02/27/02

- **Exam #2:** ***2 weeks from today!***
  - •Exam #2 info page now online
  - •Old Exam #2 questions coming later today
- **Chapter 16:** assigned problems now online
- **Premed?**
- Demo today . . . Quiz on Friday

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Effect of Adding an Inert Gas

- Suppose we add some *Argon* to a system at equilibrium . . . Will that change the position of equilibrium?
- The Simple Answer: *No!*
  - ✓The partial pressures of the reactants and products are not affected (Q = K)
- The Real Answer: *It Depends!*
  - ✓Constant Volume or Constant Pressure?

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Added Inert Gas: *Constant Volume*

- If *volume* is unchanged upon addition of gas, then P_{total} must *increase*:

Before: $P_{total} = P_{reactants} + P_{products}$

After: $P_{total} = P_{reactants} + P_{products} + P_{gas}$

- Partial Pressures of reactants and products are unchanged:

No Shift

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Added Inert Gas: *Constant Pressure*

- If *pressure* is unchanged upon addition of gas, then ***volume*** must increase.

Before: $P_{total} = P_{reactants} + P_{products}$

After: $P_{total} = P_{reactants} + P_{products} + P_{gas}$

BUT: P_{total} (before) = P_{total} (after)

- Partial pressures of reactants and products must *decrease* in order to keep total pressure constant

Reaction Can Shift

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Effect of Temperature

- Treat *heat* as a:
  - Product (for exothermic process)
  - Reactant (for endothermic process)

<u>Example:</u>

$$N_2\ (g) + 3H_2\ (g) \leftrightarrows 2NH_3\ (g) + \text{heat}$$

(ΔH = -92.4 kJ)

Quantify using van't Hoff equation!

increase temperature ←

decrease temperature →

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Manipulating K's and Equilibria

- What happens to K when we add/subtract/reverse equilibria?

<u>Reverse Reaction:</u>

1) A $\leftrightarrows$ B $\quad K_1 = P_B/P_A$

2) B $\leftrightarrows$ A $\quad K_2 = P_A/P_B = 1/K_1$

✓Reverse Reaction = **INVERSE of K**

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Adding Equilibria

Let's add these two reactions:

- ✓Add Rxns = Multiply K's
- ✓Subtract Rxns = *Divide K's*

1) A + B ⇆ C $K_1 = \frac{P_C}{P_A P_B}$

2) C + D ⇆ E + B $K_2 = \frac{P_E P_B}{P_C P_D}$

3) A + ~~B~~ + ~~C~~ + D ⇆ ~~C~~ + E + ~~B~~

A + D ⇆ E

$K_3 = K_1 K_2 = \frac{\cancel{P_C} P_E \cancel{P_B}}{P_A \cancel{P_B} \cancel{P_C} P_D} = \frac{P_E}{P_A P_D}$

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K_p versus K_c

- What if gas amounts are expressed as **concentrations (mol/L)?**
  - K_p = thermodynamic K (atm)
  - K_c = *concentration* -based equilib constant

<u>Ideal Gas Law:</u> **P = (n/V)RT**

It can be shown that:

$$K_p = K_c\,(RT)^{Dn}$$

Change in #mol *gas*

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