Chemical Kinetics: Reaction Rates

The rate of reaction refers to how quickly or slowly reactants are consumed or products are formed in a reaction.

$$\text{Average Reaction Rate} = \frac{\text{Amount of Reactant Consumed}}{\text{Time}}$$

$$\text{Average Reaction Rate} = \frac{\text{Amount of Product Produced}}{\text{Time}}$$

For example, for the decomposition of water:

$$2\ H_2O\ (l) \longrightarrow 2\ H_2\ (g) + O_2\ (g)$$

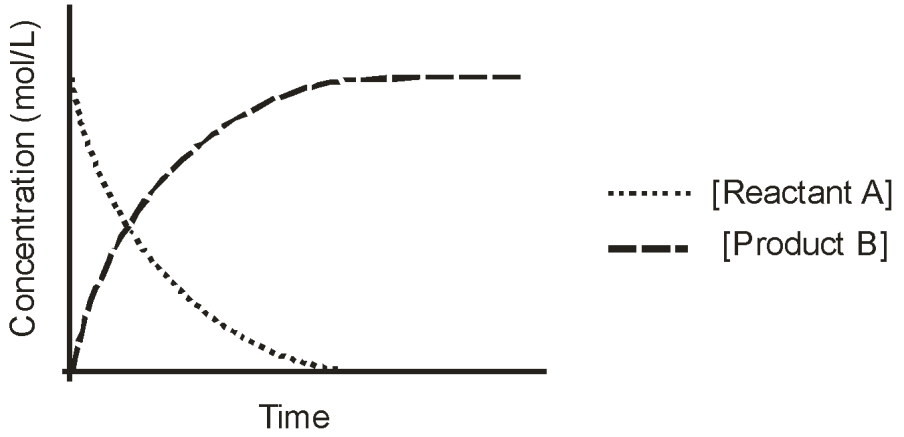
The rate of reaction can be expressed in several ways:

2.0 mol of water is consumed per hour (r = 2.0 mol/h or 2.0 mol·h^{-1})
2.0 mol of hydrogen is produced per hour (r = 2.0 mol/h)
1.0 mol of oxygen is produced per hour (r = 1.0 mol/h)
32.0 grams of oxygen is produced per hour (r = 32.0 g/h)
44.8 L of hydrogen is produced per hour at STP (r = 44.8 L/h)

It is common to calculate the rates as the concentration change per unit time:

$$\text{Average Reaction Rate} = \frac{\text{Concentration Change}}{\text{Time}} \qquad r = \frac{\Delta c}{\Delta t}$$

Concentration vs. Time for the Reaction A → B



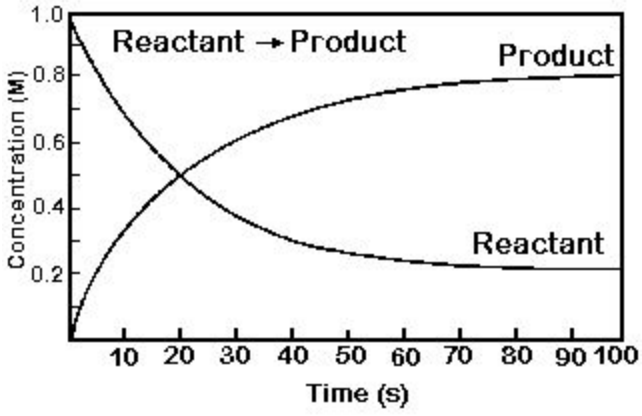
As a reaction proceeds, the rate slows as the reactants are consumed and the products are produced. Reaction rates are usually measured at the start of the reaction, where the rate of reaction is approximately linear.

e.g.1) If 144 g of carbon dioxide gas is produced in 1.00 minute during a chemical reaction, calculate the average rate of reaction in terms of moles CO_2 produced per second.

e.g. 2) 11.2 L of ethane gas (C_2H_6) at STP are consumed in a natural gas furnace every minute. Calculate the rate of formation of CO_2 gas in grams per second.

e.g. 3) Examine the following concentration-time curves

a. What is the average rate of reaction from 0 to 50 seconds?



b. What is the initial rate of reaction?