3106

PSYCHROMETER

SAMPLE MANUAL

Eye Opener

What is always in the air, invisible, and can make you wet...even when it's not raining?

The answer is water vapor.

Water vapor is the invisible, gaseous form of water that hangs around in our atmosphere along with liquid water (cloud droplets, rain drops) and ice water (snow, hail, and sleet). When the air contains abundant water vapor, we say the air feels humid; when the air has very little water vapor in it, we say the air feels dry or arid. In the driest deserts, the volume of water vapor present in the air can be nearly 0 while in tropical rainforests, water vapor can occupy as much as 4% of the air's volume. Although the amount of water vapor changes over distance and time, it is always measurable.

Vocabulary

Psychrometer
Absolute Humidity
Saturation
Water Vapor
Dry-Bulb/Wet-Bulb
Evaporation
Condensation
Dew Point
Relative Humidity
Wet-Bulb Depression

PURPOSE

The Psychrometer Kit you are about to use measures two variables relating to water vapor in the air– **relative humidity** and **dew point.** Each relates to the nature of moisture in the atmosphere and provides vital information about our daily weather. Along with other variables such as air temperature and barometric pressure, people such as weather forecasters, pilots, and farmers use measurements of the air's relative humidity and dew point each day. Understanding how to measure relative humidity is a key concept in the earth and atmospheric sciences.

♦ *Find Out*

Compare the humidity between a summer day in Miami Florida with that of Phoenix Arizona. Which city would you predict would have a higher humidity? Name other cities or locations you predict would have very different humidities? Why?

BACKGROUND

Where does water vapor come from? The primary source is from the Earth's vast reservoirs of liquid water, the oceans. The Sun provides the energy to convert liquid water into water vapor through the process of **evaporation**. Just as a street puddle gradually disappears after the sun has warmed it up, the surface waters of the Earth's tropical oceans also evaporate each day. When humid air rises, it cools, and condenses into water droplets we recognize as clouds or fog. This water vapor is carried along Earth's global winds and moving air masses, eventually to be released back to the surface as precipitation once again.

♦ *Try it*

Near a sunlit window, position two shallow bowls or saucers with half filled cold water so that the sun shines directly on them. Completely shade one of the saucers with a "sunshade" such as a piece of cardboard or an open hard-covered book. Let them sit for a few hours. Which saucer dries quickest? Where does the water go?

♦ Absolute and Relative Humidity

Humidity, when simply expressed as a measure of how much water vapor is present at a given temperature is called **absolute humidity**. On warm, humid days, we sense this by observing how muggy or sticky the air feels. Water or sweat from your skin cannot evaporate easily because the air already carries much water vapor. More commonly, though, humidity is reported as **relative humidity**. For a given temperature, relative humidity is expressed as a percentage of how much moisture the air actually contains *relative* to how much moisture the air could contain. In other words, air like a sponge, could "absorb" that much volume of water.

For example, at 30° C (86° F), warm air can hold a maximum of 26 g/m^3 (grams per cubic meter) of air. If, in our example, that much water was indeed present, the air would be "filled" with water vapor and no more evaporation could take place. At this point, the air becomes **saturated,** condensation begins to take place, and water droplets form on tiny particles in the air or on cool surfaces along the ground. The temperature at which the air becomes saturated with water vapor is called the **dew point**. In our example 30° C is the dew point and the relative humidity is 100% because the air is holding all the moisture it can. If the same air only contains 13 g/m^3, the relative humidity would be 50%. When the air temperature cools to the dew point, dew, fog and clouds can form. Frost forms when the air temperature is low enough that the water vapor turns directly into ice.

♦ *Try it*

The same air as described before now contains 6.5 g/m^3. What is the relative humidity now? How would this air feel on your skin? How would your skin feel if the same air cooled to the dew point?

STUDENT WORKSHEET

INVESTIGATION 1: DETERMINING DEW POINT

Trial Number	Dry-Bulb Reading	Wet-Bulb Depression (Dry-Bulb Temperature – Wet-Bulb Temperature)	Dew Point from Dew Point Chart
	_____ °C	_____ °C	_____ °C
	_____ °C	_____ °C	_____ °C

Dew Points

Wet-Bulb Depression (° C)

Dry Bulb Temperature (° C)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
-10	-15	-22																		
-8	-12	-18	-30																	
-6	-9	-14	-23																	
-4	-7	-11	-17	-30																
-2	-5	-8	-13	-20																
0	-2.5	-6	-10	-15	-25															
2	-0.5	-3	-7	-11	-18	-30														
4	2	-1	-4	-7.5	-12	-17														
6	4	1.5	-1	-4	-8	-14	-22													
8	6	4	1	-1.7	-4.5	-9	-15	-20												
10	3	5	4	1	-1.3	-5	-9.5	-15	-28											
12	10	9	6	4	1	-2	-5.5	-10	-16	-30										
14	12	11	8	6	4	1	-2	-6	-10	-17.5										
16	14	12.5	10.7	8.5	6	4	1	-2	-6	-10	-18									
18	16	14.5	13	11	9	6.5	4	1	-2	-4.5	-10	-18								
20	18	16.7	15	13	10.5	9.5	7	4.5	2	-1	-5	-10	-18							
22	20	18.7	17	16	13.5	11.5	10	7.5	5	2	-1.5	-5	-10	-18						
24	22	20.7	19	17.5	16	14	12	10	8	5	2.5	-1	-5	-10	-18					
26	24	22.7	21	19.5	18	16.5	15	13	10.5	8	6	3	-1	-5	-10	-18				
28	26	24.7	23	22	20	19	17	15	13	11	9	6	3	-1	-5	-10	-18			
30	28	26.7	25	24	22	21.5	20	18	16	14	12	10	6	3	-1	-5	-10	-18		
32	30	28.7	27	26	24	23	22	20	18	17	15	13	10	6	3	-1	-5	-10	-18	
34	32	30.7	29	28	26	25	24	22	20	19	17	15	13	10	6	3	-1	-5	-10	-18
36	34	32.7	31	30	28	27	26	24	22	21	19	17	15	13	10	6	3	-1	-5	-10
38	36	34.7	33	32.5	30	29	28	26	24	23	21	19	17	15	13	10	6	3	-1	-5
40	38	36.9	35	34	32	31	30	28	26	25	23	21	19	17	15	13	10	6	3	1

Figure 1