

## **PART 2: EQUILIBRIUM**

### **A: What is equilibrium?**

Go to <https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/equilibrium-103/>

Read and watch the video (at bottom of page) about Chemical Equilibrium.

You may use the following link for more information. <http://www.chem1.com/acad/webtext/chemeq/Eq-01.html>

#### Questions:

1. What is equilibrium?
2. Why do reactions go towards equilibrium?
3. What is a reversible reaction?
4. Why must a container or system be closed or equilibrium to be established?
5. A chemical reaction is in equilibrium when there is\_\_\_\_\_.
6. Compare the 2 graphs (these graphs can be found on the video from Boundless website above).  
What is the same?  
What is different?  
At equilibrium, what is unchanging?  
At equilibrium, what is equal?
7. According to the law of mass action, what must be EQUAL at equilibrium?
8. Why is chemical equilibrium considered dynamic?

### **B: Le Chatelier's Principle**

Go to the site shown here. I would recommend reading information from the first site and watch the video at the bottom and using the other sites below as additional resources.

<https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/chemical-equilibrium-14/factors-that-affect-chemical-equilibrium-106/le-chatelier-s-principle-443-6137/>

Answer the questions based on what you've read.

1. What does LeChatelier's principle mean?
2. What is a stress?
3. If you ADD something (a reactant, product or heat/energy), will the equilibrium shift toward the side of the reaction to make even more of it, or will the equilibrium shift in the direction to use it up? Explain.
4. If you REMOVE a chemical or heat from a system, will the system shift toward the side that replaces what you took out or try to use even more of it?
5. Explain what happens when you increase pressure on a system that was at equilibrium?
6. View this Ted Ed video on an important application of Le Chat's Principle (<http://ed.ted.com/on/mb1mycbe#watch>). Write down what Haber did to optimize the production of ammonia and how it relates to the Le Chat's principle.

Additional resources:

<http://www.chem1.com/acad/webtext/chemeq/Eq-02.html>

<http://www.chem.ox.ac.uk/vrchemistry/ChemicalEquilibrium/HTML/page29.htm>

<http://www.youtube.com/watch?v=4-fEvVNTIE> See me for override if needed.

### C: What is K?

Visit this website: [http://www.mhhe.com/physsci/chemistry/animations/chang\\_7e\\_esp/kim2s2\\_5.swf](http://www.mhhe.com/physsci/chemistry/animations/chang_7e_esp/kim2s2_5.swf)

1. Watch the animation and write down the K expression.
2. Choose to start with all  $\text{NO}_2$ . Write down the equilibrium concentrations for both compounds. Use these values in the equilibrium K expression and calculate the value of K. Show all work. Draw a rough graph showing how the reactant and product concentrations change over time as equilibrium is being established.
3. Choose to start with all  $\text{N}_2\text{O}_4$ . Write down the equilibrium concentrations for both compounds. Use these values in the equilibrium K expression and calculate the value of K. Show all work. Draw a rough graph showing how the reactant and product concentrations change over time as equilibrium is being established.
4. Choose to start with a mixture of both compounds. Write down the equilibrium concentrations for both compounds. Use these values in the equilibrium K expression and calculate the value of K. Show all work. Draw a rough graph showing how the reactant and product concentrations change over time as equilibrium is being established.

Refer to <http://www.chem.ox.ac.uk/vrchemistry/ChemicalEquilibrium/HTML/page40.htm>

5. What is the general formula for equilibrium expressions?
6. What states of matter are included in this expression?
7. What is the difference between the equilibrium constant and the equilibrium expression?
8. What would be the equilibrium expression for  $\text{O}_2 + \text{N}_2 \rightleftharpoons 2\text{NO}$  if all chemicals involved are gases?

### D: Phase equilibrium

<http://www.youtube.com/watch?v=JsoawKguU6A>

At what temperature are ice and liquid water in equilibrium with each other?

This temperature is called the \_\_\_\_\_.

What rates are equal?

What appears constant?

At what temperature are steam and liquid water in equilibrium with each other?

This temperature is called the \_\_\_\_\_.

What rates are equal?

What appears constant?

### E: Solution Equilibrium

View this video

<http://www.youtube.com/watch?v=Vgw1fYBYW3g><http://www.youtube.com/watch?v=Vgw1fYBYW3g>

What type of solution is at equilibrium?

What is happening to the solute on a molecular level when it is at equilibrium?

What is equal in this type of equilibrium?

What is constant during this type of equilibrium?