

Name:  
College ID:  
Thomas Edison State University  
General Chemistry II with Labs (CHE-122)  
Section no.:  
Semester and year:

## Written Assignment 9: Spontaneity Reactions

Answer all assigned questions and problems, and show all work.

1. How does the entropy of a system change for each of the following processes?  
(14 points)

- A solid melts.
- A liquid freezes.
- A liquid boils.
- A vapor is converted to a solid.
- A vapor condenses to a liquid.
- A solid sublimes.
- Urea dissolves in water.

(Reference: Chang 17.5)

2. For each pair of substances listed here, choose the one having the larger standard entropy value at 25°C. The same molar amount is used in the comparison. Explain the basis for your choice. (12 points)

- Li(s) or Li(l)
- C<sub>2</sub>H<sub>5</sub>OH(l) or CH<sub>3</sub>OCH<sub>3</sub>(l)
- Ar(g) or Xe(g)
- CO(g) or CO<sub>2</sub>(g)
- O<sub>2</sub>(g) or O<sub>3</sub>(g)
- NO<sub>2</sub>(g) or N<sub>2</sub>O<sub>4</sub>(g)

(Reference: Chang 17.9)

3. Using the data in Appendix 3 of the textbook, calculate the standard entropy changes for the following reactions at 25°C. (8 points)

- a.  $\text{S}(s) + \text{O}_2(g) \rightarrow \text{SO}_2(g)$
- b.  $\text{MgCO}_3(s) \rightarrow \text{MgO}(s) + \text{CO}_2(g)$

(Reference: Chang 17.11)

4. Without consulting Appendix 3 in the textbook, predict whether the entropy change is positive or negative for each of the following reactions. Give reasons for your predictions. (12 points)

- a.  $2\text{KClO}_4(s) \rightarrow 2\text{KClO}_3(s) + \text{O}_2(g)$
- b.  $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$
- c.  $2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) + \text{H}_2(g)$
- d.  $\text{N}_2(g) \rightarrow 2\text{N}(g)$

(Reference: Chang 17.13)

5. Calculate  $\Delta G^\circ$  for the following reactions at 25°C: (15 points)

- a.  $\text{N}_2(g) + \text{O}_2(g) \rightarrow 2\text{NO}(g)$
- b.  $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$
- c.  $2\text{C}_2\text{H}_2(g) + 5\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 2\text{H}_2\text{O}(l)$

(Reference: Chang 17.17)

6. From the values of  $\Delta H$  and  $\Delta S$ , predict which of the following reactions would be spontaneous at 25°C:

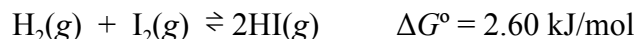
Reaction A:  $\Delta H = 10.5 \text{ kJ/mol}$ ,  $\Delta S = 30 \text{ J/K} \cdot \text{mol}$

Reaction B:  $\Delta H = 1.8 \text{ kJ/mol}$ ,  $\Delta S = -113 \text{ J/K} \cdot \text{mol}$

If any of the above reactions is nonspontaneous at 25°C, at what temperature might it become spontaneous? (16 points)

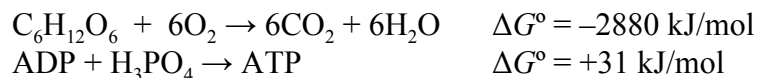
(Reference: Chang 17.19)

7. Calculate  $K_p$  for the following reaction at 25°C: (8 points)



(Reference: Chang 17.23)

8. Referring to the metabolic process involving glucose, calculate the maximum number of moles of ATP that can be synthesized from ADP from the breakdown of one mole of glucose. (8 points)



(Reference: Chang 17.35)

9. Consider the following facts: Water freezes spontaneously at  $-5^\circ\text{C}$  and 1 atm, and ice has a more ordered structure than liquid water. Explain how a spontaneous process can lead to a decrease in entropy. (4 points)

(Reference: Chang 17.45)

10. Under what conditions does a substance have a standard entropy of zero? Can a substance ever have a negative standard entropy? (3 points)

(Reference: Chang 17.55)