

Determination of Second-Order Reaction Rate Constant

Practical 10 | Physical Pharmaceutics II

Aim

To determine Second-Order Reaction Rate Constant, and interpret the recorded observations.

Principle

- For the stated single-reactant second-order model, reciprocal concentration increases linearly with time. Other second-order stoichiometries need their own integrated equation.
- The property is obtained from a defined observable under controlled conditions.
- Replicate measurements, instrument checks and consistent units are needed before comparison.

Materials and Apparatus

- Assigned concentration-time data and calculation software.
- Assigned test material and calibration or comparison material.
- The apparatus specified for this property, a balance or volumetric equipment where relevant, and a record sheet.

Method

1. Identify whether the supplied data fit the stated single-reactant second-order model.
2. Tabulate time, concentration and reciprocal concentration.
3. Plot reciprocal concentration against time.
4. Fit the appropriate interval and obtain k from its slope.
5. Calculate half-life with the initial concentration and retained units.
6. State the model rather than transferring the equation to a different stoichiometry.

Observation Record

Complete this record using actual laboratory findings or the provided teaching data.

Observation / parameter	Record / finding
Time t	_____
C ₀	_____
C _t	_____
1/C _t	_____
Fitted slope	_____

Calculations and Interpretation

- $1/C_t = 1/C_0 + kt$.
- $k = (1/C_t - 1/C_0)/t$ for this model.
- Half-life = $1/(kC_0)$.

Worked Illustration

Illustration for the stated model: C₀ = 1.00 mol/L, C_t = 0.500 mol/L at 10.0 min give k = 0.100 L/(mol min) and half-life = 10.0 min.

The values in this illustration are for calculation practice.

Result

Record the actual finding, calculated value with units where relevant, and a conclusion supported by the observations.

Finding: _____

Conclusion: _____

Precautions

- Keep temperature and test conditions consistent across comparative readings.
- Record raw readings before rounding calculated values.
- Do not compare results obtained with different methods as if they were interchangeable.

Viva Questions

1. Why control the test conditions?

A change in conditions may alter the measured property independently of the intended variable.

2. Why retain replicate readings?

They show repeatability and help identify an anomalous measurement.

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