

12.8: Rate Law and Specific Rate Constant

Where are people moving from and where are they moving to? How fast is the population changing in different areas? These are important considerations for those individuals or companies who decide where to build schools or hospitals, or where to open new businesses. If an area is growing rapidly, action needs to be taken quickly to accommodate the growth. Rates of change affect many decisions.

Rate Law and Specific Rate Constant

Consider a simple chemical reaction in which reactant A is converted into product B, according to the equation below.



The rate of reaction is given by the change in concentration of A as a function of time. The rate of disappearance of A is also proportional to the concentration of A.

$$-\frac{\Delta[A]}{\Delta t} \propto [A]$$

Since the rate of a reaction generally depends upon collision frequency, it stands to reason that as the concentration of A increases, the rate of reaction increases. Likewise, as the concentration of A decreases, the rate of reaction decreases. The expression for the rate of the reaction can be shown as follows:

$$\text{rate} = -\frac{\Delta[A]}{\Delta t} \quad \text{or} \quad \text{rate} = k[A]$$

The proportionality between the rate and [A] becomes an equal sign by the insertion of a constant (k). A **rate law** is an expression showing the relationship of the reaction rate to the concentrations of each reactant. The **specific rate constant** (k) is the proportionality constant relating the rate of the reaction to the concentrations of reactants. The rate law and the specific rate constant for any chemical reaction must be determined experimentally. The value of the rate constant is temperature dependent. A large value of the rate constant means that the reaction is relatively fast, while a small value of the rate constant means that the reaction is relatively slow.

Summary

- A rate law is an expression showing the relationship of the reaction rate to the concentrations of each reactant.
- The specific rate constant (k) is the proportionality constant relating the rate of the reaction to the concentrations of reactants.
- The rate law and the specific rate constant for any chemical reaction must be determined experimentally.

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