Design a Natural pH Indicator: Engineering Design Challenge

Concepts:

Acid-base, pH, indicators

This lab as written is Level 2*. Use the following recommendations to increase and/or decrease the challenge difficulty for your students.

Level 1:

The natural indicators in this lab can be prepared in advance. The students would then simply test them and determine their pH ranges. (30 min)

Level 2:

Students are asked to prepare three natural indicators and use standard pH solutions to develop a color chart. They will then pick the indicator they think performed the best and use it to determine the pH of unknown acid and base solutions. They will test the accuracy of their natural indicator against synthetic indicators to see if they were successful in their design. (50 min)

Level 3:

Instead of providing natural indicators, students can choose their own. A table of good indicators is provided or the students can be challenged to bring in their own natural substances and test their efficacy as pH indicators. (50–90 min)

Level 4:

This lab can be made more challenging by omitting the natural indicator preparation instructions and having the students determine the best way to extract each pigment. They could then be given several household substances and be tasked with evaluating their acid-base properties using their natural indicators. (60–90 min)

*Engineering levels are delineated 1–4. Level 1 is the easiest, increasing in difficulty to the most advanced, Level 4.

Outcomes:

Students will find that natural indicators provide great substitutions for synthetic indicators. The key to creating an effective indicator is picking a natural substance that contains the organic pigment anthocyanin, which changes color as pH changes. Anthocyanins are generally found in flowers and vegetables that are red or purple in color. The pigment is then concentrated by different extraction methods depending on the source. Students will be impressed how well their natural indicators work when measured against a synthetic one. This lab will give them an appreciation of how the chemistry they learn in the classroom applies to the world around them.

Associated Phenomena:

How does acid rain impact the environment?

Standards

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking questions and defining problems Planning and carrying out investigations Constructing explanations and designing solutions	HS-PS1.B: Chemical Reactions HS-ETS1.C: Optimizing the Design Solution	Stability and change

Performance Expectations

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.