CH302H – Principles of Chemistry II: Honors
Fall 2016, Unique 49420

Homework, Week 5

1. Sketch the phase diagram for oxygen using the following data: triple point, 54.3 K and 1.129 x 10^{-3} bar; critical point, 154.6 K and 42.86 bar; standard melting point, -218.4 ˚C; and standard boiling point, -182.9 ˚C. Does oxygen melt as pressure increases?

2. Draw the phase diagram for water, indicating regions of solid, liquid, and vapor. Make the values of *P* and *T* on your axis reasonable based on what you know about the melting and boiling temperatures of water at 1 bar.

3. In class, we began discussing the following problem: because the melting temperature of water decreases with increasing pressure, a commonly repeated hypothesis is that an ice skater is able to move across the surface of solid ice by exerting enough force on the ice to temporarily melt the ice to water, thus dramatically reducing the coefficient of friction. Assume that the above hypothesis is true if the skater is able to exert enough force to lower the melting temperature of ice by 0.1 K. Also assume that the ice is maintained at 0˚C, that the density of ice is approximately 0.92 g cm^{-3}, and that the density of liquid water is 1.0 g mL^{-1}. $\Delta H_{fus}(H_2O)$ = 6.01 kJ mol^{-1} at 273 K. You may approximate the force of gravity as 10 N kg^{-1}.

a) Is this a reasonable hypothesis for a person weighing 70 kg who is wearing ice skating blades that are 30 cm long and 3 mm wide? Justify your answer.

b) To achieve the conditions of the above hypothesis, how much would this skater have to weigh (if wearing the same blades described above)?

c) Provide an alternative hypothesis for how skating across solid ice may be possible.

4. The enthalpy of fusion of Hg is 2.292 kJ mol^{-1} at its normal freezing temperature of 234.3 K. The molar volume of Hg changes 0.517 cm^{-3} mol^{-1} on melting. At what temperature will the bottom of a column of a 10.0 m column of liquid mercury (density of 13.6 g cm^{-3}) be expected to freeze.

5. At a camp high in the Andes, water boils at 90˚C. Using the phase diagram for water in your text book, estimate the atmospheric pressure at the altitude of the camp and fraction of the earth's atmosphere that is below the altitude of the camp.

6. Provide a physical interpretation to explain the observation that ice melts as pressure is applied. It might be useful to think about the dominant intermolecular forces in water.