

<b>Grade &amp; Course:</b> 9-12 Chemistry	<b>Topic:</b> Solutions and Acids/Bases	<b>Duration:</b> 6 weeks
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**Georgia Standards and Content:**

**SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and bases.**

- Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation.
- Plan and carry out an investigation to evaluate the factors that affect the rate at which a solute dissolves in a specific solvent.
- Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e. molarity and percent by mass).
- Communicate scientific and technical information on how to prepare and properly label solutions of specified molar concentration.
- Develop and use a model to explain the effects of a solute on boiling point and freezing point.
- Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH. (Clarification Statement: Understanding of the mathematical relationship between negative logarithm of the hydrogen concentration and pH is not expected in this element. Only a conceptual understanding of pH as related to acid/basic conditions is needed.)
- Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted-Lowry models of acid and bases.
- Plan and carry out an investigation to explore acid-base neutralization.

**Narrative / Background Information**

**Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)**

**SPS6. Obtain, evaluate, and communicate information to explain the properties of solutions.**

- Develop and use models to explain the properties (solute/solvent, conductivity, and concentration) of solutions.
- Plan and carry out investigations to determine how temperature, surface area, and agitation affect the rate solutes dissolve in a specific solvent.
- Analyze and interpret data from a solubility curve to determine the effect of temperature on solubility.
- Obtain and communicate information to explain the relationship between the structure and properties (e.g., pH, and color change in the presence of an indicator) of acids and bases. (Clarification statement: Limited to only the structure of simple acids and bases (e.g., HCl and NaOH) that demonstrates the presence of an H<sup>+</sup> or OH<sup>-</sup>).
- Plan and carry out investigations to detect patterns in order to classify common household substances as acidic, basic, or neutral.

**Year-Long Anchoring Phenomenon (LEARNING PROCESS)**

Changes to the measurement of chemicals added to Flint Michigan's water supply created dangerous levels of lead contamination in the drinking water.

**Unit Phenomenon (LEARNING PROCESS)**

When engaging in vigorous physical activity the body produces lactic acid which is neutralized by the body through various chemical processes.

**MYP Inquiry Statement:**

The interaction of components within a system influences its properties and behavior.

**MYP Global Context:**

Fairness and Development

**Approaches to Learning Skills:**

- Communication skills: take effective notes in class
- Critical Thinking Skills: interpret data
- Information Literacy Skills: collect, record and verify data

**Disciplinary Core Ideas: (KNOWLEDGE & SKILLS)**

- Solutions
  - Parts of a Solution
  - Solvation
  - Dissociation
  - Rate of Dissolving
- Concentration / Saturation
  - Molarity
  - Percent by Mass
  - Dilution
  - Saturated, unsaturated, supersaturated solutions
- Solution Preparation and Proper Labeling
- Colligative Properties
  - Boiling Point Elevation
  - Freezing Point Depression

**Crosscutting Concepts: (KNOWLEDGE & SKILLS)**

- Systems and System Models
- Patterns
- Stability and Change
- Cause and Effect

- Acids and Bases
  - $\text{H}_3\text{O}^+$  Concentration
  - pH
  - Arrhenius Model
  - Bronsted-Lowry Model
- Neutralization
  - Equivalence Point
  - Titration
  - Indicator
  - End point

**MYP Key and Related Concepts:**

- Key Concepts: Systems
- Related Concepts: Models, Movement, Interaction, Conditions, Function

**Possible Preconceptions/Misconceptions: (REFLECTION – PRIOR TO TEACHING THE UNIT)**

- To dissolve means a substance disappears or is lost
- Freezing point and melting points are constant values
- Acids always have Hs and bases always have OHs
- Solutions are always liquids
- Acids are dangerous and bases are not
- Acids and bases cannot be consumed by humans (aka all chemicals, not in everyday products)
- All solutions are saturated
- You can tell the difference between the solutions just by looking at them

**Key Vocabulary: (KNOWLEDGE & SKILLS)**

- Solution
- Solvation
- Dissociation
- Rate of solvation
- Solute
- Solvent
- Saturated Solution
- Unsaturated Solution
- Supersaturated Solution
- Concentration
- Molarity
- Percent by mass
- Percent by volume
- Colligative property
- Boiling point
- Freezing point
- Percent dissociation
- Acid
- Base
- Arrhenius Acid/Base
- Lewis Acid/Base
- Bronsted-Lowry Acid/Base
- Neutralization
- Hydronium ion
- pH
- Equivalence point
- Titration
- Indicator
- End Point

**Inquiry Questions:**

**Factual:**

- What are the key properties that define a solution, and how do solutes and solvents interact?
- How do acids and bases differ in terms of pH, ion concentration, and their chemical properties?
- What are the common indicators used to determine whether a substance is an acid or a base?
- How does the process of neutralization occur, and what are the products of an acid-base reaction?

**Conceptual:**

- How do the properties of solutions, such as concentration and solubility, influence their real-world applications?
- Why is pH important in biological and environmental systems, and how can changes in pH impact these systems?
- How do acids and bases interact in neutralization reactions, and why are these reactions significant in everyday life?
- What factors affect the solubility of a substance, and how can solubility be manipulated in different industries (e.g., medicine, food production)?

**Debatable**

- Should the use of strong acids and bases in household products be more strictly regulated to prevent environmental and health hazards?
- Is the widespread use of acid rain mitigation strategies enough to counteract its long-term effects on ecosystems?
- Should industries be required to neutralize all acidic and basic waste before disposal, even if it increases production costs?
- Are artificial pH-balancing methods in food and water necessary, or do they pose more risks than benefits?

MYP Objectives		Summative assessment	
<ul style="list-style-type: none"> <li>• MYP Criterion B (iv): design scientific investigations</li> </ul>		Relationship between summative assessment task(s) and statement of inquiry: Students will perform tasks and respond to assessment items that will gauge their mastery of solutions and acids and bases as required by the Georgia Standards of Excellence. Mastery of these concepts is necessary to move forward in our study of chemical behavior.	
Learning Activities and Experiences	Inquiry & Obtain: (LEARNING PROCESS)	Evaluate: (LEARNING PROCESS)	Communicate: (LEARNING PROCESS)
<b>Weeks 1 to 3:</b> <b>Georgia Standards of Excellence:</b> SC6(a) - Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation. SC6(c) - Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e. molarity and percent by mass). SC6(d) - Communicate scientific and technical information on how to prepare and properly label solutions of specified molar concentration.			
<b>Lesson 1</b> <b>(Solvation and Dissociation)</b>  SC6(a)	Engage - what is a solution, and what are its characteristics?  Explore - modeling dissociation and solvation	Explain - compare and contrast dissociation and solvation, practice with modeling  Elaborate - hydration (how do we form a metal hydrate?)	Evaluate - Ticket out the Door or other formative assessment
<b>Lesson 2</b> <b>(Concentration and Dilution)</b>  SC6(c) SC6(d)	Engage - importance of understanding concentration in daily life  Explore - calculations with molarity and dilutions	Explain - practice with molarity and dilution calculations  Elaborate - other units of concentration besides molarity (examples: molality, percent by volume, ppm, ppb)	Evaluate - Ticket out the Door or other formative assessment
<b>Lesson 3</b> <b>(Preparing a Solution)</b>  SC6(d)	Engage - review molarity calculations (determining mass of solute required for a given concentration and volume)  Explore - steps for preparing a stock solution and diluting	Explain - practice with calculations, lab practice with stock solutions and dilutions  Elaborate - serial dilution and other advanced techniques	Evaluate - Lab Practical assessment (performance task judged by teacher)

<b>Lesson 4</b> <b>(Stoichiometry with Solutions)</b>  <b>SC6(c)</b> <b>SC6(d)</b>	Engage - review Stoich with masses - <i>why do we need to do something a little different with solutions?</i>  Explore - extending stoichiometry to solutions (including $n=cV$ )	Explain - practice with solution-based stoichiometry  Elaborate - percentage yield with solutions	Evaluate - Common Formative Assessment on SC6(a), SC6(c), and SC6(d) - Solutions
<b>Weeks 4 to 6:</b> <b>Georgia Standards of Excellence:</b> SC6(f) - Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH. SC6(g) - Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted-Lowry models of acid and bases. SC6(h) - Plan and carry out an investigation to explore acid-base neutralization.			
<b>Lesson 5</b> <b>(Acid and Base Models)</b>  <b>SC6(g)</b>	Engage - revisit solvation and dissociation - <i>what is an acid? what is a base?</i>  Explore - compare and contrast merits and limitations of Arrhenius and Bronsted-Lowry models	Explain - practice with Bronsted-Lowry model and identifying conjugate acid-base pairs  Elaborate - compare and contrast with Lewis acid-base theory	Evaluate - Ticket out the Door or other formative assessment
<b>Lesson 6</b> <b>(pH Calculations)</b>  <b>SC6(f)</b>	Engage - pH scale overview  Explore - calculations involving pH, pOH, $[H^+]$ , and $[OH^-]$	Explain - practice with pH calculation  Elaborate - connect with solution stoichiometry	Evaluate - Ticket out the Door or other formative assessment
<b>Lesson 7</b> <b>(Neutralizing Acids and Bases)</b>  <b>SC6(h)</b>	Engage - lactic acid neutralization in the body (revisit anchoring phenomenon)  Explore - introduction to titrations and related calculations	Explain - practice with acid-base titration calculations  Explain - Acid-Base Titration Lab Investigation (either hands-on or virtual)  Elaborate - back titration or redox titration	Evaluate - Common Formative Assessment on SC6(f), SC6(g), and SC6(h) - Acids and Bases
<b>Resources (hyperlink to model lessons and/or resources):</b> Discovery Education Science Techbook			

Reflection: Considering the planning, process and impact of the inquiry		
Prior to teaching the unit	During teaching	After teaching the unit