COMPILATION: Stoichiometry BCA Tables, vs ICE tables

Date: Sun, 13 May 2018
From: James Smith
Subject: Stoichiometry BCA Tables
As I am setting up my plan to teach the Stoichiometry Unit, I read in the Notes that the plan of using "**Before, Change and After" Tables (BCA)** is excellent to get students used to using ICE tables when one teaches equilibrium. I'm thinking, why make students go through a terminology change? Why don't we all them ICE tables right from Stoichiometry? Thoughts?

Date: Mon, 14 May 2018
From: Brenda Royce, a Modeling Workshop leader and curriculum developer

The term ICE stands for "Initial, Change, Equilibrium" which does not fully apply to simple stoichiometry. I would think the name difference would help students distinguish between the two distinct situations.

The common line of "Change" is identical in meaning in both - the reaction ratio applied to the actual quantities that change in this setting. My students rather naturally call the measured values "before" and "after" for a reaction without my prompting. I deliberately build on this in introducing the BCA table (after starting the Nail Lab) by having them consider the data they are collecting. They label the masses as "before" and "after", and we discuss how we know the amounts that react that we can't measure directly. This leads to needing to describe the observed "before" and "after" measurements, and the desired "change" amounts that must follow the reaction ratio.

In equilibrium, we're interested in the equilibrium state, which differs from the initial amounts by the amounts that change (according to the reaction ratio) as the system comes to equilibrium. The foundation from the BCA tables makes this more conceptually accessible when we start introducing variables into the change line.

Date: Mon, 14 May 2018
From: Mitchell Sweet, a Modeling Workshop leader

There are two reasons that spring to mind on why we would want to use the BCA terminology. First, the reactions that we deal with in a first year class are pretty much all quantitative reactions, so calling them equilibrium reactions would likely be confusing. Secondly, many students taking a first year Chemistry course will not take a second year course and as such will not get into equilibrium reactions.

That being said, the Modeling police will not show up at your school if you choose to use ICE terminology for both stoichiometry and equilibrium if you determine it would make sense for your particular group of students.

Date: Mon, 14 May 2018
From: Phil Root, a Modeling Workshop leader

I would like to echo my colleagues that I feel there is validity in using both "BCA" and "ICE" tables. As Mitch pointed out, the BCA table is for a model of quantitative (limiting reactant) situations. These are typical of a first year course in which a chemical change is in an open

system or equilibrium effectively favors the product to the extent that we observe "no" remaining reactant.

In a second year course, we look at closed systems in which not "all" of the reactant is used up, but only "some". This type of ICE analysis helps us construct a model in which there is also "some" of everything left at the observed "end" of the reaction. In reality, that "some" is the necessary concentration for the reaction to continue in an equilibrium state.

The next piece I would like to add is that maintaining two types of tables and lines of reasoning is very beneficial when considering acid-base chemistry. Neutralization reactions are effectively quantitative, and so using a BCA analysis is helpful when analyzing that step of, say, a titration. The equilibrium that is established after the 'consumption' of added acid or base can then be analyzed using an ICE analysis. So for titrations and buffers, asking the question of whether the reaction is quantitative or not, and whether to use a BCA analysis or an ICE analysis can be very effective to help with typically challenging phenomena.

I really love this topic and would be willing to discuss with anyone further, and to share, receive, or trade other ideas!

May 15, 2018

From: Larry Dukerich, a Modeling Workshop leader and curriculum development team leader.

James Smith asked why bother making a terminology change from BCA to ICE. One reason is that when we teach stoichiometry, we assume that the reactions we are considering go to completion. We also assume that there are no products before the reaction begins. In equilibrium situations, products could be present in the initial state, and the reactions do not go to completion. So**, the switch from BCA to ICE is a refinement of the existing model to address more complex reactions**. My students simply regarded it as one of the many changes we made in models over the course of the year.