

## 20 • Entropy & Free Energy

### STUDY QUESTIONS

1. Imagine tossing two coins in the air.
  - a. Predict the distribution of various combinations of heads and tails.
  - b. What is the probability of the result being two heads?
  - c. What is the most probable result?

Now imagine tossing three coins in the air.

- d. What is the probability of a three heads result?
  - e. Which system has the highest entropy, the two-coin system or the three-coin system?
2. Which one of the following pairs of samples has the higher entropy?
    - a. Br<sub>2</sub>(l) or Br<sub>2</sub>(g)
    - b. C<sub>2</sub>H<sub>6</sub>(g) or C<sub>3</sub>H<sub>8</sub>(g)
    - c. MgO(s) or NaCl(s)
    - d. KOH(s) or KOH(aq)
  3. Predict the entropy change for the following processes:
    - a. O<sub>2</sub>(g) → 2O(g)
    - b. 2O<sub>3</sub>(g) → 3O<sub>2</sub>(g)
    - c. CH<sub>4</sub>(g) + 2O<sub>2</sub>(g) → CO<sub>2</sub>(g) + 2H<sub>2</sub>O(g)
    - d. NaCl(s) → Na<sup>+</sup>(aq) + Cl<sup>-</sup>(aq)
    - e. C<sub>2</sub>H<sub>5</sub>OH(l) → C<sub>2</sub>H<sub>5</sub>OH(g)
    - f. Ag<sup>+</sup>(aq) + Cl<sup>-</sup>(aq) → AgCl(s)

9. Of the following reactions,
  - which are spontaneous at any temperature,
  - which are never spontaneous regardless of the temperature,
  - which are spontaneous only at a high temperature,
  - and which are spontaneous only at low temperature?

	$\Delta H$	$\Delta S$
a. C <sub>8</sub> H <sub>18</sub> (l) + <sup>25</sup> / <sub>2</sub> O <sub>2</sub> (g) → 8CO <sub>2</sub> (g) + 9H <sub>2</sub> O(g)	-	+
b. N <sub>2</sub> (g) + 2F <sub>2</sub> (g) → N <sub>2</sub> F <sub>4</sub> (g)	-	-
c. Cl <sub>2</sub> (g) → 2Cl(g)	+	+
d. 2O <sub>3</sub> (g) → 3O <sub>2</sub> (g)	-	+
e. 2C(s) + 2H <sub>2</sub> (g) → C <sub>2</sub> H <sub>4</sub> (g)	+	-