3.19 Assume 100 mol mix.

$$m_{C_2H_5OH} = \frac{10.0 \text{ mol } C_2H_5OH \mid 46.07 \text{ g } C_2H_5OH}{\text{mol } C_2H_5OH} = 461 \text{ g } C_2H_5OH$$

$$m_{C_4H_8O_2} = \frac{75.0 \text{ mol } C_4H_8O_2 \mid 88.1 \text{ g } C_4H_8O_2}{\text{mol } C_4H_8O_2} = 6608 \text{ g } C_4H_8O_2$$

$$m_{CH_3COOH} = \frac{15.0 \text{ mol } CH_3COOH \mid 60.05 \text{ g } CH_3COOH}{\text{mol } CH_3COOH} = 901 \text{ g } CH_3COOH$$

$$x_{C_2H_5OH} = \frac{461 \text{ g}}{461 \text{ g} + 6608 \text{ g} + 901 \text{ g}} = \underline{0.0578 \text{ g } C_2H_5OH / \text{g mix}}$$

$$x_{C_4H_8O_2} = \frac{6608 \text{ g}}{461 \text{ g} + 6608 \text{ g} + 901 \text{ g}} = \underline{\underline{0.8291 \text{ g } C_4H_8O_2 / \text{g mix}}}$$

$$x_{CH_3COOH} = \frac{901 \text{ g}}{461 \text{ g} + 6608 \text{ g} + 901 \text{ g}} = \underline{0.113 \text{ g } CH_3COOH / \text{g mix}}$$

$$\overline{MW} = \frac{461 \text{ g} + 6608 \text{ g} + 901 \text{ g}}{100 \text{ mol}} = \underline{79.7 \text{ g / mol}}$$

$$m = \frac{25 \text{ kmol EA} \mid 100 \text{ kmol mix} \mid 79.7 \text{ kg mix}}{75 \text{ kmol EA} \mid 1 \text{ kmol mix}} = \underline{2660 \text{ kg mix}}$$

3.28 **(a)** Basis: 1 liter of solution

$$\frac{1000 \text{ mL} \mid 1.03 \text{ g} \mid 5 \text{ g } H_2SO_4 \mid \text{mol } H_2SO_4}{\text{mL} \mid 100 \text{ g} \mid 98.08 \text{ g } H_2SO_4} = 0.525 \text{ mol / L} \Rightarrow \underline{0.525 \text{ molar solution}}$$

(b) $$t = \frac{V}{\dot{V}} = \frac{55 \text{ gal} \mid 3.7854 \text{ L} \mid \text{min} \mid 60 \text{ s}}{\text{gal} \mid 87 \text{ L} \mid \text{min}} = \underline{\underline{144 \text{ s}}}$$

$$\frac{55 \text{ gal} \mid 3.7854 \text{ L} \mid 10^3 \text{ mL} \mid 1.03 \text{ g} \mid 0.0500 \text{ g } H_2SO_4 \mid 1 \text{ lbm}}{\text{gal} \mid 1 \text{ L} \mid \text{mL} \mid \text{g} \mid 453.59 \text{ g}} = \underline{\underline{23.6 \text{ lb}_m \text{ } H_2SO_4}}$$

(c) $$u = \frac{\dot{V}}{A} = \frac{87 \text{ L} \mid \text{m}^3 \mid 1 \text{ min} \mid}{\text{min} \mid 1000 \text{ L} \mid 60 \text{ s} \mid (\pi \times 0.06^2 / 4) \text{ m}^2} = 0.513 \text{ m / s}$$

$$t = \frac{L}{u} = \frac{45 \text{ m}}{0.513 \text{ m / s}} = \underline{\underline{88 \text{ s}}}$$

3.43 $P_{\text{atm}} = \rho_f g(7.23\text{ m}) \Rightarrow \rho_f = \dfrac{P_{\text{atm}}}{7.23\text{ g}}$

$$P_a - P_b = (\rho_f - \rho_w)g(26\text{ cm}) = \left(\frac{P_{\text{atm}}}{7.23\text{ m}} - \rho_w g\right)(26\text{ cm})$$

$$= \left(\frac{756\text{ mm Hg}}{7.23\text{ m}} \left|\frac{1\text{ m}}{100\text{ cm}}\right. - \frac{1000\text{ kg}}{\text{m}^3} \left|\frac{9.81\text{ m/s}^2}{}\right. \left|\frac{1\text{ N}}{1\text{ kg}\cdot\text{m/s}^2}\right. \left|\frac{760\text{ mm Hg}}{1.01325\times10^5\text{ N/m}^2}\right. \left|\frac{1\text{ m}}{100\text{ cm}}\right.\right)(26\text{ cm})$$

$$\Rightarrow P_a - P_b = \underline{\underline{8.1\text{ mm Hg}}}$$

3.47 **(a)** Let ρ_f = manometer fluid density $\left(1.10\text{ g/cm}^3\right)$, ρ_{ac} = acetone density $\left(0.791\text{ g/cm}^3\right)$

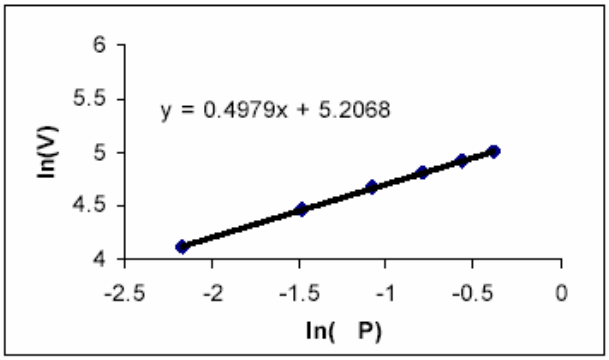
Differential manometer formula: $\Delta P = (\rho_f - \rho_{ac})gh$

$$\Delta P(\text{mm Hg}) = \frac{(1.10-0.791)\text{g}}{\text{cm}^3} \left|\frac{981\text{ cm}}{\text{s}^2}\right. \left|\frac{\text{h (mm)}}{}\right. \left|\frac{1\text{ cm}}{10\text{ mm}}\right. \left|\frac{1\text{ dyne}}{1\text{ g}\cdot\text{cm/s}^2}\right. \left|\frac{760\text{ mm Hg}}{1.01325\times10^6\text{ dyne/cm}^2}\right.$$

$$= 0.02274\text{ h(mm)}$$

$\dot{V}$(mL/s)	62	87	107	123	138	151
h(mm)	5	10	15	20	25	30
ΔP(mm Hg)	0.114	0.227	0.341	0.455	0.568	0.682

(b) $\ln\dot{V} = n\ln(\Delta P) + \ln K$



From the plot above, $\ln\dot{V} = 0.4979\ \ln(\Delta P) + 5.2068$

$$\Rightarrow \underline{\underline{n = 0.4979 \approx 0.5}},\ \ln K = 5.2068 \Rightarrow \underline{\underline{K = 183\frac{\text{ml/s}}{(\text{mm Hg})^{0.5}}}}$$

(c) $h = 23 \Rightarrow \Delta P = (0.02274)(23) = 0.523 \text{ mm Hg} \Rightarrow \dot{V} = 183(0.523)^{0.5} = \underline{132 \text{ mL/s}}$

$$\frac{132 \text{ mL}}{\text{s}} \left| \frac{0.791 \text{ g}}{\text{mL}} \right. = \underline{104 \text{ g/s}} \qquad \frac{104 \text{ g}}{\text{s}} \left| \frac{1 \text{ mol}}{58.08 \text{ g}} \right. = \underline{1.80 \text{ mol/s}}$$

3.48 **(a)** $T = 85°\text{F} + 459.7 = \underline{544°\text{R}} / 1.8 = \underline{303 \text{ K}} - 273 = \underline{30°\text{C}}$

(b) $T = -10°\text{C} + 273 = \underline{263 \text{ K}} \times 1.8 = \underline{474°\text{R}} - 460 = \underline{14°\text{F}}$

(c) $\Delta T = \dfrac{85°\text{C}}{1.0°\text{C}} \left| \dfrac{1.0°\text{K}}{1.0°\text{C}} \right. = \underline{85°\text{K}}; \quad \dfrac{85°\text{C}}{1°\text{C}} \left| \dfrac{1.8°\text{F}}{1°\text{C}} \right. = \underline{153°\text{F}}; \quad \dfrac{85°\text{C}}{1.0°\text{C}} \left| \dfrac{1.8°\text{R}}{1.0°\text{C}} \right. = \underline{153°\text{R}}$

(d) $\dfrac{150°\text{R}}{1°\text{R}} \left| \dfrac{1°\text{F}}{1°\text{R}} \right. = \underline{150°\text{F}}; \quad \dfrac{150°\text{R}}{1.8°\text{R}} \left| \dfrac{1.0°\text{K}}{1.8°\text{R}} \right. = \underline{83.3°\text{K}}; \quad \dfrac{150°\text{R}}{1.8°\text{R}} \left| \dfrac{1.0°\text{C}}{1.8°\text{R}} \right. = \underline{83.3°\text{C}}$