Chemical Equilibrium

1. Determine the value of the equilibrium constant, K goal K_goal, for the reaction

N 2 (g)+H 2 O(g)⇌NO(g)+ 1 2 N 2 H 4 (g) \rm N_2(g) + H_2O(g) \rightleftharpoons NO(g) + \frac{_1}{^2} N_2H_4(g), K goal =?  ~~~~K_{\rm goal}=\,?

by making use of the following information:

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| 1.N 2 (g)+O 2 (g)⇌2NO(g) \rm N_2(g) + O_2(g) \rightleftharpoons 2NO(g), | K 1 = ~~~~~~{\it K}_1~= | 4.10×10 −31 4.10 \times 10^{-31} |
| 2.N 2 (g)+2H 2 (g)⇌N 2 H 4 (g) \rm N_2(g) + 2H_2(g) \rightleftharpoons N_2H_4(g), | K 2 = ~~~~~~{\it K}_2~= | 7.40×10 −267.40 \times 10^{-26} |
| 3.2H 2 O(g)⇌2H 2 (g)+O 2 (g) \rm 2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g), | K 3 = ~~~~~~{\it K}_3~= | 1.06×10 −10 1.06 \times 10^{-10} |

Express your answer numerically.

1. Determine the equilibrium constant, K goal K_goal, for the reaction

4PCl 5 (g)⇌P 4 (s)+10Cl 2 (g), K goal =? {\rm 4PCl_5(g)\rightleftharpoons P_4(s)+10Cl_2(g)},~~~~K_{\rm goal}=\, ?

by making use of the following information:

1. P 4 (s)+6Cl 2 (g)⇌4PCl 3 (g), K 1 =2.00×10 19 \rm P_4{(s)}+6Cl_2{(g)}\rightleftharpoons 4PCl_3{(g)},~~~~~~~{\it K}_1=2.00\times10^{19}
2. PCl 5 (g)⇌PCl 3 (g)+Cl 2 (g), K 2 =1.13×10 −2 \rm PCl_5{(g)}\rightleftharpoons PCl_3{(g)}+Cl_2{(g)},~~~~~~~{\it K}_2=1.13\times10^{-2}

Express your answer numerically.

1. For the reaction 2A(g)+2B(g)⇌C(g)

K c K_c= 89.2 at a temperature of 303 ∘ C \, ^{\circ}C.

Calculate the value of K p K_p.

Express your answer numerically.

1. For the reaction X(g)+3Y(g)⇌2Z(g) \rm X(g) +3Y(g)\rightleftharpoons 2 Z(g)

K p K_p= 1.35×10−2 at a temperature of 265 ∘ C\, ^{\circ}C

Calculate the value of K c K_c.

Express your answer numerically.

1. Why are pure solids and pure liquids not included in a *K*c expression? Choose from:

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| Pure solids and pure liquids are not reactive enough to be included in an equilibrium expression. |
| Pure solids and pure liquids do not participate in reversible (equilibrium) reactions. |
| Pure solids and pure liquids do not change in volume over the course of a reaction. |
| The concentrations of pure solids and pure liquids do not change during reactions. |

1. Part A :Phosgene (carbonyl chloride), COCl 2 \rm COCl_2, is an extremely toxic gas that is used in manufacturing certain dyes and plastics. Phosgene can be produced by reacting carbon monoxide and chlorine gas at high temperatures:

CO(g)+Cl 2 (g)⇌COCl 2 (g) \rm CO( g)+ Cl_2(g) \rightleftharpoons COCl_{2}(g)

Carbon monoxide and chlorine gas are allowed to react in a sealed vessel at 465 ∘ C \, ^{\circ}\rm C. At equilibrium, the concentrations were measured and the following results obtained:

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| Gas | Partial Pressure  (atm \rm atm) |
| CO \rm CO | 0.740 |
| Cl 2 \rm Cl_2 | 1.14 |
| COCl 2 \rm COCl_2 | 0.150 |

What is the equilibrium constant, K p K_p, of this reaction?

Express your answer numerically.

1. In Part A, you were given the equilibrium pressures, which could be plugged directly into the formula for K K. In Part B however, you will be given initial concentrations and only one equilibrium concentration. You must use this data to find all three equilibrium concentrations before you can apply the formula for K K .

Part B

The following reaction was performed in a sealed vessel at 783 ∘ C \, ^{\circ}\rm C:

H 2 (g)+I 2 (g)⇌2HI(g) \rm H_2(g) + I_2(g) \rightleftharpoons 2 HI(g)

Initially, only H 2 \rm H_2and I 2 \rm I_2were present at concentrations of [H 2 ]=3.20M \rm [H_2]= 3.20<units>\it M</units> 
   and [I 2 ]=2.00M .The equilibrium concentration of I 2\rm I_2is 0.0700M \it M. What is the equilibrium constant, K c K_c, for the reaction at this temperature?

Express your answer numerically.

1. How can *Q*c and *K*c differ from one another despite having the same algebraic expression? Choose from:

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| *Q*c can include pure liquids and solids; *K*c does not. |
| Because the two expressions have different units, they can never be equal unless the proper conversion factor is used. |
| *Q*c is calculated from the current concentrations of the species, while *K*c only uses the equilibrium concentrations. |
| Because *Q*c represents the change from initial to equilibrium conditions, *K*c represents the equilibrium conditions. |

1. A mixture initially contains A, B, and C \rm C in the following concentrations: [A] \rm [A]= 0.700M {\it M}, [B] \rm [B]= 1.05M, and [C] \rm [C]= 0.600M. The following reaction occurs and equilibrium is established:

A+2B⇌C \rm A+2B \rightleftharpoons C

At equilibrium, [A] \rm [A]= 0.580M {\it M}and [C] \rm [C]= 0.720M {\it M}. Calculate the value of the equilibrium constant, K c K_c.

Express your answer numerically.