

Determination of Equilibrium Constant

Spoken Tutorial Project

<http://spoken-tutorial.org>

National Mission on Education through ICT

<http://sakshat.ac.in>

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Learning Objectives



Learning Objectives

We will learn,



Learning Objectives

We will learn,

- ▶ **To determine equilibrium constant for cobalt chloride reaction**



Learning Objectives

We will learn,

- ▶ To determine **equilibrium constant** for cobalt chloride reaction
- ▶ Observe the effect of change in temperature and concentration on equilibrium



Pre-requisites



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- ▶ ChemCollective Vlabs interface



Pre-requisites

- ▶ **ChemCollective Vlabs interface**
- ▶ **If not for relevant tutorials please visit our website**
www.spoken-tutorial.org



System Requirement



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▶ Mac OS v 10.10.5



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- ▶ **Mac OS v 10.10.5**
- ▶ **ChemCollective Vlabs v 2.1.03**



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- ▶ **Mac OS v 10.10.5**
- ▶ **ChemCollective Vlabs v 2.1.03**
- ▶ **Java v 8**



Chemical Equilibrium



Chemical Equilibrium

- ▶ **Chemical equilibrium** is a state of the reversible reaction when two opposing reactions occur at the same rate



Chemical Equilibrium

- ▶ **Chemical equilibrium** is a state of the reversible reaction when two opposing reactions occur at the same rate
- ▶ **Concentration of reactants and products do not change with time at equilibrium**



Chemical Equilibrium: Equations



Chemical Equilibrium: Equations

General Equilibrium Reaction



Equilibrium Constant Equation

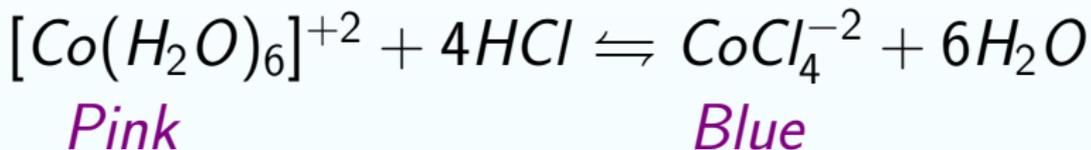
$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$



Equilibrium Constant Equation



Equilibrium Constant Equation



Equilibrium Constant Equation

$$K_c = \frac{[\text{CoCl}_4^{-2}]}{[\text{Co}(\text{H}_2\text{O})_6^{+2}][\text{Cl}^-]^4}$$



Factors Affecting Equilibrium Constant



Factors Affecting Equilibrium Constant

Equilibrium constant changes with,



Factors Affecting Equilibrium Constant

Equilibrium constant changes with,

- ▶ **Change in concentration of reactants/products**



Factors Affecting Equilibrium Constant

Equilibrium constant changes with,

- ▶ Change in concentration of reactants/products
- ▶ Change in temperature



Calculation of Equilibrium Constant



Calculation of Equilibrium Constant

$$[\text{CoCl}_4^{-2}] = 0.208 \text{ mol/L}$$

$$[\text{Co}(\text{H}_2\text{O})_6^{+2}] = 0.574 \text{ mol/L}$$

$$[\text{Cl}^-] = 3.36 \text{ mol/L}$$

$$K_c = \frac{[\text{CoCl}_4^{-2}]}{[\text{Co}(\text{H}_2\text{O})_6^{+2}][\text{Cl}^-]^4}$$

$$K_c = \frac{0.208}{0.574 \times (3.36)^4}$$

$$K_c = 2.84 \times 10^{-3}$$



Equilibrium Constant Values



Equilibrium Constant Values

S. No	Vol of HCl (mL)	[CoCl ₄ ⁻²] (mol/L)	[Co(H ₂ O) ₆ ⁺²] (mol/L)	[Cl ⁻] (mol/L)	K _c
1	7	0.208	0.574	3.36	2.84x10 ⁻³
2	15	0.328	0.297	4.44	2.84x10 ⁻³
3	18	0.349	0.232	4.79	2.85x10 ⁻³
4	23	0.364	0.157	5.34	2.85x10 ⁻³



Le Chatelier Principle



Le Chatelier Principle

Le Chatelier's Principle states that,

- ▶ If an equilibrium is disturbed by changing the conditions, position of equilibrium moves to counteract the change



Le Chatelier Principle



Le Chatelier Principle

- ▶ According to the principle, for endothermic reactions, rate of forward reaction increases with increase in temperature



Effect of Temperature on K_c



Effect of Temperature on K_c

$$[CoCl_4^{-2}] = 0.447 \text{ mol/L}$$

$$[Co(H_2O)_6^{+2}] = 0.074 \text{ mol/L}$$

$$[Cl^-] = 5.00 \text{ mol/L}$$

$$K_c = \frac{[CoCl_4^{-2}]}{[Co(H_2O)_6^{+2}] \times [Cl^-]^4}$$

$$K_c = \frac{0.447}{0.074 \times (5.00)^4} = 9.65 \times 10^{-3}$$



Comparison of Equilibrium Constants



Comparison of Equilibrium Constants

$$K_c \text{ at } 35^{\circ}C = 9.65 \times 10^{-3}$$

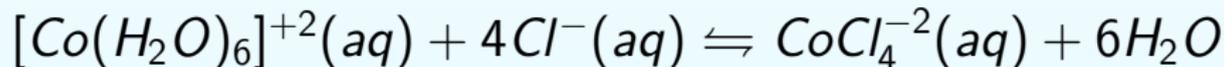
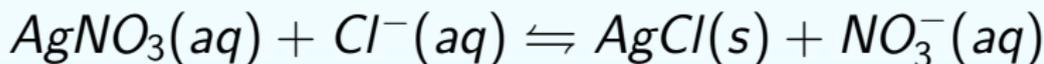
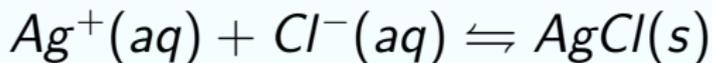
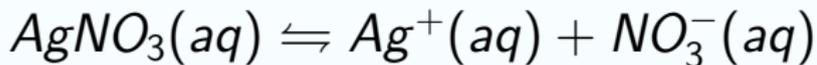
$$K_c \text{ at } 25^{\circ}C = 2.85 \times 10^{-3}$$



Chemical Equilibrium: Equations



Chemical Equilibrium: Equations



Summary



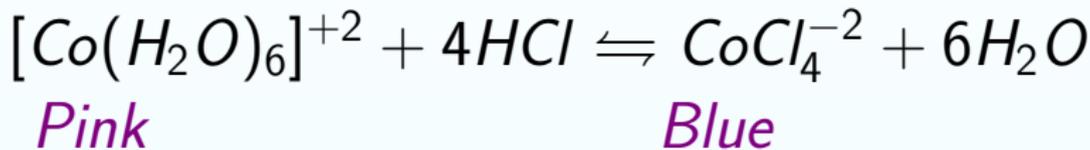
Summary

We have learnt,

- ▶ To determine **equilibrium constant** for cobalt chloride reaction
- ▶ Observe the effect of change in temperature and concentration on equilibrium



Assignment 1



1. Prepare a solution by adding 25 mL of CoCl_2 solution and 23 mL of HCl
2. Add 40 mL of water in 10 mL increments to the prepared solution



Assignment II

3. Observe the color in the flask
4. Calculate **equilibrium constant** before and after addition of water



About the Spoken Tutorial Project

- ▶ Watch the video available at http://spoken-tutorial.org/What_is_a_Spoken_Tutorial
- ▶ It summarises the Spoken Tutorial project
- ▶ If you do not have good bandwidth, you can download and watch it



Spoken Tutorial Workshops

The Spoken Tutorial Project Team

- ▶ Conducts workshops using spoken tutorials
- ▶ Gives certificates to those who pass an online test
- ▶ For more details, please write to contact@spoken-tutorial.org



Forum for specific questions

- ▶ Do you have questions in THIS Spoken Tutorial?
- ▶ Please visit <http://forums.spoken-tutorial.org>
- ▶ Choose the minute and second where you have the question
- ▶ Explain your question briefly
- ▶ Someone from our team will answer them



Acknowledgements

- ▶ **Spoken Tutorial Project is a part of the Talk to a Teacher project**
- ▶ **It is supported by the National Mission on Education through ICT, MHRD, Government of India**
- ▶ **More information on this Mission is available at**

[http://spoken-tutorial.org /NMEICT-Intro](http://spoken-tutorial.org/NMEICT-Intro)

