# What happens if...

1. You are running on a trendmill and someone increases the speed?

2. You are riding your bike and the wind picks up?

These are stresses being put on you!

Chemists put stresses on chemical reactions.

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# Why do we care?

Why do we want to stress a chemical reaction?

- Chemists will manipulate equilibrium equations to their benefit .
- Chemists will control the equilibrium of a reaction for thei benefit.
- They do this to produce more products!

INDUSTRY!

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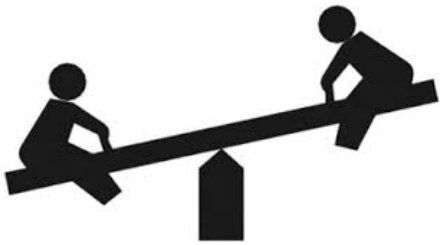
# What is this called?

## Le'Chatelier's Principle

-- If a stress is applied to a system at equlibrium, the system shifts in the direction that relieves the stress.



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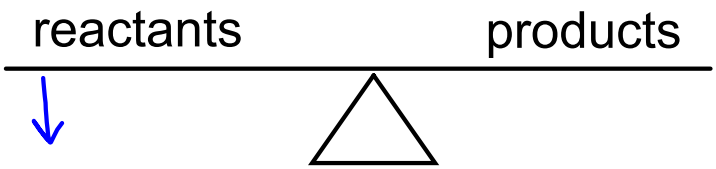
# Changes in Concentration

## Adding Reactants

What will happen if you add more reactants t a reaction?

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# Changes in Concentration

## Adding Reactants

$CO(g) + 3H_2(g) \leftrightharpoons CH_4(g) + H_2O(g)$

What happens if I add more CO?

We say the reaction shifts to the right.

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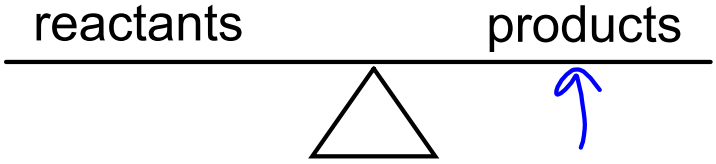
# Changes in Concentration

## Removing Products

What will happen if you remove products?

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# Changes in Concentration

## Removing Products

$$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$$

What happens if I remove $H_2O$?

$\rightleftharpoons$

We say the reaction shifts to the right.

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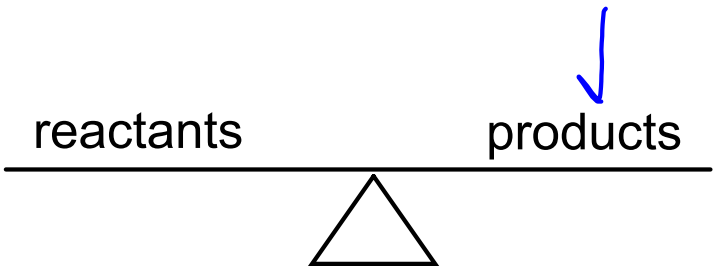
# Changes in Concentration

## Adding Products

What will happen if you add products?

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# Changes in Concentration

## Adding Products

$$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$$

What happens if I add $H_2O$?

We say the reaction shifts to the left.

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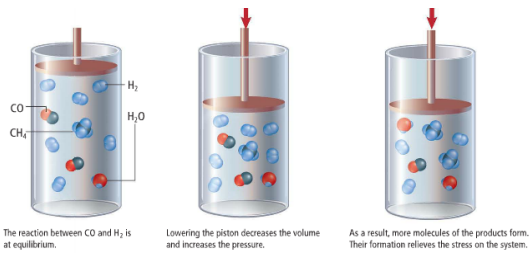
# Changes in Volume and Pressure

## Decreasing the volume




The reaction between CO and $H_2$ is at equilibrium. Lowering the piston decreases the volume and increases the pressure. As a result, more molecules of the products form. Their formation relieves the stress on the system.

What happens to the pressure if I decrease the volume? P↑

What happens to the number of collisions? #Collisions ↑

To determine if the reaction will shift, we need to look at th number of moles of the reactants and products.

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# Changes in Volume and Pressure

## Decreasing the volume

$CO(g) + 3H_2(g) \leftrightarrows CH_4(g) + H_2O(g)$

4 moles 2 moles

-- Which side of the reaction contains more moles?

left (reactants)

--Volume only has an effect on the reaction if the number of mole reactants differs from the number of moles of products.

--This reaction has more moles of reactants than products, so the reaction shifts to the right. ⇄

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# Changes in Temperature

## Temp. Changes

$CO(g) + 3H_2(g) \leftrightarrows CH_4(g) + H_2O(g) + heat$

$K_{eq}$

-- Alters both the equilibrium position and the equilibrium constant.

--Think of heat as either a reactant or a product.

--In this reaction, heat is a product so adding more heat wou shift the reaction to the left.

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# Addition of a Catalyst

## Catalysts

-- Speeds up a reaction, but does so both ways

-- Equilibrium is just reached sooner.

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# Le'Chatelier's Principle

## Summary

stresses to the system

-- Changes in concentration, volume and temperature make a difference in the amount of product formed in a reaction.

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# Le'Chatlier's Practice:

1. For the reaction below, which change will cause the reaction to shift to the right?

$$CH_4(g) + 2H_2S(g) + heat \leftrightarrow CS_2(g) + 4H_2(g)$$

3 moles 5 moles

a. decrease the concentration of dihydrogen sulfide

R left

b. increase the pressure on the system

L left

c. increase the temperature on the system

X R

d. increase the concentration of carbon disulfide

L

e. decrease the concentration of methane

X L

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