**Chem 12: Lab 2A – Effect of Concentration on Equilibrium Systems**

*Teacher Notes*

**Reference:**The structured version of this lab can be found as Experiment 12A (Part 2) from *Essential Experiments for Chemistry* (Morrison & Scodellaro). You will find materials lists, concentrations, etc. in this resource.

**Prior Knowledge:**

Students have a general definition of equilibrium.
The concept of a shift was introduced through analogy (You’re carrying grocery bags in both hands… it’s heavy, but you are balanced. Someone adds 3 bags to your right hand. How do you react? You re-distribute the extra weight.)

We have NOT talked in any detail about stress/shift (Le Châtelier) in a chemistry context.

**Pre-Lab Demo & Conversation:**

Ask students to predict the products of the following reaction:
 FeCl3 + KSCN 🡪

In this double replacement, the Fe and SCN will combine but not to make Fe(SCN)3. Rather they make a complex ion: thiocyanotoiron(III). At this point, I like to review the concepts of dissociation of salts and of spectator ions. I guide students from the double replacement reaction to the following net ionic equation:

 Fe+3(aq) + SCN- (aq)  FeSCN+2 (aq)

Observe the Fe+3 (as FeCl3). It is yellow
Observe the SCN-1 (as KSCN). It is colourless
Observe the complex ion (Put 1-2 drops of FeCl3 and 2mL of KSCN together) It is deep red.

Put these observations under the reaction as follows:

 Fe+3(aq) + SCN- (aq)  FeSCN+2 (aq)

 *Yellow colourless red*

Perform the reaction. Combine 2mL of each reactant into a small test tube. Observe.
(it is a rich orange colour)

What does the orange colour of the reaction mixture tell us about the system?

* It contains a mixture of yellow Fe+3 and red FeSCN+2. Both reactants & products.

Is this system at equilibrium?

* Most students will say yes, and when asked why, will answer: because it’s orange.
* We refer back to an earlier demo: it’s not the colour, but rather the fact that the colour’s not changing… yes, it is at equilibrium AND it has significant quantities of reactants and products.

Tell students they will be creating this reaction mix (directions are on the student handout), and then adding stresses to the system to see how it responds. Work through the questions on the student handout.

**The actual procedure/materials:**

Agree upon a set of tests. The goals are to:

-Add Fe+3 (as Fe(NO3)3)

-Add SCN-1 (as KSCN)

-Remove Fe+3 by precipitation. Add NaOH to create Fe(OH)3 \*\*

 Students may need prompting to come up with this option

-We don’t have a source of FeSCN+2, but if we did, it would be great to try

-Add spectator ions to see what happens (KCl contains both)

Depending on students’ comfort levels (and your timing), you may choose to provide a data table:

|  |  |  |  |
| --- | --- | --- | --- |
| Reagent added | Stress  | Colour observation | Direction of Eq’m shift (use an arrow) |
| None (Control)(test tube A) | none |  | none |
| KSCN(test tube B) |  |  |  |
| FeCl3 (test tube C) |  |  |  |
| KCl(test tube D) |  |  |  |
| NaOH(test tube E) |  |  |  |

Because I do this lab as an introduction to equilibrium, students don’t really know what “shift” means. I have this conversation with each group while they’re collecting data.

After we have data, we de-brief.

-Is the dark red test tube at eq’m? How do you know? How/why is it different from the control?

-Is the pale yellow one at eq’m? How do you know? How/why is it different from the control?

-The addition of spectator ions dilutes the mixture, resulting in a paler orange. Some students interpret this as a shift toward reactants. Encourage them to notice the difference between “Lighter, but still orange” and “more yellow”

**Conclusion:**

Students will build stronger connections to theory if you’ve worked through the details in class. I spend a day talking about Le Chatelier/Concentration, graphing, practicing – and having students play with the bromcresol green equilibrium (Lab 12A – Part 1) before I set them the task of making conclusions in this lab.