

Determination of First-Order Reaction Rate Constant

Practical 09 | Physical Pharmaceutics II

Aim

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

Principle

- For a first-order process, the concentration declines exponentially and a logarithmic concentration-time plot is linear within the model range.
- 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 time-concentration data or supervised reaction-assay readings.
- 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 the measured concentration and time units in the assigned data.
2. Tabulate concentration with time and check the initial concentration.
3. Calculate natural logarithms and plot $\ln(\text{concentration})$ against time.
4. Fit the suitable model interval and record the slope.
5. Obtain k as the negative slope and calculate the half-life.
6. Inspect departures from linearity before accepting the first-order model.

Observation Record

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

Observation / parameter	Record / finding
Time t	_____
Initial concentration C ₀	_____
Concentration C _t	_____
ln(C _t)	_____
Fitted slope	_____

Calculations and Interpretation

- $\ln(C_t) = \ln(C_0) - kt$.
- $k = \ln(C_0/C_t)/t$; fitted $\ln(C_t)$ -versus-time slope = $-k$.
- Half-life = $0.693/k$ for the first-order model.

Worked Illustration

Illustration: C₀ = 10.0 mg/L and C_t = 5.00 mg/L after 2.00 hours give $k = \ln(2)/2 = 0.347$ per hour and half-life = 2.00 hours.

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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