

# Lab: Le Chatelier's Principle



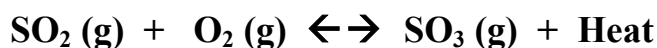
## Recall that:

- equilibrium occurs when any chemical reaction or physical change occurs such that the forward rate of change is equal to the reverse rate of change
- equilibrium is possible when the process occurs in a closed system.
- if any of the reacting species leave the reaction as gases or as precipitates, equilibrium can not be established.

Henri Le Chatelier stated the following idea about reactions that are in a state of equilibrium:

*When a process that is in a state of equilibrium is “stressed” by a change in the concentration of one of the reactants or products, by a change in temperature or by a change in pressure, the reaction will counter-react to this change by “shifting” to minimize the effect of this change.*

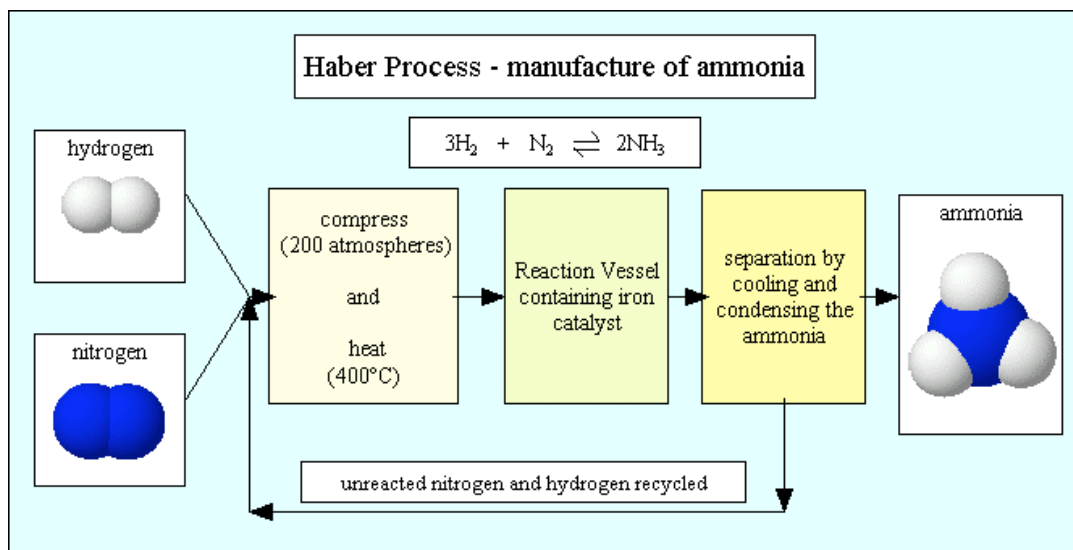
**PRELAB:** Study this equilibrium reaction:



Predict the shifts caused by:

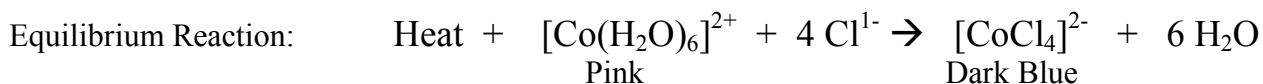
1. Increasing the amount of  $\text{SO}_2$  gas: \_\_\_\_\_
2. Increasing the amount of  $\text{SO}_3$  gas: \_\_\_\_\_
3. Decreasing the amount of  $\text{O}_2$  gas: \_\_\_\_\_
4. Heating the system: \_\_\_\_\_
5. Explain why this system will be affected by changes in pressure: \_\_\_\_\_
6. Which way will the reaction shift when pressure is decreased? \_\_\_\_\_

Question 7 refers to the diagram below of the Haber Process.



7. If all reactants and products in this reaction are in the GAS phase, explain why the “reaction vessel” needs to be “compressed” in order to produce ammonia ( $\text{NH}_3$ ). \_\_\_\_\_
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## **Reaction #1: Cobalt Chloride System**



A color change will be the evidence of a shift in this equilibrium system:

- More pink, or lighter indicates a shift to the \_\_\_\_\_
- More intensely blue or darker, a shift to the \_\_\_\_\_

### **DATA:**

<b>Change</b>	<b>Stress Caused by the Change</b>	<b>Predicted Shift</b>	<b>Actual Color Change</b>	<b>Actual Shift</b> <b>Does it match the prediction?</b>
None (control)				
Add HCl	Increasing $\text{Cl}^{1-}$ ion concentration			
Add $\text{AgNO}_3$				
Increase Temp				
Decrease Temp				

1. Explain the shift that happened when HCl was added.
  
2. Explain the shift that happened when the system was heated, based on the location of “heat” in the reaction.
  
3. Draw an appropriate PE diagram for this system, and label  $\Delta H$  on it, with an appropriate sign value on  $\Delta H$ .
  
4. a. What does Table F say about the interaction between  $\text{Ag}^{1+}$  ion and  $\text{Cl}^{1-}$  ion?  
  
b. From your observations about what happened when you added  $\text{AgNO}_3$ , what evidence do you have that the Table F interaction happened?  
  
c. Explain the shift caused by adding  $\text{AgNO}_3$ .

## **Reaction #2: NO<sub>2</sub> → N<sub>2</sub>O<sub>4</sub> Equilibrium.**

The Δ H value for this reaction as written is **-58kJ**. Write this value in the appropriate place in the reaction below:



### **Observe video demonstration for this reaction on the class Moodle:**

Color in the Hot Water Bath \_\_\_\_\_ Color in the Cold Water Bath \_\_\_\_\_

6. In terms of *stresses*, *shifts*, and *heat*, explain the color changes you observed in this reaction.

## **Reaction #3: The carbonic acid/carbon dioxide system.**



1. This system is the one present in any container of carbonated beverage. As you know, when you open the seal on the bottle or can, pressure is released over the solution and the solution bubbles. This bubbling is called effervescence. What gas is in the bubbles? \_\_\_\_\_
2. The effervescence of CO<sub>2</sub> is an indication of a shift to the \_\_\_\_\_.
3. Using what you know about Le Chatelier's Principle as it pertains to gases and pressure, explain what happens when the bottle or can is opened. Use the words *equilibrium*, *shift*, *gas*, and *pressure* in your answer. \_\_\_\_\_

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**\*\*Don't forget to complete your lab credit sheet!**