

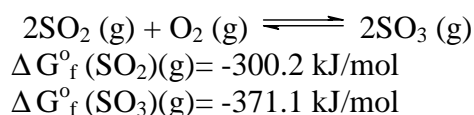
## CHEM 105-Fundamentals of Chemistry

### Problem Set 6-Thermodynamics

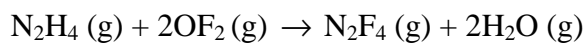
1. Predict the sign (+ or -) of  $\Delta S$  for the following processes:
  - a.  $\text{Br}_2(\text{g}) \rightarrow 2\text{Br}(\text{g})$
  - b.  $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
  - c. Sugar (s)  $\rightarrow$  Sugar (aq)
  - d.  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$
  - e. Cooling of water from 70 °C to 14 °C
2. Calculate  $\Delta S$  when 1 g of  $\text{H}_2\text{O}(\text{l})$  is reversibly evaporated at 100 °C. ( $\Delta H_{\text{vap}}=540$  cal/g)
3. Some asymmetrical compounds like CO may not have third law of thermodynamics (The entropy of a pure perfect crystal at 0 K is zero). Can you explain why?
4. Boiling point of propane is -22 °C at 1 atm. Calculate  $\Delta H_{\text{vap}}$  for propane using Trouton's rule.
5. "Dissociation of a diatomic gas is favored by high temperature". Justify this statement by using thermodynamics. Use your knowledge of bond energy and entropy.
6. A traveller goes from California to Colorado. Which of the followings are state functions?
  - a. distance traveled
  - b. latitude change
  - c. altitude change
  - d. gasoline consumed
  - e. elapsed time
  - f. longitude change
7. Given the following information:  $\Delta H_{\text{f}}^{\circ}(\text{H}_2\text{O})(\text{g})= -242$  kJ/mol  
 $\Delta H_{\text{f}}^{\circ}(\text{CH}_4)(\text{g})= -74.9$  kJ/mol

the heat of combustion of  $\text{CH}_4(\text{g})$  to  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{g})$  is -803 kJ/mol.

- a. Calculate  $\Delta H_{\text{rxn}}^{\circ}$  for the reaction:  $\text{C}(\text{s}) + 2\text{H}_2\text{O}(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2(\text{g})$
  - b. Calculate  $\Delta U^{\circ}$  for the same reaction
8. Use thermodynamic data at 298 K to decide in which direction the below reaction is spontaneous when the partial pressures of  $\text{SO}_2(\text{g})$ ,  $\text{O}_2(\text{g})$  and  $\text{SO}_3(\text{g})$  are  $1 \times 10^{-4}$ , 0.20 and 0.10 atm, respectively.



9. Assess the feasibility of the reaction:



by determining each of the following quantities of this reaction at 25 °C.

a.  $\Delta S^\circ$

	<u><math>S^\circ</math> (J/mol K)</u>
$\text{N}_2\text{H}_4 (\text{g})$	238.5
$\text{OF}_2 (\text{g})$	247.4
$\text{N}_2\text{F}_4 (\text{g})$	301.2
$\text{H}_2\text{O} (\text{g})$	188.8

b.  $\Delta H^\circ$

	<u>Bond Energies (kJ/mol)</u>
N-H	389
O-F	222
N-F	301
O-H	464

c.  $\Delta G^\circ$  (Is the reaction feasible? If so, is it favored at high or low temperatures?)