5.4: Standard Entropies Can Be Used to Calculate Entropy Changes of Chemical Reactions

Entropy is a state function, so we can calculate values for a process using any path. This allows us to calculate the entropy change of a chemical reaction using standard entropies. Specifically, we sum the entropies of the products and subtract the entropies of the reactions:

$$\Delta_{rxn} S^\circ = \sum_{\text{Products}} v_i S_i^\circ - \sum_{\text{Reactants}} v_i S_i^\circ$$

Where v_i is the stoichiometric coefficient. Let's look at the combustion of methane:

$$\mathrm{CH_4}\,(g) + 2\mathrm{O_2}\,(g) \rightarrow 2\mathrm{H_2O} + \mathrm{CO_2}\,(g)$$

The standard entropies are:

Molecule	Entropy $\left(\frac{\mathrm{J}}{\mathrm{mol \cdot K}}\right)$
$\mathrm{CH_4}$	186.25[1]
$\mathrm{O_2}$	205.15[1]
$\mathrm{H_2O}$	188.84[1]
$\mathrm{CO_2}$	213.79[1]

The entropy for the combustion of methane is:

$$\Delta S^\circ = [2\,(188.84) + 1\,(213.70)] - [1\,(186.25) + 2\,(205.15)] = -5.17\ \frac{\mathrm{J}}{\mathrm{mol \cdot K}}$$

5.4.1: References

1. Chase, M.W., Jr., *NIST-JANAF Themochemical Tables, Fourth Edition*, **J. Phys. Chem. Ref. Data, Monograph 9**, 1998, 1-1951.