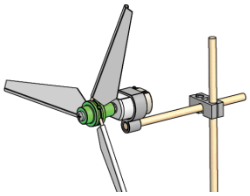


MINI WIND TURBINE LAB

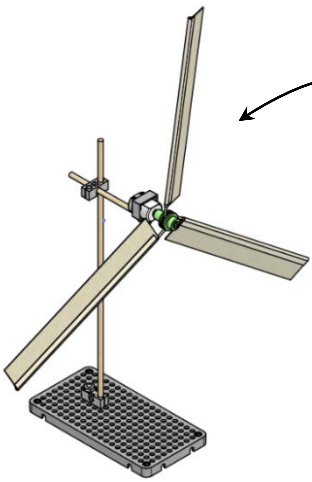
Name: ______________________________________ Set: _________ Date: _________

The Lab:

This lab can begin after you complete the basic mini turbine build. 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 Turbine Kits: 1823-12 or 1823-13

Materials Required - From the Kit:



The turbine from the basic mini turbine build:
http://www.teachergeek.org/mini_turbine_build.

7 Skewer Sticks

Materials Required - Not in the Kit

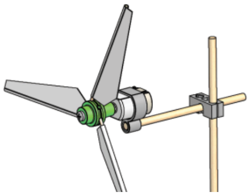
 Tape	 Material for Blades (cardboard, chipboard, posterboard)

A fan is required to power the turbine during testing.

Tools & Supplies Required - Not in the Kit, Available at TeacherGeek.com

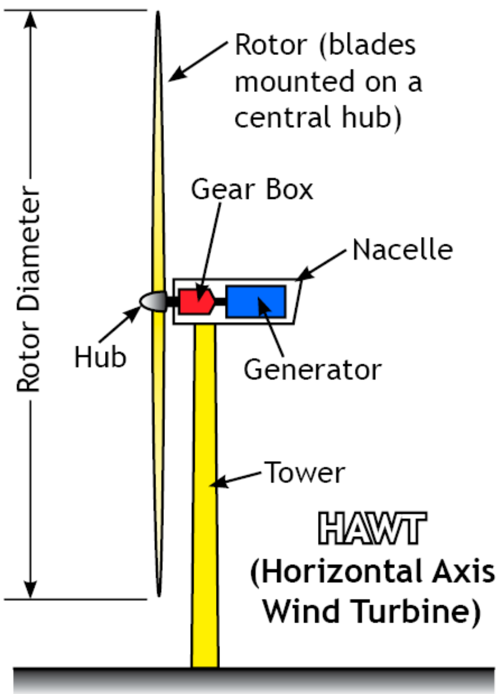
 Cutter	 Screwdriver	 Optional: Pliers	 Multi-Meter & Test Leads

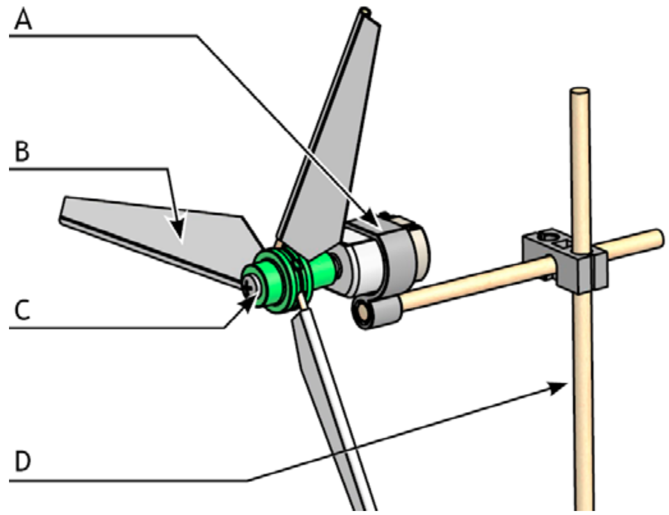
Safety Glasses should be worn when building and testing.



MINI WIND TURBINE LAB

Name: ______________________________ Set: ________ Date: ________





1. Write the names of the components diagramed above:

A. ______________________________

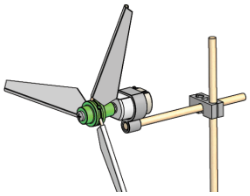
B. ______________________________

C. ______________________________

D. ______________________________

2. Which of the following components is your turbine missing? hub, tower, Gear Box, rotor, generator

____

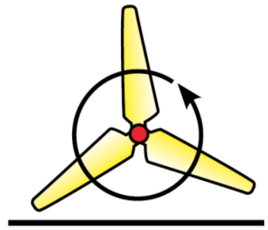


MINI WIND TURBINE LAB

What is RPM?

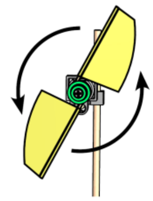
RPM = Revolutions Per Minute

(The number of times something rotates in a 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 seconds hand on a clock?

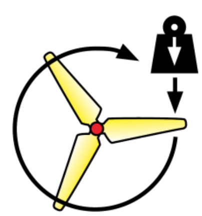
____

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

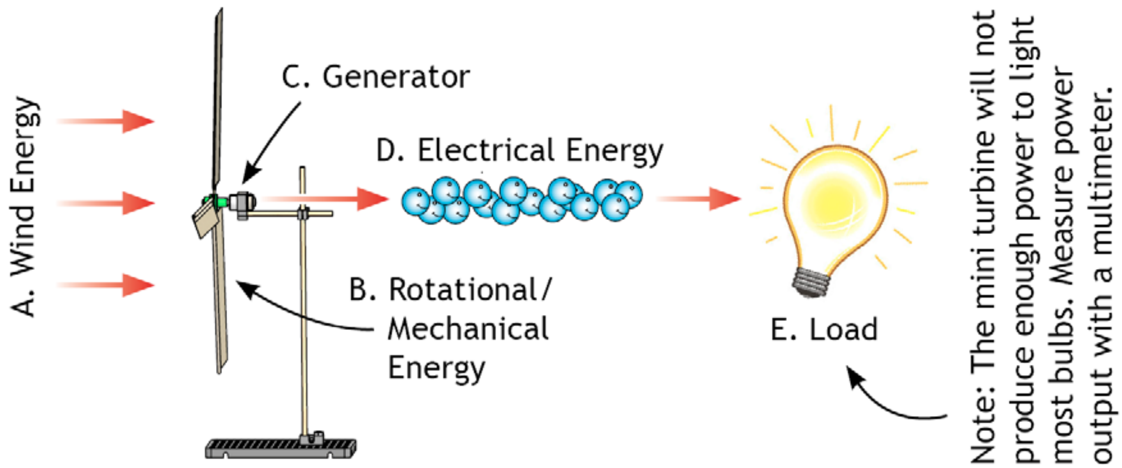
Hint: $\frac{\text{3500 RPM}}{\text{Your RPM}}$ = Your Answer

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



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?

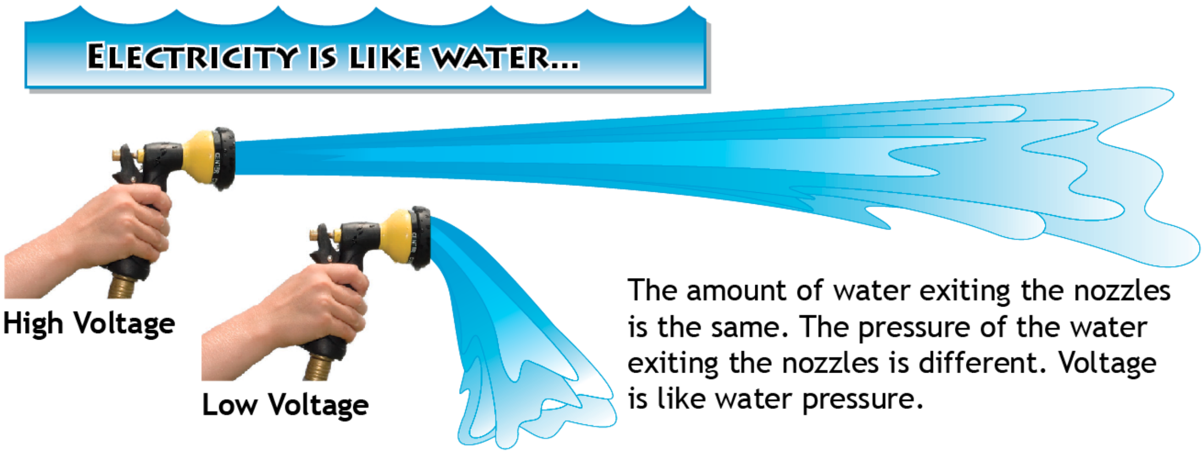
Your mini turbine doesn't produce enough electricity to light a bulb or run a motor (there are other TeacherGeek turbines that can).

How will you measure the power it produces?

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

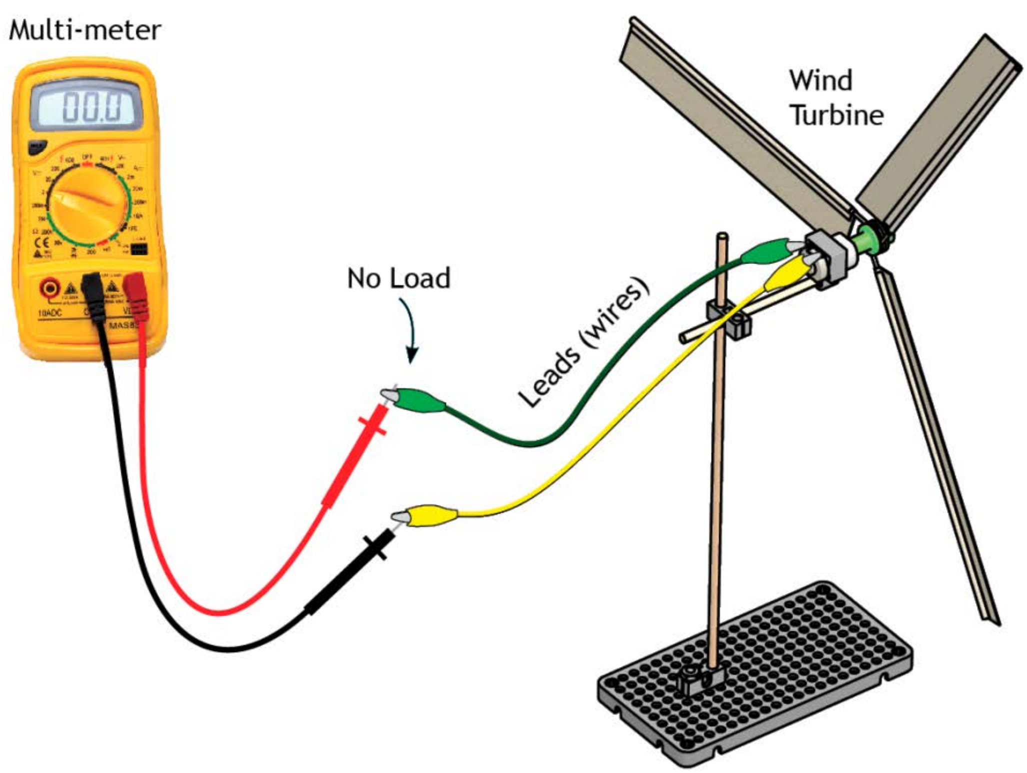
What is Voltage?

You will measure the voltage output by your turbine. **Voltage** is the potential energy that makes the electrical current flow (by pushing and pulling the electrons). The unit of **voltage** is volt shown as 'v'



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:

____

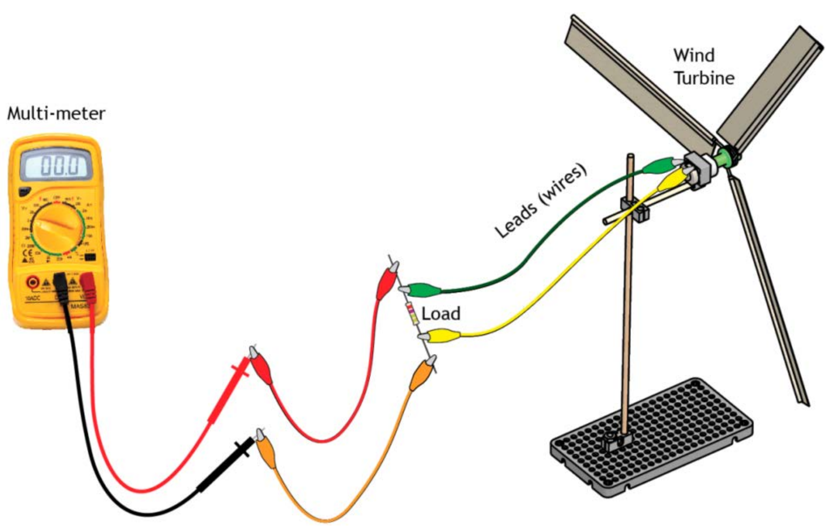
____

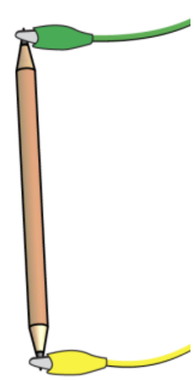
____

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.

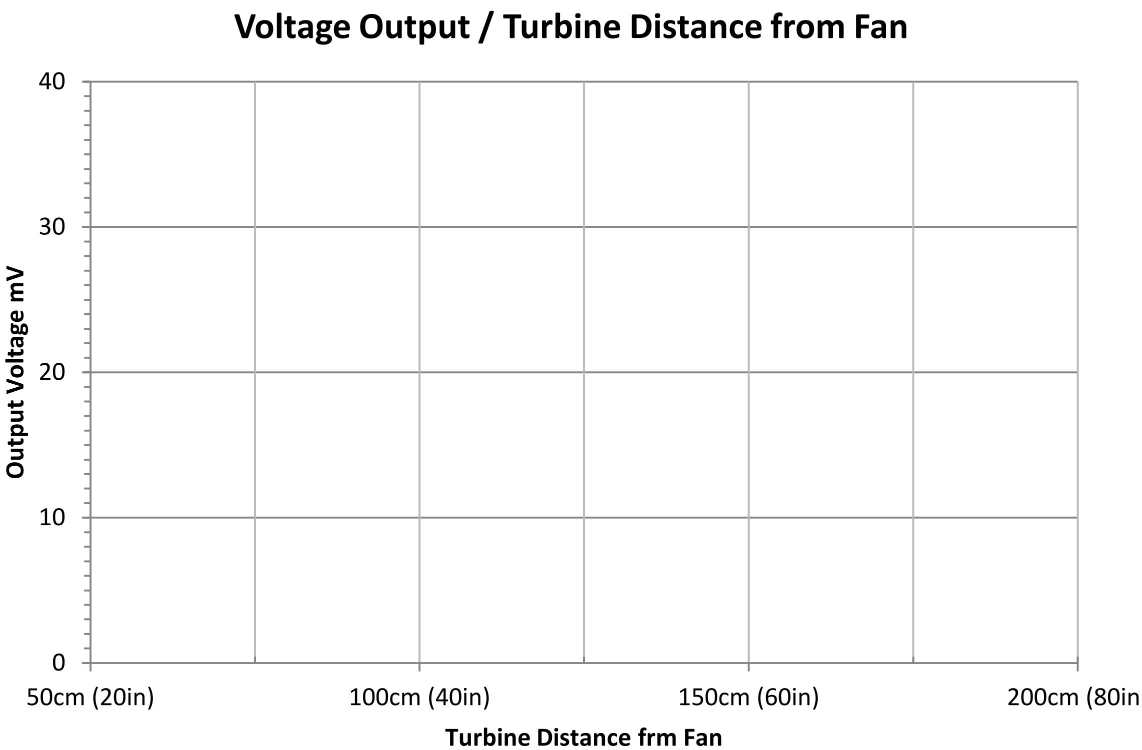
Optional: Testing Your Turbine with a Load:

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, resistor, 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:

____

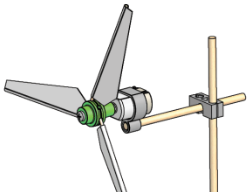
____

____

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:

75cm (30in): ________________ 125cm (50in): ________________



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?

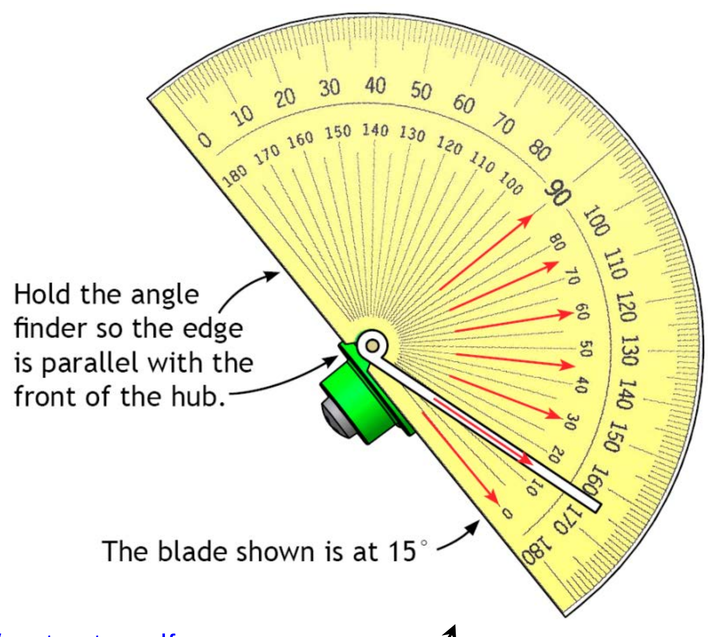
____

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°).



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

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

____

Hypothesis: a prediction of the effects of changing one variable on another.

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

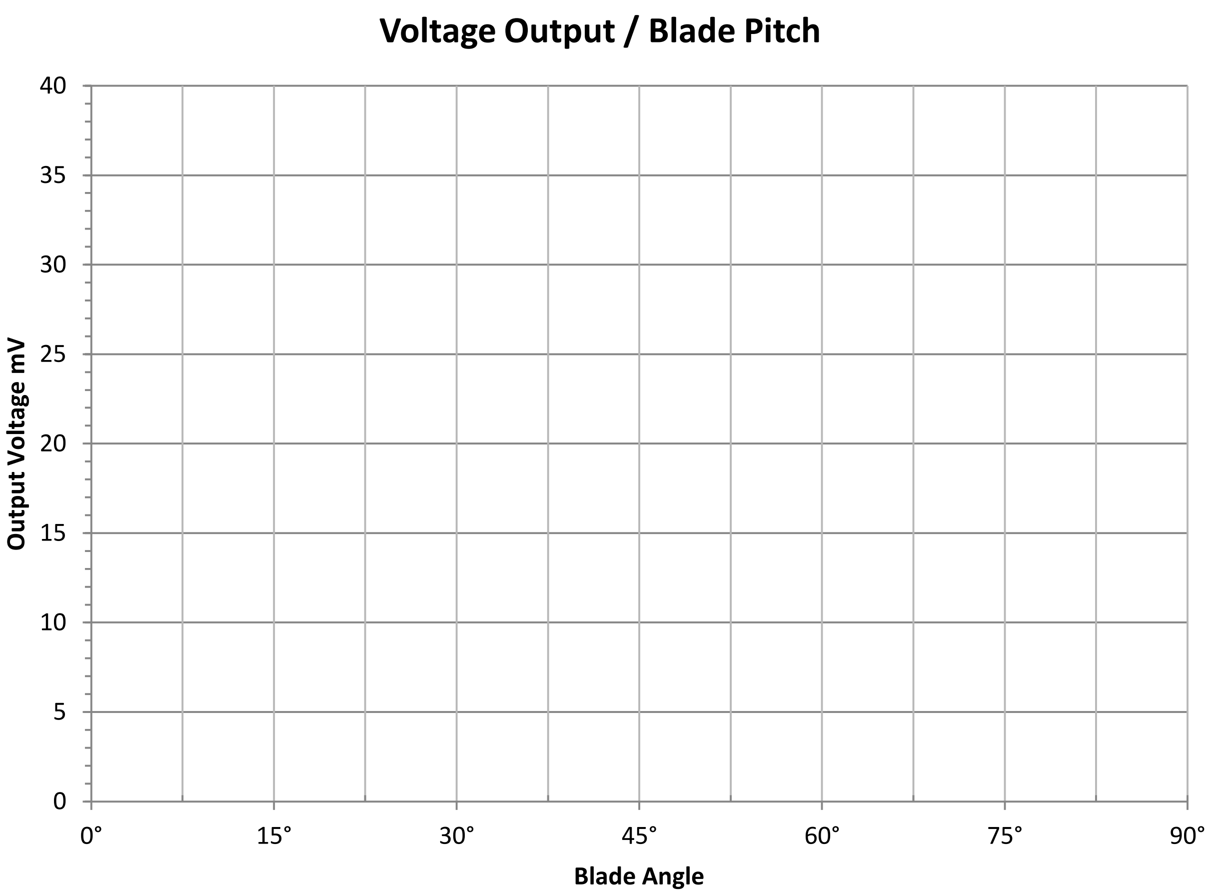
____

____

____

____

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?

Create Your Own Experiment

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

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

Your experiment should:

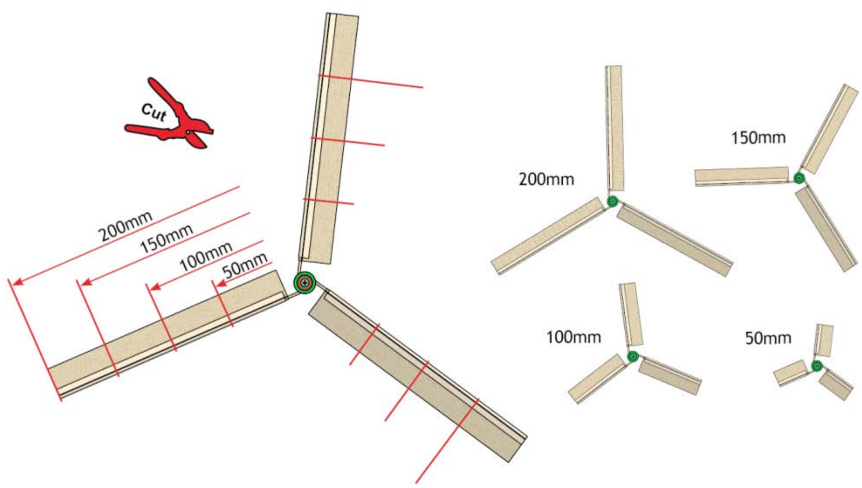
- test a hypothesis
- follow the scientific process
- document all steps
- detail findings in a concussion

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.



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 → 1 → 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 → 1 → 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:

It is time to move on to the mini turbine engineering challenge.