Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Rainbow Lab

Background Information: Design a display illustrating the use of LeChâtelier’s principle to produce the colors of the rainbow. At a minimum, you must have red, orange, yellow, green, blue, and violet. Stresses that can be applied include adding or removing a reactant or product and increasing or lowering the temperature of the system.

Purpose: Investigate Le Chatelier’s principle by testing several systems at equilibrium and then selecting specific ones to produce the colors of the rainbow.

Materials: Test tubes, test tube rack, small beakers, graduated cylinders, spatulas, solutions.

Pre-Lab Questions:

1. What is meant by the term “stock” solution?
2. Explain what LeChatelier's Principle means in terms of adding or removing substances

from a reaction at equilibrium.

1. For each Part A procedure, predict the color change and shift in the tables below.

Procedure Part A: Add a small amount of the stock solution to test tubes, perform the reactions, and record observations.

1. Tray 1 Bromothymol Blue (BTB): Acid-base indicators such as indicator BTB are large organic molecules that can gain and lose hydrogen ions to form substances that have different colors. BTB acts as a weak acid in water. The stock BTB solution usually starts out green.

**HBTB  BTB- + H+**

Yellow Blue

|  | Predicted Shift | Predicted Color | Actual Observations | Actual Shift |
| --- | --- | --- | --- | --- |
| 1. Add NaOH(aq)   (removes H+) |  |  |  |  |
| 1. Add HCl(aq)   (adds H+) |  |  |  |  |
| 1. Add HC2H3O2(aq)   (adds H+) |  |  |  |  |
| 1. Add NH3(aq)   (removes H+) |  |  |  |  |

1. Tray 2 Iron (III) nitrate and potassium thiocyanate: These compounds form the FeSCN2+ ion when combined. The starting stock solution of aqueous iron (III) nitrate will be light yellow/orange.

**Fe3+ (aq) + SCN− (aq)  [Fe(SCN)]2+ (aq)**

*Light yellow-orange colorless reddish-brown*

|  | Predicted Shift | Predicted Color | Actual Observations | Actual Shift |
| --- | --- | --- | --- | --- |
| a. Add FeCl3(s)  (adds Fe+3) |  |  |  |  |
| b. Add KSCN(s)  (adds SCN-) |  |  |  |  |
| c. Add HC2H3O2(aq)  (removes SCN-) |  |  |  |  |
| d. Add Na3PO4(s) (removes Fe+3) |  |  |  |  |

1. Tray 3 Hydrated cobalt complex ions in alcohol solution: The stock solution contains [Co(H2O)6]2+ dissolved in ethanol, which is why it is labeled with the (alc).

**[Co(H2O)6]2+(alc) + 4 Cl-(alc) + Heat  [CoCl4]2-(alc) + 6 H2O(alc)**

*Pink Blue*

|  | Predicted Shift | Predicted Color | Actual Observations | Actual Shift |
| --- | --- | --- | --- | --- |
| a. Add NaCl(s)  (adds Cl-) |  |  |  |  |
| b. Add H2O |  |  |  |  |
| c. Add acetone (removes H2O) |  |  |  |  |
| d. Add AgNO3(aq) (removes Cl-) |  |  |  |  |
| e. Place in hot bath (adds heat) |  |  |  |  |
| f. Place in ice bath (removes heat) |  |  |  |  |

Procedure Part B: Time to Plan! Based on your prelab predictions, make a plan for how you will create a rainbow of test tubes. For each color, identify a tray from Procedure Part A you will start with. Summarize *at least one way* you will try to create it by explaining which stress to apply to which equilibrium system.

# Choose one Tray to start. Put some of the stock solution (~2 cm high) into the correct number of test tubes to get the right colors.

# Use small quantities of the stress reagents and add these reagents little by little (dropwise, if a liquid) with stirring. Keep track of how many drops or amounts of solid reagents you added. Estimates are allowed, such as ~0.5g or a “pea sized “amount.

# You may use hot plates and/or water baths to heat/cool your samples.

# Once you reach the desired color, record how much of each chemical or the specific temperature changes you used in the final data table below.

# Before moving on to a different tray return materials and clean the table.

# Once you have created a rainbow of test tubes, show it to your teacher for approval.

|  |  | Plan | Observations of results |
| --- | --- | --- | --- |
| Color | Tray # | Stress |
| Purple |  |  |  |
| Blue |  |  |  |
| Green |  |  |  |
| Yellow |  |  |  |
| Orange |  |  |  |
| Red |  |  |  |