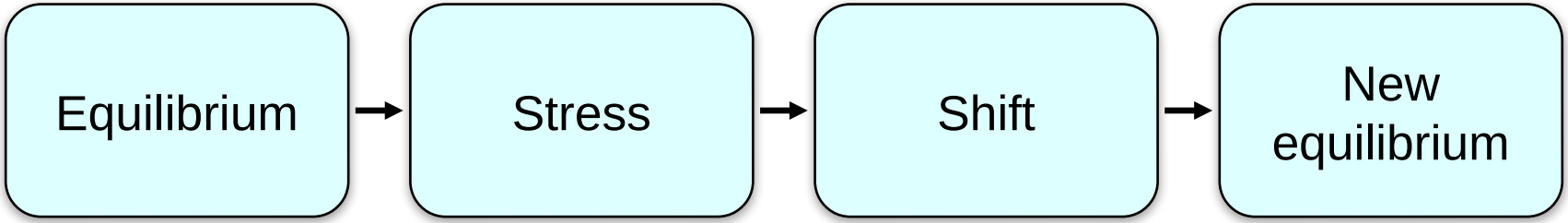
Introduction to Le Châtelier's Principle

Essential Question

How does a system at equilibrium respond when we disturb it?

Le Châtelier's Principle

- A stress disturbs equilibrium
- The system shifts to reduce the stress



Adding or Removing a Substance

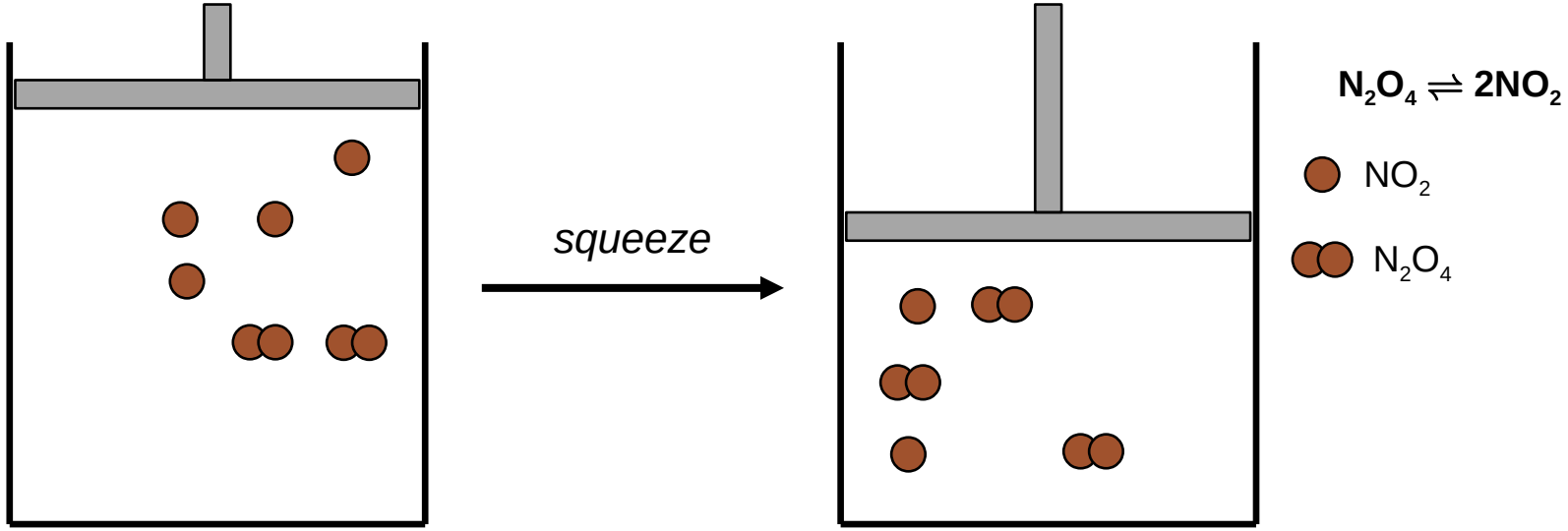
- Add a substance → shift away from it
- Remove a substance → shift toward it

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

add N_2 → **shift right** → more NH_3 forms

Changing the Volume of a Gas

- Smaller volume → shift to fewer gas moles
- Larger volume → shift to more gas moles



Changes That Do NOT Shift Equilibrium

Catalyst
speeds up both directions equally

Inert gas
added at constant volume

Solid or liquid
added or removed

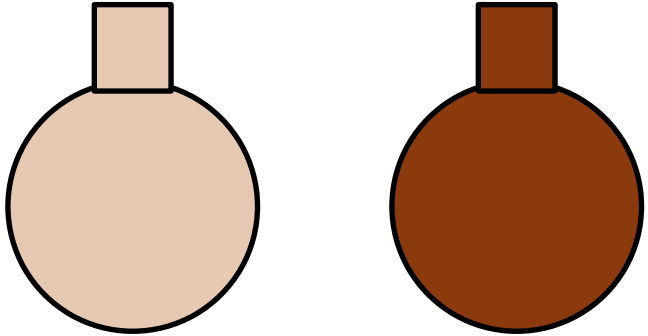
These do not change Q or K.

Changing Temperature

- Treat heat like a reactant or product
- Heating → shift away from heat
- Cooling → shift toward heat

$$\text{heat} + N_2O_4 \rightleftharpoons 2NO_2$$

endothermic: $\Delta H > 0$



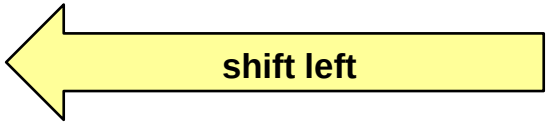
ice bath *hot water*

Dilution

- Adding water lowers every concentration
- Shift toward the side with more dissolved particles

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons FeSCN^{2+}(aq)$$

2 particles **1 particle**

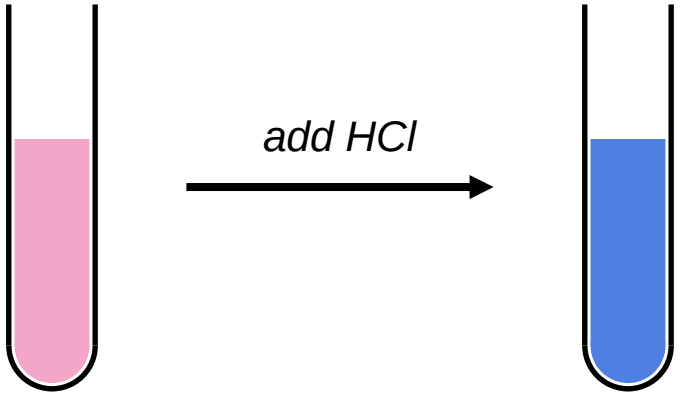


Seeing a Shift

- Watch for color, pH, or temperature changes

$$Co(H_2O)_6^{2+}(aq) + 4Cl^-(aq) \rightleftharpoons CoCl_4^{2-}(aq) + 6H_2O(l)$$

pink **blue**



Example: Changing Volume

The volume of the container is decreased at constant temperature.

Which way does the equilibrium shift? Explain.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Example: Changing Temperature

This reaction is exothermic ($\Delta H < 0$). The temperature is increased.

Which way does the equilibrium shift? What happens to $[SO_3]$?

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

Example: Explaining a Color Change

A blue test tube of this mixture is placed in an ice bath and turns pink.

Is the forward reaction endothermic or exothermic? Justify.

$$Co(H_2O)_6^{2+} + 4Cl^- \rightleftharpoons CoCl_4^{2-} + 6H_2O$$

pink blue

Introduction to Le Châtelier's Principle

Big Ideas

- A stress makes the system shift
- Add → shift away. Remove → shift toward.
- Smaller volume → fewer gas moles
- Treat heat like a reactant or product

