Le Chatelier's Principle

If a stress is placed on a system at equilibrium,
the system will shift in a direction that will minimize the stress.

Stresses:

- change in concentration of R or P
- change in Pressure (volume)
  (if R or P are gas)
- change in Temperature

other: catalyst

inert substance

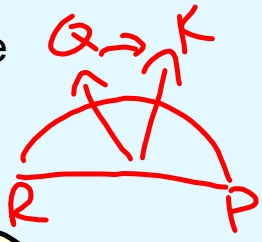
Stress: change in concentration of R or P
(add or remove reactant or product)

add

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.4\ kJ$$

if N_2 is added:
(to keep K_c constant)
$[N_2]$ will decrease
$[NH_3]$ will increase

if NH_3 is removed:
(to keep K_c constant)
$[NH_3]$ will increase
$[N_2]$ will decrease



equilibrium expression:

$$K_c = \frac{[NH_3]^2}{[N_2]\,[H_2]^3}$$

shift away from where you add

Stress: change in Temperature

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.4\ kJ$

energy given off
exothermic

if increase T?

shift away from where you add

endothermic

photosynthesis

$CO_2 + H_2O + sun \longrightarrow C_6H_{12}O_6 + O_2$

What happen in its sunny?

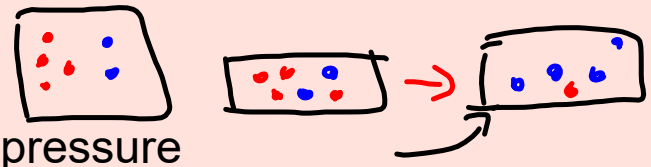
Cloudy?

Stress: change in Pressure (volume) (if R or P are gas) – (different amounts)

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.4\ kJ$$

1 mol + 3 mol = 4 mols

2 mol



shift to "relieve" the pressure

increase pressure, shift toward less moles

4 → 2

less moles will relieve P

decrease pressure, shift toward more moles

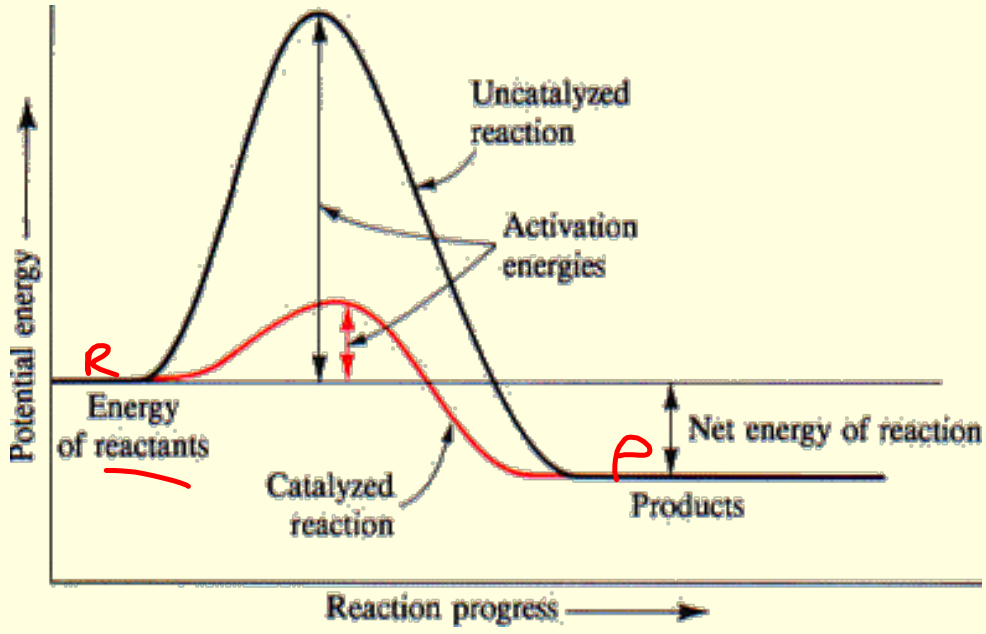
4 ← 2

more moles will relieve the lack of P

How does a **catalyst or inhibitor** affect equilibrium?

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.4\ kJ$$

catalyst:
- no shift in Equilibrium (no change in K)
- activation energy is decreased
- change in rate of reaction



Add inert substance

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 92.4\ kJ$$

add He gas to reaction vessel:

no effect, no shift