CHAPTER 18ENTROPY, FREE ENERGY, AND EQUILIBRIUM

1. Calculate ΔG^o of formation, in kJ/mol, for H_3PO_4.

$4P(s) + 5O_2(g) \rightarrow P4O10(s)$ $\Delta G° = -269.8$ kJ/mol

$H_2O(l) \rightarrow H_2(g) + ½O_2(g)$ $\Delta G° = 237.2$ kJ/mol

$P_4O_{10}(s) + 6\ H_2O(l) \rightarrow 4H_3PO_4(l)$ $\Delta G° = 630.2$ kJ/mol

$P(s) + 3/2\ H_2(g) + 2O_2(g) \rightarrow H_3PO_4(l)$ $\Delta G°_f = ?$

a. -1063
b. -265.7
c. 1063
d. 265.7

2. Which quantity has a value of zero for an element in its standard state?

a. ΔH^o_f
b. S^o
c. ΔG^o_f
d. both a and c

3.When ammonium nitrate dissolves in water, the solution becomes cold. We can conclude the following:

a. ΔH^o is positive and ΔS^o is positive
b. ΔH^o is positive and ΔS^o is negative
c. ΔH^o is negative and ΔS^o is negative
d. ΔH^o is negative and ΔS^o is positive

4. Which of these species would you expect to have the lowest standard entropy (S°)?

a. $CH_4(g)$
b. HF(g)
c. $NH_3(g)$
d. $H_2O(g)$

5. Which of these species has the highest entropy (S°) at 25°C?

a. $CH_3OH(l)$
b. $\underline{CO(g)}$
c. $MgCO_3(s)$
d. $H_2O(l)$

6. Calculate ΔS° at 25°C for thereduction of PbO(s), $2PbO(s) + C(s) \rightarrow 2Pb(s) + CO_2(g)$ given these absolute entropies: S° (J/K·mol) : PbO(s) 69.45, C(s) 5.7, Pb(s) 64.89 , $CO_2(g)$ 213.6

a. +198.8 J/K·mol
b. –203.3 J/K·mol
c. +488.0 J/K·mol
d. +203.3 J/K·mol

7. HI has a normal boiling point of –35.4°C, and its ΔHvap is 21.16 kJ/mol. Calculate the molar entropy of vaporization (ΔSvap).

a. 598 J/K·mol
b. 0.068 J/K·mol
c. 68.6 J/K·mol
d. $\underline{89.0\ J/K\cdot mol}$

8. A negative sign for ΔG indicates that, at constant T and P,

a. the reaction is exothermic.
b. $\underline{\text{the reaction is spontaneous.}}$
c. the reaction is endothermic.
d. ΔS must be > 0.

9. Hydrogen peroxide (H_2O_2) decomposes according to the equation

$$H_2O_2(l) \rightarrow H_2O(l) + 1/2O_2(g).$$

Calculate Kp for this reaction at 25°C. (ΔH° = –98.2 kJ/mol, ΔS° = 70.1 J/K·mol)

a. $1.3 \times 10^{-2}1$
b. 20.9
c. 3.46×10^{17}
d. $\underline{7.5 \times 10^{20}}$

10. Determine the equilibrium constant (Kp) at 25°C for the reaction

$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$ $\Delta G° = -28.5$ kJ/mol.

a. 2.9×10^{-60}
b. $\times 10^{-4}$
c. 1.2
d. $\underline{\times 10^{5}}$

Calculate $\Delta G°$ for the reaction $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(l) + NO(g)$.

	$\Delta G°_f$ (kJ/mol)
$H_2O(l)$	−237.2
$HNO_3(l)$	−79.9
$NO(g)$	86.7
$NO_2(g)$	51.8

a. 8.7 kJ/mol
b. 192 kJ/mol
c. −414 kJ/mol
d. −192 kJ/mol

For the reaction $H_2(g) + S(s) \rightarrow H_2S(g)$, $\Delta H° = -20.2$ kJ/mol and $\Delta S° = +43.1$ J/K·mol. Which of the following statements is *true*?

a. The reaction is only spontaneous at low temperatures.
b. The reaction is spontaneous at all temperatures.
c. $\Delta G°$ becomes less favorable as temperature increases.
d. The reaction is spontaneous only at high temperatures.