1. Use the following two facts to answer the questions below
   - $SO_2(g)$ $k_H = 1.3\,\frac{\text{mol}}{\text{kg}\cdot\text{bar}}$
   - $Na_2S_2O_3(s)$ solubility increases with temperature

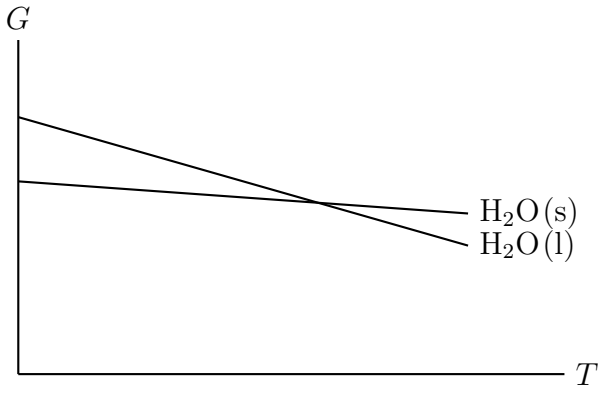
   (a) What is the sign of ΔH_{sol} for $SO_2(g)$

   ☐ $\Delta H_{\text{sol}} > 0$ ☐ $\Delta H_{\text{sol}} = 0$ ☐ $\Delta H_{\text{sol}} < 0$

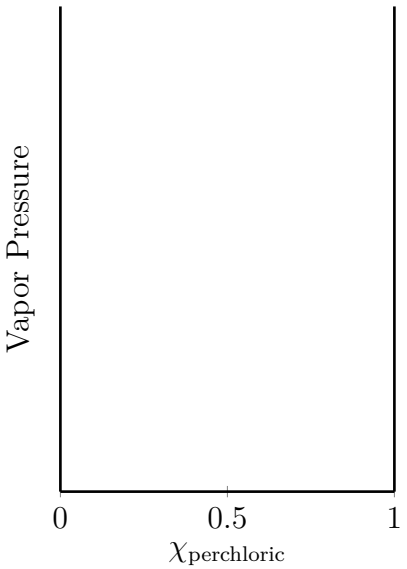
   (b) What is the sign of ΔH_{sol} for $Na_2S_2O_3(s)$

   ☐ $\Delta H_{\text{sol}} > 0$ ☐ $\Delta H_{\text{sol}} = 0$ ☐ $\Delta H_{\text{sol}} < 0$

   (c) Draw lines for the aqueous solutions of equimolar $SO_2(g)$ and $Na_2S_2O_3(s)$ in water. You should consider the relative melting points, relative slopes, and the answers to ΔH_{sol}.



2. Pure perchloric acid ($HClO_4$) has a boiling point of 110 °C. A solution of perchloric acid and water that is 71.6 % by mass $HClO_4$ has a boiling point of 203 °C. On the graph below, sketch both the ideal and real vapor pressure curves for the $HClO_4$/water mixture, labeling both lines. No azeotropes are formed.



3. A mixture of chloroform and n-hexane has a boiling point of 60 °C. What is the sign of ΔH_{mix}?

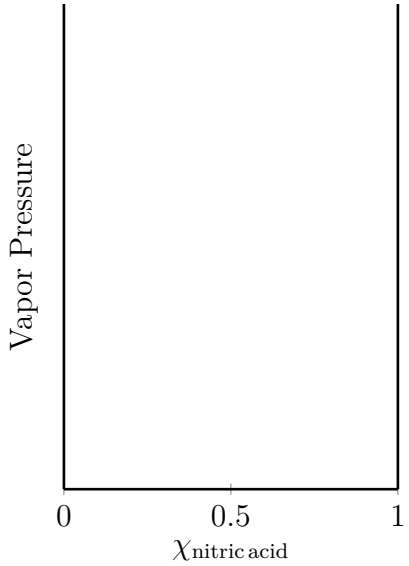
	molar mass	bp	P_{vap} at 25 °C
chloroform	119.38 $\frac{\text{g}}{\text{mol}}$	61.15 °C	0.21 bar
n-hexane	86.18 $\frac{\text{g}}{\text{mol}}$	—	0.17 bar

4. Nitric acid has a boiling point of 86 °C. A mixture of nitric acid and water form an azeotrope at a mol fraction of 0.7 has a boiling point of 120 °C.

   (a) What is the sign of ΔH_{mix}?

   (b) If you mix nitric acid with water in lab, will the solution feel warm or cold to touch?

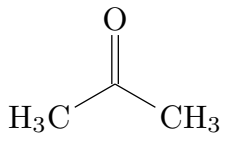
   (c) Sketch the ideal and real vapor pressure curves for this mixture, labeling each, on the figure to the right.



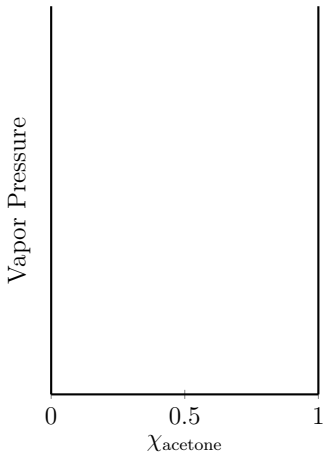
5. Benzene and toluene form an ideal mixture. The vapor pressure of pure benzene at 298 K is 0.125 atm. The vapor pressure of pure toluene at 298 K is 0.038 atm. The mol fraction of benzene in the liquid phase is 0.40. What is the total vapor pressure of the solution and the mol fraction of benzene in the gas phase?

$$\begin{aligned} P_{\text{vap,soln}} &= \chi_{\text{benz (l)}}\, P^{\text{benz}}_{\text{vap}} + \chi_{\text{tol (l)}}\, P^{\text{tol}}_{\text{vap}} \\ &= 0.0500\,\text{atm} + 0.0228\,\text{atm} \\ &= \boxed{0.0728\,\text{atm}} \\ \chi_{\text{benz (g)}} &= \frac{\chi_{\text{benz (l)}}\, P^{\text{benz}}_{\text{vap}}}{P_{\text{total}}} \\ &= \frac{(0.40)(0.125\,\text{atm})}{0.0728\,\text{atm}} \\ &= \boxed{0.686} \end{aligned}$$

6. Sketch and label ideal and real vapor pressure curves for a mixture of acetone and hexane in the figure to the right. $\Delta H_{\text{mix}} > 0$. No azeotropes are formed.



Acetone Structure



Homework Problem 30

1. On the graphs below, sketch the vapor pressure and temperature of an ideal mixture of diethyl ether (MW = 74.12 $\frac{g}{mol}$, BP = 34.6 °C) and methyl formate (MW = 60.05 $\frac{g}{mol}$, BP = 32.0 °C), as well as that of a real mixture containing 44 % by mass diethyl ether, which has a boiling point of 28.2 °C. Label each line as ideal or real. No azeotropes are formed.