

Rates of Reaction

Consider the decomposition of dinitrogen pentoxide:



Suppose the average rate of change in N_2O_5 concentration per second was determined to be $-1.36 \times 10^{-3} \text{ %}$ at a particular moment:

$$\frac{\Delta[\text{N}_2\text{O}_5]}{\Delta t} = -1.36 \times 10^{-3} \text{ %}$$

Since 4 mol NO_2 are produced for every 2 mol of N_2O_5 used, the average rate of formation of NO_2 would be:

$$\frac{\Delta[\text{NO}_2]}{\Delta t} = \left(\frac{4}{2}\right)(-1.36 \times 10^{-3} \text{ %}) = 2.72 \times 10^{-3} \text{ %}$$

Since 1 mol O_2 is produced for every 2 mol N_2O_5 that react, the average rate of formation of O_2 would be:

$$\frac{\Delta[\text{O}_2]}{\Delta t} = \left(\frac{1}{2}\right)(-1.36 \times 10^{-3} \text{ %}) = 6.80 \times 10^{-4} \text{ %}$$

The average rate of reaction could also be written:

$$\frac{1}{2} \frac{\Delta[\text{N}_2\text{O}_5]}{\Delta t} = \frac{1}{4} \frac{\Delta[\text{NO}_2]}{\Delta t} = \frac{\Delta[\text{O}_2]}{\Delta t} = 6.80 \times 10^{-4} \text{ %}$$

Note: The units % could also be written as M s^{-1} , $\text{mol L}^{-1}\text{s}^{-1}$ or M s^{-1} .

In general, for the reaction:



the rate of reaction is defined by:

$$\text{rate} = -\frac{1}{a} \frac{\Delta A}{\Delta t} = -\frac{1}{b} \frac{\Delta B}{\Delta t} = \frac{1}{c} \frac{\Delta C}{\Delta t} = \frac{1}{d} \frac{\Delta D}{\Delta t}$$

Note: the use of a negative sign denotes a decrease in the concentration of a reactant with time, and a positive sign denotes the increase in the concentration of a product with time.