Homework Set 3

CH 353, Vanden Bout, Summer 2009

Chapter 4

D4.4, E4.2a, E4.5a, E4.8a, P4.5, P4.17

Chapter 5

D5.3, E5.3a, E5.14a, 5.16a

1. Water has a higher density in its liquid state than its solid state. Therefore if you apply pressure, it will melt. The pressure at the bottom of a large object or fluid can be determined from the force of the weight of the mass on top of it. The pressure is given by $P = \rho gh$, where g is the acceleration due to gravity, h is the height of the substance, and ρ is the density of the material (be careful with your units). Using the data below and and pressure formula given in the problem how thick could a glacier made of pure water get before the bottom of the glacier would begin to melt at -5°C? You can assume $\Delta_{FUS}H°$ and the densities are independent of temperature over this small range.

Density (solid) = 0.917 g/cm^{-3}
Density (liquid) = 1.000 g/cm^{-3}
$\Delta_{FUS}H° = 333.5\ J\ g^{-1}$

2. Use the vapor pressures at various temperature for the liquid and solid for a substance **X** to find $\Delta_{SUB}H$, $\Delta_{VAP}H$, $\Delta_{FUS}H$, and the triple point. The vapor pressure of solid **X** is 2.64 Torr at -112°C. At -126.5°C it is only 0.263 Torr. The vapor pressure of liquid **X** is 11.93 Torr at -100°C and 55.36 at -80°C.

3. Imagine a super-cooled liquid **X** at –10°C whose normal melting temperature is 0°C. Iif left alone the super-cooled water will remain a liquid for a long time even below its freezing point. In this metastable state it will be in equilibrium with vapor just like a normal liquid. The vapor pressure of super-cooled **X** at –10°C is 2.9×10^{-3} bar. Solid **X** at –10°C is also in equilibrium with **X** vapor and its vapor pressure is 2.6×10^{-3} bar. Using only the vapor pressures find ΔG for super-cooled **X** freezing to a solid at –10°C.

4.

What is the boiling point, freezing point and osmotic pressure of a solution of 1 L of water with 10 g of NaCl in it? Note: NaCl will become Na+ and Cl- in solution effectively doubling the effect on the salt on the colligative properties.