(1) How many pounds in a cup of mercury?

Data: Density of mercury @ 25°C = 13.5 g/cm³

4 cups = 1 qt; 16 cups = 1 gal (Ref: Merck Index v. 11)

\[
\frac{1}{\text{cup}} \times \frac{13.5 \text{ g}}{\text{cm}^3} \times \frac{\text{cm}^3}{\text{mL}} \times \frac{1000 \text{ mL}}{\text{L}} \times \frac{\text{L}}{0.2642 \text{ gal}} \times \frac{\text{gal}}{16 \text{ cups}} \times \frac{16}{453.29 \text{ g}}
\]

= 7.05 lbs

Note: The common saying "a pint's a pound the world around" applies to water at around room temperature ...

\[
\frac{1}{\text{pt}} \times \frac{1.0 \text{ g}}{\text{cm}^3} \times \frac{\text{cm}^3}{\text{mL}} \times \frac{1000 \text{ mL}}{\text{L}} \times \frac{\text{L}}{0.2642 \text{ gal}} \times \frac{\text{gal}}{8 \text{ pints}} \times \frac{16}{453.29 \text{ g}}
\]

= 1.04 lbs
(2) Find the mass fraction of NaOH in an 8M NaOH solution.

Data: Density of 8M NaOH @ 20°C = 1.275 g/cm³

(Ref: Handbook of Chemistry & Physics)

If we select 1 liter as a basis for calculations:

\[ \text{M}_{\text{NaOH}} = 1.0 \text{L} \times \frac{8 \text{ mol}}{\text{L}} \times \frac{40.0 \text{ g NaOH}}{\text{mol}} = 320.0 \text{ g NaOH} \]

\[ \text{M}_{\text{TOTAL}} = 1.0 \text{L} \times \frac{1.275 \text{ g}}{\text{ml}} \times \frac{1000 \text{ml}}{\text{L}} = 1275 \text{ g soln} \]

\[ \omega_{\text{NaOH}} = \frac{320.0 \text{ g NaOH}}{1275 \text{ g soln}} = 0.251 \]
3) What are the mole fraction and mass fraction of carbon in acetic acid?

**Acetic Acid** = CH₃COOH  \( M_{AA} = 60.0 \text{ g/mol} \)

**If we select 1.0 mole of acetic acid as a basis for our calculations:**

- \# moles of atoms = 8
- \# moles of C = 2

\[ X_c = \frac{\text{moles C}}{\text{moles total}} = \frac{2}{8} = 0.25 \]

\[ M_{tot} = 1.0 \text{ mol AA} \times \frac{60.0 \text{ g AA}}{\text{mol AA}} = 60.0 \text{ g AA} \]

\[ M_c = 1.0 \text{ mol AA} \times \frac{2 \text{ mol C}}{\text{mol AA}} \times \frac{12.0 \text{ g C}}{\text{mol C}} = 24.0 \text{ g C} \]

\[ W_c = \frac{24.0 \text{ g C}}{60.0 \text{ g AA}} = 0.40 \]
If exhaled breath is 5.0% by mass CO₂, what is partial pressure of CO₂ in 16.1 psi balloon?

Molecular weights: \( M_{\text{Air}} = 29.0 \text{ g/mol} \)
\( M_{\text{CO₂}} = 44.0 \text{ g/mol} \)

In balloon: \( w_{\text{Air}} = 0.95 \)
\( w_{\text{CO₂}} = 0.05 \)

\[
Y_{\text{CO₂}} = \frac{w_{\text{CO₂}}}{M_{\text{CO₂}}} + \frac{w_{\text{Air}}}{M_{\text{Air}}} = \frac{0.05}{44} + \frac{0.95}{29} = 0.0335
\]

\[
P_{\text{CO₂}} = Y_{\text{CO₂}} P = (0.0335)(16.1 \text{ psi}) = 0.540 \text{ psi}
\]
5) What is the maximum mass fraction of ethanol that can exist as vapor at 35°C and 775 mm Hg?

ConcePt: The maximum mass fraction occurs when the air is saturated with ethanol.

First, find vapor pressure of ethanol @ 35°C

\[ \log p_e^* = 8.32109 - \frac{1718.10}{35 + 237.52} \]  
\[ p_e^* = 103.9 \text{ mm Hg} \]

If air is saturated with ethanol, then \( p_e = p_e^* = 103.9 \text{ mm Hg} \)

\[ y_e = \frac{p_e}{p} = \frac{103.9 \text{ mm Hg}}{775 \text{ mm Hg}} = 0.134 \]

\[ \omega_e = \frac{x_e M_e}{x_e M_e + x_{\text{air}} M_{\text{air}}} = \frac{(0.134)(46.1)}{(0.134)(46.1) + (0.866)(29)} = 0.197 \]