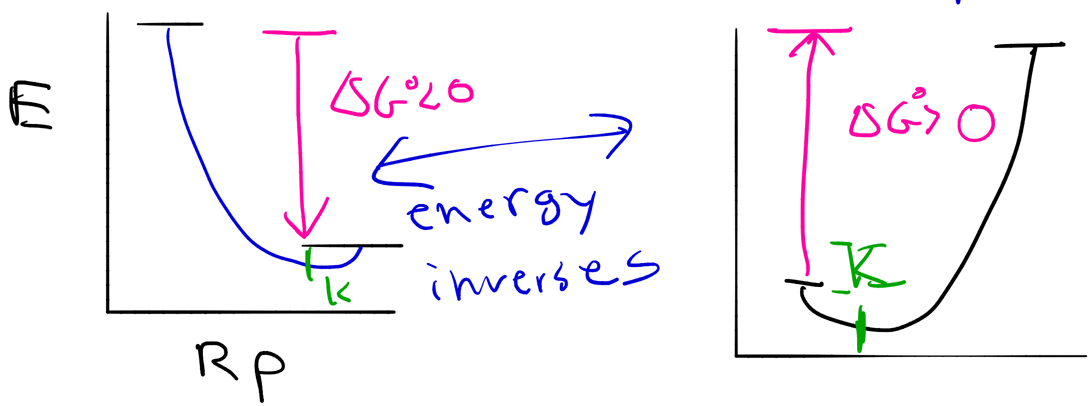
5/18/20

Exam #2 – Now Friday May 22nd

$$\Delta G^\circ = -RT \ln K$$

balance of energy between products and reactants → establishes the concentrations of reactants & products



$A \rightleftarrows B$ $\qquad$ $B \rightleftarrows A$

$$-\Delta G^\circ_{for} = -(-RT \ln K_{for})$$

$$-\Delta G^\circ_{for} = -\left(RT \ln \frac{1}{K_{for}}\right) \qquad 17.5$$

$$\Delta G^\circ_{rev} = -RT \ln \frac{1}{K_{for}}$$

If the rxn goes in reverse, $K_{rev} = \frac{1}{K_{for}}$

$A \rightleftharpoons B \quad K_1$

$C \rightleftharpoons D \quad K_2$

$A + C \rightleftharpoons B + D$?

$K_T = K_1 \cdot K_2$

$\Delta G_1^\circ = -RT \ln K_1$

$\Delta G_2^\circ = -RT \ln K_2$

$\Delta G_1^\circ + \Delta G_2^\circ = -RT(\ln K_1 + \ln K_2)$

$= -RT \ln(K_1 \cdot K_2)$

The only factor that can change an equilibrium constant (K) is temperature, because only a change in temperature will change balance in energy between reactants and products.

ICE problem strategy

- what is the rxn that is occurring?
  - → the stoichiometry determines K
- what are the initial conditions?

HCN is a weak acid that has an $K_a = 6.2 \times 10^{-10}$, what is the pH of a 0.1M aqueous solution of HCN?

What is the rxn? → auto-ionization

$$HCN_{(aq)} \rightleftharpoons H^+_{(aq)} + CN^-_{(aq)}$$

Definition of an acid → dissociates to produce H^+

What are the initial concentrations?

$[HCN] = 0.1M$ → It is assumed that dissociation has not yet occurred.

$[CN^-] = 0$ → The rxn hasn't happened yet!

$[H^+] = 1.0 \times 10^{-7} M$ @ 25°C

→ Due to the auto-ionization of water

In most problems, the acid dissociates significantly more than water does, so the auto-ionization of water can usually be ignored.

$HCN(aq) \rightleftharpoons H^+(aq) + CN^-(aq)$

$$K_a = \frac{[H^+][CN^-]}{[HCN]}$$

$Q = 0$

because $Q = 0$, the rxn goes forward

	HCN	H^+	CN^-
I	0.1M	0 *	0
C	−x	+x	+x
E	0.1 − x	x	x

$$K_a = \frac{(x)(x)}{(0.1 - x)} = 6.2 \times 10^{-10}$$

from a table

Since HCN is a weak acid ($K_a \ll 1$) x is likely very small compared to 0.1M. ⟶ $0.1 - x \approx 0.1$

$$x^2 = (0.1)(6.2 \times 10^{-10}) = 6.2 \times 10^{-11}$$

$$x = 7.87 \times 10^{-6}$$

$pH = -\log_{10}(7.87 \times 10^{-6}) = 5.1$

– Yes, x is small compared 0.1M, so it was fine to approximate the [HCN]

x is 78 times greater than $[H^+]$ in water, so it was fine to ignore water.

Exam #2

Equilibrium

- 3 definitions
- equilibrium constants
  - excludes pure liquids and solids
  - how to write K/Q expression
  - how to calculate K/Q
  - manipulations of K

    $K_{rev} = 1/K_{fwd}$; $K_T = K_1 \cdot K_2$
- no K_p/K_c problem
- Q vs K
- ICE problem → pH
- Le Châteliers Principle
  - what is it (3 definitions)
  - effects of volume on ~~K~~/Q
  - effects of concentration on ~~K~~/Q
  - no temperature effect