Absolute Entropies can be used to calculate Reaction Entropies

Entropies are tabulated in order to facilitate the calculation of the entropy change of chemical reactions. For the general reaction

$$aA + bB \rightarrow yY + zZ$$

the standard entropy change is given by

$$\Delta_r S^o = yS^o[Y] + zS^o[Z] - aS^o[A] - bS^o[B]$$

where the absolute entropies S^o are molar quantities.

Note the significant difference compared to enthalpy. There is no such thing as an absolute enthalpy. Instead, we used a reference of the elements in their standard states. In that case the enthalpy of formation was set arbitrarily to zero. Since entropies are zero and T = 0 K we can use S^o as an absolute quantity.

The standard reaction entropy

The standard reaction entropy, $\Delta_r S^{\ominus}$, is the difference between the standard molar entropies of the reactants and products, with each term weighted by the stoichiometric coefficient.

$$\Delta_r S^{\varnothing} = \sum \nu S_m^{\varnothing}(\textit{products}) - \sum \nu S_m^{\varnothing}(\textit{reactants})$$

The standard state is for reactants and products at 1 bar of pressure. The unit of energy used is J/mol-K.

IMPORTANT: Do not confuse entropy and enthalpy. One common mistake is to set the entropies of elements equal to zero as one does for enthalpies of formation. Elements have an entropy that is not zero (unless the temperature is T = 0 K).

Calculate the entropy of formation of water at 25 ^oC, given the following absolute entropies (in J/mol-K):

$S^o(H_2)$: 130.6 $S^o(O_2)$: 205.0 $S^o(H_2O,l)$: 69.9

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Solution:

$$H_2(g) + {}^{1}/_{2}\, O_2(g) \rightarrow H_2O(l)$$

$$\Delta S^o = [1(69.9)] - [1(130.6) + {}^{1}/_{2}(205.0)]$$

$$\Delta S^o = -163.2 \text{ J/mol-K}$$