

Lesson 4: Humidity

☐ Getting Started

There is always water in the air, even when we can't see it. Water can appear in the atmosphere as a gas (in the form of water vapor) or as a liquid (in the form of clouds or precipitation). We can see clouds and precipitation, but we can't see water vapor because the water molecules are so small. This water vapor is called **humidity**. It affects the weather in your environment, but it also affects your body. One of the substances that is most affected by humidity is human hair! Humidity makes human hair get curlier or frizzier.

NOTE: You will fill in your weather journal for today during Activity 2.

Stuff You Need

- clear tape
- plastic water bottle with cap (kit)
- scissors
- shoelace (kit)
- thermometers (kit)

Ideas to Think About

- How do the weather and climate impact humans?
- How is the water cycle evident in weather patterns?

Things to Know

- **Relative humidity** describes how much water vapor is currently in the air, compared to the maximum amount of water that could be in the air at that temperature. It is expressed as a percentage.
- A **hygrometer** is a tool that measures the amount of water vapor in the air, usually using a material that behaves differently in wet weather and dry weather.

Activities

☐ Activity 1: Building a Hygrometer

One important part of the water cycle is evaporation. Evaporation is the process of water changing from a liquid to a gas (water vapor). Humidity is the measurement of how much water vapor is in the air, and it changes depending on the air's temperature. Warm air can contain more water vapor than cold air.

Relative humidity describes how much water vapor is currently in the air, compared to the maximum amount of water that *could* be in the air at that

temperature. Relative humidity is expressed as a percentage. For example, if it is 70°F outside and the relative humidity is 30%, that means the air contains 30% of the water vapor that could be there when air is at that temperature.

We can measure the relative humidity in the air by using a wet/dry bulb hygrometer. A wet/dry bulb hygrometer works by comparing the temperature of the air measured by a dry thermometer (the "dry bulb") with the temperature of a thermometer that is damp (the "wet bulb"). When the water on the wet bulb evaporates, it lowers the temperature for that thermometer. The less humidity present in the air, the more quickly the water will be able to evaporate. So a greater temperature difference between thermometers indicates a lower relative humidity level. On the other hand, the more humid the air is, the closer the temperatures of the two thermometers will be.

Follow the instructions on the "Building a Hygrometer" page to create your own wet/dry bulb hygrometer and determine the relative humidity. You will use the thermometer you had placed outside in Lesson 1 in addition to the extra thermometer provided in the science kit. You may want to take a picture of the hygrometer to use in your final project (it will be disassembled in Lesson 10!).

NOTE: Your relative humidity reading may differ from the relative humidity reported by your local weather forecaster. This could be because the weather station is far from your home and has different environmental conditions (this may be true for the temperature as well), or simply because the weather station's hygrometer is more sensitive.

If your reading is close (within 15-20 percentage points), you can use your hygrometer during the rest of this unit to find the relative humidity each day and record this reading in your weather journal. If your reading today is not close, use the humidity levels from your local forecast for your weather journal instead. If you wish, you can attach the "Relative Humidity" activity page to your weather journal for easy reference.

☐ Activity 2: What Does "Heat Index" Mean?

When you watch or read the weather report for your area in the summer, you will probably hear something called the "heat index" or the "feels like" temperature. In the summer, the "feels like" temperature refers to the heat index. The heat index and the "feels like" temperatures consider how much warmer you will feel because of the water vapor in the air.

When it's hot, you sweat. The sweat usually evaporates into the air, which makes your skin feel cooler (just as evaporation cooled the wet bulb thermometer in Activity 1). But if the air is humid, there's nowhere for the sweat to go in the air, so it just sits on your skin and makes you feel sticky. Because humidity prevents your body from cooling off, it can also contribute to heat exhaustion or heat stroke. Heat exhaustion can make you feel weak and dizzy. Heat stroke causes a body temperature over 104°F and requires immediate medical attention.

Find the "Heat Index Chart" page, which provides a heat index chart based on one created by the National Weather Service. It is very similar to the wind chill chart you used yesterday. Try these questions:

- If the temperature is 80°F and the relative humidity is 70%, what is the heat index?
- You hear a weather report that says that the temperature is 90°F and the heat index is 100°F. What is the relative humidity?
- If the temperature is 95°F, how high must the relative humidity be for there to be an extreme danger of heat stroke?

Weather Journal: Fill in your Weather Journal for today. If the temperature today is 70°F or higher, use the "Heat Index Chart" page and the temperature and relative humidity readings you collected in Activity 1 to determine the heat index temperature and heat-stroke risk. Record these in your weather journal.

If the temperature is 40°F or lower, fill in the wind chill (or "feels like") temperature from your local forecast, and use the wind chill chart to determine the frostbite risk. (If the temperature is between 41°F and 69°F, there is no risk of either frostbite or heat stroke. You can leave the columns blank or write "none" in your journal.)

Record the rest of today's data: temperature, air pressure, wind speed and direction (with the compass and Beaufort scale or anemometer, or the local forecast), and precipitation. Use your air pressure reading to predict the weather for tonight or tomorrow.

NOTE: For future days, you will use the reading on the dry bulb thermometer as the day's temperature.

Wrapping Up

Review your weather journal with your parent and watch tomorrow's forecast. Listen for ways the humidity has affected the weather today and how it might impact you tomorrow. Discuss your thoughts with your parent.

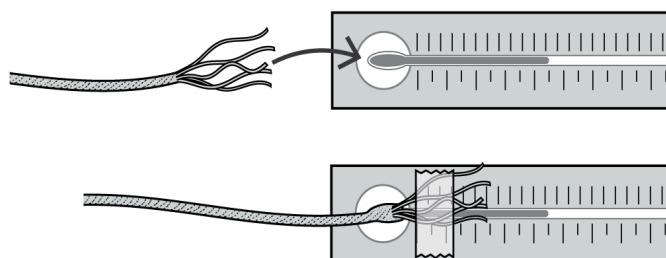
Building a Hygrometer

Materials:

- plastic water bottle with cap (kit)
- scissors
- shoelace (kit)
- 2 thermometers (kit)
- clear tape

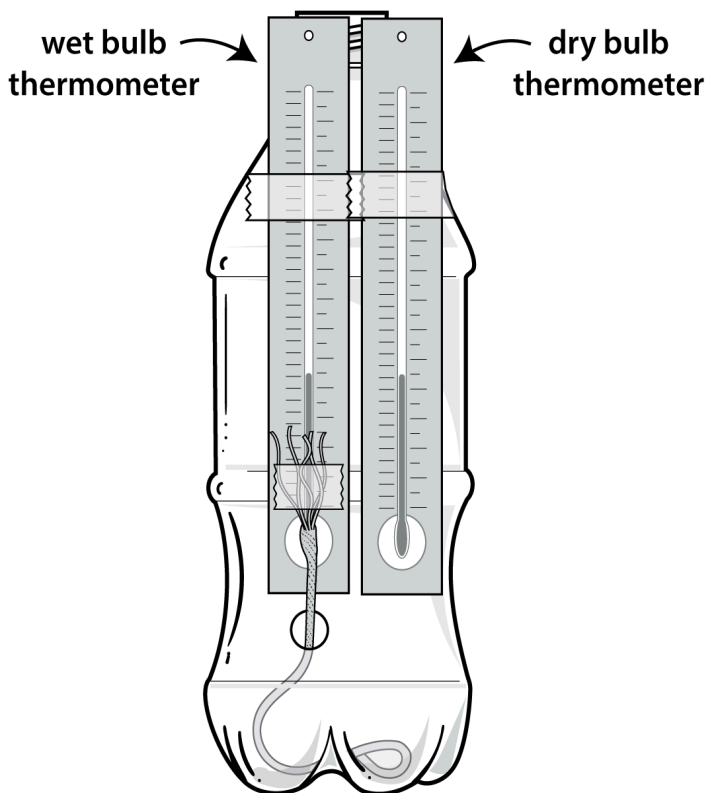
Directions:

1. Pull open one end of the shoelace, and guide the bulb (bottom rounded part) of one of the thermometers into the shoelace end so that the shoelace encases the bulb. Tape the top of the shoelace above the bulb (don't put tape over the bulb) to make sure the shoelace does not slip off.

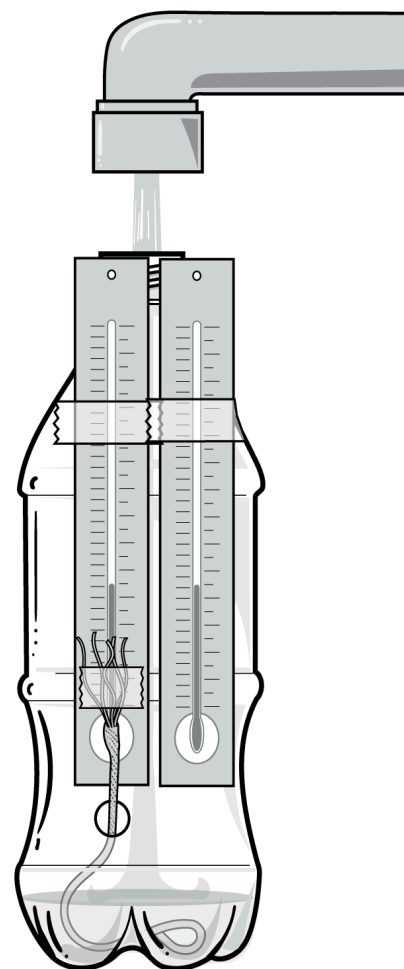


2. Thread the other end of the shoelace through the hole, making sure that it touches the bottom of the bottle. If needed, you can use a pencil inserted through the top of the bottle to arrange the shoelace's position.

3. Tape the thermometer to the side of the bottle so that the bottom of the thermometer is above the hole. (Put the tape high enough that you can still read the thermometer.) Then tape the second thermometer to the right of the first thermometer.



4. Pour water into the bottle to cover the shoelace (the water level should be well below the hole). Screw the cap back on the bottle. Let the water soak into the shoelace.
5. Place your hygrometer outside protected from direct sunlight. The hygrometer works best when air circulates around the wet bulb. If it is windy outside, surround the hygrometer with rocks or secure it to a porch railing or other outdoor object to prevent it from blowing over. If there is no breeze, put the hygrometer in front of a fan (preferably outside) or fan it yourself for 1-2 minutes with a piece of stiff paper or cardboard each time you check the temperature.
6. Wait at least 30 minutes, checking every 10-15 minutes. When the wet bulb temperature has stopped going down, read the temperatures on both thermometers. Record them in the box below.
7. On future days, be sure to check the water level and refill as needed. The shoelace must be wet in order to get a good hygrometer reading. As it dries, the wet bulb temperature will eventually equal the dry bulb temperature.



DETERMINING THE RELATIVE HUMIDITY:

What is your dry bulb temperature? _____

What is your wet bulb temperature? _____

What is the difference between your dry bulb temperature and your wet bulb temperature? _____

Find the "Relative Humidity" activity page. Locate your dry bulb temperature on the left side of the chart. Locate the difference between your wet and dry bulb temperatures at the top of the chart. The relative humidity is where these two readings intersect.

What is your relative humidity? _____

Relative Humidity (%)

Air Temp. (°F)	Dry Bulb Minus Wet Bulb																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	67	33	1																											
5	73	46	20																											
10	78	56	34	13																										
15	82	64	46	29	11																									
20	85	70	55	40	26	12																								
25	87	74	62	49	37	25	13	1																						
30	89	78	67	56	46	36	26	16	6																					
35	91	81	72	63	54	45	36	27	19	10	2																			
40	92	83	75	68	60	52	45	37	29	22	15	7																		
45	93	86	78	71	64	57	51	44	38	31	25	18	12	6																
50	93	87	80	74	67	61	55	49	43	38	32	27	21	16	10	5														
55	94	88	82	76	70	65	59	54	49	43	38	33	28	23	19	14	9	5												
60	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5	1									
65	95	90	85	80	75	70	66	61	56	52	48	44	39	35	31	27	24	20	16	12	9	5	2							
70	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19	15	12	9	6	3					
75	96	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24	21	18	15	12	9	7	4	1		
80	96	91	87	83	79	75	72	68	64	61	57	54	50	57	44	41	38	35	32	29	26	23	20	18	15	12	10	7	5	3
85	96	92	88	84	81	77	73	70	66	63	59	57	53	50	47	44	41	38	36	33	30	27	25	22	20	17	15	13	10	8
90	96	92	89	85	81	78	74	71	68	65	61	58	55	52	49	47	44	41	39	36	34	31	29	26	24	22	19	17	15	13
95	96	93	89	86	82	79	76	73	69	66	63	61	58	55	52	50	47	44	42	39	37	34	32	30	28	25	23	21	19	17
100	96	93	89	86	83	80	77	73	70	68	65	62	59	56	54	51	49	46	44	41	39	37	35	33	30	28	26	24	22	21
105	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44	42	40	38	36	34	32	30	28	26	24
110	97	93	90	87	84	81	78	75	73	70	67	65	62	60	57	55	52	50	48	46	44	42	40	38	36	34	32	30	28	26
115	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48	46	44	42	40	38	36	34	33	31	29
120	97	94	91	88	85	82	80	77	74	72	69	67	65	62	60	58	55	53	51	49	47	45	43	41	40	38	36	34	33	31

Heat Index Table

		Temperature (°F)										
		70	75	80	85	90	95	100	105	110	115	120
Relative Humidity (%)	30	67	73	78	84	90	96	104	113	123	135	148
	35	67	73	79	85	91	98	107	118	130	143	
	40	68	74	79	86	93	101	110	123	137	151	
	45	68	74	80	87	95	104	115	129	143		
	50	69	75	81	88	96	107	120	135	150		
	55	69	75	81	89	98	110	125	142			
	60	70	76	82	90	100	114	132	149			
	65	70	76	83	91	102	119	138				
	70	70	77	85	93	106	124	144				
	75	71	77	86	95	109	130					
	80	71	78	86	97	113	136					
	85	71	78	87	99	117						
	90	71	79	88	102	122						
	95	71	79	89	105							
	100	72	80	91	108							

Heat Index	Effects on the Body	Risk Level
130+	heat stroke highly likely with continued exposure	extreme danger
105 - 129	heat stroke likely with prolonged exposure	danger
90 - 104	heat stroke possible with prolonged exposure	extreme caution

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Getting Started

? Ideas to Think About

- How do the weather and climate impact humans?
- How is the water cycle evident in weather patterns?



Things to Know

- **Relative humidity** describes how much water vapor is currently in the air, compared to the maximum amount of water that could be in the air at that temperature. It is expressed as a percentage.
- A **hygrometer** is a tool that measures the amount of water vapor in the air, usually using a material that behaves differently in wet weather and dry weather.

⦿ Skills

- Understand how the cycling of matter (water and gases) in and out of the atmosphere relates to Earth's atmosphere, weather and climate and the effects of the atmosphere on humans. (S)
- Explain how the cycling of water in and out of the atmosphere and atmospheric conditions relate to the weather patterns on Earth. (S)
- Use appropriate tools, and other necessary equipment to collect, record, and analyze information. (S)
- Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. (S)

Introducing the Lesson

Humidity can be a difficult concept because it's impossible to see. It has to be measured by observing materials that are affected by humidity. In this lesson, your child will explore what humidity is, the difference it makes in her environment, and some materials that are used to measure humidity. NOTE: Your child will fill in her weather journal for today during Activity 2.

Activities

Activity 1: Building a Hygrometer

Your child will use simple materials to make a hygrometer to measure the humidity in the air. Encourage your child to do the other activities in the lesson while she waits for the hygrometer to measure the current temperatures. She will use the difference in temperature between the two thermometers and the chart provided to determine the relative humidity. She may also want to take a picture of the hygrometer to use in her final project.

NOTE: The dry bulb thermometer on your child's hygrometer should be accurate to measure the outdoor temperature for her weather journal. However, as this is a homemade hygrometer, your child's humidity readings may differ from the relative humidity reported by your local weather forecaster. This could be

because the weather station is far from your home and has different environmental conditions (this may be true for the temperature as well), or simply because the weather station's hygrometer is more sensitive.

If her reading is close (within 15-20 percentage points), she can use her hygrometer to find the relative humidity and record this reading in her weather journal each day. If her reading is not close, she should use the humidity levels from her local forecast instead.

Activity 2: What Does "Heat Index" Mean?

Your child will read about the heat index and look at the heat index chart created by the National Weather Service. She will also answer some questions about the chart.

- If the temperature is 80°F and the relative humidity is 70%, what is the heat index? (85°F)
- You hear a weather report that says that the temperature is 90°F and the heat index is 100°F. What is the relative humidity? (60%)
- If the temperature is 95°F, how high must the relative humidity be for there to be an extreme danger of heat stroke? (75%)

If today's temperature is 70°F or above, your child should use the temperature and relative humidity readings she's already recorded and the heat index chart to figure out the heat index temperature and the heat stroke risk level. If today's temperature is 40°F or below, she can instead fill in the wind chill and frostbite risk sections of the weather journal. (If the temperature is between 41°F and 69°F, she can skip both readings.)

Starting tomorrow, if she prefers, your child can use the heat index or wind chill (or "feels like") temperature from a weather report and use the heat index or wind chill chart to find the risk level of heat stroke or frostbite.

Wrapping Up

Questions to Discuss

- Do you think it is more important to know the heat index temperature or the actual temperature? Why? (Your child should understand that the heat index reading is useful to know whether there's a danger of heat-related illness.)
- How is a hygrometer different from a thermometer? (A hygrometer measures water vapor in the air. The difference of the wet bulb and the dry bulb can be used to find the relative humidity, using a chart.)

Things to Review

Review the definitions of humidity, relative humidity, heat index, and hygrometer. Review how to use hygrometer and the chart to determine the relative humidity. Review how to use the heat index chart.