

# Exploring Equilibrium: It Works Both Ways

## Student Laboratory Kit

### Introduction

The word *equilibrium* has two roots: *aequi*, meaning equal, and *libra*, meaning weight or balance. Our physical sense of equilibrium suggests a condition of equal balance of opposing forces. How does this physical sense of equilibrium translate to chemical equilibrium? The purpose of this lab is to explore the nature and consequences of equilibrium in a variety of chemical reactions.



### Chemical Concepts

- Reversible chemical reaction
- Chemical equilibrium
- LeChâtelier's Principle
- Endothermic vs. exothermic reactions

### Background

In our first exposure to the nature of chemical change, we learn to distinguish between chemical and physical changes by emphasizing that physical changes can be easily reversed. In contrast, early examples of chemical change often feature reactions that cannot be reversed, such as burning wood, rusting metal, or spoiling food. A closer look at chemical change, however, reveals that many chemical reactions are indeed reversible.

Consider the following example of a reversible chemical reaction. Nitrogen and hydrogen gas react under high-pressure conditions to make ammonia. At relatively high temperatures, however, ammonia decomposes to reform the nitrogen and hydrogen starting materials. The reaction can go both ways! This reversible chemical reaction is represented symbolically using double arrows, as shown in Equation 1.



Equation 1

What happens when nitrogen gas and hydrogen gas are allowed to react? As ammonia is produced, the amounts of nitrogen and hydrogen decrease and the amount of ammonia begins to increase. As the concentration of ammonia increases, however, the reverse reaction begins to take place at a significant rate as well. Eventually, the amount of ammonia consumed due to the reverse reaction becomes equal to the amount of ammonia formed in the forward reaction. At this point, no further changes are observed in the amounts of either the reactants or product. This is the position of chemical equilibrium.

*Chemical equilibrium* is defined as the state where the concentrations of reactants and products remain constant with time. This does not mean that both reactions have stopped. Both the forward and reverse reactions are still taking place, but at equal rates, so the amounts of reactants and products remain constant. Chemical equilibrium represents an equal balance of opposing forces due to the forward and reverse reactions.

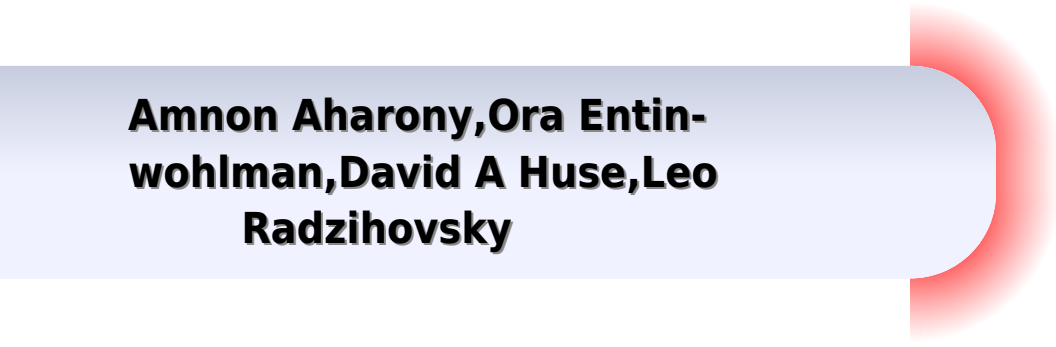
#### LeChâtelier's Principle

What happens when the balance is disturbed—due to changes in reactant and product concentrations, temperature, or pressure, for example? *LeChâtelier's Principle* provides an intuitive explanation for how balance can be restored:

"If an equilibrium system is subjected to a stress,  
the system will react in such a way as to remove the stress."

# Exploring Equilibrium It Works Both Ways Answers

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## **Exploring Equilibrium It Works Both Ways Answers:**

## Unveiling the Energy of Verbal Art: An Mental Sojourn through **Exploring Equilibrium It Works Both Ways Answers**

In a world inundated with screens and the cacophony of quick conversation, the profound power and mental resonance of verbal beauty often fade in to obscurity, eclipsed by the regular onslaught of noise and distractions. However, set within the lyrical pages of **Exploring Equilibrium It Works Both Ways Answers**, a interesting function of literary beauty that pulses with fresh emotions, lies an unique journey waiting to be embarked upon. Written with a virtuoso wordsmith, this interesting opus instructions visitors on a psychological odyssey, delicately exposing the latent potential and profound affect stuck within the delicate internet of language. Within the heart-wrenching expanse of this evocative analysis, we can embark upon an introspective exploration of the book is central styles, dissect its interesting publishing model, and immerse ourselves in the indelible effect it leaves upon the depths of readers souls.

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