**Equilibrium and Le Chatelier’s Principle Lab** Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Go to <http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/equil.htm> and read the introduction and **ALL** of the background information. Then complete **ALL** parts of the virtual lab: the prelab, the six experiments, and the post lab. Write your answers to the questions on this handout.

Prelab Questions

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| 1.  | Which describes a solution that contains a system at equilibrium? Explain your answer.One in which the color of the solution is changing slowly, or one in which the color is not changing.  |
| 2.  | The following equilibrium is established when copper ions and bromide ions are placed in solution. heat + Cu(H2O)6+2 + 4 Br- http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.jpg6 H2O + CuBr4-2The tube on the left contains only copper sulfate dissolved in solution. The tube on the right is the result of adding some potassium bromide solution. Given that the Cu(H2O)6+2 ion is blue and that the CuBr4-2 ion is green, answer the questions below. a. What happened to the concentration of each of the ions when the KBr was added?b. Explain why the solution changed color. c. Would the tube feel hot or cold when the KBr was added?

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| 3.  | Consider the following equilibrium. Mg(OH)2(s) http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifMg+2 + 2 OH-The tube on the left contains Mg(OH)2(s) and water. A chemical has been added to cause the change shown in the tube on the right. Suggest a possibility for what chemical could have been added.  |
| 4.  | Methanol has the formula CH3OH and can be produced by the reaction of carbon monoxide with hydrogen gas. CO + 2 H2 http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifCH3OH + heatIn an attempt to maximize the yield of methanol (amount of methanol produced), a chemist would try to shift the equilibrium as far to the right as possible. Which of the following would accomplish this? a. heating the mixtureb. adding an excess of carbon monoxidec. removing the methanol as it is formedd. adding a substance that reacts with carbon monoxide  |

The Experiments1. Cobalt System

**CoCl4-2 {blue} + 6 H2O http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifCo(H2O)6+2 {red} + 4 Cl- + heat**

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| **Action** | **Observation** | **Shift** | **Explanation** |
| **Heat** |  |  |  |
| **Cool** |  |  |  |
| **Add H2O** |  |  |  |
| **Add KCl** |  |  |  |
| **Add AgNO3** |  |  |  |

1. Ammonium Sulfate System

heat + NH4+ + OH- http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifNH3 + H2O

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| **Action** | **Observation** | **Shift** | **Explanation** |
| **Add NH4Cl** |  |  |  |
| **Add HCl** |  |  |  |
| **Add NaOH** |  |  |  |

Iron Thiocyanate SystemFe+3 {pale yellow} + SCN- http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifFeSCN+2 {red} + heat

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| **Action** | **Observation** | **Shift** | **Explanation** |
| **Heat** |  |  |  |
| **Add KSCN** |  |  |  |
| **Add Fe(NO3)3** |  |  |  |
| **Add Na2HPO4** |  |  |  |

Chromate System2 CrO4-2 {yellow} + 2 H+ http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifCr2O7-2 {red} + H2O

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| **Action** | **Observation** | **Shift** | **Explanation** |
| **Add HCl** |  |  |  |
| **Add NaOH** |  |  |  |

Nitrogen Dioxide System2 NO2 {brown} http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifN2O4 {colorless} + heat

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| **Action** | **Observation** | **Shift** | **Explanation** |
| **Heat** |  |  |  |
| **Cool** |  |  |  |

Copper Sulfate SystemCuSO4.5 H2O + heat http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifCuSO4 + 5 H2O

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| **Action** | **Observation** | **Shift** | **Explanation** |
| **Heat** |  |  |  |
| **Add H2O** |  |  |  |

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Post-lab Questions

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| 1.  | Predict what would happen if the ammonium system described in the experiment was heated.  |
| 2.  | Consider the following equilibrium. Cu+2 + 4 NH3 http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.jpgCu(NH3)4+2The copper ion in solution is light blue. The Cu(NH3)4+2 ion is a deep blue. The tube on the left contains only copper ions. Identify what chemical was added to produce the results shown in the center tube. Identify what chemical may have been added to the center tube to produce the results shown in the right tube.  |
| 3.  | The barium ion is toxic to humans. However, barium sulfate is commonly used as an image enhancer for gastrointestinal x-rays. What does this imply about the position of the equilibrium shown below. BaSO4 http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifBa+2 + SO4-2 |
| 4.  | Hemoglobin (Hb) and oxygen gas form a complex (HbO2) that carries oxygen throughout the human body. Unfortunately, carbon monoxide also binds to hemoglobin so that an equilibrium is established. Carbon monoxide poisoning occurs when the concentration of HbO2 in the blood is reduced. HbO2 + CO http://www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/eqarrow.gifHbCO + O2The first aid for a person suffering from carbon monoxide poisoning is to (1) remove them to an area of fresh air, and (2) administer oxygen. Using the principles of equilibrium, explain how each of these helps to restore the HbO2 concentration.  |