

## Building a Psychrometer

### Background

Air is made of gas particles that are constantly moving. Warm air particles move rapidly; cold air particles move more slowly. When air is warm, the distance between the particles is greater than when air is cold.

Water vapor particles can move freely between air particles. At higher temperatures, when air particles are farther apart and moving faster, a lot of water vapor particles can fit in between. At lower temperatures, when air particles are closer together and moving slower, less water vapor particles can fit between the spaces, so they have to “band together,” or condense. There’s your white cloud above the tea kettle.

The amount of water vapor actually in air as opposed to how much the air is capable of holding is called relative humidity. If the weather report says, “The relative humidity is 72%,” that really means that the air (at that temperature) is holding 72% of its actual capacity. The hotter it gets, the more water can fit into the spaces between air particles.

### Calculating Relative Humidity

1. Measure the dry bulb temperature.
2. Measure the wet bulb temperature.
3. Calculate the difference between the dry bulb and wet bulb temperatures.
4. Find the dry bulb temperature on the table.
5. Find the difference between the wet and dry bulb temperatures on the table.
6. The relative humidity will be at the intersection of the row and column.

**Relative Humidity (%)**

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
-20	100	28														
-18	100	40														
-16	100	48														
-14	100	55	11													
-12	100	61	23													
-10	100	66	33													
-8	100	71	41	13												
-6	100	73	48	20												
-4	100	77	54	32	11											
-2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

## Building a Psychrometer

A psychrometer or a hygrometer is used to measure relative humidity. A wet-bulb/dry-bulb hygrometer actually measures how fast air will let water evaporate into it. Evaporation is a cooling process. A wet surface covering the bulb end of a thermometer will cool as water evaporates from it into the air. The drier the air, the faster the evaporation and the cooler the wet bulb will become. The wetter the air, the slower water will evaporate into it and the wet bulb's temperature is not lowered as much.

### Materials

- 2 alcohol-filled air thermometers (they must read exactly the same temperature when placed side by side out of direct sunlight)
- clear packing tape
- cotton shoelace (the hollow type)
- 1- or 2-liter bottle (label removed)
- water (distilled is best but tap will do)
- thread
- awl
- relative humidity chart

### Procedure

1. Punch a hole in the side of the bottle about an inch from the bottom. Heating the awl will make a perfect hole. The same thing can be done with a hot nail held with tongs. Use great caution when doing this so you don't burn yourself or others. When you've made the hole, place the hot object in cold water.
2. Be sure the tips are cut off the shoestring. Cut about 2 inches of shoestring and slip it over the bulb of one of the thermometers. Carefully tie it in place with thread.
3. Cut a small piece of packing tape. Position the bulb of the shoestringed thermometer about 1/8 inch over the hole. Be sure the top of the thermometer is aligned with the top of the bottle. Tape the thermometer to the bottle. Tape the other thermometer parallel to the first one and about 1/4 inch away. Put a strip of tape around the bottle and both thermometers to make sure they don't fall off.
4. Push the shoelace through the hole. Put room temperature water in the bottle until it reaches just below the hole.
5. Wait 5 to 10 minutes and read both thermometers. There will be a difference in the two. Use the chart below to calculate the relative humidity.
6. Keep a record of the daily humidity for a few weeks. Next to your entries, describe the way you feel on those days.
7. The dry-bulb temperature can also be used to record the air temperature!