

Module 12: Kinetics and Equilibrium

Topic 2 Application: Le Chatelier's Principle Scientific Investigation

Before you begin the scientific investigation below, make sure to download the *Le Chatelier's Principle Scientific Investigation Report*. As you complete this scientific investigation, fill in any needed information on the report template. If you need more information about each section of the report, please visit the Developmental Module.

Introduction

Le Chatelier's Principle states that if a system at equilibrium is subjected to a stress, the equilibrium is shifted in the direction that tends to relieve the stress. This shift will cause the reaction to reach a new equilibrium. Le Chatelier's Principle is an example of cause and effect. In this investigation, you will observe Le Chatelier's Principle as you manipulate one stress: temperature.

Objectives

In this scientific investigation, you will:

- observe the effects of temperature on a reversible reaction; and
- observe how the concentrations of the products and reactants change as the reaction reaches equilibrium.

Hypothesis

Using the **Procedure and Data Collection** section below, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe the expected results. You should consider the following questions: How will temperature affect the equilibrium of a reversible reaction? How will the concentrations of reactants change as equilibrium is reached? Record these hypotheses in the **Hypothesis** section of your *Le Chatelier's Principle Scientific Investigation Report*.

Required Simulation

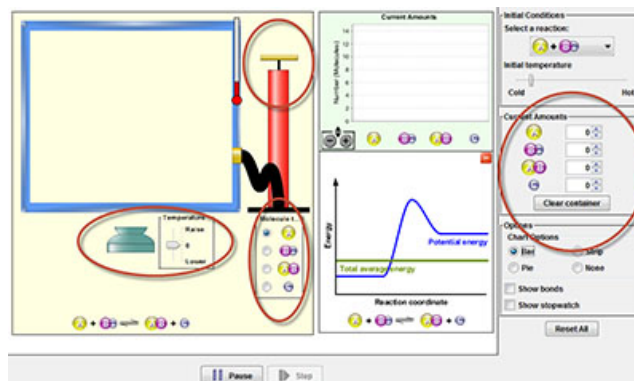
Reactions and Rates Simulation: http://phet.colorado.edu/sims/reactions-and-rates/reactions-and-rates_en.jnlp

Provided by:
PhET Interactive Simulations
University of Colorado
<http://phet.colorado.edu>

Procedure and Data Collection

Simulation Set-Up

1. Open the Reactions and Rates simulation.
2. Click on the *Many Collisions* tab. Click **Bar** under Chart Options.
3. Take a few moments to become familiar with the simulator. Add amounts of reactants, change the temperature, and



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pump the handle. View the image to the right to see where each of these controls are located.

- Once you are done experimenting with the simulation, click **Reset All** to reset the simulation.

Procedures

- Click on the **Many Collisions** tab. Click **Bar** under Chart Options.
- Under **Current Amounts**, give both A and Bc an amount of 25.
- Using the temperature menu, raise the temperature until the experiment reaches equilibrium. Equilibrium is indicated by the Reaction Coordinate graph to the right of the container.
- Record the amounts of reactants and products in the data table provided on your *Le Chatelier's Principle Scientific Investigation Report*.
- Repeat Steps 1-4 four times to ensure a valid experiment through repeated trials.

Data

Use the data table provided in the **Data** section of your *Le Chatelier's Principle Scientific Investigation Report* to record your data from this scientific investigation. The data table is also shown below.

Current Amounts	Trial #1	Trial #2	Trial #3	Trial #4
A				
Bc				
AB				
c				

Data Analysis

In the **Data Analysis** section of your *Le Chatelier's Principle Scientific Investigation Report*, provide the answers to the following questions:

- How did the concentrations of the reactants and products change as the reaction came to equilibrium?
- Explain how Le Chatelier's Principle is an example of cause and effect. What are some causes? What are some effects?

Conclusion

In the **Conclusion** section of your *Le Chatelier's Principle Scientific Investigation Report*, compose three to four sentences describing an overall conclusion about the Le Chatelier's Principle. Base your conclusions on your data. Were your hypotheses true or false, and how do you know? Use the data and notes that you collected from your simulation experience to form your conclusion. Make sure that you include information that you gained from data analysis to support your conclusion.

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Experimental Sources of Error

On your *Le Chatelier's Principle Scientific Investigation Report*, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?



Once you have completed the *Le Chatelier's Principle Scientific Investigation Report*, please submit your work to the dropbox.