2018-Spring semester: General Chemistry (034.020-005): Chapter 7 and 8 Practice

Due on 2018-05-10 Thursday, 9:30 am

1. A cylinder confines 2.00 L gas under a pressure of 1.00 atm. The external pressure is also 1.00 atm. The gas is heated slowly, with the piston sliding freely outward to maintain the pressure of the gas close to 1.00 atm. Suppose the heating continues until a final volume of 3.50 L is reached. Calculate the work done on the gas and express it in joules.

2. Suppose 61.0 g hot metal, which is initially at 120.0 ^{o}C, is plunged into 100.0 g water that is initially at 20.00 ^{o}C. The metal cools down and the water heats up until they reach a common temperature of 26.39 ^{o}C. Calculate the specific heat capacity of the metal, using 4.18 J K^{-1} g^{-1} as the specific heat capacity of the water.

3. If 0.500 mol neon at 1.00 atm and 273 K expands against a constant external pressure of 0.100 atm until the gas pressure reaches 0.200 atm and the temperature reaches 210 K, calculate the work done on the gas, the internal energy change, and the heat absorbed by the gas.

4. Suppose 2.00 mol of an ideal, monoatomic gas is initially at a pressure of 3.00 atm and a temperature T = 350 K. It is expanded irreversibly and adiabatically (q=0) against a constant external pressure of 1.00 atm until the volume has doubled.
(a) Calculate the final volume.
(b) Calculate w, q, and ΔU for this process, in joules.
(c) Calculate the final temperature of the gas.

5. Predict the contribution of each type of molecular motion to the heat capacity, $C_{v,m}$ and their total for each of the following molecules
(a) NO (b) NH_3 (c) HClO (d) SO_2 (e) HCN (f) C_2H_6 (g) Ar (h) HBr

6. Calculate the change in enthalpy when 2.00 moles of argon is heated from 298 K to 573 K at constant pressure of 1 atmosphere. Calculate the change in enthalpy for 2.00 moles of ethylene C_2H_4 for the same process.

7. When glucose, a sugar, reacts fully with oxygen, carbon dioxide and water are produced:

$$C_6H_{12}O_6\,(s) + 6O_2\,(g) \rightarrow 6CO_2(g) + 6H_2O(l) \qquad \Delta H^{o} = -2820\ \text{kJ}$$

Suppose a person weighing 50 kg (mostly water, with specific heat capacity 4.18 J K^{-1} g^{-1}) eats a candy a bar containing 14.3 g glucose. If all the glucose reacted with oxygen and the heat produced were used entirely to increase the person's body temperature, what temperature increase would result? (In fact, most of the heat produced is lost to the surroundings before such a temperature increase occurs).

8. If 4.00 mol hydrogen (c_p= 28.8 J K^{-1} mol^{-1}) is expanded reversibly and isothermally at 400 K from an initial volume of 12.0 L to a final volume of 30.0 L, calculate ΔU, q, w, ΔH, and ΔS for the gas.

9. The dissolution of calcium chloride in water is a spontaneous process at 25 °C, even though the standard entropy change of the preceding reaction is negative (ΔS = -44.7 J K^{-1}). What conclusion can you draw about the change in entropy of the surroundings in this process?

10. Ethanol's enthalpy of vaporization is 38.7 kJ/mol at its normal boiling point, 78 °C. Calculate q, w, ΔU, and ΔS_{sys}, and ΔG when 1.00 mol ethanol is vaporized reversibly at 78 °C and 1 atm. Assume that the vapor is an ideal gas and neglect the volume of liquid ethanol relative to that of its vapor.

11. The normal boiling point of liquid ammonia is 240 K; the enthalpy of vaporization at that temperature is 23.4 kJ/mol. The heat capacity of gaseous ammonia at constant pressure is 38 J mol^{-1} K^{-1}. (a) Calculate ΔU, q, w, and ΔH for the following change in state:

2.00 mol NH_3 (*l*, 1atm, 240 K) → 2.00 mol NH_3 (*g*, 1atm, 298 K)

Assume that the gas behaves ideally and that the volume occupied by the liquid is negligible.
(b) Calculate the entropy of vaporization of NH_3 at 240 K.