Determination of K_{eq} for $FeSCN^{2+}$

Inquiry Guidance and AP* Chemistry Curriculum Alignment

Introduction

The equilibrium constant gets its name from the fact that for any reversible chemical reaction, the value of K_{eq} is a constant at a particular temperature. The concentrations of reactants and products at equilibrium will vary, depending on the initial amounts of materials present. The special ratio of reactants and products described by K_{eq} is always the same, however, as long as the system has reached equilibrium and the temperature does not change. The value of K_{eq} can be calculated if the concentrations of reactants and products at equilibrium are known.

Opportunities for Inquiry

Determining the value of K_{eq} for a reaction reinforces and integrates understanding of key learning objectives, from equilibrium and reversible reactions to colorimetric analysis.

Transition the classic AP chemistry experiment to a guided-inquiry experiment with some of the following approaches, which will improve student preparation, increase engagement, and encourage ownership of the lab results.

- Introduce the lab by demonstrating the general complex-ion reaction of Fe^{3+} and SCN^{-} ions in acidic solution. Guide students to design a spectroscopic experiment for determining the equilisium constant by asking leading questions. What information (data) is needed to calculate the equilibrium constant for a substance? Using LeChâtelier's principle, ask students to predict the general concentrations of Fe^{3+} and SCN^{-} ions needed to ensure that all SCN^{-} ions have been converted to the complex ion $FeSCN^{2+}$. They should then design a calibration procedure to measure absorbance vs. concentration for several known concentrations of $FeSCN^{2+}$.
- How can the calibration curve determined above be used to find the $[FeSCN^{2+}]$ in a solution containing both reactants and products? If $[FeSCN^{2+}]$ is measured spectroscopically, and the initial concentrations of Fe^{3+} and SCN^{-} are known, design an experiment to determine K_{eq}. Choose the independent and dependent variable for the experiment and describe the variables that should be kept constant during the experiment. Students could also discuss variables or other factors that will affect the accuracy of the results and how these may be controlled.
- After the students have determined a value of K_{eq}, challenge the students to create a solution of a specific absorbance. Students must work backwards from Beer's law to determine the desired concentration of $FeSCN^{2+}$ and then use the equilibrium expression to calculate the initial amounts of Fe^{3+} and SCN^{-} required.

Alignment with AP Chemistry Curriculum Framework—Big Ideas 1 and 6

Enduring Understanding and Essential Knowledge

Atoms are so small that they are difficult to study directly; atomic models are constructed to explain experimental data on collections of data. (Enduring Understanding 1D)

1D3: The interaction of electromagnetic waves or light with matter is a powerful means to probe the structure of atoms and molecules, and to measure their concentration.

Chemical equilibrium is a dynamic, reversible state in which rates of opposing processes are equal. (Enduring Understanding 6A)

6A4: The magnitude of the equilibrium constant, K, can be used to determine whether the equilibrium lies toward the reactant side or product side.

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Systems at equilibrium are responsive to external perturbations, with the response leading to a change in the composition of the system. (Enduring Understanding 6B)

6B1: Systems at equilibrium respond to disturbances by partially countering the effect of the disturbance (LeChâtelier's principle).

6B2: A disturbance to a system at equilibrium causes Q to differ from K, thereby taking the system out of the original equilibrium state. The system responds by bringing Q into agreement with K, thereby establishing a new equilibrium state.

Learning Objectives

1.16 The student can design and/or interpret the results of an experiment regarding the absorption of light to determine the concentration of an absorbing species in a solution.

6.9 The student is able to use LeChâtelier's principle to design a set of conditions that will optimize a desired outcome, such as product yield.

Science Practices

2.2 The student can apply mathematical routines to quantities that describe natural phenomena.

4.3 The student can collect data to answer a particular scientific question.

5.1 The student can analyze data to identify patterns or relationships.

6.1 The student can justify claims with evidence.

The *Determination of* K_{eq} *for* $FeSCN^{2+}$*—AP Chemistry Classic Laboratory Kit* is available from Flinn Scientific, Inc.

Catalog No.	Description
AP6352	The Determination of K_{eq} for $FeSCN^{2+}$—AP Chemistry Classic Laboratory Kit

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