

| Lesson 4-1: Chemical Equilibrium | |
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| Curriculum Expectations | <ul style="list-style-type: none"> • E2.1 • E2.2 • E3.1 • E3.2 • E3.3 |
| Learning Goals | <p>Learning Goals:</p> <ul style="list-style-type: none"> • Define dynamic equilibrium. • Explain the concept of chemical equilibrium. • Describe Le Chatelier's principle and apply it to solve problems predicting how changing variables will affect the chemical equilibrium of a system. |
| Success Criteria | <p>I know I have achieved the goals for this lesson when I can describe dynamic equilibrium and explain how it relates to chemical reactions. I will also be able to explain Le Chatelier's principle and use it to predict the direction of reactions when different variables such as temperature and concentration are changed.</p> |
| Teacher Prep | <ul style="list-style-type: none"> • Materials for Modeling Equilibrium Group Activity <ul style="list-style-type: none"> ○ 48 buttons, rocks, coins or some similar object that you can obtain in bulk and that can be easily passed among students. ○ Pencils ○ Paper plates • Check equilibrium simulation 4-1 works |

Minds On

Goal: In this activity students will observe dynamic equilibrium in action.

Big Idea: When there is a continuous exchange of items between one population and another, the system will reach dynamic equilibrium. In chemical reactions an equilibrium state can be recognized when the number of particles or concentration of each of the two populations (reactants and products) remains constant, but there is evidence that individual atoms or molecules are still exchanging between the two populations. This Activity explores factors that influence dynamic equilibrium, including how long it takes two populations to reach equilibrium, and the relative amounts of reactants and products present at equilibrium.

Teacher's Notes:

- Groups should, ideally, be no larger than 4 students.
- Teacher's can use different materials depending on what is available (instead of buttons you can use rocks, coins, etc.)
- Teacher should ensure that all students in each group take a turn at calculating/moving buttons.
- If time permits, discussion questions should be completed as part of the activity. If not, questions can be handed in at the start of next day's class.
- Remind students that when doing discussion questions, they can still use the buttons and the piles to figure out the answer if they are having difficulty calculating the answer.

1. Modelling Equilibrium

Instructions:

1. Have students open the activity instructions by clicking on the "Modeling Equilibrium with Buttons" link.
2. Read through the instructions carefully with the whole class. Ensuring that everyone understands the protocol and purpose.
3. Have students follow the step-by-step instructions while the teacher oversees and ensures proper protocol is followed.
4. Data should be collected by groups individually.
5. When completed the data from all the groups should be collected as a class and displayed for all to see. One member from each group can come to the front to report their data.
6. A brief class discussion should be held at this point, discussing any differences in the data and addressing areas where errors may have arisen.
7. Students should go back into their original groups and answer the analysis questions together.

8. While students are answering the questions, the teacher should circulate among the groups, asking questions and ensuring that they are on the right path.
9. Once all groups have answered all the questions, take up the answers as a class.
10. Teacher should use the teacher's version linked to in the assignment to help guide the answers to the questions.

Action

****Refer to the Differentiation Resources link for additional practice worksheets, and to enrich your classroom teaching using different tools throughout the lesson. ****

1. 4-1A: Equilibrium Simulation

- For this activity, students will navigate through an interactive simulator to help introduce the concept of equilibrium.
- Instruct students to use the tabs at the top of the simulator, beginning with "Introduction" and move their way through.
- Instruct students to try different iterations of the simulation, observing how the forward and reverse rates affect how the equilibrium proceeds.
- Once students have played around with the interactive have them select the "Exercises" tab at the top.
- Students should answer the questions on their own and record their responses.
- As a class, put the simulator up on a display and go through each of the scenarios presented in the "exercises" tab and see how the answers play out.
- You may want to refer back to this simulator to reinforce concepts of equilibrium or to use as an exemplar when describing different conditions or changes to the system (i.e. Le Chatelier's Principle)

2. 4-1A: Chemical Equilibrium

- Use the content and images in activity 4-1B to create a lecture introducing the fundamental concepts underlying equilibrium.
- Students should make notes of their own from this material, highlighting the most important concepts and examples.
- Emphasize that students must be able to produce, read and interpret concentration vs. time graphs and understand how they might behave when experimental conditions change.
- Refer back to the group activity that used buttons to help students visualize the content.
- ****You may wish to bring the buttons in for this activity to help reinforce concepts.****

- Have students answer embedded question on their own and take up the answer as a class.

3. 4-1C: Le Chatelier's Principle

- Students should make notes from this activity, recording most important points and examples.
- read the introduction together as a class to make sure that equilibrium concepts are well understood before proceeding.
- Use the image on the activity page showing how shifts to the left (towards the reactants) and the right (towards the products) would be reflected in the reaction equation and what effects this would have on the concentrations of the different product and reactant species.
- Have students complete the interactive activity in the middle of the lesson on their own, taking notes along the way.
- Once all students are finished, navigate through the activity as a class, focusing on each example of a stress and exploring in depth how and why these changes shift the equilibrium.
- Use the graphs and images on the lesson page to help students visualize the application of Le Chatelier's principle.

Consolidation

1. 4-1D: Chemical Equilibrium & Le Chatelier's Principle Quiz

- To be completed individually, in class or at home. Take up the answers together the following day.
- Address any misconceptions or questions by reviewing material from the lesson.
- Emphasize definitions and the underlying reasons for why equilibrium shift when systems are stressed.

2. 4-1E: Equilibrium & Le Chatelier's Principle Practice Activity

- To be completed individually by students either at home or in class.
- Answers should be taken up together as a class, identify any issues or areas of weakness and review this material.
- Call on individual students to share their answers and explanations to each question.
- Also recommended to assign additional worksheets from the differentiation resources if there are misunderstandings or the need to reinforce material.

3. Exit Card

- Print out the following on an exit card and hand to students as they leave.
- Student responses are to be brought in the following class presented and discussed among the class.

Exit Card Question:

“Find an example of an equilibrium that you encounter in your day-to-day life. Describe the components of the equilibrium and give an example of a stress that the system may encounter and how the system would react to regain equilibrium. “

****Refer to Differentiation Resources for additional practice worksheets, and to enrich your classroom teaching using different tools. ****