

Teacher Guide Information for Activities

Shifting Reactions A Activity

The primary goal for the Shifting Reactions A activity is to provide students with an introduction to a chemical reaction modeled at the microscopic level. Students know about chemical reactions and have used the coefficients to perform stoichiometry calculations. In those reactions there was always a limiting reagent and an excess reagent. We call such reaction irreversible reactions. Although we have not discussed it, such reactions that are used in stoichiometry are assumed to have very large equilibrium constants. Under such circumstances the reaction goes completely. In this activity the student discovers that not all reactions go to completion. Such reactions are identified as reversible reactions. In the activity the student is introduced to three characteristics of reversible reactions: i) at the microscopic level the reaction goes in both directions, left to right and right to left; ii) the reaction continuously occurs; iii) there are amounts of all species present, i.e. no reactant ever has zero amount. To assess the difference two microscopic reactions are explored by the student to assign reversibility or irreversibility character.

Shifting Reactions B Activity

One of several goals of the Shifting Reactions B activity is to introduce or re-introduce the use of ICE tables to organize Initial, Change and Ending amounts of reactants and products in a reversible reaction. Another goal is to perform a set of experiments and collect Initial and Ending amounts and calculate Change amounts to discover that the ratio of the amounts in the Change row correspond to the coefficients of the reactants and products in the balance chemical equation. Other terms that are introduced to describe result in this activity are stress, and reaction shift. Students must summarize all the stresses and shifts observed into a statement. The statement would correspond to Le Chatelier's principle, however, without the reference to the term equilibrium. That term is introduced in the follow up activity titled Extent of a Reaction. At the end of this activity one type of common equilibrium problem is given to the student to answer.

Extent of a Reaction Activity

The primary goal of the Extent of a Reaction activity is to invent the equilibrium constant and the equilibrium expression from data similar to the data collected in the Shifting Reactions B activity. The same reversible reaction is investigated, and ICE tables are used to organize the Initial, Change and Ending amounts. The Initial amounts that are used in this series of experiments have been selected to try to get the students to make predictions about the Ending amounts.

Students are not expected to correctly predict the Ending amount in Experiment #1. To make a correct prediction would most likely mean that student knows the main goal of the experiment. There are several important points for making a prediction. 1) most students despite the previous two activities will make a prediction based on an irreversible reaction (see Prediction P1 in Slide 3); 2) hopefully one or more predictions will reflect a reversible reaction (that all species has an Ending amount); 3) the prediction of the Ending amount will reflect a correct ratio of Change amounts (see Prediction P1 - 3, while P4 does not have reasonable Change amounts).

The expectation is no one will correctly predict the Ending amounts for Experiment #1. That is OK. However, after playing the movie for Experiment #1 they see the result. Now in Experiment #2 the Initial amounts are exactly half the Initial amounts in Experiment #1. Hopefully, students will make that connection and their prediction for the Ending amounts for Experiment #2 will be exactly correct. This should work for Experiment #3 also. Experiments #4 - #6 are a little more difficult to make predictions. Once all of the experiments have been completed students are asked to summarize all of the Ending amounts for the six experiments. Students are then challenged to develop a mathematical expression that when using the Ending amounts from each set of experiments produces a constant value, or close to a constant value. Some direction on how to arrive at the mathematical expression is provided.

NOTE to self: remind teachers that given the initial amount and the amount reacting, or percent ionization to calculate all the equilibrium amounts and the value of K it is important NOT to

neglect x (the amount reacting) compared to the initial amount of reactant. Students must subtract x from the initial amount.