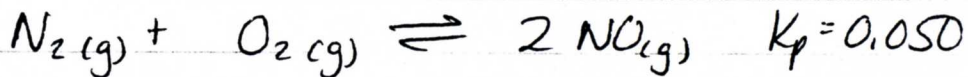


①

ANSWERS

Gaseous Equilibrium Practice Problems

1. $P_{N_2} = 0.80 \text{ atm}$ $P_{O_2} = 0.20 \text{ atm}$



Start	0.80 atm	0.20 atm	0
Δ	$-x$	$-x$	$+2x$
eq.	$0.80-x$	$0.20-x$	$2x$

$$K_p = \frac{P_{NO}^2}{P_{N_2} P_{O_2}} = \frac{(2x)^2}{(0.80-x)(0.20-x)} = 0.050$$

$$4x^2 = 0.050(0.80-x)(0.20-x) \quad \text{FOIL}$$

$$4x^2 = 0.050(0.16 - 0.20x - 0.80x + x^2)$$

$$4x^2 = 0.0080 - 0.050x + 0.050x^2 \quad -4x^2$$

$$0 = 0.0080 - 0.050x - 3.95x^2 \quad -4x^2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{+0.050 \pm \sqrt{(0.050)^2 - 4(-3.95)(0.0080)}}{2(-3.95)}$$

$$x = \frac{+0.050 \pm 0.359}{-7.90}$$

$$x = -0.0518 \text{ or } x = 0.0391 \text{ atm}$$

↑
doesn't make sense

$$\begin{aligned} P_{N_2} &= 0.80 - 0.039 = 0.76 \text{ atm} \\ P_{O_2} &= 0.20 - 0.039 = 0.16 \text{ atm} \\ P_{NO} &= 2(0.039) = 0.078 \text{ atm} \end{aligned}$$

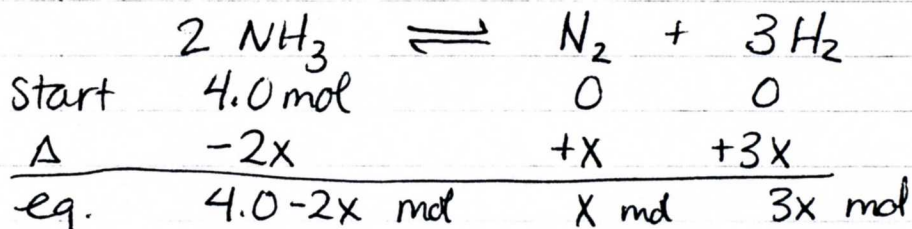
check:

$$\frac{(0.078)^2}{(0.76)(0.16)} = 0.050$$

✓

(2)

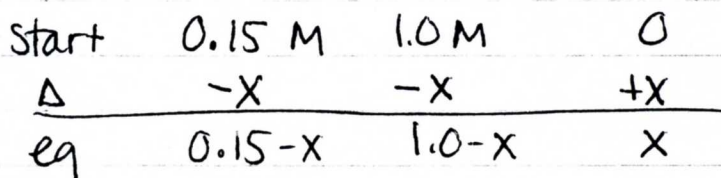
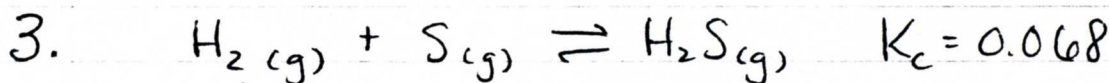
2. 4.0 mol NH_3 in 2.0 L \Rightarrow start
at eq, 2.0 mol NH_3



$$\begin{array}{l} \text{at eq, } 2.0 \text{ mol NH}_3 = 4.0 - 2x \text{ mol} \\ \frac{-4.0}{-2.0} = \frac{-2x}{-2} \quad x = 1.0 \text{ mol} \end{array}$$

$$\begin{array}{l} 2.0 \text{ mol NH}_3 \div 2.0 \text{ L} \Rightarrow 1.0 \text{ M NH}_3 \\ 1.0 \text{ mol N}_2 \div 2.0 \text{ L} \Rightarrow 0.50 \text{ M N}_2 \\ 3(1.0) = 3.0 \text{ mol H}_2 \div 2.0 \text{ L} = 1.5 \text{ M H}_2 \end{array}$$

$$K_c = \frac{[\text{N}_2][\text{H}_2]^3}{[\text{NH}_3]^2} = \frac{(0.50)(1.5)^3}{(1.0)^2} = 1.7 \text{ to 2 sf.}$$



$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]} = \frac{x}{(0.15-x)(1.0-x)} = 0.068$$

3

$$x = 0.068(0.15-x)(1.0-x)$$

$$x = 0.068(0.15 - 1.0x - 0.15x + x^2)$$

$$x = 0.0102 - 0.0782x + 0.068x^2$$

$$0 = 0.0102 - 1.0782x + 0.068x^2$$

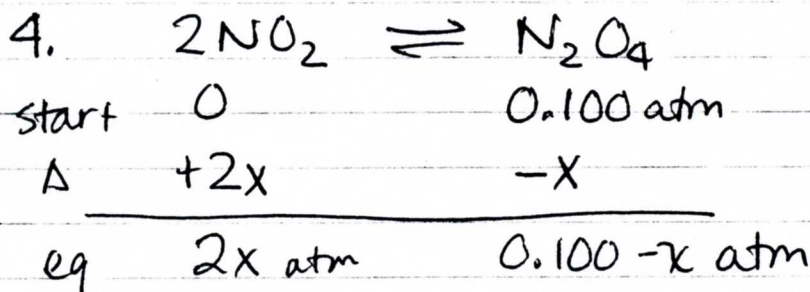
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{+1.0782 \pm \sqrt{(1.0782)^2 - 4(0.068)(0.0102)}}{2(0.068)}$$

$$x = \frac{1.0782 \pm 1.0769}{0.136} = 15.84 \text{ or } x = 0.00956$$

$$x = [H_2S] \text{ at eq} = 9.6 \times 10^{-3} \text{ M } H_2S$$

check: $\frac{(9.56 \times 10^{-3})}{(0.15 - 9.56 \times 10^{-3})(1.0 - 9.56 \times 10^{-3})} = 0.069$
close enough.

4



$$K_p = \frac{P_{\text{N}_2\text{O}_4}}{(P_{\text{NO}_2})^2} = \frac{0.100 - x}{(2x)^2} = 6.7$$

$$\begin{aligned} 0.100 - x &= 6.7(2x)^2 = 6.7(4x^2) \\ 0.100 - x &= 26.8x^2 \\ 0 &= 26.8x^2 + x - 0.100 \end{aligned}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-1 \pm \sqrt{1^2 - 4(26.8)(0.100)}}{2(26.8)}$$

$$x = \frac{-1 \pm 3.423}{53.6} = 0.0452 \text{ atm}$$

or $x = -0.0825 \text{ atm}$
doesn't make sense

$$\begin{aligned} 2x &= 2(0.0452 \text{ atm}) = 0.0904 \text{ atm N}_2\text{O}_2 \\ 0.100 - x &= 0.100 - 0.0452 \text{ atm} = 0.0548 \text{ atm N}_2\text{O}_4 \end{aligned}$$

check:

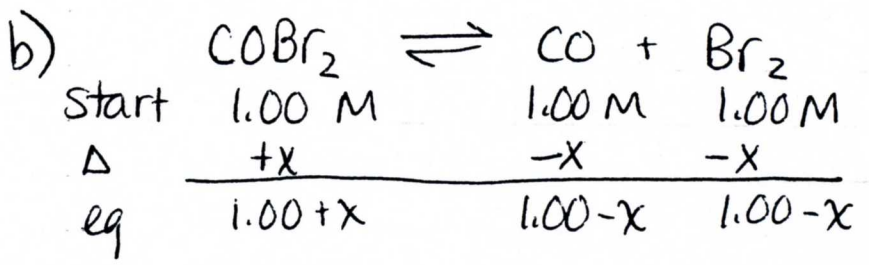
$$K_p = \frac{0.0548}{(0.0904)^2} = 6.7 \quad \checkmark$$

at equilibrium

5. 1.00 mole of each in 1.0 L
each initial M is 1.00 M
Which way will it go? calc. Q

$$Q = \frac{[CO][Br_2]}{[COBr_2]} = \frac{(1.00)(1.00)}{(1.00)} = 1.00$$

a) $K = 0.190$ so $Q > K$, Q must decrease to get to equilibrium. Rxn must go backward.



$$K_c = 0.190 = \frac{[CO][Br_2]}{[COBr_2]} = \frac{(1.00-x)(1.00-x)}{1.00+x} = 0.190$$

$$(1.00-x)(1.00-x) = 0.190(1.00+x)$$

$$1.00 - 1.00x - 1.00x + x^2 = 0.190 + 0.190x$$

$$\begin{array}{cccc} -0.190 & -0.190x & -0.190 & -0.190x \end{array}$$

$$0.81 - 2.19x + x^2 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{+2.19 \pm \sqrt{(2.19)^2 - 4(1)(0.81)}}{2(1)}$$

$$x = \frac{+2.19 \pm 1.247}{2} = \cancel{1.72} \text{ or } x = 0.4715 \text{ M}$$

6

$$[\text{COBr}_2] = 1.00 + 0.47 \Rightarrow 1.47 \text{ M}$$

$$[\text{CO}] = 1.00 - 0.47 \Rightarrow 0.53 \text{ M}$$

$$[\text{Br}_2] \Rightarrow 0.53 \text{ M}$$

check $K_c = \frac{(0.53)^2}{1.47} = \underline{0.191}$ close enough!