Quiz 18.1 – Entropy

Name: Key

Question 1

For each process, indicate whether the entropy change for the system is positive or negative:

- $H_2O(g) \longrightarrow H_2O(l)$ −
- $CO_2(s) \longrightarrow CO_2(g)$ +
- $N_2(g) + 3\,H_2(g) \longrightarrow 2\,NH_3(g)$ −
- $Na_2CO_3(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2\,H_2O(l) + CO_2(g)$ +
- $NaC_2H_3O_2(aq) \longrightarrow NaC_2H_3O_2(s)$ −
- The valve on a pressurized gas tank is opened, and gas comes streaming out +
- A sample is taken out of the freezer and left on the counter for twenty minutes +

Question 2

Use the Boltzmann definition of entropy to find the entropy of each system:

- Tossing a single six-sided die

  $W = 6 \quad S = k_B \ln W = 2.47 \cdot 10^{-23}\ J/K$

- Tossing two six-sided dice (consider the dice to be distinguishable)

  $W = 6 \cdot 6 = 36 \quad S = 4.95 \cdot 10^{-23}\ J/K$

- A $0.0100\ g$ diamond is cooled to near absolute zero. The only excited state accessible at this temperature is a nuclear spin state, which each carbon atom having an equal probability of being in the excited or ground state (consider the carbon atoms to be distinguishable)

  $W = 2^n \quad \frac{0.0100\ g}{12.01\ g} \left| \frac{1\ mol}{1\ mol} \right| \frac{6.022 \cdot 10^{23}}{1\ mol} = 5.012 \cdot 10^{20} \quad S = k_B \ln\left(2^{5.012 \cdot 10^{20}}\right)$

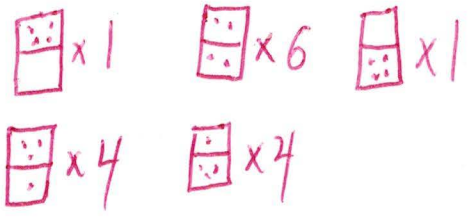
  $S = 5.012 \cdot 10^{20}\, k_B \ln(2) = 0.00480\ J/K$

- 4 He atoms are placed in a chamber with two halves. Each atom has equal probability to be in either half of the chamber (consider the He atoms to be indistinguishable)

  $W = 5 \quad S = 2.22 \cdot 10^{-23}\ J/K$

- 4 different gas particles are placed in a chamber with two halves. Each atom has equal probability to be in either half of the chamber (consider the particles to be distinguishable)

  $W = 16 \quad S = 3.83 \cdot 10^{-23}\ J/K$