Equilibrium -

TARGET:

I CAN DETERMINE HOW TO RE-ESTABLISH EQUILIBRIUM WHEN A REACTION UNDERGOES A "STRESS"

WHAT IS A REVERSIBLE REACTION?

Some reactions can go forwards AND backwards

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

OR

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

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

REACTIONS WILL REACH "EQUILIBRIUM"

EQUILIBRIUM = the point at which the forward reaction is happening at the same ***RATE*** as the reverse reaction

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

– NO!!!!! (well *maybe*, but it doesn't have to be!)

"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!

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

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 <u>aqueous</u> and <u>gas</u> phases affect equilibrium
  - ***Solids and liquids do NOT affect equilibrium!***
    - They do not have "concentrations" so they can't factor in.
  - Adding an Noble Gas, an INERT gas, does NOTHING
  - 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
  - Shift to the right, use up the extra by making more products!
- Remove H_2
  - 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.

[N_2] DURING the Stress
no longer @ equilibrium

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

[N_2] AFTER reacting a
NEW equilibrium
position

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

[N_2] BEFORE Stress Applied
@ ORIGINAL equilibrium
position

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
  - Shift to the right, fewer moles, less crowded, lowers pressure back down
- Decrease pressure
  - 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:

Link to YouTube Video of Presentation

https://youtu.be/h2GhVv8w1G0

Link to YouTube Video of Practice Problems

https://youtu.be/SBU2BwFmj-c

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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:**		
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