Review Package: Equilibrium Constant Keq & Calculations

3. Consider the following equilibrium system:

\[ \text{O}_2(g) + 2\text{HF}(g) \rightleftharpoons \text{OF}_2(g) \quad \Delta H = +318 \text{ kJ/mol} \]

If the temperature of the system is increased,

A. $K_{eq}$ will decrease
B. $\Delta H$ will decrease
C. $K_{eq}$ will increase
D. $\Delta H$ will increase

4. Consider the following equilibrium system:

\[ \text{O}_2(g) + 2\text{HF}(g) \rightleftharpoons \text{OF}_2(g) \quad \Delta H = +318 \text{ kJ/mol} \]

After a catalyst has been added to the system

A. $K_{eq}$ cannot now be determined
B. $K_{eq}$ increases
C. $K_{eq}$ remains the same as before
D. $K_{eq}$ decreases

5. Consider the following equilibrium system:

\[ \text{Fe}_2\text{O}_3(s) + 3\text{CO}(g) \rightleftharpoons 2\text{Fe}(s) + 3\text{CO}_2(g) \]

The equilibrium constant expression for the forward reaction is

A. $K = \frac{[\text{CO}_2]^3}{[\text{CO}]^3}$
B. $\frac{[\text{Fe}]^2[\text{CO}_2]^3}{[\text{Fe}_2\text{O}_3][\text{CO}]^3}$
C. $\frac{[\text{Fe}]^2[\text{CO}_2]^3}{[\text{CO}]^3}$
D. $\frac{[\text{CO}_2]^3}{[\text{Fe}_2\text{O}_3][\text{CO}]^3}$
Review Package: Equilibrium Constant Keq & Calculations

6. For which of the following systems at equilibrium will the reaction go most fully to completion?

A. \(2\text{KClO}_3(s) \rightleftharpoons 2\text{KCl}(s) + 3\text{O}_2(g)\) \(K_{eq} = 2.6 \times 10^{40}\)

B. \(\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)\) \(K_{eq} = 9.0\)

C. \(\text{HC}_2\text{H}_3\text{O}_2(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{C}_2\text{H}_3\text{O}_2(aq)\) \(K_{eq} = 1.8 \times 10^{-5}\)

D. \(2\text{HgO}(s) \rightleftharpoons 2\text{Hg}(l) + \text{O}_2(g)\) \(K_{eq} = 3.4 \times 10^{-40}\)

7. Consider the following equilibrium system:

\[\text{N}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}_2(g)\] \(K_{eq} = 3.4 \times 10^{-3}\)

The equilibrium constant expression for the reverse reaction is

A. \(3.4 \times 10^{-6}\)

B. \(3.4 \times 10^{3}\)

C. \(2.9 \times 10^{2}\)

D. \(6.8 \times 10^{-3}\)

8. Consider the following equilibrium system: \(A + B \rightleftharpoons C + D\) \(K_{eq} = 2.50 \times 10^{-7}\)

At the non-equilibrium situation, \([A] = 2.00\ M,\ [B] = 2.00\ M,\ [C] = 1.00\ M\ and\ [D] = 1.00\ M\), the reaction will

A. move to the left

B. move to the right

C. remain unchanged

D. not enough information is available.

9. Calculate the value of the equilibrium constant \(K\) for the equation

\(A \rightleftharpoons B + 3C\)

when equilibrium concentrations are \([A] = 2.00 \times 10^{-4}\ M,\ [B] = 8.00 \times 10^{-3}\ M,\ [C] = 1.00 \times 10^{-4}\ M\).

A. \(2.40 \times 10^{12}\)

B. \(4.00 \times 10^{-11}\)

C. \(4.00 \times 10^{-5}\)

D. \(4.00 \times 10^{-3}\)
10. When initial concentrations \([\text{CO}] = 2.12 \, \text{M} \) and \([\text{O}_2] = 1.10 \, \text{M}\) are heated, an equilibrium is established in which \([\text{CO}_2] = 2.02 \, \text{M}\). If the equation is

\[
2\text{CO} + \text{O}_2 \rightleftharpoons 2\text{CO}_2
\]

\[
K_{eq} = \frac{[\text{CO}_2]^2}{[\text{CO}]^2[\text{O}_2]}
\]

calculate the value of \(K\).

A. \(2.24 \times 10^2\)
B. \(4.53 \times 10^3\)
C. \(8.94 \times 10^{-6}\)
D. \(8.25 \times 10^{-1}\)

12. What is the value of the equilibrium constant, \(K\), for the reaction

\[
\text{A} + \text{B} \rightleftharpoons 2\text{C}
\]

if at equilibrium, \([\text{A}] = 0.0300 \, \text{M}\), \([\text{B}] = 0.0400 \, \text{M}\), and \([\text{C}] = 1.20 \, \text{M}\)?

A. \(8.33 \times 10^{-3}\)
B. \(1.20 \times 10^3\)
C. \(1.00 \times 10^4\)
D. \(2.00 \times 10^4\)

16. Which one of the following statements about a reaction indicates that the products are favoured at equilibrium?

A. The reaction is endothermic.
B. The equilibrium constant is large.
C. The activation energy of the forward reaction is high.
D. The \(\Delta H\) value is large.

17. The \(K_{eq}\) value for the Haber process: \(\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)\)

at a particular temperature and pressure is 75. If the equilibrium \([\text{N}_2]\) is 0.023 \, \text{M} and \([\text{H}_2]\) is 0.078 \, \text{M}, what is the equilibrium \([\text{NH}_3]\)?

A. \(8.2 \times 10^{-4} \, \text{M}\)
B. \(6.7 \times 10^{-7} \, \text{M} \times 4.4 \times 10^{-3} \, \text{M}\)
C. \(0.029 \, \text{M}\)
D. \(0.37 \, \text{M}\)
19. For the equation: \( A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)} + \text{heat} \)

how will the equilibrium constant be affected by a temperature increase?

A. The equilibrium constant increases.
B. The equilibrium constant decreases.
C. The equilibrium constant is unchanged.
D. There are insufficient data to make a prediction.

20. The reaction for the decomposition of hydrogen sulphide gas at high temperatures is

\[
2\text{H}_2\text{S}_{(g)} \rightleftharpoons 2\text{H}_2{_{(g)}} + \text{S}_2{_{(g)}},
\]

What is the \( K_{eq} \) expression for this reaction?

A. \( K_{eq} = \frac{[\text{H}_2][\text{S}_2]}{[\text{H}_2\text{S}]} \)
B. \( K_{eq} = \frac{[\text{H}_2]^2[\text{S}_2]}{[\text{H}_2\text{S}]^2} \)
C. \( K_{eq} = \frac{[\text{H}_2\text{S}]^2}{[\text{H}_2]^2[\text{S}_2]} \)
D. \( K_{eq} = [\text{H}_2]^2[\text{S}_2] \)

25. Consider the following equilibrium system:

\[
\text{CO}_2{_{(g)}} + \text{H}_2{_{(g)}} \rightleftharpoons \text{CO}_2{_{(g)}} + \text{H}_2\text{O}_{(g)}
\]

At equilibrium, \([\text{CO}_2] = 0.648 \text{ mol/L}, [\text{H}_2] = 0.148 \text{ mol/L}, [\text{CO}] = 0.352 \text{ mol/L}, \) and \([\text{H}_2\text{O}] = 0.352 \text{ mol/L}. \) From these data, the \( K_{eq} \) value for the above system is

A. 0.774
B. 1.29
C. 3.07
D. 3.67
26. Given the following equilibrium system:

\[ C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g) \]

The equilibrium constant expression for the above system is

A. \( K_{eq} = [CO][H_2] \)
B. \( K_{eq} = \frac{[CO][H_2]}{[H_2O]} \)
C. \( K_{eq} = \frac{[CO][H_2]}{[H_2O][C]} \)
D. \( K_{eq} = \frac{[H_2O]}{[CO][H_2]} \)

28. Consider the following equilibrium system:

\[ 2HI(g) \rightleftharpoons H_2(g) + I_2(g) \]

An analysis of the above equilibrium system shows that the [reactants] are much larger than the [products]. Which of the following equilibrium constant values would be consistent with these data?

A. -0.040
B. 0.0030
C. 1.0
D. 25

33. Given the following equilibrium system:

\[ Br_2(g) \rightleftharpoons Br_2(l) \]

The equilibrium constant expression for the above system is:

A. \( K_{eq} = \frac{[Br_2(l)]}{[Br_2(g)]} \)
B. \( K_{eq} = [Br_2(g)] \)
C. \( K_{eq} = \frac{1}{[Br_2(g)]} \)
D. \( K_{eq} = [Br_2(g)][Br_2(g)] \)
34. Consider the following equilibrium system:

\[ \text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g) \]

The percent of I\(_2\) (by volume) is determined in the above equilibrium at four different temperatures. The results are displayed in the following pie graphs:

![Pie charts showing percent of I\(_2\) at different temperatures.]

From this data, the K\(_{eq}\) value for the above equilibrium is largest at temperature

A. I.
B. II.
C. III.
D. IV.

35. Consider the following equilibrium system:

\[ 2\text{NO}(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}_2(g) \]

At equilibrium, [NO] = 0.600 M, [O\(_2\)] = 0.800 M and [NO\(_2\)] = 4.40 M. From these data, the K\(_{eq}\) value for the above system is

A. 0.105
B. 9.17
C. 40.3
D. 67.2
36. Consider the following equilibrium system:

\[ 2\text{NO}(g) + \text{Cl}_2(g) \rightleftharpoons 2\text{NOCl}(g) \]

0.80 moles of NO and 0.60 moles of Cl\(_2\) are placed into a 1.0 L container and allowed to establish equilibrium. At equilibrium, [NOCl] = 0.56 mol/L. The equilibrium [Cl\(_2\)] is

A. 0.28 mol/L  
B. 0.32 mol/L  
C. 0.40 mol/L  
D. 0.60 mol/L

41. Which of the following systems most favours products at equilibrium?

A. \(2\text{NO}(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}_2(g)\)  \(K_{eq} = 1.55 \times 10^{-6}\)  
B. \(\text{H}_2(g) + \text{Cl}_2(g) \rightleftharpoons 2\text{HCl}(g)\)  \(K_{eq} = 1.80 \times 10^8\)  
C. \(\text{CO}(g) + \text{Cl}_2(g) \rightleftharpoons \text{COCl}_2(g)\)  \(K_{eq} = 8.20 \times 10^{-1}\)  
D. \(2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)\)  \(K_{eq} = 2.61 \times 10^2\)

42. When air is drawn into a car’s engine, the following endothermic reaction occurs:

\[ \text{N}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}(g) \]

At room temperature the \(K_{eq}\) for this reaction is \(4.8 \times 10^{-31}\). At the high temperatures found in a car’s engine the

A. [NO] increases and the \(K_{eq}\) increases.  
B. [NO] increases and the \(K_{eq}\) decreases.  
C. [NO] decreases and the \(K_{eq}\) increases.  
D. [NO] decreases and the \(K_{eq}\) decreases.

43. Consider the following equilibrium:

\[ \text{H}_2(g) + \text{Br}_2(g) \rightleftharpoons 2\text{HBr}(g) \quad K_{eq} = 1.02 \]

Equal moles of H\(_2\) and Br\(_2\) were placed in a flask and at equilibrium the [HBr] was 0.500 mol/L. The equilibrium concentration of H\(_2(g)\) was

A. 0.123 mol/L  
B. 0.245 mol/L  
C. 0.495 mol/L  
D. 0.700 mol/L
44. Consider the following reaction:

\[ 2O_3(g) \rightleftharpoons 3O_2(g) \quad K_{eq} = 55 \]

If 0.050 mol of O\(_3\) and 0.70 mol of O\(_2\) are introduced into a 1.0 L vessel, the

A. \( K_{trial} > K_{eq} \) and the \([O_2]\) increases.
B. \( K_{trial} < K_{eq} \) and the \([O_2]\) increases.
C. \( K_{trial} > K_{eq} \) and the \([O_2]\) decreases.
D. \( K_{trial} < K_{eq} \) and the \([O_2]\) decreases.

49. Consider the following equilibrium constant expression

\[ K_{eq} = [CO_2] \]

Which one of the following equilibrium systems does the above expression represent?

A. \( CO_2(g) \rightleftharpoons CO_2(s) \)
B. \( PbO(s) + CO_2(g) \rightleftharpoons PbCO_3(s) \)
C. \( CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g) \)
D. \( H_2CO_3(aq) \rightleftharpoons H_2O(l) + CO_2(aq) \)

50. Hydrogen gas dissociates into atomic hydrogen as follows:

\[ H_2(g) \rightleftharpoons 2H(g) \quad K_{eq} = 1.2 \times 10^{-71} \]

The value of the equilibrium constant for the above system indicates that

A. the reaction rate is very slow.
B. the equilibrium is exothermic.
C. reactants are favoured at equilibrium.
D. a catalyst is necessary to establish equilibrium.
Review Package: Equilibrium Constant KEq & Calculations

51. Consider the following equilibrium system:

\[ \text{CO}_{(g)} + \text{Cl}_{2(g)} \rightleftharpoons \text{COCl}_{2(g)} \]

At equilibrium, a 2.0 litre sample was found to contain 1.00 mol CO, 0.500 mol Cl₂ and 0.100 mol COCl₂. The KEq value for the above system is

A. 0.40  
B. 0.20  
C. 2.5   
D. 5.0

52. Consider the following equilibrium system:

\[ 2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)} \quad \text{KEq} = 4.0 \]

In an experiment, 0.40 mol SO₂(g), 0.20 mol O₂(g) and 0.20 mol SO₃(g) are placed into a 1.0 litre container. Which of the following statements relates the changes in [SO₂] and [O₂] as the equilibrium becomes established?

A. The [SO₂] and [O₂] increase.  
B. the [SO₂] and [O₂] decrease.  
C. The [SO₂] and [O₂] do not change.  

57. Consider the following equilibrium system:

\[ \text{SnO}_{2(s)} + 2\text{CO}_{(g)} \rightleftharpoons \text{Sn}_{(s)} + 2\text{CO}_{2(g)} \]

The equilibrium constant expression for the above system is

A. KEq = \( \frac{[\text{CO}_2]^2}{[\text{CO}]^2} \)  
B. KEq = \( \frac{[2\text{CO}_2]^2}{[2\text{CO}]^2} \)  
C. KEq = \( \frac{[\text{CO}_2]^2 [\text{Sn}]}{[\text{CO}]^2 [\text{SnO}_2]} \)  
D. KEq = \( \frac{[2\text{CO}_2]^2 [\text{Sn}]}{[2\text{CO}]^2 [\text{SnO}_2]} \)
Review Package: Equilibrium Constant Keq & Calculations

58. An equal number of moles of I2(g) and Br2(g) are placed into a closed container and allowed to establish the following equilibrium:

\[ \text{I}_2(g) + \text{Br}_2(g) \rightleftharpoons 2\text{IBr}(g) \quad K_{eq} = 280 \]

Which one of the following relates [IBr] to [I2] at equilibrium?

A. \([\text{I}_2] = [\text{IBr}]\)
B. \([\text{I}_2] < [\text{IBr}]\)
C. \([\text{I}_2] = 2[\text{IBr}]\)
D. \([\text{I}_2] = 280[\text{IBr}]\)

59. Consider the following equilibrium

\[ 2\text{NO}(g) + \text{O}_2(g) \rightleftharpoons 2\text{NO}_2(g) \quad K_{eq} = 65 \]

At equilibrium, the [NO] = 0.600 M and the [O2] = 0.300 M. Using this data, the equilibrium [NO2] is

A. 7.0 M
B. 3.4 M
C. 2.6 M
D. 0.60 M

60. Consider the following equilibrium system:

\[ \text{CO}_2(g) + \text{H}_2(g) \rightleftharpoons \text{CO}(g) + \text{H}_2\text{O}(g) \]

1.00 mole of CO2(g) and 2.0 moles of H2(g) are placed into a 2.00 litre container. At equilibrium, the [CO] = 0.31 mol/L. Based on this data, the equilibrium [CO2] is

A. 0.19 M
B. 0.31 M
C. 0.38 M
D. 0.69 M
For the remainder of the questions, marks will be awarded as shown. Your steps and assumptions leading to a solution must be shown. In questions involving calculations, full marks will not be given for providing only an answer. Students will be expected to communicate the knowledge and understanding of chemical principles in a clear and logical manner.

1. For the reaction, \( \text{H}_2 (g) + \text{I}_2 (g) \rightleftharpoons 2 \text{HI} (g) \), the equilibrium constant is 49. If the initial \([\text{H}_2] = 5.0 \times 10^{-2} \text{ M}\) and the initial \([\text{I}_2] = 5.0 \times 10^{-2} \text{ M}\), find the equilibrium concentration of HI. (4 marks)

2. 1.0 mol of \( \text{NH}_3 (g) \) was introduced into a 1.0 L flask and allowed to come to equilibrium. At equilibrium, analysis indicated that 0.60 mol of hydrogen had been produced. Calculate the equilibrium constant for the reaction given the equation below : (4 marks)

\[
2 \text{NH}_3 (g) \rightleftharpoons \text{N}_2 (g) + 3 \text{H}_2 (g)
\]

3. \( K_{eq} = 798 \) for the reaction \( 2 \text{SO}_2 (g) + \text{O}_2 (g) \rightleftharpoons 2 \text{SO}_3 (g) \)
In a particular mixture at equilibrium, \([\text{SO}_2] = 4.20 \text{ M}\) and \([\text{SO}_3] = 11.0 \text{ M}\). Calculate the equilibrium \([\text{O}_2]\) in this mixture. (3 marks)

4. \( K_{eq} = 0.0183 \) for the reaction \( 2 \text{HI} (g) \rightleftharpoons \text{H}_2 (g) + \text{I}_2 (g) \)
If 3.00 mol of HI is placed in a 5.00 L vessel and allowed to reach equilibrium, what is the equilibrium concentration of \( \text{H}_2 \)? (4 marks)

5. \( \text{SO}_3 (g) + \text{NO} (g) \rightleftharpoons \text{NO}_2 (g) + \text{SO}_2 (g) \)
The value of \( K_{eq} \) for the above mixture is 0.800. A particular reaction mixture has the following concentrations:
- \([\text{SO}_3] = 0.400 \text{ M}\)
- \([\text{NO}] = 0.480 \text{ M}\)
- \([\text{NO}_2] = 0.600 \text{ M}\)
- \([\text{SO}_2] = 0.450 \text{ M}\)
   a) Show, by calculation, that this mixture is not at equilibrium. (2 marks)
   b) What will happen to the concentration of \( \text{SO}_3 \) and \( \text{SO}_2 \) as the system moves towards equilibrium? (1 mark)

7. Consider the following reaction:
   \( 2 \text{NO} (g) + \text{Br}_2 (g) \rightleftharpoons 2 \text{NOBr} (g) \)
When 0.30 mol of NO and 0.30 mol of \( \text{Br}_2 \) are placed in a 1.0 L container, it is found that the equilibrium \([\text{NOBr}] = 0.20 \text{ M}\). Calculate the value of \( K_{eq} \). (3 marks)

9. When 1.00 mol of HBr is placed in a 1.00 L flask at 510°C, the following equilibrium is achieved:
   \( 2 \text{HBr} (g) \rightleftharpoons \text{H}_2 (g) + \text{Br}_2 (g) \)
At equilibrium, 0.14 mol of \( \text{H}_2 \) is present. Calculate the value of \( K_{eq} \). (3 marks)

10. \( 2 \text{NO}_2 (g) + \text{Cl}_2 (g) \rightleftharpoons 2 \text{NO}_2 \text{Cl} (g) \)
Initially, 0.600 mol of \( \text{NO}_2 \) and 0.800 mol of \( \text{Cl}_2 \) are placed in a 2.00 L container. At equilibrium, the \([\text{NO}_2 \text{Cl}]\) is found to be 0.200 M. Calculate the value of \( K_{eq} \). (4 marks)
Review Package: Equilibrium Constant Keq & Calculations

12. \[ 2 \text{HBr} (g) \rightleftharpoons \text{H}_2 (g) + \text{Br}_2 (g) \]
    
    \( K_{eq} \) for the above reaction is 1.47 at 32\(^{\circ}\)C. 2.0 mol of HBr are placed in a 1.0 L vessel and the system is allowed to achieve equilibrium. Calculate the equilibrium \([\text{H}_2]\). (4 marks)

13. Consider the following equilibrium system:
    \[ \text{NH}_4\text{Cl(s)} \rightleftharpoons \text{NH}_3(g) + \text{HCl(g)} \]
    
    \( K_{eq} = 0.45 \) at 250\(^{\circ}\)C 
    
    Calculate the equilibrium concentration of NH\(_3\) when an excess of NH\(_4\)Cl is placed in a container at 250\(^{\circ}\)C and allowed to reach equilibrium. (2 marks)

15. Consider the following equilibrium:
    \[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \]

    When 0.600 mole of SO\(_2\) and 0.600 mole of O\(_2\) are placed into a 1.00 litre container and allowed to establish equilibrium, the equilibrium \([\text{SO}_3]\) is found to be 0.500 M. Calculate the \(K_{eq}\) value. (3 marks)

17. Consider the following equilibrium system:
    \[ 2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g) \]
    
    \( K_{eq} = 75 \)
    
    A student places 0.40 moles of SO\(_2\), 0.050 moles of O\(_2\) and 0.80 moles of SO\(_3\) into a 1.00 litre sealed flask. The students predicts that the \([\text{SO}_2]\) will decrease as the equilibrium is established. Do you agree with the student’s prediction? Explain, using appropriate calculations. (3 marks)

19. 0.400 mol of H\(_2\) and 0.200 mol of I\(_2\) were placed in a 2.00 L flask and allowed to reach equilibrium according to the reaction:
    \[ \text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g) \]

    At equilibrium the concentration of HI was 0.150 mol/L. Calculate the equilibrium constant value. (3 marks)

21. Consider the following equilibrium system:
    \[ \text{PCl}_3(g) + \text{Cl}_2(g) \rightleftharpoons \text{PCl}_5(g) \]

    At 250\(^{\circ}\)C, 0.40 mol of PCl\(_3\) and 0.60 mol of Cl\(_2\) are placed into a 1.0 L container. At equilibrium, the \([\text{PCl}_5]\) = 0.11 mol/L. Calculate the value of \(K_{eq}\). (3 marks)
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ANSWER KEY

MULTIPLE CHOICE

12. B  27. C  42. A  57. A
15. D  30. A  45. D  60. A

WRITTEN RESPONSE

1. 0.078 M
2. $K_{eq} = 0.12$
3. $8.60 \times 10^{-3} \text{ M}$
4. 0.0639 M
5. a) $K_{\text{trial}} = 1.4$ This does not equal $K_{eq}$ therefore the system is not at equilibrium.
b) Because $K_{\text{trial}} > K_{eq}$, the system will shift to the left so $[\text{SO}_3]$ will increase and $[\text{SO}_2]$ will decrease.
7. 20
9. $3.8 \times 10^{-2}$
10. 13.3
12. 0.71 mol/L
13. $K_{eq} = [\text{NH}_3][\text{HCl}] \frac{1}{2}$ mark \[\text{let } x = [\text{NH}_3]_{eq} = [\text{HCl}]_{eq} \frac{1}{2} \text{ mark}\]
\[0.45 = x^2 \frac{1}{2} \text{ mark}\]
\[0.67 = x = [\text{NH}_3] \frac{1}{2} \text{ mark}\]
Review Package: Equilibrium Constant Keq & Calculations

15. \[2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)\]

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\[K_{eq} = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} \quad (1/2 \text{ mark})\]

\[K_{eq} = \frac{(0.500)^2}{(0.100)^2(0.350)} = 71.4 \quad (1 \text{ mark; } 1/2 \text{ for substituting, } 1/2 \text{ for ans})\]

17. Trial \(K_{eq} = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} \quad (1 \text{ mark})\)

\[= \frac{0.80^2}{(0.40)^2(0.050)} = 80 \quad (1 \text{ mark})\]

Disagree because Trial \(K_{eq} > K_{eq}\) so the system will shift left to establish equilibrium and \([\text{SO}_2]\) will increase. \((1 \frac{1}{2} \text{ marks})\)

19. \([\text{H}_2] = 0.400 \text{ mol}/2.00 \text{ L} = 0.200 \text{ M}\) \((1/2 \text{ mark})\)

\([\text{I}_2] = 0.200 \text{ mol}/2.00 \text{ L} = 0.100 \text{ M}\) \((1/2 \text{ mark})\)

\[K_{eq} = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} \quad (1/2 \text{ mark})\]

\[= \frac{(0.150)^2}{(0.200)(0.100)} = 1.125 = 1.12 \quad (1 \text{ mark; } 1/2 \text{ for incorrect sig figs; } 1/2 \text{ for incorrect rounding})\]
Review Package: Equilibrium Constant Keq & Calculations

21. \[ \text{PCl}_3(g) + \text{Cl}_2(g) \rightleftharpoons \text{PCl}_5(g) \]

\[
\begin{array}{ccc}
\text{I} & 0.40 & 0.60 & 0.00 \\
\text{C} & -0.11 & -0.11 & +0.11 \\
\text{E} & 0.29 & 0.49 & 0.11 \\
\end{array}
\]

(1 ½ marks)

\[ K_{eq} = \frac{[\text{PCl}_5]}{[\text{PCl}_3][\text{Cl}_2]} \]  

(1/2 mark)

\[ = \frac{(0.11)}{(0.29)(0.49)} \]  

(1/2 mark)

\[ = 0.77 \]  

(1/2 mark)