Chemistry 130A	First Midterm Exam	Sept. 15, 1999	50 min	1 2 3 4	
Name	Discussion Leader				
Prof. K. Sauer Total Points - 100	SHOW YOUR WORK			T	

Data: $R = 8.314\ J\ K^{-1}\ mol^{-1} = 0.082\ L\ atm\ K^{-1}\ mol^{-1}$

1. (Credit 24) For each of the following processes, is the enthalpy change, ΔH, greater than, equal to or less than zero? In each case, state whether there is a change in only the kinetic energy, only the potential energy, both or neither for the system The system in each case is given in *italics*.

   a) *100 mL of liquid water* is vaporized at 100°C and a constant pressure of 1 atm.

   b) A *mixture of methane and oxygen* at room temperature is ignited and converted to hot CO_2 (g) and H_2O (g), releasing heat to the surroundings.

   c) An *ice cube* initially at 0°C is placed into *1L of liquid water* initially at 25°C, all in a thermally insulated container. The ice cube melts completely and the system comes to equilibrium.

2. (Credit 20) A heavy dictionary is sitting on the floor of your room. You need to lift it to the top of a bookcase that is 4 feet high. You decide to do the lifting in 2 stages.

A. First you lift the dictonary from the floor to a shelf 2 feet above the floor.

B. Next you lift it from the shelf to the top of the bookcase.

Compare the amount of work that you do in steps A and B. Circle the correct answer below.

$$|w_A| > |w_B|$$

$$w_A = w_B$$

$$|w_A| < |w_B|$$

Briefly explain your reasoning.

3. (Credit 30) For the following statements underline the word or words inside the parentheses that serve to make a correct statement. More than one answer may be correct. One credit will be subtracted for any wrong answers underlined. Asterisks (*) are in the margin to indicate where answers are needed.

For an ideal gas the enthalpy will necessarily change if there is a change in the
* (pressure, volume, temperature, number of moles) of the gas. If a fixed amount of an ideal gas undergoes an adiabatic expansion against a pressure of 1 atm, the temperature of the
* gas will (increase, remain unchanged, decrease). If the adiabatic expansion occurs into a
* vacuum, the temperature of the gas will (increase, remain unchanged, decrease).
* An isolated system is one where no (temperature difference, work, heat transfer, chemical difference) can occur between it and the surroundings. A green plant, where metabolism occurring inside the plant cells is driven by light, takes up atmospheric CO_2
* and releases O_2, is an example of a (closed, isolated, open) system. If the system is taken
* from an initial to a final state at the same temperature, then the (heat, enthalpy change, internal energy change, work) is independent of the path taken. To calculate the enthalpy
* change at a different temperature, we need to know values for ($\Delta V°_{fus}$, C_v, C_p, $\Delta P°$) for the system.

When an exothermic chemical reaction occurs at a constant pressure, like the decomposition of aqueous H_2O_2 initially at 25°C to produce water and gaseous O_2, the
* temperature will necessarily change if the process is carried out (isobarically, isothermally, adiabatically, in isolation from the surroundings). For this reaction the enthalpy change ΔH
* is (more negative than, equal to, less negative than) the internal energy change ΔE. Decreasing the concentration of H_2O_2 in the aqueous solution results in a corresponding
* decrease in the (molar enthalpy change, final temperature, final pressure, final volume) if the reaction is carried out in a thermally insulated container.

Standard Enthalpies of Formation		Average Bond Dissociation Enthalpies at 25°C	
Compound	$\Delta H°_{f,298}$ (kJ mole^{-1})	Bond	D(kJ mol^{-1})
H_3C-CH_2-S-CH_2-CH_3 (g)	-83.47	C-C	344
H_3C-CH_2-S-S-CH_2-CH_3 (g)	-74.64	C-H	415
H_3C-CH_2-S-H (g)	-46.11	C-O	350
S (g)	278.8	C-S	288
C (g)	716.7	O-O	143
H (g)	218.0	O-H	463
		S-H	368

4. (Credit 14+12) One of the factors that stabilizes the structure of proteins is the presence of disulfide bonds between cysteine amino acid side chains. The disulfide bond, S-S, is relatively weak and is sometimes broken under denaturation conditons.

   a) Calculate the bond dissociation enthalpy for the disulfide bond, D(S-S), using thc data above.

4. b) The molecule glutathione, GSH, is a tripeptide containing cysteine that is present at high levels (5 mM) in animal cells. It serves as a sulfhydryl buffer by cycling between a reduced thiol form (GSH) and an oxidized form (GSSG), in which two tripeptides are linked by a disulfide bond. Glutathione plays a key role in detoxification by reacting with hydrogen peroxide

$$2GSH + HOOH \rightarrow GSSG + 2H_2O$$

Use your result from part (a) together with other bond enthalpies to estimate $\Delta H°_{298}$ for this reaction.