01 - Matter, Energy, and Measurement

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **16 Blocks**
Status: **Published**

General Overview, Course Description or Course Philosophy

Chemistry CP aims to provide students with a fundamental understanding of the composition, structure, properties, and transformations of matter. Through a combination of theoretical concepts, laboratory investigations, and real-world applications, students will explore the principles and laws that govern chemical reactions and interactions. The course emphasizes the development of scientific inquiry skills, critical thinking abilities, and the application of problem-solving strategies. Students will actively engage in the process of scientific discovery, asking questions, seeking answers, and making connections between theory and practical applications. Laboratory experiences will integrate with theoretical knowledge, fostering the development of practical skills, scientific inquiry, and responsible practices. Students will also explore the ethical considerations and societal implications of chemistry, promoting informed decision-making as responsible citizens. By the end of the course, students will have a deepened appreciation for the relevance of chemistry in everyday life and will be prepared for further study and careers in scientific fields.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Objectives:

- Describe the properties and characteristics of matter, including its composition, states, and classification.
- Explain the concepts of energy, including its forms, conservation, and role in chemical reactions.
- Apply measurement techniques and units to collect, analyze, and interpret data in chemical experiments.
- Differentiate between physical and chemical changes and identify the factors that influence them.
- Demonstrate an understanding of the relationship between matter, energy, and measurement through hands-on experiments and real-life applications.
- Develop critical thinking and problem-solving skills by analyzing and evaluating experimental data and scientific claims.
- Communicate scientific ideas and findings effectively using appropriate terminology and graphical representations.

Essential Questions:

- What is the nature of matter and how can it be classified and described?
- How is energy involved in chemical reactions and changes in matter?
- Why is measurement important in chemistry, and how can it be utilized to obtain accurate and meaningful data?

Enduring Understandings:

- Matter is composed of atoms and molecules that interact and undergo various changes.
- Energy is involved in all chemical processes and can be transferred or transformed.
- Measurement is crucial for accurately describing and quantifying chemical phenomena.

CONTENT AREA STANDARDS

SCI.HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
SCI.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
SCI.HS-PS1-3	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.
SCI.HS-PS3-4	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).
SCI.HS-PS4-2	Evaluate questions about the advantages of using a digital transmission and storage of information.
SCI.HS-PS1-1	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.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity

	(e.g., NJSLSA.SL5).
TECH.K-12.1.4.a	know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

STUDENT LEARNING TARGETS

Refer to the 'Declarative Knowledge' and 'Procedural Knowledge sections.

Declarative Knowledge

Students will understand that:

- Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.
- Understanding the development of scientific ideas is essential for building scientific knowledge.
- Mathematics is a tool used to model objects, events, and relationships, in the natural and designed world.
- Very large and very small numbers can be expressed as a product of a number between 1 and 10 and a power of 10.
- Uncertainty in a measurement can be indicated using significant figures, which carries through any subsequent calculation.
- Dimensional analysis can be used as an orderly approach to a wide variety of different problems.
- The three different temperature scales (Fahrenheit, Celsius, Kelvin) can be converted to another.
- Density can be calculated from mass and volume, and it can be used as a way to distinguish one substance from another.
- Matter, on all levels, has predictable properties that can be related to structures of the elements that make up that matter
- Elements and compounds are pure substances. Elements cannot be decomposed into simpler materials by chemical reactions.
- Elements can react to form compounds. Elements and/or compounds may also be physically combined to form mixtures.
- Elements, compounds, and mixtures have unique physical and chemical properties.
- Temperature is a measure of the average kinetic energy for the molecules/atoms in a substance (i.e. the significance of absolute zero)
- Heat flow is the energy transfer between objects due to a temperature difference between them.

Procedural Knowledge

Students will be able to:

- Address phenomena or scientific theories
- Evaluate the given questions in terms of whether or not answers to the questions would provide examples of features associated with digital transmission and storage of information.

    - Describe the stability and importance of the systems that employ digital information as they relate to the advantages and disadvantages of digital transmission and storage of information;
    - Discuss the relevance of the answers to the question to real-life examples (e.g., emailing your home to a teacher, copying music, using the internet for research, social media).
- Identify and analyze a major global problem.
    - Describe the challenge with a rationale for why it is a major global challenge;
    - Describe, qualitatively and quantitatively, the extent and depth of the problem and its major consequences to society and/or the natural world on both global and local scales if it remains unsolved;
    - Document background research on the problem from two or more sources, including research journals.
- Develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including:
    - The measurement of the reduction of temperature of the hot object and the increase in temperature of the cold object show that the thermal energy lost by the hot object is equal to the thermal energy gained by the cold object and that the distribution of thermal energy is more uniform after the interaction of the hot and cold components;
    - The heat capacity of the components in the system (obtained from scientific literature).
- Identify and describe the components of the model that are relevant for their predictions, including:
    - Elements and their arrangement in the periodic table;
    - A positively-charged nucleus composed of both protons and neutrons, surrounded by negatively-charged electrons;
    - Electrons in the outermost energy level of atoms (i.e., valence electrons);
    - The number of protons in each element.
- Develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including bulk properties of a substance that would allow inferences to be made about the strength of electrical forces between particles. Students describe why the data about bulk properties would provide information about strength of the electrical forces between the particles of the chosen substances, including the following descriptions:
    - The spacing of the particles of the chosen substances can change as a result of the experimental procedure even if the identity of the particles does not change (e.g., when water is boiled the molecules are still present but further apart).
    - Thermal (kinetic) energy has an effect on the ability of the electrical attraction between particles to keep the particles close together. Thus, as more energy is added to the system, the forces of attraction between the particles can no longer keep the particles close together.

EVIDENCE OF LEARNING

Refer to the 'Formative Assessments' and 'Summative Assessments' sections.

Formative Assessments

- POGIL Activities:
    - Experimental Design
    - Organizing Data
    - Significant Digits and Measurement
    - Classification of Matter
- Labs
    - Observations of a Candle
    - Reaction in a Bag
    - Density of Water/Metals
    - "Black Box" experiment
    - Separation of a Mixture
    - Paper Chromatography
    - Specific Heat of Water/Metals
- Group practice
    - Significant figures
    - Density and Temperature
    - Metric Conversions
    - Other Conversions
- Performance Scale/ Student Tracking Chart
- Whiteboards
- Exit Tickets
- Homework

Summative Assessments

- Benchmarks – departmental benchmark given at the end of MP1, MP2, and MP3 based on lab practices
- Alternative Assessments
    - Lab inquiries and investigations
    - Lab Practicals
    - Exploratory activities based on phenomenon
    - Gallery walks of student work
    - Creative Extension Projects
    - Build a model of a proposed solution
    - Let students design their own flashcards to test each other
    - Keynote presentations made by students on a topic
    - Portfolio

RESOURCES (Instructional, Supplemental, Intervention Materials)

CK-12 Online Textbook

POGIL Chemistry

Gizmos Simulations

PhET Simulations

Khan Academy

Bozeman Science

American Chemical Society

Climate Change-CK12: https://www.ck12.org/section/climate-change-%3a%3aof%3a%3a-hs-climate/

Climate change lessons: https://subjecttoclimate.org/lesson-plans

INTERDISCIPLINARY CONNECTIONS

ELA/Literacy

Mathematics

Technology

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.