# Determination of the Order and Rate Constant of Reaction

**Student Handout**

**Purpose:** To determine the order and rate constant of reactions.

## Introduction

Electronic spreadsheets enable us to play interactively with formulae and simultaneously observe the graphical consequences of changing variables within the formulae. They can also be used as a tool to perform chemical calculations. In this activity, you will determine the order of a reaction by constructing appropriate kinetic plots from experimental data.

| | Differential rate law | Integrated rate law | Linear plot |
|---|---|---|---|
| **First order** | $-\frac{d[\mathrm{A}]}{dt} = k\,[\mathrm{A}]$ | $[\mathrm{A}] = [\mathrm{A}]_o \exp(-kt)$ | ln [A] vs $t$, slope = $-k$ |
| **Second order** | $-\frac{d[\mathrm{A}]}{dt} = k\,[\mathrm{A}]^2$ | $\frac{1}{[\mathrm{A}]} - \frac{1}{[\mathrm{A}]_o} = kt$ | $\frac{1}{[\mathrm{A}]}$ vs $t$, slope = $k$ |

## Tasks

1. Using a spreadsheet software and the experimental data below, plot the following graphs to determine the order and rate constant of the reaction:
   - concentration vs time
   - ln (concentration) vs time
   - $\frac{1}{\text{concentration}}$ vs time

**$\mathrm{A} \rightarrow \mathrm{B} + \mathrm{C}$**

| Time/s | [A] / mol dm$^{-3}$ |
|---|---|
| 0 | 0.80 |
| 400 | 0.58 |
| 800 | 0.40 |
| 1200 | 0.28 |
| 1600 | 0.20 |
| 2000 | 0.14 |
| 2400 | 0.10 |

2. Repeat step (1) using the following experimental data:

**$2\mathrm{A} \rightarrow \mathrm{B} + \mathrm{C}$**

| Time/s | [A] / mol dm$^{-3}$ |
|---|---|
| 0 | 0.1000 |
| 2000 | 0.0498 |
| 7600 | 0.0207 |
| 10000 | 0.0166 |
| 12300 | 0.0139 |
| 14300 | 0.0122 |
| 17000 | 0.0105 |