Advanced Topics in Chemistry

Summit High School
Summit, NJ

Grade Level / Content Area:
11th and 12th Grade / Chemistry

Length of Course: 1 Semester

Developed by
Jodi Friedman and Christine Stelmach
Summit High School
2013-2014
## Unit 1: Organic Chemistry

**NJ SCIENCE STANDARD 5.1 Science Practice:** All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge.

**NJ SCIENCE STANDARD 5.2 Physical Science:** All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

### Big Ideas: Scientific Reasoning & Investigative Skills

**5.1.A Understand Scientific Explanations:** Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

**5.1.B Generate Scientific Evidence Through Active Investigations:** Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

**5.1.C Reflect on Science Knowledge:** Scientific knowledge builds on itself over time.

**5.1.D Participate Productively in Science:** The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

### Big Ideas: Matter and Energy

**5.2.A Properties of Matter:** All objects and substances in the natural world are composed of matter. Matter has two fundamental properties: matter takes up space, and matter has inertia.

**5.2.B Changes in Matter:** Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

### Essential Questions

**What provocative questions will foster inquiry, understanding, and transfer of learning?**

- How are organic compounds used in the body to treat different diseases and disorders?
- Can molecular structure predict physiological application?

### Enduring Understandings

**What will students understand about the big ideas?**

Students will understand that...

- Organic chemistry is the study of compounds containing carbon and hydrogen.
- Different functional groups are used to change the physical and chemical properties of organic compounds.
- Functional groups can be identified
Based on their name and structure.

- Most pharmaceutical compounds consist of organic compounds.
- There is a relationship between molecular structure and biological application.

### Areas of Focus: Proficiencies (Cumulative Progress Indicators) | Examples, Outcomes, Assessments
---|---

<table>
<thead>
<tr>
<th>NJCCCS CPI #'s:</th>
<th>Instructional Focus</th>
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<tbody>
<tr>
<td>5.1.12.A.1 Refine interrelationships among concepts and patterns of evidence found in different central scientific explanations.</td>
<td>SWBAT recognize, name and draw simple organic compounds and specific organic functional groups.</td>
</tr>
<tr>
<td>5.1.12.A.2 Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories.</td>
<td>SWBAT use the ChemDraw, an organic drawing tool to draw organic compounds.</td>
</tr>
<tr>
<td>5.1.12.A.3 Use scientific principles and theories to build and refine standards for data collection, posing controls, and presenting evidence.</td>
<td>SWBAT recognize patterns in organic structure and pharmaceutical application.</td>
</tr>
<tr>
<td>5.1.12.B.1 Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/correlational relationships, and anomalous data.</td>
<td>SWBAT describe how particular organic compounds react in the body.</td>
</tr>
<tr>
<td>5.1.12.B.2 Build, refine, and represent evidence-based models using mathematical, physical, and computational tools.</td>
<td>Sample Assessments:</td>
</tr>
<tr>
<td>5.1.12.B.3 Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories.</td>
<td>- Overall the material in this unit will be presented in a problem based learning format. Students will be given opportunities to synthesize their own information through online research and ChemDraw and pattern recognition.</td>
</tr>
<tr>
<td>5.1.12.B.4 Develop quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations.</td>
<td>- Specifically (for the PBL) Students will choose three diseases/disorders they wish to research. They will identify three organic compounds that are used to treat each disease. They will use ChemDraw to draw the structure of each compound then explain how the drugs work in the body.</td>
</tr>
<tr>
<td>5.1.12.C.1 Reflect on and revise understandings as new evidence emerges.</td>
<td>- Project will be discussed in the class and presented in written format (ether paper or poster)</td>
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<tr>
<td>5.1.12.C.2 Use data representations</td>
<td>Instructional Strategies:</td>
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and new models to revise predictions and explanations.

5.1.12.C.3 Consider alternative theories to interpret and evaluate evidence-based arguments.

5.1.12.D.1 Engage in multiple forms of discussion in order to process, make sense of, and learn from others' ideas, observations, and experiences.

5.1.12.D.2 Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.

5.1.12.D.3 Demonstrate how to use scientific tools and instruments.

5.1.12.A.1 Use atomic models to predict the behaviors of atoms in interactions.

5.2.12.A.2 Account for the differences in the physical properties of solids, liquids, and gases.

5.2.12.B.3 Balance chemical equations by applying the law of conservation of mass.

### Interdisciplinary Connections
- **Medicine**: Application of Chemistry to medicine.
- **Economics/Ethics**: World wide availability of pharmaceutical products
- **Communication**: oral and written presentation of work.

### Technology Integration
- **ChemDraw** or a similar drawing program will be used to draw organic compounds.

### Media Literacy Integration
- Students will use on line resources to research the molecular structure of active pharmaceutical ingredients.
- Students will use on line resources to research how active pharmaceutical ingredients act in the body.

### Global Perspectives
- We will focus on the use organic compounds to treat and to cure diseases and disorders. Although some of these compounds occur naturally, many are produced by large companies and sold for profit.
- **Biodiversity** – natural products have many physiological applications and often serve as the basis for pharmaceutical research.

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### Unit 2: Analytical Chemistry

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**NJ SCIENCE STANDARD 5.2 Physical Science**: All students will understand that physical science principles, including fundamental ideas about matter,
energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

**Big Ideas: Scientific Reasoning & Investigative Skills**

**5.1.A Understand Scientific Explanations:** Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

**5.1.B Generate Scientific Evidence Through Active Investigations:** Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

**5.1.C Reflect on Science Knowledge:** Scientific knowledge builds on itself over time.

**5.1.D Participate Productively in Science:** The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

**Big Ideas: Matter and Energy**

**5.2.B Changes in Matter:** Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

**5.2.C Forms of Energy** Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

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**Essential Questions**

*What provocative questions will foster inquiry, understanding, and transfer of learning?*

- What is the best analytical tool or tools for solving a particular problem, collecting a set of data or answering a particular question?
- How does the question determine the instrumentation?
- How do mixtures change the question and therefore the instrumentation?

**Enduring Understandings**

*What will students understand about the big ideas?*

Students will understand that…

- A variety of analytical tools are available to scientists. Although no one person can be an expert in each tool or technique, each of us must recognize that different tools are used for different purposes.
- Analytical tools can be used for physical and chemical characterization of substance and mixtures. We will focus on spectroscopy (UV/Vis, IR, mass, polarized light), XRPD, chromatography (liquid, gas, thin layer, paper), NMR, microscopy, DCS, and TGA.
- Analytical chemistry is used to generate qualitative and quantitative data and can therefore be used to support studies of
kinetics and thermodynamics.

- Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data or evidence.
- Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
- Mathematical tools and technology are used to gather, analyze, and communicate results.
- Empirical evidence is used to construct and defend arguments.
- Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.
- Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
- Data and refined models are used to revise predictions and explanations.
- Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges.
- Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.
- Only properly maintained equipment provides reliable results.

### Areas of Focus: Proficiencies (Cumulative Progress Indicators)

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<td><strong>5.1.12.A.2</strong></td>
<td>Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories.</td>
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<td><strong>5.1.12.A.3</strong></td>
<td>Use scientific principles and</td>
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### Instructional Focus

- Beer’s Law and spectrophotometry for quantitative analysis of solutions.
- How to make Relative Humidity Chambers using desiccators or jars.
theories to build and refine standards for data collection, posing controls, and presenting evidence.

5.1.12.B.1 Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/ correlational relationships, and anomalous data.

5.1.12.B.2 Build, refine, and represent evidence-based models using mathematical, physical, and computational tools.

5.1.12.B.3 Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories.

5.1.12.B.4 Develop quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations.

5.1.12.C.1 Reflect on and revise understandings as new evidence emerges.

5.1.12.C.2 Use data representations and new models to revise predictions and explanations.

5.1.12.C.3 Consider alternative theories to interpret and evaluate evidence-based arguments.

5.1.12.D.1 Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences.

5.1.12.D.2 Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.

5.1.12.D.3 Demonstrate how to use scientific tools and instruments.

5.2.12.B.2 Describe oxidation and reduction reactions.

5.2.12.B.3 Balance chemical equations by applying the law of conservation of and appropriate salt solutions.

- Use of thermo gravimetric analysis (TGA) to determine hygroscopicity.
- Measure rate of oxygen uptake using oxygen polagrophy (Vernier probes).
- Determine tools used to determine crystal structure (melting point apparatus, DSC, XRPD, polarized light microscopy).
- Use of IR, NMR and mass spec to study molecular structure.
- Convert between units of light intensity, relate to ambient lighting and photo reactivity.
- Study different tools and techniques based on student interest and instrument availability.
- Discuss the environmental impact (solvent waste, cost, dust) of different techniques.

Sample Assessments:
- Beer’s Law lab
- Hygroscopicity lab
- Oxygen Polarography Lab
- Analysis of on line data
- Analysis of article in popular press.

Instructional Strategies:

Interdisciplinary Connections

- Environmental Science: Analytical chemistry used to determine concentration of toxins in water, air, soil etc.
- Mathematics: Identify rate of degradation or oxidation.
- Biology/Physiology: analytical chemistry used for blood work to determine organ efficiency, ratio of “good” and “bad” cholesterol, and ratio of fast twitch to slow twitch muscles. Also used to study presence of drugs or alcohol in the blood or breath.
- Biology – DNA labs
5.2.12.C.2 Account for any trends in the melting points and boiling points of various compounds.

- Forensics – crime scene investigation

**Technology Integration**
- Logger pro software.
- Excel tables, formulas and graphs.
- How do breathalyzers work?
- High throughput, robotics

**Media Literacy Integration**
- Interpretation of online data.
- Read an article in the popular press that includes some type of analytical data. Identify what analytical techniques may have been used to generate the data; and the limitations and reliability of these techniques.

**Global Perspectives**
- Analytical tools and techniques have specific applications and limitations. Which techniques can be used reliably? Can we trust analytical data discussed in popular press?

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**Unit 3: Biochemistry and Biopharmaceutical Chemistry**

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**NJ SCIENCE STANDARD 5.2 Physical Science**: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

**Big Ideas: Scientific Reasoning & Investigative Skills**

- **5.1.A Understand Scientific Explanations**: Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.
- **5.1.B Generate Scientific Evidence Through Active Investigations**: Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.
- **5.1.C Reflect on Science Knowledge**: Scientific knowledge builds on itself over
5.1.D Participate Productively in Science: The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

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<td>What will students understand about the big ideas?</td>
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| • What is a drug? What happens to a drug when it goes into the body? How long does it stay in body? | Students will understand that…
| • How can the formulation of a drug effect its pharmacokinetic profile? |  ▪ Any foreign substance that enters the body is subject to the adsorption by the body, distribution into the tissue, metabolism, and excretion. The study of these processes is called ADME studies or pharmacokinetics.
| • What studies can or should be done in the lab to predict the behavior of a compound *in vivo*? |  ▪ The half-life of a drug in the body can be directly related to dosing strategies.
| • How do enzymes effect the lifetime of a drug in the body? |  ▪ Certain physical properties like solubility, partition and permeability can be used to predict in vivo behavior.
| |  ▪ Enzymes are biological catalysts that increase the rate of reaction of substances in the body.
| |  ▪ Interpretation and manipulation of evidence-based models are used to build and critique arguments and explanations.
| |  ▪ Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations.
| |  ▪ Mathematical tools and technology are used to gather, analyze, and communicate results.
| |  ▪ Empirical evidence is used to construct and defend arguments.
| |  ▪ Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions.
| |  ▪ Refinement of understandings, explanations, and models occurs as new evidence is incorporated.
Data and refined models are used to revise predictions and explanations.
Only properly maintained equipment provides reliable results.

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*5.1.12.A.2* Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories.  
*5.1.12.A.3* Use scientific principles and theories to build and refine standards for data collection, posing controls, and presenting evidence.  
*5.1.12.B.1* Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/correlational relationships, and anomalous data.  
*5.1.12.B.2* Build, refine, and represent evidence-based models using mathematical, physical, and computational tools.  
*5.1.12.B.3* Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories.  
*5.1.12.B.4* Develop quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations.  
*5.1.12.C.1* Reflect on and revise understandings as new evidence emerges.  
*5.1.12.C.2* Use data representations and new models to revise predictions | **Instructional Focus**  
- Use two-dimensional models to show how molecules bind to enzymes.  
- Use physical properties of molecules to predict binding to specific enzymes.  
- Relate common enzymes to their specific function.  
- Show how the biopharmaceutical classification system (BCS) is used to predict in vivo behavior of drugs.  
- Classify compounds using the BCS classification system based on measurement of physical properties.  
- Devise a method for measuring the dissolution rate of a compound in aqueous solution. Explore factors that will affect the rate of dissolution.  
- Relate dissolution studies to in vivo pharmacokinetics.  
- Use the ADME model to describe the processes that a drug is subject to when it enters the body.  

**Sample Assessments:**  
- Dissolution Lab  
- Bipharmaceutical classification system worksheet and lab  
- Enzyme Problem Based Learning – identify three enzymes in the human body. Describe what process or processes each enzyme effect. What would happen to a person who had a low concentration of
and explanations.

5.1.12.C.3 Consider alternative theories to interpret and evaluate evidence-based arguments.

5.1.12.D.1 Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences.

5.1.12.D.2 Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.

5.1.12.D.3 Demonstrate how to use scientific tools and instruments.

these enzymes in the body? How do enzyme levels vary across the population? Are there synthetic enzymes?

- Examining case studies of drug interactions

Instructional Strategies: Interdisciplinary Connections

- Health: how drugs work in the body
- Physiology, Biochemistry: enzymes

Technology Integration

- Use computer software or online resources to produce enzyme models.
- Use Excel spread sheets and graphs to create dissolution profiles.
- Use spectrometers to determine drug solubility.

Media Literacy Integration

- Marketing of drugs in popular media
- Scientific Journal articles on BCS, dissolution, and pharmacokinetics.

Global Perspectives

- Do drugs behave differently in different populations. Can the behavior of a drug be enhanced by formulation?
- Biology: Enzymes are biological catalysts that increase the rate or reactions in our bodies. People who lack the enzyme lactase cannot digest the sugar in dairy products and are said to lactose intolerant.

Unit 4: Environmental Chemistry

NJ SCIENCE STANDARD 5.1 Science Practice: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge.
**Big Ideas: Scientific Reasoning & Investigative Skills**

5.1.D Participate Productively in Science: The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

**Big Ideas: Matter and Energy**

5.2.B Changes in Matter: Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

5.2.C Forms of Energy Knowing the characteristics of familiar forms of energy, including potential and kinetic energy, is useful in coming to the understanding that, for the most part, the natural world can be explained and is predictable.

5.2.D Energy Transfer and Conservation: The conservation of energy can be demonstrated by keeping track of familiar forms of energy as they are transferred from one object to another.

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<td>- Can chemistry find the answer to: the energy crisis, global warming and other environmental issues?</td>
<td>Students will understand that…</td>
</tr>
<tr>
<td>- Is Nuclear energy an environmental solution or a disaster waiting to happen?</td>
<td>- The second Law of Thermodynamics is a fundamental law of science and plays a critical role in environmental issues.</td>
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<tr>
<td>- Are all plastics really recyclable?</td>
<td>- Chemistry and chemical reactions can be used to benefit the environment by reducing and reusing waste.</td>
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<td>- Properly managing waste is a key component to sustainable use of resources.</td>
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<td></td>
<td>- Chemical production processes that incorporate waste management are critical to a sustainable society. (e.g. biodegradable plastics)</td>
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<td></td>
<td>- Oxidation of hydrocarbons is an exothermic process. The amount of energy produced and waste created depends on the amount of fuel burned and the structure of the fuel.</td>
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- Nuclear energy has both positive and negative environmental consequences.

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  5.1.12.D.2 Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.  
  5.1.12.D.3 Demonstrate how to use scientific tools and instruments.  
  5.2.12.B.3 Balance chemical equations by applying the law of conservation of mass.  
  5.2.12.C.2 Account for any trends in the melting points and boiling points of various compounds.  
  5.2.12.D.2 Describe the potential commercial applications of exothermic and endothermic reactions.  
  5.2.12.D.3 Describe the products and potential applications of fission and fusion reactions | **Instructional Focus**  
  - Diesel Fuel PBL – students will show by research and experimentation how waste vegetable oil can be converted to diesel fuel.  
  - Biodegradable Plastic PBL – students will be able to show by research and experimentation how biodegradable plastics can be made. Analytical strategies to determine the properties of the plastics will be devised and executed.  
  - Nuclear Chemistry PBL – explain nuclear reactions in terms of the energy produced.  

**Sample Assessments:**  
- Biodegradable Plastics PBL  
- Diesel Fuel PBL  
- Nuclear Chemistry PBL  
- Specifically (for the PBL) Students Project will be discussed in the class and presented in written format (ether paper or poster)

**Instructional Strategies:**  
**Interdisciplinary Connections**  
- Environmental Science: Renewable Resources, Pollution  
- Economics: fuel costs

**Technology Integration**  
- ChemDraw or a similar drawing program will be used to draw organic compounds.

**Media Literacy Integration**  
- ChemMatters
Journal of Chemical Education

Global Perspectives
- Application of Chemistry to solve real world problems of energy and pollution.
- Nuclear power is used around the world as a clean and economical energy source. Recent nuclear disasters include the episode in Japan and Chernobyl.

Unit 5: Chemistry of Acids and Bases

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<td>What provocative questions will foster inquiry, understanding, and transfer of learning?</td>
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<td>• What is the relationship between pH and human health?</td>
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<tr>
<td>• How do acids and bases affect our ecosystems?</td>
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<td>What will students understand about the Big Ideas?</td>
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<tr>
<td>Students will understand that…</td>
</tr>
<tr>
<td>• What the pH scale measures and how it changes.</td>
</tr>
<tr>
<td>• Acids and bases are important in numerous chemical processes that occur around us, from industrial to biological processes, from the laboratory to the environment.</td>
</tr>
</tbody>
</table>
| • Organisms have narrow ranges of
tolerance to changes in pH.

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<td>NJCCCS CPI #: 5.1.12.D.2 Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.</td>
<td><strong>Instructional Focus:</strong></td>
</tr>
<tr>
<td><strong>5.2.12.A.6</strong> Relate the pH scale to the concentrations of various acids and bases.</td>
<td>- Explain how buffers work in the body to maintain pH.</td>
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<td>- Study the effect of soil acidity on plant growth. Explain how some common substances are used to change soil pH. Correlate recommended soil pH with plant type.</td>
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<td>- Why is the pH of rainwater acidic?</td>
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<td>- Define and use the Bronsted and Arrhenius concepts of acids and bases.</td>
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<td>- Recognize common monoprotic and polyprotic acids and bases and write equations for their chemical ionizations in water.</td>
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<td>- Identify Bronsted Lowery acids and bases and their conjugates in a balance chemical equation.</td>
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<td>- Identify substances as amphoteric.</td>
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<td>- Write an equation for the autoionization of water and relate the value of Kw to the concept of pH.</td>
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<td>- Identify common strong acids and strong bases.</td>
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<td>- Predict the products of an acid-base reaction and calculate the pH of the resulting solution.</td>
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<td>- Describe the acid-base titration experiment and predict the pH of an acid-base reaction at its equivalence point.</td>
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<tr>
<td><strong>Sample Assessments:</strong></td>
<td></td>
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<tr>
<td>- Draw a diagram of the human body. Clearly show the pH and buffer systems located in different parts of the body.</td>
<td></td>
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<tr>
<td>- PBL – what is the environmental effect of acids and bases?</td>
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Instructional Strategies: Interdisciplinary Connections
- Mathematics: converting between base ten log and decimal notation
- Biology: activity of buffer systems in the human body.
- Environmental Science: Environmental impact of acids and bases.

Technology Integration
- Vernier software and pH probes.

Media Literacy Integration
- Use online resources to find information on acids and bases in the environment.

Global Perspectives
- Safety of acids and bases.
- Effect of acids and bases in the environment.

Unit 6: Careers Related to Chemistry

NJ SCIENCE STANDARD 5.1 Science Practice: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge.

NJ SCIENCE STANDARD 5.2 Physical Science: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

Big Ideas: Scientific Reasoning & Investigative Skills
5.1.C Reflect on Science Knowledge: Scientific knowledge builds on itself over time.
5.1.D Participate Productively in Science: The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.

<table>
<thead>
<tr>
<th>Essential Questions</th>
<th>Enduring Understandings</th>
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<tbody>
<tr>
<td>What provocative questions will foster</td>
<td>What will students understand about</td>
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<tr>
<td>inquiry, understanding, and transfer of learning?</td>
<td>the big ideas?</td>
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| • Is chemistry in my future?  
  • Are careers in Chemistry rewarding? | Students will understand that…  
  ▪ Many career options are available for people who have a background in Chemistry and other sciences.  
  ▪ A degree in chemistry is a flexible and valuable asset as you start a career. |

<table>
<thead>
<tr>
<th>Areas of Focus: Proficiencies (Cumulative Progress Indicators)</th>
<th>Examples, Outcomes, Assessments</th>
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<tbody>
<tr>
<td>NJCCCS CPI #'s:</td>
<td>Instructional Focus</td>
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<tr>
<td>5.1.12.C.1 Reflect on and revise understandings as new evidence emerges.</td>
<td>• Some of the career choices that will be explored include: pharmacist, forensic scientist, medical technician, patent attorney, pharmaceutical sales and marketing, chemist, environmental scientist, technical writer, project manager, teacher, professor, medical doctor, stone conservator and inventor.</td>
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<td>5.1.12.C.3 Consider alternative theories to interpret and evaluate evidence-based arguments.</td>
<td>• Guest speakers with careers related to chemistry will be invited to give presentations to students.</td>
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<td>5.1.12.D.1 Engage in multiple forms of discussion in order to process, make sense of, and learn from others’ ideas, observations, and experiences.</td>
<td>• The role and process of patents as a tool to protect and inspire scientific discovery.</td>
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<td>5.1.12.D.2 Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.</td>
<td>• Brainstorm chemistry/science related inventions would require a patent.</td>
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<td>5.1.12.D.3 Demonstrate how to use scientific tools and instruments.</td>
<td>Sample Assessments:</td>
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| Instructional Strategies: | • Careers Related to Chemistry Essay – Reflection on possible careers and how they align with future goals.  
  • Interview of Person working in a Chemistry Related Field  
  • Online patent search |

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<tr>
<th>Interdisciplinary Connections</th>
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<tr>
<td>• Law</td>
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<tr>
<td>• Business</td>
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<tr>
<td>• Environmental Science</td>
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<tr>
<td>• Communication</td>
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<td>• Biology/Ethics: Patents for Genes?</td>
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<th>Technology Integration</th>
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<tbody>
<tr>
<td>• Microsoft Word</td>
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<tr>
<td>• Use online resources to search patent websites.</td>
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<th>Media Literacy Integration</th>
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<tr>
<td>• Use online resources to find job descriptions.</td>
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<td>• Patent verbiage.</td>
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<th>Global Perspectives</th>
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<tbody>
<tr>
<td>• Many jobs require a scientific background.</td>
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<tr>
<td>• Inventions need to be patented to protect inventor.</td>
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