

## ChemActivity 56

# How Does Reactant Concentration Change as a Reaction Proceeds?

### WARM-UP

#### Model 1: Integrated First- and Second-Order Rate Laws.

The concentration of a reactant decreases as a reaction proceeds. In some cases, the decrease in concentration of a reactant is a (relatively) simple function of time. We will examine two such cases.

For a reaction that is *first order* in a single reactant,  $R$ , the rate law is

$$\text{rate} = - \frac{d(R)}{dt} = k(R)^1 \quad (1)$$

This equation can be rearranged and integrated to provide the explicit relationship between  $(R)$  and time. The resulting equation is

$$\ln(R) = \ln(R)_0 - kt \quad (2)$$

where  $(R)_0$  is the  $(R)$  at time 0 (the initial concentration) and  $t$  is the time. Equation 2 is called the **integrated form** of a first order rate law.

For a reaction that is *second order* in a single reactant, the rate law is

$$\text{rate} = - \frac{d(R)}{dt} = k(R)^2 \quad (3)$$

and the corresponding relationship between concentration and time is

$$\frac{1}{(R)} = \frac{1}{(R)_0} + kt \quad (4)$$

Equation 4 is the integrated form of a second-order rate law. Note that equations 2 and 4 each contain four potential variables:  $(R)$ ,  $(R)_0$ ,  $k$ , and  $t$ . Knowledge of any three of these variables permits the calculation of the fourth variable.

### Critical Thinking Questions

1. Show that  $(R)$  decreases as  $t$  increases for each integrated rate law, equations 2 and 4.

**END OF WARM-UP**

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**Robert C. Smoot, Smoot, Richard G.  
Smith, Jack Price**

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**Chemistry** Richard S. Moog, John J. Farrell, 2017-06-26 In the newly updated 7th Edition Chemistry A Guided Inquiry continues to follow the underlying principles developed by years of extensive research on how students learn and draws on testing by those using the POGIL methodology. This text follows the principles of inquiry based learning and correspondingly emphasizes underlying chemistry concepts and the reasoning behind them. This text provides an approach that follows modern cognitive learning principles by having students learn how to create knowledge based on experimental data and how to test that knowledge.

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