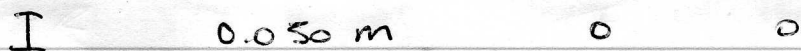
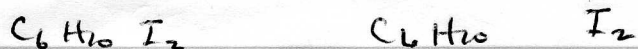
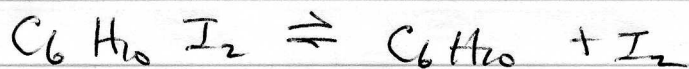


From last time: (Exercise 16.5)



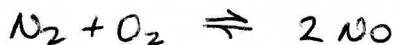
$$K = \frac{[\text{I}_2][\text{C}_6\text{H}_6]}{[\text{C}_6\text{H}_6\text{I}_2]} = \frac{(0.035)(0.035)}{0.015}$$

$$K = 0.82$$

Good first example

Know K , find conc. at equilibrium

Other extreme: small values of K .



$$K = 1 \times 10^{-5} \text{ at } 1500\text{K}$$

Initially, $[\text{N}_2] = 0.8 \text{ M}$ (air, under pressure, at high T)
 $[\text{O}_2] = 0.2 \text{ M}$ compression of ~ 4.5

what is $[\text{NO}]$ at equilibrium?

	N_2	$+$	O_2	\rightleftharpoons	2NO
I	0.8		0.2		0
C	-x		-x		+2x
E	0.8-x		0.2-x		2x

$$K = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]} = \frac{(2x)^2}{(0.8-x)(0.2-x)} = 1 \times 10^{-5}$$

K is small \rightarrow look at expression \rightarrow
this means that $(2x)^2$ is small

so x is small and

$$0.8 - x \approx 0.8$$

$$0.2 - x \approx 0.2 \quad \dots \text{ try it.}$$

$$\frac{(2x)^2}{(0.8)(0.2)} = 10^{-5}$$

$$4x^2 = 1.6 \times 10^{-6}$$

$$x^2 = 4 \times 10^{-7}$$

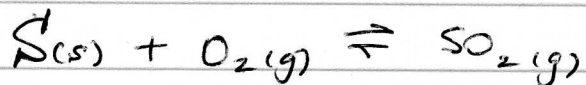
$$x = 6.3 \times 10^{-4}, \text{ so } [\text{NO}] = 2x = 1.26 \times 10^{-3} \text{ M}$$

check answer! (in full expression)

$$\frac{[2(6.3 \times 10^{-4})]^2}{(0.8 - 6.3 \times 10^{-4})(0.2 - 6.3 \times 10^{-4})} = 1.0 \times 10^{-5} \quad \checkmark$$

also, note that $0.2 - x$ really is very close to 0.2 (good approx.)

What to include in K : ^{and not include}



→ don't include solid reactants or products!
(Conc = density (for a solid) → unchanged by rxn)

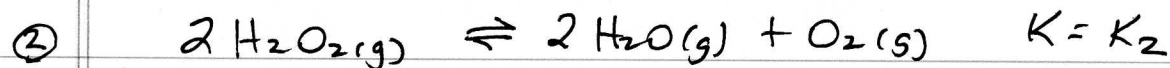
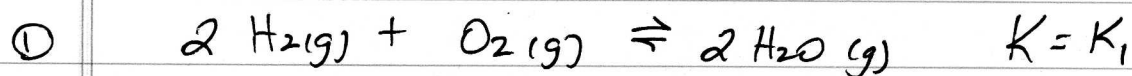
$$K = \frac{[\text{SO}_2]}{[\text{O}_2]}$$

→ in aqueous solution, don't include H_2O if it's a reactant or product (as $[\text{H}_2\text{O}]$ doesn't really change much at all) → $[\text{H}_2\text{O}] \approx 55\text{M}$

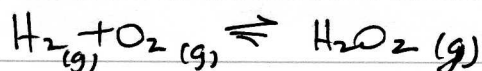


$$K = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$$

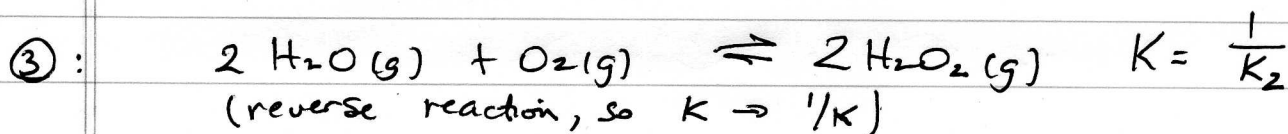
Math with equilibrium constants



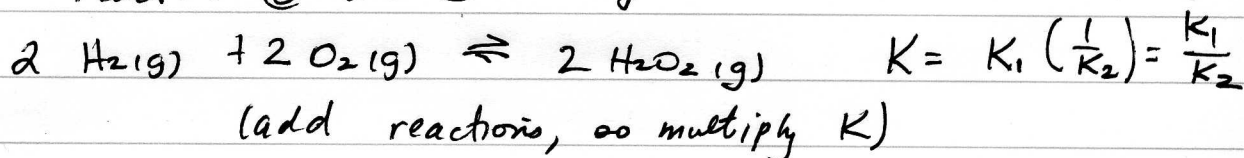
Want: to know K for



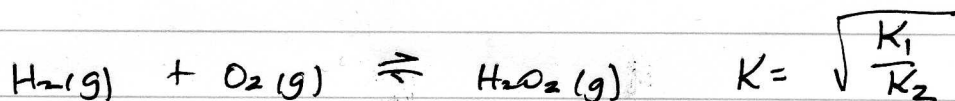
Write reverse of rxn ②:



Add reaction ① and ③ to get



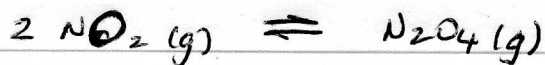
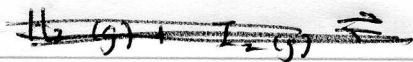
This is the correct reaction, but coefficients are not in lowest terms



divide coefficients by two \rightarrow take square root of K

(ie, multiply coefficients by $1/2$, so raise K to the $1/2$ power).

→ gases: so far we've used $K_p \leftarrow$ pressures.



$$K_p = \frac{P_{\text{N}_2\text{O}_4}}{(P_{\text{NO}_2})^2}$$

This is ~~is~~ E_0

Use K_p for $\Delta G_{\text{rxn}} = -RT \ln K_p$

Could use concentrations for gases (as for solutions)

$$PV = nRT$$

$$\frac{n}{V} = \frac{P}{RT} \quad \text{conc} \propto P$$

conc ↑

$$\text{conc} = \frac{P}{RT}$$

$$P = RT \cdot \text{conc.}$$

From above,

$$K_p = \frac{P_{\text{N}_2\text{O}_4}}{(P_{\text{NO}_2})^2} = \frac{[\text{N}_2\text{O}_4] RT}{[\text{NO}_2]^2 (RT)^2} = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2} \frac{1}{RT} = K_c \frac{1}{RT}$$

In general, $K_p = K_c (RT)^{\Delta n}$

where $\Delta n = \text{moles of gas products} - \text{moles of gas reactants}$

($\Delta n = 1 - 2 = -1$ here).

use R in L atm/mol K , as P is in atm.

Note: text uses K for K_c , even for gases