HW 11-3: Ch 11.8: Phase Changes (Boiling Pt, Liquid-Solid Equil and Solid-Vapor Equil)
p.480 # 59, 61, 66, 67, 78, 80, 81, 82, Extra Problems A, B

11.59 What is a phase change? Name all possible changes that can occur among the vapor, liquid, and solid phases of a substance.

11.61 Use any one of the phase changes to explain what is meant by dynamic equilibrium.

11.66 Define boiling point. How does the boiling point of a liquid depend on external pressure? According to table 5.3, what is the boiling point when the external pressure is 187.54 mmHg? Explain

11.67 As a liquid is heated at constant pressure, its temperature rises. This trend continues until the boiling point of the liquid is reached. No further rise in temperature of the liquid can be induced by heating. Explain.

11.78 How much heat is needed to convert 866 g of ice at –10°C to steam at 126 °C? Needed quantities: \(s_{\text{ice}} = 2.03 \text{ J/g.°C}, \ s_{\text{steam}} = 1.99 \text{ J/g.°C}, \ \Delta H_{\text{fus}} = 6.01 \text{ kJ/mol}, \ \Delta H_{\text{vap}} = 40.79 \text{ kJ/mol}
11.80 The molar heats of fusion and sublimation of molecular iodine are 15.27 kJ/mol and 62.30 kJ/mol, respectively. Estimate the molar heat of vaporization of liquid iodine.

11.81 The following compounds, listed with their boiling points, are liquid at −10°C: butane, −0.5°C; ethanol, 78.3°C; toluene, 110.6°C. At −10°C, which of these liquids would you expect to have the highest vapor pressure? Which the lowest? Explain.

11.82 Freeze-dried coffee is prepared by freezing brewed coffee and then removing the ice component with a vacuum pump. Describe the phase changes taking place during the process.

Heating and Cooling Curves
A. How much heat, in kJ, is required to convert 25.0 g of solid bromine at −7.25 °C to the gas phase at 58.8 °C?

Before calculating, label the heating curve with the mp, bp and phases.
- Bromine melts at −7.25 °C and boils at 58.8 °C.
- The enthalpy of fusion of bromine is 10.57 kJ/mol and the enthalpy of vaporization of bromine is 29.96 kJ/mol.
- The specific heat of liquid bromine is 0.474 J/g⋅K.

To help work through the solution, calculate the heat required for each of the following steps and add up the total heat at end.

a) Step 1: solid bromine melts at −7.25°C.

b) Step 2: liquid bromine must heat up to 58.8°C.

c) Step 3: liquid bromine boils at 58.8°C. (Why is heat absorbed in this step?)

d) Calculate the total heat required for the full process.
B. Determine the heat released when 15.0 g of an unknown gas starting at 120.0 °C is cooled to a solid at 0.0 °C.

Before calculating, label the cooling curve with the mp, bp and phases.

- The substance undergoes phase changes at 85.0 °C and 10.0 °C.
- The heat of condensation is 3.00 kJ/g and the heat of crystallization is 1.00 kJ/g.
- The specific heat of the gas is 0.100 kJ/g °C. The specific heat of the liquid is 0.0500 kJ/g °C. The specific heat of the solid is 0.0300 kJ/g °C.

a) Step 1: From ______ → ______

b) Step 2: From ______ → ______

c) Step 3: From ______ → ______

d) Step 4: From ______ → ______ (Why is heat released by this step?)

e) Step 5: From ______ → ______

f) Calculate total heat released