

**Lesson Title** (topics can be chemistry, environmental education, geology, art, biology or other appropriate topics)

<b>Objectives</b> 1. (there will always be at least 3 objective) 2. 3.	<b>Materials</b> <ul style="list-style-type: none"><li>Bulleted list with up to 10 or 12 items</li></ul>
<b>Green Chemistry Principles</b> <ul style="list-style-type: none"><li>(there will always be at least 3)</li><li>but there could be more</li><li></li></ul>	
<b>IL State Standards</b> (Science/EE/Art/other—please identify) This will be running text	
<b>Grade Levels</b> Running text	<b>Time</b> Running text generally only as much as one class period
<b>Vocabulary</b> Running text	<b>Credit</b> This material is adapted from...

#### **Overview**

Text will be in paragraph form. There will generally be 3-4 paragraphs.

#### **Procedure**

Text in this area will be numbered. Generally there will be anywhere from 5 to 20 steps.

#### **Teacher Background**

Running text up to 15 paragraphs

## The Twelve Principles of Green Chemistry

1. It is better to prevent waste than treat or clean up waste after it is formed.
2. Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product. (Preventing waste)
3. Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. Chemical products should be designed to preserve efficacy of function while reducing toxicity.
5. The use of auxiliary substances (e.g. solvents, separation agents) should be made unnecessary whenever possible and, innocuous when used.
6. Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.
7. A raw material feedstock should be renewable rather than depleting whenever technically and economically practical.
8. Unnecessary derivatization (blocking group, protection/deprotection, temporary modification of physical/chemical processes) should be avoided whenever possible.
9. Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into innocuous degradation products.
11. Analytical methodologies need to be further developed to allow for real-time in-process monitoring and control prior to the formation of hazardous substances.
12. Substances and the form of a substance used in a chemical process should be chosen so as to minimize the potential for chemical accidents, including releases, explosion and fires.

### Suggested Discussion Questions/Answers

Questions	Possible answers
These questions set up so that they can be copied and folded back and used like cards.	The answers will be on the back of the questions if cut and folded.
Provide space for up to 8 questions.	Provide space for up to 8 answers.

#### Scientific Process:

- 1. Formulate or evaluate question or form a hypothesis.** *Running text will follow this standard statement.*
- 2. Plan and conduct experiments or test the hypothesis.** *Running text will follow this standard statement.*
- 3. Make systematic observations and measurements.** *Running text will follow this standard statement.*
- 4. Interpret and analyze data.** *Running text will follow this standard statement.*
- 5. Draw conclusions.** *Running text will follow this standard statement.*
- 6. Communicate the results either orally or in writing.** *Running text will follow this standard statement.*
- 7. Re-evaluate the results.** *Running text will follow this standard statement.*

#### Real World Applications

Running text will follow, generally only one paragraph.

#### On the Web

Space for up to six resources, each having links.

#### Ideas for Further Study

Lists of possible research projects, lessons, or other resources.