

Average & Instantaneous Rates With Graphs



Outcomes:

- Perform a lab to measure the average and instantaneous rates of a chemical reaction.

Rates With Graphs:

We can use a graph of concentration vs. time to find average and instantaneous rates of a reaction.

Average Rates:

- Found by calculating the SLOPE of a concentration vs. time graph over a certain INTERVAL.

Instantaneous Rates:

- Are rates at a SPECIFIC TIME in a reaction.
- Are found by calculating the SLOPE of the line TANGENT to a point on the curve.
- A TANGENT line is a STRAIGHT LINE through a certain POINT on a curve.
- We use this method because the rate of a reaction will change over time and not produce a LINEAR graph.

Example:

The following data was collected for the reaction $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$

| $[\text{SO}_2\text{Cl}_2]$ (mol/L) | Time (s) |
|------------------------------------|----------|
| 0.100 | 0 |
| 0.082 | 100 |
| 0.067 | 200 |
| 0.055 | 300 |
| 0.045 | 400 |
| 0.037 | 500 |
| 0.030 | 600 |
| 0.025 | 700 |
| 0.02 | 800 |

a) Determine the average rate for the first 200 seconds.

$$\text{Rate} = \frac{\Delta[\text{SO}_2\text{Cl}_2]}{\Delta t} = \frac{0.067 \frac{\text{mol}}{\text{L}} - 0.1 \frac{\text{mol}}{\text{L}}}{200 \text{ s}} = 1.65 \times 10^{-4} \frac{\text{mol}}{\text{L} \cdot \text{s}}$$

b) Determine the average rate of reaction for the 500 to 700 second time interval.

$$\text{Rate} = \frac{\Delta[\text{SO}_2\text{Cl}_2]}{\Delta t} = \frac{0.025 \frac{\text{mol}}{\text{L}} - 0.037 \frac{\text{mol}}{\text{L}}}{200 \text{ s}} = 6 \times 10^{-5} \frac{\text{mol}}{\text{L} \cdot \text{s}}$$

c) Account for the difference between the rates in (a) and (b)

$a > b \rightarrow$ more reactant @ beginning, more collisions, \therefore faster rate.

Example:

$$1 \times 10^{-4}$$
$$9.62 \times 10^{-5}$$

$$0.0000938$$
$$0.0000962$$
$$0.0001$$
$$0.0000837$$

$$8.133 \times 10^{-5}$$

$$\text{Rate} = \frac{\Delta C}{\Delta t} = \frac{0.03 - 0.045}{560 - 400}$$
$$= 9.38 \times 10^{-5} \frac{\text{mol}}{\text{L} \cdot \text{s}}$$

d) Use the graph to find the instantaneous rate of decomposition of SO_2Cl_2 at 400s

Concentration of SO_2Cl_2

