Free Energy Questions

1. Predict the sign of ΔS^o for the following reactions:

(a) $CaO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ ΔS is _____

(b) $CS_{2(l)} \rightarrow CS_{2(g)}$ ΔS is _____

(c) $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ ΔS is _____

(d) $CO_{2(g)} + 2\ H_2O_{(l)} \rightarrow CH_{4(g)} + 2\ O_{2(g)}$ ΔS is _____

(e) $C_{(graphite)} \rightarrow C_{(diamond)}$ ΔS is _____

(f) $CO_{2(g)} \rightarrow CO_{(g)} + \frac{1}{2}\ O_{2(g)}$ ΔS is _____

2. There are two primary driving forces behind a chemical reaction, ΔH (enthalpy) and ΔS (entropy).

What type of reaction tends to be spontaneous, endothermic or exothermic?

What is the sign on ΔH when this is the case?

Does an increase or decrease in entropy tend to be the spontaneous change?

What is the sign on ΔS when this is the case?

3. What is "free energy"? For a given reaction what does ΔG represent?

4. How do you go about predicting the spontaneity of a reaction? To insure that a reaction will be <u>nonspontaneous</u>, what must the signs of ΔH and ΔS be?

5. Consider the reaction $N_2 + O_2 \rightarrow 2\ NO$

Given: $\Delta H^o = 180.7$ kJ and $\Delta S^o = 24.7$ J/K

Is this reaction spontaneous? If not, at what temperature would it become spontaneous? Justify your answer.

6. The process: $H_2O_{(s)} \rightarrow H_2O_{(l)}$ proceeds spontaneously at room temperature in spite of having a postive ΔH value. Explain.....

7. Predict the ***signs*** of ΔH , ΔS and ΔG of the system for the following processes at 1 atm:
(The normal melting point of mercury is -39^{o}C.)

(a) mercury melts at -19^{o}C ΔH _____ ΔS _____ ΔG _____

(b) mercury melts at -39^{o}C ΔH _____ ΔS _____ ΔG _____

(c) mercury melts at - 80^{o}C ΔH _____ ΔS _____ ΔG _____

8. Dry ice, $CO_{2(s)}$ sublimes (changes form a solid to a gas) at room temperature.

(a) Write a reaction for the above process

$\rightarrow$

(b) What is the sign of ΔH for this process? _____

(c) What is the sign of ΔS for this process? _____

(d) What is the sign of ΔG for this process? _____ *(hint – does it happen?)*

(e) Which driving force, ΔH or ΔS, has final "say" in the outcome of the react? Explain……

9. Your body metabolizes sugar (sucrose) according to the following reaction:

$$C_6H_{12}O_{6(s)} + 6\ O_{2(g)} \rightarrow 6\ CO_{2(g)} + 6\ H_2O_{(l)}$$

Where ΔH = -2803kJ/mol, ΔS = 257.6 J/Kmol at 310K. Calculate ΔG and determine if this reaction spontaneous.