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CHEM 3410: Physical Chemistry I — Fall 2008

In-class Practice Problems

September 19, 2007

1. One mole of an ideal gas, with $C_v = \frac{3}{2}R$, is heated (a) at constant pressure and (b) at constant volume, from 298 K to 353 K. Calculate ΔS for the system in each case.

2. The standard entropy of Pb(s) at 298.15 K is 64.80 J/mol·K. Assume the heat capacity of Pb(s) is given by:

$$C_p(Pb, s) = 22.13 + 0.01172T + 1.00 \times 10^{-5}T^2$$

   The melting point of lead is 327.4°C and the heat of fusion under these conditions is 4770 J/mol. Assume the heat capacity of liquid lead is given by:

$$C_p(Pb, l) = 32.51 - 0.00301T$$

   (a) Calculate the standard entropy of Pb(l) at 500°C.

   (b) Calculate ΔH for the transformation Pb(s, 25°C) to Pb(l, 500°C).

3. At 100°C 200 g of mercuty are added to 100 g of water at 20 °C. The specific heat capacities of water and mercury may be taken as constant at 4.18 and 0.140 J/K·g, respectively. Calculate the entropy change of

   (a) the mercury

   (b) the water

   (c) the system

4. One mole of H_2O(l) is supercooled to -2.25°C at 1 bar pressure. The freezing temperature of water at this pressure is 0.00°C. The transformation $H_2O(l) \rightarrow H_2O(s)$ is suddenly observed to occur. By calculating ΔS, $\Delta S_{surroundings}$ and ΔS_{total}, verify that this transformation is spontaneous at -2.25°C.

   The heat capacities are given by $C_p(H_2O_{(l)}) = 75.3\ J\ K^{-1}\ mol^{-1}$ and $C_P(H_2O_{(s)}) = 37.7\ J\ K^{-1}\ mol^{-1}$, and $\Delta H_{fusion} = 6.008$ kJ mol^1 at 0.00°C. Assume that the surroundings are at -2.25°C.

   [Hint: Consider the two pathways at 1 bar: (a) H_2O(l, -2.25°C) $\rightarrow$ H_2O(s, -2.25°C) and (b) H_2O(l, -2.25°C) $\rightarrow$ H_2O(l, 0.00°C) $\rightarrow$$H_2O$(s, 0.00°C) $\rightarrow$ H_2O(s, -2.25°C). Because S is a state function, ΔS must be the same for both pathways.]