



ANEMOMETER WITH DATA

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WIND LESSON

| Time Frame: | Standards: |
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| 2-3 hours done in multiple sessions 5 th Grade | <p>5.S.1.2.1 Use observation and data as evidence on which to base scientific explanations and predictions.</p> <p>5.S.1.2.3 Use models to explain or demonstrate a concept.</p> <p>5.S.1.5.1 Explain how the shape or form of an object or system is frequently related to its use or function.</p> <p>5.S.1.6.3 Select and use appropriate tools and techniques to gather and display data.</p> <p>5.S.5.1.1 Identify issues for environmental studies.</p> <p>5.S.5.2.1 Describe how science and technology are part of a student's life.</p> <p>5.S.5.3.1 Identify the difference between renewable and nonrenewable resources.</p> |
| Objectives: | |
| SWBAT to work in groups and develop an anemometer. | |
| Background Information: | |
| <p>A simple anemometer (wind speed meter) is easy to make, but it will generally only tell you the speed of the wind at the time you read it. A bicycle computer can be used to provide more useful information: it is a small electronic device that measures the speed and distance of a bicycle by counting how often a magnet on the spokes passes a sensor attached near the wheel. It also records the maximum speed attained and the average speeds for the recording period. All of this information is provided by an LCD display and the various functions are operated by a couple of buttons on the front of the device. The sensor for the data logger is similar to anemometers on top of weather stations, and is made from a brush type DC motor mounted inside a watertight enclosure, with the familiar cup and arm arrangement attached to the shaft of the motor.</p> | |

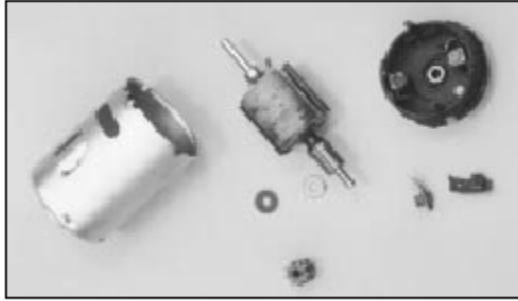
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Materials:

- Programmable bicycle computer (Need the have magnets and sensors)
- Small electric motor. This motor can have metal or plastic gears.
- 1 steel can with lid
- 4 pieces of aluminum flat bar
- 4 plastic spherical cups
- Insulated wire
- Solder and soldering iron
- Angle bracket
- Hub to fit the motor
- Coffee jar lid

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The motor components. Note the armature in the middle of the photo.



Procedure:

What to do – preparing the motor

Start by pulling the back end of the motor and removing the armature (the bit that turns) from the case. This can take a bit of force in some motors, as the magnets inside them are very strong. Remove the magnets from the motor case to allow the armature to rotate easily when everything is reassembled. This is done by removing a spring clip between the two magnets and pressing them out with a screwdriver. Some magnets may be glued in, so a fair bit of persuasion may be required. Wash the case in a detergent solution, using a paint brush to remove any accumulated dirt, rinse it and put it in the sun to dry.

Remove the brushes on the inside of the motor end cap. These are the little carbon blocks that rub on the copper section of the armature, and are usually mounted on bits of springy metal and can just be snapped off. (Some more expensive racing motors have a brush/spring system similar to larger motors, with the brush sliding in a square tube with a spring pressing on the back of it. By removing the springs and cutting the brush leads first, the brushes can just be slid out of their holders.)

Reassemble the motor and place a single drop of light machine oil on the bearing at each end of the motor.

Making the housing

Drill three holes in the bottom of a waterproof can (e.g. a Milo can): one large one in the center and one smaller one on each side of it for the motor mounting screws (most of the motors will have threaded holes in the front end which accept 3mm metric screws). Install the motor in the can. Solder a mounting bracket to the can, then prime and paint the whole assembly to make it weather proof.

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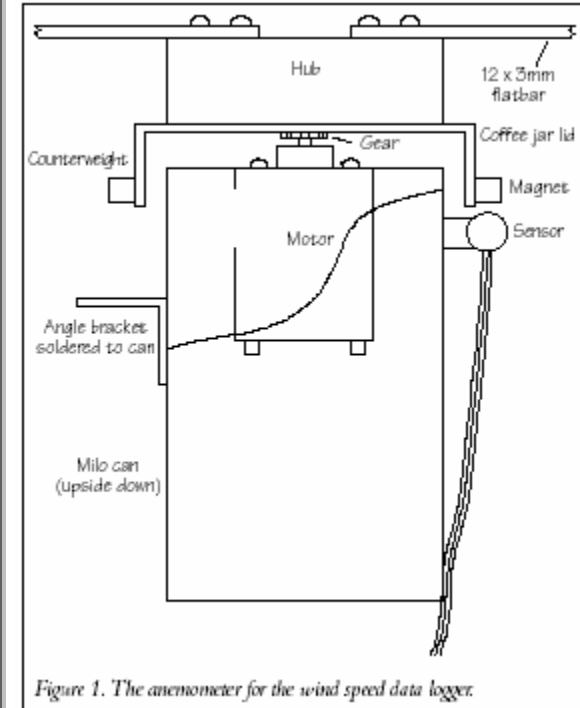


Figure 1. The anemometer for the wind speed data logger.




Figure 2. This is how the rotor arms are twisted along their length.

Make a rotor for the anemometer from a small gear that fits the motor shaft (these are usually available for little cost), glued into a painted wooden hub about 60mm in diameter. (The gear is used as a strong and reliable way of attaching the rotor hub to the motor shaft.)

On the bottom of the hub mount a coffee jar lid or similar to protect the top of the motor from the weather.

Make the arms by twisting each of the aluminum flatbars 90 degrees along their length (Figure 2).

Cut each of the toy balls in half to make four ‘cups’. Attach a cup to the end of each arm by a small bolt and nut. Attach the arms to the rotor.

Assembly (refer to Figure 1)

As the bicycle computer’s original sensor provides the pulses to the computer, mount the sensor on the outside of the can on a small block of wood to set it at the correct height. The sensor has a small flat on one side, which needs to be the side closest to the passing magnet. The magnet (also supplied with the computer) is attached to the coffee jar lid with a couple of short self-tapping screws. A counterweight (such as a small bolt) should be attached to the opposite side of the lid for balance.

Extend the length of the wires from the sensor by cutting them and joining in an appropriate length of wire (either solder the wires or use one of the many types of connectors and splices made for this purpose. These are readily available from electronic component shops.)

Calibrating the computer

To calibrate the computer, you need to reset it by pressing the small reset button on the

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back, and then enter in the wheel circumference. Here are two options for calibrating your data logger.

If you have **access to a calibrated anemometer** (you don't need the data-logging type, just one that gives an accurate instantaneous wind speed), the calibration will be easy. Just program a number, say 1000, into the computer and compare the speed it shows with the speed showing on the other anemometer. If it reads, say, twenty percent low, then increase the number by that figure (giving 1200 in this example) and program it in. The data logger will now be calibrated.

The second way involves **running and using a stop watch: moving the anemometer through still air at a known speed**. Reset and then program the computer with, say 1000. The easiest way to do this is to hold it away from you and run at the same speed for a known distance (e.g. 100 meters), stopping the anemometer the instant you get to the 'finish' line. Get someone to time you, and divide the distance by that time to find your speed in m/s. You then multiply this by 3.6 to get the real speed in km/h. You would then check what the computer reads for an average speed, and work out the adjustment to the programmed number accordingly.

Calculations

There are a few of points that need to be addressed concerning the calculations and the numbers provided by the bike computer. The maximum wind speed recorded will be accurate (well, as accurate as your calibration of the computer, at least), but the average wind speed will need to be recalculated. This is because the computer only averages the speed for the period that it receives input, not for the whole time period.

Fortunately the computer also records the distance traveled by the air passing the anemometer, so the actual average speed can be easily calculated. An example would go as follows. If the computer recorded a distance of, say 138 kilometers passing the anemometer, and this distance was recorded over a time period of 24 hours, then the average speed is simply the distance divided by the time, or $138/24$, which equates to 5.75km/h. Dividing this by 3.6 gives you 1.6m/s – you would need to find another site if every day was this bad!

We should also note here that it is probably best to record the data and reset the computer each week or so, as it only counts up to 9999 kilometers and then clocks over to zero again. But apart from these limitations, this device should allow you to log wind speed data over extended periods, without the cost of buying a commercial logger.

Assessment:

Observational assessment. Are the students able to complete this anemometer? Can the students complete the calculations and work as a team?



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References:

Wind Power is one of a series of five publications collated by the Queensland Sustainable Energy Industry Development Group, a nongovernment alliance of organizations whose aim is to enhance the sustainability of Queensland's energy supply. Each of the topics in the series contain a range of practical activity-based workshops for use in Queensland schools and aims to allow students and teachers to explore and discover the fundamental principles that underpin sustainable energy.

Other activity sets in this series include

- Global Warming and Climate Change
- Passive Solar Building Design
- Photovoltaics (Solar Electricity)
- Solar Cooking

The project "*Expand community knowledge, understanding and uptake of renewable energy and energy efficiency technologies*" was undertaken with the assistance and support of the Queensland Government, through the Sustainable Industries Division of the EPA and the Commonwealth Government, through the Australian Greenhouse Office.

http://apps1.eere.energy.gov/education/lessonplans/pdfs/wind_power.pdf