The Way we balance eq also affects K

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

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}_{eq}$$

$$2N_2O_4(g) \rightleftharpoons 4NO_2(g)$$

$$K_c' = \frac{[NO_2]^4}{[N_2O_4]^2}$$

$$= \left(\frac{[NO_2]^2}{[N_2O_4]}\right)^2$$

$$= K_c^2$$

Rules of K_c:

1. reverse rxn : invert K

$$K \rightarrow 1/K$$

2. multiply rxn by x, raise K to x!

$$K \rightarrow K^x$$

@25°C

$$N_2O_4 \rightleftharpoons 2NO_2 \quad , K_c = 4.63 \times 10^{-3}$$

×2

$$2N_2O_4 \rightleftharpoons 4NO_2 \quad , K_c' = K_c^2$$

$$= 2.14 \times 10^{-5}$$

reverse.

$$2NO_2 \rightleftharpoons N_2O_4 , \quad K_c'' = \frac{1}{K_c}$$

$$= 216$$

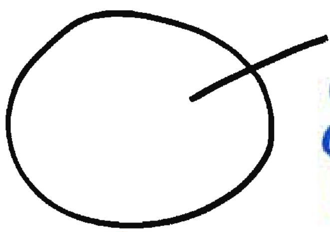
What use is K_c?

- can predict direction of a chem. rxn!

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

$K_c = 54.3$ (@ 430°C)

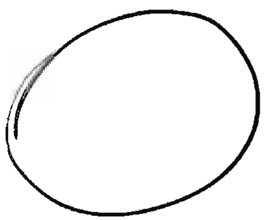
not @ eq^m ??



1.00 L
0.243 mol H_2
0.146 mol I_2
1.98 mol HI

↓

@ Eq^m.



?? mol H_2
?? mol I_2
?? HI mol.

$$K_c = \frac{[HI]^2}{[H_2]\cdot[I_2]_{eq}} = 54.3 \qquad H_2 + I_2 \rightleftharpoons 2HI$$

↑ eq^m constant.

Reaction Quotient.

$$Q_c = \frac{[HI]^2}{[H_2][I_2]_i}$$

← instantaneous or actual or original values

if $Q_c = K_c$ @ eq^m.

if $Q_c > K_c$
or $Q_c < K_c$ } not @ eq^m.

Since $Q \sim P/R$

if $Q < K$, then to reach eq^m, $Q \uparrow$

and so: $Q = \frac{P\uparrow}{R\downarrow}$

shift to RHS

$$R \rightleftharpoons P$$

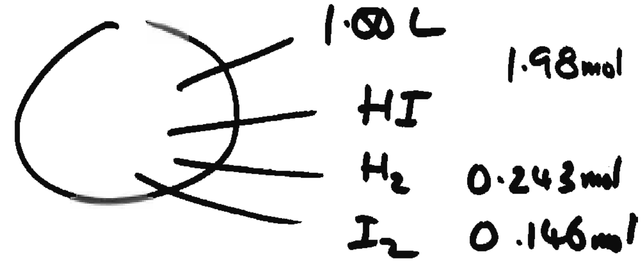
if $Q > K$, then to reach eq^m, $Q \downarrow$

and so $Q \sim \frac{P\downarrow}{R\uparrow}$

shift to LHS

$$R \rightleftharpoons P$$

For our last rxn:



$H_2 + I_2 \rightleftharpoons 2HI$, $K_c = 54.3$

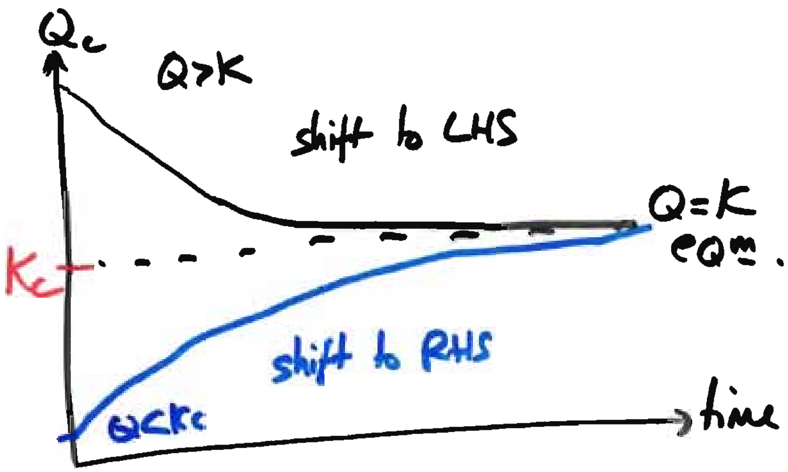
$$Q_c = \frac{[HI]_i^2}{[H_2]_i [I_2]_i}$$

$$= \frac{1.98^2}{0.243 \times 0.146} = 111$$

$Q_c > K_c$ ~~eqm~~ $Q_c \sim \frac{P\downarrow}{R\uparrow}$

shift to LHS

$$H_2 + I_2 \rightleftharpoons 2HI$$

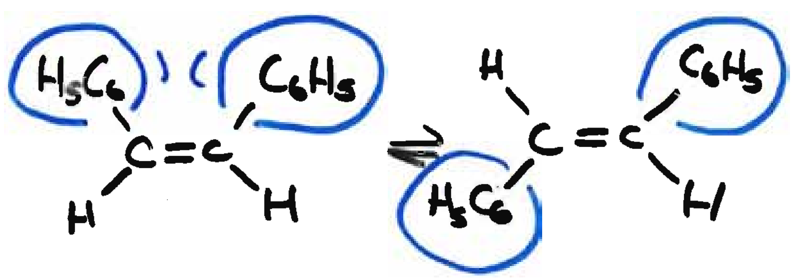


Calculating eq^m concs.

- if we know K_c, and init concs, let's calculate eQ^m concs!

@200°C $K_c = 24.0$

ex: cis-stilbene ⇌ trans-stilbene



let's say we start w/ a sol^n of 0.850 M cis-stilbene and 0 M trans-stilbene } what will concs be @ eq^m?

	1 cis	⇌ 1 trans
Initial	0.850M	0
Change	−1x	+1x
Equilibrium	(0.850M − x)	(x)

x

x

$$K_c = \frac{[\text{trans}]_{eq}}{[\text{cis}]_{eq}}$$

$$24.0 = \frac{x}{(0.850 - x)}$$

can solve for x ...

$x = 0.816$

$$[\text{cis}]_{eq} = 0.850 - x$$
$$= 0.850 - 0.816$$
$$= 0.034\,M$$

$$[\text{trans}]_{eq} = x = 0.816\,M$$

More examples...

$$H_2 + Br_2 \rightleftharpoons 2HBr, \; K_c = 78.2$$

if we place 0.282 mol H_2
0.282 mol Br_2 (exact)
into an empty 2-L flask.

- what will all 3 concs be @ eq^m?

$$[H_2]_i = [Br_2]_i = \frac{0.282\,\text{mol}}{2\text{-L}} = 0.141\,M$$

$$H_2 + Br_2 \rightleftharpoons 2HBr \; ; \; K_c = 78.2$$

	H_2	Br_2	$2HBr$
I	0.141M	0.141M	0
C	$-x$	$-x$	$+2x$
E	$(0.141-x)$	$(0.141-x)$	$(2x)$

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

$$78.2 = \frac{(2x)^2}{(0.141-x)(0.141-x)}$$