

## 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.  $\text{Br}_2(\text{l})$  or  $\text{Br}_2(\text{g})$
    - b.  $\text{C}_2\text{H}_6(\text{g})$  or  $\text{C}_3\text{H}_8(\text{g})$
    - c.  $\text{MgO}(\text{s})$  or  $\text{NaCl}(\text{s})$
    - d.  $\text{KOH}(\text{s})$  or  $\text{KOH}(\text{aq})$
  3. Predict the entropy change for the following processes:
    - a.  $\text{O}_2(\text{g}) \rightarrow 2\text{O}(\text{g})$
    - b.  $2\text{O}_3(\text{g}) \rightarrow 3\text{O}_2(\text{g})$
    - c.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
    - d.  $\text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}(\text{aq})$
    - e.  $\text{C}_2\text{H}_5\text{OH}(\text{l}) \rightarrow \text{C}_2\text{H}_5\text{OH}(\text{g})$
    - f.  $\text{Ag}^+(\text{aq}) + \text{Cl}(\text{aq}) \rightarrow \text{AgCl}(\text{s})$

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?

	<b>DH</b>	<b>DS</b>
a. $\text{C}_8\text{H}_{18}(\text{l}) + \frac{25}{2}\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 9\text{H}_2\text{O}(\text{g})$	-	+
b. $\text{N}_2(\text{g}) + 2\text{F}_2(\text{g}) \rightarrow \text{N}_2\text{F}_4(\text{g})$	-	-
c. $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$	+	+
d. $2\text{O}_3(\text{g}) \rightarrow 3\text{O}_2(\text{g})$	-	+
e. $2\text{C}(\text{s}) + 2\text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_4(\text{g})$	+	-