# CHEM 489 Advanced Environmental Chemistry – Spring 2020

## Worksheet #2: Green & Sustainable Chemistry (10 points)

**Due: Tuesday, February 11 at 9:30 AM (not accepted late)**

**Journal Club #3:** Your topic is “The UN Sustainable Development Goals in Green & Sustainable Chemistry”.

You can select one of the SDG articles I placed on the class website, or find your own article.

**Due - Tuesday, February 11,** you need to send me an email identifying the article you selected or found.

**Due - Thursday, February 13** you will give a 5 minute, informal presentation on your article, focusing on the connections and/or relevance of the UN SDGs to green and sustainable chemistry.

**Writing Prompt #3 - What is green and sustainable chemistry?** Update your document by including the connection between green chemistry and metrics for reaction efficiency. You must include one relevant reference. You do NOT need to send me your updated document, but will be responsible for including this prompt in your final paper.

**Worksheet #2: Green Chemistry Metrics for Reaction Efficiency.**

**Due - Tuesday, February 11**

To answer the questions on this worksheet you will need your handout of the 12 Principles of Green Chemistry, and you should review your lecture notes from Tuesday, February 4. This material is also on the class website: [**http://webhost.bridgew.edu/ebrush/CHEM%20489.HTM**](http://webhost.bridgew.edu/ebrush/CHEM%20489.HTM). You can type your answers directly on this document, but for calculations you will need to write these out on a separate sheet of paper. You can work together, but must submit your own worksheet and your own answers.

(1) “Green chemistry is an approach to chemistry that aims to maximize efficiency and minimize hazardous effects on human health and the environment.” Based on the class lectures, you should be able to list six metrics that a chemist can take to design a greener synthesis or process. Identify those that are considered to be reaction efficiency metrics.

(2) What are the advantages and disadvantages of Atom Economy as a metric?

(3) A reaction can have 100% Atom Economy, yet less than 100% yield. How is this possible?

(4) The remaining questions require you to **think critically** about the design and outcome of the following chemical process. Phloroglucinol is an important bulk chemical and feedstock for the production of pharmaceuticals. Up to the mid-1980s phloroglucinol was synthesized from trinitrotoluene (TNT). An overview of this process is shown below:



A more detailed synthetic scheme with proper stoichiometry, molecular weights and mass quantities is below:



**PROCESS ASSESSMENT**:

(a) Why is the product needed, who needs it, and why? Besides the background given above, you will need to find an additional reference (not Wikipedia), and include this reference in your answer.

(b) Conduct a simple **Risk Assessment** by identifying two hazards, and discuss exposure and vulnerability. Again, if you use a resource to answer this question you must cite the reference.

(c) Based on the information given in the balanced equation above, calculate the % yield for this process (note that mass quantities are in units of Kilograms). **Show all work.**

(d) Based on the information given in the balanced equation above, calculate the % atom economy for this process. Note that you must use the reactant stoichiometry as a multiplier for the molecular mass of H2SO4, Fe and HCl. **Show all work.**

(e) Based on the information given in the balanced equation above, calculate the PMI for this process. **Show all work.**

(f) Based on all information above and Green Chemistry Principles 1-5, write an assessment about the efficiency of this process. Please note that you will be asked to address a similar question on your exam. Please write your assessment on a separate sheet of paper and attach to this worksheet. I am expecting approximately 150-200 words.