B. UNIT NAME: EXPERIMENTING WITH MIXTURES, COMPOUNDS, AND ELEMENTS NGSS 8-15

Content Area: **Science**
Course(s):
Time Period: **Trimester 2**
Length: **11 lessons**
Status: **Published**

Unit Overview

In this unit, students focus on building an understanding of the physical and chemical properties that distinguish mixtures, compounds, and elements. This unit builds upon the student's awareness, from previous study, of some of the physical properties of a substance and some of its defining characteristics. In this unit, students investigate how such properties can be used to separate mixtures, or how additional energy, in the form of heat or electricity, is needed to separate compounds. The students examine elements and discover that elements can combine to form compounds, but cannot be separated further into different components. Students also learn the properties of the elements through study of the Periodic Table of the Elements by naming chemical compounds, writing chemical formulas, and balancing chemical equations.

This unit is mostly laboratory and project based. However, there are many important reading selections from both the STC and Pearson publications. The Pearson Interactive Science series listed in the bibliography is used mainly as a reinforcement for the lab activities and as an additional source of readings, vocabulary, and diagrams. In addition, many other sources of reading materials, videos, and other media are used to enhance the lesson, such as *National Geographic, Smithsonian Magazine, Science Scope* (NSTA), *BrainPop, YouTube, Science Illustrated,* and other relevant books and current events.

This unit will be learned in the second trimester.

Essential Questions

- What is an element?
- What is an atom?
- Of what is an atom composed?
- How are protons, electrons, and neutrons held together to create an atom?
- What particles make up the nucleus of an atom?
- What is a molecule?
- What is a compound?
- What is a mixture?
- How are the elements arranged on the Periodic Table of Elements?
- What is an acid?
- What is a base?
- What is the pH scale and what does it measure?
- What is a solution?
- What is a chemical equation?
- What does it mean to "balance" an equation?
- What is a chemical formula?
- How does one "write" a chemical formula?

- What is a subscript and a coefficient?
- What is a chemical bond?
- How do chemical bonds form and how are they broken?

Content

- An element is a pure substance that cannot be broken down into simpler substances.
- An atom's nucleus consists of protons and neutrons while electrons occupy the spaceoutside of the nucleus.

- Most elements are composed of a combination of positively charged particles (protons), neutral particles (neutrons), and negatively charged particles (electrons).
- Elements consist of metals, nonmetals, and metalloids.
- The Periodic Table of Elements presents and arranges the elements in order of increasing atomic mass and was proposed by Mendeleev. The atomic number of an element describes the numbers of protons each atom contains
- Compounds form when one or more elements chemically bond.
- Bonds between atoms can be described as ionic, covalent, hydrogen, or metallic.
- Compounds held together by these types of bonds vary greatly in their respective properties.
- Specific ratios of elements combine to form compounds.
- Compounds can be described in a chemical formula, such as H_2O (water), $C_6H_{12}O_6$ (glucose), and NaCl (table salt).
- Mixtures differ in respect to their properties, and can be described as solutions, suspensions, and colloids.
- Solutions are very well-mixed mixtures.
- Solutions can be separated into individual components by several methods.
- Solutions can be described in terms of their pH values.
- pH describes the concentration of H^+ or (OH^-) and can be detected by indicators on litmus and pH paper.
- An indicator is a chemical that changes color when in contact with an acid or a base.
- The relative strength of a solution can be described in terms of its concentration
- Mixtures differ in respect to their properties, and can be described as solutions, suspensions, and colloids.
- Evaporation, decanting, and filtration are several methods by which substances within a mixture can be separated.
- Compounds can be described in a chemical formula, such as H_2O (water), $C_6H_{12}O_6$ (glucose), and NaCl (table salt).
- A "sentence" describing a chemical reaction between two or more elements or compounds is a chemical equation.
- In a chemical equation, the number of atoms of a particular element must be equal in both the reactant and product, according to the Law of Conservation of Mass.
- Balancing chemical equations shows the relationship between elements and/or compounds during a chemical reaction.
- Subscripts and coefficients indicate the number of atoms of each element in a chemical compound.
- Electrical charges of each element determine the number of atoms of each element that combine to form a molecule in a chemical formula.

- Bonds between atoms can be described as ionic, covalent, hydrogen, or metallic.
- Compounds held together by these types of bonds vary greatly in their respective properties.
- These bonds can vary greatly in their strength, and stability, and therefore affect the compounds that they hold together.

Skills

- Balance chemical equations to show how mass is conserved during a chemical reaction
- Write chemical formulas to demonstrate balancing of element's electrical charges
- Identify ways to separate the individual components of a mixture
- Learn the characteristics of each of the elements in the Periodic Table
- Become familiar with the traits of each of the families of elements, and be able to predict the reactivity of an element based on its position in the Periodic Table Determine the pH value of a substance using pH paper, red litmus paper, and blue litmus paper
- Demonstrate activities to separate components of a mixture, such as decanting, filtering, use of magnetism, and evaporation
- Perform pH laboratory exercise, where students determine acidity and alkalinity of substances by use of red and blue litmus paper, and pH paper
- Balance chemical equations to show how mass is conserved during a chemical reaction
- Write chemical formulas to demonstrate balancing of element's electrical charges
- Identify that mass of chemicals remains the same before and after a chemical Identify bonds

based on their electron configurations

- Learn to write and decipher electron dot diagrams

- Determine the proper number of valance electrons of an atom (and compounds) in order to write electron dot diagrams reaction

Assessments

The majority of this unit is an inquiry-based hands-on approach to learning. It consists of laboratory activities which vary in their intensity, approach, skill, and evaluative measurements. For example, some of the lab activities are "walk-through" labs, where the student is guided through a procedure and a process, and is asked to make connections among the main concepts presented in the activity and associated readings. Other lab activities consist of a problem that is presented to the student, which he or she must solve by designing an experiment (which is then peer and teacher evaluated before proceeding with the lab activity) and collecting data. Regardless of the lab activity, students are evaluated based on the quality and presentation of the collected data in graphic organizers; the efficacy and accuracy of the experimental design; the connections made between the experimental design, the data collected, and the conclusion of the laboratory report- i.e. "tying it all together to see the big picture"; and lab etiquette and adherence to safety rules.

Other evidence for learning includes several short 5-10 question quizzes, and end-of-unit lab practical (hands-on) test, end-of-unit paper test based on the labs, and several creative projects, which may include posters, skits, songs and poems, presentations, and science fair projects (Science Fair projects span several

units and may not be completed within any one single unit presented within Folsom School's Science Curriculum).

Standards

NGSS Standard Correlation

MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [*Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.*]

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [*Assessment boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.*]

MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [*Assessment Boundary: Assessment is limited to qualitative information.*]

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawing and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [*Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.*]

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [*Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*]

MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or

maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]

MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]

MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [*Assessment Boundary: Assessment does not include calculations of energy.*]

Resources

Smithsonian Institution, 2012. *Experimenting With Mixtures, Compounds, and Elements*.. (Smith- Developer of module).

Pearson 2011. Interactive Science: *Introduction to Chemistry.* Upper Saddle River, NJ