

A graphic showing two overlapping circles with a starburst effect, representing a collision, positioned above the word "collisions".

collisions®

Equilibrium Game Guide

Equilibrium Snapshot

Game Levels

The Challenge Levels increase in rigor and complexity.

- 21 Challenge Levels*

*The first 4 levels are Tutorial levels.

Sandbox*

The Sandbox is an exploratory learning space for extended practice and review of phase change.

- 14 Achievements

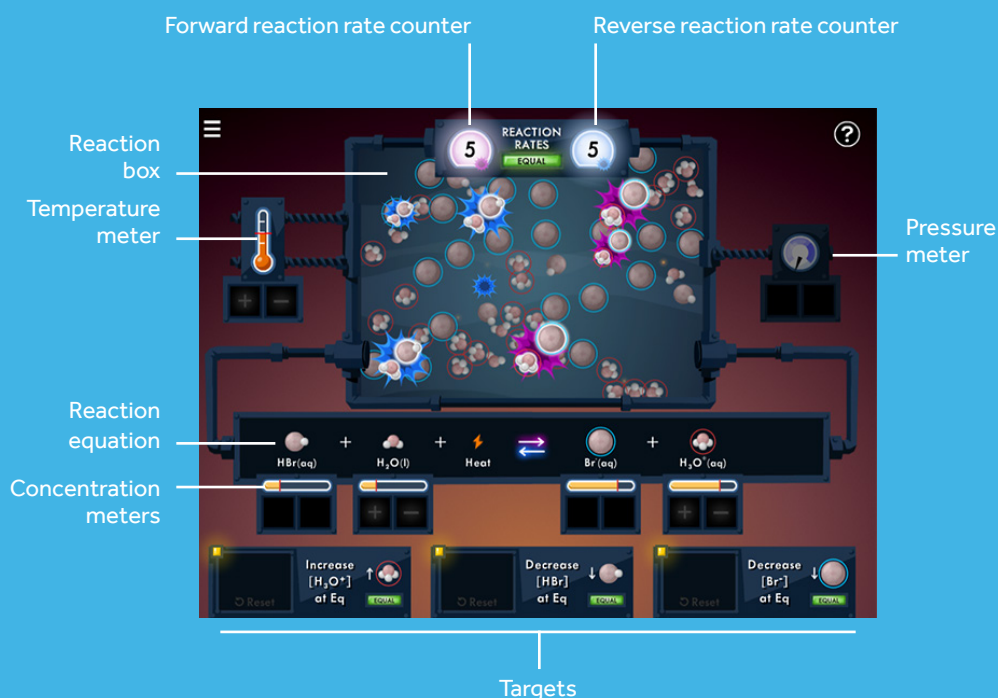
* Players must complete Challenge Levels 1-4 before unlocking the Sandbox

Integrated Concepts

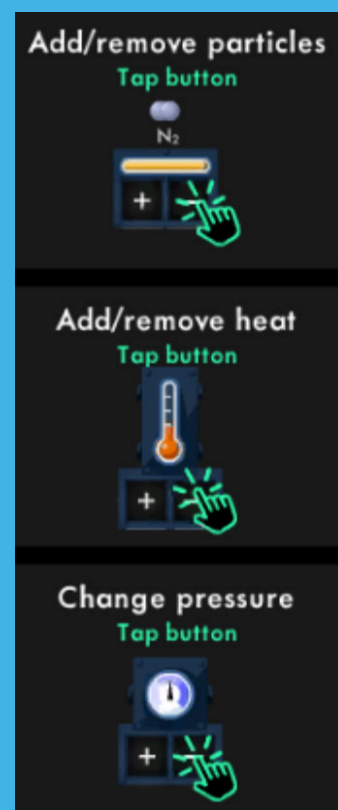
- All reactions can proceed in the forward and reverse directions.
- At equilibrium, the rate of the forward and reverse reactions are equal
- When a system at equilibrium is disturbed by a change in concentration, pressure, or temperature, it will shift to re-establish equilibrium

General Information

Equilibrium game level layout

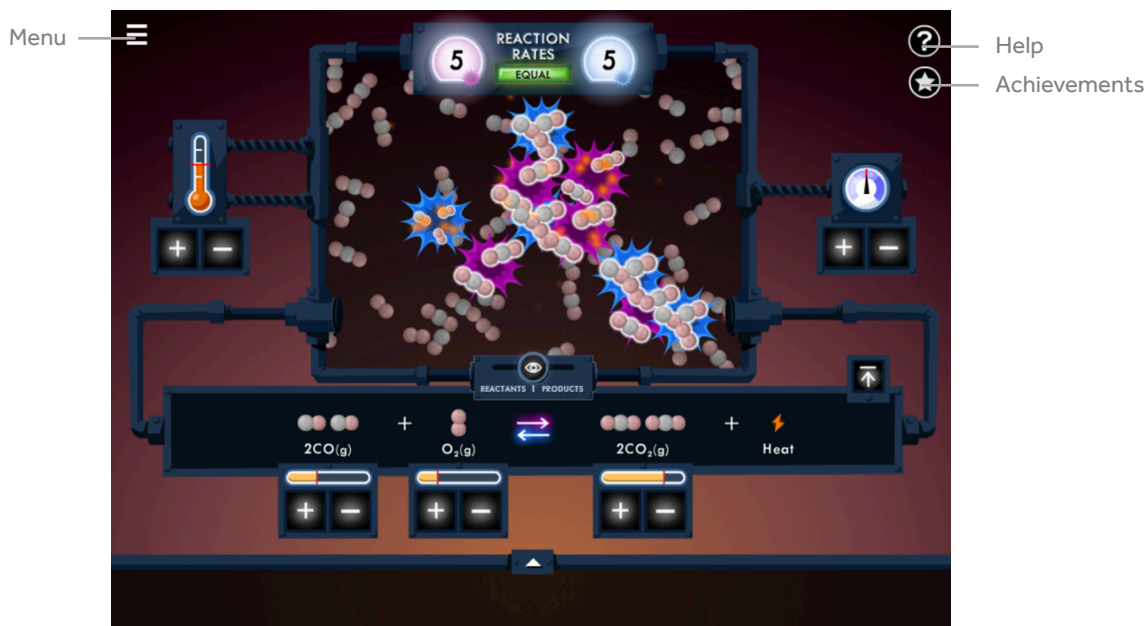


Skills

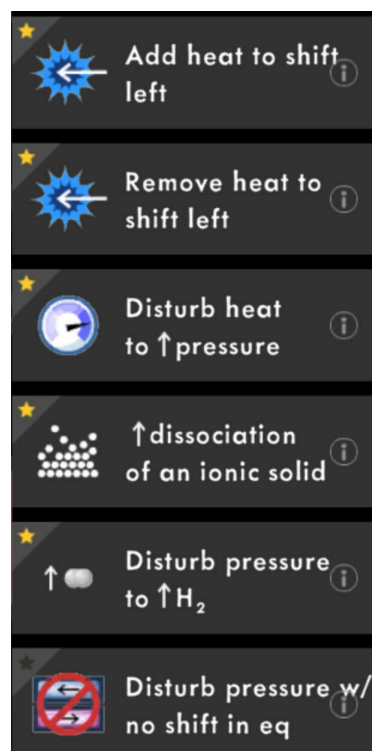
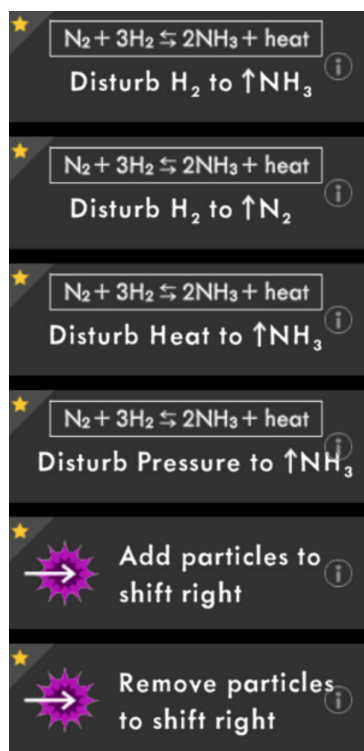


Equilibrium: Overview

Equilibrium Sandbox



Sandbox Achievements



Equilibrium: Overview (cont.)

Equilibrium Challenges

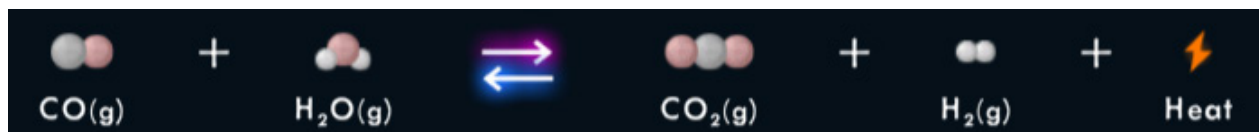
Level 1-21 GOAL: Disturb the reaction to cause changes to the system at equilibrium.



Equilibrium: Chemistry Connections

CHEMISTRY CONCEPT:

All reactions can proceed in the forward and reverse directions.



Forward reaction:
 $\text{CO(g)} + \text{H}_2\text{O(g)} \rightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{(g)}$

Reverse reaction:
 $\text{CO}_2\text{(g)} + \text{H}_2\text{(g)} \rightarrow \text{CO(g)} + \text{H}_2\text{O(g)}$

CHEMISTRY CONCEPT:

At equilibrium, the rate of the forward and reverse reactions are equal.



At equilibrium, both the forward and reverse reactions are happening.

Equilibrium: Chemistry Connections (cont.)

CHEMISTRY CONCEPT:

When a system at equilibrium is disturbed by change in concentration, it will adjust to reestablish equilibrium.

Change in Reactants



Increase reactants



*Return to Equilibrium
(shifts right)*



Increases products



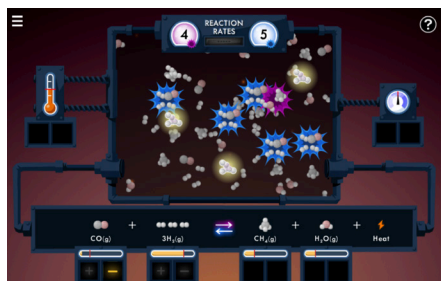
Decrease reactants



*Return to Equilibrium
(shifts left)*



Decreases products



Equilibrium: Chemistry Connections (cont.)

CHEMISTRY CONCEPT:

When a system at equilibrium is disturbed by change in concentration, it will adjust to reestablish equilibrium (cont.).

Change in Products



Increase products



*Return to Equilibrium
(shifts left)*

Increase reactants



Decrease products



*Return to Equilibrium
(shifts right)*

decrease reactants



Equilibrium: Chemistry Connections (cont.)

CHEMISTRY CONCEPT:

When a system at equilibrium is disturbed by change in temperature, it will adjust to reestablish equilibrium.

Exothermic Reactions



Increase temperature → *Return to Equilibrium (shifts left)* → *Increase products*

The first screenshot shows the effect of increasing temperature. The thermometer is turned up, and the reaction rates for both forward and reverse reactions increase to 7. The system is now labeled 'OUT OF BALANCE'. The second screenshot shows the effect of increasing products. The product slider is moved to 75%, and the reaction rates increase to 7. The system is still 'OUT OF BALANCE'. The third screenshot shows the effect of decreasing products. The product slider is moved back to 50%, and the reaction rates decrease to 3. The system is still 'OUT OF BALANCE'.

Decrease temperature → *Return to Equilibrium (shifts right)* → *Decrease products*

The fourth screenshot shows the effect of decreasing temperature. The thermometer is turned down, and the reaction rates for both forward and reverse reactions decrease to 3. The system is now labeled 'OUT OF BALANCE'. The fifth screenshot shows the effect of decreasing products. The product slider is moved to 25%, and the reaction rates decrease to 3. The system is still 'OUT OF BALANCE'.

Equilibrium: Chemistry Connections (cont.)

CHEMISTRY CONCEPT:

When a system at equilibrium is disturbed by change in temperature, it will adjust to reestablish equilibrium (cont.).

Endothermic Reactions



Increase temperature → *Return to Equilibrium (shifts right)* → *Increase products*



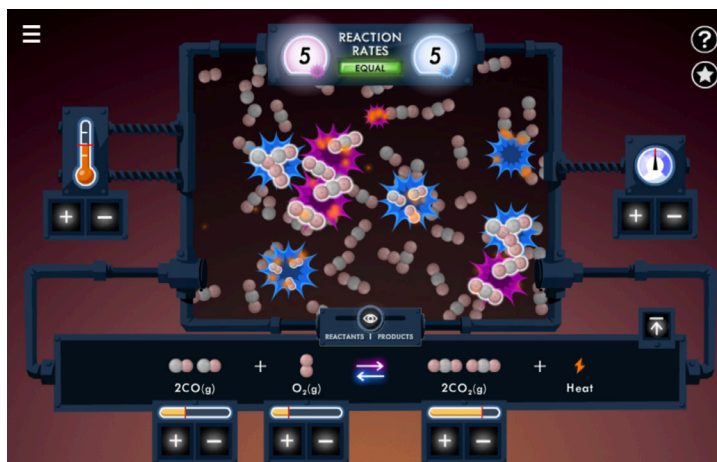
Decrease temperature → *Return to Equilibrium (shifts left)* → *Decrease products*



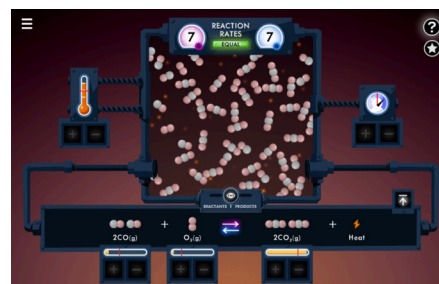
Equilibrium: Chemistry Connections (cont.)

CHEMISTRY CONCEPT:

When a system at equilibrium is disturbed by change in pressure, it will adjust to reestablish equilibrium.



*Increase pressure → increase chance of collisions on side with more molecules
→ reaction shifts to direction with **fewer molecules***



*Decrease pressure → decrease chance of collisions on side with more molecules
→ reaction shifts to direction with **more molecules***

