Sections 13.3 - 13.4: Instantaneous Rate

The rate of reaction or reaction rate at a particular time is called the **instantaneous rate**.

Example: Consider the decomposition of nitrogen dioxide:

$$2\,NO_{2\,(g)} \rightarrow 2\,NO_{(g)} + O_{2\,(g)}$$

The experimental data of NO_2 concentration as a function of time during the reaction is given in the following table:

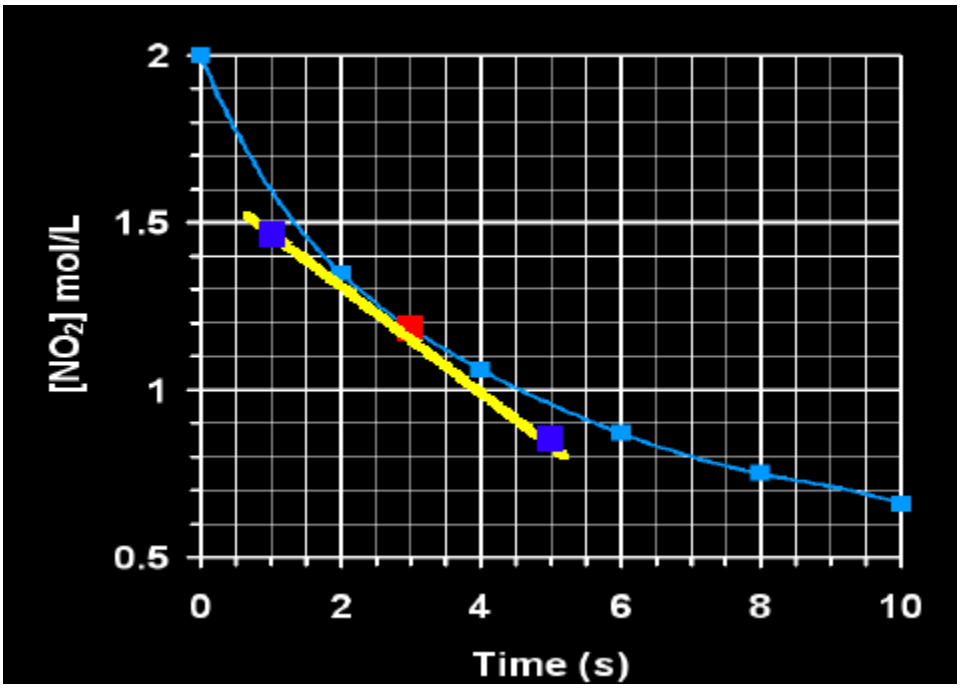
Time, s	$[NO_2]$, $mol.L^{-1}$
0	2.00
2	1.35
4	1.06
6	0.87
8	0.75
10	0.66

Calculate the instantaneous rate of decomposition of NO_2 at 3 s.

The reaction rate is expressed in terms of reactants as:

$$\text{reaction rate} = -\frac{\Delta[NO_2]}{2\Delta t}$$

To calculate the instantaneous rate, first, make a graph of $[NO_2]$ vs. time.



At 3 s, draw a vertical line that intersects the curve. Draw the tangent line to the curve at the point of intersection. Now select two points at a reasonable distance from each other on the tangent line. Find the x- and y-values for each of these points.

The difference in x-values is $x_2 - x_1 = 5 - 1 = 4$ s

The difference in y-values is $y_2 - y_1 = 0.85 - 1.46 = -0.61$ mol/L

$$\text{Instantaneous rate} = \frac{1}{\text{coeff of the reactant}} \times (-\text{ slope of the tangent})$$

$$\text{Slope of the tangent} = \frac{y_2 - y_1}{x_2 - x_1} = -0.15 \text{ mol.L}^{-1}.\text{s}^{-1}$$

Instantaneous rate = ½ x 0.15 $\text{mol.L}^{-1}.\text{s}^{-1}$ = 0.08 $\text{mol.L}^{-1}.\text{s}^{-1}$