N14 - Equilibrium

Le Châtelier's Principle

Link to YouTube Presentation: https://youtu.be/lUdunOfj-OE

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Le Châtelier's Principle

Target: I can describe how a reaction shifts in response to a change in conditions (a stress) in order to reach a new equilibrium position.

Le Châtelier's Principle

Le Châtelier's Principle

Guides us in predicting the effect various changes in conditions have on the position of equilibrium.

If a system at equilibrium is disturbed, the position of equilibrium will shift to **minimize** the disturbance.

You don't go back to the ORIGINAL equilibrium position, you will find a NEW equilibrium position.

Le Châtelier's Principle

Equilibrium Position ≠ numerical K value

LOTS of [ ]'s lead to same K value!

$$\frac{2}{1} = 2 \qquad \frac{4}{2} = 2 \qquad \frac{3}{1.5} = 2$$

What is the only thing that changes K value ?

TEMPERATURE!

- **Exothermic**
  - Increase temp, shift left, make more reactants - **K** ↓
  - Decrease temp, shift right, make more products – **K** ↑

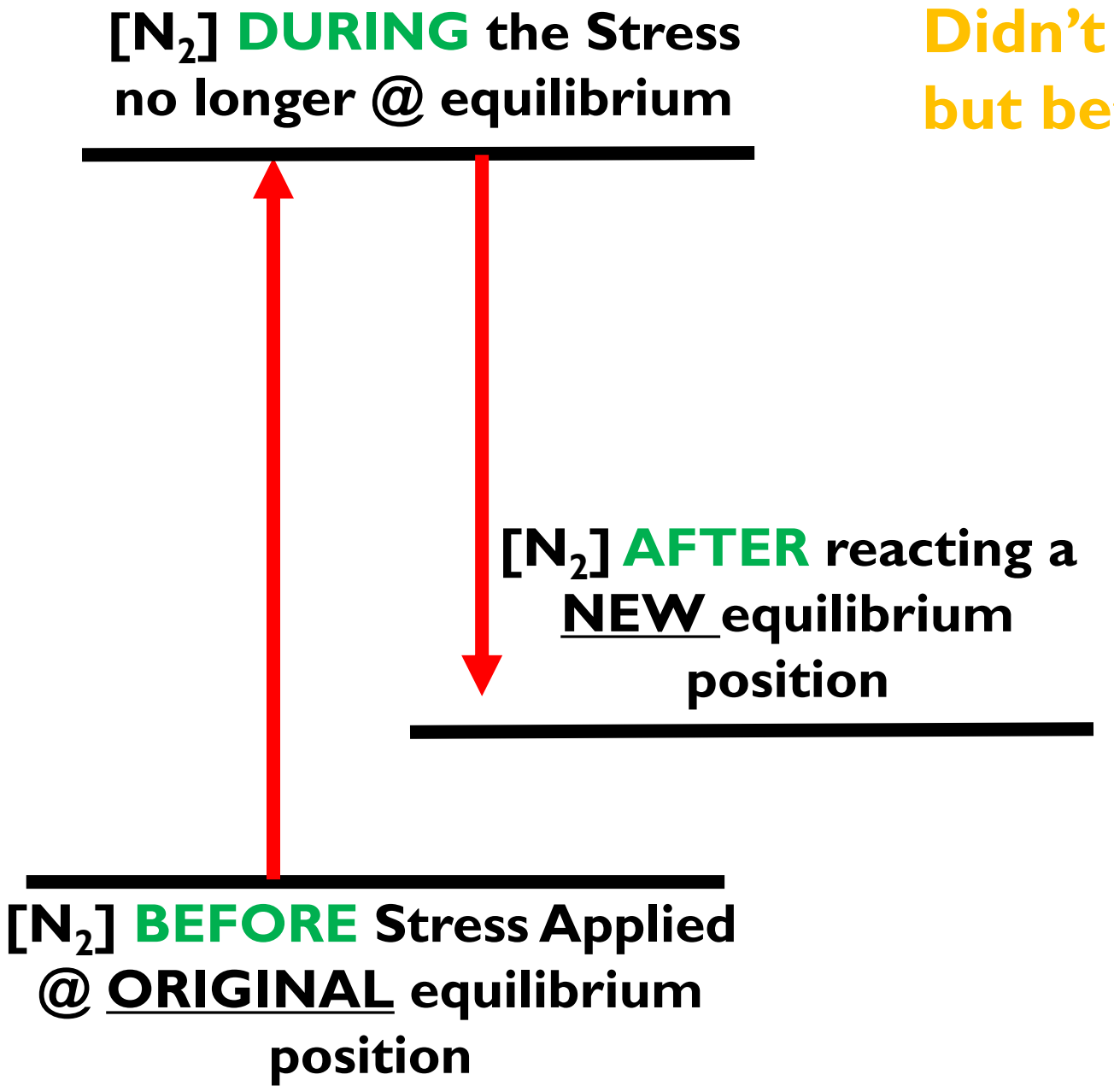
- **Endothermic**
  - Increase temp, shift right, make more products - **K** ↑
  - Decrease temp, shift left, make more reactants - **K** ↓

Don’t forget BEFORE vs DURING vs AFTER!

- NOT at equilibrium YET....calculate Q!
- Which way are you shifting DURING a stress?
- How much of everything do you have at the end after the adjustment?

Can be really hard to talk about. Remember when talking about comparisons you need to ACTUALLY compare! This time that might include TIME aspects! Before, during, or after!

There is more of _____ **THAN** before the stress was applied



Didn't get back to starting point, but better than during the stress!

So comparing BEFORE stressor to AFTER stressor, there is a ***SLIGHT*** increase to the thing you added extra of.

Le Chatelier Example #1

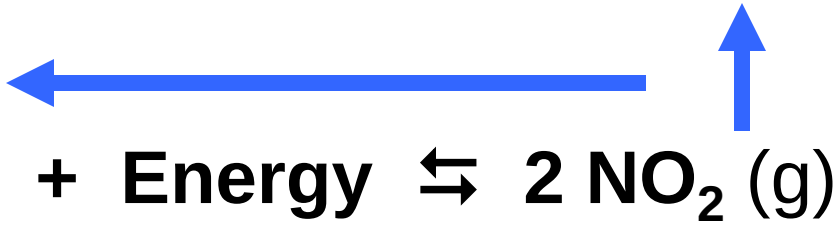
A closed container of ice and water is at equilibrium. Then, the temperature is raised.

Ice + Energy ⇆ Liquid Water

The system temporarily shifts to the **right** to reach a new equilibrium.

Le Chatelier Example #2

A closed container of N_2O_4 and NO_2 is at equilibrium. NO_2 is added to the container.



The system temporarily shifts to the **left** to reach a new equilibrium.

Le Chatelier Example #3

A closed container of water and its vapor is at equilibrium. Vapor is removed from the system.

water + Energy ⇆ vapor

The system temporarily shifts to the **right** to reach a new equilibrium.

Le Chatelier Example #4

A closed container of N_2O_4 and NO_2 is at equilibrium. The pressure is increased.

N_2O_4 (g) + Energy ⇆ 2 NO_2 (g)

The system temporarily shifts to the **left** to reach a new equilibrium, because there are ***fewer moles of gas*** on that side of the equation.

The Effect of Volume Changes on Equilibrium

Increase Pressure, Lower Volume

Equilibrium will shift to the side that has ***fewer moles of gas particles***.

Helps to relieve the pressure.

$$N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$$

4 moles of gas ↔ **2 moles of gas**

Reaction would shift to right, make more products

The Effect of Volume Changes on Equilibrium

Decrease Pressure, Increase Volume

Equilibrium will shift to the side that has ***more moles of gas particles***.

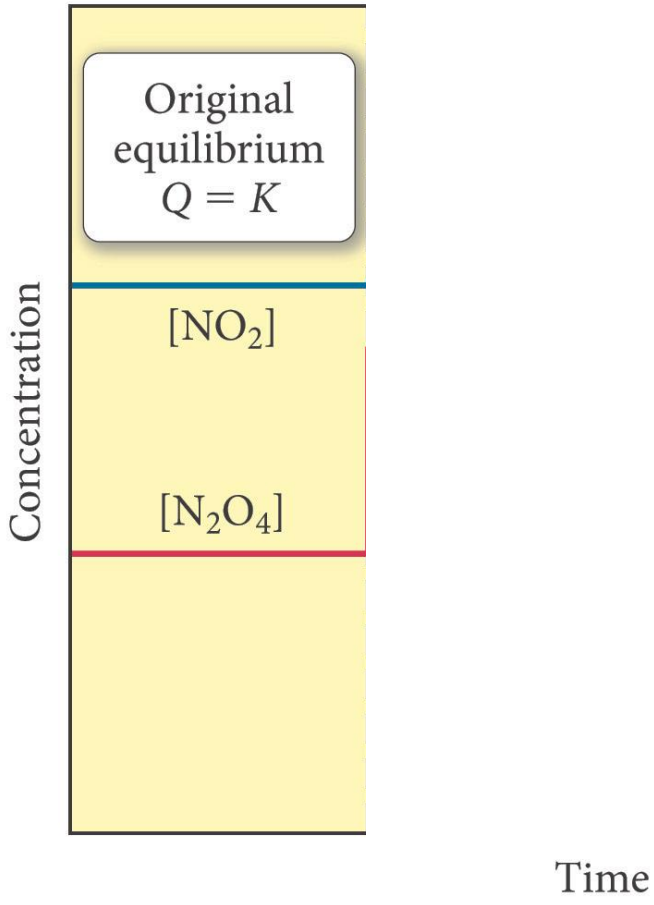
Helps to raise the pressure.

$$N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$$

4 moles of gas | **2 moles of gas**

Reaction would shift to left, make more reactants

The Effect of [ ] Changes on Equilibrium



When N_2O_4 is added, some of it decomposes to make more NO_2.

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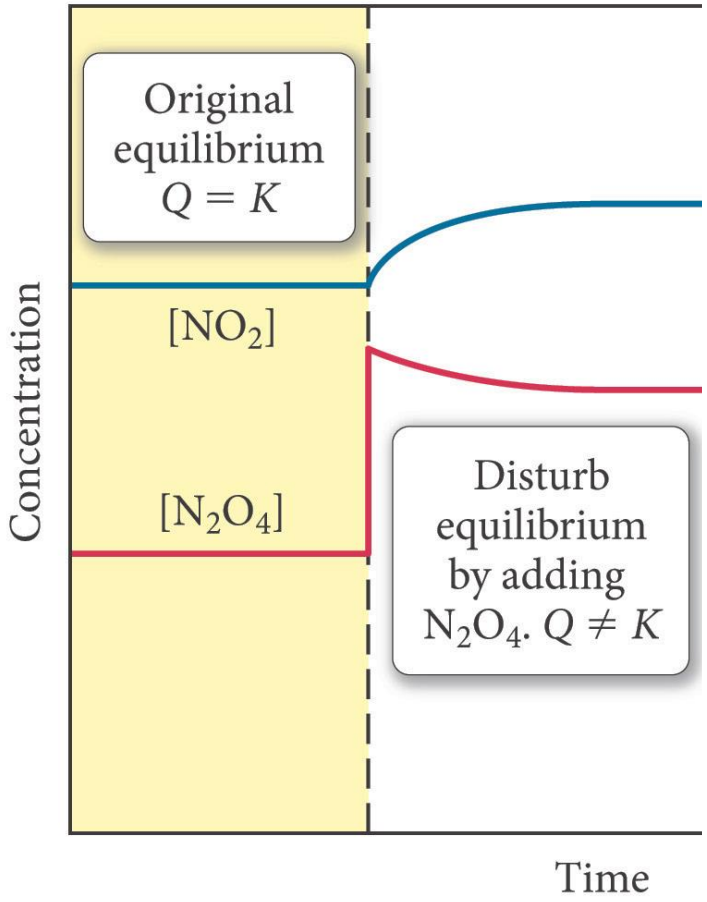

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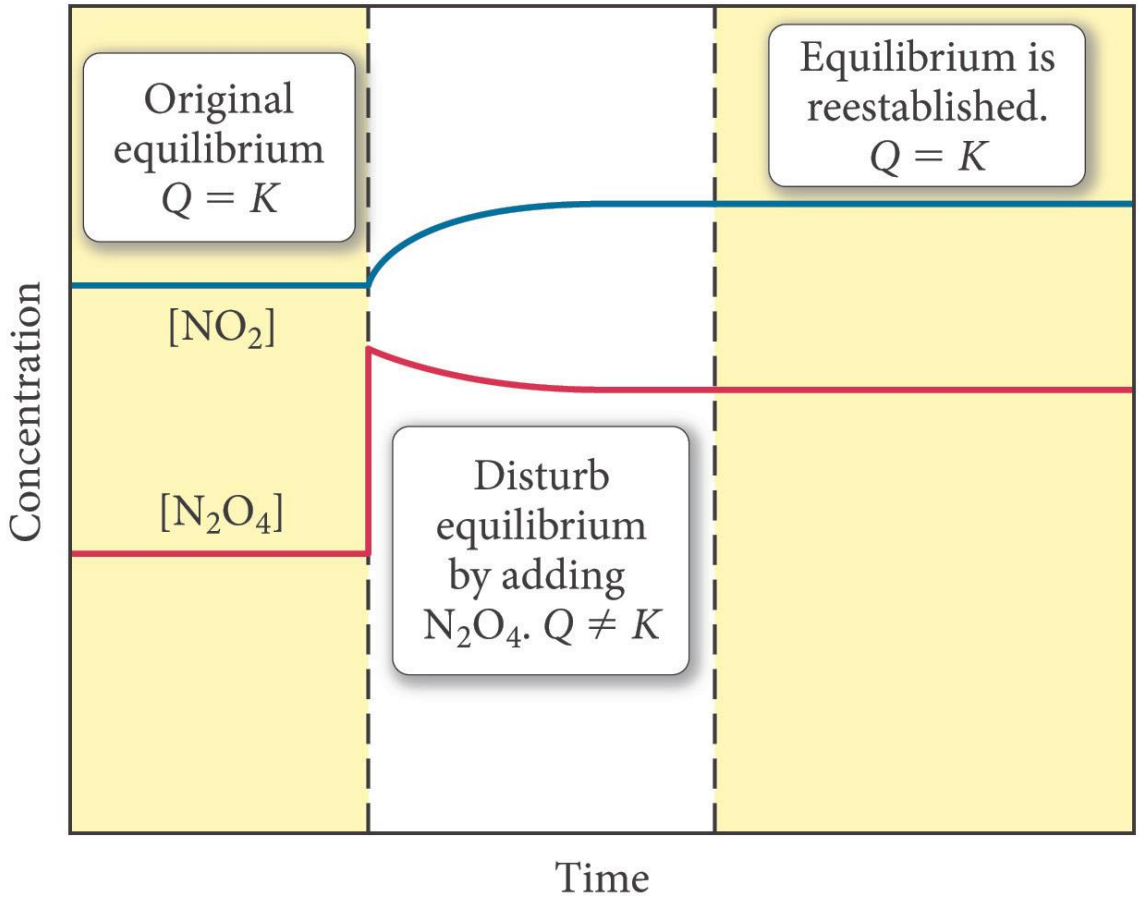
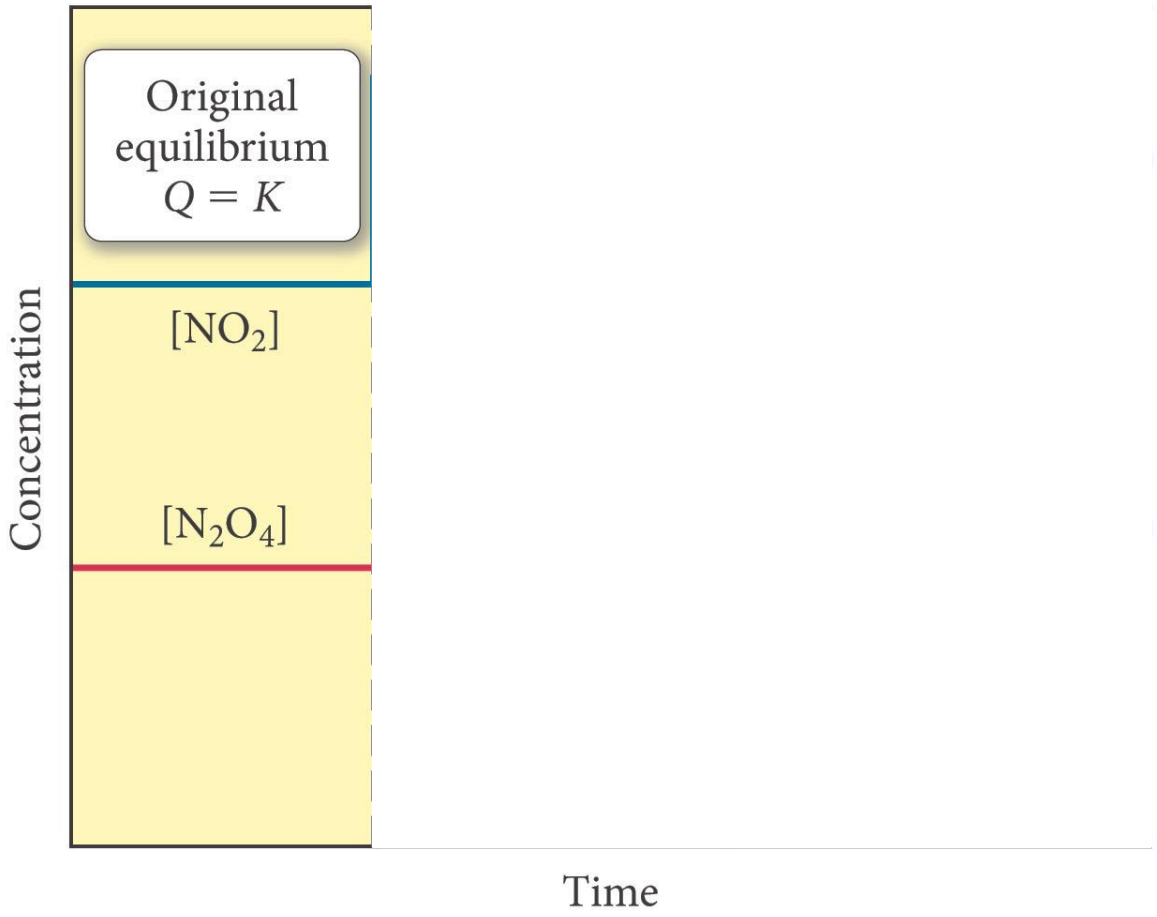


Notice how it is at a NEW equilibrium?

When N_2O_4 is added, some of it decomposes to make more NO_2.

The Effect of [ ] Changes on Equilibrium



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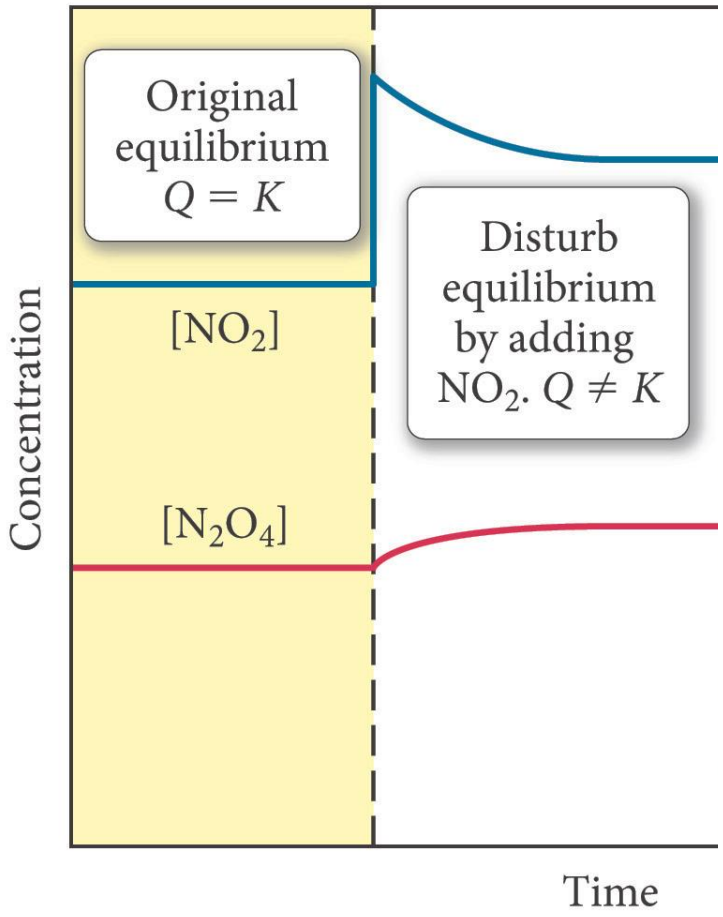

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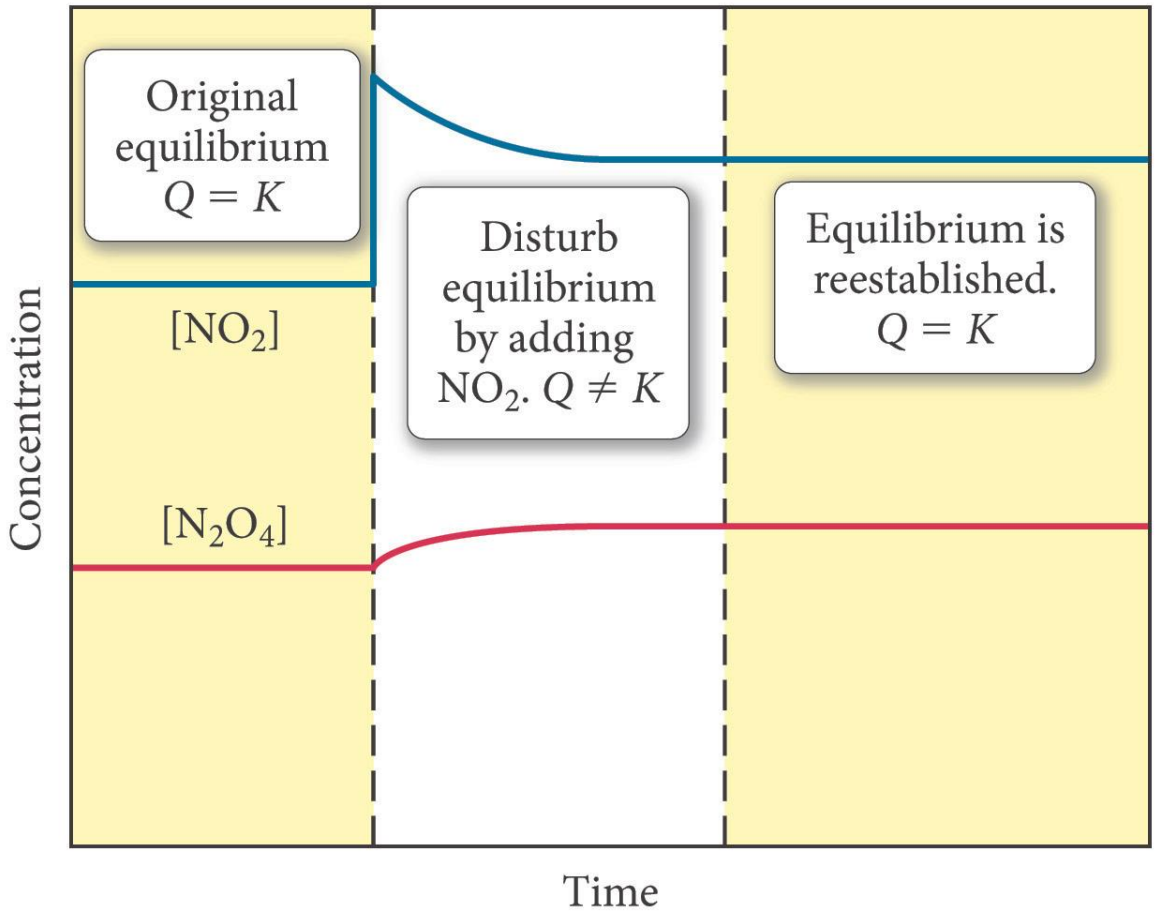

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When NO_2 is added, some of it decomposes to make more N_2O_4.

The Effects of Catalysts – *Careful!*

- Provide an alternative, more efficient mechanism.
- Works for both forward and reverse reactions.
- Affect the rate of the forward *and* reverse reactions by the same factor.
- Therefore, catalysts do *not* affect the **position** of equilibrium.

They do not change the position of equilibrium…

You just get to equilibrium faster!

The Effects of Catalysts

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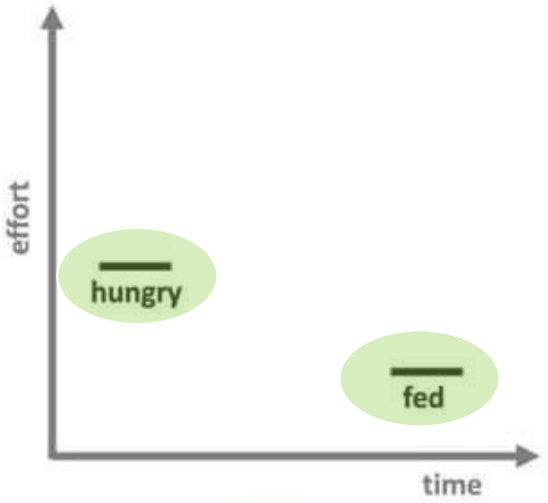

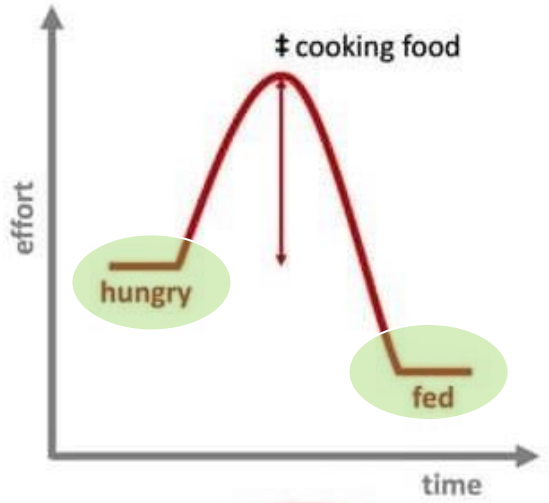

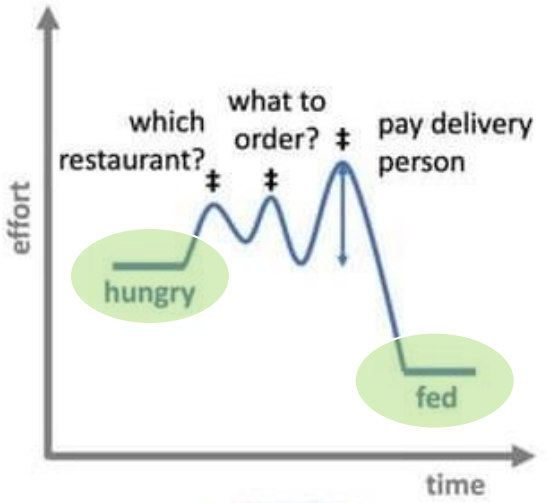

Sometimes there are REALLY tricky ones ☹

Adding a (l) doesn't affect the equilibrium position right???

BUT...

What if you add water as your liquid???

It changes the CONCENTRATION of what you have...

Does that affect **Q** ???

YES! Q changes! K stays the same!

So you will end up making more reactants or products depending on the equation. SO tricky! Have to be careful...not everything is tricky, but sometimes they are!

Things that Make a Good Equilibrium Answer

1) **IDENTIFY** the stressor
2) **WHAT** will change because of that stressor?
3) **WHY** will things change?
4) **HOW** does the change happen?
5) **IMPACT** on [ ] , Partial Pressures, K_{eq} etc

(We will do a warmup where we use this as our format!)

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