Factors that affect chemical eqm.

- Qualitative way to predict how equilibrium is affected by an applied ~ STRESS

① Change in conc
② Change in tot pressure, normally by changing volume.
③ change in temp.

Le Châtelier's Principle

① Changes in conc.

- the eqm will respond in a way to "undo" the stress.
  or
  "relieve"

ex: $A \rightleftharpoons B$ → shift to RHS

let's say we increase [A].
⇒ want to remove A ⇒ shift to RHS

$C \rightleftharpoons D$ ←

say: we decrease conc of C. (STRESS)
⇒ to relieve stress, we need to make more C.
⇒ Shift to LHS

blood — breath

ex: $H_2CO_3(aq) \rightleftharpoons H_2O(l) + CO_2(g)$
carbonic acid →

- hyperventilate ~ breathing rapidly
  - reduces CO_2 conc. (stress)
  ⇒ causes a RHS shift to make more CO_2.

Problem: lowered conc H_2CO_3 in blood ⇒ it's less acidic → Alkalosis

ex: $Ca_3(PO_4)_2(s) \rightleftharpoons 3Ca^{2+}(aq) + 2PO_4^{3-}(aq)$

bones blood.

if we lower Ca^{2+} conc (STRESS).

relief: → RHS. make more Ca^{2+}.

(2) What about p/V changes?

V↑, p↓ (Boyle's Law)

V↓, p↑

$pV = nRT$, then $p \propto n$

→ If we increase tot. pressure (by lowering V)
- then eqm will respond in a way to reduce tot p

⇒ must reduce # gas molecules.

colorless red

ex: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

STRESS: Reduce tot. vol.

⇒ P_{TOT} ↑ (stress)

Relief: lower P_{TOT}.

How? make fewer gas molecules.

⇒ Shift to LHS

(3) Change in temp.

- changes in p/V and conc do not alter K_c or K_p.
- T changes do affect K!

consider:

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$; $\Delta H^\circ = +58.0 \frac{kJ}{mol}$

we can (sometimes) write this as:

$58.0\,kJ + N_2O_4(g) \rightleftharpoons 2NO_2(g)$

- If we increase T (stress)
  - adding "heat" (stress).
  - Relief: getting rid of heat.
    ⇒ Shift to RHS!

w/ increasing T ↑ $K_c = \frac{[NO_2]^{2}\uparrow}{[N_2O_4]_{eq}\downarrow}$ (endothermic)

T↑ K↑ (endothermic)

$A \rightleftharpoons B$; ΔH = -ve (exothermic)

$A \rightleftharpoons B + heat$

as we increase T... (stress)
- like adding heat.

⇒ relief: shift to LHS
- removes heat.

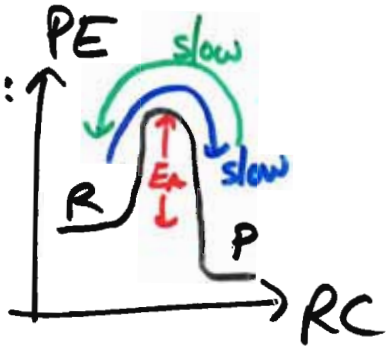
$K_c = \frac{[B]\downarrow}{[A]\uparrow}$

then for an exothermic rxn,

T↑ K↓

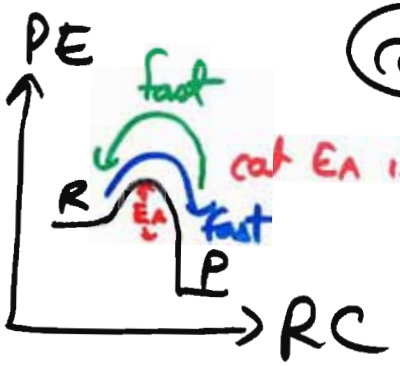
The affect of cat.

recall:



uncat.

$$K = \frac{[P]}{[R]}$$



cat

cat E_A is smaller!

K is unchanged.