3. LE CHATELIER'S PRINCIPLE – CONCENTRATION & TEMPERATURE

UNIT 3 – CHEMICAL EQUILIBRIUM

CH40S MR. WIEBE

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EQUILIBRIUM POSITION CAN BE INFLUENCED

Le Châtelier's Principle
When a chemical system at equilibrium is disturbed by a change in a property, the system adjusts in a way that opposes the change.

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TRANSLATION:

- When you take something away from a system at equilibrium, the system shifts in such a way as to replace some of what you've taken away.
- When you add something to a system at equilibrium, the system shifts in such a way as to use up some of what you've added.

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CHANGES IN CONCENTRATION

Adding more of a **reactant** or **product** shifts the reaction in the direction that uses them up.

$$2CO_2(g) \rightleftharpoons 2CO(g) + O_2(g)$$

stress- **reaction-**

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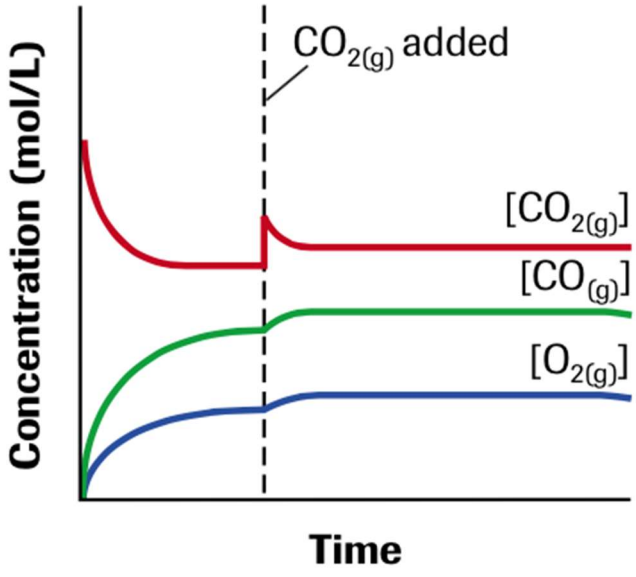
5

WHY?



6

CHANGES IN CONCENTRATION

Removing a **reactant** or **product** from the equilibrium shifts the reaction in a direction that replaces them.

$$2CO_2(g) \rightleftharpoons 2CO(g) + O_2(g)$$

stress- **reaction-**

7

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8

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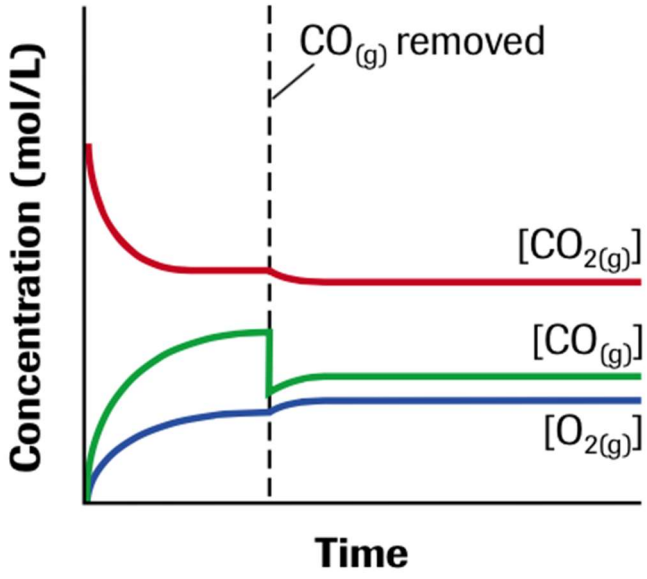

9

CHANGES IN TEMPERATURE

Increasing the **temperature** of a reaction causes equilibrium to shift in the direction that **decreases** the added energy.

$$2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g) + \textbf{Energy}$$

stress- **reaction-**

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CHANGES IN TEMPERATURE

Decreasing the **temperature** of a reaction causes equilibrium to shift in the direction that replaces the lost energy by **increasing** it.

$$2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g) \quad + \quad \textbf{Energy}$$

stress- **reaction-**

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CHANGES IN TEMPERATURE

Increasing the **temperature** of a reaction causes equilibrium to shift in the direction that **decreases** the added energy.

$$2CO_2(g) + \textbf{Energy} \rightleftharpoons 2CO(g) + O_2(g)$$

stress- **reaction-**

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CHANGES IN TEMPERATURE

Decreasing the **temperature** of a reaction causes equilibrium to shift in the direction that replaces the lost energy by **increasing** it.

$$2CO_2(g) + \text{Energy} \rightleftharpoons 2CO(g) + O_2(g)$$

stress- **reaction-**

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SEE FOR YOURSELF!

$$\underbrace{CoCl_4^{2-}(aq)}_{\text{BLUE}} + 6H_2O(l) \leftrightarrow \underbrace{Co(H_2O)_6^{2+}(aq)}_{\text{PINK}} + 4Cl^-(aq) + \text{Energy}$$

- Heat it up…
- Cool it down…

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Other Stuff…

1. Adding an **inert** (non-reactive) gas does **not shift** the equilibrium.

2. Only changes to **(aq)** and **(g)** reactants or products **cause** the equilibrium to **shift**, **(s)** and **(l)** do **not!**

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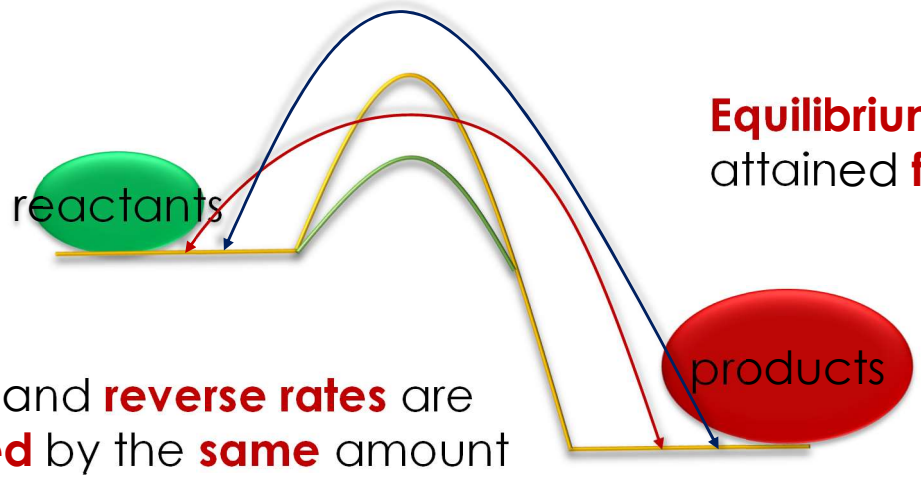
Other Stuff…

3. Adding a **catalyst** does **not shift** the equilibrium



Equilibrium is attained **faster**

Forward and **reverse rates** are **increased** by the **same** amount

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EXAMPLE 1

$$PCl_3(g) + Cl_2(g) \leftrightarrow PCl_5(g) + ENERGY$$

Stress	$[PCl_3]$	$[Cl_2]$	$[PCl_5](g)$	Shifts	Creates More
$[Cl_2]$ is Increased					
$[PCl_5]$ is increased					
$[PCl_3]$ is decreased					
Temp is increased					

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