

INSTRUCTOR NOTES

Homemade Weather Instruments

Objective:

Many of the weather instruments that are used to record weather observations can be recreated (in simplified versions) using materials commonly found at home. The objective of this lab experiment is to build a simple anemometer and barometer to record weather observations.

Estimated Completion Time: 60 minutes

Part I. Building a Barometer

Materials:

- Small coffee can or empty food can
- Plastic wrap
- Scissors
- Tape
- Drinking straw
- Index Card or sturdy piece of paper
- Rubber band

1. Using the plastic wrap, cover the top of the can and secure it using the rubber band. The plastic wrap should form an airtight seal over the can.
2. Tape the straw on the plastic wrap so that it is lying flat in the center with 2/3 of the straw is on the can.
3. Tape the index card to the can behind the straw.
4. Record the location of the straw on the index card with a pencil.
5. Continue recording the location of the straw as often as you want. Does the location of the straw change? For a particular straw reading, you can look up the current pressure at a nearby station on CRONOS and make note of it on your card.

You've now built your very own barometer!

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Questions:

1. Record a few observations, do you see any changes in the location of the straw?

Could be yes or no. During the allotted time for the lab, it is unlikely any significant changes will be observed. Since the interns will be able to take home their barometers, they will have the opportunity observe changes over longer periods of time.

2. Describe how your homemade barometer works.

The homemade barometer measures the differences in pressure between the air inside the can and the air outside the can. When the atmospheric pressure is low, the air inside the can will have a higher pressure than the air outside the can, causing the plastic wrap to 'bubble out' and the straw to move up on the index card. The opposite happens when the atmospheric pressure is high.

3. If the straw moves up on the card, what kind of pressure would you expect?

Low. When the atmospheric pressure is low, the air in the can will have a higher pressure than the air outside the can and the air in the can will push outward.

4. Recall the ECONet tour you went on at the beginning of this internship. Do you think your homemade barometer is more or less accurate than the one on the tower? What are some advantages the *automated* barometer on the tower has over your homemade barometer?

The homemade barometer is probably much less sensitive to variations in atmospheric pressure than the sensor used on the tower. Additionally, it is more difficult to capture the accuracy of the homemade barometer because there may be imperfections in the can, card, airtightness of the plastic wrap, or even errors when recording the location of the straw. Since the barometer on the tower can record its own measurements, we don't need someone to physically come out and record what the pressure is. This makes having hourly (or sub-hourly) observations during all types of weather possible.

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Part II. Building an Anemometer

Materials:

- Scissors
- 5 small cups (such as dixie or solo cups), for best results, one should have a different color than the others
- Pen
- 2 strips of stiff cardboard cut to the same length
- Ruler
- Stapler
- Push pin
- Sharpened pencil with an eraser on the end
- Watch with a second hand or a timer.
- Small fan (optional).

Steps:

1. If all your cups are the same color, take the pen or marker and color one of the cups so it will be easily recognizable from the others.
2. Cross the cardboard strips so they make a plus sign and staple them together.
3. Using the ruler and pencil, determine the exact center of the two pieces of cardboard by drawing lines down the center of each piece, from one end to the other, and finding where they intersect.
4. Staple 4 of the cups, including the cup with the different color, to the ends of each cardboard piece. Make sure all the cups are facing the same direction relative to the cardboard piece.
5. Push the pushpin through the center of the cardboard pieces. Take the pencil and push the eraser onto the pin sticking out of the cardboard pieces (you should now be able to hold up the cardboard and stapled cups using just the pencil).
6. Using the scissors, poke a small hole in the center of the bottom of the remaining cup. Insert the pencil into this cup. It might be best to cut the cup so that it is smaller and to tape the cup to the table to make it sturdier.
7. If you have a small fan available, set it up several feet away from the anemometer and turn it on to a low speed. Using the stopwatch, count the number of rotations in 15 seconds and multiply this number by 4 to get the number of rotations per minute. If you do not have a fan, take the anemometer outside to a bench or table and repeat the exercise.

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Questions:

1. Record a few observations at various wind speeds or locations. Does the anemometer reflect the wind speeds you expected? If you took your anemometer outside, what differences did you observe in the rotations per minute at the various locations? What might have caused these differences?

You would expect the rotations/minute on the anemometer to increase with faster fan speeds. Depending on outside locations, proximity to a building (blocking the wind) or open area (lets the wind flow) will yield different recorded wind speeds.

2. What is the actual wind speed measured by your anemometer? To determine this, you will need to find the circumference of the circle made by the two cardboard pieces and multiply this number by the recorded rpm (rotations per minute).

Example:

rpm: 20

Length of cardboard piece: 20 inches (this is the diameter of the circle)

π : 3.14159

$$\begin{aligned}\text{Circumference} &= \pi * \text{diameter} \\ &= \pi * 20\text{in} \\ &= 62.83 \text{ in}\end{aligned}$$

$$\begin{aligned}\text{Speed} &= \text{circumference} * \text{rpm} \\ &= 62.83\text{in} * 20 \\ &= 1256.6 \text{ in/minute} \\ &= 0.0198 \text{ miles/minute (divide by } 63360 = 5280*12) \\ &= 1.19 \text{ miles/hour (multiply by } 60)\end{aligned}$$

3. The speeds you calculated in question 2 are likely slightly different than the actual wind speeds. What are some possible reasons? How do your results compare to your fellow interns?

Both drag and friction are being ignored in this calculation. Additionally sources of error may include: differences in the lengths of the cardboard pieces, the cups may be stapled at slightly different positions on each of the cardboard legs, or the anemometer itself may not be exactly vertical either because of the surface it is resting on. Despite all of these, the homemade anemometer can provide a good estimate of the wind speed. The results between interns should be very similar; the first attempt at this lab resulted in the counts of rpm being different, which led to slightly different results. Discuss why automated sensors have an advantage over this (less human error).