Statistical mechanics is a branch of physics that uses statistical and probabilistic methods to understand the behavior of macroscopic systems, such as gases. It is based on the idea of the partition function and has applications in predicting the behavior of gases and other systems at equilibrium and interpreting the behavior of chemical systems using statistical models.

Example 1: Thermodynamics

Consider the following chemical reaction:

2H2 + O2 -> 2H2O

This reaction is exothermic, meaning that it releases heat as a product. The enthalpy change for this reaction, or the heat released or absorbed during the reaction, can be calculated using the equation:

ΔH = [2H2O] - [2H2 + O2]

The enthalpy change for this reaction is -286 kJ/mol, which means that 286 kJ of heat are released per mole of H2O formed.

The second law of thermodynamics states that the total entropy (a measure of the disorder or randomness of a system) of a closed system will always increase over time. In this case, the entropy of the system increases as the heat is released, as the heat is distributed throughout the system and increases the disorder of the system.

Example 2: Kinetics

Consider the following reaction:

2H2 + O2 -> 2H2O

The rate of this reaction can be determined by measuring the change in the concentration of one of the reactants or products over time. For example, if we were to measure the change in the concentration of H2 over time, we might observe the following data: