Thermodynamics Practice Problems

1. Predict the sign of ΔS_{rxn} (positive or negative) for the following reactions:
   a. $2\ Mg\ (s) + O_2\ (g) \rightarrow\ 2\ MgO\ (s)$ ΔS_____
   b. $C_6H_{12}O_6(s)\ \rightarrow\ 2C_2H_5OH(l)\ +\ 2CO_2(g)$ ΔS_____
   c. $2\ NH_3(g)\ + CO_2(g) \rightarrow\ H_2O(l)\ + NH_2CONH_2(aq)$ ΔS_____
   d. $Cu(s)$ (at 100^oC) $\rightarrow$ $Cu(s)$ (at 25^oC) ΔS_____

2. Which two variables can indicate if a reaction is spontaneous or not? _____

3. The second law of thermodynamics tells us that:
   a. Energy is conserved.
   b. The entropy of a pure solid crystal at 0 Kelvin is zero.
   c. The total enthalpy of the universe is increasing.
   d. The total entropy of a spontaneous process is increasing.
   e. The free energy of a spontaneous process is increasing.

4. Which combination of ΔH and ΔS for a reaction is not spontaneous at low temperatures and becomes spontaneous at higher temperatures? Answer: ΔH _____ and ΔS _____

5. The process of a liquid boiling has a:
   a. Positive enthalpy change and a positive entropy change.
   b. Positive enthalpy change and a negative entropy change.
   c. Negative enthalpy change and a positive entropy change.
   d. Negative enthalpy change and a negative entropy change.
   e. Not enough information is given.

6. Calculate the temperature at which this reaction changes from being spontaneous to non spontaneous: $Mg(s) + O_2(g) \leftrightarrows MgO(s)$. Is the reaction spontaneous above or below this temperature? *(Hint – balance the rxn and use data from Appendix B)*

7. Calculate ΔG^o_{rxn} for this reaction: $2\ CH_3OH\ (l) + 3\ O_2\ (g)\ \rightarrow\ 2\ CO_2\ (g) + 4\ H_2O\ (l)$
   Given: $\Delta H_f^o\ CH_3OH\ (l) = -238.6$ kJ/mol
   $S^o\ CH_3OH\ (l) = 126.8$ J/molK
   $S^o\ O_2\ (g) = 205.0$ J/molK
   $S^o\ H_2O\ (l) = 69.91$ J/molK
   $\Delta H_f^o\ H_2O\ (l) = -285.83$ kJ/mol
   $\Delta H_f^o\ CO_2\ (g) = -393.5$ kJ/mol
   $S^o\ CO_2\ (g) = 213.6$ J/molK
   (only use this given data for your answer)