Unit 5 Multiple Choice Practice

$$3\,H_2(g) + N_2(g) \rightarrow 2\,NH_3(g)$$

1. Gaseous hydrogen and nitrogen combine in the reaction above to form ammonia, NH_3. Using the table of entropies provided below, calculate the standard entropy change, ΔS°_{rxn}, for the reaction shown at 25°C.

Substance	S° at 25°C (J/mol K)
$H_2(g)$	131
$N_2(g)$	192
$NH_3(g)$	193

(a.) −199 J/mol K b. −386 J/mol K c. +199 J/mol K d. +386 J/mol K

$\Delta S^\circ = \Sigma S^\circ(pr) - \Sigma S^\circ(re) = [2 \cdot NH_3] - [3 \cdot H_2 + N_2]$

$= [2(193)] - [3(131) + 192] = -199$

$$MgO(s) \rightarrow Mg^{2+}(aq) + O^{2-}(aq)$$

2. Is the process above endothermic or exothermic? Why?

relates to ΔS

a. Exothermic, because one solid particle becomes two aqueous particles, increasing the total possible positions.

b. Endothermic, because one solid particle becomes two aqueous particles, increasing the total possible positions.

c. Exothermic, because overcoming the Coulombic forces within MgO(s) releases energy.

(d.) Endothermic, because overcoming the Coulombic forces within MgO(s) requires the input of energy.

3. When ammonium nitrate (NH_4NO_3) dissolves in water, the temperature of the water decreases dramatically. Which is the primary driving factor behind this reaction?

⇒ $+\Delta H_{soln}$

(a.) Entropy c. Both enthalpy and entropy

b. Enthalpy d. Neither enthalpy and entropy

$$2\,AlCl_3(s) \rightarrow 2\,Al(s) + 3\,Cl_2(g)$$

4. The reaction above is spontaneous under standard conditions, but it becomes thermodynamically unfavorable as temperature decreases. Which of the following is true?

⇒ fav. @ ↑T

a. ΔS and ΔH are both negative. c. ΔS is negative, and ΔH is positive.

(b.) ΔS and ΔH are both positive. d. ΔS is positive, and ΔH is negative.

$$CH_3OH(l) \rightarrow CH_3OH(g)$$ ⇒ 298 K

5. For the boiling of methanol, CH_3OH, $\Delta H^\circ = +37.6$ kJ mol^{-1} and $\Delta S^\circ = +111$ J mol^{-1} K^{-1}. Calculate the standard free energy change of this reaction, ΔG°_{rxn}.

a. −4.5 kJ/mol b. −2.8 kJ/mol c. +2.8 kJ/mol d. +4.5 kJ/mol

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 37.6 \frac{kJ}{mol} - (298\,K)(0.111 \frac{kJ}{mol \cdot K})$

$= 37.6 -$

$$I_2(g) + 3\ Cl_2(g) \rightarrow 2\ ICl_3(g) \qquad \Delta H = -390 \text{ kJ/mol}$$

6. Which of the following statements accurately describes the above reaction?

a. The entropy of the products exceeds that of the reactants.

b. $I_2(g)$ will always be the limiting reagent.

c. This reaction is never thermodynamically favored.

(d.) The temperature of the surroundings will increase as this reaction progresses.

$$H_2O(l) \rightarrow H_2O(s)$$

7. Is the process above endothermic or exothermic? Why?

(a.) Exothermic, because forming new intermolecular attractions between water molecules releases energy.

b. Endothermic, because energy is needed to form new intermolecular attractions between water molecules.

c. Exothermic, because forming new bonds between water molecules releases energy.

d. Endothermic, because energy is needed to form new bonds between water molecules.

$$H_2O(l) \rightarrow H_2O(g)$$

8. Which of the following is true for the above reaction?

a. The value of ΔS is negative.

b. The value of ΔG is negative at 298 K.

(c.) The value of ΔH is positive.

d. The reaction is favored at 1.0 atm and 298 K.

Use the following information to answer the next two questions.

Reaction 1: $N_2H_4(l) + H_2(g) \rightarrow 2NH_3(g)$	$\Delta H = ?$
Reaction 2: $N_2H_4(l) + CH_4O(l) \rightarrow CH_2O(g) + N_2(g) + 3H_2(g)$	$\Delta H = -37\ kJ/mol_{rxn}$
Reaction 3: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	$\Delta H = -46\ kJ/mol_{rxn}$
Reaction 4: $CH_4O(l) \rightarrow CH_2O(g) + H_2(g)$	$\Delta H = -65\ kJ./mol_{rxn}$

9. If reaction 4 (shown above) were repeated at a higher temperature, how would the reaction's value for ΔG be affected?

   (a) It would become more negative because entropy is a driving force behind this reaction.
   b. It would become more positive because enthalpy is a driving force behind this reaction.
   c. It will stay the same because reaction 4 is never thermodynamically favorable.
   d. It will stay the same because reaction 4 is thermodynamically favorable at all temperatures.

10. Under what conditions would reaction 2 (shown above) be thermodynamically favored?

   (a) It is always favored.
   b. It is never favored.
   c. It is only favored at low temperatures.
   d. It is only favored at high temperatures.