Homework Set I

CH 353, Vanden Bout, Summer 2009

Chapter 1

D1.3, E1.2a, E1.13a, E1.18a, E1.22a (is the gas dominated by attractive or repulsive forces?), N1.23

Chapter 2

D2.3, E2.2a, E2.7a, E2.16a, E2.22a, E2.27a, N2.1

1. Stuff with units

It is useful to be able to simply unit conversions and think about units. You may need the book or other resources to answer these questions.

A. What is the ideal gas constant in units of gal-psi mol^{-1} K^{-1}?

2. How much energy is that?

Find the answer to each in Joules.

A. Potential energy change in dropping a 50 kg mass 1 meter?

B. Energy from burning one gram of carbon. Complete oxidation of carbon to carbon dioxide releases 393 kJ mol^{-1} of carbon burned.

C. Energy in a Double Whopper™ with Cheese Value Meal (this includes a King-size fries and a medium Coca-Cola®) from Burger King™ . This meal will provide you with 1840 Calories[*]. (note: dietary Calories are really a kcal).

D. Energy required to run a 100 W light bulb for one day.

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[*] Data from Burgerking.com

3.

2 moles of an ideal gas ($C_{V.M}$ = 1.5R) are compressed isothermally from 10 bar to 100 bar at 300 K against a constant pressure of 100 bar. Then the gas is expanded isothermally against a constant pressure of 10 bar. After the compression and the expansion what is ΔU for the gas? What is the total work, w, and heat, q, for the combined compression/expansion. What would the total work, heat, and ΔU be if the compression and expansion cycle had been performed reversibly?

4.

The Berthelot equation of state is very similar to the van der Waals equation of state, but performs better under some circumstances.

$$P = \frac{RT}{V_m - b} - \frac{a}{TV_m^{\ 2}}$$

Assume that CO_2 obeys the Berthelot equation of state (with the van der Waals constants a and b for CO_2), how much work is done by expanding 2 moles of the gas isothermally and reversibily at 300 K from and initial volume of 4 L to a final volume of 10 L.
a = 1080 L^2 bar K mol^2

b = 0.0427 L mol^{-1}

For such a system can we know q for this process? Explain.

5.
Using the relationship

$$C_P = C_V + T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P$$

A.
find the relationship between C_P and C_V for a hard sphere gas that obeys the equation of state

P(V-nb) = nRT   where b is a constant.

7. Find $\Delta_r H°$ for this reaction at 298K and 350K using data from the appendix in the text.

$$2Na(s) + 2H_2O(l) \rightarrow H_2(g) \ + \ 2Na^+(aq) + \ 2OH^-(aq)$$

For this reaction calculate the heat and work for reacting 10 g of Na with excess water at a constant pressure of 1atm at 298K and at 350K.

What does this say about the magnitude of the work and temperature changes compared to the heat of the reaction?