CH353 – Physical Chemistry I
Spring 2013, Unique 52575

Homework, Week 4

For this problem set, you will need to download the handout of thermodynamic data from the link on the bottom of the course homepage. Keep this handy throughout the semester.

1. The standard enthalpy of combustion of cyclopropane is -2091 kJ mol^{-1} at 25˚C. From this information and the enthalpy of formation for $CO_2(g)$ and $H_2O(g)$, calculate the enthalpy of formation of cyclopropane. The enthalpy of formation of propene is +20.4 kJ mol^{-1}. Calculate the enthalpy of isomerization of cyclopropane to propene.

2. Calculate the standard enthalpy of solution of AgCl(s) in water from the enthalpies of formation of the solid and aqueous ions.

3. Calculate the molar entropy of a constant-volume sample of neon at 500 K given that it is 146.22 J K^{-1} mol^{-1} at 298 K.

4. Determine ΔS (for the system) when 3.0 mol of an ideal gas at 25˚C and 1.0 atm is heated to 125˚C and expanded to 5.0 atm. Rationalize the sign of ΔS.

5. Consider a system containing 2.0 mol $CO_2(g)$ ($C_{v,m}$ = 28.8 J K^{-1} mol^{-1}), initially at 25˚C and 10 atm and confined to a cylinder of cross-section 10.0 cm^2. It is allowed to expand adiabatically against a constant external pressure of 1.0 atm until the piston has moved outwards through 20 cm. Determine q, w, ΔU, ΔH, and ΔS.

6. Determine the standard reaction entropy at 298 K of the following reactions:

a) $2\ CH_3CHO(g) + O_2(g) \rightarrow 2\ CH_3COOH(l)$
b) $Hg(l) + Cl_2(g) \rightarrow HgCl_2(s)$

7. Consider a system composed of 14 g of $N_2(g)$ at 298 K and 1.0 atm. Determine the change in entropy of this system, the surroundings, and the total change in entropy when the system is expanded to twice its original volume a) isothermally and reversibly, b) isothermally and against a constant external pressure of 0, and c) adiabatically and reversibly.

8. A 500 g block of copper ($C_{p,m}$ = 24.4 J K^{-1} mol^{-1}) initially at 293 K is in thermal equilibrium with an electric heater of resistance 1.0 kΩ and negligible mass. A current of 1.0 A is passed for 15.0 s. Determine the change in entropy of the copper block. The experiment is then repeated with the copper immersed in a stream of water that maintains its temperature at 293 K. Determine the change in entropy of the copper and the water.

9. 4.0 moles of an ideal gas is divided evenly in a cylinder separated into 2 chambers, A and B, that are partitioned with a movable adiabatic boundary. Initially, the volume and temperature of both chambers is 2.0 L and 300 K, respectively. Each chamber has an independent heater that is

used to supply heat. The heater for chamber B is used to maintain the temperature of B at all times. The heater for chamber A is used to supply heat to chamber A to move the boundary between A and B reversibly to decrease the volume of chamber B by half. Determine ΔH for each chamber, assuming $C_{V,m} = 20$ J K^{-1} mol^{-1}.