The Funnel Chain

Reaction Pathways

Introduction

Pour water through a series of funnels with varying stem sizes to demonstrate reaction rate-determining steps.

Concepts

- Chemical kinetics
- Rate of reactions
- Rate-determining step

Materials

Bucket or large beaker, 2

Funnels, 4 (one should have a smaller diameter stem than the others)

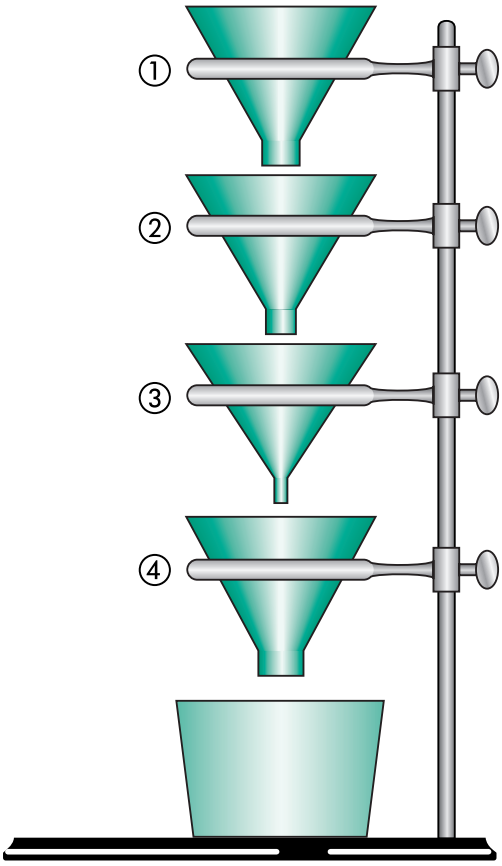
Ring clamps, 4

Ring stand

Water

Safety Precautions

The materials in this activity are considered nonhazardous, please observe all normal laboratory safety guidelines.



Preparation

Assemble four funnels on a ring stand using ring stand clamps (see diagram). Each of the funnels should have a different diameter stem. The second largest diameter funnel is placed in the top position. It is followed by the third largest diameter funnel followed by the smallest diameter funnel. The largest diameter funnel is placed in the bottom position. The funnels are lined up in such a way that each will drain into the one below. A bucket is placed at the bottom of the ring stand to collect the water.

Procedure

1. Pour water into the top funnel. Notice that the rate of water flow is dependent on the narrow funnel (#3). This is the rate-determining step.
2. Try moving the smallest diameter funnel to a different position and measure the length of time it takes a known quantity of water to flow through the system. It should be the same.

Tips

- Add a few drops of food coloring to the water to make it more visible to the students.
- If different stem-diameter funnels are not available, identical size funnels can be used. Simply place some glass–wool, cotton, or even a stopper in the funnel to slow down the flow through one funnel.
- Demonstrate that lowering the temperature may effect the overall rate of reaction but not the rate-determining step by "racing" water and Karo® syrup through parallel identical setups. The Karo® syrup will simulate the same reaction, but only at a lower temperature and therefore a slower rate. No matter the rate, the rate-determining step will still be the same.

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Discussion

During the study of chemical kinetics and rates of reactions, the concept of rate-determining steps can be difficult to demonstrate. Often, one step in a multi-step reaction mechanism is much slower than the others, as much as 100 to 1000 times slower than any other step. This step is called the rate-determining step and determines the overall rate for the reaction.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standard G: History and Nature of Science, nature of science
Content Standards: Grades 5–8
Content Standard G: History and Nature of Science, nature of science
Content Standards: Grades 9–12
Content Standard B: Physical Science, chemical reactions
Content Standard G: History and Nature of Science, nature of scientific knowledge

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of *The Funnel Chain* activity, presented by Peg Convery is available in *Reaction Pathways*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *The Funnel Chain* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP2268	Powder Funnel, Polypropylene, 65 mm
AP2270	Powder Funnel, Polypropylene, 80 mm
AP2269	Powder Funnel, Polypropylene, 100 mm
AP2271	Powder Funnel, Polypropylene, 150 mm

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.