Acids and Bases

Preparation

******Please complete the following BEFORE your presentation*******

- **Email your teacher the flow chart and observation table (CLICK HERE) to print for the students.**
- **Part 3 (the shell-less egg) requires that you place a raw egg in a jar with vinegar ONE WEEK prior to giving the presentation.**

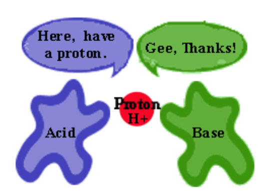
How this relates to the curriculum:

In the Grade 5 Chemistry unit, students are expected to use an indicator to identify a solution as acidic or basic.

** Atoms, molecules, protons and the pH scale are not mentioned until junior high

Part 1: Mysterious Acids and Bases

Background:



Acids and bases are all around us, the classic examples being baking soda and vinegar. However, all liquids are actually acids and bases. There is an exception, and we will get to that later!

Have you ever tasted a lemon? What does it taste like? (A: SOUR) Exactly: acids can be sour, whereas, examples of bases are **soap** or **bitter** like baking soda. From this, we can assume that acids taste sharp or sour whereas bases taste bitter.

Some acids/bases are harmful but others are used in everyday items. Sometimes, drinking acids and bases aren't a very good idea, unless you're looking for an excuse to go to the hospital. To help identify solutions, scientists use pieces of paper made of litmus, which change to different colours in the presence of acids and bases. Litmus paper is known as an indicator.

-What are some household or food items that are acids or bases?

Some common examples of acids:

- Coffee
- Soda
- Citrus fruits
- Stomach acid

Some examples of bases:

- Soap
- Baking Soda
- Laundry Detergent
- Bleach

-Do you use any of them daily?

Everyone interacts with acids and bases everyday.

Fun Fact: The acid in your stomach helps you digest food!

Indicators

So we have defined what an acid or a base is, but how can we identify each without tasting them? We use something called indicators.

Indicators are chemicals that can act as either an acid or base. But how do indicators work? And what exactly are an acid and a base? Two famous scientists (their names are Johannes Brønsted, and Thomas Lowry, if you were wondering) postulated that acids are molecules that give away protons (H+) and bases are molecules that grab protons. Therefore, an indicator is a molecule that can give away and grab protons.

The more acidic something is, the more it tends to steal hydrogen ions from the molecules in the indicator. In the next experiment we will use an indicator made from boiling red cabbage.

Part 1: Mystery Acids and Bases and the Magical Color Changes

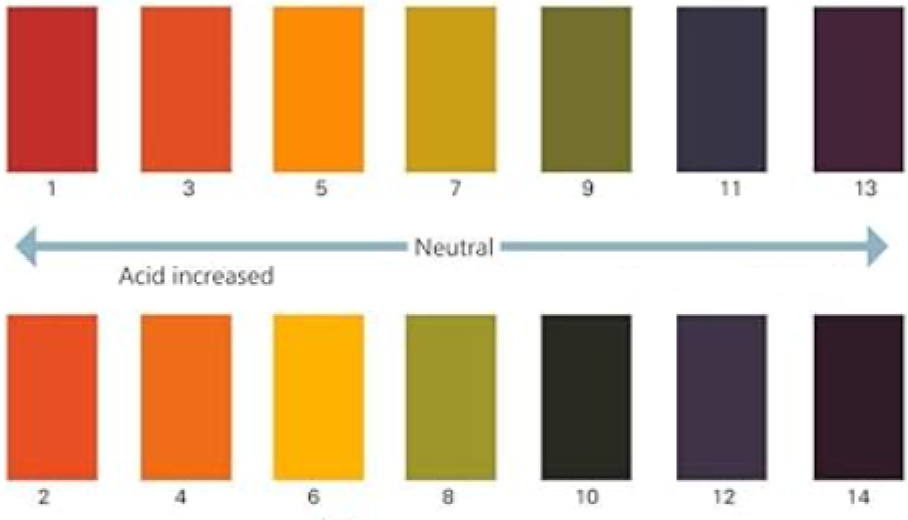
Materials

- 2 Beakers (glass jars are used as a substitute)
- pH Strips (this replaces the cabbage juice indicator)
- Vinegar, Lemon juice, and Bleach (diluted)
- 2 Pairs of safety glasses and gloves (volunteers are required to supply their own safety glasses, gloves will be provided)
- Masking tape and a pen (for labelling stuff)

Video Events

1. 2 solutions are placed out in front. Bleach solution in **beaker A** and vinegar into beaker **B.** **Try to keep the identities of the solutions secret and encourage the kids to figure out what is going on. (ask them to describe what the solution looks like or guess what it might be)*
2. A pH strip is used to check the acidity of both solutions. The pH strip should indicate that bleach is basic, while vinegar is acidic.
3. What's going on? Indicators are chemicals that change colour when they contact an acid or base. pH Strips contain indicators (litmus) which changes colour when exposed to basic or acidic solutions.. **Solution A must therefore be basic and solution B acidic**. We've used vinegar as an acid and bleach as a base.

The more acidic something is, the more it tends to steal hydrogen ions from the molecules in the cabbage juice. The cabbage juice turns from blue to purple when the solution it's in steals some of its hydrogen ions, and from purple to red when even more of hydrogen ions are stolen.



(For colours, see the online version)

You may want to introduce the pH scale. Also note that most indicators only have two possible colours. As pH strips have a range of colours, it can give you even more information than most indicators.

Part 2: Classroom Chemistry

Since (almost) everything is an acid or base, we don't have to use potentially dangerous solutions to understand them. Here is an example:

Materials:

- Lemon juice, soap powder (detergent), water
- Spoons and Cups
- pH Strips
- Eye dropper/Pipette
- Water Bottle (fill at the school)

Video Events

- 3 solutions are placed out in front: lemon juice water and detergent.
- Use pH strips to measure each of the 3 liquids (can ask the students to assist to make this more engaging)
- The pH indicator will turn red in the lemon juice (acidic) , the pH strip will stay yellow in water (netural), and the cabbage juice will appear dark blue due to to colour of the detergent (basic)

Discussion Questions:

Why are the solutions changing color?

Indicators react to the changing pH of the solution. They help determine the H+ ion concentration of the solution. If one of these ions are present, Indicators are weak acids or bases so when they lose (deprotonation) or accept (protonation) a proton, the indicator will form their conjugate acid or base. This will lead to the colour change.

Why didn't the cabbage juice indicator change colors when adding it to the water?

*Be sure to save time to explain that water is **'neutral'**. In chemistry terms, the acidic and basic properties of water are approximately equal and therefore "cancel one another out". That's good for us because if water was acidic, there would be no life on earth!

<u>Part 3: The Shell-less Egg *PLEASE FOLLOW PRE-PREP INSTRUCTIONS*</u>

Materials:

- Egg in jar with vinegar (MUST provide your own)
- *Optional: bring another egg to compare to the 'naked egg'
- Gloves
- Spoon

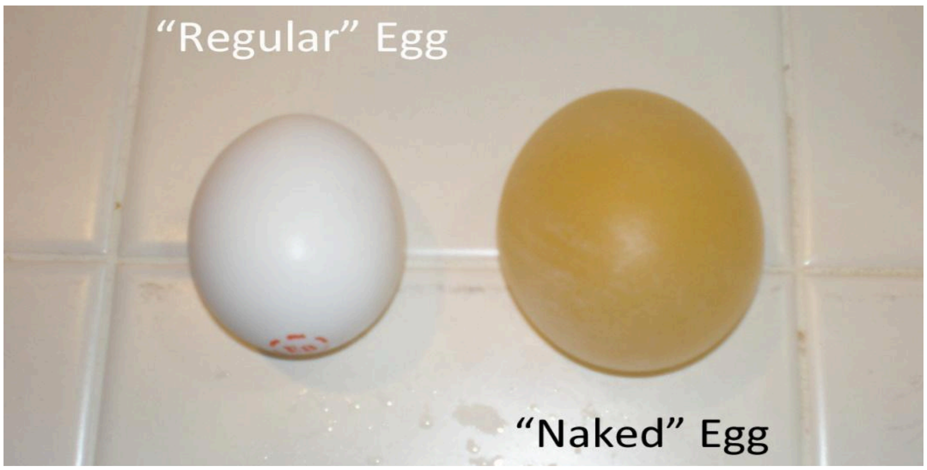
Video Events

- The egg is put in a jar and filled with enough vinegar to submerge the egg. This egg has been sitting in the solution for a week. A fresh egg is placed side by side to show the difference.
- The egg can be taken out of the jar for closer observation.
- The egg can be **gently** squeezed but may be damaged by rough handling.
- There are no eggshells left on the egg, just the membrane.

<u>So what happened???</u>

Egg shells are mostly made of **calcium carbonate ($CaCO_3$)**, which is a **base**. Vinegar is **acetic acid (CH_3COOH)** and therefore reacts with the egg shell in an acid-base reaction. The reaction causes the degradation of the egg shell, leaving behind a naked egg!

$$2\ CH_3COOH + CaCO_3 \text{ -------}\twoheadrightarrow H_2O + CO_2 + Ca(CH_3COO)_2$$



This is the same reaction as vinegar and baking soda, except it takes a much longer time to finish. A translucent (see through) membrane inside the shell remains around the egg.

Many plants and animals other than chickens need calcium

carbonate to form their skeletons and shells:

- **What are some other animals that have shells? (A: sea urchins, crabs, etc.)**

- **Most marine life, especially on the coral reefs, use $CaCO_3$ to build-up their skeletons and shells (even the coral themselves use this compound: which is why acidification of the oceans is such a concern)**

<u>Part 4: An Explosive Acid/Base Reaction</u>

Materials:

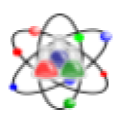
- Baking Soda
- Vinegar
- Beaker
- Tin Pan
- Garbage bag to contain the mess
- Erlenmeyer Flask

Video Events

This is the classic baking soda and vinegar neutralization reaction.

- A beaker full of baking soda is placed into a flask.
- Some vinegar is added to the flask resulting in the neutralization reaction.

The reaction between the baking soda and vinegar is identical to the one in the Shell-less egg experiment, but since the chemicals used are stronger base, the transfer of protons is very aggressive, making quite a show. The second reaction also contains a powder, baking soda, which increases the reaction rate as well.



Why does vinegar and baking soda react? (A: guide them to remember that vinegar is a sour acid and baking soda is a bitter base)

Would this work with something like lemon juice? (A: yes, because the acid in lemon juice (citric acid) has a even slightly lower pH than acetic acid - the display isn't as explosive though) FYI: citric acid can also be found in Kool-Aid!