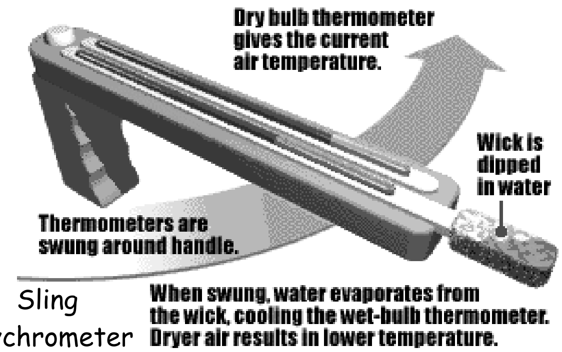
Name Example

MEASURING HUMIDITY

While there are more "modern" ways of measuring humidity, one of the oldest techniques (and still the scientific standard) is the "dry bulb-wet bulb" thermometer. Here is the idea: When the humidity is high, there will be little tendency for water to evaporate. On the other hand, when the humidity is low, water will evaporate rapidly. If one could measure the rate of evaporation for a given air temperature, one could figure out the humidity of the surrounding air. In particular, if one had a piece of wet cloth wrapped around the bulb of a thermometer, evaporation would cool the thermometer – the faster the rate of evaporation, the cooler the thermometer would get. By comparing the temperature of the air (the "dry bulb" temperature) to the temperature of the wet cloth, one can find the relative humidity by using a psychrometric chart.



Sling Psychrometer

The standard instrument for this is a sling psychrometer. We don't happen to have any commercial ones, so we'll make our own using thermometers, wicking, water, and waving our arms.

Use a regular thermometer and one with wet wicking on the bulb to record the Dry Bulb and Wet Bulb temperatures (swing the thermometer with the rapidly and record the lowest temperature it shows).

Dry-bulb air temperature: T_D = 20 °C
Wet bulb air temperature: T_W = 16 °C
Atmospheric Pressure: P = 30.35"Hg = 1027.7 hPa
Location, Date & Time: Locker Room, 3/8/13 1:25 pm

Dry-bulb air temperature: T_D = 3 °C
Wet bulb air temperature: T_W = -0.6 °C
Atmospheric Pressure: P = 30.36"Hg = 1028.0 hPa
Location, Date & Time: Science Quad, 3/8/13 3:00 pm

Dry-bulb air temperature: T_D = 6 °C
Wet bulb air temperature: T_W = 5 °C
Atmospheric Pressure: P = 29.81"Hg = 1009.5 hPa
Location, Date & Time: Science Quad, 3/12/13 8:45 am: raining!

Use the Psychometric Chart from Trane and the equations below to determine

Relative Humidty: 68 %

From right-hand side of psychrometric chart.

Moisture Content: 0.0097 (kg H_2O)/(kg Dry Air)

Specific Humidity: 9.7 (g H_2O)/(kg Dry Air)

Air Density: 1.22 (kg Dry Air)/(m^3 Dry Air)

Moisture Content: 11.8 (ml H_2O)/ (m^3 Dry Air)

Location, Date & Time:

Locker Room, 3/8/13 1:25 pm

$$\rho_{dry\ air} = \frac{102700\ Pa}{(287)(20+273)} = 1.22\frac{kg}{m^3}$$

$$\frac{9.7\ g\ water}{kg\ Dry\ Air} \times \left(\frac{1.22\ kg\ Dry\ Air}{m^3\ Dry\ Air}\right) = 11.8\frac{g\ water}{m^3\ Dry\ Air}$$

$$11.8\frac{g\ water}{m^3\ Dry\ Air} = 11.8\frac{m\ell\ water}{m^3\ Dry\ Air}$$

Relative Humidty: 40 %

Moisture Content: 0.0023 (kg H_2O)/(kg Dry Air)

Specific Humidity: 2.3 (g H_2O)/(kg Dry Air)

Air Density: 1.30 (kg Dry Air)/(m^3 Dry Air)

Moisture Content: 2.99 (ml H_2O)/ (m^3 Dry Air)

Location, Date & Time:

Science Quad, 3/8/13 3:00 pm

$$\rho_{dry\ air} = \frac{102800\ Pa}{(287)(3+273)} = 1.30\frac{kg}{m^3}$$

$$\frac{2.3\ g\ water}{kg\ Dry\ Air} \times \left(\frac{1.30\ kg\ Dry\ Air}{m^3\ Dry\ Air}\right) = 2.99\frac{g\ water}{m^3\ Dry\ Air}$$

$$2.99\frac{g\ water}{m^3\ Dry\ Air} = 2.99\frac{m\ell\ water}{m^3\ Dry\ Air}$$

Relative Humidty: 86 %

Moisture Content: 0.0052 (kg H_2O)/(kg Dry Air)

Specific Humidity: 5.2 (g H_2O)/(kg Dry Air)

Air Density: 1.26 (kg Dry Air)/(m^3 Dry Air)

Moisture Content: 6.55 (ml H_2O)/(m^3 Dry Air)

Location, Date & Time:

Science Quad, 3/12/13 8:45 am: raining!

$$\rho_{dry\ air} = \frac{100950\ Pa}{(287)(6+273)} = 1.26\frac{kg}{m^3}$$

$$\frac{5.2\ g\ water}{kg\ Dry\ Air} \times \left(\frac{1.26\ kg\ Dry\ Air}{m^3\ Dry\ Air}\right) = 6.55\frac{g\ water}{m^3\ Dry\ Air}$$

$$6.55\frac{g\ water}{m^3\ Dry\ Air} = 6.55\frac{m\ell\ water}{m^3\ Dry\ Air}$$

Using the table to the right and the moisture content you found, calculate how many milliliters of water are in a cubic meter (m^3) of air in the location n you sampled. Comment on your results

$$\rho_{dry\ air} = \frac{p}{RT} = \frac{\_\_\_\_\_\ Pa}{(287)(\_\_\_\_+273)} = \_\_\_\_\frac{kg}{m^3}$$

$$\frac{\_\_\_\_\ g\ water}{kg\ Dry\ Air} \times \left(\frac{\_\_\_\_\ kg\ Dry\ Air}{m^3\ Dry\ Air}\right) = \_\_\_\_\frac{g\ water}{m^3\ Dry\ Air} = \_\_\_\_\frac{m\ell\ water}{m^3\ Dry\ Air}$$