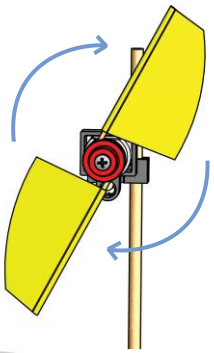


Minute

Cars have RPM guages. →

3. How many times can you spin your tubine rotor around in 30 seconds?

Revolutions in 30 seconds: _____ RPM: _____



4. If your turbine blades rotate 400 times in two minutes, what is the RPM of the blades?

_____

5. What is the RPM of the second's hand on a clock?

_____

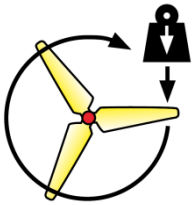
6. A fast mini turbine can spin at over 3500 RPM. How many times faster is that than the RPM at which you spun your turbine by hand? Show your work.

Hint: $\frac{\text{3500 RPM}}{\text{Your RPM}}$ = Your Answer

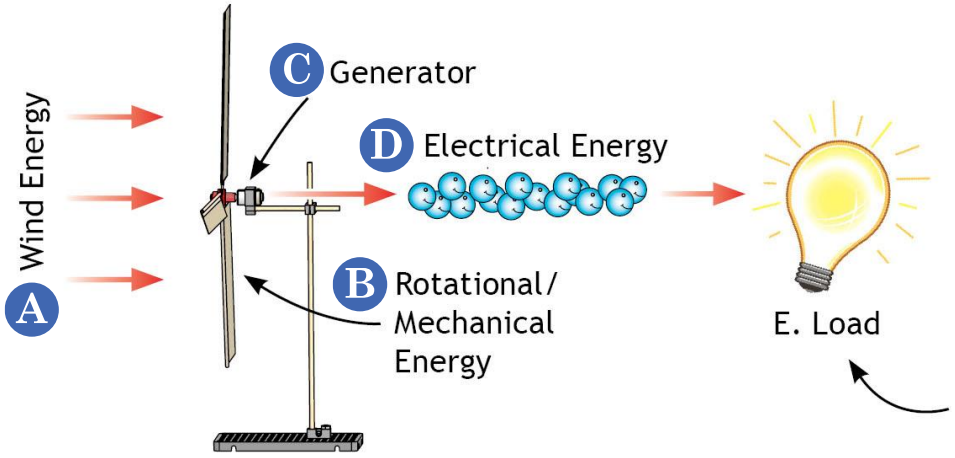
Answer: _____

Torque

***Torque** is a **twisting force**. Some turbines use a gearbox to convert torque to additional RPM. Your mini turbine does not have a gearbox, so additional torque (more torque than it takes to spin the blades) will be lost.*



Energy Conversion



Note: The mini turbine will not produce enough power to light most bulbs. Measure power output with a **multimeter**.

7. Use the following words to properly fill in the blanks.
Use every word: *load* *sun* *rotational* *energy* *electrical* *generator*

The _____ from the wind is converted into

_____ energy which turns the _____

to produce _____ energy. That energy is used to power a

_____. Wind energy is created by uneven heating of the earth's

surface by the _____.

What can your mini turbine power?

Your mini turbine doesn't produce enough electricity to light a bulb or run a motor (there are other TeacherGeek turbines that can).

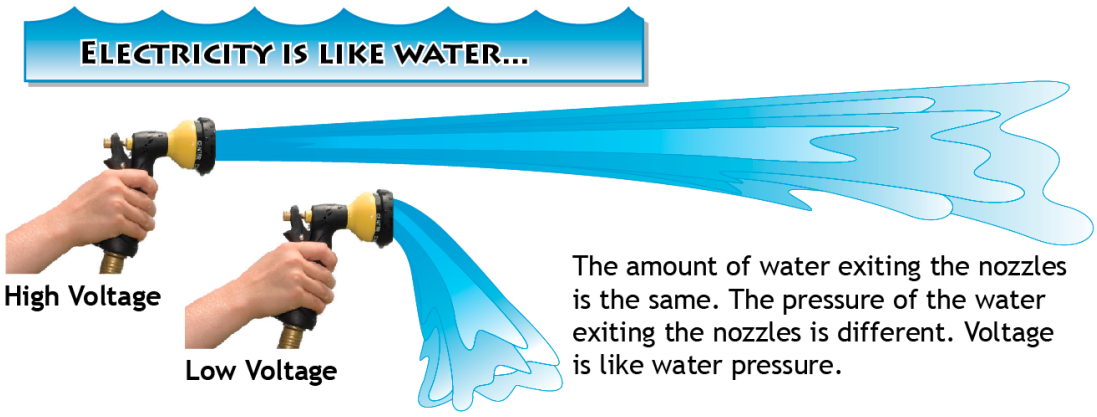
How will you measure the power it produces?

It will produce plenty of power for a standard multi-meter to measure.

Feel the POWER

What is Voltage?

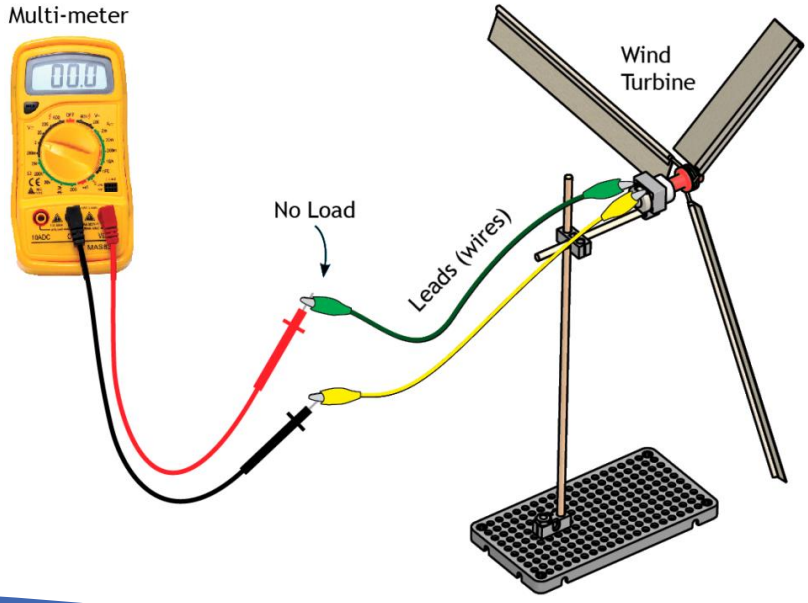
Voltage *is the* ***potential energy*** *that makes the* ***electrical current flow*** *(by pushing the electrons). The unit of voltage is shown as* ***'v'****.*



You will measure the voltage output by your turbine. Find out how below!

Testing Your Turbine (Without a Load)

Set your multi-meter to measure 200-0 m volts. Connect leads from the multi-meter to the terminals on your mini turbine. The multi-meter should display a voltage output when the turbine rotor is turned. Note: Without a load, the readings on your multi-meter many not be stable. See how to test your turbine with a load on the next page.



8. Voltage and RPM: Is there a correlation between RPM and Voltage? Spin your wind turbine with a finger and record your findings:

Voltage at a low RPM (spinning slow): _____

Voltage at a medium RPM: _____

Voltage at a high RPM (spinning fast): _____

9. Describe the correlation between RPM and voltage:

_____

_____

_____

Load

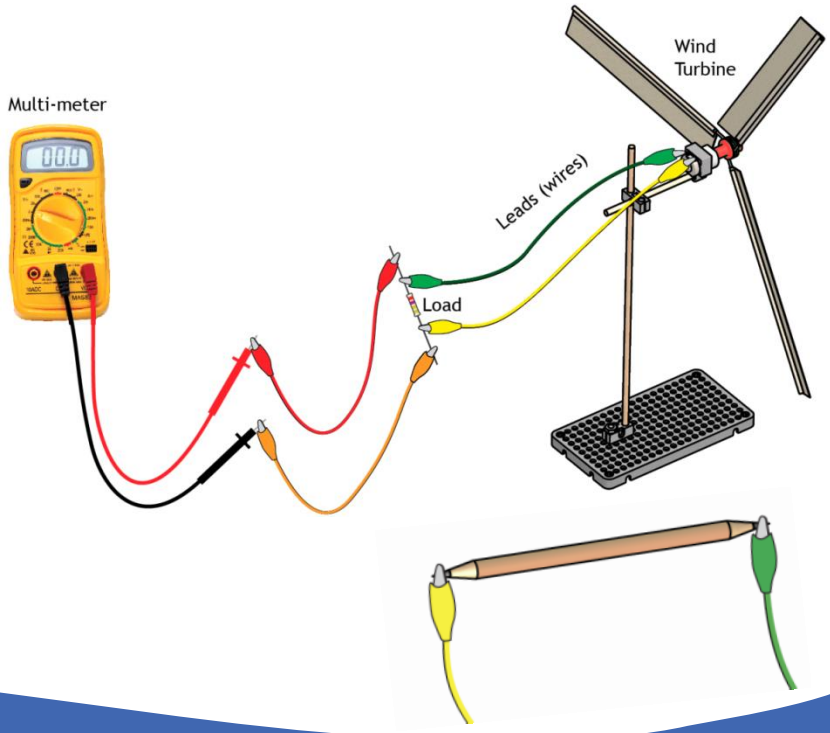
*A **load** is the part of an electrical circuit that "**used the electricity**." The load **converts** the **electrical energy** into another **form** of energy.*

Optional Testing:

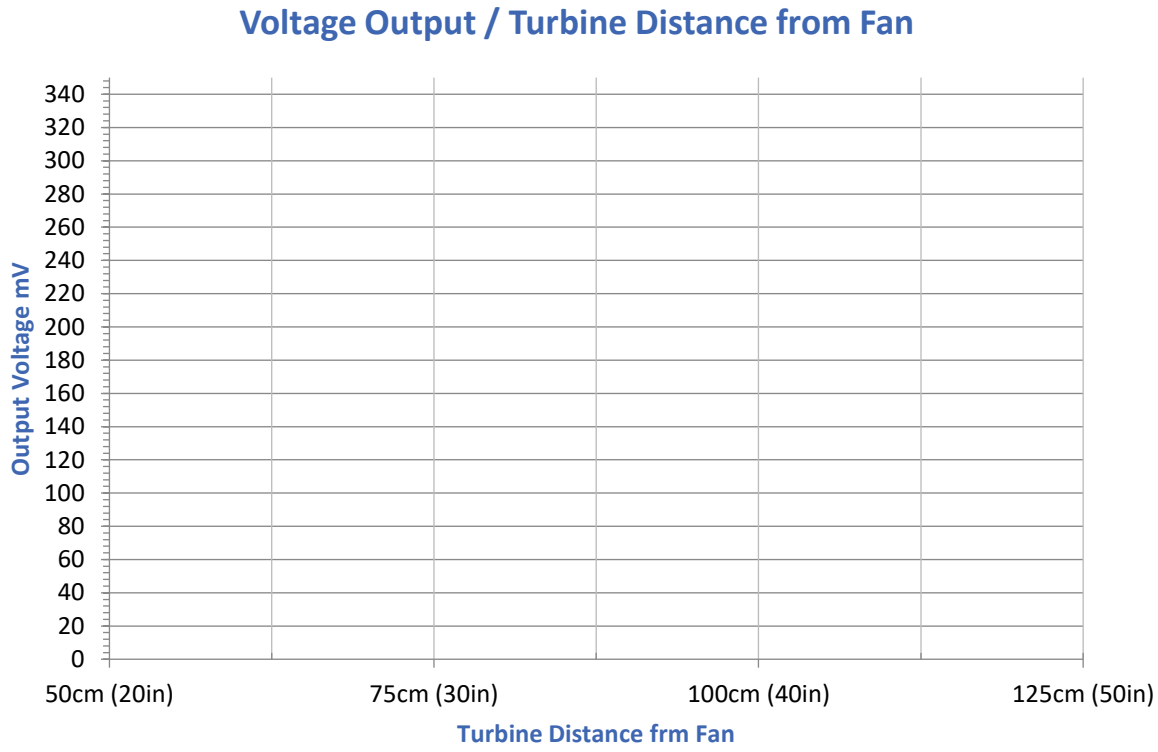
Testing Your Turbine with a Load

The proper way to test your turbine is to measure voltage across a load. Use a load if your meter measurements jump around while you are trying to read them. The load can be a bulb, 2.7ohm resistor (SKU 1823-76), small dc motor, or even a pencil with both ends sharpened.

Note: *the bulb and motor with not light up/run, but they will still use some electrical energy to heat up. The same load should be used throughout the lab.*



10. Measure and graph the peak voltage output of your turbine at the distances from the fan shown below.



11. Draw a line of best fit between your data points on the graph above.

12. Describe the correlation between voltage and turbine distance from the fan:

_____

_____

_____

Interpolate
*to **estimate** values of data **between** two **known values***

13. Using the graph above, interpolate the voltage output for the distances from the fan:

63.5cm (25in): _____ 115cm (45in): _____

Independent Variables

variables *you* ***change*** *in an experiment.*

Dependent Variables

variables *that* ***change as a result*** *of changes made to independent variables.*

14. What was the independent variable for the question 11 experiment?

_____

15. What was the dependent variable for the question 11 experiment?

_____

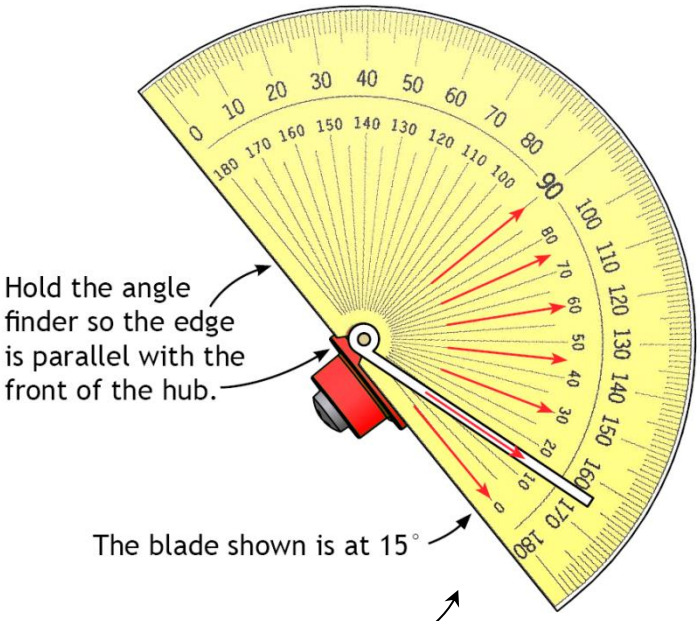
Changing Blade Pitch

The **pitch** (angle) of **blades** can easily be changed by slightly loosening the hub screw so the skewer sticks can rotate, but not fall out. The screw can be retightened after all blades are adjusted to the proper angle.

Measuring Blade Pitch

The TeacherGeek protractor is the best way to easily measure blade angles.

Here's how you use it:
The red arrows show the most common angles used on mini wind turbines (0°, 15°, 30°, 45°, 60°, 75°, 90°).



16. What is the pitch of the blade shown above?

_____

Protractor Download:
http://www.teachergeek.org/protractor.pdf

Hypothesis

*a **prediction** of the **effects** of **changing one variable** or **another**.*

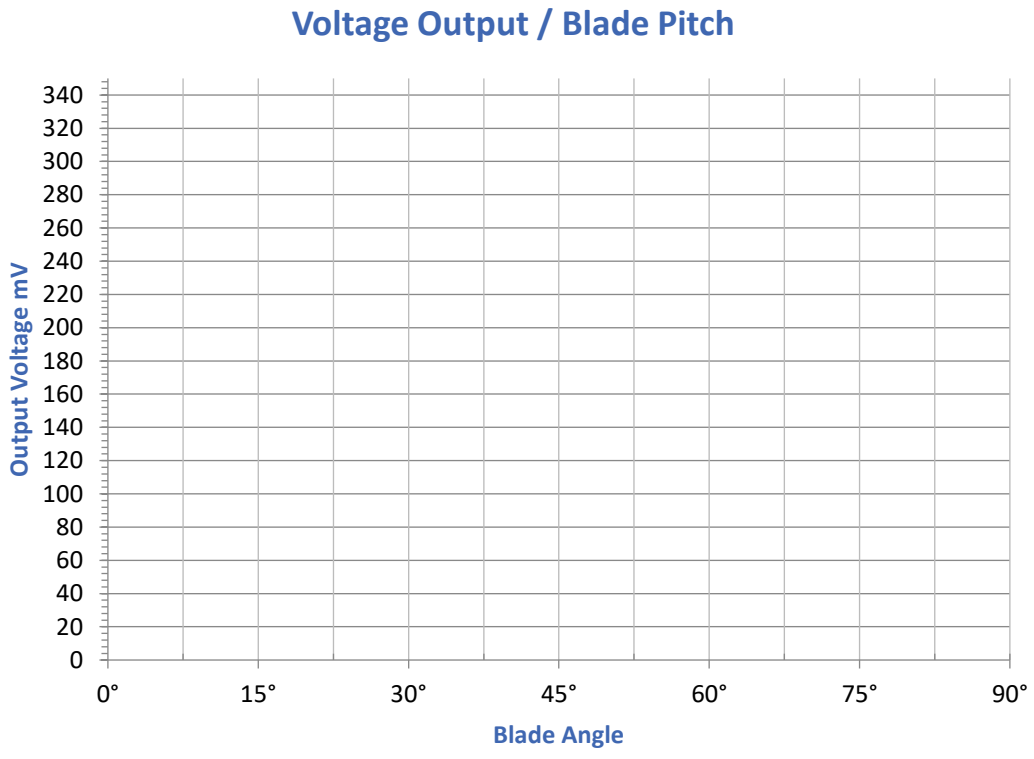
17. Your hypothesis: How do you think changes in blade pitch will affect voltage output?

_____

_____

_____

18. Measure and graph the peak voltage output of your turbine with the blades pitched to 0°, 15°, 30°, 45°, 60°, 75°and 90°. Use a TeacherGeek protractor to measure and set the blade pitch. Your turbine must be 50cm (20in) away from the fan for this experiment.



19. Draw a line of best fit to connect your data points on the graph above.

20. Was your hypothesis correct? _____

Explain what the graph shows.

_____

_____

_____

21. Is the relationship between blade pitch and voltage output linear or nonlinear? You need to figure out what linear and nonlinear mean.

_____

22. Use the Voltage Output /Blade Pitch Graph to calculate the ideal blade angle for the highest voltage output:

Interpolated (theoretical) blade pitch for highest voltage: _____

23. Adjust your turbine blades to the pitch provided for question 22. Test the wind turbine with configuration used for the Voltage Output /Blade Pitch experiment (50mm away from the fan). Show your teacher your turbine during testing. What is the voltage output?

Teacher Signature: _____ Voltage Produced: _____

24. What is the difference between the actual and calculated voltage? _____

25. What could cause the interpolated and actual voltage to be different?

_____

_____

Mini Wind Turbine Lab Activity

Create your own experiment

It is now time for you to create your own experiment and share your findings with the class.

A Your experiment should test a **single variable**, such as:

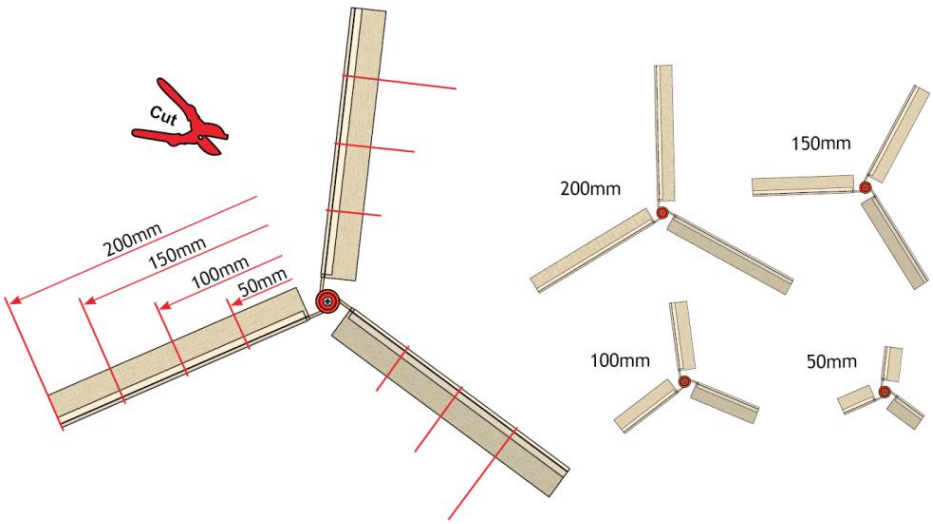
- diameter of blades
- number of blades
- shape of blades
- mass of blades
- effect of load on voltage output

B Your **experiment** should:

- test a hypothesis
- follow the scientific process
- document all steps
- detail findings in a conclusion

C Your **presentation** should:

- last approximately 2 minutes
- be informative and entertaining
- document all aspects of your experiment



Example

Research the effects of blade diameter on voltage output. Create a hypothesis.

Measure voltage output for different blade lengths (rotor diameters) by progressively cutting and testing the blades. Graph and interpret the data.

Write a conclusion. Create a 2 minute presentation documenting your experiment and findings.

Mini Wind Turbine Lab Activity

Experiment & Presentation Evaluation

Experiment – 15pts

Did your **experiment:**

- test a hypothesis
- test a single variable
- follow the scientific process
- document all steps
- detail findings in a conclusion

0 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10 → 11 → 12 → 13 → 14 → 15

Presentation Delivery – 10pts

Did your **presentation**:

- last approximately 2 minutes
- document all aspects of the experiment

0 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10

Bonus – 2pts

Was your presentation incredibly unique, entertaining, informative and memorable?

0 → 1 → 2

Lab Score: _____ /25 Experiment & Presentation Score: _____

(Lab Score + Experiment & Presentation Score) x 2 = Overall Score

Overall Score _____