Chapter 13.1 (Pg. 453)

Relative Humidity LAB

Water vapor is the gaseous, invisible form of water in the atmosphere. It is better known as humidity. When the air in the atmosphere contains a large amount of water, the air feels very humid. The opposite is true when the air is relatively void of water vapor—the air feels very dry. When air holds the maximum amount of moisture, dew or frost will be present and small droplets will begin to form as clouds. As the clouds become saturated with water droplets, they will become too dense to hold all of the droplets and the droplets will start to fall toward the Earth's surface in the form of rain or snow. This is known as 100% humidity.

A sling psychrometer can be used to measure the relative humidity of the air. *Relative humidity* is the percentage of moisture air is holding compared to the maximum it can hold. When water in the air evaporates, a certain amount of heat is required to convert the air into water vapor. Therefore, a cooling effect takes place when evaporation occurs. A *sling psychrometer* consists of two thermometers; a dry-bulb and a wet-bulb. The dry-bulb thermometer measures the temperature of the surrounding air while the wet-bulb thermometer records the amount of cooling that is required for the water to evaporate at that specific temperature. If the air is very humid, the differences between the dry-bulb and wet-bulb thermometers will not be large because there is little evaporation. However, if the air is arid or dry, a large amount of evaporation takes place (which causes a cooling effect on the wet-bulb thermometer) and the difference between the two temperatures of the thermometers will be greater.

To use the Relative Humidity Table, first find the temperature difference between the dry- and wet-bulb thermometers. Locate this value on the Relative Humidity Table. Now use this value and the final temperature of the dry-bulb thermometer to obtain the relative humidity reading.

Dew point is defined as the temperature at which air must be cooled (at constant pressure and water vapor content) for saturation (dew formation) to occur. When the dew point is below freezing, (32 °F), it is commonly referred to as the *frost point.*

The dew point is an important measurement used to predict the formation of dew, frost, and fog. Since atmospheric pressure varies only slightly at the Earth's surface, the dew point is a good indicator of the air's water vapor content. High dew points indicate high water vapor content and low dew points indicate low water vapor content.

The difference between the air temperature and dew-point temperature indicates whether the relative humidity is low or high. When the air temperature and dew point are dramatically different, the relative humidity is low. When the air temperature and dew point are close to the same value, the relative humidity is high. When the air temperature and dew point are equal, the relative humidity is 100% (see the Dew Point Calculation Chart on page 8).

To find the dew point, use the temperature of the air and the relative humidity percent reading. Find each of these values on the Dew Point Calculation Chart and locate the corresponding dew point value.

Concepts

- Relative humidity
- Water vapor
- Dew point

Materials

Beral-type pipet

Sling psychrometer

Procedure

1. Determine the air temperature using the dry-bulb thermometer. Record the temperature in the data table.
2. Using a Beral-type pipet, place a few drops of water on the cotton wick of the wet-bulb thermometer.
3. Place the plastic handle of the sling psychrometer in your hand and slowly rotate the thermometers around the screw. The spinning motion will increase the rate of the evaporation rate of the water.
4. Spin the thermometers on the sling psychrometer for thirty seconds or until the wet-bulb thermometer drops to a point where it remains constant.
5. When the wet-bulb thermometer reading is stable, immediately record the temperature of both thermometers in the data table.
6. Determine the difference between the dry-bulb and wet-bulb thermometers. Record this value in the data table.
7. Use the Relative Humidity Table to determine the relative humidity of the air. Record this value in the data table.

Observations and Results (°F)

Air temperature (°F)	
Dry-bulb temperature after spinning (°F)	
Wet-bulb temperature after spinning (°F)	
Difference between dry- and wet-bulb temperature values (°F)	
Relative humidity (%)	

1. Define the terms relative humidity and dew point.

2. Given your results, how do relative humidity and dew point compare?

3. Compare your relative humidity [redacted] values with your local weather station or Internet weather site. How do your values compare to the actual or reported values?

Formula → Relative Humidity = Absolute Humidity / Capacity x 100

Example 1. At 10° C, the water capacity is 11 g/m³.

Example 2. At 25° C, the water capacity is 22 g/m³.

4. If the temperature is 10° C and the absolute humidity in Example 1 (in the box above) is 5.5 g/m³, calculate the relative humidity. Show your work.

5. If the temperature is 25° C and the absolute humidity for Example 2 (in the box on the previous page) is 5.5 g/m³, calculate the relative humidity. Show your work.

Relative Humidity Table

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

Refer to the following table to determine the relative humidity using Fahrenheit temperatures. In this table, the dry-bulb reading is on the left in the vertical column. The difference between the dry- and wet-bulb reading (that is, the wet-bulb depression) is on top horizontally. You can determine the relative humidity by drawing an imaginary line horizontally from the dry-bulb temperature and an imaginary line vertically from the wet-bulb depression. The number listed on the chart at the point where these two lines meet is the relative humidity. For example, if the dry-bulb temperature is 30 degrees F and the wet-bulb depression is 6 degrees F, then the relative humidity is 37%.

PART IV (°C)

13. Dry-bulb reading: _____ °C

    Wet-bulb reading: _____ °C

14. Calculate the difference between the dry- and wet-bulb temperature reading (that is, the wet-bulb depression).

    Difference in C° _____ °C

Refer to the following tables to determine the relative humidity. (The table on this page is for Celsius readings; the table on the following page is for Fahrenheit readings.) In both tables, the dry-bulb reading is on the left in the vertical column. The difference between the dry- and wet-bulb reading (that is, the wet-bulb depression) is on top horizontally. You can determine the relative humidity by drawing an imaginary line horizontally from the dry-bulb temperature and an imaginary line vertically from the wet-bulb depression. The number listed on the chart at the point where these two lines meet is the relative humidity. For example, if the dry-bulb temperature is 20° C and the wet-bulb depression is 1° C, then the relative humidity is 91%.

Relative Humidity (%) [use Celsius readings]

Dry-bulb temperature (°C)	Wet-bulb temperature depression (°C) (Temp dry bulb – Temp wet bulb)																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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	23	15	7								
14	90	79	70	60	51	42	34	26	18	10								
15	90	80	71	61	53	44	36	27	20	13	6							
16	90	81	71	63	54	46	38	30	23	15	8							
17	90	81	72	64	55	47	40	32	25	18	11							
18	91	82	73	65	57	49	41	34	27	20	14	7						
19	91	82	74	65	58	50	43	36	29	22	16	10						
20	91	83	74	66	59	51	44	37	31	24	18	12	6					
21	91	83	75	67	60	53	46	39	32	26	20	14	9					
22	92	83	76	68	61	54	47	40	34	28	22	17	11	6				
23	92	84	76	69	62	55	48	42	36	30	24	19	13	8				
24	92	84	77	69	62	56	49	43	37	31	26	20	15	10	5			
25	92	84	77	70	63	57	50	44	39	33	28	22	17	12	8			
26	92	85	78	71	64	58	51	46	40	34	29	24	19	14	10	5		
27	92	85	78	71	65	58	52	47	41	36	31	26	21	16	12	7		
28	93	85	78	72	65	59	53	48	42	37	32	27	22	18	13	9	5	
29	93	86	79	72	66	60	54	49	43	38	33	28	24	19	15	11	7	
30	93	86	79	73	67	61	55	50	44	39	35	30	25	21	17	13	9	5