**5E Lesson Plan**

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**Cal Teach Student Name**: Carisza Lenaburg

**Mentor Teacher Name:** Henry Curtin **School/Room #:**

**Grade Level and Subject:** High school students that are in grades 10-12

**Date/Time to be taught:** To be determined

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| **Lesson Source(s):** | Lab is from resource center, A Demo a Day A Year of Chemistry Demonstrations.<br>Lab questions from Conejo Valley using a similar lab. |
| **Focus/Essential Question:** | How could concentration and pressure be changed in order to produce more products in a chemical reaction? |
| **Student Learning Objectives:** | Students will be able to<br>- make connections between what is seen at the macroscopic level to what is happening molecularly in a chemical reaction.<br>- explain changes that can shift a chemical system in favor of more products by changing a single variable. |
| **CCSSM or NGSS Standards:** | HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. |
| **Student Prior Knowledge:** | Students should have a good idea what equilibrium is.<br>-when the forward reaction proceeds at the same rate as the reverse reaction.<br>I think they also will have a pretty good understanding of elements and compounds in regards to how they may interact with each other such as metals and nonmetals forming salts. They should also have an understanding about moles and atomic mass. |
| **Lesson Agenda for Your Students:** | -Warm up<br>-Ted-Ed video and brief discussion<br>-Lab<br>1. Get materials<br>2. Write down observations<br>3. Clean up<br>-Lab debriefing (what did they see) |

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| **Lesson Rationale:** | Students will be shown a video that demonstrates an increase in the amount of products by changing pressure. The video can be related to the lab they will do in class. The lab will allow them to change one condition (concentration) and make observations. Thus students can compare and contrast effects of concentration and pressure on the amount of products. |

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| **Materials and Technology List:** | Distilled water<br>(2) 125mL Erlenmeyer flasks<br>Cupric chloride dehydrate, $CuCl_2 \cdot 2H_2O$ (3.4g per pair)<br>Hydrochloric acid (HCl)<br>Ethanol ($C_2H_5OH$)<br>Goggles and gloves<br>-Each pair is in charge of getting the material they need. There should be multiple balances for them to get the cupric chloride dehydrate to practice weighing. |
| **Preparation Tasks:** | It would need to be determined how much water is needed to shift the equilibrium. It is then also needed to find how much HCl is needed to shift it back. It would need to be checked that there are a sufficient amount of gloves and goggles. |
| **Safety Concerns:** | I will emphasize that these are chemicals that need to be handled carefully. If they at any point do not follow safety rules they will be asked to leave the lab. They must wear gloves and goggles at all times. But if they get any chemicals on themselves they need to wash thoroughly with soap and water. They will have already gone on the safety tour showing eye wash and shower in case of extreme incident. |

***5E Lesson Plan, continued:*** *Write the lesson plan as you would give it, providing yourself with a tool that summarizes flow and transitions, records age-appropriate wording for all instructions and prompts, and describes what you expect students to be doing and/or talking about at key points.*

**Lesson Title:** *Chemical Equilibrium: Le Chatelier's Principle*

**Evaluate:** *Observe and adjust your lesson as you teach.*

| **Engage:** *Activities that engage students' interest and build connections to their lives and prior knowledge.* | *Previous Experience and Baseline Learning* |
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| - What will you say and do to introduce your topic and to engage students' attention?<br>• (written on board) Objective: To refine (make small changes) a chemical system to increase the amount of products at equilibrium.<br>• Today's topic: Le Chatelier's Principle (pressure and concentration)[emphasize students to focus on this principle during the video]<br>• (Warm up) In the lab you must make a solution. Find the amount of grams needed to make a 200mL solution of 0.1M $CuCl_2 \cdot 2H_2O$.<br>• What is chemical equilibrium?<br>- What questions will connect topic to students' lives and elicit prior knowledge? How do you expect students to answer? (Interactive portion engaging students to relate chemistry to ordinary things such as food they eat.)<br>• Topic- California Drought Pair-share How does this affect central California farms? What is else is crucial for vegetables to grow? Hint: soil.<br>-After they have this brief discussion I will ask them what they remember about the nitrogen cycle from biology.<br>Watch Ted-Ed video **https://www.youtube.com/watch?v=o1_D4FscMnU**<br>• Key Points<br>1. Haber Process produces large amounts of ammonium to be used as fertilizer. (side note- California produces almost half of US-grown fruits, nuts and vegetables)<br>2. This process uses increased pressure to reach equilibrium<br>- How will you transition to exploration?<br>• What is chemical equilibrium?(discuss from warm up<br>• How does pressure work to get a chemical reaction back to equilibrium? Next we are going to see how concentration effects a chemical reaction.<br>- What structures are in place to support academic language development for a variety of learning needs, including for English language learners?<br>• After the video there will be a discussion to reinforce what was watched. By allowing the students to discuss what they saw the idea is that students will hear different interpretations. Also students will be able to ask questions for more clarification. Therefore this addresses auditory and visual learners and helps develop communication skills.<br>• I hope to support ELL students is by having them paired with another student who is doing well and communicate well. I also hope that having the students explain the vocabulary in their own words helps other students out.<br>• Equilibrium, consume, decompose, closed container (all words in terms of chemistry)<br>**Time**: 15 | *Watch for:* How will you know that students are engaged?<br>-They should be writing and not talking for the warm up. They should be sitting quietly while watching the video as well. There will be a brief discussion and students should have ideas from the video pointing out main concepts.<br>What do you expect the range of prior knowledge to be?<br>-They should have a pretty good idea about chemical equilibrium and that is the most important for this lab since they are not calculating anything really. Some students will have a better understanding knowing that equilibrium does not mean equal concentrations. But there will be those who still struggle with understanding rates of reactions. It is their responsibility to seek help but I will ask questions that can allow students to hear explanations in other words.<br>*Response:* What might you do to revisit prior knowledge, if needed?<br>-The warm up question should be something they did for a previous chapter which will emphasize that material carries throughout the class. Also I will ask about equilibrium and if clarification is needed it will be given. When we discuss the video I can check for understanding of equilibrium, reactants, products, pressure and concentration and get a few students to put it in their own words. |

| **Explore:** *Hands-on tasks designed to explore ideas and to develop skills together.* | *Focus, Involvement, Collaboration, Results, and Recording* |
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| - What specific directions and demonstrations will you use to introduce the task(s), problem(s), activities or project?<br>• We are seeking to reach equilibrium. The question we are examining is how does concentration affect equilibrium?<br>• Briefly refresh on safety precautions as well as clean up procedures.<br>- What will you tell students about student grouping and material distribution for the task(s)?<br>• I would want students to work in pairs so that they can discuss as a team and then discuss as a whole group.<br>• Will discuss the materials they will be using, hopefully all the stations will be set up for them. Will also discuss the general chemical equation they are working with. Allow them to make guesses at how they can cause a shift.<br>-I will have them go over the lab worksheet and explain the copper solution for what it is basically like the paper says it is blue at this time and green at this time.<br>- What handouts or other written materials will you give students? Lab with lab questions (attached at bottom) hands on interaction, observing chemical equilibrium<br>- What will you do or say during activities to encourage cooperative student work?<br>• I can ask questions such as<br>-Do you and your partner agree with your reasoning for question…?<br>• I will also walk around to check they are following safety protocol and that they each student is writing their own observations. I mainly just want them to go through the lab just to practice techniques of weighing and I hope that not much HCl or water is needed for the color change so I may even have them practice dropper techniques.<br>- What will you tell students to prompt clean-up and transition to explanation?<br>• After you have written down your observations clean up according to the procedures.<br>- What structures are in place to support academic language development for a variety of learning needs, including for English language learners?<br>• The students will be physically changing a chemical system. They also will be working with a partner who can help clarify understanding. The questions in the lab use the vocabulary equilibrium, reactants, and products and hopefully during their discussion and explanations to their partner they will understand what is occurring.<br>**Time:** 20 | *Watch for:* What do you expect to see students doing to construct meaning?<br>-Questions on the worksheet ask for their explanation. They will be in pairs so they can discuss what they believe is happening.<br>*Response:* What specific prompts or questions might help students focus attention, improve observation and encourage reasoning?<br>-The questions I found follow the lab almost step by step which will allow the students to think about what they are doing and why. They have to use critical thinking to think about what is happening molecularly versus the macroscopic changes they see.<br>Why is the solution changing colors?<br>What is happening with the addition of HCl?<br>Assessing<br>While students fill out worksheet I'll read what they write. Based on their observations the macroscopic level will be easiest know if they understand. Understanding the molecular level will be assessed during discussion by listening to their explanations as well as how they answer questions specific to the molecules present in the system. |

| **Explain:** *Students explain the phenomena they explored and discuss their different ideas and perspectives.* | *Participation, Reporting, Debating, and Evidence-Based Reasoning* |
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| - How will you organize students to discuss their observations and explain their thinking?<br>• Have a lab debriefing, talk to the person behind you. Why was there a color change?<br>• Also find what might be confusing.<br>- What prompts might help foster sharing and support critical listening and reasoning? *(e.g. What did you notice about …? What are some different approaches to …? What else might cause…? What evidence supports …? What are our rules for debate/sharing?...)* How do you expect students to answer?<br>• What did you notice when water was added? What is happening chemically?<br>• Then what happened when HCl was added?What happens to HCl when it is added to water? What about the HCl causes the shift?<br>• If we weren't able to added more HCl or water what could we do to have a shift in equilibrium? Why?<br>• I would ask a student if they could quickly draw on the board what they think was happening. Then ask who can explain what the drawing is showing. Or student can further explain what they are showing<br>- What big observations and conclusions might arise from student discussion?<br>• Students should be able to connect pressure and concentration, similarities and differences.<br>-When there is greater pressure there is less room for the molecules to move around so they shift to less molecules.<br>-By adding more of something it takes up more space which is similar to pressure because there is less space.<br>-It is constraining the volume by "squishing" the area versus adding more to the volume… Gas vs liquid<br>- How will you briefly summarize the student discussion?<br>• Make a bulleted list of the key findings and ask if there is anything I seem to be missing.<br>- What structures are in place to support academic language development for a variety of learning needs, including for English language learners?<br>• I feel that there is a lot of opportunity for there to be lots of communication. I would not be opposed to pairs sharing with others as long as it is not the whole class sharing answers. I probably would want to pair an English language learner with someone they can communicate well and also understands the material.<br><br>**Time:** 15 | <u>*Watch for:*</u> What are common misconceptions that might arise?<br>-I feel students might not understand which chemicals are being used at certain points.<br><u>*Response:*</u> How might you prompt the group to think together about possible misconceptions?<br>-I feel that the questions that I found do a pretty good job and targeting misconceptions because the questions follow the procedures and make the students think about what is happening.<br>How will you respond to individual reluctance to share, too much sharing, or overly critical debate?<br>-I think if I don't see many willing to share I could start with asking what they thought was going to happen. I could ask someone to share their answer because it could be an answer they came up with their partner.<br>-Sharing too much could be handled by asking specific questions so that the answers are not open ended.<br>How will you differentiate instruction when you notice a range of different student understandings, and ensure that all students meet your learning objectives?<br>-If I notice students struggling I may try and relate what is happening to the video from the beginning. By asking them to address something that is certain they may be able to draw conclusions. If I feel a student is doing really well I could ask them to think about a related concept such as the effect of temperature and volumes, letting them get a head start on the next material. |

| **Elaborate:** *Teacher-stimulated application and clarification of concepts, skills, attitudes, processes or terminology.* | *Demonstrated Understanding, Use of Skills, and Other Applications* |
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| • Continuing from the list of key findings if anything is missing I will add and emphasize the importance.<br><br>- What opportunity will you provide for students to apply or recognize concepts or skills in another situation?<br><br>• Another scenario could be related to endothermic reactions and relate them back to each other.<br>• Carbon monoxide<br>$2C(s) + O_2(g) \rightarrow 2CO(g) + heat$<br><br>- How will you connect to students' previous understanding and encourage students to see the development of their ideas?<br><br>• This is related to equilibrium so that is straight forward. I could help them make connections by the following day when we finish Le Chatelier's principle the warm up could be asking them to think about temperature and volume and based off what they learned what they is going to happen when we change these variables.<br><br>- How will you review useful vocabulary and definitions in a few sentences?<br><br>• I want to tackle this as it happens. I feel this is more beneficial to base this on what I observe in the class. I could thus make it a dialogue that I start statements and allow the students to finish the thought/idea.<br><br>**Time:** 5 | *Watch for:* How will you know if a student needs help with applying what they learned?<br><br>-Depending on their explanations when answering questions could be a good show. Similar scenarios could be found to be used as warms or pop quizzes to check.<br><br>A struggling student would not be able to explain what is happening in the chemical reaction. They would not be able to explain that HCl dissociates and the excess chloride ions cause the shift towards reactants.<br><br>The explanations are in the questions but a struggling student would not be able to make the connections.<br><br>*Response:* How will you support students who are having trouble applying ideas or skills?<br><br>-Try explaining the concept again but with a not so technical explanation.<br><br>-Suggest they come at lunch to work out the details. |

Name: _____ Period: _____ Date: _____

What is chemical equilibrium?

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_____
_____

What is the Haber process? Label the reactants and the products and which way equilibrium is.

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_____
_____

What is the central nutrient for plants to grow?

_____
_____
_____

Why can't nitrogen from the air be used by plants?

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_____
_____

Why is Le Chatelier's principle important for the equilibrium process Haber was experiencing?

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# Le Chatelier's Principle: Copper Chloride Equilibrium

When a system at equilibrium is subjected to change in concentration, pressure, volume, or temperature, then the equilibrium readjusts itself to counteract the effect of the applied change and a new equilibrium is established.

A solution of cupric chloride in ethanol is green due to the presence of copper chloride containing species such as CuCl2(H2O)2. Addition of water turns the solutions blue as water molecules replace the chloride ions in the coordination sphere around the copper. The reaction sis:

$$\underset{\text{(green)}}{\mathrm{CuCl_2(H_2O)_2}} + 2\mathrm{H_2O} \rightarrow \underset{\text{(blue)}}{\mathrm{Cu(H_2O)_4}^{2+}} + 2\mathrm{Cl^-}$$

As predicted by Le Chatelier's principle, the reaction is shifted back towards reactants by the addition of excess chloride ion in the HCl

**OBJECTIVES:**

**1)** Observe chemical and physical changes and identify each

**2)** Compare and contrast chemical and physical changes in matter

**EQUIPMENT:**

Cupric chloride dehydrate, $CuCl_2 \cdot 2H_2O$
Hydrochloric acid, HCl
Ethanol, $C_2H_5OH$
Distilled water
125-mL Erlenmeyer flasks (2)

**PROCEDURE:**

Record observations

1. Make 200mL of a 0.1M $CuCl_2 \cdot 2H_2O$ solution in ethanol.
2. Added sufficient distilled water to shift the color.
3. Divide this solution equally between the two flasks.
4. To one of the flasks add sufficient HCl to restore the green color.

Find the amount of grams needed to make a 200mL solution of 0.1M $CuCl_2 \cdot 2H_2O$. (Show work)
_____g

**CLEAN UP:**

All solutions can be flushed down the drain with excess water. Clean all flasks with tap water and then distilled water. Dry flasks and return them. Wipe table area down and dispose of any paper towels in the trash.

**Effect of Concentration on Equilibrium**

1. Are there more reactants or products present in this initial equilibrium system? How can you tell?

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   _____
   _____

2. Le Chatelier's principle states that if a system at equilibrium is subjected to a stress, reactions will occur to relieve the stress and establish a new equilibrium. Let's "stress" this system by adding some water. There are now more water molecules causing the system to have a lot more reactant molecules. Describe the color change that occurs.

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   _____
   _____

3. The stress was increased water concentration; therefore the system reacted so as to "use up" some of the added water. The color change indicates that there is (more/less) reactant, and (more/less) product.

4. Has the new equilibrium been established? How can you tell?

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   _____

5. Now let's "stress" this new equilibrium by adding some $Cl^-$. We will use an HCl solution, which contains both $H^+$ ions and the $Cl^-$ ions. The $H^+$ ions, however are NOT a source of "stress" for this equilibrium system. Why not?

6. Describe the color change you observe as excess $Cl^-$ ions are added.

7. The stress was increased $Cl^-$ concentration, therefore the system reacted so as to "use up" some of the added $Cl^-$ ions. The color change indicates that there is now (more/less) reactant, and (more/less) product.

8. We could remove the $Cl^-$ ions we just added by precipitating them as AgCl. To do this, we add some $AgNO_3$. Since $NO_3^-$ is not in the balanced equation for this equilibrium, it is just a spectator ion. The $Ag^+$ ions combine with $Cl^-$ ions, effectively removing $Cl^-$ from the equilibrium system. The system relieves this "stress" by reacting to replace some of the lost $Cl^-$ ions. THIS stress is said to "favor" the forward reaction. What is the color of the liquid above the AgCl precipitate? Has a new equilibrium been established? How can you tell?

**Predict**

With the information given how can the given reaction shift towards products.

$CoCl_4^{2-}(aq) + 6H_2O \text{ <===> } [Co(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) + \text{heat}$

**BLUE (reactant)** **PINK (product)**

Bilash, Borislaw, George R. Gross, and John K. Koob. A Demo a Day: A Year of Chemical Demonstrations. Flinn Scientific, Incorporated, 1995.

Lab questions are taken from Conejo Valley Unified School District document