The Chemical Hazard Awareness Module is designed to be used in conjunction with a current laboratory exercise that you currently use in your classroom or laboratory. We have outlined this exercise for use with Beyond Benign’s laboratory exercise “Reactions Lab” (download here: http://www.beyondbenign.org/K12education/highschool.html). The Reactions Lab involves students observing different types of reactions and identifying which type (single displacement, double displacement, composition (synthesis), or decomposition), as well as analyzing different reaction procedures for their “greenness”. The module can be adapted for use with other chemistry laboratory experiments in order to assess the hazards of the chemicals used.

There are many organizations that have been working to streamline and figure out a consistent way of communicating chemical hazards. If each group has different criteria, then how do we communicate how hazardous a chemical is to each other (i.e., from one company to another)? This module is to help students to understand the language of chemical hazards. It is designed to be used after introducing students to Safety Data Sheets (SDS’s).

**Background readings:**
The following articles are suggestions for student background reading in advance of this exercise:
How Toxic is Toxic?
Chem Matters, American Chemical Society, December 2014
http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues.html

Natural vs. Synthetic Chemicals is a gray matter

http://www.safecosmetics.org/get-the-facts/chemicals-of-concern/

Banned in Europe Safe in the US

When it comes to chemicals how safe is safe?
http://www.ewg.org/enviroblog/2013/06/when-it-comes-chemicals-how-safe-safe

**Chemistry Concepts:**
**Recommended Procedure:**

1. Introduce the students to the various resources that are available to gather data about chemical hazards, including:
   a. Globally Harmonized Safety Data Sheets (SDS’s): We recommend the following module by MoDRN titled “How to Read an SDS for Chemistry Classrooms” [http://modrn.yale.edu/teachers-modules](http://modrn.yale.edu/teachers-modules). The module will help students be able to better read and understand SDS’s.
   b. Local Hazardous Waste Management Program in King County, Washington, Hazard Chemicals in Schools, Schools Chemical List: Approximately 1,000 chemicals are cataloged and characterized by physical hazard, health hazard, environmental hazard, lowest grade allowed, storage category, common experiment usage, and disposal method. [http://www.hazwastehelp.org/educators/chemlist.aspx](http://www.hazwastehelp.org/educators/chemlist.aspx)

2. Hand out the student sheet and have the students research the information on the list of chemicals and fill out the data table.
Chemical Hazard Awareness Module
Student Worksheet

There are many organizations that have been working to streamline and figure out a consistent way of communicating chemical hazards. If each group has different criteria, then how do we communicate how hazardous a chemical is to each other (i.e., from one company to another)?

Let’s take three chemical reactions as examples and compare them. The three reactions listed below are commonly used to demonstrate double displacement reactions in high school lab experiments. If we take a look at the SDS’s for the starting materials for these three chemical reactions and compare them, which one would you suggest to use in your classroom? And, why?

**Reaction 1:**
\[
Pb(NO_3)_2 + 2 KI \rightarrow PbI_2 + 2 KNO_3
\]

**Reaction 2:**
\[
CuSO_4 + K_2CO_3 \rightarrow CuCO_3 + K_2SO_4
\]

**Reaction 3:**
\[
CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl
\]

**Procedure:**

1. Write the name for the chemicals used in the above reactions:
   a. Pb(NO_3)_2
   b. KI
   c. CuSO_4
   d. K_2CO_3
   e. CaCl_2
   f. Na_2CO_3

2. Gather the SDS’s for the above chemicals. We will start by analyzing only the starting materials, not the products.

3. List the data from two different sources for each of the chemicals in the Student Data Sheet: the Hazardous Chemicals in Schools (HCS List) (http://www.hazwastehelp.org/educators/chemlist.aspx) and the data found on the Safety Data Sheet (SDS).
4. Assign a hazard level of low, medium, or high for the Health Hazard data and the Environmental Hazard data. Use the following as a reference:
   a. H-Statements (or H-Phrases):

<table>
<thead>
<tr>
<th>Health Hazard</th>
<th>Environmental Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>H350, H340, H360, H301, H311, H331, H310, H330, H300</td>
</tr>
<tr>
<td>Medium</td>
<td>H351, H341, H361, H302, H312, H332</td>
</tr>
<tr>
<td>Low</td>
<td>H303, H313, H333 or No H-Phrases</td>
</tr>
</tbody>
</table>

   b. Toxicity Data from SDS’s:

<table>
<thead>
<tr>
<th>Health Hazard</th>
<th>Environmental Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>IARC Group 1 or 2a Carcinogen; Oral LD50 ≤ 300 mg/kg; Dermal LD50 ≤ 1,000 mg/kg; Inhalation (g) LC50 ≤ 2,500 ppm; Inhalation (v) LC50 ≤ 10.0 mg/l; Inhalation (dust, mist) LC50 ≤ 1.0 mg/l</td>
</tr>
<tr>
<td>Medium</td>
<td>IARC Group 2b or 3 Carcinogen, Oral LD50 &gt; 300 but ≤ 2,000 mg/kg; Dermal LD50 &gt; 1,000 but ≤ 2,000 mg/kg; Inh. (g) LC50 &gt; 2,500 but ≤ 20,000 ppm; Inh. (v) LC50 &gt; 10.0 but ≤ 20.0 mg/l; Inh. (dust, mist) LC50 &gt; 1.0 but ≤ 5.0 mg/l</td>
</tr>
<tr>
<td>Low</td>
<td>Oral LD50 &gt; 2,000 mg/kg; Dermal LD50 &gt; 2,000 mg/kg; Inh. (g) LC50 &gt; 20,000 ppm; Inh. (v) LC50 &gt; 20.0 mg/l; Inh. (dust, mist) LC50 &gt; 5.0 mg/l</td>
</tr>
<tr>
<td></td>
<td>96 hr LC50 (fish) ≤ 10 mg/l, 48 hr EC50 (crustacea) ≤ 10 mg/l, 72 or 96 ErC50 (algae) ≤ 10 mg/l</td>
</tr>
<tr>
<td></td>
<td>96 hr LC50 (fish) &gt; 10 but ≤ 100 mg/l, 48 hr EC50 (crustacea) &gt; 10 but ≤ 100 mg/l, 72 or 96 ErC50 (algae) &gt; 1 but ≤ 100 mg/l</td>
</tr>
<tr>
<td></td>
<td>Technical Criteria: 96 hr LC50 (fish) &gt; 100 mg/l, 48 hr EC50 (crustacea) &gt; 100 mg/l, 72 or 96 ErC50 (algae) &gt; 100 mg/l</td>
</tr>
</tbody>
</table>

5. Assign the overall Hazard Level score using the following rules:
   a. If one or both of the Health Hazard or Environmental Hazard are High, then assign the overall Hazard Level → High
   b. If one or both of the Health Hazard or Environmental Hazard are Medium, then assign the overall Hazard Level → Medium
   c. If both of the Health Hazard or Environmental Hazard are Low, then assign the overall Hazard Level → Low

6. Based on your evaluation of the reactants in the three reactions, which reaction do you recommend performing in the lab?
Supplemental Activities:

1. Write the name for the **products** created in the above reactions:
   a. PbI₂
   b. KNO₃
   c. CuCO₃
   d. K₂SO₄
   e. Ca₂CO₃
   f. NaCl

2. Gather the SDS’s for the above chemicals.

3. List the data from two different sources for each of the chemicals in the Student Data Sheet: the Hazardous Chemicals in Schools (HCS List) ([http://www.hazwastehelp.org/educators/chemlist.aspx](http://www.hazwastehelp.org/educators/chemlist.aspx)) and the data found on the Safety Data Sheet (SDS).

4. Assign a hazard level of low, medium, or high for the Health Hazard data and the Environmental Hazard data.

5. Based on your evaluation of the products in the three reactions, would you still recommend performing the same reaction? Why or why not?