

## Chapter 7 - Lecture Worksheet 1

From the table on back of this page, what trends can you observe about absolute entropies for substances ?

In general:

All  $> 0$  ... What does this tell us ?

$S^0(\text{gases}) > S^0(\text{l}) > S^0(\text{s})$

More complex, higher molecular weight, higher  $S^0$

Without doing any calculations, predict if the entropy for each of the following reactions is

**1. positive**    **2. negative**    or    **3. approximately zero**    Explain !!

A.     $2 \text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$     **2. negative.** Fewer moles of gas.  $\Delta n_{\text{gas}} = -1$

B.     $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}(\text{g})$     **3. approximately zero (but slightly positive).**  $\Delta n_{\text{gas}} = 0$   
Same number of moles of gas but NO more disordered than  $\text{N}_2$  or  $\text{O}_2$

C.     $\text{CaCO}_3(\text{s}) + 2 \text{H}^+(\text{aq}) \rightarrow \text{Ca}^{+2}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$     **1. positive.**  $\Delta n_{\text{gas}} = +1$

Predict the sign of  $\Delta S^0_{\text{rxn}}$  for the reaction.    1. positive    2. negative    or    3. approximately zero.  
 $\text{C}(\text{graphite}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$     but small.  $\text{CO}_2(\text{g})$  more disordered than graphite or  $\text{O}_2(\text{g})$

Using the table on the back of this page, calculate  $\Delta S^0_{\text{rxn}}$

$\Delta S^0_{\text{rxn}} = S^0(\text{CO}_2(\text{g})) - S^0(\text{C}(\text{graphite})) - S^0(\text{O}_2(\text{g})) = \{213.7 - 5.6 - 205.1\} \text{ J/mol K} = 3.0 \text{ J/mol K}$   
positive but small

Predict the sign of  $\Delta H^0$  for this reaction.    1. positive    2. negative    or    3. approximately zero  
Burn charcoal, exothermic

Using the table on the back of this page, calculate  $\Delta H^0_{\text{rxn}}$

$\Delta H^0_{\text{rxn}} = \Delta H^0_f(\text{CO}_2(\text{g})) = -394 \text{ kJ/mol}$

Predict the sign of  $\Delta S_{\text{rxn}}$  and  $\Delta H_{\text{rxn}}$  for each of the following reactions.

Classify whether they are favorable or unfavorable for a spontaneous reaction.

|                                                                                  | $\Delta H_{\text{rxn}}$                       | $\Delta S_{\text{rxn}}$ |
|----------------------------------------------------------------------------------|-----------------------------------------------|-------------------------|
| A. $2 \text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$          | Negative - Favorable<br>Make bond, exothermic | Negative - Unfavorable  |
| B.    Combustion of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{s})$ | Negative - Favorable                          | Positive - Favorable    |
| C.    Crystallization of a supersaturated solution of sodium acetate.            | Negative - Favorable                          | Negative - Unfavorable  |