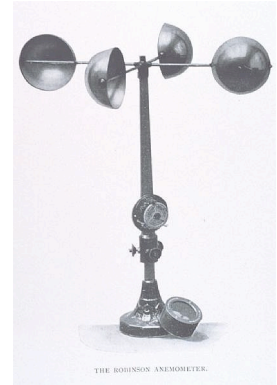


# Building an Easter Egg Anemometer

## What is an Anemometer?

An anemometer is used to measure windspeed, the etymology of the word being Greek from the word *anemos*, meaning wind. There are various ways to measure windspeed, whether it is knots, mph, or km/h, but all of them relate the velocity of flowing air to speed value. Anemometers are priceless in their ability to provide quantitative windspeed data. This data can be collected in simple ways such as counting the number of revolutions of the anemometer vanes over a period of time, or using the principles of electricity and magnetism to turn a turbine and output a voltage. Windmills and anemometers differ very little in principle in that they are trying to “collect” the wind, but anemometers are smaller, lighter, cheaper devices for simply measuring windspeed. The original anemometer design had four cups at 90° angles to one another. After some research, 3-cup anemometers were invented that have cups at 120° to one another.



## Can't I just buy one?

Yes, but they tend to be a little pricey. Average commercial anemometers begin around \$50 and can cost upwards of \$300. A lot of research has gone into making the devices small and portable as well as very, very accurate. Remember, these devices are used to site new windfarms and give meteorological information. In general, however, the device you will build is very similar in operating principle to the commercial units.

**PLUS, this is going to be way more fun.**

## What parts are required?

In this assembly, only a few parts are needed. Both simpler and more intricate devices can be made. For this rudimentary anemometer you will need:

DC fan with wire connections  
1" PVC tubing  
1" PVC coupling  
Electrical tape  
1/4" dowels

Crimping hub (specialized item from  
*KidWind*)  
Plastic Easter egg shells  
Drill with 1/4" twist bit  
Voltage measuring device  
*Vernier with voltage probe*

Other designs could be made and you are welcome to try them out. There are websites that show you how to build anemometers from Styrofoam cups and ping-pong balls and monitor windspeed with sophisticated circuitry. See the list of resources at the end of this lab.

## How do I calibrate the anemometer?

The simplest way to calibrate the anemometer is to count the number of rotations of vanes per minute, or RPM. By knowing the radius of the anemometer arms, the revolutions per minute can be converted into a distance per minute:

Circumference,  $C = 2\pi r$  in units of cm

Linear distance per minute =  $C \times \text{RPM}$  in units of cm/minute

Distance per hour =  $C \times \text{RPM} \times 60$  in units of cm/h

Distance in km/h =  $C \times \text{RPM} \times 60 \times (1/100000 \text{ km/cm})$  in units of km/h

Distance in MPH =  $\text{km/h} \times (1 \text{ mile}/1.6 \text{ km})$

→ Acquiring this data is only feasible, however, if the windspeed is low.

An easier method is to calibrate the anemometer against a known standard windspeed. There are a few ways to do this, but they can be generally categorized into two realms: 1) Using a speedometer of some sort or 2) use a standardized anemometer. For case (1) it is common to use a car or bicycle speedometer to calibrate, but this requires a friend to drive, a long straight road, and no wind. Still, very fun. Method (2) uses a standardized anemometer. As described, they can be expensive, but one meter can be used to calibrate many anemometers. We will be using this method during the Workshop using a Kestrel 1000 anemometer.

## Is this Anemometer as good as commercial ones?

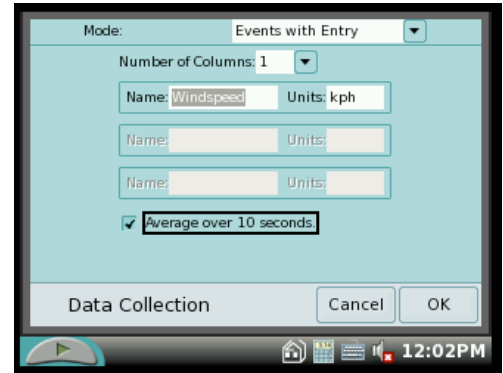
Err...no. If you need a commercial-grade anemometer for accuracy such as siting a new wind turbine, splurge for the expensive stuff. Better yet, splurge for the professionals. The meter you will construct is good for educational uses only.

## Constructing the Anemometer

Begin by obtaining the materials listed above.

1. Connect the PVC coupling to the PVC pipe.
2. Tape around the exterior of motor with electrical tape so it fits snugly inside the PVC coupling. Fish the wire through the coupling and pipe and insert the motor.
3. Attach the crimp-on hub to the DC motor. You now have a center axis for mounting the anemometer cups.
4. Attach as many wooden dowels as you feel necessary for making a good anemometer (3-4).
5. Use the hemispherical half of the plastic Easter egg as your anemometer cup. Push the cups through the dowels. They should fit snugly. The eggs should be facing all in the same direction.
6. Test your anemometer by connecting the wire leads to the voltage probe of the Vernier system. Spin the turbine. What do you observe? If the voltage is negative, simply switch the electrodes.

7. Calibrate your anemometer using the “lab fan” and the Kestrel windmeter. You need to be sure to position the windmeter and your anemometer in the same location and distance from the fan.
8. Setup the Vernier system to collect data with “Events by Entry” and name the cell “windspeed” and set the data to average for 10 seconds. Start each entry by recording the windspeed followed by the voltage data. *You may need to hide the keyboard to see the “Average over 10 seconds” box.*
9. Vary location of the anemometer to change the speed of rotation. Begin to create a voltage vs. windspeed table.
10. Graph the voltage vs. speed data and obtain a calibration curve for the anemometer (this should be a linear fit).
11. Try to use this anemometer to obtain windspeed data outside.
12. Do not disassemble your anemometer, you will use it the next day.



Windspeed (kph)	Voltage (V)

Linear equation for voltage vs. windspeed (in the form  $y = mx + b$ )

What other data might be useful when obtaining windspeed data outside when establishing a location for a wind turbine?

**Other Sites for Constructing an Anemometer (accessed 7/20/2009)**

<http://otherpower.com/anemometer.html>

<http://www.instructables.com/id/Easter-Egg-Anemometer-Wind-Speed-Meter/>

<http://mcs.uwsuper.edu/sb/Electronics/Wind/>

