KEY

Intro to Keq Calculations

1.) In a Keq equation (equilibrium expression) the reactants appear in the denominator of the expression.

2a.) $H_{2\,(g)} + S_{(g)} \leftrightarrow H_2S_{(g)}$ Answer - $K_{eq} = \frac{[H_2S]}{[H_2][S]}$

b.) $PCl_{5\,(g)} \leftrightarrow PCl_{3\,(g)} + Cl_{2\,(g)}$ Answer - $K_{eq} = \frac{[PCl_3][Cl_2]}{[PCl_5]}$

c.) $4\ NH_{3\,(g)} + 5\ O_{2\,(g)} \leftrightarrow 4\ NO_{(g)} + 6\ H_2O_{(g)}$ Answer - $K_{eq} = \frac{[H_2O]^6[NO]^4}{[NH_3]^4[O_2]^5}$

d.) $CH_{4\,(g)} + 2\ O_{2\,(g)} \leftrightarrow CO_{2\,(g)} + 2\ H_2O_{(g)}$ Answer - $K_{eq} = \frac{[H_2O]^2[CO_2]}{[CH_4][O_2]^2}$

3.) $PCl_{5\,(g)} \leftrightarrow PCl_{3\,(g)} + Cl_{2\,(g)}$ Answer - $K_{eq} = \frac{[PCl_3][Cl_2]}{[PCl_5]}$ $K_{eq} = \frac{[0.40][0.40]}{[0.32]}$ $K_{eq} = 0.50$

4.) $PCl_{5\,(g)} \leftrightarrow PCl_{3\,(g)} + Cl_{2\,(g)}$ Answer - $1.78 = \frac{[PCl_3][Cl_2]}{[PCl_5]}$ $1.78 = \frac{[0.85][0.85]}{[PCl_5]}$ $[PCl_5] = 0.405\ M$

5.) $2\ NO_{2\,(g)} \leftrightarrow N_2O_{4\,(g)}$ Answer - $x = 0.64$

I	2.0	0
C	$-2x$	$+x$
E	$2.0 - 2x$	0.64

Therefore → $[CO_2] = 2.0 - 2(0.64)$

$[CO_2] = 0.72$ M

6.) $X_{(g)} + 2\ Y_{(g)} \leftrightarrow 2\ Z_{(g)}$ Answer - $K_{eq} = \frac{[Z]^2}{[X][Y]^2}$ $K_{eq} = \frac{[0.080]^2}{[0.26][0.12]^2}$

$K_{eq} = 1.7$

I	0.30	0.20	0
C	$-x$ $(= -0.040)$	$-2x$ $(= -0.080)$	$+2x$ $(2x = 0.080)$
E	0.26	0.12	0.080

7.) $H_{2\,(g)} + CO_{2\,(g)} \leftrightarrow H_2O_{(g)} + CO_{(g)}$ Answer - $K_{trial} = \frac{[H_2][CO_2]}{[H_2O][CO]}$ $K_{trial} = \frac{[0.40][0.40]}{[0.40][0.40]}$

$K_{trial} = 1.0$

I	0.40	0.40	0.40	0.40
C	$-x$	$-x$	$+x$	$+x$
E	$0.40 - x$	$0.40 - x$	$0.40 + x$	$0.40 + x$

$K_{eq} = \frac{[H_2][CO_2]}{[H_2O][CO]}$ $1.50 = \frac{[0.40+x][0.40+x]}{[0.40-x][0.40-x]}$

$\sqrt{1.50} = \sqrt{\frac{[0.40+x]^2}{[0.40-x]^2}}$ $1.2247 = \frac{[0.40+x]}{[0.40-x]}$ $x = 0.040408$ $[CO_2] = 0.44$ M

$CO = 0.40 - 0.040408$ $[CO] = 0.36$ M

KEY

8.) $N_{2\,(g)} + 3\,H_{2\,(g)} \leftrightarrow 2\,NH_{3\,(g)}$

I	0.10	0.50	0
C	$-x$ $(= -0.06)$	$-3x$ $(= -0.18)$	$+2x$ $(2x = 0.12)$
E	0.04	0.32	0.12

Answer - $K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$ $K_{eq} = \frac{[0.12]^2}{[0.04][0.32]^3}$

$K_{eq} = 11$

9.) $H_{2\,(g)} + I_{2\,(g)} \leftrightarrow 2\,HI_{\,(g)}$

I	0.40	0.40	0
C	$-x$	$-x$	$+2x$
E	$0.40 - x$	$0.40 - x$	$+2x$

Answer - $K_{eq} = \frac{[HI]^2}{[H_2][I_2]}$ $400 = \frac{[2x]^2}{[0.40-x][0.40-x]}$

$400 = \frac{[2x]^2}{[0.40-x]^2}$ $\sqrt{400} = \sqrt{\frac{[2x]^2}{[0.40-x]^2}}$

$x = 0.363636$ $H_2 = 0.40 - 0.36$

$[H_2] = 0.036\ M$