

Lesson 4-2: Equilibrium Constants	
Curriculum Expectations	<ul style="list-style-type: none"> • E2.1 • E2.3 • E2.4 • E3.2 • E3.4
Learning Goals	<p>Learning Goals:</p> <ul style="list-style-type: none"> • Explore the factors that contribute to equilibrium constant for different reactions. • Investigate equilibrium constants for common chemical reactions.
Success Criteria	<p>I know I have achieved the goals for this lesson when I can define what an equilibrium constant is, the factors that determine the value of equilibrium constants and can describe equilibrium constants for different common reactions.</p>
Teacher Prep	<ul style="list-style-type: none"> • Confirm that podcast and video for the Haber Process Forum activity are working. • If there are issues with the podcast or video, click on the links provided in the activity and download the resources directly to your computer.

Minds On

Goal: To review the concept of dynamic equilibrium and how systems at equilibrium react when they are stressed (pushed out of equilibrium)

1. Exit Card Review

Instructions:

- Use the exit card question from the previous lesson:
 - **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.”
- Have each student present their example and introduce an example of the stress to the system. Then have other students in the class explain how the system will react to the given stress.
- Use this activity as an opportunity to review concepts related to equilibrium and Le Chatelier’s Principle as well as to identify any misconceptions and/or areas of weakness.

Action

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

1. 4-2A: Equilibrium Constants Introduction & Expression

- Section A-B
- For this activity, students will explore how to quantify the equilibrium constant of a given reaction at equilibrium.
- Students should read through each section on their own, taking notes along the way.
- Their notes should include instructions for how to derive equilibrium constants as well as what the relative values of different equilibrium constants reflect.
- At the end of section B there are links to 2 videos. Watch these 2 videos as a class and encourage students to take notes and ask questions as they watch.
- After each video open the class to ask questions and discuss the content of each video.

2. 4-2A: Solving Problems with K_{eq}

- Have a student read the introductory paragraph of section C out loud to the class.

- Make sure everyone understands before proceeding.
- Using the materials on the activity page, lead the class through the proper steps required to solve problems with Keq.
- Go through the step-by-step protocol for setting up an ICE table.
- Have students recreate the ICE table in their notes and have a solid understanding of the material before moving on.
- Check your understanding question: Have students answer the embedded question on their own and take up answers as a class.

3. 4-2B: Common Equilibrium Constants

- Review the content as a class, including the embedded video.
- Students should take notes as they progress and should understand the reactions that each of the different common constants represent.
- For acids and bases students must be clear about how the size of the Keq reflects on the strength of the acid or base.

4. 4-2C: Haber Process – Science for the Benefit of Society Forum

- As a class, listen to the podcast and watch the embedded video.
- Have a class discussion about the ethical issues underlying scientific discovery and technologies.
- Probe the students to uncover their own original thoughts about how to properly use and celebrate scientific knowledge that can have both positive and negative consequences.
- After the discussion, **each member of the class must post their response** to the question in the forum:
Should Haber have received the Nobel prize for developing the process given the environmental and humanitarian consequences of the process he pioneered?
- Emphasize that there are no right/wrong answers for this activity it is meant to explore the ethics of science.
- Encourage students to comment on other responses, in an attempt to trigger lively, meaningful discussion.

5. 4-2 Group Activity: Haber Process Debate

- In this classroom activity you will have a classroom debate about the benefits and consequences of the discovery of the Haber process.
- The debate format is flexible, but the suggested format is as follows:
 1. Each team will perform research to prepare a 3-5 minute opening statement outlining their side of the argument in general terms. Ample time should be given for this (a whole period is appropriate).

2. Each team delivers their opening statement. (This can be delivered by one member of the group or several)
3. Following each opening statement, Team A will have 2 minutes to further their argument using persuasive arguments and facts.
4. Team B will then have a few minutes to confer and prepare a response and then 2 minutes to respond/refute the previous statement.
5. Team A side will have 2-3 minutes to respond.
6. Team B will then have 2-3 minute to further their side using persuasive argument and facts.
7. Team A will then have a few minutes to confer and prepare a response and will then have 2 minutes to respond/refute the previous statement.
8. Team B side will have 2-3 minutes to respond.
9. This pattern can repeat until arguments have been exhausted or after a set amount of time.
10. The debate should conclude with 2 minute closing statements from each team summarizing their argument and addressing any relevant points introduced by the other side.

- Following the debate you can hold a class vote to see if anyone has changed their mind based on the arguments presented or a general class discussion can be held to cover any interesting points that were raised.
- There are different ways to structure the teams for this activity.

1. Survey the class and split them in to groups based on their response to the question: "Should Haber have received the Nobel prize for developing the Haber process?" Based on their responses to the questions split them up into teams (those who think he should have vs. those who think he shouldn't have)

2. Assign students to a group. If you use this method an interesting way to further the activity is to then have teams switch sides and now argue the opposite sides of the question.

Consolidation

1. 4-2D: Equilibrium Constants 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.

2. 4-2E: Equilibrium Constant Practice I

- To be completed individually or in groups 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. 4-2E: Equilibrium Constant Practice 2

- To be completed individually or in groups 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.

4. 4-2F: Equilibrium Constants Assignment

- To be completed individually by the students.
- Before they begin, review the assignment as a class.
- Emphasize where marks are allocated, proper completion and submission protocol (file size, name, etc.)
- For all calculations students must show all their work.

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