**Objectives:**
- Chemical Reactions
- Acid Base Chemistry

Based on BC curriculum requirements for Science 10

**Learning Outcomes:**
- What is a chemical reaction and how can we identify one?
- Know what the basic kinds of reactions are including: acid base (neutralization), combustion, single replacement, double replacement, decomposition and synthesis

**Target Audience:** Grade 10, not intended for groups

**Duration of Workshop:** approximately 1 Hour & 30 Minutes

**Delivery Method:** Online Instruction

**Allergy risks/Safety Protocols:** Do experiments with help and supervision of an adult
A Quick Review of concepts:
A chemical reaction requires a change in the molecular or ionic composition of atoms, and it can be identified by change in color, formation of solid (AKA precipitate), gas, heat, and/or light.

The law of conservation of mass tells us that all the chemicals we start out with must be there at the end of the reaction in some form. This information helps us balance chemical equations.

The types of reactions that we know are:

- **Acid Base Reactions** - In these reactions an acid (a chemical in a solution with a pH value below 7) and a base (a chemical in a solution with a pH value above 7) react to form water and a salt.
  
  \[ \text{Acid} + \text{Base} \rightarrow \text{Water} + \text{Salt} \]
  
  Example: \[ \text{HCl (aq)} + \text{NaOH (aq)} \rightarrow \text{H}_2\text{O (l)} + \text{NaCl (s)} \]

  In this reaction Hydrochloric acid (HCl) and sodium hydroxide (NaOH) react to form water (H₂O) and sodium chloride (NaCl, table salt). This is why acid-base reactions are sometimes called neutralization reactions because the products are neither acidic nor basic when compared to the reactants.

- **Single-Replacement** - In this reaction molecule A exchanges places with molecule C. A and C are usually metals and molecule B would be a non-metal.
  
  \[ \text{A + CB} \rightarrow \text{AB} + \text{C} \]
  
  Example: \[ \text{Zn + CuCl}_2 \rightarrow \text{ZnCl}_2 + \text{Cu} \]

  In this example Zinc replaces Copper and bonds with Chlorine.

- **Double Replacement** - In this reaction 2 metals swap places – every molecule gets a new “partner”.
  
  \[ \text{AB} + \text{CD} \rightarrow \text{AD} + \text{CB} \]
  
  Example: \[ 2\text{NaBr} + \text{BaCl}_2 \rightarrow 2\text{NaCl} + \text{BaBr}_2 \]

- **Decomposition** - In this reaction 1 molecule breaks down into its components
  
  \[ \text{AB} \rightarrow \text{A} + \text{B} \]
  
  Example: \[ 2\text{Al}_2\text{O}_3 \rightarrow 2\text{Al} + 3\text{O}_2 \]
In this reaction Aluminium oxide decomposes into aluminum and oxygen.

- **Synthesis** - In this reaction 2 (or more) atoms or molecules combine to form a larger molecule.
  
  \[ A + B \rightarrow AB \]
  
  Ex. \[ 2K + Cl_2 \rightarrow 2KCl \]
  
  In this reaction potassium and chlorine react to form potassium chloride.

- **Combustion** - This is probably the reaction you are most familiar with; it involves the combustion (burning) of a hydrocarbon fuel in the presence of oxygen gas to produce carbon dioxide and water. This reaction always produces carbon dioxide and water.

  Ex. \[ C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O \]

Today, our activity focuses on acid base reactions, specifically the use of a pH indicator. A solution’s pH value is the unit of measurement that we commonly use to evaluate how acidic or basic it is. The pH scale ranges from 1 to 14, where 1 is the most acidic, 14 is the most basic, and 7 being neutral. A pH indicator is a chemical compound that is used to visually determine if a solution is acidic or basic. The color changes depend on the indicator that is used.

**Real-Life Applications:**
- Antacid tablets like Alka Selzer and Tums help neutralize some of the excess acid in your stomach if you’ve been eating a lot of acidic things and are feeling what is commonly called “heart burn.”

Now that we have reviewed our knowledge, let’s get started with the experiment!

But First...
Prepare for the experiment

1. Watch this video: https://www.youtube.com/watch?v=mQxknvSKwU4
2. Use the Internet to find some pH values for the following solutions. These are your initial “guesses” before we carry out the actual experiment. There is an empty row in case there is something in the house that you want to try that hasn’t been listed):

<table>
<thead>
<tr>
<th>Item</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemon Juice</td>
<td></td>
</tr>
<tr>
<td>Tap Water in BC</td>
<td></td>
</tr>
<tr>
<td>Vinegar</td>
<td></td>
</tr>
<tr>
<td>Baking Soda</td>
<td></td>
</tr>
<tr>
<td>Window Cleaner</td>
<td></td>
</tr>
<tr>
<td>Coca Cola</td>
<td></td>
</tr>
<tr>
<td>Antacid Tablets (e.g. Tums/ Alka Selzer)</td>
<td></td>
</tr>
</tbody>
</table>

3. Gather the materials needed (listed below) and make sure to wear gloves and an apron!
4. Read the method and then start the experiment when you are ready!

Now we are finally ready for the fun stuff!

Experiment: Red Cabbage pH indicator
Adapted from SciGuys & BBC Earth Labs

<table>
<thead>
<tr>
<th>Materials needed</th>
<th>Method</th>
<th>Results &amp; Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Cabbage</td>
<td>- Fill half of the blender with water. Try to not use tap water, use filtered water or bottled water for this step</td>
<td>Note &amp; Record all the cool stuff you notice while you are doing the experiment here.</td>
</tr>
<tr>
<td>Bottled/filtered water</td>
<td>- Now cut about ¼ of a red cabbage into rough pieces and add to blender with water</td>
<td>i.e. what color the solution turns when you add in the red cabbage solution.</td>
</tr>
<tr>
<td>Lemon Juice</td>
<td>- Put the lid of the blender on and blend till most of the cabbage is blended- make sure this is a watery mixture not a smoothie like</td>
<td></td>
</tr>
<tr>
<td>Vinegar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cola</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baking Soda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap Water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Antacid tablets (Alka-Selzer, Tums)- Optional
- Multiple glasses
- Blender
- Gloves
- Apron
- An adult for supervision 😊

| texture, if it is chunkier then add more water and blend again till you get a juice like consistency |
| Slowly pour the mixture from the blender through a sieve into a jug – again make sure the consistency is watery |
| You have now made your very own pH indicator! |
| Now generously pour your indicator solution into as many glasses as the number of items you want to test- for example if you have 7 items get out 7 glasses |
| And one by one add your solutions into their separate glasses and observe the color changes! Ex. Add some lemon juice to one glass, vinegar in the other, baking soda in the other etc. Make sure not to add too much of the other solutions- add equal amount of indicator or less. |

A rough guide to what your results mean:
(The most basic should be green → blue → purple → magenta → red → pink (most acidic))

The Lemon Juice turned __________ when I added the red cabbage solution

Another Question to think about: Is the pH of tap water different to bottled/filtered water?
To finish off: make your own pH scale with the items that you studied!
- Label the scale with the pH’s that you googled and color the scale with what you observed. i.e. lemon juice pH is about 2.2 and let’s say the solution turned pink when I added it to the cabbage indicator.

Example:

![Lemon Juice pH Scale](image)

My pH Scale (based on Red Cabbage Indicator)

![My pH Scale](image)

Finally, write a brief summary of what you have discovered today with your experiment. A good scientific summary paragraph should address a few important points. (1) What was the purpose of the experiment? (2) What were a few of the key findings or results? (3) What are some ways to improve the experiment if you had to do it again? (4) Are there other measurements that you would like to make?