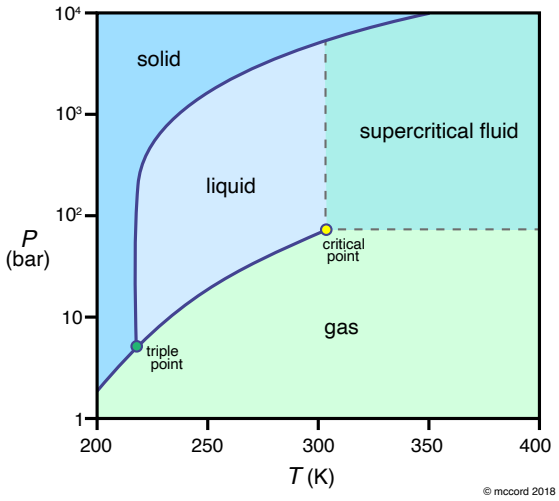
HW02 - Phase Diagrams & Colligative Properties

Question 1 — 1.5 pts

Use the phase diagram for CO_2 provided below to answer the following question:

At 300K and 10 bar, what is the stable phase of carbon dioxide?



a. solid carbon dioxide
b. liquid carbon dioxide
c. gaseous carbon dioxide
d. carbon dioxide as supercritical fluid

Question 2 — 1.5 pts

Use the phase diagram for CO_2 in the question above to answer the following:

A sample of carbon dioxide is stored at 10,000 bar and 250K. This sample is then decompressed to 1 bar at constant temperature. Then, at constant pressure it is heated to 400K. Next, it is compressed at constant temperature to 200 bar. According to the phase diagram, how many phase changes has the sample of carbon dioxide gone through, and what is its final state?

a. 2, gas
b. 3, supercritical fluid
c. 3, liquid
d. 2, supercritical fluid

Question 3 — 1.5 pts

_____ are made when _____ are dissolved in _____.

a. solutions, solutes, solvents
b. solutes, solutions, solvents
c. solutions, solvents, solutes
d. solvents, solutes, solutions

Question 4 — 1.5 pts

Both ammonia (NH_3) and phosphine (PH_3) are soluble in water. Which is least soluble and why?

a. phosphine because the P-H bonds are so strong that they cannot break to enable phosphine to hydrogen-bond with water
b. phosphine because it does not form hydrogen bonds with water molecules
c. ammonia because the N-H bonds are so strong that they cannot break to enable the ammonia to hydrogen-bond with water
d. ammonia because it does not form hydrogen bonds with water molecules

Question 5 — 1.5 pts

Rank the following in terms of decreasing miscibility in C_8H_{18} (octane), a major component of gasoline: C_2H_5Cl (chloroethane), H_2O (water), C_2H_5F (fluoroethane), and C_9H_{20} (nonane).

a. $C_9H_{20} > C_2H_5Cl > C_2H_5F > H_2O$
b. $H_2O > C_2H_5F > C_2H_5Cl > C_9H_{20}$
c. $H_2O > C_9H_{20} > C_2H_5Cl > C_2H_5F$
d. $C_2H_5Cl > C_2H_5F > H_2O > C_9H_{20}$

Question 6 — 1.5 pts

Which of the following is a possible combination of values for $\Delta H_{lattice}$ and $\Delta H_{hydration}$ respectively for a salt whose dissolution is endothermic?

a. +500, -520
b. +640, -620
c. -560, +560
d. -200, -304

Question 7 — 1.5 pts

Which of the following would increase the solubility of a gas in water?

1. increase the temperature of the water

2. decrease the temperature of the water

3. increase the pressure of the gas above the water

a. 2 and 3
b. 1 and 3
c. 2 only
d. 1 only

Question 8 — 1.5 pts

In which of the following pairs do both compounds have a van't Hoff factor (i) of 2?

a. sodium sulfate and potassium chloride

b. sodium chloride and magnesium sulfate

c. glucose and sodium chloride

d. perchloric acid and barium hydroxide

Question 9 — 1.5 pts

For solutions of a non-electrolyte, the van't Hoff factor is:

Question 10 — 1.5 pts

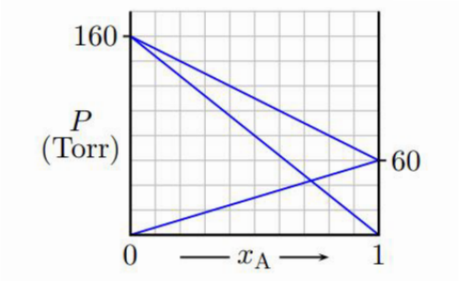
How many moles of ions are contained in 1.27 L of a 1.75 M solution of $Mg(NO_3)_2$? Please answer in mol and round to the second decimal place.

Question 11 — 1.5 pts

Calculate the vapor pressure at 20°C of a solution containing 0.61g of naphthalene in 16g of chloroform ($CHCl_3$). Naphthalene ($C_{10}H_8$) has a low vapor pressure and may be assumed to be nonvolatile. The vapor pressure of chloroform at 20°C is 156 torr. Please answer in torr and round to the second decimal place.

Question 12 — 1.5 pts

Substances A and B are mildly volatile solvents. Using the diagram below, determine the mole fraction of B when the vapor pressure of the mixture is 80 Torr.



Question 13 — 1.5 pts

At 293 K, methanol has a vapor pressure of 97.7 Torr and ethanol has a vapor pressure of 44.6 Torr. What would be the vapor pressure of a mixture of 80 g of ethanol and 97 g of methanol at 293 K? Please answer in torr and round to the first decimal place.

Question 14 — 1.5 pts

The freezing point of seawater is about -1.85 °C. If seawater is an aqueous solution of sodium chloride, calculate the molality of seawater. The k_f for water is 1.86 K/m. Please answer in molal and round to the third decimal place.

Question 15 — 1.5 pts

What will be the freezing point of a solution of 8 moles of sodium dichromate ($Na_2Cr_2O_7$) dissolved in 16 kg of water? Please answer in K and round to the first decimal place.

Use the following values:

K_b = 0.512 K/m

K_f = 1.86 K/m

Question 16 — 1.5 pts

Rank the following aqueous solutions from lowest to highest boiling point: 0.5 m NaCl, 1 m KCl, 0.5 m $BaCl_2$, and 1 m $Ba(NO_3)_2$. All salt are dissolved in water.

a. 1 m $Ba(NO_3)_2$ < 0.5 m NaCl < 0.5 m $BaCl_2$ < 1 m KCl

b. 0.5 m NaCl < 0.5 m $BaCl_2$ < 1 m KCl < 1 m $Ba(NO_3)_2$

c. 0.5 m $BaCl_2$ < 1 m KCl < 1 m $Ba(NO_3)_2$ < 0.5 m NaCl

d. 1 m KCl < 1 m $Ba(NO_3)_2$ < 0.5 m NaCl < 0.5 m $BaCl_2$

Question 17 — 1.5 pts

A semi-permeable membrane can withstand an osmotic pressure of 0.75 atm. What molarity of aqueous magnesium bromide solution would reach the limit for this membrane? (Assume RT = 25 $L{\cdot}atm{\cdot}mol^{-1}$)

a. 0.03 M

b. 0.01 mM

c. 0.01 M

d. 0.03 mM

Question 18 — 1.5 pts

Catalase (a liver enzyme) dissolves in water. A 14mL solution containing 0.166g of catalase exhibits an osmotic pressure of 1.2 Torr at 20°C. What is the molar mass of catalase?

a. 1.49×10^5 g/mol

b. 1.69×10^5 g/mol

c. 1.81×10^5 g/mol

d. 2.81×10^5 g/mol

Question 19 — 1.5 pts

Two aqueous solutions are separated by a semi-permeable membrane:

Solution A = 0.34 M KCl

Solution B = 0.34 M $MgCl_2$

Which of the following statements is TRUE?

a. There is a net flow of H_2O molecules from solution A to solution B.

b. There is a net flow of Cl^- ions from solution B to solution A.

c. There is no net flow of H_2O molecules from one solution to another.

d. There is a net flow of H_2O molecules from solution B to solution A.

Question 20 — 1.5 pts

Red blood cells contain Na^+ ions, K^+ ions, and water. If we place some red blood cells into a beaker full of pure water, what will happen to them?

a. nothing

b. they will shrivel and collapse

c. they will swell and burst

d. they will wiggle around rapidly