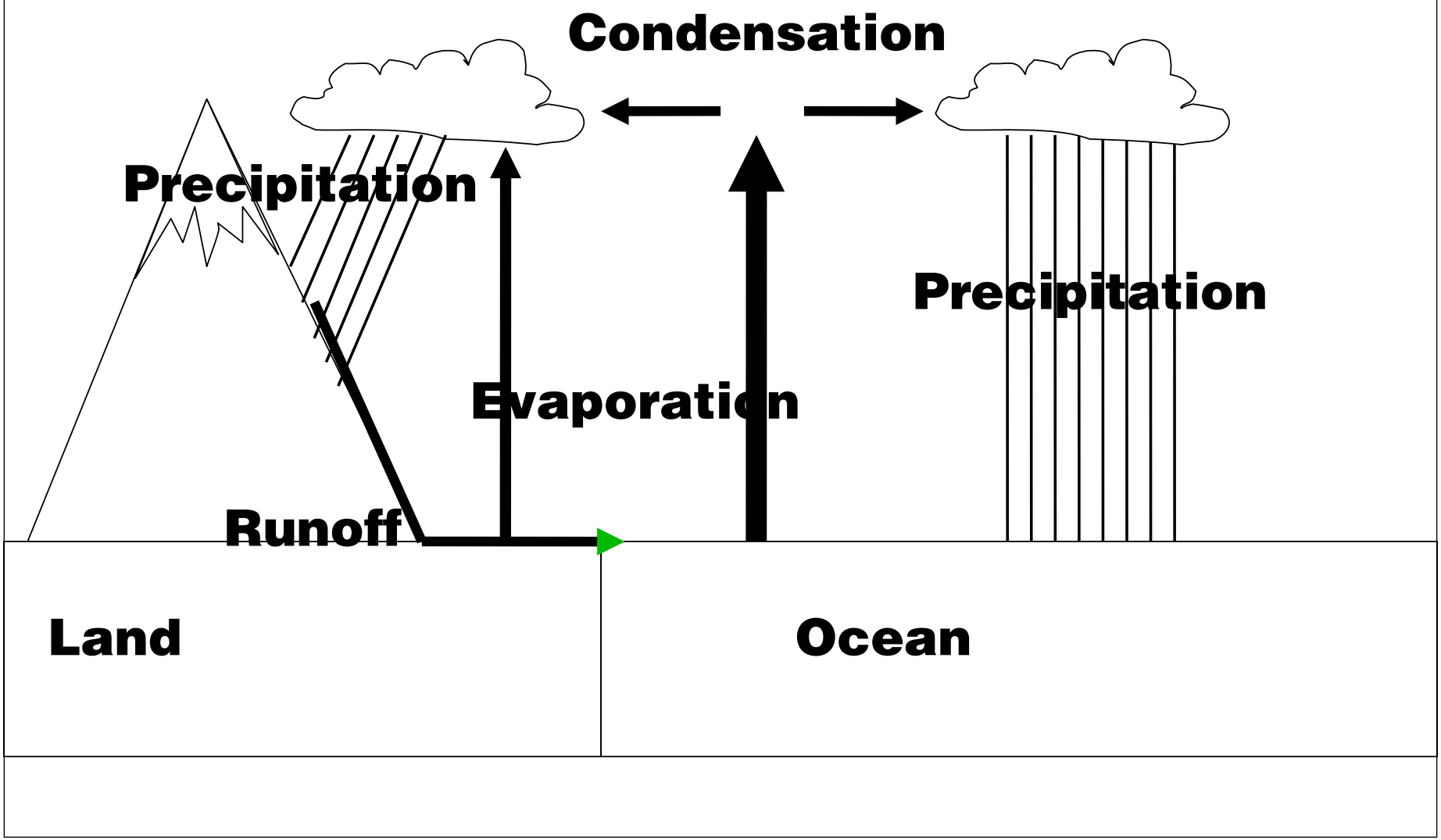
Humidity

Water Vapor in the Air

Ch. 5: Humidity

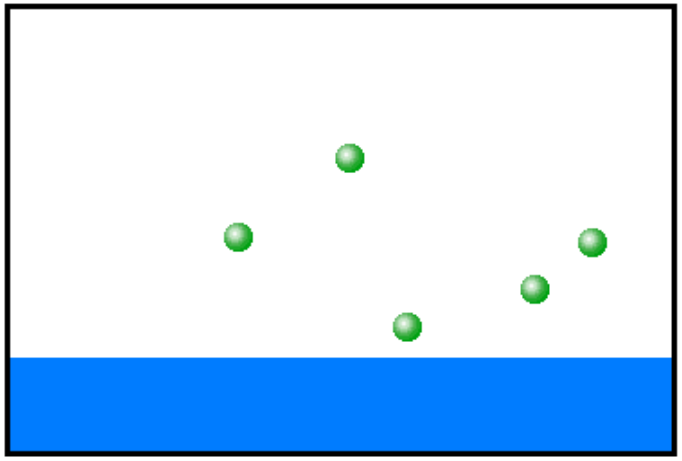
- **Hydrologic Cycle**
- **Saturation**
- **Humidity**
  - → **Vapor Pressure**
  - → **Relative Humidity**
  - → **Dew Point Temperature**
- **Heat Index**

Hydrologic Cycle



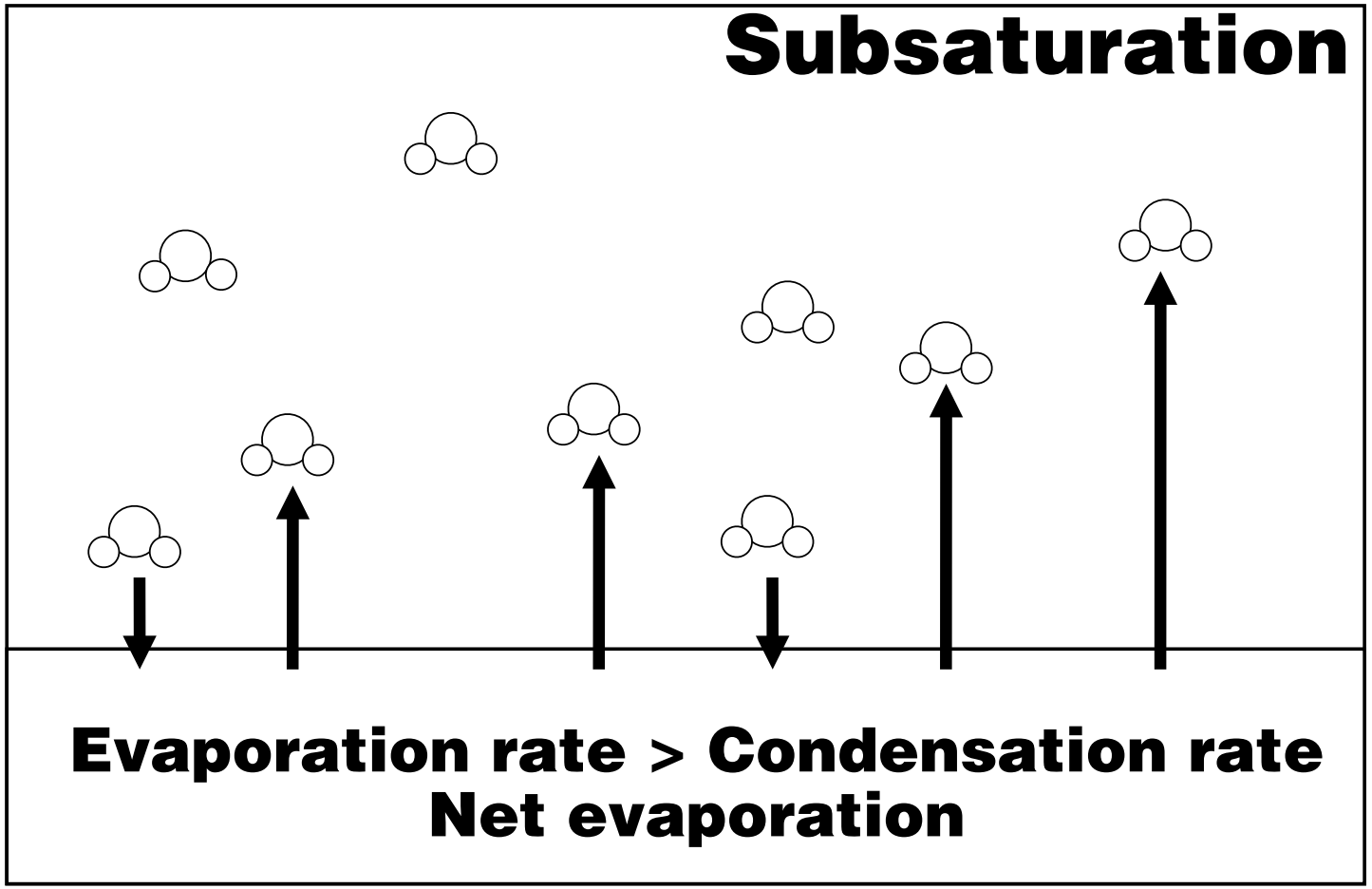
Basic Concepts

- **Evaporation: Adds vapor to the air**
- **Condensation: Removes vapor from the air**

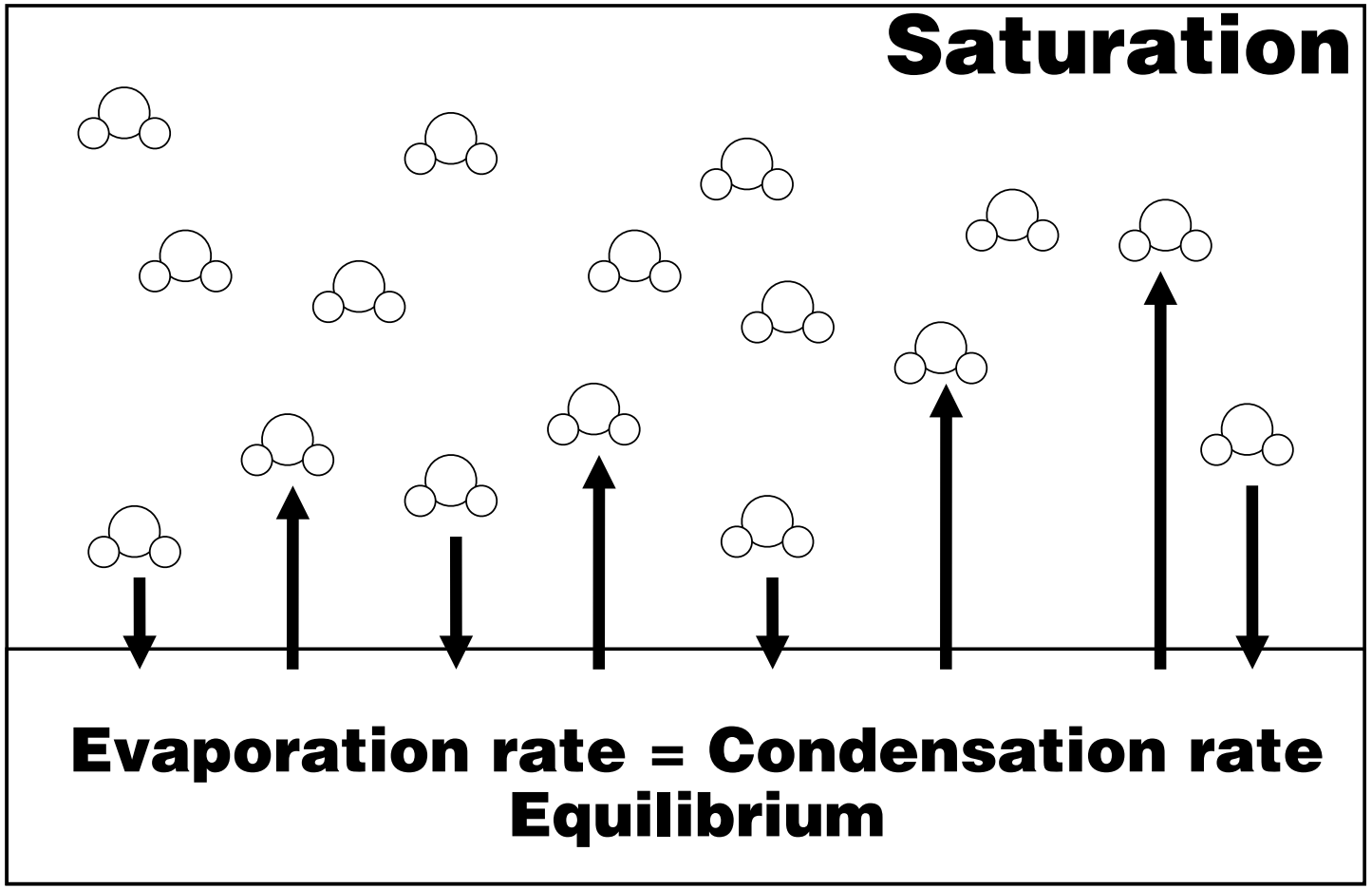


- **Case: liquid water inside a closed container with no air. Water begins to evaporate into the air space. . .**

Saturation of Air With Water Vapor

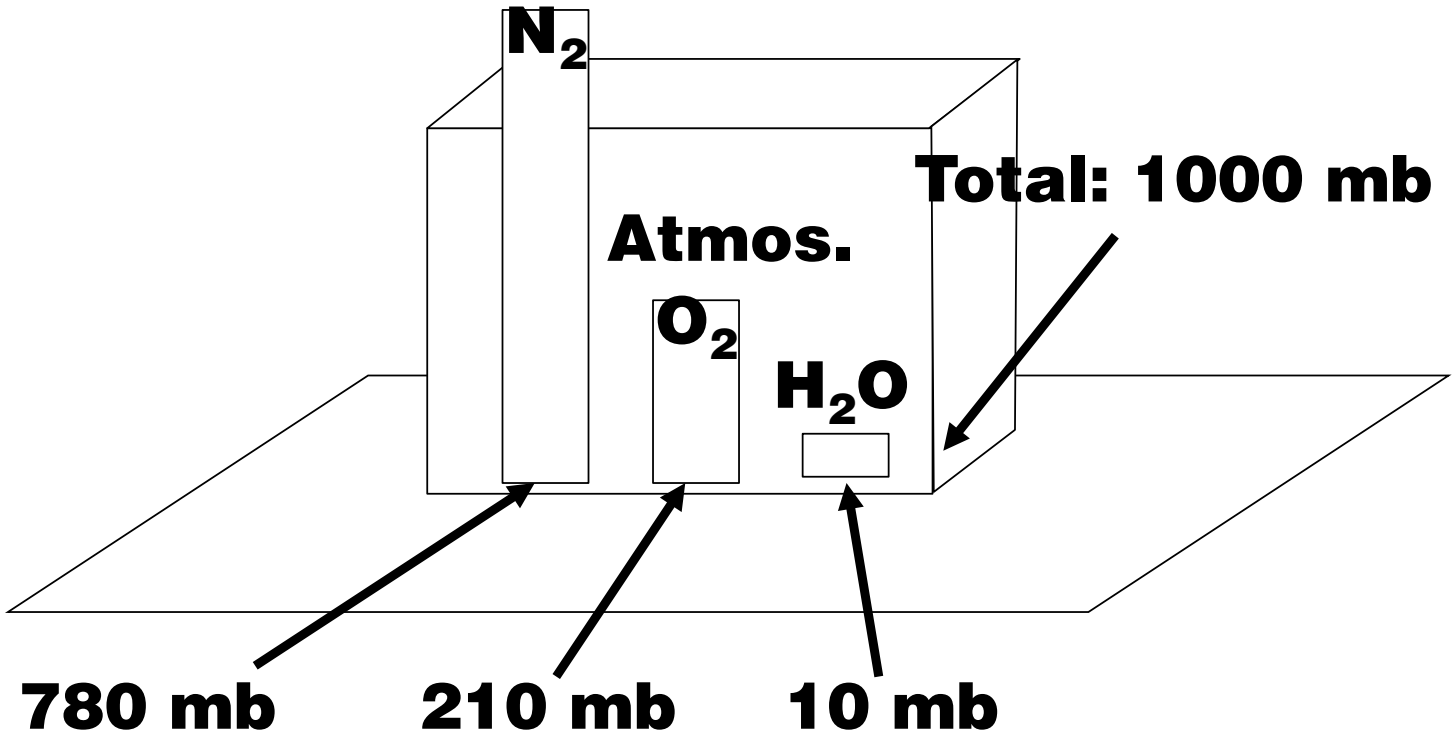


Saturation of Air With Water Vapor



Vapor Pressure (e)

Unit of pressure: millibar (mb) = 0.001 bar



Dalton's Law: The total pressure exerted by a mixture of gases is the sum of the partial pressures of each gas

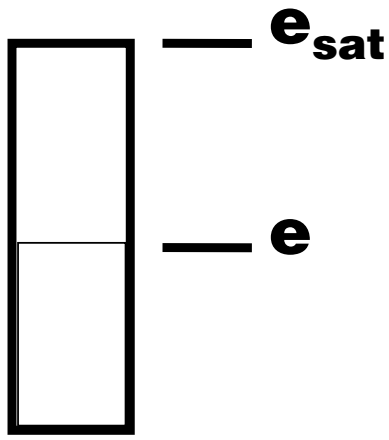
More Humidity

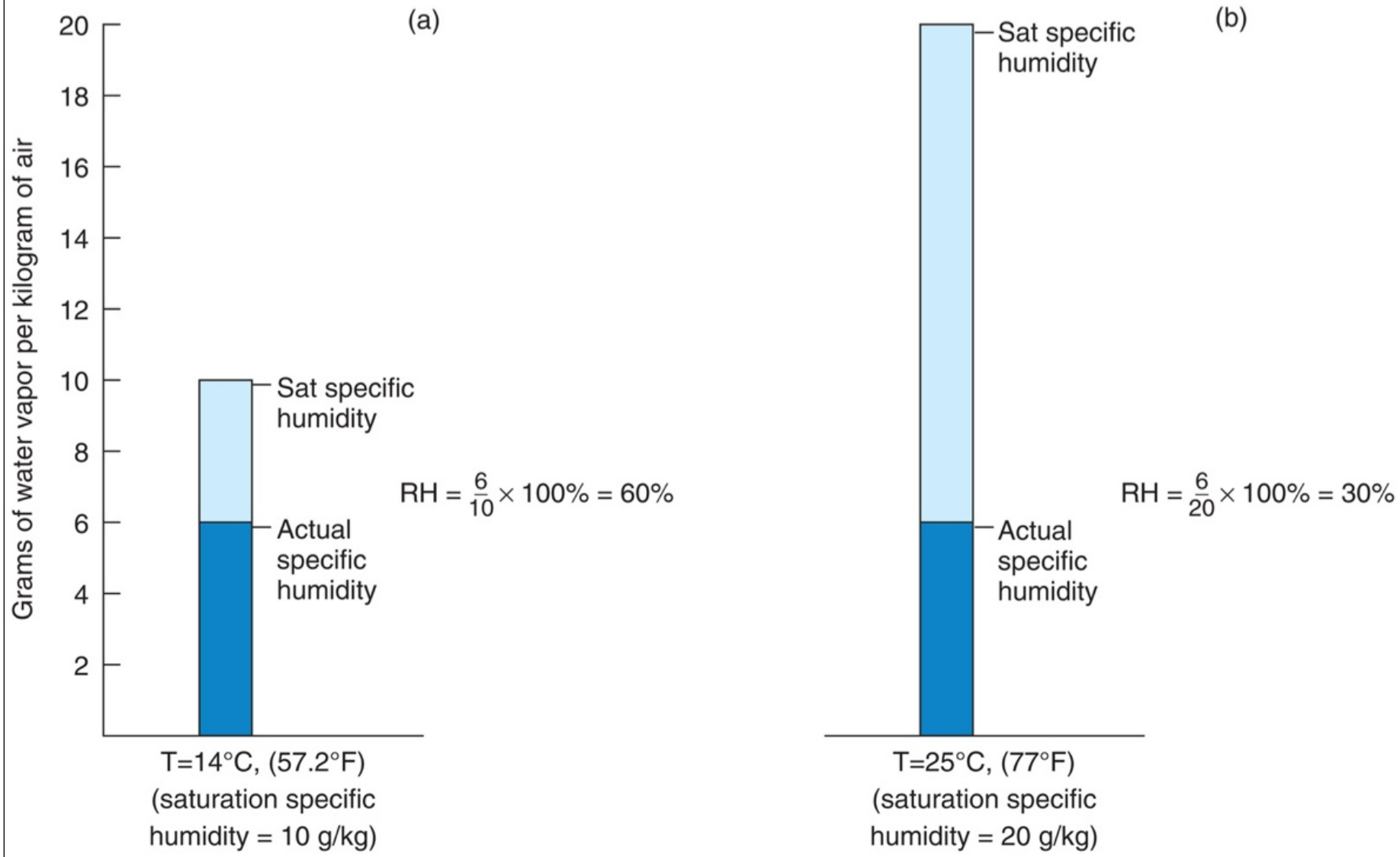
- **Absolute Humidity**
  - → **Mass of water vapor per unit volume of air (g/m^3)**
- **Specific Humidity**
  - → **Mass of water vapor per unit mass of air (including the water vapor) (g/kg)**
- **Mixing Ratio**
  - → **Mass of water vapor per unit mass of dry air (not including the water vapor) (g/kg)**

Relative Humidity

A fraction representing the amount of water vapor in the air vs. the amount of vapor needed to saturate the air

$$RH\ (\%) = \frac{e_{actual}}{e_{saturation}} \times 100\%$$

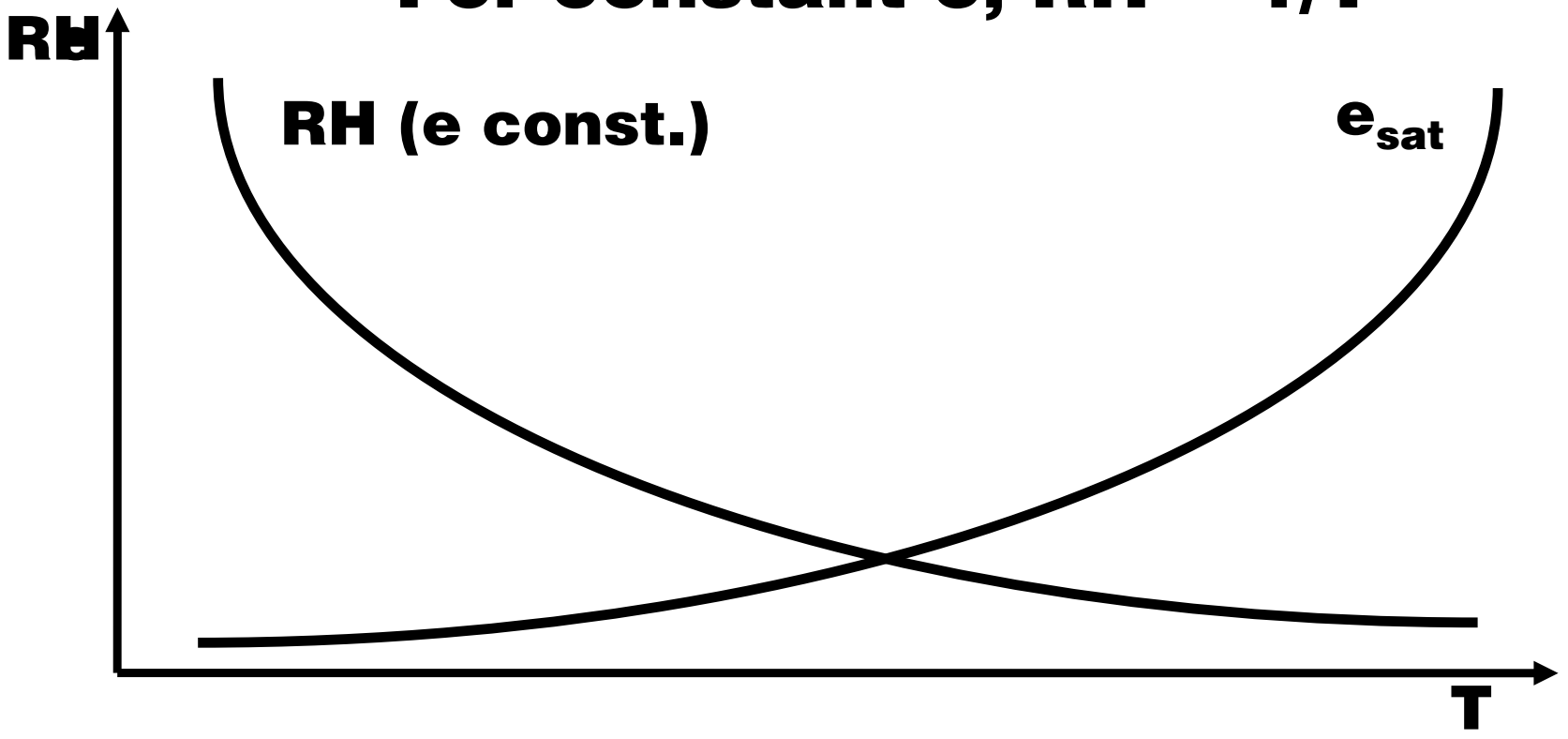


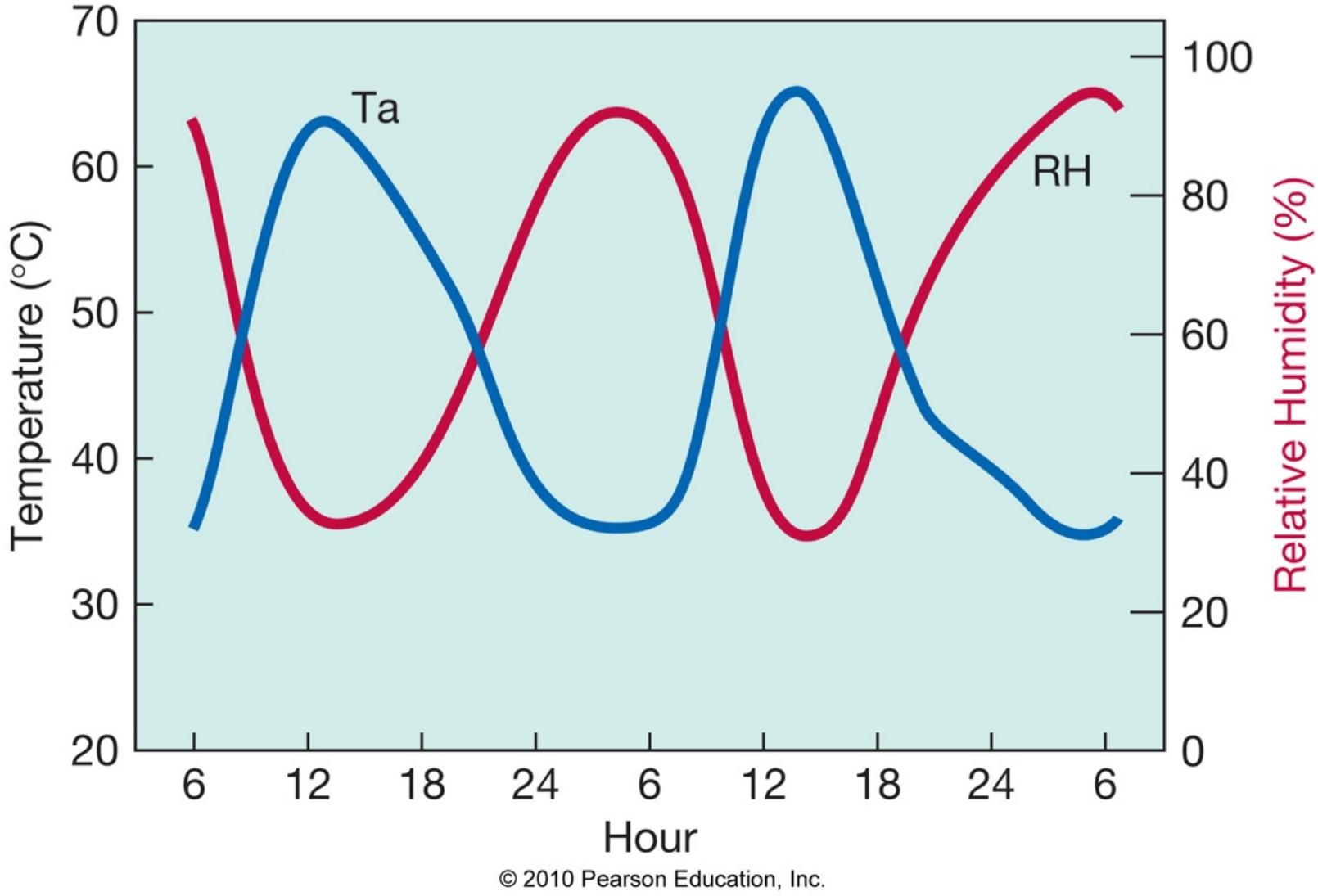


RH vs. Temperature

$e_{sat} \propto$ Temperature

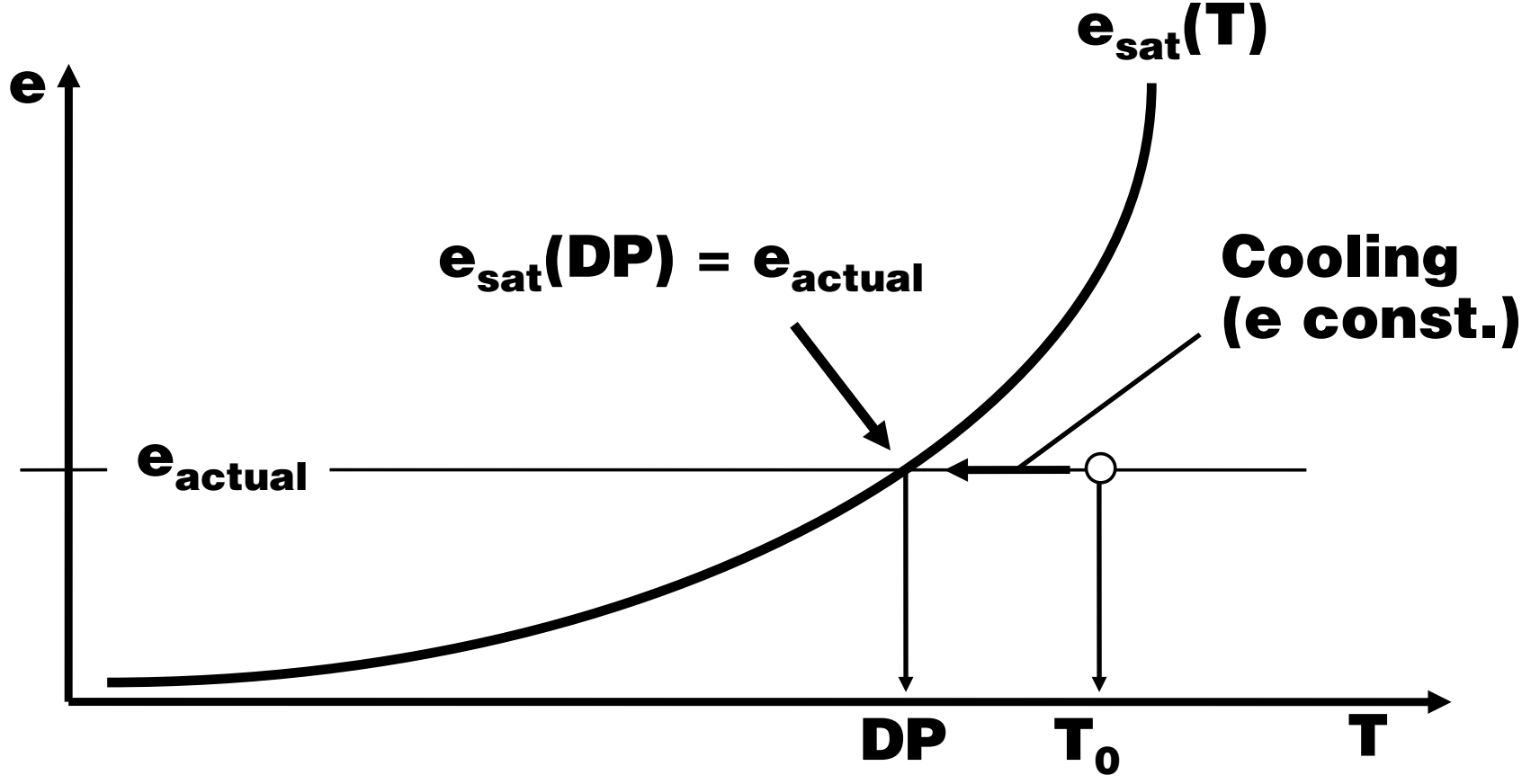
— For constant e, RH $\propto$ 1/T





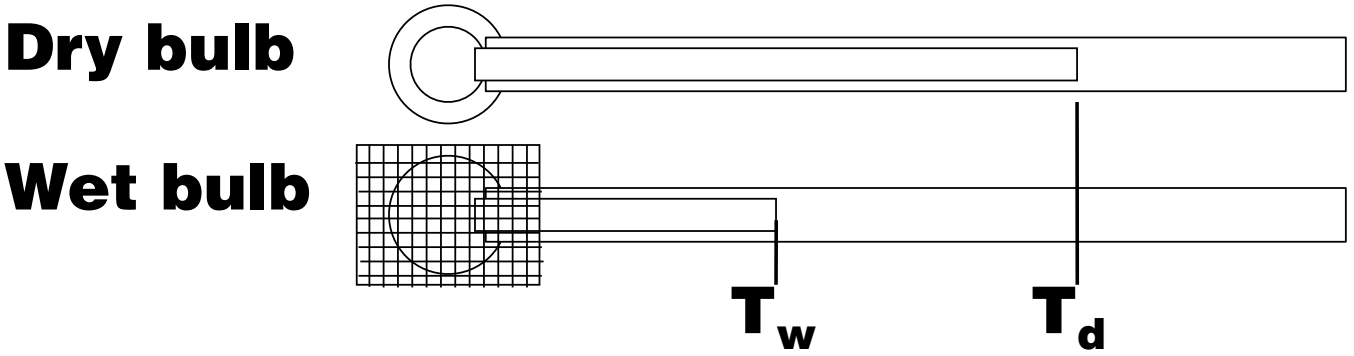
Dew Point Temperature

Temperature to which air is cooled at constant pressure in order to produce saturation



Hygrometers

Psychrometer: Wet-bulb thermometer measures temperature to which objects are cooled by evaporation of water. Dry-bulb thermometer indicates current air temperature.



Wet-bulb depression: $T_d - T_w$

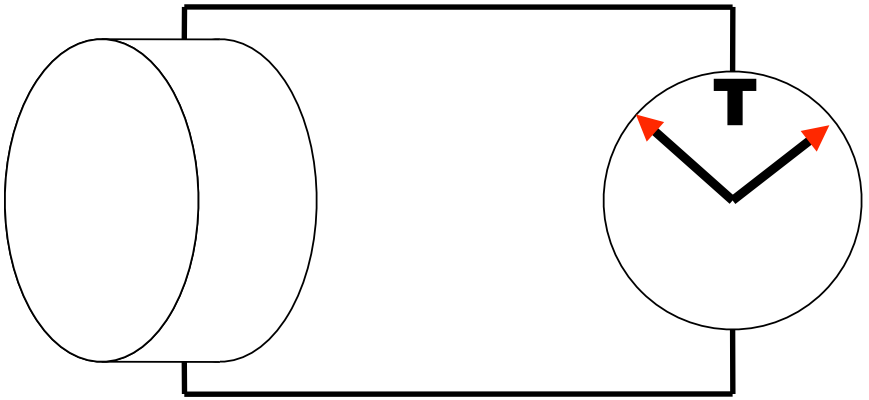
Small RH $\rightarrow$ large evaporation rate

$\rightarrow$ Low wet-bulb temperature

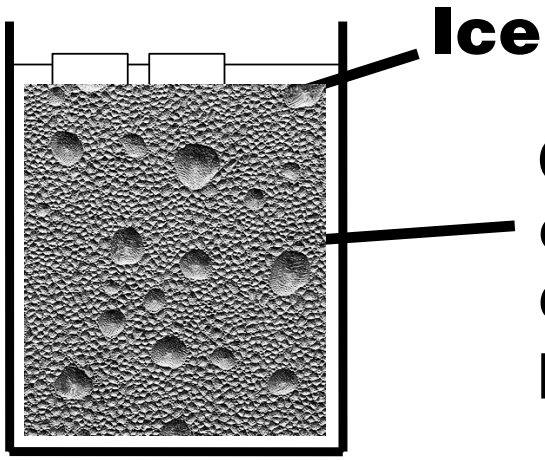
$\rightarrow$ Large wet-bulb depression

Dew Cell

Cool a mirror until condensation forms; mirror temperature = dew point temperature



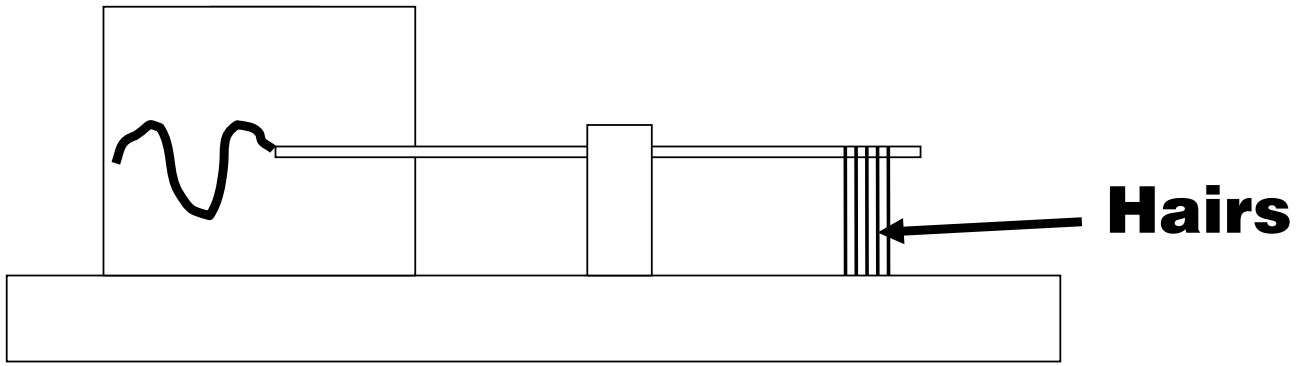
Poor Man's Dew Cell



Condensation forms on cup when it cools down to the dew point temp.

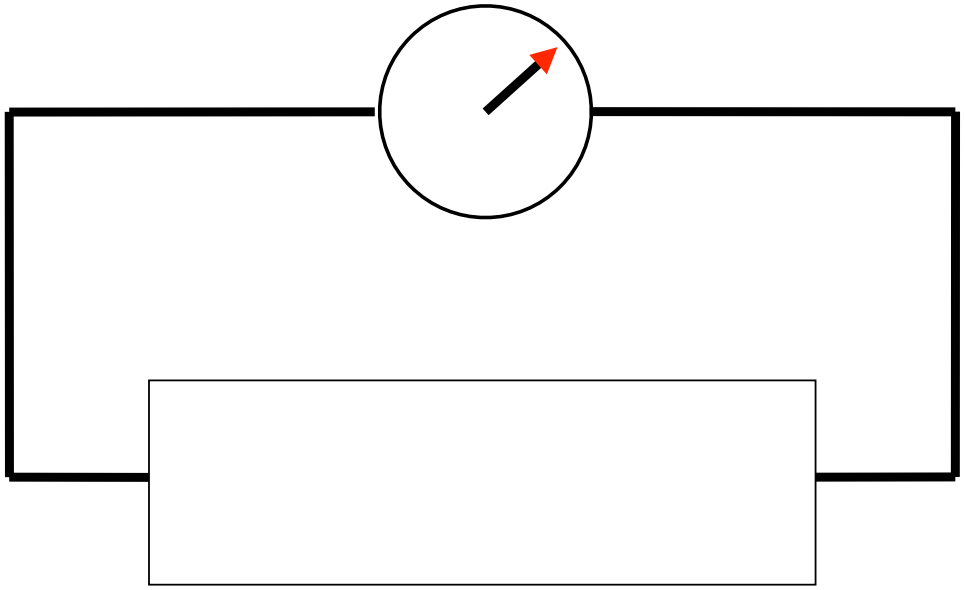
Hair Hygrometer

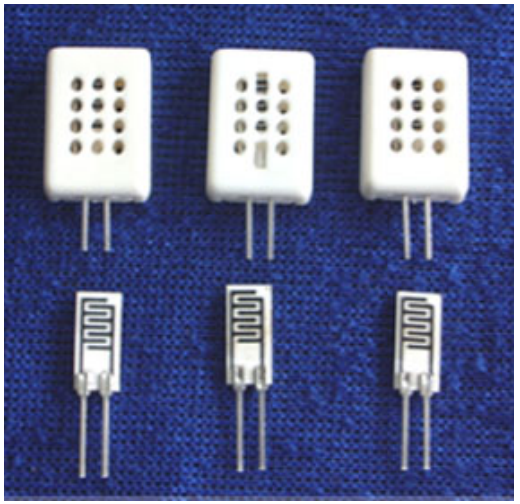
Hair lengthens as relative humidity increases.



Carbon Resistance Hygrometer

As the vapor pressure increases, the pores between particles of carbon in a carbon resistor ("hygristor") increases, lowering the resistance to an electric current.

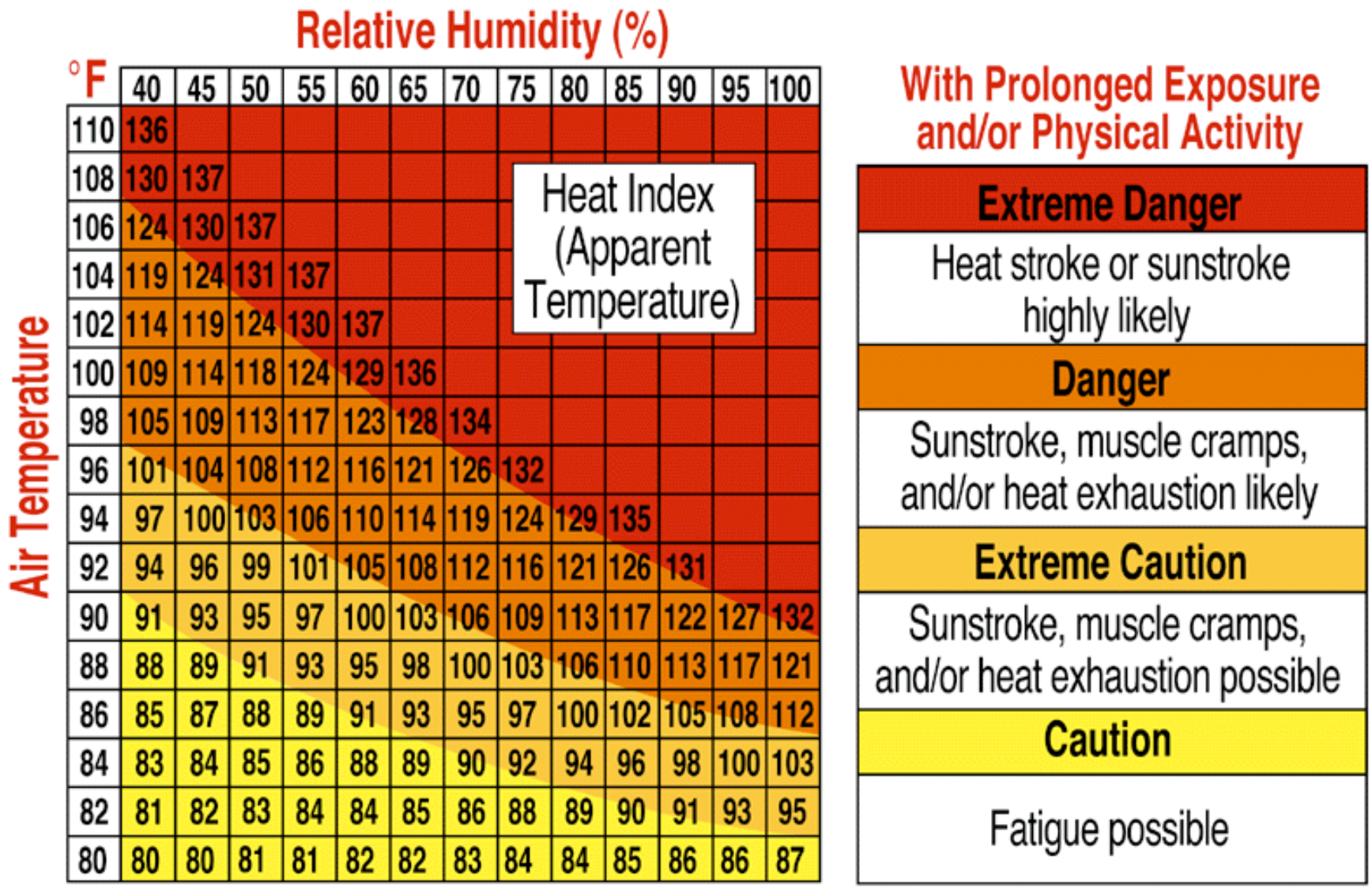




Resistance $\propto$ 1/e

Perceived Temperature: Heat Index

- **At high air temperatures, human body cools by evaporation of sweat**
- **At high relative humidity:**
  - **→ Low evaporation rate**
  - **→ Less latent heat absorbed; less cooling of body**
  - **➡ Higher perceived temperature**


Relative Humidity (%)
°F
40 45 50 55 60 65 70 75 80 85 90 95 100
110 136
108 130 137
106 124 130 137
104 119 124 131 137
102 114 119 124 130 137
100 109 114 118 124 129 136
98 105 109 113 117 123 128 134
96 101 104 108 112 116 121 126 132
94 97 100 103 106 110 114 119 124 129 135
92 94 96 99 101 105 108 112 116 121 126 131
90 91 93 95 97 100 103 106 109 113 117 122 127 132
88 88 89 91 93 95 98 100 103 106 110 113 117 121
86 85 87 88 89 91 93 95 97 100 102 105 108 112
84 83 84 85 86 88 89 90 92 94 96 98 100 103
82 81 82 83 84 84 85 86 88 89 90 91 93 95
80 80 80 81 81 82 82 83 84 84 85 86 86 87
Heat Index (Apparent Temperature)
Air Temperature
With Prolonged Exposure and/or Physical Activity
Extreme Danger
Heat stroke or sunstroke highly likely
Danger
Sunstroke, muscle cramps, and/or heat exhaustion likely
Extreme Caution
Sunstroke, muscle cramps, and/or heat exhaustion possible
Caution
Fatigue possible