

# AP CHEMISTRY

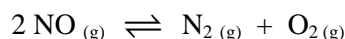
## TOPIC 6: EQUILIBRIUM, PART E

## EXAMPLES ( PART IV )

Day 69:

- A few example problems

1. At 223 °C,  $K = 4.10 \times 10^{-4}$  for the reaction



Calculate the concentrations of all the species at equilibrium for each of the following original mixtures.

a) 2.0 mol pure NO in a 4.0 liter flask.

**Answers:**

	2 [ NO ]	$\rightleftharpoons$	[ N <sub>2</sub> ]	+	[ O <sub>2</sub> ]
I	2.0 mol / 4.0 L		0		0
C	- 2x		+ x		+ x
E	0.5 - 2x		x		x

$$K = 4.10 \times 10^{-4} = \frac{[ \text{N}_2 ] [ \text{O}_2 ]}{[ \text{NO} ]^2} = \frac{(x)(x)}{(0.5 - 2x)^2} = \frac{(x)^2}{(0.5 - 2x)^2}$$

( assuming  $0.5 - 2x \approx 0.5$ , since the size of  $K$  is so small )

$$4.10 \times 10^{-4} = \frac{x^2}{(0.5)^2}, \quad (4.10 \times 10^{-4})(0.5)^2 = x^2$$

$$1.03 \times 10^{-4} = x^2 \quad ; \quad \sqrt{1.03 \times 10^{-4}} = x = 0.0101$$

$$[ \text{NO} ] = 0.5 \quad ; \quad [ \text{N}_2 ] = x = 0.0101 \quad ; \quad [ \text{O}_2 ] = x = 0.0101$$

$$K = \frac{[ \text{N}_2 ] [ \text{O}_2 ]}{[ \text{NO} ]^2} = \frac{(0.0101)^2}{(0.5)^2} = 4.08 \times 10^{-4}$$

$$\% \text{ Error} = \frac{|\text{calculated} - \text{true}|}{\text{true}} \times 100 = \frac{|4.08 \times 10^{-4} - 4.10 \times 10^{-4}|}{4.10 \times 10^{-4}} \times 100 = 0.488 \%$$

Check is very good (within the 5%) !!!

b) 2.0 mol pure NO, and 1.0 mol pure N<sub>2</sub> in a 4.0 liter flask.

**Answers:**

	2 [ NO ]	⇌	[ N <sub>2</sub> ]	+	[ O <sub>2</sub> ]
I	2.0 mol / 4.0 L		1.0 mol / 4.0 L		0
C	- 2x		+ x		+ x
E	0.5 - 2x		0.25 + x		x

$$K = 4.10 \times 10^{-4} = \frac{[ N_2 ] [ O_2 ]}{[ NO ]^2} = \frac{(0.25 + x)(x)}{(0.5 - 2x)^2}$$

( assuming  $0.5 - 2x \approx 0.5$ , and  $0.25 + x \approx 0.25$ , since the size of  $K$  is so small )

$$4.10 \times 10^{-4} = \frac{(0.25)(x)}{(0.5)^2}, \quad \frac{(4.10 \times 10^{-4})(0.5)^2}{0.25} = x = 4.10 \times 10^{-4}$$

$$[ NO ] = 0.5 ; \quad [ N_2 ] = x = 0.25 ; \quad [ O_2 ] = x = 4.10 \times 10^{-4}$$

$$K = \frac{[ N_2 ] [ O_2 ]}{[ NO ]^2} = \frac{(0.25)(4.10 \times 10^{-4})}{(0.5)^2} = 4.1 \times 10^{-4}$$

$$\% \text{ Error} = \frac{|\text{calculated} - \text{true}|}{\text{true}} \times 100 = \frac{|4.10 \times 10^{-4} - 4.10 \times 10^{-4}|}{4.10 \times 10^{-4}} \times 100 = 0.0 \%$$

Check is very good (within the 5%) !!!

2. AN EXCELLENT AP exam or TEST question:

At 345 °C,  $K = 1.3 \times 10^{-6}$  for the reaction



Calculate the concentrations of all the species at equilibrium. (hint: you do not need to use the 5% rule)

**Answers: Recall pure solids and/or liquids do not APPEAR in the equilibrium expression !!! Therefore a dash is represented in the ICE chart NOT a zero !!!**

	[ CaCO <sub>3</sub> ]	⇌	[ CaO ]	+	[ CO <sub>2</sub> ]
I	-		-		0
C	-		-		+ x
E	-		-		x

$$K = 1.3 \times 10^{-6} = [ CO_2 ] = (x) = 1.3 \times 10^{-6} M$$

**That's it !!!**