In Class Exercise for Chapters 11 – Liquids & Intermolecular Forces

1. For each of the following sets, pick the substance that best fits the given property.
   a. highest boiling point: CCl_4, CF_4, CBr_4 due to polarizability so has largest London Dispersion forces
   b. highest boiling point: HBr, Kr, Cl_2 – only polar molecule so has dipole-dipole intermolecular forces
   c. highest absolute value freezing point: H_2O, NaCl, HF – ion – ion forces are stronger than dipole-dipole so the highest freezing point = highest melting point
   d. lowest absolute value: LiF, F_2, HCl – only nonpolar molecule so it possesses only LD forces and will have the lowest freezing point
   e. lowest polarizability: Xe, NH_3, HF – HF since it is the smallest, hardest species

2. For each of the following sets, pick the substance that best fits the given property.
   a. lowest vapor pressure at 25°C: Cl_2, Br_2, I_2 – due to polarizability has largest LD so it would be more difficult to convert to a gas as such will possess the lowest vapor pressure (the lowest v.p. belongs to the least volatile substance)
   b. lowest vapor pressure at 25°C: CH_3OCH_3, $CH_3CH_2CH_3$, CH_3CH_2OH – can H-bond and will therefore be the most difficult to evaporate
   c. greatest viscosity: H_2S, HF, H_2O_2 – leads to a stronger H-bond than HF because there are two O-atoms which can bond to two other adjacent molecules – the greater the intermolecular force the more the liquid will resist flow
   d. greatest heat of vaporization: H_2CO, CH_3CH_3, CH_4 – only polar molecule and so it has dipole-dipole intermolecular forces
   e. smallest enthalpy of fusion: I_2, CsBr, CaO – only nonpolar molecule and so it will require the least amount of energy to melt

3. What pressure would have to be applied to steam at 350°C to condense the steam to liquid water $\left(\Delta H_{vap} = 40.7 \frac{kJ}{mol}\right)$?

$$\ln\left(\frac{P_2}{1.00}\right) = \frac{40.7\times10^3\ \text{J/mol}}{8.3145\ \text{J/K}\bullet\text{mol}}\left(\frac{1}{373\ \text{K}} - \frac{1}{623\ \text{K}}\right),\ \ln P_2 = 5.27,\ P_2 = e^{5.27} = 194\ \text{atm}$$

4. Br_2 has a normal melting point of -7.2°C and a normal boiling point of 59°C. The triple point is -7.3°C and 40 torr, and the critical point is 320°C and 100 atm. Using this information, sketch a phase diagram for bromine indicating the points described above. Make sure to indicate the phases for each section of your diagram.