N43

Le Chatelier’s Principle

Target: I can define equilibrium and can describe how a reaction will change its equilibrium position when it is stressed by applying changes to various conditions

Link to YouTube Presentation:
https://youtu.be/VVnUPA8P_bA

Link to YouTube Video of Practice Qs:
https://youtu.be/bBF-9FWHknU

WHAT IS A REVERSIBLE REACTION?

Some reactions can go forwards AND backwards

$$N_2\ (g) + 3H_2\ (g) \rightarrow 2NH_3\ (g) + 92.05\ KJ$$

OR

$$2NH_3\ (g) + 92.05\ KJ \rightarrow N_2\ (g) + 3H_2\ (g)$$

Use a "double headed arrow" so you don't have to write it both ways! $\leftrightarrow$

REACTIONS WILL REACH "EQUILIBRIUM"

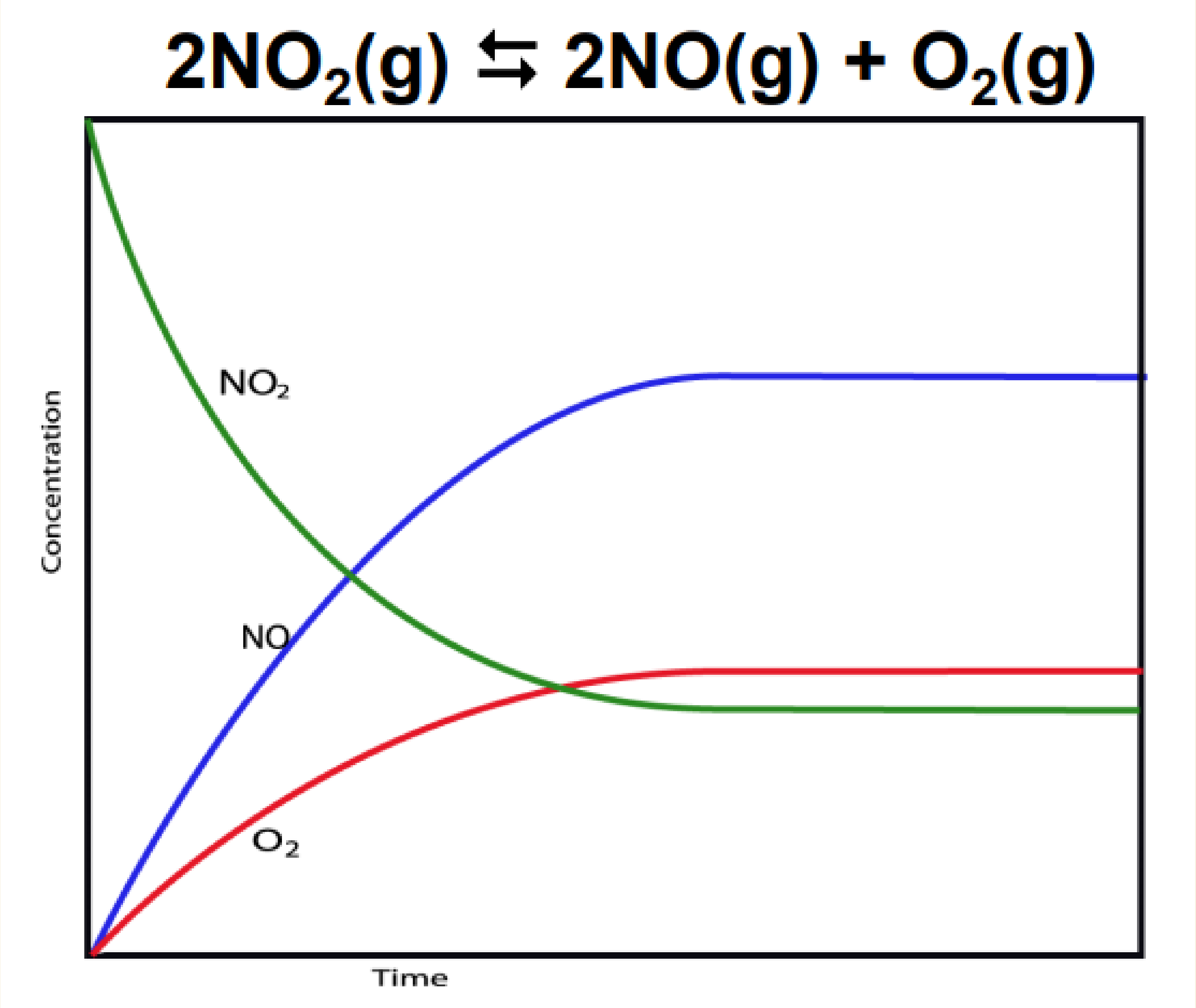
<u>EQUILIBRIUM</u> = the point at which the forward reaction is happening at the same ***<u>RATE</u>*** as the reverse reaction

Are the CONCENTRATIONS of reactants and products the same?????

- NO!!!!! (well *maybe*, but it doesn't have to be! If they are the same then it is a coincidence!)

REACTIONS WILL REACH "EQUILIBRIUM"

- **See how the rate appears to plateau after a while?**
- That means reactants are being made at the **same rate** that the products are being broken back into reactants.
- The **RATE** of forward and backwards is the same. So we **don't PERSEVE any change** happening to the concentration.
- **ALSO –** see how the concentrations are **NOT** the same during this equilibrium



"FINDING" EQUILIBRIUM POINT

EQUILIBRIUM POINT

We use ratios of [products] to [reactants]

You can have different ratios that all result in the rate forward being the same as the rate backwards!

There isn't just one equilibrium point!

If you are pushed away from the original equilibrium point, then find a NEW ratio of concentrations that is "at equilibrium!"

"FINDING" EQUILIBRIUM POINT

<u>EQUILIBRIUM POINT</u>

We use ratios of [products] to [reactants]

You can have different ratios that all result in the rate forward being the same as the rate backwards!

There isn't just <u>one</u> equilibrium point!

LOTS of [ ]'s lead to same ratio! Example:

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

LE CHATELIER'S PRINCIPLE

If a stress is applied to a reaction at equilibrium the reaction changes to relieve that stress, it will find a *new* equilibrium point where the forward and backwards reactions are equal again. It will try to "undo" whatever you did!

- ***Took something away? Make more of it!***
- ***Added extra of something? Use some up!***

HOW DO YOU “STRESS” A REACTION?

- Concentration change
- Temperature change
- Pressure/volume change for gases
  – the equivalent of a concentration change!

STRANGE FACTS…

- ONLY changes to aqueous and gas phases affect equilibrium
  - ***Solids and liquids do NOT affect equilibrium!***
    - They do not have "concentrations" so they can't factor in.
    - We will see this better when we get to the math portion of the chapter!
- Adding an Noble Gas, an INERT gas, does NOTHING because it doesn't change the PARTIAL PRESSURES of the gases involved!
- Adding a catalyst does NOTHING! You will reach equilibrium faster but it won't change the equilibrium point.

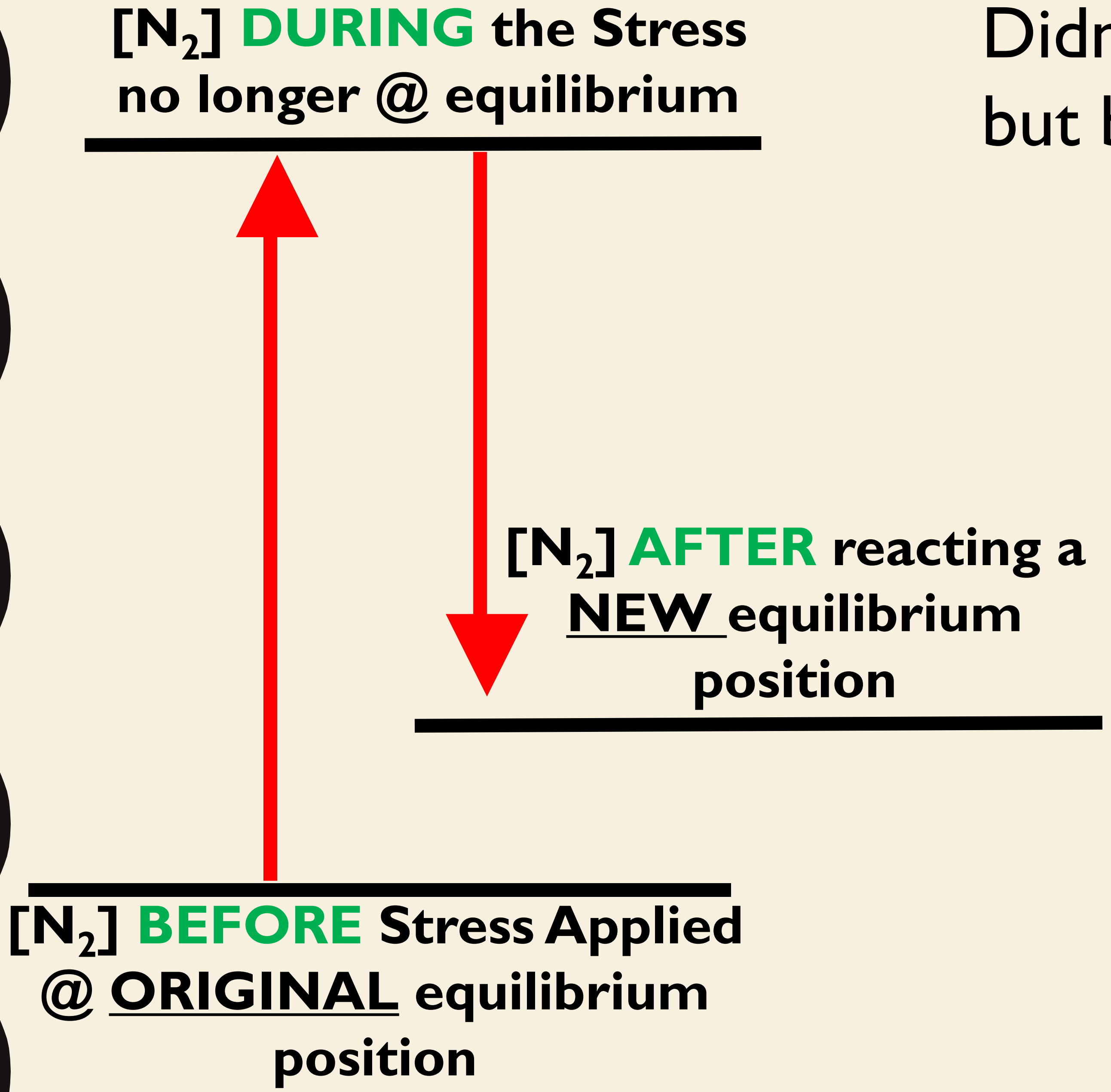
QUICK EXAMPLE

$N_2 + 3H_2 \leftrightarrow 2NH_3 + 92.05\ KJ$

- Add more N_2
  - Proceed in the forward direction
    "Shift to the right"
    Use up the extra by making more products!
- Remove H_2
  - Proceed in the reverse direction
    "Shift to the left"
    Replace what you took away by making more reactants!

CAN'T GET BACK TO THE START, BUT YOU CAN FIND A NEW EQUILIBRIUM

- You can't completely undo the stress and get back to your original concentrations…*BUT* you can at least end up "better off" than when totally stressed.
- The reaction will find *new ratios of concentrations* where the forward and backwards rate can once again be equal.



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.

WHAT ABOUT CHANGING PRESSURE?

- Increasing pressure causes molecules to be too crowded, too close together
- If you can reduce the *number of moles of gas particles* it will make things less crowded and relieve some of the pressure
  - ***Move to the side with fewer moles of gas!***
- Reducing pressure?
  - ***Move to the side with more moles to get the pressure back up!***

QUICK EXAMPLE

$$N_{2\,(g)} + 3H_{2\,(g)} \leftrightarrow 2NH_{3\,(g)} + 92.05\ KJ$$

4 moles of gas *2 moles of gas*

- Increase pressure
  - Proceed in the forward direction
    "Shift to the right"
    Fewer moles, less crowded, lowers pressure back down
- Decrease pressure
  - Proceed in the reverse direction
    "Shift to the left"
    More moles gas, more crowded, raises pressure back up

EQUILIBRIUM VIDEOS

1) **Blue Bottle Demo:** https://www.youtube.com/watch?v=kGSPAkOgN3U
2) **Bozeman Science Reversible Reactions:** https://www.youtube.com/watch?v=b6WmwtVNDf4
3) **Water Beaker Demo Video:** https://www.youtube.com/watch?v=_QnRt7PYzeY
4) ***TED what is Equilibrium Cartoon Explanation:** https://www.youtube.com/watch?v=dUMmoPdwBy4
5) **Fuse School Dynamic Equilibrium:** https://www.youtube.com/watch?v=wlD_ImYQAgQ
6) ***TEDEd The chemical reaction that feeds the world** https://www.youtube.com/watch?v=o1_D4FscMnU
7) ***Crash Course Equilibrium:** https://www.youtube.com/watch?v=g5wNg_dKsYY
8) **Fuse School Intro to Le Chatelier’s Principal** https://www.youtube.com/watch?v=7zuUV455zFs

LE CHATELIER'S PRACTICE PROBLEMS

Q#	Equation	Shift Left or Right?	Changes?
1	$N_{2(g)} + O_{2(g)} \leftrightarrow 2NO_{(g)}$ **Stressor:**		
2	$H_{2(g)} + I_{2(g)} \leftrightarrow 2HI_{(g)}$ **Stressor:**		
3	$CO_{(g)} + H_2O_{(g)} \leftrightarrow CO_{2(g)} + H_{2(g)}$ **Stressor:**		
4	$2SO_{2(g)} + O_{2(g)} \leftrightarrow 2SO_{3(g)}$ **Stressor:**		
5	$3O_{2(g)} \leftrightarrow 2O_{3(g)}$ **Stressor:**		
6	$H_2O_{2(l)} \leftrightarrow H_{2(g)} + O_{2(g)}$ **Stressor:**		
7	$CO_{(g)} + 2H_{2(g)} \leftrightarrow CH_3OH_{(g)}$ **Stressor:**		
8	$CH_{4(g)} + 2O_{2(g)} \leftrightarrow CO_{2(g)} + 2H_2O_{(g)}$ $\Delta H = -5kJ$ **Stressor:**		

YOUTUBE LINKS:

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