



Make Your Own Psychrometer

Difficulty

Time Required	Average (6-10 days)
Prerequisites	None
Material Availability	Readily available
Cost	Low (\$20 - \$50)
Safety	No issues

Abstract

From the name, you might guess that a psychrometer is an instrument designed to measure your thoughts. Psych! Actually, it is an instrument that can help you forecast the weather. Read more to find out how it works.

Objective

The goal of this project is to build and use a *psychrometer*, a simple instrument for measuring the relative humidity of the air.

Credits

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Sources

The instructions for building the psychrometer used in this project are from:

- Miami Museum of Science, 2000. "Make a Psychrometer," Miami Museum of Science [accessed January 25, 2007] <http://www.miamisci.org/hurricane/psychrometer.html> (<http://www.miamisci.org/hurricane/psychrometer.html>).

Cite This Page

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Introduction

Changes in humidity are an important part of daily weather. In this project you will build an instrument to measure the humidity level in the air. The instrument is called a *psychrometer*.

A psychrometer is a pretty simple device. It is basically just two securely mounted thermometers and a piece of gauze. The gauze is wrapped around the bulb of one thermometer, and wetted with water. We will refer to this thermometer as the *wet bulb* thermometer. The other thermometer is simply left dry. The instrument is then swung through the air (which is why you will often see these instruments referred to as *sling* psychrometers).

As the psychrometer moves through the air, water evaporates from the gauze. This evaporation cools the wet bulb thermometer. The dry bulb thermometer is unaffected. After 2–3 minutes, the temperature reading of the wet bulb thermometer will stop changing. This indicates that the thermometer has reached a new equilibrium state, where the heat of the surrounding air and the evaporative cooling from the wet gauze are in balance.

The wet bulb and dry bulb thermometers will now have different readings. The amount of the difference will depend on three factors:

1. the air temperature,
2. the air pressure (i.e., barometric pressure),
3. the amount of water vapor already in the air.

You can read the air temperature from the dry bulb thermometer, and you can look up the current barometric pressure on the National Weather Service webpage for your local area. With these numbers and the wet bulb reading, you can calculate the relative humidity.

This project shows you how to build a simple psychrometer. Instead of swinging it through the air, you can use a fan to move the air past the psychrometer. (The Variations section has a suggestion for securely mounting the thermometers if you want to make your own sling psychrometer.) You can use your psychrometer to measure humidity changes inside your home, or outside to help you predict the weather.

Terms and Concepts

To do this project, you should do research that enables you to understand the following terms and concepts:

- psychrometer,
- relative humidity,
- evaporation,
- evaporative cooling,
- equilibrium.

Questions

- Which can hold more water vapor: warm air or cool air?
- What effect does barometric pressure have on evaporation?

Bibliography

- Wikipedia contributors, 2007. "Hygrometer," Wikipedia, The Free Encyclopedia [accessed January 25, 2007] <http://en.wikipedia.org/w/index.php?title=Hygrometer&oldid=103201516> (<http://en.wikipedia.org/w/index.php?title=Hygrometer&oldid=103201516>).
- Here is an excellent site for learning about weather prediction:
Haby, J. date unknown. "Weather Prediction Education," The Weather Prediction.com [accessed January 25, 2007] <http://www.theweatherprediction.com/> (<http://www.theweatherprediction.com/>).
- Palmer, C., 2005. "How a Sling Psychrometer Works," USA Today [accessed January 25, 2007] <http://www.usatoday.com/weather/wsling.htm> (<http://www.usatoday.com/weather/wsling.htm>).
- This webpage has an online calculator you can use to convert your psychrometer reading to relative humidity. In addition to your psychrometer reading, you will also need to know the barometric pressure:
Brice, T. and T. Hall, date unknown. "The Weather Calculator: Relative Humidity," National Weather Service Forecast Office, El Paso Area [accessed January 10, 2014] http://www.srh.noaa.gov/epz/?n=wxcalc_rh (http://www.srh.noaa.gov/epz/?n=wxcalc_rh).
- The instructions for building the psychrometer used in this project are from:
Miami Museum of Science, 2000. "Make a Psychrometer," Miami Museum of Science [accessed January 25, 2007] <http://www.miamisci.org/hurricane/psychrometer.html> (<http://www.miamisci.org/hurricane/psychrometer.html>).

Materials and Equipment

- Celsius thermometers (2). They should meet the following requirements: Have a range of at least -5 to 50°C ; be marked in 1 degree increments; be spirit-filled or, in other words, be *not* mercury-filled because mercury is toxic and will be released if a mercury thermometer is broken. Thermometers that meet these requirements are available through the [Carolina Biological Supply Company](http://www.carolina.com/lab-thermometers/red-spirit-filled-partial-immersion-12-in-thermometer--20-to-110-c/745390.pr?s_cid=ptnr_scibuddies) (http://www.carolina.com/lab-thermometers/red-spirit-filled-partial-immersion-12-in-thermometer--20-to-110-c/745390.pr?s_cid=ptnr_scibuddies).
- Water
- Gauze
- Solid piece of wood or Styrofoam for mounting
- Tape
- Small fan
- Lab notebook

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Experimental Procedure

1. Attach the thermometers firmly to a small board or sturdy piece of Styrofoam. The bulbs of the thermometers should stick out past the end of the board.
2. Wrap gauze around the bulb of one of the thermometers, and tape it in place. Wet the gauze with water. This will be your 'wet bulb' thermometer.
3. To measure the relative humidity, air needs to be moving past the wet bulb to cause evaporation. Use a small fan to blow on the two thermometers (or see the Variations section for an alternative method).
4. Take readings from the two thermometers at regular intervals. The dry bulb thermometer reading should remain constant. The wet bulb thermometer reading should stop changing within two or three minutes. When the wet bulb reading is stable, write down both the dry bulb and wet bulb readings.
5. To figure out the relative humidity, subtract the dry bulb reading from the wet bulb reading, then use the table (Miami Museum of Science, 2000), or use the online calculator referenced in the Bibliography (Brice and Hall, date unknown).
 - a. Note: for the online calculator, you'll also need to know the current barometric pressure at your location. If you don't have your own barometer, you can make one, or look up the information online. In the U.S., you can use the [National Weather Service](http://www.weather.gov/) (<http://www.weather.gov/>) website.

Dry Bulb Temperature (°C)	Temperature Difference (dry bulb – wet bulb, °C)									
	1	2	3	4	5	6	7	8	9	10
10	88	77	66	55	44	34	24	15	6	–
11	89	78	67	56	46	36	27	18	9	–
12	89	78	68	58	48	39	29	21	12	–
13	89	79	69	59	50	41	32	22	15	7
14	90	79	70	60	51	42	34	25	18	10
15	90	81	71	61	53	44	36	27	20	13
16	90	81	71	63	54	46	38	30	23	15
17	90	81	72	64	55	47	40	32	25	18
18	91	82	73	65	57	49	41	34	27	20
19	91	82	74	65	58	50	43	36	29	22
20	91	83	74	67	59	53	46	39	32	26
21	91	83	75	67	60	53	46	39	32	26
22	91	83	76	68	61	54	47	40	34	28
23	92	84	76	69	62	55	48	42	36	30
24	92	84	77	69	62	56	49	43	37	31
25	92	84	77	70	63	57	50	44	39	33

6. Here are some ideas for measurements you can make with your psychrometer:

- Use your psychrometer to measure how the humidity changes in the bathroom when you run the shower. Take a baseline measurement with the shower off. With the bathroom door closed, turn the shower on for one minute and take another measurement. Repeat for additional one-minute showers. How does the humidity change?
- Use your psychrometer to measure how the humidity changes in your house when cooking pasta in an open pot on the stove.
- Use your psychrometer to measure how the humidity changes outdoors as a storm system moves through. Take regular measurements over several days.

Variations

- Instead of using a fan to move the air past your psychrometer, you can move your psychrometer through the air to cause evaporation from the wet-bulb thermometer. This is called a 'sling psychrometer.' In order to do sling your psychrometer, you'll need to attach the thermometers securely to their base. A simple way to do this is with plastic cable ties. For each thermometer, drill four holes through the support board (two each near the top and bottom of each thermometer) separated by slightly less than the width of the thermometers. Wrap some padding material around the thermometer (e.g., a small section of a wide rubber band), and then cinch the cable tie through the board to attach the thermometer snugly in place. Test to make sure that the thermometers are well-secured. You can then attach the board to a handle so that it can swing freely in a circle (see illustration in Palmer, 2005), or you can tie a short length of rope to a hole drilled in one end so that you can swing it in a circle. Make sure you have enough room before you swing: you don't want those fragile thermometer bulbs hitting something and breaking!
- How does humidity change as a storm approaches and passes through your area?
- Track the relative humidity change in the bathroom as someone takes a hot shower. How long does it take for the relative humidity to return to baseline level? Does the humidity also change in nearby areas of the house?
- How much does the relative humidity change in your kitchen when you cook pasta? How much does it change in other rooms of the house?
- For a different method of measuring humidity, see the Science Buddies project [Make a Hygrometer with Strands of Hair](http://www.sciencebuddies.org/science-fair-projects/project_ideas/Weather_p010.shtml) (http://www.sciencebuddies.org/science-fair-projects/project_ideas/Weather_p010.shtml). How do the two methods compare?

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Meteorologist

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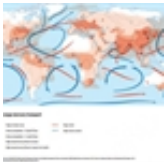
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