

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

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

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.

Chemistry 130A

-2-

Name _____

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 dictionary 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.

Chemistry 130A

-3-

Name _____

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 ($\Delta V_{\text{fus}}^\circ$, C_v , C_p , ΔP°) 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.

Chemistry 130A

-4-

Name _____

Standard Enthalpies of Formation		Average Bond Dissociation Enthalpies at 25°C	
Compound	$\Delta H^\circ_{f,298}$ (kJ mole ⁻¹)	Bond	D(kJ mol ⁻¹)
H ₃ C-CH ₂ -S-CH ₂ -CH ₃ (g)	-83.47	C-C	344
H ₃ C-CH ₂ -S-S-CH ₂ -CH ₃ (g)	-74.64	C-H	415
H ₃ C-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

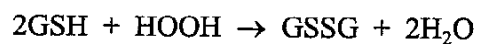
4. (Credit 14+12) One of the factors that stabilizes the structure of proteins is the presence of disulfide bonds between cysteine amino acid side chains. The disulfide bond, S-S, is relatively weak and is sometimes broken under denaturation conditions.
- a) Calculate the bond dissociation enthalpy for the disulfide bond, D(S-S), using the data above.

Chemistry 130A

-5-

Name _____

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



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