I. Disturbing Chemical Equilibrium: Effect of temperature and concentration

II. Background and Theory: Chemical reactions that are reversible simultaneously have the reactants forming products while the products act as reactants to reform the original reactants. In a closed system, these opposing reactions may reach a condition of dynamic equilibrium. A state of equilibrium can be recognized when the macroscopic properties (pressure, color, and solubility) are constant.

Imagine you are starting a terrarium. You ass dirt, plants, and water, then seal the container. Some of the water in the terrarium will vaporize. Soon the air in the terrarium will hold as much water as possible. At this point, some of the vapor will begin to condense. Eventually, as much water is condensing as is vaporizing; the liquid water and its vapor are in *equilibrium.* What happens to the equilibrium if the conditions change? A change of conditions in the system is called a stress. For example, if the terrarium gets colder (undergoes a stress), some of the water vapor will condense. In response to the stress, a new equilibrium will be established. The new equilibrium will have less water vapor and more liquid water than the old equilibrium.

Are there any rules to help predict what happens when a stress is applied to physical and chemical systems in equilibrium? Yes, LeChatelier's principle applies to systems in equilibrium. It states that, if a stress is places on a system at equilibrium, the system will change in a way that relieves the stress.

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III. PURPOSE**:** In this experiment, you will impose stress on physical and chemical systems at equilibrium to see how the systems change in the response to the stresses.

IV. Prelab:

1. Summary of the procedure
2. What is LeChatelier's Principle?
3. Watch: https://www.youtube.com/watch?v=XvFyd0LD--U

V. Procedure:

Part A. **Effect of Temperature:**

1. Obtain a color changer object. Record the color. Is the object cold, warm, or at room temperature? Dip the object in a beaker of warm water. Record the color. Do the same with cold water. Record the color. Observe how the color disappears after a time.

Part B. **Effect of a Change in Concentration:**

2. In 2 TT obtain 5 mL of 0.1 M potassium chromate and 5 mL of 0.1M potassium dichromate. Record the color of each solution.
3. Pour approximately 0.5 mL of each in separate TT. Add, drop by drop, 1M NaOH to each TT alternating from 1 tube to the next until one of the solutions changes color. Record the color of each. (One of them will be the same as before). Keep these solutions for step 6.
4. Pour approximately 0.5 mL of fresh solution into 2 separate TT. Add, drop by drop as before, 1 M Hcl to each TT alternating from 1 tube to the next until one of the solutions changes color. Record the color of each. (One of them will be the same as before).
5. Using the solutions from step 4, add 1 M NaOH drop by drop to each TT as before until one changes color.
6. Use the TT from step 3. Add 2 M Hcl, by 1 mL increments, to the TT until a color change results.

VI. Data:

Effect of Temperature

color changer object:

warm T

room T

cool T

Effect of Concentration:
Chromate <---------> Dichromate
Color Chart

Solution	Aqueous (2)	NaOH (3)	Hcl (4)	NaOH (5)	Hcl (6)
chromate					
dichromate					

VII.Discussion:

1. Why did the color change of the object? What is happening to the molecules in the objects? Definitely look this one up and explain in simplistic terms.

2. Write the chemical equation demonstrating how chromate can change into dichromate. Use this unbalanced equilibrium equation to get started.
   2 CrO_4^{-2} <----> $Cr_2O_7^{-2}$
   Write the color of the aqueous solutions on both sides of the equilibrium sign.
3. The presence of acid causes the production of or shift in equilibrium toward which ion?
4. The presence of an excess of base favors a shift in equilibrium toward which ion?
5. A rather interesting equilibrium exists between cobalt (II) ion complexes. This equilibrium is the basis for commonly found "fuzzy" weather indicators. The ionic equilibria in solution is:
   $Co(H2O)62+ + 4Cl- + heat \rightarrow CoCl42- + 6H2O$

   _____ _____

   Addition of water drives the reaction to a pink color from a blue color. Use this information to label the two complexes above as to proper color. What color would you expect the weather indicator to be on a rainy day.

6. Investigate the addition of $Ba(NO_3)_2$ to the chromate-dichromate TT. You can research many sites for this, however, this one is of great help:
   http://www.digipac.ca/chemical/equilibrium/dichromate/dichromate3.htm
   A. Draw a particulate diagram showing the Ba+2 ion, nitrate ion, & chromate ion present. Is there a greater amount of one? Make sure to add label everything.
   B. What would happen if more acid was added to the dichromate solution? Draw particulate diagrams to show the ions in solution or not.
   C. What would happen is more NaOH was added to the dichromate solution? Draw particulate diagrams to show the ions in solution or not.

VIII. Conclusion:
Discuss the factors that effect equilibrium. How will new equilibria be established? What does LeChatelier's principle have to do with the two parts of this experiment.