CH302 Spring 2009 Worksheet 1: A Little Thermo Review

1. What two processes (a.k.a. path functions) can transfer internal energy between a system and its surroundings? What symbols are used for these variables?

2. Write a good definition for a state function.

3. Name some state functions.

4. The first law states that the value of which state function is conserved in an isolated system? What **two** symbols are used for this state function?

5. What is an isolated system? Name the most obvious example of an isolated system (hint: big).

6. What **inequality** is often associated with the second law of thermodynamics? What does it mean in plain English?

7. What **equality** is often associated with the second law of thermodynamics? What does it mean in plain English?

8. What does the third law of thermodynamics state?

9. How many translational, rotational and vibrational modes, respectively, does C_2H_4 have?

10. What would be the total internal energy associated with the vibrational motion of 1 molecule of C_2H_4? What about 1 mole of C_2H_4?

11. In the list of elements below, mark (circle, underline, etc.) all of the elements that are not shown in their standard state.

$C_{diamond}(s)$ Ca(s) $B_2(s)$ Na(s) Fe(s) Hg(s)
$Br_2(l)$ Mo(s) H(g) He(g) Xe(g) $Rb_2(s)$
Cd(l) As(s) $N_2(l)$ $O_2(l)$ $Si_{60}(s)$ $F_2(g)$

12. Write the standard formation reactions for the following chemical species

$NH_3(g)$

$Fe_2O_3(s)$

$O_2(l)$

$O_3(g)$

$NH_2OH(s)$

13. Assume we want to use a bomb calorimeter to determine the specific heat capacity of an unknown liquid. We use 3 L of the unkown liquid and perform a known reaction that releases 400 kJ of heat. We measure an initial and final temperature of 25 ºC and 28.7 ºC, respectively. If the heat capacity of the calorimeter is 85 $J \cdot K^{-1}$, and the density of the liquid is 2.34 $g \cdot mL^{-1}$, what is the specific heat capacity of the unknown liquid?

14. Given the following data:

$H_2SO_4(l) \leftrightarrow H_2S(g) + 2O_2(g)$ $\Delta H = 793\ kJ \cdot mol^{-1}$

$H_2O(g) + SO_3(g) \leftrightarrow H_2SO_4(l)$ $\Delta H = -176\ kJ \cdot mol^{-1}$

$H_2O(l) + SO_3(g) \leftrightarrow H_2S(g) + 2O_2(g)$ $\Delta H = 661\ kJ \cdot mol^{-1}$

calculate ΔH for the process: $H_2O(l) \rightarrow H_2O(g)$

15. Consider the reaction below and approximate the value of the work function at room temperature. (Note: this doesn't require a calculator.)

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$

16. If a system at -272 °C absorbs 545 J of heat, what is its change in entropy?

17. Ammonia (the common name for NH_3, the odor of windex and cat urine), has a $\Delta H°_{vap} = 23.35\ kJ \cdot mol^{-1}$ and a $\Delta S°_{vap} = 97.43\ J \cdot mol^{-1} \cdot K^{-1}$. What is the normal boiling point of ammonia expressed in centigrade?

18.Consider the reaction below:

$HNO_3(l) + H_2(g) \leftrightarrow H_2O(l) + NO_2(g)$

Using the provided table values, calculate $\Delta G°_{rxn}$ if it is performed under standard conditions.

	$\Delta H°_f$ ($kJ \cdot mol^{-1}$)	$\Delta S°_m$ ($J \cdot mol^{-1} \cdot K^{-1}$)
$HNO_3(l)$	-174.1	156
$H_2(g)$	not provided	131
$H_2O(l)$	-285.8	70
$NO_2(g)$	33.2	240

19. Rank the following compounds in terms of decreasing standard molar entropy: CO(s), CO_2(g), CO_2(l), CO(l).

20. Assuming you have one mole of each of the following, rank them in terms of decreasing value of the term W in the Boltzmann equation: HF, NaF, ClF, F_2.