# CHEM 489 Advanced Environmental Chemistry – Spring 2020

## Worksheet #1: Green & Sustainable Chemistry (10 points)

**Due: Tuesday, February 4 at 9:30 AM (not accepted late)**

**Journal Club #2:** Your topic is “Undergraduate Degree Programs in Green & Sustainable Chemistry”.

Your goal is to find at least three (3) undergraduate programs using one or more of the following search terms:

* Undergraduate green chemistry programs
* Undergraduate green and sustainable chemistry programs
* Undergraduate green chemistry engineering programs
* Undergraduate green and sustainable chemistry engineering programs
* Undergraduate green chemistry certificate programs
* Undergraduate environmental engineering programs

**By next Tuesday, you need to send me an email that contains:**

I. A brief (one sentence) description for each of the three (or more) programs you found, and the URL for each (minimum of three), and

II. Identify your favorite program that you will discuss with the class on Thursday.

**In class next Thursday, February 6** you will give a 5 minute, informal presentation on your favorite program where you will address the following points:

1) You will call up the program web page on screen.

2) Identify program and institution.

3) Give an overview of the program including courses required for the degree.

4) Discuss special highlights, career benefits, your personal assessment, etc.

**Writing Prompt #2 - What is green and sustainable chemistry?** I will send you feedback on Prompt-1 by email via “track changes” mark-up. You will need to address my Prompt-1 comments, and update your document based on the lecture material this week. In particular, you should include the connection between green chemistry and risk assessment, and provide one relevant reference connecting green chemistry and risk assessment.

**Worksheet #1:** Read PDF articles 1-4 found on the course web page, and review the 12 Principles of Green Chemistry (handout). These articles provide a good overview of green chemistry, are an easy read, and may be helpful in answering some of these questions. You should answer these questions on a separate sheet of paper. You can work together, but must submit your own worksheet and your own answers.

1. Define green and sustainable chemistry (in your own words please).

2. In your own words, give you opinion on how green chemistry and sustainability are or are not related.

3. What is the purpose of the 12 Principles of Green Chemistry?

4. Simple application of Green Chemistry Principles. A student synthesized the ionic liquid BMIM-Cl using the reaction shown below. Acetonitrile is the solvent.



(a) From this list, identify the type of reaction, and explain your answer: SN1, SN2, E1, E2, Electrophilic Addition

(b) Define % Yield and % Atom Economy. How do these two metrics differ?

(c) Do all reactant atoms end up in the desired product? If no, which atoms do not? Without doing a calculation, what is your preliminary assessment of the reactions Atom Economy?

(d) Based on the balanced equation given above, what component(s) of this reaction is/are not considered in evaluating efficiency based on % Yield and Atom Economy?

(e) Based on your lab experience (especially CHEM 243/244 labs), what other components of this process might be relevant to a full assessment based on Molecular Design?

(f) This reaction used 5.0 g of N-methylimidazole and 20.0 g of 1-chlorobutane. Loo up or calculate the molecular weight and number of moles of each. Based on the stoichiometry in the balanced equation, do you see a potential problem here? Explain.

(5) Compare and contrast how green chemists reduce Risk as compared to traditional “command and control”?

(6) The 12 Principles of Green Chemistry can serve as a useful guide to the design, creation and use of chemicals and chemical technologies focused on the potential for human health and environmental benefits. For each idea or concept in the table below, identify a Primary and Secondary green chemistry principle that might apply. You do not need to justify your answers.

 **The answers here can be subjective and depend on the interpretation of the Principles by the user!**

|  |  |
| --- | --- |
| **Idea or Concept** | **Application of 12 Principles of Green Chemistry** |
| **Primary** | **Secondary** |
| Simplifying the overall process by reducing the number of steps |  |  |
| Reducing the need for solvents and reagents and their risks |  |  |
| Reducing energy use for heating, drying and/or cooling |  |  |
| Use of safer processes and chemicals |  |  |
| Processes based on aqueous solutions instead of organic solvents |  |  |
| Developing more efficient processes that minimize waste |  |  |
| Continuous process production with real time monitoring and control |  |  |
| Recycling chemicals used in the process |  |  |
| Production and use of biodiesel as fuel |  |  |
| Plastics made from plant products rather than crude oil fractions |  |  |
| Development and use of solar, geothermal, wave or wind energy |  |  |