

Name _____	Lab Partner _____
TA Name _____	Section _____ Date _____

Equilibrium and Le Châtelier's Principle PreLab Worksheet

As you work through the steps in the lab procedures, record your experimental values and the results on this worksheet.

Data Table A: Observations for the Equilibrium: $\text{Fe}^{3+} + \text{SCN}^- \rightleftharpoons \text{FeSCN}^{2+}$

Well #	Stress Applied	Observations Upon Applying Stress
1	None; control for comparison	
2	Add 0.10 M $\text{Fe}(\text{NO}_3)_3$	
3	Add 0.05 M NaSCN	
4	Add 0.10 M AgNO_3	
5	Add 1.0 M NaNO_3	

Question 1: When $\text{Fe}(\text{NO}_3)_3$ was added to the system,

- a. Which ion in the equilibrium system caused the “stress”?
- b. Which way did the equilibrium shift?
- c. What happened to the concentration of SCN^- ?
- d. What happened to the concentration of FeSCN^{2+} ?

Question 2: When NaSCN was added to the system,

- a. Which ion in the equilibrium system caused the “stress”?

- b. Which way did the equilibrium shift?
- c. What happened to the concentration of Fe^{3+} ?
- d. What happened to the concentration of FeSCN^{2+} ?

Question 3: When AgNO_3 was added to the system, it caused the precipitation of solid AgSCN .

- a. Which ion in the equilibrium had its concentration changed by addition of AgNO_3 ?
- b. Did the concentration of that ion increase or decrease?
- c. When AgNO_3 was added, which way did the equilibrium shift?

Question 4: When you added NaNO_3 , did anything happen? Can you explain this result?

Data Table B: Observations for the Equilibrium: $\text{CoCl}_4^{2-} + 6 \text{H}_2\text{O} \rightleftharpoons \text{Co}(\text{H}_2\text{O})_6^{2+} + 4 \text{Cl}^-$

Exp't	Stress Applied	Observations Upon Applying Stress
Well 1A	Add 12 M HCl	
Well 1B	Add water	
Well 2A	Add 12 M HCl	
Well 2B	Add 0.10 M AgNO_3	
Beaker 1	Heat Solution	
Beaker 2	Cool Solution	

Question 5: Adding HCl has the effect of adding Cl^- ions to the system. When Cl^- was added to the system,

- a. Which way did the equilibrium shift?

- b. What happened to the concentration of CoCl_4^{2-} ?

- c. What happened to the concentration of $\text{Co}(\text{H}_2\text{O})_6^{2+}$?

Question 6: When water was added to the system,

- a. Which way did the equilibrium shift?

- b. What happened to the concentration of CoCl_4^{2-} ?

- c. What happened to the concentration of $\text{Co}(\text{H}_2\text{O})_6^{2+}$?

Question 7: When you added AgNO_3 , it caused the precipitation of solid AgCl .

- a. Which ion in the equilibrium had its concentration changed by addition of AgNO_3 ?

- b. Did the concentration of that ion increase or decrease?

- c. When AgNO_3 was added, which way did the equilibrium shift?

Question 8: State a general rule concerning a system at equilibrium when more of one of the components is added.

Question 9: State a general rule concerning a system at equilibrium when one of the components is removed.

Question 10: For the $\text{CoCl}_4^{2-} + 6 \text{H}_2\text{O} \rightleftharpoons \text{Co}(\text{H}_2\text{O})_6^{2+} + 4 \text{Cl}^-$ Equilibrium

a. Which way did the equilibrium shift upon heating?

b. Which way did the equilibrium shift upon cooling?

c. A general rule concerning temperature changes to equilibrium systems is that the input of energy (raising the temperature) shifts the equilibrium to the higher energy side of the equilibrium. Based on your observations, which side of the equilibrium is the higher energy side?

d. Is the reaction, $\text{CoCl}_4^{2-} + 6 \text{H}_2\text{O} \rightleftharpoons \text{Co}(\text{H}_2\text{O})_6^{2+} + 4 \text{Cl}^-$ endothermic or exothermic?

Data Table C: Observations and Measurements for Bromothymol Blue Equilibrium

Buffer pH	Solution Color	Absorbance at ~635 nm	Absorbance at ~470 nm
6.30			
6.80			
7.30			

Question 11a: In the series from pH 6.30 to 6.80 to 7.30, the pH is increasing and the $[\text{H}_3\text{O}^+]$ is decreasing. As the $[\text{H}_3\text{O}^+]$ decreases, what happens to the concentration of BB^- at ~635 nm?

Question 11b: Explain how this observation agrees with Le Châtelier's principle.

Question 12a: As the $[\text{H}_3\text{O}^+]$ decreases, what happens to the concentration of HBB at ~ 470 nm?

Question 12b: Explain how this observation agrees with Le Châtelier's principle.

Question 13: What is the equilibrium expression for the reaction under study?

