

## What happens if...

1. You are running on a treadmill 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 their benefit.
- They do this to produce more products!

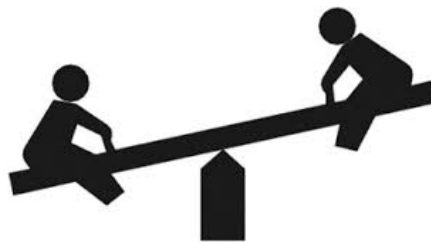
**INDUSTRY!**

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# What is this called?

## Le'Chatelier's Principle

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

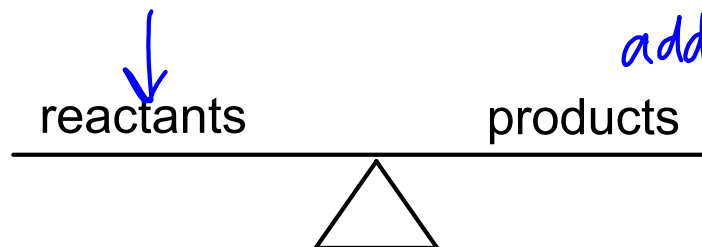


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# Changes in Concentration

## Adding Reactants

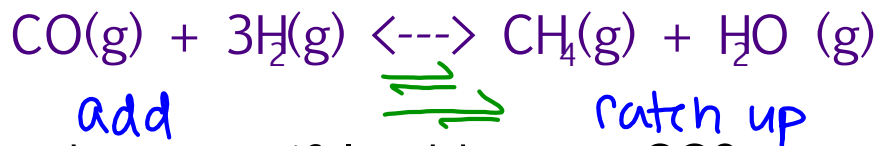
What will happen if you add more reactants to a reaction?



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# Changes in Concentration

## Adding Reactants



What happens if I add more CO?

Stress reactants

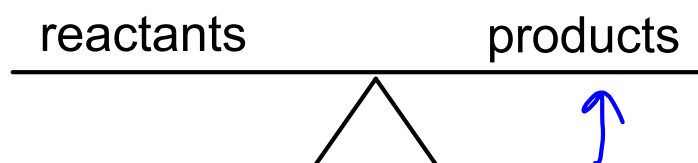
We say the reaction shifts to the right.

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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



What happens if I remove  $\text{H}_2\text{O}$ ?



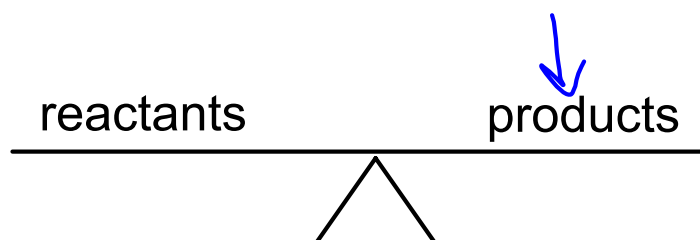
We say the reaction shifts to the right.

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# Changes in Concentration

## Adding Products

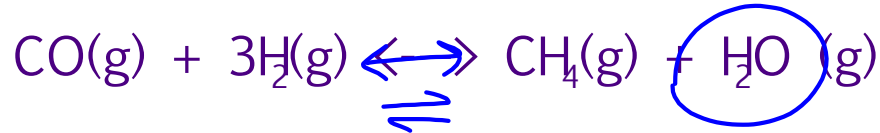
What will happen if you add products?



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# Changes in Concentration

## Adding Products



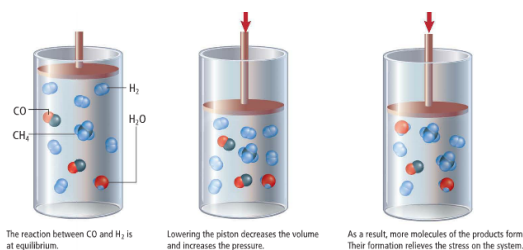
What happens if I add  $\text{H}_2\text{O}$ ?

We say the reaction shifts to the left.

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# Changes in Volume and Pressure

## Decreasing the volume



What happens to the pressure if I decrease the volume?

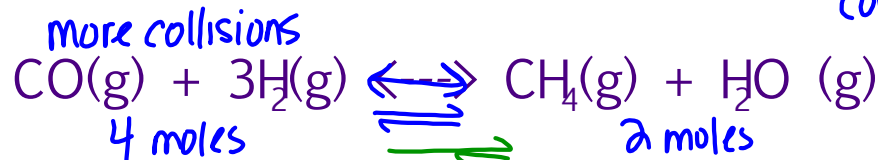
What happens to the number of collisions?  $\# \text{ collisions} \uparrow$

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

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## Changes in Volume and Pressure

Decreasing the volume  $P \uparrow$  - more collisions

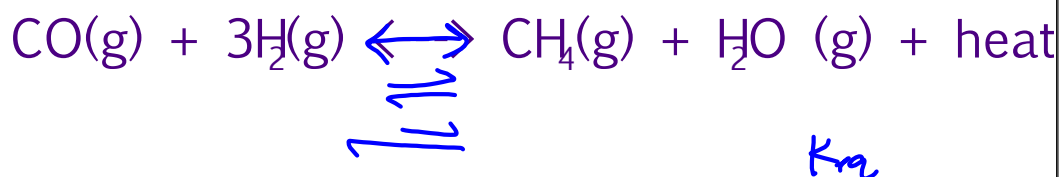


- Which side of the reaction contains more moles?
- Volume only has an effect on the reaction if the number of mole reactants differs from the number of moles of products.
- This reaction has more moles of reactants than products, so the reaction shifts to the right.

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## Changes in Temperature

### Temp. Changes



- 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 would 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

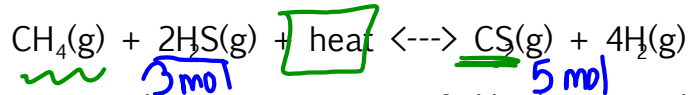
## Summary

- Changes inconcentration, 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?



- a. decrease the concentration of dihydrogen sulfide  
~~Right~~ left
- b. increase the pressure on the system  
Shift left
- c. increase the temperature on the system  
~~Left~~ right
- d. increase the concentration of carbon disulfide  
left
- e. decrease the concentration of methane  
~~Right~~ left

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# Le'Chatlier's Practice:

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

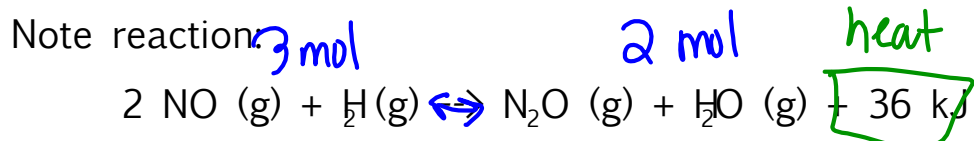


- a. decrease the concentration of dihydrogen sulfide
- b. increase the pressure on the system
- c. increase the temperature on the system
- d. increase the concentration of carbon disulfide
- e. decrease the concentration of methane

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# Practice:



In which direction, left or right, will the equilibrium shift if following changes are made?

- 1 NO is added R
- 2 H<sub>2</sub> is removed left
- 3 N<sub>2</sub>O is added L
- 4 the system is cooled R
- 5 pressure is increased R
- 6 H<sub>2</sub> is ~~removed~~ <sup>added</sup> R

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