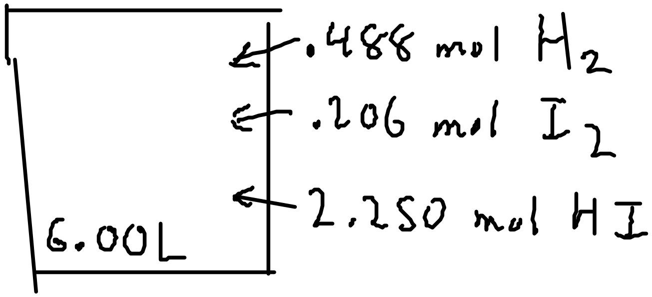
Here are some of the problenms we discussed in class on 3/30/2010

p616, 14.43



$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

This mixture is AT EQUILIBRIUM at 491 C

Find Kc!

$$K_c = \frac{[HI]^2}{[H_2][I_2]} = ?$$

$$\frac{0.488\text{ mol}}{6.00\text{L}} = 0.081333 \text{ M } H_2$$

$$\frac{.206\text{ mol}}{6.00\text{L}} = 0.034333 \text{ M } I_2$$

$$\frac{2.250\text{ mol}}{6.00\text{L}} = 0.375 \text{ M HI}$$

$$K_c = \frac{(0.375)^2}{(.081333)(.034333)}$$

$$K_c = 50.4$$

Writing some equilibrium constant expressions

$$PCl_3(g) + 3NH_3(g) \rightleftharpoons P(NH_2)_3(g) + 3HCl(g)$$

$$K_c = \frac{[P(NH_3)_2][HCl]^3}{[PCl_3][NH_3]^3}$$

$$Na_2CO_3(s) + SO_2(g) + \tfrac{1}{2}O_2(g) \rightleftharpoons Na_2SO_4(s) + CO_2(g)$$

$$K_c = \frac{[CO_2]}{[SO_2][O_2]^{1/2}}$$

Don't include:
* pure solids or liquids
* solvents
... in the equilibrium expression

More equilibrium expressions

$$H_2SO_4(aq) + H_2O(l) \rightleftharpoons HSO_4^-(aq) + H_3O^+(aq)$$

$$K_c = \frac{[HSO_4^-][H_3O^+]}{[H_2SO_4]}$$

$$A + B \rightleftharpoons C + D \; ; \; K = 15000$$

... at equilibrium, we should have more PRODUCTS than reactants! Why?

$$K_c = \frac{[C][D]}{[A][B]} = 15000$$

To make a large number, this fraction's numerator must be larger than its denominator

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If $K = 0.0000015$?

$$K_c = \frac{[C][D]}{[A][B]} = 0.0000015$$

If Kc is small, we expect the equilibrium mixture to contain mostly reactant.

Equilibrium problems from the book

14.91

$$2\,HBr(g) \rightleftharpoons H_2(g) + Br_2(g)\ ;\ K = 0.016$$

0.010 mol HBr
0 mol H_2
0 mol Br_2
1L

Find moles of each species at equilibrium

$$K_c = 0.016 = \frac{[H_2][Br_2]}{[HBr]^2}$$

Species	Initial	Change	Equilibrium
HBr	$\frac{0.010\text{ mol}}{1\text{ L}} = 0.010\text{ M}$	$-2x$	$0.010 - 2x$
H_2	0	$+x$	x
Br_2	0	$+x$	x

$$0.016 = \frac{(x)(x)}{(0.010 - 2x)^2}$$

$$0.016 = \frac{x^2}{(0.010 - 2x)^2}$$

$$\sqrt{0.016} = \sqrt{\frac{x^2}{(0.010 - 2x)^2}}$$

Take the square root of both sides to easily solve this.
(Alternatively, multiply everything out and solve the quadratic)

$$0.126491106 = \frac{x}{0.010 - 2x}$$

$\div 0.126491106$
$\times 0.010 - 2x$

We need to isolate 'x'

$$0.010 - 2x = \frac{1}{.126491106}x$$

$$0.010 = \left(\frac{1}{.126491106} + 2\right)x$$

$$x = \frac{.010}{\left(\frac{1}{.126491106} + 2\right)}$$

$$x = 0.00101$$

Species	Initial	Change	Equilibrium
HBr	$\frac{0.010\ mol}{1\ L} = 0.010\ M$	$-2x$	$0.010 - 2x$
H_2	0	$+x$	x
Br_2	0	$+x$	x

$x = 0.00101$

Solve for the concentrations by plugging into the table we made earlier!

$[HBr] = 0.010 - 2x = 0.00798\ \underline{M}$

$[H_2] = x = 0.00101\ \underline{M}$

$[Br_2] = x = 0.00101\ \underline{M}$

To get the number of moles of each substance, multiply the concentration by the volume.

$mol\ HBr = 0.00798\ \underline{M} \times 1\ L = 0.00798\ mol\ HBr$

$mol\ H_2 = 0.00101\ \underline{M} \times 1\ L = 0.00101\ mol\ H_2$

$mol\ Br_2 = 0.00101\ \underline{M} \times 1\ L = 0.00101\ mol\ Br_2$