Fair Lawn

Public Schools

Fair Lawn, NJ

Conceptual Chemistry CP

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Conceptual Chemistry CP is a lab science class developed by the Fair Lawn High School science team and aligned to the Next Generation Science Standards which are correlated to the Common Core Standards for Language Arts Literacy and for Math

Science Department

Fair Lawn School District

Committee Credits

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Conceptual Chemistry CP

I. Course Synopsis

This course will encourage students to make sense of new evidence and revise their thinking to accommodate it by building true understanding of the course material instead of relying on prior knowledge, assumptions, and misconceptions. Conceptual Chemistry is a course based on regular laboratory investigations of matter, chemical reactions, and the role of energy in those reactions. Students enrolled in Conceptual Chemistry will engage, explore, explain, elaborate, and evaluate useful models of structure and properties of matter and the mechanisms of its interactions. In addition, students enrolled in this course are expected to: (1) gain an understanding of the history of chemistry, (2) explore the uses of chemistry in various careers, (3) investigate chemical questions and problems related to personal needs and societal issues, and (4) learn and practice laboratory safety. This course also includes mathematical problem solving.
*Prerequisites apply, see your Guidance Counselor

II. Philosophy & Rationale

Chemistry is the study of the composition, structure, and properties or matter and the changes it undergoes. Chemistry explains a wide range of everyday activities. For instance in cooking chemistry explains how food changes as it is being cooked, how food is preserved properly, and how the body uses the food we eat, and how ingredients interact to make food. In cleaning chemistry can help students to decide which cleaner is best for dishes, laundry, themselves and for their homes. The field of medicine incorporates a tremendous amount of chemistry. For example, students can learn how vitamins, supplements, and drugs can help or harm them, as well as, developing and testing new medical treatments and medicines. Chemistry is at the heart of all environmental issues. This course will emphasize how students can distinguish between how a chemical can act as a nutrient or develop into a pollutant that can affect the environment. Learning chemistry will also allow students to understand what processes produce the items they need without harming the environment. It is important to understand chemistry because all of the sciences involve matter and the interactions between different kinds of matter.

This course has been aligned to and developed with the Next Generation Science Standards (NGSS) as its focus. Efforts have been made to integrate aspects of other science standards, particularly the earth and space science standards into this course to assure that students are provided an opportunity to form connections.

All NGSS aligned courses in the Fair Lawn Schools demonstrate a commitment preparing students to become college and career ready as well as the other guiding assumptions of the Frameworks for Science Education (NRC, 2011) and the NGSS including

- Students are born investigators;
- Science instruction should focus on core ideas and practices;
- An understanding of science develops over time;
- Science and engineering require both knowledge and practice;
- Science education must connect to students' interests and experiences; and
- Promoting equity for all students must be a focus of science education.

Additionally, all NGSS aligned courses in the Fair Law Schools integrate the three dimensions discussed in the Frameworks for Science Education and the NGSS, including

- Science & Engineering Practices which describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems; (NGSS PDF)
- Cross Cutting Concepts which link all domains of science and provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world; (NGSS PDF) and
- Disciplinary Core Ideas which focus and unite K-12 science, have a broad importance across multiple sciences or engineering disciplines or are a key organizing concept within a single discipline; provide a key tool for understanding or investigating more complex ideas and solving problems; relate to the interests and life experiences of students; are connected to societal or personal concerns that require scientific or technological knowledge; and are teachable and learnable over multiple grades at increasing depth and sophistication. (NGSS PDF)

Since coherence is a main dimension of the NGSS, consider reviewing the "story line" for the middle school physical science, life science, earth and space science, and engineering, technology and applications of science, as well as the high school physical science, life science, earth and space science, and engineering, technology and application of science for a full picture of the NGSS philosophy. For a full picture of how these programs are implemented in the Fair Lawn Schools, visit the district curriculum website.

As described in the NGSS, technical writing and reading non-fiction is also a focus of our 6-12 science curricula as required by the CCSS. Students are expected to think critically about data they collect or read about and then express their thoughts through text-based narratives, journal entries, short-constructed response, argument-based writing, and/or in-class discussion.

Differentiated instruction for students at different levels of achievement and specific learning needs (e.g. special education, English Language Learners (ELL), at-risk, and Gifted & Talented) is embedded in targeted scaffolding based on knowledge of each student's interests, needs, and assessment data, including, but not limited to, in class formative and summative assessments.

When deemed appropriate, department teachers will engage students in purposeful paired discussions to share information more effectively, such as the "turn and talk" (Harvey & Daniels, 2009). "Text annotation" could be used, for example to optimize reading comprehension (Daniels & Steineke, 2010).

This is an elective lab science class. During this transition from the 2009 NJCCS to the 2013 NGSS, this course will address HS-LS-1 and HS-LS-3 as well as many 2009 NJCCCS.

A particular focus will be made on the cross cutting concepts and the science and engineering processes

III. Scope & Sequence

Unit 1: <Alchemy: Matter, Atomic Structure, and Bonding><6.5 Weeks>
- Chapter 1 – Defining Matter
- Chapter 2 – Basic Building Materials
- Chapter 3 – A World of Particles
- Chapter 4 – Moving Electrons
- Chapter 5 – Building with Matter

Unit 2: <Smells: Molecular Structure and Properties><5.5 Weeks>
- Chapter 6 – Speaking of Molecules
- Chapter 7 – Building Molecules
- Chapter 8 – Molecules in Action

Unit 3: <Weather: Phase Changes and Behavior of Gases><5.5 Weeks>
- Chapter 10 – Physically Changing Matter
- Chapter 11 – Pressing Matter
- Chapter 12 – Concentrating Matter

Unit 4: <Toxins: Stoichiometry, Solution Chemistry, and Acids and Bases><7 Weeks>
- Chapter 13 – Toxic Changes
- Chapter 14 – Measuring Toxins
- Chapter 15 – Toxins in Solution
- Chapter 16 – Acidic Toxins
- Chapter 17 – Toxic Clean-up

Unit 5: <Fire: Energy, Thermodynamics, and Oxidation-Reduction><6 Weeks>
- Chapter 18 – Observing Energy
- Chapter 19 – Measuring Energy
- Chapter 20 – Understanding Energy
- Chapter 21 – Controlling Energy
- Chapter 22 – Radiating Energy

Unit 6: <Showtime: Reversible Reactions and Chemical Equilibrium><2.5 Weeks>
- Chapter 23 – Chemical Equilibrium

IV. Unit Descriptions

Unit 1: < Alchemy: Matter, Atomic Structure, and Bonding >

Enduring Understanding

Chemistry has some of its roots in the ancient practice of alchemy. The alchemists experimented with trying to make gold out of ordinary substances. In the process, they learned a great deal about matter and about chemistry. When you understand the nature of matter and its composition, you will be able to answer the question, “Is it possible to turn ordinary substances into gold?”

1. Atoms are the building blocks of everything
2. Everything in the universe is made of matter with unique properties

Essential Question(s)

1. Why do chemists use certain equipment to do their research?
2. How do the properties of matter allow us to better understand the world around us?
3. How do properties provide evidence of the identity of materials?
4. How do you know which material is best for a particular product or need?
5. How do we recognize chemical changes in matter?
6. How does the structure of the periodic table allow us to predict the chemical and physic al properties of an element?
7. How is the periodic table a template of organization for the material world?
8. What role does chemistry play in the world around us?
9. How has chemistry affected the growth of society?
10. How is chemical stability related to the arrangement of electrons in atoms?
11. Why is it important to understand the world around us?

Learning Objectives

1. Understand that matter is composed of atoms.
2. Use the language of chemistry.
3. Decode information contained in the periodic table, such as atomic number and atomic mass.
4. Analyze how elements on the periodic table are arranged based on similarities in their chemical and physical properties.
5. Describe how new substances with new properties are made through chemical reactions.
6. Categorize different substances by its intensive properties, including density.

7. Classify matter as elements, compounds, or mixtures.
8. Determine that an atom has a nucleus made of protons and neutrons, and electrons orbiting the nucleus.
9. Recall that isotopes are atoms of the same element, but with different numbers of neutrons.
10. Understand that substances are held together by chemical bonds.
11. Demonstrate how one element can change into another by changing the number of protons in the nucleus.
12. Outline the arrangement of atoms in the periodic table to reflect the arrangement of electrons in the atom.
13. Predict the stability of atoms based on their location on the periodic table.
14. Classify the main types of chemical bonds.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning.
2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.
4. Safety
    a. Watch video where students identifying good and bad safety practices. (http://www.youtube.com/watch?v=V-fNpaOX0-g)
    b. POGIL activity regarding safe and unsafe activities in the lab
    c. Class requirements and safety rules handed out and reviewed aloud.
    d. Locations of safety equipment and fire exits discussed.
5. Laboratory Walk Around: Students walk use worksheet with photos to identify laboratory equipment and its function.
6. Map of classroom including safety equipment and general classroom supplies
7. Safety Quiz
8. Penny for your Thought Demonstration
9. POGIL: Organizing Data
10. Density Demos
11. Density Lab
12. Determining Density of Unknown Substances Lab
13. Physical/Chemical Change Lab

14. Alpha and Beta Decay Activity
15. POGIL: Isotopes
16. Pizza Pan Atomic Model
17. Copper Cycle Lab
18. Flame Test Lab
19. Salty Eights or Tooth and Notch Activity
20. POGIL: Electron Configuration
21. Element Project – Students research a particular element on the periodic table
22. Elementally Me Project – Students describe themselves as a new periodic table element

Next Generation Science Standards

HS-PS1-1 (Periodic Table) High School Evidence Statement PS1-1

1. **Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*]

HS-PS1-2 (Chemical Reactions) High School Evidence Statement PS1-2

1. **Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

HS-PS1-8 (Nuclear Change) High School Clarification Statement PS 1-8

1. **Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [*Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.*]

HS-PS4-1. (Waves and Electromagnetic Radiation) High School Evidence Statement PS4-1

1. **Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

Unit 2: **<** Smells: Molecular Structure and Properties **>**

Enduring Understanding

The sense of smell is a familiar and important part of our lives. It helps us detect pleasant smells, as well as, unpleasant smells that alert us to possible dangers. Sometimes we detect things with our sense of smell that we can't see. Sometimes we detect something all the way across the room, or even in another room. But how does it work? The way atoms are connected in molecules, and the structures of the molecules, have a great deal to do with the properties of those molecules. Understanding the chemistry of molecules allow us to understand the chemistry of smell.

1. Science involves coming up with ideas based on observations and then refining these ideas based on further observation.
2. Combining matter creates diversity in materials
3. Matter cannot be created or destroyed. Matter is conserved.

Essential Question(s)

1. What does chemistry have to do with smell?
2. How can molecules with the same molecular formula be different?
3. How do atoms bond to form molecules?
4. What does the structure of a molecule have to do with smell?
5. How can a molecule be changed into a different molecule?
6. What happens to molecules during the creation of a new smell?
7. How do electrons affect the shape of a molecule?
8. How is the shape of a molecular compound related to its smell?
9. How does the nose detect and identify different smells?
10. Why do some molecules smell while others do not?
11. How can electronegativity be used to compare bonds?
12. What does polarity have to do with smell?

13. What generalization can be made about smell and molecules?

Learning Objectives

1. Determine how atoms form molecules.
2. Predict the smell of a compound.
3. Analyze how the nose detects different molecules.
4. Compare and contrast covalent bonds (nonpolar vs. polar) and ionic bonds.
5. Interpret how the difference in electronegativity determines the type of bonds.
6. Predict how one atom bonds to another in a molecule.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning.
2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.
4. Ester Synthesis Lab
5. Lewis Dot Bingo Chip Activity
6. Polar Bears vs. Penguins Cartoon
7. Electronegativity Difference Practice

Cross-Content Connections:
CCCS Math: Students will be expected to perform measurement, modeling, apply algebra, and geometry and statistics.
CCCS Literacy: Click on the link to the High School Evidence Statements to see expectations related to literacy for this unit. In addition, a focus of the course will be on the development of the LAL standards for science & technical subjects.
8.1: Use technology to collect and analyze data and to communicate findings with local peers and peers from other communities.
9.2: Explore careers directly related to health careers.

Next Generation Science Standards
HS-PS1-1 (Periodic Table) High School Evidence Statement PS1-1

1. **Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** [Clarification

Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*]

HS-PS1-2 (Chemical Reactions) High School Evidence Statement PS1-2

2. **Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

HS-PS1-3 (Forces Between Particles) High School Evidence Statement PS1-3

1. **Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]

HS-PS2-6. (Structure and Properties of Matter) High School Evidence Statement PS2-6

1. **Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

Unit 3: **<** Weather: Phase Changes and Behavior of Gases **>**

Enduring Understanding

Thunderstorms dump great quantities of rain, fog seeps into a bay at nightfall, warm temperatures entice us to the beach, and hurricanes devastate coastal communities. The weather is a part of our everyday lives. Physical change is at the core of weather. Weather occurs when matter undergo changes in location, density, phase, temperature, volume, and pressure. Understanding the relationships between these changes allow us to answer questions about the chemistry of weather.

1. Weather is the result of physical changes in matter.
2. Most matter expands in volume as it is heated and contracts as it is cooled.
3. The atmosphere is a mixture of gases, including gaseous water.
4. Gas pressure is caused by the collisions of molecules or atoms.

<u>Essential Question(s)</u>

1. What causes weather?
2. How is temperature measured?
3. How cold can substances become?
4. How do weather fronts affect the weather?
5. What evidence do we have that gases exert pressure?
6. How areas of high and low air pressure are related to the weather?
7. How are the gas laws useful in daily life?

<u>Learning Objectives</u>

1. Differentiate temperature scales and explain how thermometers work.
2. Predict the effects of changing temperature, pressure, and volume of matter.
3. Analyze weather maps and make weather predictions.
4. Compare and contrast the densities of gases, liquids, and solids.
5. Illustrate the relationship between the temperature and pressure of a gas in a closed container.
6. Demonstrate the relationship between amount of molecules and its pressure.
7. Identify that the mole is a counting unit, and recognize that one mole of gas particles as standard temperature and pressure occupies a volume of 22.4 liters.
8. Analyze how meteorologists keep track of the amount of rainfall.
9. Compare and contrast the amount of water present in equal volumes of snow and rain.
10. Analyze the relationship between the volume and pressure of a gas.
11. Determine how does gas pressure change in flexible and rigid containers.
12. Evaluate how gas molecules cause pressure.
13. Identify the causes of hurricanes.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning.
2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.
4. Density, Temperature, and Fronts Activity
5. Boyle's Law Lab
6. Cloud in a Bottle Lab
7. Condensation Lab
8. Gas & Atmospheric Pressure Demonstrations/Lab
9. Mole Day Project

Cross-Content Connections:

CCCS Math: Students will be expected to perform measurement, modeling, apply algebra, and geometry and statistics.

CCCS Literacy: Click on the link to the High School Evidence Statements to see expectations related to literacy for this unit. In addition, a focus of the course will be on the development of the LAL standards for science & technical subjects.

8.1: Use technology to collect and analyze data and to communicate findings with local peers and peers from other communities.

9.2: Explore careers directly related to health careers.

Next Generation Science Standards

HS-PS1-3 (Forces Between Particles) High School Evidence Statement PS1-3

1. **Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]

HS-PS1-5 (Effects on Rates of Reactions) High School Evidence Statement PS1-5

1. **Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.** [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [*Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.*]

Interdisciplinary Connections

HS-ESS-2-4

Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [*Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.*]

HS-ESS-2-5

Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

Unit 4: <Toxins: Stoichiometry, Solution Chemistry, and Acids and Bases>

<u>Enduring Understanding</u>

Chemical reactions help our bodies to process food and create new tissues. However, some chemical reactions have toxic and harmful outcomes. The toxicity of substance is highly dependent on the dose. Sometimes a small amount of a compound, such as a vitamin, can be therapeutic, but a large amount can damage your health. This unit investigates chemical changes by exploring how toxic substances are measured and tracked through their transformations.

1. Chemical equations keep track of changes in matter
2. When a substance changes phase or dissolves, its chemical formula does not change
3. The concentration of a solution does not change with the size of the sample
4. The greater the concentration of H^+ ions in a solution, the lower its pH, and the more acidic it is
5. Acids and bases neutralize each other, producing a salt and water
6. Some ionic solids are more soluble than others. When a compound reaches the limits of its solubility, undissolved solid is visible

Essential Question(s)

1. How do chemists keep track of changes in matter?
2. How can you predict what you will observe based on a chemical equation?
3. What is the relationship between mass and moles?
4. How are acids and bases important in living things?
5. How is pH related to the acid or base concentration of a solution?

Learning Objectives

In this unit, students will learn

1. Determine the definition of a toxin.
2. Explain how chemists determine toxicity.
3. Identify the mechanisms by which toxic substances act in our bodies and what these mechanisms have to do with chemical reactions.
4. Examine the concept that the concentration of a solution does not change with the size of the sample.
5. Understand that the greater the concentration of H^+ ions in a solution, the lower its pH, and the more acidic it is.
6. Examine how acids and bases neutralize each other, producing a salt and water
7. Illustrate that when a compound reaches the limits of its solubility, undissolved solid is visible.
8. Demonstrate how are changes in matter are classified.
9. Determine how mass changes during a chemical or physical change.
10. Understand how you balance atoms in a chemical equation.
11. Model how atoms rearranged to form new products.
12. Explain how you can use the moles of a substance to compare toxicity.
13. Compare and contrast how you can keep track of different compounds when they are in solution.
14. Illustrate how the solution concentration affects the properties of the solution.

15. Determine if molarity calculations be used to identify a toxic substance.
16. Experiment with what happens when acids and bases are mixed.
17. Distinguish what substances precipitate from aqueous solutions.
18. Understand the relationship between which reactants determine how much product you can make.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning.
2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.
4. Counting by Weighing Activity
5. Paperclip Balancing Equations
6. Types of Reactions Skits
7. Solution Concentration Lab
8. Neutralization Reactions
9. Mole Ratios in a Single Replacement Lab
10. Acids and Bases Lab

Cross-Content Connections:

CCCS Math: Students will be expected to perform measurement, modeling, apply algebra, and geometry and statistics.

CCCS Literacy: Click on the link to the High School Evidence Statements to see expectations related to literacy for this unit. In addition, a focus of the course will be on the development of the LAL standards for science & technical subjects.

8.1: Use technology to collect and analyze data and to communicate findings with local peers and peers from other communities.

9.2: Explore careers directly related to health careers.

Next Generation Science Standards

HS-PS1-2 (Chemical Reactions) High School Evidence Statement PS1-2

1. **Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [Clarification Statement: Examples

of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

HS-PS1-5 (Effects on Rates of Reactions) High School Evidence Statement PS1-5

1. **Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.** [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [*Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.*]

HS-PS1-7 (Conservation of Atoms & Mass) High School Evidence Statement PS1-7

1. **Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [*Assessment Boundary: Assessment does not include complex chemical reactions.*]

Unit 5: **<** Fire: Energy, Thermodynamics, and Oxidation-Reduction **>**

Enduring Understanding

Every change that happens to matter is accompanied by a change in energy. Fire is visible evidence of the energy associated with one particular type of chemical change. When a compound burns, it is broken down into smaller, less complex substances, and heat and light are released. When fire is uncontrolled, it can be destructive. However, this same chemical reaction can also provide heat, light, and mechanical or electrical energy. This unit explores how energy from chemical and physical change can be observed, measured, understood, and controlled.

1. Changes in matter are accompanied by changes in energy.
2. Heat is a transfer of energy due to temperature differences.
3. The direction of heat transfer is always from a hotter substance or object to a colder one.

4. Energy is conserved. It cannot be created or destroyed.
5. Energy tends to disperse.
6. Temperature depends on the average kinetic energy of matter. Thermal energy depends on the average kinetic energy and the mass of the sample.
7. Substances with low specific heat capacities can heat up and cool down easily.
8. Heat transfer does not always result in a temperature change.
9. Bond breaking requires energy. Bond making releases energy.
10. Some reactions are energetically favored over other reactions.
11. Energy disperses; it does not collect.

Essential Question(s)

1. What is the difference between temperature and heat?
2. How do different substances respond to heat?
3. What happens to the heat during a phase change?
4. How do different fuels compare?
5. How is energy transferred in chemical systems?
6. How does the potential energy and kinetic energy of molecules change during thermo-dynamic processes?
7. How can you control the speed of a reaction?
8. How can a chemical reaction be used to do work?
9. How can you use a redox reaction as an energy source?

Learning Objectives

1. Explain the nature of heat, energy, and fire.
2. Examine and measure changes in energy.
3. Identify the source of energy in chemical changes.
4. Demonstrate how chemical energy is transformed into work.
5. About energy exchanges during reactions with metals and ionic compounds
6. What reactions are sources of heat?
7. Describe the direction of heat transfer during chemical process.
8. Explain how temperature differences correlate with heat transfer.
9. Identify what types of substances burn.
10. Explain how food Calories measured.
11. Relate how calorimetry experiments translate into Calories.
12. Predict the reaction between metals and oxygen.
13. Calculate the amount of energy transferred during oxidation of metals.

14. Determine how electron transfers occur in nature and explain what happens to electrons during oxidation.
15. Compare and contrast the oxidation of the different types of metals.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning.
2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.
4. Heat Transfer Activity
5. Thermochemistry Demonstration
6. Specific Heat of Metals Lab
7. Make it or Break it Activity
8. Reactivity of Metals Lab

Cross-Content Connections:
CCCS Math: Students will be expected to perform measurement, modeling, apply algebra, and geometry and statistics.
CCCS Literacy: Click on the link to the High School Evidence Statements to see expectations related to literacy for this unit. In addition, a focus of the course will be on the development of the LAL standards for science & technical subjects.
8.1: Use technology to collect and analyze data and to communicate findings with local peers and peers from other communities.
9.2: Explore careers directly related to health careers.

Next Generation Science Standards
HS-PS1-2 (Chemical Reactions) High School Evidence Statement PS1-2

1. **Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

HS-PS1-4 (Energy of Reactions) High School Evidence Statement PS1-4

1. **Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.** [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [*Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.*]

HS-PS3-4 (Thermodynamics) High School Evidence Statement PS3-4

1. **Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).** [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [*Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.*]

HS-PS4-1. (Waves and Electromagnetic Radiation) High School Evidence Statement PS4-1

1. **Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

HS-PS4-3. (Waves and Electromagnetic Radiation) High School Evidence Statement PS4-3

1. **Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

HS-PS4-4. (Waves and Electromagnetic Radiation) High School Evidence Statement PS4-4

1. **Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]

HS-PS4-5. (Waves and Electromagnetic Radiation) High School Evidence Statement PS4-5

1. **Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

Unit 6: <Showtime: Reversible Reactions and Chemical Equilibrium>

Enduring Understanding

Sometimes chemical reactions and used simply to entertain. After all, what is the purpose of a fireworks display except to delight and astonish the audience? In the chemistry classroom, chemical reactions can demonstrate new chemistry concepts in an intriguing way. Chemical demonstrations often involve reversible reactions. These reactions can be fine-tuned and controlled when you understand the balance between products and reactants in a reversible chemical system. This balance is referred to as equilibrium. In this unit we will explore chemical equilibrium and how it can be used in chemical demonstrations.

1. Many reactions are reversible
2. In reversible systems, the forward and reverse reactions can occur at the same time
3. At equilibrium, the rate of the forward process is equal to the rate of the reverse process

Essential Question(s)

1. What is a reversible process?
2. What is equilibrium?
3. How can you predict if products are favored in a reversible reaction?
4. Why is k called a “constant?”

Learning Objectives

In this unit, students will learn

1. Determine what happens in a chemical system at equilibrium.
2. Analyze how the balance in a reversible reaction is maintained.
3. Explain the mathematical relationship between reactants and products in a system at equilibrium.
4. Identify which variables affect reversible reactions.

Suggested Activities & Suggested Modifications for Special Education Students, ELL Students, Students at Risk, and Gifted Students:

1. Students with special needs and ELL learners may be provided with key vocabulary terms prior to the unit beginning.
2. ELL students may be provided with additional visual aids. For additional modifications, refer to Classroom Instruction that Works for ELL Learners *or the* SIOP protocol.
3. Gifted students may be challenged by asking them to form additional connections between biology, chemistry, and physics.
4. Reversible Reactions Lab
5. Chemistry and Magic Video/Demonstration

Cross-Content Connections:

CCCS Math: Students will be expected to perform measurement, modeling, apply algebra, and geometry and statistics.

CCCS Literacy: Click on the link to the High School Evidence Statements to see expectations related to literacy for this unit. In addition, a focus of the course will be on the development of the LAL standards for science & technical subjects.

8.1: Use technology to collect and analyze data and to communicate findings with local peers and peers from other communities.

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Next Generation Science Standards

HS-PS1-2 (Chemical Reactions) High School Evidence Statement PS1-2

1. **Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and

oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

HS-PS1-6. (Chemical Reactions) High School Evidence Statement PS1-6

1. **Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*** [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]

V. Course Materials

- Stacy, Angelica M. *Living by Chemistry*. Emeryville, CA: W.H. Freeman and Company/BFW, 2015. Print / Purchased for 2015-2016 school year (2nd Edition).
- Trout, Laura. *POGIL Activities for High School Chemistry*. Batavia, IL: Flinn Scientific, 2012. Print / Teacher Resource Only

VI. Assessments

Classroom assessments are included to primarily guide instruction (formative assessment) and to support decisions made beyond the classroom (summative assessment).

Sample assessments and classroom activities aligned to the NGSS can be found on the NGSS website.

Assessments in this course measure students' performance of scientific and engineering practices in the context of crosscutting concepts and disciplinary core ideas. These may include quizzes, tests, lab reports, lab questions, experimental design projects, engineering design projects, project-based assessments and other assessments with multiple components. (NRC, 2014)

All students in Conceptual Chemistry will take a midterm exam which will contain a common aspect among all students. Students will also take a final exam covering the remaining of the course. There will be a project which will account for one third of their 5th marking period grade. In addition each marking period grade will consist of: regular tests, quizzes, laboratory reports, homework assignments, class participation, and group or individual projects.

NJDOE Science Related Assessment Resources

All Fair Lawn High School grading procedures will be followed.

VII. Interdisciplinary Connections and Alignment to Technology standards

Science classes in the Fair Lawn Public schools promote career-readiness skills related to Personal Financial Literacy (9.1) and Career Awareness, Exploration, and Presentation (9.2). Some course concepts from the Career and Technical Education Standards (9.3), but these are not directly correlated since our district is not a CTE program.

The Fair Lawn Public Schools District fosters an environment that promotes career-readiness skills in all content areas. Whereas Career Ready Practices are explored consistently, specific alignment to Personal Finance Literacy (9.1) and Career Awareness, Exploration, and Presentation Standards (9.2) are included in the district level document (below). When appropriate, the Career and Technical Education Standards (9.3) have been reviewed and aligned as well.

Examples: 9.2B: Career exploration in each unit of study.

In addition, every effort is made to integrate technology and engineering into our science classes. Educational Technology (8.1) and Technology Education, Engineering, Design, and Computational Thinking – Programming (8.2) standards are cross connected throughout our science programs.

Examples:

8.1A:	Use spreadsheets to analyze & interpret data from laboratories, 6-12. Use the internet to increase productivity and efficiency, 9-12.
8.1B,C:	Use data to solve real-world problems, 6-12. Use online platforms to collaborate & address global issues, 9-12.
8.1F:	Collect and analyze data using internet and data simulations, 6-12.
8.2A:	Become aware of the invention process, 3-5.
8.2B:	Become aware of the global impacts on technology, 6-12.
8.2C:	Apply the design process to pushes & pulls, K-2.
8.2D:	Use tools to reduce work, K-2.

For additional detail on how these standards are integrated throughout the Fair Lawn Schools curriculum, review the Fair Lawn Public Schools District Alignment to Technology & Career Readiness & 21st Century Skills Standards Curriculum Appendix.