Solving Equilibrium Problems – Given K_{eq} and Perfect Squares

Example: 0.500 mol of HI is placed in a sealed 2.0 L container and allowed to reach equilibrium as follows: $2HI_{(g)} \rightleftarrows H_{2(g)} + I_{2(g)}$. At 400 °C K_{eq} is 3.2×10^{-2}. Determine the equilibrium concentration for each species.

	$2HI_{(g)}$	$\rightleftarrows H_{2(g)}$	$+ I_{2(g)}$
I	0.25	0	0
C	$-2x$	$+x$	$+x$
E	$0.25-2x$	$+x$	$+x$

① calculate M

$[HI] = \frac{0.500 mol}{2 L} = 0.25 M$

④ $K_{eq} = \frac{[H_2][I_2]}{[HI]^2}$

⑤ add in values from ICE chart

$0.032 = \frac{[x][x]}{[0.25-2x]^2}$

$0.032 = \frac{x^2}{[0.25-2x]^2}$

perfect square → take $\sqrt{}$ of both sides

$\frac{x}{0.25-2x} = 0.1789$ multiply by $0.25-2x$

$x = 0.1789(0.25-2x)$

$x = 0.0447 - 0.3578x$

add $0.3578x$

$1.3578x = 0.0447$

divide by 1.3578

$x = 0.0329 M$

⑥ find [ ]

$[H_2] = [I_2] = x = 0.033 M$

$[HI] = 0.25-2x$

$= 0.25-2(0.0329)$

$= 0.18 M$

Solving Equilibrium Problems – Given K_{eq} and Imperfect Squares

Example: At 100 °C the following reaction has an equilibrium constant of 2.2×10^{-10}:

$COCl_{2(g)} \rightleftarrows CO_{(g)} + Cl_{2(g)}$.

If 1.00 mol of phosgene, $COCl_2$, is placed in a closed 10.0 L flask, calculate the equilibrium concentration of carbon monoxide.

	$COCl_{2(g)}$	$\rightleftarrows CO_{(g)}$	$+ Cl_{2(g)}$
I	0.10	0	0
C	$-x$	$+x$	$+x$
E	$0.10-x$	$+x$	$+x$

$K_{eq} = \frac{[CO][Cl_2]}{[COCl_2]}$

$2.2 \times 10^{-10} = \frac{[x][x]}{[0.10-x]}$

$K_{eq} = \frac{P}{r}$ small → big

very small

$2.2 \times 10^{-10} = \frac{x^2}{0.10-x}$

imperfect square → can NOT take $\sqrt{}$

but x is so tiny it is insignificant in denominator

$2.2 \times 10^{-10} = \frac{x^2}{0.10}$ $\times 0.10$

$0.10-$

$x^2 = 2.2 \times 10^{-11}$

$x = 4.7 \times 10^{-6} M$

$[CO] = x = 4.7 \times 10^{-6} M$