Exercise 8.2
Henry's Law and Raoult's Law

1.

(a) What two properties are related by Henry's law? What is the relationship?
In other words, as one property increases, what happens to the other one?

(b) What two properties are related by Raoult's law? What is the relationship?
In other words, as one property increases, what happens to the other one?

2. The value for any Henry's law constant is specific to the gas, solvent and temperature. The table below shows selected values for Henry's law constants of various gases in water at different temperatures:

Gas	k_H at 0 ℃ $\left(\frac{mol}{L \cdot bar}\right)$	k_H at 25 ℃ $\left(\frac{mol}{L \cdot bar}\right)$	k_H at 30 ℃ $\left(\frac{mol}{L \cdot bar}\right)$
He	0.00041	0.00038	0.00038
Ar	0.0025	0.0015	0.0010
CO	0.0016	0.00095	0.00044
CO_2	0.077	0.034	0.016
N_2	0.0011	0.00066	0.00040
O_2	0.0025	0.0013	0.00088

(a) Based on the data in the table above, does the solubility of a gas in water appear to increase or decrease as temperature is increased? How can you tell?

(b) Based on the data in the table above, which of these gases has the highest solubility in water at 25 ℃? How can you tell?

3. Identify whether you would use Henry's law, Raoult's law or neither to answer each of the following questions. If either of the two laws can be used, you should also identify what information you would need to perform the calculation.

(a) Calculate the equilibrium vapour pressure of water above a pot of salted water.

(b) Calculate the pressure of helium in a balloon.

(c) Calculate the concentration of dissolved oxygen in a fish tank.

(d) Calculate the equilibrium vapour pressure of water above a bucket of pure water.

4. The equilibrium vapour pressure for water at 25 ℃ is 0.0317 bar. If a solution of 45 g sucrose ($C_{12}H_{22}O_{11}$) and 250 g water is poured into a drink container that is then sealed and stored at 25 ℃, what is the partial pressure of water vapour in the container when equilibrium is reached?

5. A popular science website explaining how to make your own beverage-carbonating device suggests that soda water can be prepared using 30 psi carbon dioxide and cold water. $(14.5\ psi = 1\ bar)$

(a) Calculate the concentration of dissolved carbon dioxide in the soda water if it is prepared using water at 0 ℃ and if it is prepared using water at 25 ℃. Why does the website recommend that the water be cold? *You will need to use data from the previous page…*

(b) The website also suggests that a person wanting to use the same technology to make carbonated alcoholic drinks should use 45 psi carbon dioxide since carbon dioxide has a higher solubility in alcohol than it does in water. Do you have enough information to calculate the concentration of dissolved carbon dioxide in a gin fizz if it is prepared at 0 ℃? If you do, do so. If you cannot, explain why not.