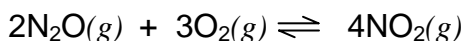


1. A mixture of 1.79 g O<sub>2</sub> and 0.840 g N<sub>2</sub>O is placed in a 5.00 L container at 50 °C. After equilibrium is established, there is 0.989 g of NO<sub>2</sub>. (a) What are the equilibrium concentrations of O<sub>2</sub>, N<sub>2</sub>O and NO<sub>2</sub>? (b) Calculate K<sub>c</sub>. (c) Calculate K<sub>p</sub> at 50 °C. (8 pts)



$$\text{initial: } [\text{N}_2\text{O}] = \left(\frac{0.840 \text{ g}}{5.00 \text{ L}}\right)\left(\frac{1 \text{ mol N}_2\text{O}}{44.0 \text{ g N}_2\text{O}}\right) = 3.82 \times 10^{-3} \text{ M}; [\text{O}_2] = \left(\frac{1.79 \text{ g}}{5.00 \text{ L}}\right)\left(\frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2}\right) = 1.12 \times 10^{-2} \text{ M}$$

$$\text{equilibrium: } [\text{NO}_2] = \left(\frac{0.989 \text{ g}}{5.00 \text{ L}}\right)\left(\frac{1 \text{ mol NO}_2}{46.0 \text{ g NO}_2}\right) = 4.30 \times 10^{-3} \text{ M}$$

	[N <sub>2</sub> O]	[O <sub>2</sub> ]	[NO <sub>2</sub> ]
I, M	3.82x10 <sup>-3</sup>	1.12x10 <sup>-2</sup>	0
C	-2x	-3x	4x
E, M	3.82x10 <sup>-3</sup> - 2x	1.12x10 <sup>-2</sup> - 3x	4x = 4.30x10 <sup>-3</sup>

$$4x = 4.30 \times 10^{-3} \quad \Rightarrow \quad x = 1.08 \times 10^{-3}$$

Eq concentrations: [N<sub>2</sub>O] = 3.82x10<sup>-3</sup> - 2(1.08x10<sup>-3</sup>) = 1.66x10<sup>-3</sup> M N<sub>2</sub>O

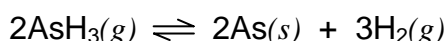
[O<sub>2</sub>] = 1.12x10<sup>-2</sup> - 3(1.08x10<sup>-3</sup>) = 8.0x10<sup>-3</sup> M O<sub>2</sub> (2 sig figs due to sig fig subtraction rule)

[NO<sub>2</sub>] = 4.30x10<sup>-3</sup> M NO<sub>2</sub>

b)  $K_c = \frac{[\text{NO}_2]^4}{[\text{N}_2\text{O}]^2[\text{O}_2]^3} = \frac{[4.30 \times 10^{-3}]^4}{[1.66 \times 10^{-3}]^2 [8.0 \times 10^{-3}]^3} = 2.4 \times 10^2$

c)  $K_p = K_c(\text{RT})^{\Delta n}$      $\Delta n = 4 - 5 = -1$      $K_p = 2.4 \times 10^2 (0.0821 \times 323)^{-1} = 9.1$

2. The gas arsine, AsH<sub>3</sub>, decomposes by the following reaction:



In an experiment at a certain temperature, AsH<sub>3</sub> gas is placed in a flask at a pressure of 0.465 atm. After equilibrium has been established, the total pressure of the gases (for AsH<sub>3</sub> and H<sub>2</sub> taken together) is 0.579 atm. (a) What is the partial pressure of each gas at equilibrium? (b) Calculate the value of K<sub>p</sub> for this reaction. (5 pts)

AsH <sub>3</sub> (g)	As(s)	H <sub>2</sub> (g)
0.465		0
-2x		+3x
0.465-2x		3x

$$\text{Total P} = P_{\text{H}_2} + P_{\text{AsH}_3}$$

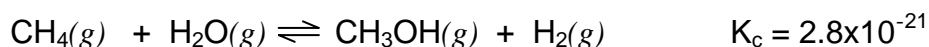
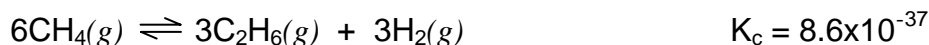
$$0.579 = 0.465 - 2x + 3x$$

$$x = 0.114$$

a)  $P_{\text{AsH}_3} = 0.465 - 2(0.114) = 0.237 \text{ atm}$      $P_{\text{H}_2} = 3x = 3(0.114) = 0.342 \text{ atm}$

b)  $K_p = \frac{P_{\text{H}_2}^3}{P_{\text{AsH}_3}^2} = \frac{(0.342)^3}{(0.237)^2} = 0.712$

3. Given the equations

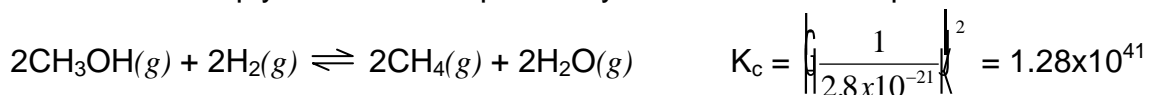


Calculate the value of  $K_c$  for:  $2\text{CH}_3\text{OH}(g) + \text{H}_2(g) \rightleftharpoons \text{C}_2\text{H}_6(g) + 2\text{H}_2\text{O}(g)$   
 Make sure to show your work! (4 pt)

Divide the first equation by 3  $\Rightarrow$  take K to the 1/3 power:



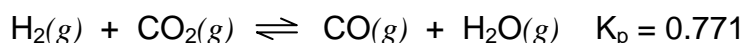
Reverse & multiply the second equation by 2  $\Rightarrow$  invert K and square K:



Add the two equations  $\Rightarrow$  multiply K values



4. A mixture of 0.500 atm  $\text{H}_2$  and 0.500 atm  $\text{CO}_2$  is placed in a container and undergoes the following reaction:



Calculate the equilibrium partial pressures of each of the four gases. (5 pts)

	$\text{H}_2$	$\text{CO}_2$	$\text{CO}$	$\text{H}_2\text{O}$
I (atm)	0.500	0.500	0	0
C	-x	-x	+x	+x
E (atm)	0.500 - x	0.500 - x	x	x

$$K_p = \frac{P_{\text{H}_2\text{O}} P_{\text{CO}}}{P_{\text{H}_2} P_{\text{CO}_2}} \quad 0.771 = \frac{x \cdot x}{(0.500 - x)(0.500 - x)} = \frac{x^2}{(0.500 - x)^2}$$

$$0.878 = \frac{x}{0.500 - x} \quad \Rightarrow \quad 0.878(0.500 - x) = x$$

$$0.439 - 0.878x = x$$

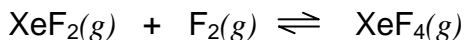
$$0.439 = 1.878x$$

$$x = 0.439/1.878 \quad \Rightarrow \quad x = 0.234$$

Equilibrium concentrations:  $P_{\text{CO}} = P_{\text{H}_2\text{O}} = 0.234 \text{ atm}$

$$P_{\text{CO}_2} = P_{\text{H}_2} = 0.500 - 0.234 = 0.266 \text{ atm}$$

5. The value of  $K_c$  for the following reaction is 3.17 at 300 K.



Suppose 0.525 moles of  $\text{XeF}_2$  and 1.12 moles of  $\text{F}_2$  are placed in a 2.50 L vessel. What are the equilibrium concentrations of  $\text{XeF}_2$ ,  $\text{F}_2$ , and  $\text{XeF}_4$ ? (8 pts)

$$\text{Initial: } [\text{XeF}_2] = \frac{0.525 \text{ moles}}{2.50 \text{ L}} = 0.210 \text{ M} \quad [\text{F}_2] = \frac{1.12 \text{ moles}}{2.50 \text{ L}} = 0.448 \text{ M}$$

	$[\text{XeF}_2]$	$[\text{F}_2]$	$[\text{XeF}_4]$
I,	0.210	0.448	0
C	-x	-x	+x
E	0.210 - x	0.448 - x	x

$$K_c = \frac{[\text{XeF}_4]}{[\text{XeF}_2][\text{F}_2]} \quad 3.17 = \frac{x}{(0.210 - x)(0.448 - x)}$$

$$3.17(0.210 - x)(0.448 - x) = x$$

$$3.17[0.09408 - 0.658x + x^2] = x$$

$$0.298 - 2.086x + 3.17x^2 = x$$

$$3.17x^2 - 3.086x + 0.298 = 0$$

$$x = \frac{+3.086 \pm \sqrt{(3.086)^2 - 4(3.17)(0.298)}}{2(3.17)} = \frac{+3.086 \pm 2.397}{6.34}$$

$x = 0.865$  or  $0.109$  so  $x = \mathbf{0.109 \text{ M}}$ ;  $x$  can't be  $0.865$  or we get (-) eq concentrations

Equilibrium concentrations:

$$[\text{XeF}_2] = 0.210 - 0.109 = \mathbf{0.101 \text{ M XeF}_2}$$

$$[\text{F}_2] = 0.448 - 0.109 = \mathbf{0.339 \text{ M F}_2}$$

$$[\text{XeF}_4] = \mathbf{0.109 \text{ M XeF}_4}$$