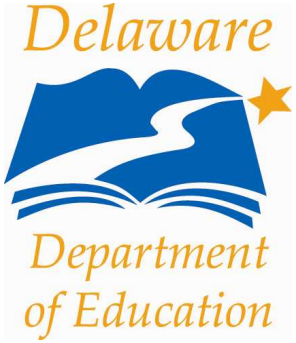
Delaware Science Coalition

Grade 9 Chemistry Unit Template
Living by Chemistry – Alchemy/Smells



Preface: This unit has been created as a model for teachers in their designing or redesigning of course curricula. It is by no means intended to be inclusive; rather it is meant to be a springboard for teacher thought and creativity. The information we have included represents one possibility for developing a unit based on the Delaware content standards and the Understanding by Design framework and philosophy.

Brief Summary of Unit – This unit is the second in the ninth grade year. Students become active learners as they investigate foundational chemistry concepts including safety, atomic structure, isotopes, periodicity, ionic and covalent bonds, and basic nomenclature and balancing of chemical equations.

Stage 1: Desired Results
Delaware Science Content Standards

Delaware Science Content Standards

This course focuses on the Delaware Science Content Standards and Grade Level Expectations in Standards 1, 2, 3, 5, 6, and 8 found on the following website: **http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml**.

Standard 1: The Nature and Application of Science and Technology

Understandings and Abilities of Scientific Inquiry

Students should know and be able to:

1. Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.
   - Be able to: Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.
2. Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.
   - Be able to: Design and conduct investigations with controlled variables to test hypotheses.
3. Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.
   - Be able to: Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams, and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

4. Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.
   - Be able to: Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models, and knowledge from other sources as well as results of further investigation.
5. Understand that: Evaluating the explanations proposed by others involves examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Conflicting data or conflicting interpretations of the same data suggest the need for further investigation. Continued investigation can lead to greater understanding and resolution of the conflict.
   - Be able to: Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.
6. Understand that: Scientific habits of mind and other sources of knowledge and skills are essential to scientific inquiry. Habits of mind include tolerance of ambiguity, skepticism, openness to new ideas, and objectivity. Other knowledge and skills include mathematics, reading, writing, and technology.
   - Be able to: Use mathematics, reading, writing, and technology when conducting scientific inquiries.

Science, Technology, and Society

Students should know that:

- Advances in technology can expand the body of scientific knowledge. Technological tools allow people to observe objects and phenomena that otherwise would not be possible. Technology enhances the quality, accuracy, speed, and analysis of data gathered.
- Science and technology in society are driven by the following factors: economical, political, cultural, social, and environmental. Increased scientific knowledge and technology create changes that can be beneficial or detrimental to individuals or society through impact on human health and the environment.

Students should be able to:

- Research and report on the processes used by municipalities to ensure water taken from local reservoirs is safe to return to the environment.
- Investigate and report on legislation such as the Clean Water Act and its impact on the quality of Delaware water.
- List ways in which human intervention can help maintain an adequate supply of fresh water for human consumption. Apply knowledge and skills learned about water as a resource to study local sources of drinking water and devise a water quality stewardship plan.
- Use various indicators (pH, turbidity, nitrates, phosphates, salinity, and macro-invertebrate surveys) to establish the health and potential potability of local bodies of water.

- Explain how sanitation measures such as sewers, landfills, and water treatment are important in controlling the spread of organisms that contaminate water and cause disease.

History and Context of Science

Students should know that:

- Over the course of human history, contributions to science have been made by different people from different cultures. Studying some of these contributions and how they came about provides insight into the expansion of scientific knowledge.

Standard 2: Materials and Their Properties

Properties and Structures of Materials

Students should know that:

- All matter is composed of minute particles called atoms. Most of the mass of an atom is concentrated in the nucleus. In the nucleus, there are neutrons with no electrical charge and positively charged protons. Negatively charged electrons surround the nucleus and overall, the atom is electrically neutral.

Students should be able to:

- Describe the relative charge; approximate mass; and location of protons, neutrons, and electrons in an atom.

Students should know that:

- Isotopes of a given element differ in the number of neutrons in the nucleus. Their chemical properties remain essentially the same.

Students should be able to:

- Describe isotopes of elements in terms of protons, neutrons, electrons, and average atomic masses. Recognize that isotopes of the same element have essentially the same chemical properties that are determined by the proton and electron number.

Students should know that:

- The periodic table arranges the elements in order of atomic number (the number of protons). The elements are grouped according to similar chemical and physical properties. Properties vary in a regular pattern across the rows (periods) and down the columns (families or groups). As a result, an element's chemical and physical properties can be predicted knowing only its position on the periodic table.

Students should be able to:

- Use the Periodic Table to identify an element's atomic number, valence electron number, atomic mass, group/family, and be able to classify the element as a metal, non-metal, or metalloid.
- Determine the physical and chemical properties of an element based on its location on the Periodic Table.
- Investigate differences between the properties of various elements in order to predict the element's location on the Periodic Table.

- Use the Periodic Table to predict the types of chemical bonds (e.g., ionic or covalent) in a variety of compounds.
- Explain how an atom's electron arrangement influences its ability to transfer or share electrons and is related its position on the periodic table. Recognize that an atom in which the positive and negative charges do not balance is an ion.

Students should know that:

- An atom's electron structure determines its physical and chemical properties. Metals have valence electrons that can be modeled as a sea of electrons where the valence electrons move freely and are not associated with individual atoms. These freely moving electrons explain the metallic properties such as conductivity, malleability, and ductility.

Students should be able to:

- Recognize that metals have the physical properties of conductivity, malleability, luster, and ductility.
- Understand the extent to which a variety of solid materials conduct electricity in order to rank the materials from good conductors to poor conductors. Based on the conductivity data, determine patterns of location on the Periodic Table for good conductors versus the poor conductors.

Students should know that:

- Ionic compounds form when atoms transfer electrons. Covalent compounds form when atoms share electrons. Both types of interactions generally involve valence electrons and produce chemical bonds that determine the chemical property of the compound.

Students should be able to:

- Explain how an atom's electron arrangement influences its ability to transfer or share electrons and is related to its position on the periodic table.
- Recognize that an atom in which the positive and negative charges do not balance is an ion.

Students should know that:

- A change of phase may occur when there is a change in the potential energy of the atoms or molecules of a substance.

Conservation of Matter

Students should know that:

- The total mass of the system remains the same regardless of how atoms and molecules in a closed system interact with one another, or how they combine or break apart.

Students should be able to:

- Balance simple chemical equations and explain how these balanced chemical equations represent the conservation of matter.

Big Ideas

- Observation and Evidence (to identify atomic structure and describe patterns in chemistry)
- Reasoning and Explanation (of observations to support predictions and inferences relating to chemistry concepts)
- Investigation (of chemical properties and interactions)
- Process Skills (in selecting tools and processes that can be used to investigate periodicity and reactivity)
- Comparison of data and observations to support predictions on a large scale (not just individual results)
- Data Organization to visually represent/present results (data tables, graphing, project reports)

Unit Enduring Understandings

Students will understand that…

- Safety is paramount when dealing with chemicals in the laboratory.
- Matter can be characterized by its physical and chemical properties
- The language of chemistry is logical and necessary when sharing information relating to chemical activity or processes.
- The periodic table is a tool that is useful in understanding and/or predicting the behaviors and/or interactions of atoms and molecules.
- All atoms have a specific structure that is key to its interaction with other atoms.
- Some atoms contain more neutrons than others while maintaining a specific electron/proton balance. These atoms are called isotopes.
- Atoms have valence electrons that determine the types of bonds an atom can make with other atoms.

Unit Essential Question(s)

1. How does the structure of an atom determine its properties?
2. How do multiple atoms combine to form larger compounds?
3. How does the conservation of mass apply to the interaction of reactants and products in a chemical reaction?
4. What is the common language used by chemists in communicating chemical information?

Knowledge & Skills

Students will know…

- Appropriate safety procedures for laboratory use.
- Matter is composed of tiny particles called atoms that are unique to each element, and that atoms are composed of subatomic particles called protons, neutrons, and electrons, each with its own distinctive properties and location within the atom.
- Elements are pure substances that cannot be separated by chemical or physical means.

- Isotopes are atoms of the same element that have different numbers of neutrons. Isotopes of the same element have essentially the same chemical properties that are determined by the proton and electron number.
- The Periodic Table is used to identify an element's atomic number, valence electron number, atomic mass, group/family, and to classify the element as a metal, non-metal or metalloid.
- The atomic structure of an element determines its physical and chemical properties as well as its position on the Periodic Table.
- Ionic bonds are formed when atoms transfer electrons, forming ions.
- Covalent bonds are formed when atoms share pairs of electrons.

Students will be able to…

- Demonstrate safe lab practice for all activities.
- Test solutions for electrical conductivity.
- Demonstrate the relationship between an atom's structure, chemical behavior, and its position in periodic table.
- Use models or drawings to illustrate how compounds are formed.
- Recognize that an atom with unequal numbers of positive and negative charges is an ion.
- Test various solids to determine which are good or poor conductors of electricity and relate this to the position of its constituent atoms on the periodic table.
- Demonstrate that ionic and molecular compounds are electrically neutral.
- Sketch and interpret graphs representing the melting, freezing, evaporation, and condensation of water.
- Balance a simple chemical equation.
- Conduct an investigation using the scientific method.
- Demonstrate how the properties of materials are used to the design manufactured goods.

Stage 2: Assessment Evidence
(Design Assessments To Guide Instruction)

Suggested Performance Task(s)

Coming soon…

Rubrics/Checklists for Performance Tasks

Other Evidence

Student Self-Assessment and Reflection

Students should keep a running journal that tracks their learning as they progress through the unit. This journal should be a combination of self-reflection and data collected as a result of unit investigations.

When students complete the lessons in this unit, they should be encouraged to make notes on their work that indicates growth in understanding. Not all worksheets should be officially graded, but all work should include opportunities for student reflection. Only those assignments which measure knowledge that should be solidified in the minds of the students should be graded. Learning experiences should not be graded as they are developed to draw out student misconceptions.

Stage 3: Learning Plan
(Design Learning Activities To Align with Goals and Assessments)

Key Learning Events Needed to Achieve Unit Goals

INVESTIGATION I: DEFINING MATTER

Tools of the Trade

This lesson encompasses and satisfies Delaware Administrative Code Title 14 EDUCATION; Regulation 800 Health and Safety. The RIGHT TO KNOW, if it has not already been addressed, should be addressed in this lesson.

Penny for Your Thoughts

This lesson is meant to pique student interest in materials and their properties as well as their ability to alter the superficial physical properties of materials. The question posed is, “Did you actually change a copper penny to gold?”

Whatsa Matter?

This lesson introduces the concept of MATTER. Students identify what matter is, what matter is not, and what matter really means.

All That Glitters

This lesson reviews a pivotal middle school standard and prepares students to move forward in their understanding of materials and their properties.

INVESTIGATION II: BASIC BUILDING MATERIALS

A New Language

This lesson INTRODUCES concepts inherent to several high school standards. Students observe patterns in the names and properties of various substances and begin to translate the formulas that represent the elements that comprise various substances and symbols that represent the phase of those substances.

Create a Table

This lesson introduces the concept of periodicity. All future lessons for this unit rely upon the foundational knowledge built in this lesson. Students discover the basic organization of the periodic table based on the properties and data found on the cards provided for this lesson.

Breaking the Code

This lesson builds on the concepts that were introduced in the Create a Table lesson. Specific trends are identified in the periodic table that was created by students, and students practice extracting and applying information from the table. Students are also expected to learn basic nomenclature including element groups and their names.

INVESTIGATION III: A PARTICULATE WORLD

Pudding and Clouds

In teaching the structure of an atom, students look at various models as they were developed over time. Students are exposed to the scientific process, a historical timeline for the development of the atomic model, and they begin to visualize the atom in a way that is useful in furthering chemistry concepts.

Building Atoms

Students are introduced to the concept of atomic number, mass number, and how to use the periodic table and these numbers to determine basic information about the atomic structure of the elements.

Subatomic Heavyweights

Students explore atomic structure by examining atomic mass and isotopes in detail. They are expected to apply their new knowledge of atomic mass to several elements, extracting information from the periodic table and determining atomic structure.

Life on the Edge

Students use the Bohr model of the atom to visualize the electron shells surrounding an atom. Valence electrons are investigated and identified as the common factor in the similar chemistry of elements in the same group.

INVESTIGATION V: BUILDING WITH MATTER

You Light Up My Life

Students investigate the dissolving and conductivity properties of various substances and identify a pattern in their data.

Electron Glue

Students consider the properties of 15 common substances and classify the substances according to the model that best describes their properties. Students are introduced to ionic, covalent network, molecular covalent, and metallic bonding.

Nobel Gas Envy

Students create their own cards showing the charges on the ions that form with noble gas configurations. They assemble the cards in the form of a periodic table and look for patterns in the charges on the atoms.

Getting Connected

Students are introduced to the octet rule for creating ionic bonds.

Salty Eights

Students practice making ionic compounds by playing a card game. By playing this game, students are reviewing concepts of what constitutes a metal and a non-metal, what a valence electron is, and what is required for elements to combine to form an ionic compound.

Smell's Lessons

Sniffing Around

Students are given 5 vials with samples of different smells and are asked to identify the smell of each substance. Students are given the chemical name of each substance as well as its molecular formula and are expected to identify any patterns or relationships between the name, the formula, and the smell of the items. This lesson has a focus on chemical nomenclature, which is a requirement for the understanding of all future chemistry standards.

Investigation II: Picturing Molecules

Molecules in Two Dimensions

Students are introduced to the structural formulas of the substances they have smelled. Through a card-sort activity, they are able to discover patterns in the way the atoms in certain smell molecules are put together. This leads to an introduction of functional groups.

Honc If You Like Molecules

Students look for patterns in the way atoms are connected in molecular structures. They are introduced to the HONC 1234 rule, which reminds students of the bonding tendencies of Hydrogen, Oxygen, Nitrogen, and Carbon. Students are expected to create rudimentary structural formulas using the HONC 1234 rule and the molecular formulas of various chemicals. This lesson is pivotal to student success with biomolecules and chemical structure/function.

Connect the Dots

Students begin to understand the nature of covalent bonds. Lewis dot structures are introduced as a graphic representation for keeping track of the electrons involved in bonding.

Eight Is Enough

The octet rule is examined and used as a foundation for creating simple molecules.

Dots, Dots, and More Dots

Students are given the opportunity to practice and become proficient with translating between molecular formulas, Lewis dot structures, and structural formulas. Double and triple bonds are introduced. By the end of this lesson, students should have mastered the concept of the octet rule and covalent bonding.

Some Things Never Change

Students learn that matter is conserved in chemical reactions. They observe a reaction in which two liquids are mixed and a solid precipitates. The mass of the reactants and products are compared and found to be identical. They also experience a chemical reaction in which a gas is produced and the compared mass decreases (because of the escaping gas molecules). Students make a direct connection to biological concepts next as they examine how plants obtain their mass.

Atom Inventory

Students work in pairs to use an atom inventory worksheet to learn how to balance simple chemical equations. Balanced chemical equations tell us the number of molecules of each reactant and product in a particular chemical reaction.

Phase Matters

Students determine and compare the freezing and melting temperatures of water. Then, students will investigate whether the freezing point of water can be changed if substances such as table salt are dissolved in the water.

Polar Bears and Penguins

Students read a comic and interpret the illustrations in which polar bears and penguins vie for bonded electrons represented as ice cream scoops. Students learn that electronegativity differences are responsible for different types of bonds: polar covalent, nonpolar covalent, and ionic bonds. They get a cursory introduction into dipoles and the idea that symmetry and shape affect the polarity of a molecule.

Thinking (Electro) Negatively

Students are introduced to the quantitative side of the concept of electronegativity. They examine a scale that numerically expresses the degree to which an atom will attract electrons in a bond. Students learn to use the electronegativity values of different atoms to predict the direction and the degree of polarity of bonds between those atoms. Bonding is shown to be on a continuum from nonpolar bonds (no difference in electronegativity) through covalent polar bonds to ionic bonds (large differences in electronegativity).

I Can Relate

Using the electronegativity scale, students figure out the location and polarity of partial charges on several molecules. Students are challenged to determine which one of seven molecules does not smell and why. Students learn about the importance of polarity in smell chemistry, and are introduced to current theories about receptor sites, polarity, and smell.

Resources & Teaching Tips

- What text/print/media/kit/web resources best support this unit?

This unit is taught using the *Living By Chemistry* Curriculum units titled Alchemy and Smells.

- Stacy, Angelica, Jan Coonrod and Jennifer Claesgens. ***Living By Chemistry—Alchemy***. California: Key Curriculum Press, 2003.
- Stacy, Angelica, Jan Coonrod and Jennifer Claesgens. ***Living By Chemistry—Smells.*** California: Key Curriculum Press, 2003.

- What tips to teachers of the unit can you offer about likely rough spots/student misunderstandings and performance weaknesses, and how to troubleshoot those issues?

Accommodation/Differentiation Ideas and Tips

- The use of group activities throughout this unit enables students with difficulty to gain insight from fellow classmates. Pair them with strong students.
- The use of computers and internet are great tools to complete activities and gain additional insight on topics students may be uncomfortable with.
- Lab demonstrations and lab activities students participate in.
- Extended time to finish activities.
- KWL technique.
- Review previous day's lesson and continuously reinforce concepts from the unit.
- Weekly graphing and analysis of weather data allow for ample time to gain understanding of weather patterns.
- Permit the apt student to accelerate their rate of progress and work independently on some content.
- Pretest students to determine their prior knowledge and misconceptions.
- Students may use graphic organizers, maps, and diagrams to effectively facilitate differing levels of cognitive processing for students of different ability levels.