

## Equilibrium and Le Chatelier's Principle Worksheet

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

**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 1.0 M $\text{AgNO}_3$	
5	Add 1.0 M $\text{NaNO}_3$	

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

- Which ion in the equilibrium system caused the “stress”?
- Which way did the equilibrium shift?
- What happened to the concentration of  $\text{SCN}^{-}$ ?
- What happened to the concentration of  $\text{FeSCN}^{2+}$ ?

**Question 2:** When NaSCN was added to the system,

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

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

**Question 3:** When  $\text{AgNO}_3$  was added to the system, it caused the precipitation of solid  $\text{AgSCN}$ .

- a. Which ion in the equilibrium had its concentration changed by addition of  $\text{AgNO}_3$ ?
- b. Did the concentration of that ion increase or decrease?
- c. When  $\text{AgNO}_3$  was added, which way did the equilibrium shift?

**Question 4:** When you added  $\text{NaNO}_3$ , did anything happen? Can you explain this result?

**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 1.0 M $\text{AgNO}_3$	
Beaker 1	Heat solution	
Beaker 2	Cool solution	

**Question 5:** Adding HCl has the effect of adding  $\text{Cl}^-$  ions to the system. When  $\text{Cl}^-$  was added to the system,

- a. Which way did the equilibrium shift?
  
- b. What happened to the concentration of  $\text{CoCl}_4^{2-}$ ?
  
- 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  $\text{CoCl}_4^{2-}$ ?
  
- c. What happened to the concentration of  $\text{Co}(\text{H}_2\text{O})_6^{2+}$ ?

**Question 7:** When you added  $\text{AgNO}_3$ , it caused the precipitation of solid  $\text{AgCl}$ .

- a. Which ion in the equilibrium had its concentration changed by addition of  $\text{AgNO}_3$ ?
  
- b. Did the concentration of that ion increase or decrease?
  
- c. When  $\text{AgNO}_3$  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?