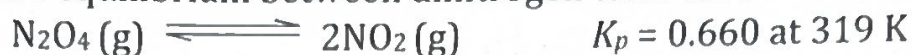


9) Consider the equilibrium between dinitrogen tetra oxide and nitrogen dioxide:



- a) What is the value of K_c for this reaction? (Ans: 0.0252)
 b) What is value of K_p for the reaction $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$ (Ans: 1.52)
 c) If the equilibrium partial pressure of $\text{NO}_2(\text{g})$ is 0.332 atm, what is the equilibrium partial pressure of $\text{N}_2\text{O}_4(\text{g})$? (Ans: 0.167 atm)

$$a) K_p = K_c (RT)^{\Delta n} ; K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{0.66}{(0.0821 \times 319)^{2-1}} = \boxed{0.0252}$$

$$b) \text{Inverse } K_p = \frac{1}{0.660} = \boxed{1.52}$$

$$c) K_p = \frac{P_{\text{NO}_2}^2}{P_{\text{N}_2\text{O}_4}} ; 0.66 = \frac{(0.332)^2}{P_{\text{N}_2\text{O}_4}}$$

$$P_{\text{N}_2\text{O}_4} = \boxed{0.167 \text{ atm}}$$

10) If a 2.50 L vessel at 1000 °C contains 0.525 mol CO_2 , 1.25 mol CF_4 , and 0.750 mol COF_2 , in what direction will a net reaction occur to reach the equilibrium? (Ans: 0.857, left)



$$\begin{array}{ccc} 0.525/2.5\text{L} & 1.25/2.5\text{L} & 0.75/2.5\text{L} \\ 0.21 & 0.5 & 0.3 \end{array}$$

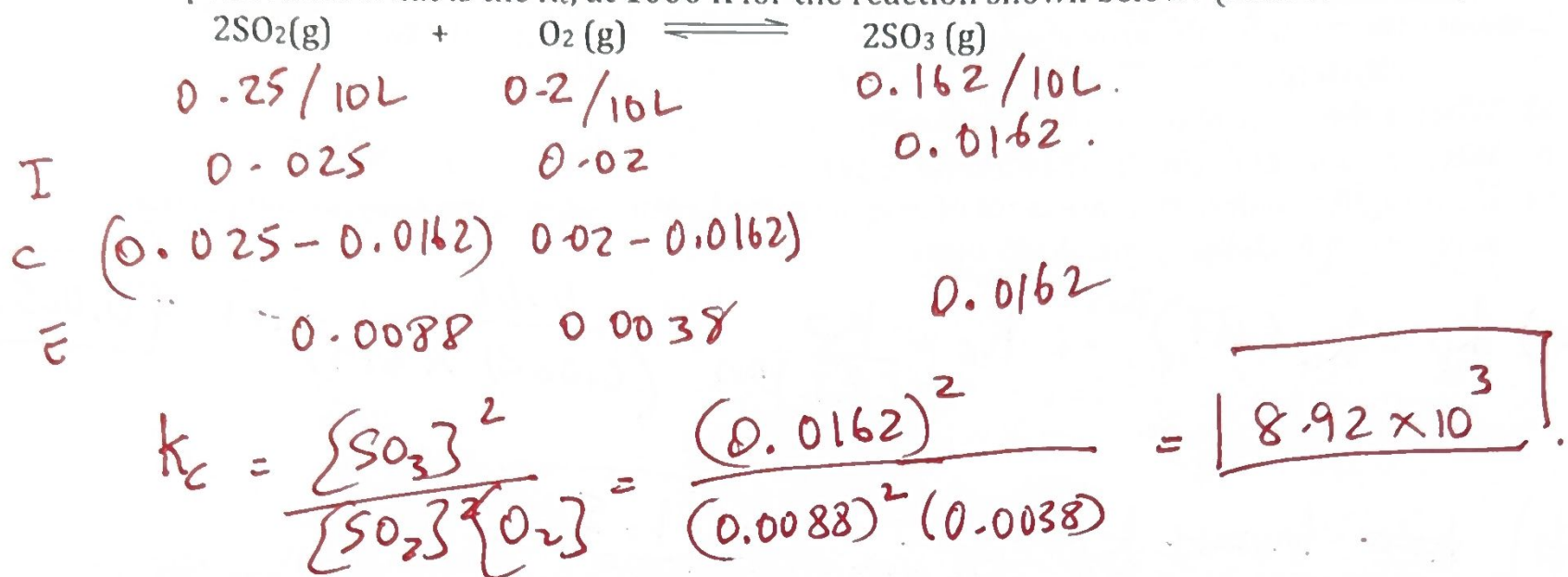
$$Q_c = \frac{[\text{COF}_2]^2}{[\text{CO}_2][\text{CF}_4]} = \frac{(0.3)^2}{(0.21)(0.5)} = \boxed{0.857}$$

$$Q_c > K_c$$

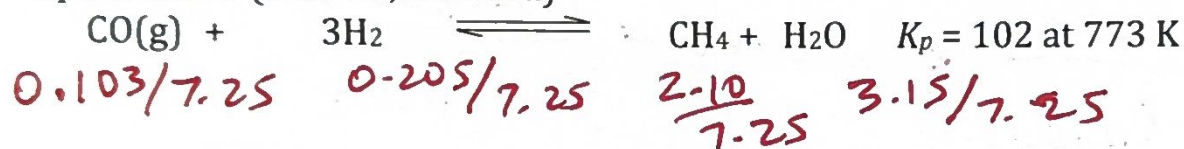
$$0.857 > 0.5$$

eq. moving to left

11) In a 10.0 L vessel at 1000 K, 0.250 mol SO₂ and 0.200 mol O₂ react to form 0.162 mol SO₃ at equilibrium. What is the K_c at 1000 K for the reaction shown below? (Ans: 8.92 × 10³)



12) The following substances are added to a 7.25 L flask at 773 °C: 0.103 mol CO, 0.205 mol H₂, 2.10 mol CH₄ and 3.15 mol H₂O. In what direction will a net reaction occur to reach the equilibrium? (Ans: 97; forward)

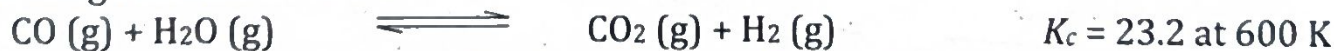


$$Q_c = \frac{(0.2897)(0.4345)}{(0.0142)(0.0283)^3} = 3.91 \times 10^5$$

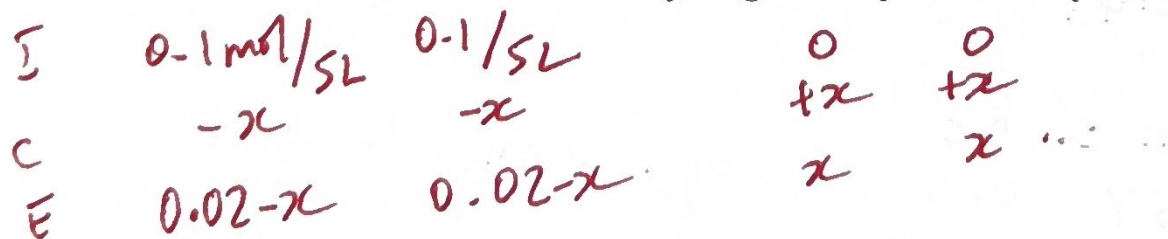
$$Q_p = Q_c (RT)^{\Delta n} = (3.91 \times 10^5) \times (0.0821 \times 773)^{-2} = 97.1$$

$Q_p < K_p$ reaction going forward.
 $\frac{97.1}{102}$

13) Starting with 0.100 mol each of CO and H₂O in a 5.00 L flask, equilibrium is established in the following reaction at 600K:



What is the concentration of hydrogen at equilibrium? (Ans: 0.0165 M)



$$K_c = 23.2 = \frac{(x)(x)}{(0.02-x)(0.02-x)} = \frac{x^2}{(0.02-x)^2}$$

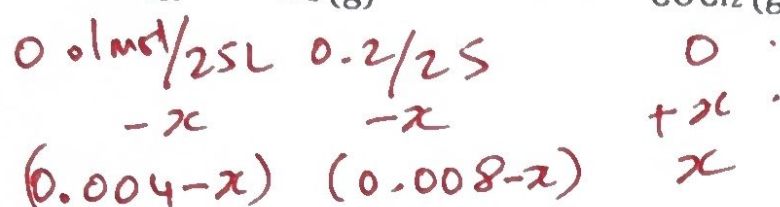
take $\sqrt{\quad}$ both sides.

$$4.82 = \frac{x}{0.02-x} \quad ; \quad \boxed{x = 0.0165 \text{ M}}$$

14) Starting with 0.100 mol CO and 0.200 mol CO₂ in a 25.0 L flask, how many mols of COCl₂ will be present at equilibrium? (Ans: 8.5×10^{-2} mol)



$$K_c = 1.2 \times 10^3$$



$$K_c = 1.2 \times 10^3 = \frac{x}{(0.004-x)(0.008-x)} = \frac{x}{3.20 \times 10^{-5} - 0.012x + x^2}$$

$$1.2 \times 10^3 x^2 - 14.4x - 3.84 \times 10^{-2} = x$$

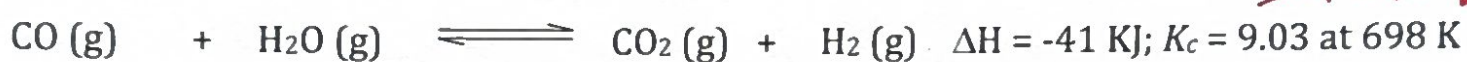
$$1.2 \times 10^3 x^2 - 15.4x - 3.84 \times 10^{-2} = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{1.28 \times 10^{-2} \pm \sqrt{(1.28 \times 10^{-2})^2 - 4(1)(3.2 \times 10^{-5})}}{2(1)}$$

Practice/Equilibrium-Le Chatelier's Principle

15) The reaction between carbon monoxide and steam is given below.



Using LeChatlier's principles predict which direction the equilibrium will proceed when the following changes are made.

a) Carbon monoxide is added $\rightarrow$

b) Carbon dioxide is removed $\rightarrow$

c) The reaction is heated up $\leftarrow$

d) The reaction vessel is compressed to half its volume

no change

e) A catalyst is added

no change

f) A 1 L of argon is added to the reaction vessel

no change.

$$x = 3.4 \times 10^{-3} \text{ M}$$

$$3.4 \times 10^{-3} \text{ M} \times 25 \text{ L} = 8.5 \times 10^{-2} \text{ mol}$$

DO NOT SUBMIT