

Measuring Temperature:

No doubt you have used a **thermometer** to measure temperature. You may even have a thermometer attached to the outside of your house to measure the outdoor temperature. In this regard temperature is one of the weather conditions measured and recorded on a regular basis. We will rarely hear a weather report that does not include temperature. In spite of the fact that you have measured temperature, perhaps hundreds of times, have you ever asked, "What is temperature?"



Temperature is defined as the measure of the average kinetic energy of a sample of matter. The atoms and molecules that compose a sample of matter vibrate. They move around and collide with neighboring particles. The rate of motion of these particles results in their kinetic energy and is measured as temperature. The higher their kinetic energy, that is the faster they move, the higher their temperature.

There are two additional factors that along with temperature determine our level of comfort. The first factor is **wind speed** and the second factor is **relative humidity**. In winter a high wind speed will make us feel much colder than on a day when the wind is very calm even though the temperature is the same in both cases. This is known as the "**wind chill factor**." During summer, we are less comfortable on a hot, humid day than we are on a hot, dry day, even if the temperatures on both days are identical. This is due to the cooling effect of evaporation from our skin. The degree of comfort based on temperature and relative humidity is known as the "**humidex scale**". This is one of the reasons that weather reports often include information on temperature, wind speed, and humidity.

Measuring Relative Humidity:

Humidity is a measure of the amount of moisture (water vapour) in the air. Humidity affects the weather. If the humidity is low it is less likely to rain than when the humidity is high, given the same conditions of temperature and atmospheric pressure.

In general, warm air can hold much more water vapour than can cold air. Since the amount of moisture that air can hold is related (relative) to the temperature of the air, the term relative humidity is used.

To better understand the concept of relative humidity consider a sample of air at room temperature. Consider that our sample of air is **saturated**. This means that it is holding its maximum amount of water. Under this condition, the air sample would have a relative humidity of 100%. If we could remove half of the water from our air sample, it would no longer be saturated. The relative humidity would now be 50% since it now holds half the maximum amount of water that it could hold when saturated.

Consider the following problem: If your sample of air when saturated (relative humidity of 100%) held 5 grams of water (in the form of vapour), how many grams would be in your air sample, if the relative humidity was reduced to 20%?

Like temperature, relative humidity is related to our comfort level (humidex scale), so measuring and reporting relative humidity is common practice in a typical weather station.

One instrument that may be used to measure relative humidity is known as a **hygrometer**. This instrument is made from a material that changes length in proportion to the amount of moisture present in the air. The material is connected to a pointing device that changes position depending on the length of the material. A scale is provided so that the pointing device can be used to read the relative humidity which ranges from 0% to 100% relative humidity. It might be possible for you to make your own hygrometer from a length of human hair, but the method described below is much more accurate.

The easiest and probably one of the most accurate methods to measure relative humidity is to make use of the wet-bulb/dry-bulb method. An instrument known as a **psychrometer** is based on this method; it is actually more accurate to measure relative humidity using separate wet-bulb and dry-bulb.

Relative Humidity (%)

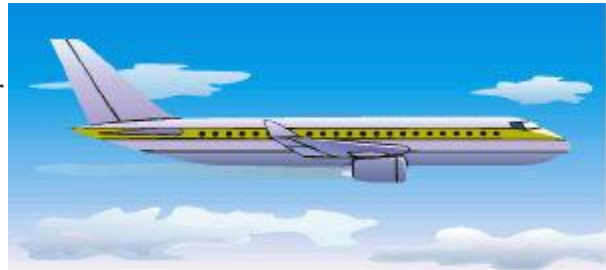
Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
-20	100	28														
-18	100	40														
-16	100	48														
-14	100	55	11													
-12	100	61	23													
-10	100	66	33													
-8	100	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	26	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

Measuring Atmospheric Pressure:

Atmospheric pressure is due to the Earth's gravity. Since air is an example of matter, it has mass and takes up space as do all other forms of matter. The Earth's gravity pulls the column of air above us toward the center of the Earth in the same way that our bodies and any object that is composed of matter would be pulled toward the centre of the Earth. Atmospheric pressure is therefore a measure of the force exerted on us by the weight of the air column above us. Atmospheric pressure is affected by wind currents such as the jet stream. Higher wind speeds tend to reduce the atmospheric pressure.

Atmospheric pressure changes both vertically (a change in altitude) and horizontally (a change in position from one region on Earth to another). Atmospheric pressure is generally greatest at the bottom of the air column and tends decrease as one goes to higher altitudes. For example, the atmospheric pressure will be a great deal higher at the surface of the Red Sea or Death Valley (both points on Earth well below sea level) than it would be at the top of Mount Everest (tallest point on Earth; approximately 8 848 m above sea level). Atmospheric pressure may also be different in two cities located at the same elevation. You can often see this on weather maps showing one part of the country under low pressure conditions while another part of the country is experiencing high pressure conditions. Needless to say, these atmospheric conditions do affect the weather conditions in each area.

We don't notice the effect of the atmospheric pressure exerted on our body because the air pressure is normally balanced. However, if we experience a sudden change in elevation (altitude) such as when we travel in an airplane, we may notice a pain against our eardrums, or even pain in our sinuses. This pain is due to the imbalance of the air pressure. The pain usually goes away as soon as the pressure balance is once again equalized. Sometimes our ear pressure is balanced suddenly as our ears "pop."



The most common way to measure atmospheric pressure is to use an instrument known as the **aneroid barometer**. The device normally contains a metal cylinder with folded sides much like the sides of an accordion. This allows the sealed metal container to expand under conditions of reduced atmospheric pressure and to collapse under increased atmospheric pressure. Attached to the surface of the metal cylinder is a pointing device that moves in direct response to the change in the volume of the metal cylinder. The pointing device is then calibrated to a measuring scale. Some measuring scales are labeled to measure the actual pressure of the atmosphere in kilopascals (kPa = the standard SI metric unit for measuring barometric pressure). Other barometers are labeled according to the likely change in weather condition that is normally associated with the particular range of atmospheric pressure. For example, low atmospheric pressure to high atmospheric pressure is normally associated with the following range of weather conditions respectively: stormy, rain, change, fair, and very dry.

Measuring Wind Speed and Direction:

The instrument normally used to measure wind speed is known as an **anemometer**. This device spins around at different rates depending on the speed of the wind. The anemometer is then calibrated to convert the number of revolutions per minute into wind speed which is measured in kilometers per hour (km/h).

The **Beaufort Wind Scale** may also be used as a measure of wind speed. This scale is based on the characteristics of smoke exiting from the top of a chimney. You may also make use of the smoke coming from the top of a chimney to determine wind direction.

Measuring wind direction is very simple. The easiest method is to use a magnetic compass to determine north, and then set up a wind-sock similar to those seen at a small airport. You can also observe the direction of a flag on a flag-pole. You may also record the direction of low level cloud movement. Just keep in mind that wind speed and direction may not always be the same at different elevations (altitudes).



Level	When you see	Wind speed is...
0	Calm. Smoke goes straight up. No wind.	0-1 MPH (0-1.6 KM/H)
1	Weather vane does not move. Smoke drifts. Slight wind.	1-3 MPH (1.6-5 KM/H)
2	Feel wind on your face. Weather vane moves. Leaves rustle. Light wind.	4-7 MPH (6-11 KM/H)
3	Leaves and twigs move steadily. Gentle breeze.	8-12 MPH (13-19 KM/H)
4	Small branches move. Dust and paper are being blown around. Moderate breeze.	13-18 MPH (21-29 KM/H)
5	Small trees sway. Waves form on lake. Fresh breeze	19-24 MPH (30-38 KM/H)
6	Large branches move. Wires whistle. Umbrellas are hard to use. Strong breeze.	25-31 MPH (40-50 KM/H)
7	Whole trees in motion. Difficult to walk. Moderate gale.	32-38 MPH (52-60 KM/H)
8	Twigs break from trees. Very hard to walk against the wind. Fresh gale.	39-46 MPH (62-72 KM/H)
9	Small damage to buildings. Large branches break. Strong gale.	47-54 MPH (74-87 KM/H)
10	Trees uprooted or snapped. Evident damage to buildings. Whole gale.	55-63 MPH (88-101 KM/H)
11	Widespread damage from wind. Storm.	64-72 MPH (102-116 KM/H)
12	Violence and destruction from wind. Hurricane.	73+ MPH (117+ KM/H)

Measuring Precipitation:

Precipitation means the amount of moisture that falls to earth from the sky. Precipitation may be either in liquid or solid form (rain, snow, etc.). Precipitation is measured in centimeters (cm) for snow, and millimetres for rain.

The instrument used to measure precipitation is the **rain gauge**.

Circle the correct response:

1. Which device is used to measure pressure?

- a. barometer
- b. thermometer
- c. psychrometer
- d. anemometer

2. Which device is used to measure wind speed?

- a. barometer
- b. thermometer
- c. psychrometer
- d. anemometer

3. Which device is used to measure relative humidity?

- a. barometer
- b. thermometer
- c. psychrometer
- d. anemometer

4. If you climb rapidly in an airplane or an elevator your ears might pop. What causes this to occur?

- a. air pressure decreases at higher altitudes
- b. air pressure increases at higher altitudes
- c. ear popping is the result of your change in speed
- d. ear popping is due to temperature change

5. Using the table in your notes, what is the relative humidity if the wet bulb temperature is 17°C and the dry bulb temperature is 24°C ?

- a. 26%
- b. 38%
- c. 49%
- d. 65%

6. Which SI unit is used to measure atmospheric pressure?

- a. kilopascal (kPa)
- b. millimeters of mercury (mm of Hg)
- c. Kelvin (K)
- d. inches (in)

7. What happens to the pressure of air when air speed is increased?

- a. change in air speed has no effect on pressure
- b. increased air speed reduces the pressure
- c. increased air speed increases the pressure
- d. pressure increases regardless of the air speed