Le Chatilier's Principle (LCP)

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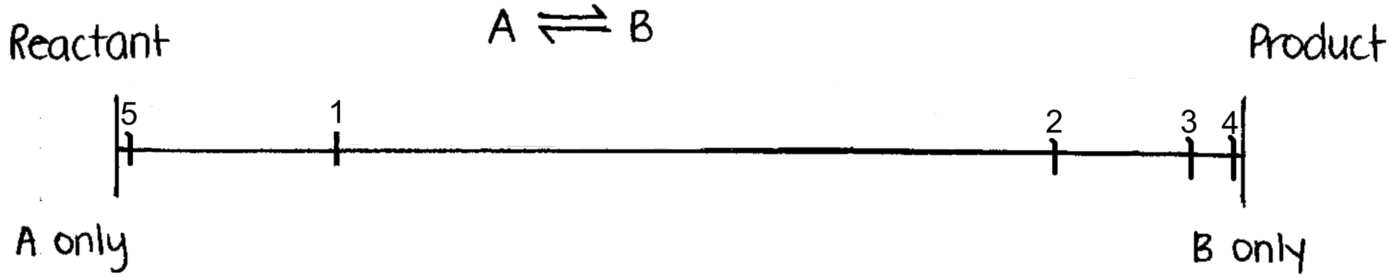
When a stress is imposed on a system at equilibrium The equilibrium will shift position, in such a way as to reduce the (but not eliminate) the effect of the stress.
↳ Equilibria fight back

- equilibrium position is the relative amount of reactants vs. products (amount = concentration)

$A \rightleftharpoons B$



① "Lie to the left" → 80% reactant, 20% products
② "Lie to the right" → 15% reactant, 85% products
③ "Lie far to the right" → 5% reactant, 95% products
④ "Lie very far to the right" → 1% reactant, 99% products
⑤ "Lie very far to the left" → 99.99% reactant, 0.001% products

- Le Chatilier's principle can be used to push the equilibrium position one way or another.

<u>Stress</u>: any change imposed on the equilibrium that can have an effect on position (some changes may not be a stress).

eg.

Change in temperature → change in heat energy
Change in volume → change in pressure
change in concentration (of a reactant or product)
↳ brought about by adding or removing a substance

Things that are not stresses :

↳ addition of a catalyst (will not alter equilibrium position but will cause equilibrium to be reached sooner)
↳ addition of an unrelated substance
↳ pressure alterations on an equal molar gas phase equilibrium

To determine the direction of shift use:

S: stress (written in terms of equilibrium)*
R: responce (opposite of stress)
H: how (written in terms of equilibrium)*
D: direction (either "shifts left" or "shifts right"
E: effect (changes in amount (easy) changes in concentration (annoying))

eg.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -$$

↳ increase in temperature

S: increase in heat energy (kinetic energy)
R: decrease in heat energy
H: endothermic reaction
D: shifts left (endothermic)
E: - increase in amount of N_2 $\uparrow n_{N_2}$
- bigger increase in amount of H_2 $\uparrow n_{H_2}$
- decrease in amount of NH_3 $\downarrow n_{NH_3}$
- $\uparrow [N_2]$, $\uparrow [H_2]$, $\downarrow [NH_3]$

eg.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H =$

↳ decrease in volume

S : increase in pressure
R : decrease in pressure
H : make less moles of gas
D : shift right (exothermic)
E : - decrease amount of N_2 $(\downarrow n_{N_2})$
- bigger decrease amount of H_2 $(\downarrow n_{H_2})$
- increase amount of NH_3 $(\uparrow n_{NH_3})$
- $\uparrow [N_2]$, $\uparrow [H_2]$, $\uparrow [NH_3]$

$C = \frac{n}{V}$ $\downarrow V$ larger effect

eg.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

↳ remove NH_3 by some "process" **

S : decrease concentration NH_3
R : increase concentration NH_3
H : makes more NH_3
D : shift right
E : - decrease amount of N_2 $(\downarrow n_{N_2})$
- bigger decrease amount of H_2 $(\downarrow n_{H_2})$
- tiny decrease of NH_3 $(\downarrow n_{NH_3})$ → removed $\downarrow n_{NH_3}$, L.C.P $\uparrow n_{NH_3}$ — overall decrease
- $\downarrow [N_2]$, $\downarrow [H_2]$, $\downarrow [NH_3]$

** removal of a substance is an effective way to "draw an equilibrium to completion"

*

stress	rewording	"how" wording
temp →	heat →	endo or exothermic reaction
heat →	heat →	endo or exothermic reaction
volume →	pressure →	make more/less mols of gas
add/remove substance →	concentration →	make/use substance