Today, we will:

- Finish Section 1.5 – Fundamentals
- Do some example problems
- Begin overview of Chapter 2 – The Respiratory System

Sec. 1.5.7 Relative Humidity

\[ \Phi = RH = \frac{\text{Actual Partial Pressure of water vapor}}{\text{Partial Pressure of saturated water vapor at the same } T} \]

\[ 0 \leq \Phi \leq 1 \]

\[ P_v = P_{\text{set } H_2O} \text{ or } P_{\text{set } H_2O} \text{ in thermodynamics often assumed same} \]

\[ \text{Therm. call it } P_{\text{set}} \]

\[ \text{Fl. } \Phi \rightarrow \Phi \text{ same } P_v = \text{vapor pressure} \]

\[ \Phi = \frac{P_{H_2O}}{P_v} \times 100\% \]

\[ P_{H_2O} = P_j \text{ with } j = H_2O \text{ (water vapor)} \]

\[ P_{\text{set}} = \text{The pressure at which water boil} \]

\[ \text{at a given temperature} \]

\[ = \text{ fun. } (T) \]

See App. A.17
Example

Given: A hot summer day:

- $T = 95.0^\circ F (35.0^\circ C)$
- $P = 99.6$ kPa
- $\phi = 90.0\%$ (90\% relative humidity)

To do: Calculate the mole fraction of water vapor in the air (in units of PPM).

Solution:

At $T = 35.0^\circ C$ → look up Table A.17

$$P_{\text{sat}} = P_v @ T = 35.0^\circ C \approx 5.628 \text{ kPa}$$

Recall, $\phi = \frac{P_{H_2O}}{P_v H_2O} \rightarrow P_{H_2O} = \phi \cdot P_v H_2O$

Recall, $y_i = \frac{P_i}{P} \rightarrow y_{H_2O} = \frac{P_{H_2O}}{P_{\text{tot}}}$

$$y_{H_2O} = \frac{\phi \cdot P_{H_2O}}{P_{\text{tot}}} = \text{mole fraction of H}_2\text{O in the air}$$

This gives:

$$y_{H_2O} = \frac{(0.900) (5.628 \text{ kPa})}{99.6 \text{ kPa}} = 0.0509 \text{ or } 5.09\%$$

$\times 10^6$ to get PPM $\rightarrow y_{H_2O} = 51,000 \text{ PPM}$

- If $\phi = 100\%$, the air is saturated (it can hold no more!)
- If you try to put more water vapor into the air, the water will condense

In Meteorology → this can be used to predict rain.
Example

Given: The same hot summer day as in the previous example:

- $T = 95.0\,^\circ\text{F} (35.0\,^\circ\text{C})$
- $P = 99.6\,\text{kPa}$
- $\phi = 90.0\%$ (90% relative humidity)
- Now the temperature drops rapidly to $86.0\,^\circ\text{F} (30.0\,^\circ\text{C})$ (cold front)
- At the same time, the pressure drops to 98.5 kPa

To do: Calculate the new relative humidity of water vapor in the air and discuss.

Solution:

\[ Y_{\text{H}_2\text{O}} = 0.0509 \quad \text{from previous problem} \]

Recall, $Y_0$ is independent of $T$ and $P$

The air is at  $20.0\,^\circ\text{C}$, $P_{\text{v}_{\text{H}_2\text{O}}} = 4.246\,\text{kPa}$

\[ \phi = \frac{Y_{\text{H}_2\text{O}} \cdot P_{\text{atm}}}{P_{\text{v}_{\text{H}_2\text{O}}}} = \frac{(0.0509)(98.5\,\text{kPa})}{4.246\,\text{kPa}} = 1.18 \]

\( \phi = 118\% \)

- We predict that it will rain!  \( \phi = 100\% \)

Sec. 1.5.6 Liquid mixture — read

Main fraction is $\omega$ of $Y$

\[ X_j = \frac{n_j}{n_t} \quad \text{for mol fraction} \]

Sec. 1.6-1.12 — Read, not qualitative
CHAPTER 2 - THE RESPIRATORY SYSTEM

Read — mostly qualitative, learn some terminology

Sec. 2.1 - Physiology

Total surface area of the lungs is \( \sim 100 \text{ m}^2 \)
(half the area of a tennis court)

See website or book for details

\[ V_t = \text{tidal volume} \quad \text{normal breathing @ rest} \]
\[ V_{vc} = \text{vital capacity} \quad \text{typ. 500 mL} \]

\[ V_b = 11\% \text{ of the vital capacity} \]

\[ V_r = \text{residual volume} \quad \text{left over} \quad \text{typ. 1.2 L} \]

\[ V_j = \text{Anatomic dead space} \quad \text{typ. 150 mL} \]

\[ V = \text{total lung capacity} = V_{vc} + V_r \]

\[ \text{typ. } 4600 + 1200 \text{ mL } \approx 5800 \text{ mL} \]

\( (5.8 \text{ L}) \)
Fig. 2.14 → The Bohr Model

- $V_d =$ dead space volume
- Inner rigid portion of the lungs

Atmospheric volume $V_a$
(expandable portion of the lungs)

$V_a =$ volume of air
in the Bohr model

$(V_a(t))$