FLINN SCIENTIFIC

Name_____

Data Table

Acid–Base Equilibrium of Bromcresol Green	
Initial color of indicator solution (step 1)	
Color after addition of HCl (step 2)	
Color after addition of NaOH (step 3)	
Number of drops of NaOH added (step 3)	
Amount of HCl required to obtain "transition" color (step 5)	
Transition color (step 5)	

Observations and Analysis

1. Write the chemical equation for the reversible reaction of bromcresol green (HIn) with water. Label this Equation A.
2. Use the color changes observed for the indicator before and after adding HCl (steps 1 and 2) to predict the colors of the HIn and In^- forms of bromcresol green. Write the colors of HIn and In^- underneath their formulas in Equation A. Explain your reasoning. *Hint:* Adding HCl increases the concentration of H^+ ions. Which reaction, forward or reverse, would that increase?
3. *Explain the observed color change:* Adding more product to an equilibrium mixture of reactants and products increases the rate of the (forward/reverse) reaction and thus (increases/decreases) the amount of product.
4. In step 3, hydroxide ions reacted with and removed H^+ ions from solution (see Equation 3). What color change was observed when NaOH was added? Which substance (HIn or In^-) increased in concentration as a result?
5. *Explain the observed color change:* Removing one of the products from an equilibrium mixture of reactants and products decreases the rate of the (forward/reverse) reaction and thus (increases/decreases) the amount of product.
6. What form(s) of the indicator were most likely present when the transition color was observed in step 5? How does this observation provide visual evidence that not all reactions "go to completion?"

Data Table

Effect of Concentration		
Procedure	**Reagents**	**Observations**
Step 2	5 drops $Fe(NO_3)_3$ in KSCN solution	
Step 4	$Fe(NO_3)_3$ in KSCN sol. + KSCN crystals	
	Initial	
	After 30 seconds	
Step 6	$Fe(NO_3)_3$ in KSCN sol. + NaH_2PO_4 crystals	
	After 60 seconds	
Step 7	Solution color	
Step 8	Step 6 solution + $Fe(NO_3)_3$ crystals	
Step 9	Step 6 solution + KSCN crystals	

Observations and Analysis

1. Use Equations 4 and 5 and changes in concentrations to explain the observed color changes.

   a. Step 2

   b. Step 4

   c. Step 6

   d. Step 7

   e. Step 8

   f. Step 9

Data Table

Effect of Temperature		
Test Tube	**Reagents**	**Observations**
A	$CoCl_2$ in alcohol (control)	
B	$CoCl_2$ in alcohol + water	
	Initial color	
	Final color after heating to 75–80 °C	
C	$CoCl_2$ in alcohol + water + HCl	
	Initial color	
	Final color after cooling to 0–5 °C	
D	$FeSCN^{2+}$ in water (control)	
E	Final color after cooling to 0–5 °C	
F	Color after heating to 75–80 °C	

Observations and Analysis

1. Below is the net ionic equation for the reversible reaction involving cobalt complex ions. The colors of the complex ions are shown underneath their formulas.

$$\underset{\textit{Pink}}{Co(H_2O)_6^{2+}(aq)} + 4Cl^-(aq) \leftrightharpoons \underset{\textit{Blue}}{CoCl_4^{2-}(aq)} + 6H_2O(l) \qquad \textit{Equation } 7$$

   Based on the initial color of the cobalt chloride control solution (test tube A), what complex ions are present in this solution? Explain.

2. Which complex ion in net ionic Equation 7 was favored when the solution was heated (step 8)? Which complex ion was favored when the solution was cooled (step 9)? Use these results to determine whether heat should be included on the reactant or product side in the cobalt complex ion Equation 7. Rewrite the equation to include the energy term (heat) directly in the equation.

3. Use LeChâtelier's Principle to explain the color changes that resulted from heating and cooling the solutions in steps 8 and 9, respectively.

4. Write the chemical equation for the reversible reaction of iron(III) ions with thiocyanate ions. Use the information in the data table to write the color of each reactant and product underneath its formula.

5. How did the color of the iron(III) thiocyanate complex ion solution change when it was cooled (step 14) or heated (step 15)? How do these results demonstrate that the reaction shown in Question #4 does indeed occur in both the forward and reverse directions?

Data Table

Step #	Volume of Liquid Plus Gas	Indicator Color	pH
2 & 3			
6			
9			
11			

Observations and Analysis

1. What effect does decreasing the pressure have on the solubility of carbon dioxide gas and on the position of equilibrium for Equation 8?

2. What effect does increasing the pressure have on the solubility of carbon dioxide gas and on the position of equilibrium for Equation 8?

3. Explain the results in terms of LeChâtelier's Principle.