UNIVERSITY OF MANITOBA
DEPARTMENT OF CHEMISTRY

Chemistry 2290, Winter 2012, G. Schreckenbach

PROBLEM SET 2, Jan. 25, 2012

Due date: The solved problem set is due on Wednesday, February 1, 2012, at the time of the lecture.
Questions to be marked: A *pre-selected* (*by me*) set of **five** (5) out of the six questions will be marked.

1. 1.35 mol of an ideal gas underwent a reversible isothermal expansion until the volume was doubled. If the work performed during the process was w = -2.50 kJ, what was the temperature of the gas? What are q, ΔU and ΔH?

2. A sealed flask with a capacity of 1.05L contains 3.20g of carbon monoxide (assumed to behave ideally; molar mass: M = 28.01 g mol^{-1}; heat capacity: $C_{p,m}$ = 28.41 J K^{-1} mol^{-1}, assumed to be independent of temperature).

The system is initially at a temperature of 25.00°C. The flask is so weak that it will burst if the pressure exceeds 6.50 x 10^5 Pa. The flask is heated slowly.
(a) At what temperature (bursting temperature) will the pressure of the gas reach the bursting pressure?
(b) What are the change in internal energy, ΔU, and the change in enthalpy, ΔH, for heating the gas from 25.0°C to the "bursting temperature" of part (a)?
(c) The molar heat capacity is, in fact, *not* temperature independent. The temperature dependence can be described as $C_{p,m} = d + eT + fT^{-2}$ where *T* is the temperature (in K) and the constants are: d = 28.41 J K^{-1} mol^{-1}; e = 4.10 x 10^{-3} J K^{-2} mol^{-1}; f = -4.6 x 10^4 J K mol^{-1}. Given these values, calculate ΔU for the process described in part (b).

3. A sample of 2.55 mol of a monoatomic ideal gas (which, from kinetic-molecular theory, means $C_{V,m} = \frac{3}{2}R$) is originally at 50.0ºC and 1.03atm pressure. Its pressure is being reduced at constant volume until the temperature has fallen to 25.0ºC. For this process, calculate q, w, ΔU and ΔH. Assume reversible conditions.

4. Ethanol and propane are both used as fuel for fireplaces.
(a) Write balanced equations for the combustion of 1.00 mole of (liquid) ethanol and (gaseous) propane, respectively.
(b) Use appropriate heats of formation data to derive the heat associated with each combustion reaction.
(c) Which fuel produces the most energy per gram? Per mole?

5. A container with 1.50L of water is placed outside in the winter, such that the temperature of the water is lowered from 30.0ºC to -25.0ºC. How much heat is given off by the water?

6. Two (2.00) moles of oxygen gas are initially at 273 K in a volume of 11.35 L. Consider the gas as ideal; heat capacity $C_{p,m}$ = 29.4 J K^{-1} mol^{-1}. The gas is heated reversibly at constant pressure to 373 K:

(a) What is the final volume?
(b) How much work is done on the system?
(c) How much heat is supplied to the system?
(d) What is the change in enthalpy?
(e) What is the change in internal energy?

<u>Comment:</u> This is essentially problem LM11 of the sample problems posted.