07
CHEMICAL EQUILIBRIUM

EFFECT OF TEMPERATURE: CO(II) COMPLEXES

CHEMISTRY 136L // FALL 2019

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GIBBS FREE ENERGY

Chemical Equilibrium

A spontaneous process is one that takes place without (continuous) input of energy.

ΔG – change in Gibbs free energy

The maximum amount of energy (in the form of work) that can be extracted from a reaction/system.

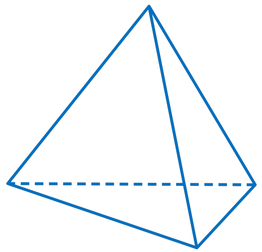
REACTION OF INTEREST

Co(II) complex

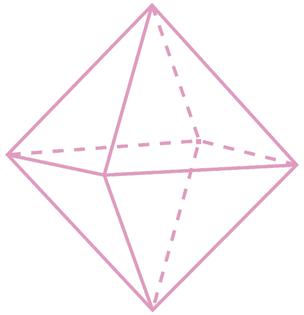
Our focus today is the following equilibrium:

$$\mathbf{CoCl_2(iprop)_2} + \mathbf{4\ H_2O} \rightleftharpoons \mathbf{[Co(iprop)_2(H_2O)_4]^{2+}} + \mathbf{2\ Cl^-}$$

Tetrahedral



Octahedral

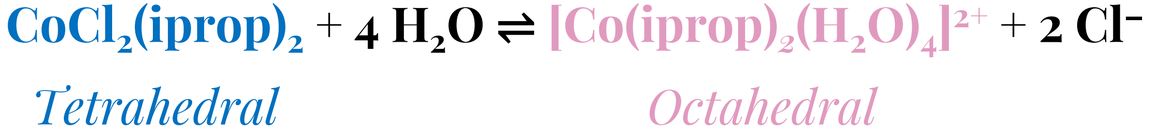


$$K = \frac{[\{Co(iprop)_2(H_2O)_4\}^{2+}][Cl^-]^2}{[CoCl_2(iprop)_2][H_2O]^4}$$

Solvent is isopropanol (iprop)

PURPOSES

Temperature dependence



Dependence of K on temperature

Determination of $\Delta H°$ and $\Delta S°$

EQUILIBRIUM CONSTANT & TEMPERATURE

General ideas

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

Gibbs Relation

$$\Delta G^\circ = -RT \ln \mathrm{K}$$

Van't Hoff Equation

Plot of ln (K) vs. 1/T is expected to be linear

$$\ln \mathrm{K} = -\frac{\Delta H^\circ}{R} \cdot \frac{1}{T} + \frac{\Delta S^\circ}{R}$$

$$\text{slope} = -\frac{\Delta H^\circ}{R}$$

$$y - \text{intercept} = \frac{\Delta S^\circ}{R}$$

Notes

Calibrate thermometer with melting point of ice

Record three values.

Try to measure absorbance and temperature simultaneously.

Place temperature probe in cuvette only ~1 cm deep!

Do not heat solution above 50 °C.

Data collection duration	600 seconds
Sampling rate	1 sample/second
Collect data between	~45 °C → 35 °C

Need two runs.