2.4.3 Lab: Disturbing Equilibrium

Prelab document (Word)

PDF of the lab manual

Rubric

- Show all calculations using dimensional analysis when possible.
- Put units on all numbers that have units.
- Do not use carrots ^.
- If you use Word, use the exponent icon to make exponents.
- If you use Google Docs, control-. makes exponents. You highlight the item you want to make an exponent and press Control-Period to raise it. On a Mac, it is probably command-period.
- Control-comma,  control-, makes a subscript like the numbers in a molecular formula. In Word, use the subscript icon.

# Disturbing Equilibrium

In this unit, you learned about how reactions adjust in order to keep a constant ratio of **concentrations** of **products** to concentrations of **reactants**.

This ratio is called the **equilibrium constant** for a reaction.

$$K_{eq} = \frac{[products]}{[reactants]}$$

It may seem pretty hard to imagine this happening. What happens as the reaction "magically" adjusts so that this ratio is always true?

In this lab, you will get to see these changes take place.

## Equilibrium Review

Click "Start" to review how to write the **equilibrium constant** ($K_{eq}$) for a reaction.
You need to go into the curriculum in APEX to get to the start button.

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

Video of the video

What does it mean for a **chemical reaction** to be at **equilibrium**?

If a reaction is at equilibrium and you add more **reactants**, the system will be pulled away from equilibrium. The **concentration** of the products divided by the concentration of the reactants will no longer equal $K_{eq}$.

However, some of these extra reactants will soon form into **products**, which will move the system back into equilibrium.

Le Châtelier's principle states that if you increase the concentration on one side of the reaction, the concentration on the other side will then increase to balance things out. In other words, the reaction will adjust so that products over reactants equals the $K_{eq}$ value.

## Formation of a Solid and Equilibrium

So how will you observe **equilibrium**?

In this lab, you'll observe a reversible reaction involving bromophenol blue, which is a **pH** indicator.

In its weak **acid** form, bromophenol blue is yellow in color. In its weak **base** form, the indicator is blue.

Adding a different acid or base to the **system** changes the equilibrium by changing the pH of the solution. A solution with a low pH (an acidic solution) has a higher concentration of $H^+$ ions than a solution with a high pH (a basic solution). As the pH changes, equilibrium shifts either toward the weak acid form or toward the weak base form of bromophenol blue. A change in color of the solution therefore *indicates* whether the solution has a low or high pH (hence, the name “pH indicator”).

In the lab, you will observe the color of the solution when different amounts of acid and base are added, thus changing $[H^+]$.

Do the Dry Lab

**2.4.3 Lab: Disturbing Equilibrium** Pre-lab

Chemistry Sem 2 Name: _____

*Points Possible:*50 Date: _____

**Answer these questions before beginning the lab. Be sure to turn them in when you submit your lab report.**

1. What does stressing an equilibrium system mean? How is stress applied?

2. The reversible reaction for the pH indicator bromophenol blue is

$(C_{19}H_8Br_4O_5S)H^- \leftrightarrow (C_{19}H_8Br_4O_5S)^{2-} + H^+$. Write the equilibrium expression for this reaction.

3. What direction do you predict the addition of an acid to the solution containing bromophenol blue will drive the equilibrium? Explain your prediction in terms of Le Châtelier's principle. Hint: Think about what the addition of an acid does to the concentration of $H^+$ ions.

Make sure you turn in the prelab questions. They may have to be in their own message. Give it the subject “2.4.3 prelab questions”.

You need to download the document (pdf) to read the instructions for the lab. It does not copy and paste well.

# LAB 7 Questions for Disturbing Equilibrium

**Table 7.1**

| Well number, contents | Color |
|---|---|
| A1, indicator + (1) HCl | Yellow |
| A2, original indicator (control) | Blue |
| A3, indicator + (1) KOH | Blue |
| A1, indicator + (1) HCl + (2) KOH | Blue |
| A3, indicator + (1) KOH + (2) HCl | Yellow |
| A1, Indicator + (1) HCl + (2) KOH + (3) HCl | Yellow |
| A3, indicator + (1) KOH + (2) HCl + (3) KOH | Blue |

1. What is the color of bromophenol blue in an acid? In a base?

2. How did you get the solution to change from blue to yellow?

3. Why did the solution change from blue to yellow (what chemical reaction happened)?

4. How did you get the solution to change from yellow to blue?

5. Why did the solution change from yellow to blue (what chemical reaction happened)?

6. After Procedure Step 3, the solution in Well A1 was in equilibrium.

What happened to the solution in Well A1 during Procedure Step 5?

Did the equilibrium shift?

Explain this based on Le Chatelier's Principle.

7. Why did the colors in the Wells A1 and A3 change a second time in Procedure Steps 7 and 8? Was this because of reversible reactions?

We are NOT doing the extension.