Homework Set 3

CH 353, Vanden Bout, Summer 2010

Chapter 22
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Chapter 23
1, 6, 28, 36,

1.
Find a formula for the change in entropy for a gas that follows the van der Waals equation of state that changes volume isothermally between V_I and V_f.

To do this you need to take into account the change in internal energy with volume (the internal pressure) as $\Delta U \neq 0$.

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$$

2. If can be shown that

$$C_p - C_V = \frac{\alpha^2 TV}{\kappa}$$

Use this result to show that $C_p - C_v = nR$ for and IG

Work example 22-6 in the book

3. 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}

4. 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.

5. 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 $2.9x10^{-3}$ bar. Solid **X** at –10°C is also in equilibrium with **X** vapor and its vapor pressure is $2.6x10^{-3}$ bar. Using only the vapor pressures find ΔG for super-cooled **X** freezing to a solid at –10°C.