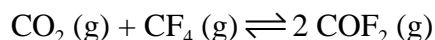


## Chapter 17 - Equilibrium Problem Set

**Instructor: Sherman Henzel**



1. 5.000 moles of  $\text{CO}_2$  and 7.000 moles of  $\text{CF}_4$  are placed in a 3.500 L evacuated flask. If 2.155 moles of  $\text{COF}_2$  are present at equilibrium, what is  $K_c$  for this reaction?

Answer \_\_\_\_\_

2. 1.750 moles of  $\text{CO}_2$  and 1.750 moles of  $\text{CF}_4$  are placed in a 5.000 L evacuated flask. Calculate all concentrations at equilibrium.

$[\text{CO}_2]$  \_\_\_\_\_  $[\text{CF}_4]$  \_\_\_\_\_  $[\text{COF}_2]$  \_\_\_\_\_

3. 2.250 moles of  $\text{CO}_2$  and 3.150 moles of  $\text{CF}_4$  are placed in a 10.000 L evacuated flask. Calculate all concentrations at equilibrium.

$[\text{CO}_2]$  \_\_\_\_\_  $[\text{CF}_4]$  \_\_\_\_\_  $[\text{COF}_2]$  \_\_\_\_\_

4. 2.500 moles of  $\text{CO}_2$ , 2.500 moles of  $\text{CF}_4$  and 5.000 moles of  $\text{COF}_2$  are placed in a 6.000 L evacuated flask. Calculate all concentrations at equilibrium.

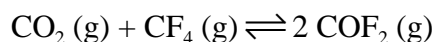
$[\text{CO}_2]$  \_\_\_\_\_  $[\text{CF}_4]$  \_\_\_\_\_  $[\text{COF}_2]$  \_\_\_\_\_

5. 1.500 moles of  $\text{CO}_2$ , 2.500 moles of  $\text{CF}_4$  and 3.000 moles of  $\text{COF}_2$  are placed in a 6.000 L evacuated flask. Calculate all concentrations at equilibrium.

$[\text{CO}_2]$  \_\_\_\_\_  $[\text{CF}_4]$  \_\_\_\_\_  $[\text{COF}_2]$  \_\_\_\_\_

6. Determine  $K_p$  for this reaction at 2500 K.

Answer \_\_\_\_\_



1. 5.000 moles of  $\text{CO}_2$  and 7.000 moles of  $\text{CF}_4$  are placed in a 3.500 L evacuated flask. If 2.155 moles of  $\text{COF}_2$  are present at equilibrium, what is  $K_c$  for this reaction?

$$\frac{5.000 \text{ mol CO}_2}{3.500 \text{ L}} = 1.429 \text{ M}; \frac{7.000 \text{ mol CF}_4}{3.500 \text{ L}} = 2.000 \text{ M}; \frac{2.155 \text{ mol COF}_2}{3.500 \text{ L}} = 0.6157 \text{ M}$$

	$\text{CO}_2(\text{g})$	+	$\text{CF}_4(\text{g})$	$\rightleftharpoons$	$2 \text{COF}_2(\text{g})$
I	1.429		2.000		0
C	-x		-x		+2x
$E_x$	1.429 - x		2.000 - x		2x
E	<b>1.121</b>		<b>1.692</b>		0.6157

$$2x = 0.6157; x = 0.3079$$

$$K_c = \frac{[\text{COF}_2]^2}{[\text{CO}_2][\text{CF}_4]} = \frac{(0.6157)^2}{(1.121)(1.692)} = 0.1999$$

Answer 0.1999

2. 1.750 moles of  $\text{CO}_2$  and 1.750 moles of  $\text{CF}_4$  are placed in a 5.000 L evacuated flask. Calculate all concentrations at equilibrium.

$$\frac{1.750 \text{ mol CO}_2}{5.000 \text{ L}} = 0.3500 \text{ M}; \frac{1.750 \text{ mol CF}_4}{5.000 \text{ L}} = 0.3500 \text{ M}$$

	$\text{CO}_2(\text{g})$	+	$\text{CF}_4(\text{g})$	$\rightleftharpoons$	$2 \text{COF}_2(\text{g})$
I	0.3500		0.3500		0
C	-x		-x		+2x
$E_x$	0.3500 - x		0.3500 - x		2x

$$K_c = \frac{[\text{COF}_2]^2}{[\text{CO}_2][\text{CF}_4]} = \frac{(2x)^2}{(0.3500 - x)(0.3500 - x)} = \frac{(2x)^2}{(0.3500 - x)^2} = 0.1999$$

$$\sqrt{\frac{(2x)^2}{(0.3500 - x)^2}} = \sqrt{0.1999}; \frac{(2x)}{(0.3500 - x)} = 0.4471$$

$$2x = 0.1565 - 0.4471 x; x = 0.06395$$

$$[\text{CO}_2] = 0.3500 - 0.06395 = 0.2861 \text{ M}; [\text{CF}_4] = 0.3500 - 0.06395 = 0.2861 \text{ M}$$

$$[\text{COF}_2] = 2(0.06395) = 0.1279 \text{ M}$$

$[\text{CO}_2]$  0.2861 M  $[\text{CF}_4]$  0.2861 M  $[\text{COF}_2]$  0.1279 M

3. 2.250 moles of  $\text{CO}_2$  and 3.150 moles of  $\text{CF}_4$  are placed in a 10.000 L evacuated flask. Calculate all concentrations at equilibrium.

$$\frac{2.250 \text{ mol CO}_2}{10.000 \text{ L}} = 0.2250 \text{ M}; \frac{3.150 \text{ mol CF}_4}{10.000 \text{ L}} = 0.3150 \text{ M}$$

	$\text{CO}_2(\text{g})$	+	$\text{CF}_4(\text{g})$	$\rightleftharpoons$	$2 \text{COF}_2(\text{g})$
I	0.2250		0.3150		0
C	-x		-x		+2x
E <sub>x</sub>	0.2250 - x		0.3150 - x		2x

$$K_c = \frac{[\text{COF}_2]^2}{[\text{CO}_2][\text{CF}_4]} = \frac{(2x)^2}{(0.2250 - x)(0.3150 - x)} = \frac{4x^2}{0.07088 - 0.5400x + x^2} = 0.1999$$

$$4x^2 = 0.01417 - 0.1080x + 0.1999x^2; 3.800x^2 + 0.1080x - 0.01417$$

$$x = \frac{-(-0.1080) \pm \sqrt{(-0.1080)^2 - 4(3.800)(-0.01417)}}{2(3.800)} = \frac{-0.1080 \pm 0.4765}{7.600}$$

$$x = 0.04849$$

$$[\text{CO}_2] = 0.2250 - 0.04849 = 0.1765 \text{ M}; [\text{CF}_4] = 0.3150 - 0.04849 = 0.2665 \text{ M}$$

$$[\text{COF}_2] = 2(0.04849) = 0.09698 \text{ M}$$

$$[\text{CO}_2] \text{ ___ } 0.1765 \text{ M} \text{ ___} \quad [\text{CF}_4] \text{ ___ } 0.2665 \text{ M} \text{ ___} \quad [\text{COF}_2] \text{ ___ } 0.09698 \text{ M} \text{ ___}$$

4. 2.500 moles of  $\text{CO}_2$ , 2.500 moles of  $\text{CF}_4$  and 5.000 moles of  $\text{COF}_2$  are placed in a 6.000 L evacuated flask. Calculate all concentrations at equilibrium.

$$\frac{2.500 \text{ mol CO}_2}{6.000 \text{ L}} = 0.4167 \text{ M}; \frac{2.500 \text{ mol CF}_4}{6.000 \text{ L}} = 0.4167 \text{ M}; \frac{5.000 \text{ mol COF}_2}{6.000 \text{ L}} = 0.8333 \text{ M}$$

$$Q = \frac{[\text{COF}_2]^2}{[\text{CO}_2][\text{CF}_4]} = \frac{(0.8333)^2}{(0.4167)(0.4167)} = 3.999; Q > K_c; \text{ reaction goes to the left}$$

	$\text{CO}_2(\text{g})$	+	$\text{CF}_4(\text{g})$	$\rightleftharpoons$	$2 \text{COF}_2(\text{g})$
I	0.4167		0.4167		0.8333
C	+x		+x		-2x
E <sub>x</sub>	0.4167 + x		0.4167 + x		0.8333 - 2x



6. Determine  $K_p$  for this reaction at 2500 K.

$$K_p = K_c(RT)^{\Delta n(\text{gas})}; K_p = 0.1999(RT)^{(2 - (1+1))} = 0.1999$$

Answer \_\_\_\_\_