**Lesson Plan: Lecture 3**

**12 Principles of Green Chemistry**

**Description**

In this lecture students will learn about the 12 Green Chemistry Principles and explore industrial examples of implementing the principles.

**Prior to Lecture**

Required Readings:

* Anastas, P.T., Eghbali, N. “Green Chemistry Principles and Practice”; *Chem. Soc. Rev.*; 2010, 39, 301-312.

<http://pubs.rsc.org/en/content/articlelanding/2010/cs/b918763b>

* Presidential Green Chemistry Awards: 1996 – 2016
* Anastas, Paul T.; Warner, John C.; “Green Chemistry: Theory and Practice”; Oxford University Press: Oxford, 1998, Chapter 4.

Optional/Supplemental Reading:

* Mulvihill et al, “Green Chemistry and Green Engineering: A Framework for Sustainable Technology Development”; *Annual Review of Environment and Resources*; 2011, 36, 271-293. (optional)

<https://www.annualreviews.org/doi/abs/10.1146/annurev-environ-032009-095500>

Videos:

* [The 12 Principles of Green Chemistry](https://www.youtube.com/watch?v=NSozp4_QeLI&feature=youtu.be)
* [John Warner: Green Chemistry](https://www.youtube.com/watch?v=TL1zbAJIaDI)
* [Introduction: Definition of Green Chemistry](https://youtu.be/rABpDIs3pBc)
* [Introduction: Green Chemistry's Role in Sustainability](https://youtu.be/SumoaUDpe2I)
* [Introduction: Life Cycle](https://youtu.be/6s1b0Aok-HU)
* [Historic and Ideal Community Relationships](https://youtu.be/SSi9hribxrc)

**Topics to Cover in Lecture**

* The 12 Principles of Green Chemistry
  + Prevention, Atom Economy, Less Hazardous Chemical Syntheses, Designing Safer Chemicals, Safer Solvents and Auxiliaries, Design for Energy Efficiency, Use of Renewable Feedstocks, Reduce Derivatives, Catalysis, Design for Degradation, Real-time Analysis for Pollution Prevention, Inherently Safer Chemistry for Accident Prevention

**Class Exercises**

E-Factor (Have materials prepared before lecture) (optional):

The objective of the E-Factor class exercise is to get the students thinking about the effects of waste. The goal of this exercise is to understand the Environmental Impact Factor (E-Factor), how it is used in chemical processes, and how it can be applied to everyday life. Through this exercise, students will realize that they don’t want to throw away their waste because they see value in the other colored M&M’s.

See class exercise folder for classroom instructions on the E-Factor exercise.

File can be downloaded from Beyond Benign here: <https://www.beyondbenign.org/lessons/environmental-impact-factor/>

Writing the 12 Principles of Green Chemistry (optional):

The objective of this class exercise is to allow the students to become familiar with the 12 Principles of Green Chemistry. The exercise utilizes a creativity to re-name the principles that will stick with the student throughout the semester.

See class exercise folder for classroom instructions on Writing the Principles exercise.

File can be downloaded from Beyond Benign here: <https://www.beyondbenign.org/lessons/writing-principles/>