Cisplatin and Anticancer Therapy: The Role of Chemical Equilibrium

Instructor Notes

Overview

This activity is intended for use in a college-level second semester/second quarter general chemistry course, and is designed to help students complete the following learning objectives:

a) using ICE tables to calculate the equilibrium concentration of reactants and/or products;
b) using ICE tables and stoichiometric calculations to predict what initial concentration of reactant would be required to yield a specific concentration of product at equilibrium;
c) understanding the concept of Le Chatelier's principle and how equilibrium reactions will respond to changes in concentration of reactant and/or product;
d) being able to calculate the reaction quotient (Q), and relating the reaction quotient to explain whether a reaction has reached dynamic equilibrium or not.
e) connecting the concept of chemical equilibrium to the real-world application of anticancer therapeutics and how the drug cisplatin imparts tumor cell death.

This activity is designed to be done at the end of the typical second quarter/second semester general chemistry equilibrium unit. Students will be expected to have learned the following concepts prior to completing this activity:

a) understanding the concept of dynamic equilibrium;
b) understanding how equilibrium expressions are generated for chemical reactions that include aqueous solutions, gas phase reactants/products, and/or heterogeneous reactions;
c) understanding how to calculate the molarity of a solution and how to carry out basic stoichiometric conversions for chemical reactions.

Pre-lecture Online Learning

a. Pre-lecture Quizzes:
Studies of previous implementations of flipped classroom modules indicate simply asking students to watch videos prior to lecture is not an effective way to ensure compliance and can result in students being unprepared for the in-class activity.[1] Therefore, instructors are encouraged to assign a pre-lecture quiz that assesses student learning from the video lecture. A pre-lecture quiz is provided as a separate file in this module, and instructors can deliver this using either the test/quiz function in their course management system or using in-class clickers to solicit answers prior to starting the in-class activity.

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[1] He, W; Holton, A; Farkas, G; and Warschauer, M. (2016), "The effects of flipped instruction on out-of-class study time, exam performance, and student perceptions." *Learning and Instruction*, 45, 61-71.

If instructors are interested in further increasing the interactivity and engagement of the pre-lecture videos they might consider embedding the videos in the Playposit system (https://learn.playposit.com/learn/). Playposit allows instructors to insert questions within the video, which then must be answered by the student before proceeding further in the video. Not only does this help increase the interactivity and engagement of the video, but since the Playposit questions can be assigned for homework and awarded points this also helps increase student compliance.

b. Pre-lecture videos explaining how ICE tables are used to determine the equilibrium concentrations of reactants/products, how the reaction quotient (Q) is calculated, and how the reaction quotient relates to Le Chatelier's principle (Khan Academy):

The videos associated with this pre-lecture learning module are found in the Chemistry course within the Khan Academy site, and are specifically located in the "Equilibrium constant" and "Factors that affect chemical equilibrium" subunits in the "Chemical equilibrium" section of the Khan Academy chemistry course. In order to be prepared to complete the in-class activity, students should watch following videos found at the following link:

https://www.khanacademy.org/science/chemistry/chemical-equilibrium

Video 1 - "Small x approximation for small Kc"

Video 2 – "Small x approximation for large Kc"

Video 3 – "Le Chatelier's principle"

Video 4 – "Le Chatelier's principle: Worked example"

Video 5 – "Comparing Q vs K example"

Even though the Khan Academy provides a freely accessible set of online videos that reduces the barrier to implementing flipped classroom modules, instructors are encouraged to create their own set of videos if time permits. The author's previous experience has found students generally appreciate seeing and/or hearing their own instructor in the video, and more importantly students have less uncertainty about what specific topics are considered important by the instructor when the video is created by their own instructor. Though there are numerous ways in which faculty can create their own online videos, the author has found using the Zoom teleconferencing system screen capture function while annotating Powerpoint slides on a tablet/laptop with touch screen functionality is the most cost-effective and convenient method for creating new videos. The following link provides instructions for creating videos using the Zoom teleconferencing system:

https://support.zoom.us/hc/en-us/articles/201362473-Local-Recording

c. Pre-lecture Readings and resources:
In addition to the pre-lecture videos and quizzes, instructors are encouraged to assign textbook reading that matches the content covered in the pre-lecture videos. This provides for students an additional resource that can be used to help answer questions related to the activity learning objectives. This activity is based on a *Journal of Chemical Education* article that describes the history of the anti-cancer drug cisplatin, and how this drug initiates tumor cell death. Instructors are strongly encouraged to assign this article as additional reading for the pre-lecture homework/preparation.

Rebecca A. Alderden, Matthew D. Hall, and Trevor W. Hambley, *Journal of Chemical Education*, 2006, 83 (5), 728-734 (https://pubs.acs.org/doi/abs/10.1021/ed083p728).

In-class Activity

It is recommended that students be given 2-3 days to complete the pre-lecture activities described above. As mentioned above, instructors are encouraged to assign the associated pre-lecture quiz or deliver these questions to students at the beginning of lecture using a clicker in-class response system. The in-class activity can be completed in one 50-minute or one 80-minute lecture period, depending on how the instructor chooses to implement the activity. If instructors are implementing this in a 50-minute lecture, using the online pre-lecture quiz instead of the in-class clicker questions would be advised to help ensure the activity can be completed in the 50-minute time frame. Below is a suggested timeline.

-Clicker questions to administer pre-lecture quiz (optional; instructors may wish to administer the pre-lecture quiz online using the test feature in their course management site): 10-15 minutes
-Introduction to the activity and relevance of the assigned readings: 5 minutes
-Groups of 3-4 students work collaboratively on in-class activity worksheet, and answer questions in free response form: 20-25 minutes
-Instructor solicits answers to multiple choice versions of the worksheet questions using an in-class clicker system (optional; instructors may wish to collect the free response answers and grade them manually): 15-20 minutes
-Summary and activity wrap up: 5 minutes

If instructors choose to solicit answers to the worksheet questions using an in-class clicker system, multiple choice versions of the questions are provided in a separate Powerpoint file within this module. The answers for the multiple choice versions of the questions are provided in the answer key, which is also included as a separate PDF file. If the instructor's institution does not use a campus-wide clicker response system instructors are encouraged to consider using either the PollEverywhere system or Kahoot. PollEverywhere is free to use with less than 40 participants, and clicker questions can be embedded within Powerpoint presentations using a PollEverywhere add-in. If instructors wish to use a system with larger enrollment classes the Kahoot system is free to use with unlimited numbers of students, however questions must be administered from the Kahoot website. Both systems allow

students to submit answers using a mobile phone or other device with wireless internet capabilities and allow instructors to download grade reports in the form of an Excel spreadsheet. Instructors can learn more about these in-class response systems at the following websites:

PollEverywhere: https://www.polleverywhere.com/

Kahoot: https://kahoot.com/