

**CH 302 Spring 2008 Worksheet 1**  
**A potpourri of thermo questions to get your mind reengaged.**

(Questions 1-6) Match the correct term for each question given below. You will only use an answer once, but not all the answers will be used.

Word Bank:

Standard enthalpy change	enthalpy of formation	bond enthalpy
bond order	bond energy	heat capacity
thermochemical	standard state	thermodynamics
state functions	equilibrium	empirical state

- Parameters that define the current state of a chemical system.
- $\Delta H$  when reactants in standard states are converted to products in standard states.
- The study of energy change in chemical systems.
- The energy necessary to break one mole of bonds in a gaseous substance.
- The most stable state of a substance under standard pressure and temperature.
- The amount of heat required to raise the temperature of an object one degree C.
- Which of the following is a correct statement concerning the Second Law of Thermodynamics?
  - Energy cannot be created nor destroyed.
  - The entropy in the universe is conserved.
  - The entropy in a system increases in the phase change from liquid to gas.
  - The free energy of a system is temperature dependent.
- Explain why the freezing of liquid water (in which the water becomes more ordered) does *not* violate the Second Law.
- If you heat 1 kg of water over a Bunsen burner for a few seconds for a few seconds, it might get a little warm. So the same for 1 kg of copper, and it's likely to burn your hand. What physical quantity explains this difference?
- Provide a simple derivation of the fact that  $\Delta G$  is negative for a spontaneous process starting with the Second Law,  $\Delta S_{\text{universe}} > 0$ .
- The following reaction is exothermic. For what temperatures is the reaction spontaneous?
$$2 \text{A}(\text{g}) + \text{B}(\text{g}) \rightarrow \text{A}_2\text{B}(\text{g})$$
- Write a single equation expressing the First Law of Thermodynamics for an isolated system.
- In terms of  $RT$ , what is the amount of motional (translational and rotational) internal energy in  $\text{H}_2\text{O}$ ? In  $\text{CO}_2$ ?

14. For the freezing of benzene,  $\Delta H = 2.375 \text{ kJ/mol}$  and  $\Delta S = 8.523 \text{ J/mol}$ . What is the freezing point of benzene?
15. Which of the following molecules will have the largest positional entropy at 0 K?
- $\text{SF}_6$
  - $\text{CH}_4$
  - $\text{CO}_2$
  - $\text{XeF}_5\text{I}$
  - $\text{CHCl}_3$

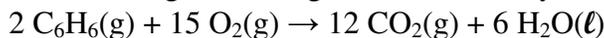
16. What is the entropy of 10 molecules of the correct answer to number 15 at 0 K?

17. Given the following table, which species is the most stable?

	$\Delta G_f^\circ \text{ (kJ/mol)}$
$\text{CO}_2 \text{ (g)}$	-394.4
$\text{NO}_2 \text{ (g)}$	+51
$\text{SO}_2 \text{ (g)}$	-300.2
$\text{H}_2\text{O} \text{ (g)}$	-228.60

18. Without using a table, give the free energy of formation for each of the following species:  $\text{He(g)}$ ,  $\text{N}_2\text{(g)}$ ,  $\text{C(graphite)}$ ,  $\text{Hg(l)}$ ,  $\text{Fe(s)}$

19. Find  $\Delta G_r^\circ$  (at 298 K) for the following reaction, given the thermodynamic data below.



	$\Delta H_f^\circ$ (kJ/mol)	$S^\circ$ (J/mol)
$\text{C}_6\text{H}_6 \text{ (g)}$	+82.931	269.2
$\text{O}_2 \text{ (g)}$	0	205.14
$\text{CO}_2 \text{ (g)}$	-393.51	213.74
$\text{H}_2\text{O} \text{ (l)}$	-285.83	69.91

20. At a certain temperature, the work done on the following reaction is 6.00 kJ. What is this temperature?

$$2 \text{A(g)} + \text{B(g)} \rightarrow \text{A}_2\text{B(g)}$$