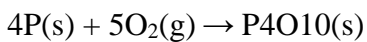
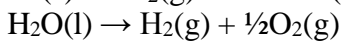


CHAPTER 18 ENTROPY, FREE ENERGY, AND EQUILIBRIUM

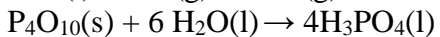
1. Calculate ΔG° of formation, in kJ/mol, for H_3PO_4 .



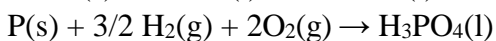
$$\Delta G^\circ = -269.8 \text{ kJ/mol}$$



$$\Delta G^\circ = 237.2 \text{ kJ/mol}$$



$$\Delta G^\circ = 630.2 \text{ kJ/mol}$$



$$\Delta G^\circ_f = ?$$

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°_f

b. S°

c. ΔG°_f

d. both a and c

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

a. ΔH° is positive and ΔS° is positive

b. ΔH° is positive and ΔS° is negative

c. ΔH° is negative and ΔS° is negative

d. ΔH° is negative and ΔS° is positive

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

a. $\text{CH}_4(\text{g})$

b. $\text{HF}(\text{g})$

c. $\text{NH}_3(\text{g})$

d. $\text{H}_2\text{O}(\text{g})$

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

- a. $\text{CH}_3\text{OH}(\text{l})$
- b. $\text{CO}(\text{g})$
- c. $\text{MgCO}_3(\text{s})$
- d. $\text{H}_2\text{O}(\text{l})$

6. Calculate ΔS° at 25°C for the reduction of $\text{PbO}(\text{s})$, $2\text{PbO}(\text{s}) + \text{C}(\text{s}) \rightarrow 2\text{Pb}(\text{s}) + \text{CO}_2(\text{g})$ given these absolute entropies: S° ($\text{J/K}\cdot\text{mol}$) : $\text{PbO}(\text{s})$ 69.45, $\text{C}(\text{s})$ 5.7, $\text{Pb}(\text{s})$ 64.89 , $\text{CO}_2(\text{g})$ 213.6

- a. +198.8 $\text{J/K}\cdot\text{mol}$
- b. -203.3 $\text{J/K}\cdot\text{mol}$
- c. +488.0 $\text{J/K}\cdot\text{mol}$
- d. +203.3 $\text{J/K}\cdot\text{mol}$

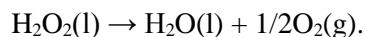
7. HI has a normal boiling point of -35.4°C , and its ΔH_{vap} is 21.16 kJ/mol. Calculate the molar entropy of vaporization (ΔS_{vap}).

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

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

- a. the reaction is exothermic.
- b. the reaction is spontaneous.
- c. the reaction is endothermic.
- d. ΔS must be > 0 .

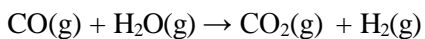
9. Hydrogen peroxide (H_2O_2) decomposes according to the equation



Calculate K_p for this reaction at 25°C. ($\Delta H^\circ = -98.2$ kJ/mol, $\Delta S^\circ = 70.1$ $\text{J/K}\cdot\text{mol}$)

- a. 1.3×10^{-21}
- b. 20.9
- c. 3.46×10^{17}
- d. 7.5×10^{20}

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



$$\Delta G^\circ = -28.5 \text{ kJ/mol.}$$

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

Calculate ΔG° for the reaction $3\text{NO}_2\text{(g)} + \text{H}_2\text{O(l)} \rightarrow 2\text{HNO}_3\text{(l)} + \text{NO(g)}$.

	<u>ΔG°_f (kJ/mol)</u>
$\text{H}_2\text{O(l)}$	-237.2
$\text{HNO}_3\text{(l)}$	-79.9
NO(g)	86.7
$\text{NO}_2\text{(g)}$	51.8

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

For the reaction $\text{H}_2\text{(g)} + \text{S(s)} \rightarrow \text{H}_2\text{S(g)}$, $\Delta H^\circ = -20.2 \text{ kJ/mol}$ and $\Delta S^\circ = +43.1 \text{ J/K}\cdot\text{mol}$.
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. ΔG° becomes less favorable as temperature increases.
- d. The reaction is spontaneous only at high temperatures.