Conceptual Story: STC/MS *PROPERTIES OF MATTER*

PART 1: CHARACTERISTIC PROPERTIES OF MATTER

Lesson 1: Our Ideas About Matter (Pre-assessment)

Focus Question: What is meant by the term "matter"?

Students complete a circuit of eight short inquiries that include exploratory experiences involving mass, volume, density, states of matter, changes of state, thermal expansion, mixtures, solubility, and chemical reactions.

CE - 1, 2, 3

Density of Pure Substances: Density is the mass of a known volume of substances and is a characteristic property of all matter. Regardless of state (solid, liquid or gas), density can be calculated and compared. Density is often used to help identify the make up of pure substances.

Lesson 2: Determining Density

Focus Questions: What does density measure? What tools and units of measure are used to calculate and report mass, volume, and density?

Students calculate the densities of regular and irregular shaped objects, including water, by taking mass and volume measurements.

Lesson 3: Density Predictions

Focus Question: How can you accurately predict if something will sink or float in a given liquid?

Students calculate the densities of various solid objects and liquids. They predict the order and build a density column using three liquids. They calculate if a copper cylinder and a nylon spacer will float or sink in their density column.

Lesson 4: Do Gases Have Density?

Focus Question: Does air have density?

Students design an experimental procedure to determine the mass, volume, and density of a bottle of air using a limited set of apparatus.

1.1 Properties of Systems*:* Properties of Substances; Energy Sources and Kinds
1.2 Structure of Systems: Energy Transfer and Transformation; Systems
1.3 Changes in Systems: Physical and Chemical Change

AAAS ATLAS: Structure of Matter: Conservation of Matter (p. 57); States of Matter (p. 59);
Systems (p. 133)
AAAS Benchmarks: Energy Transformation

CE - 1, 2, 3

The Effects of Heat on Density: Heat is an agent that can change the density of matter. Most matter expands when heated and contracts when cooled. This change in volume, but not mass, causes the density to change with varying temperatures.

Lesson 5: Temperature and Density

Focus Questions: What is the relationship between temperature, expansion, contraction and density? What is the difference between heat and temperature?

Students construct and calibrate a liquid-filled thermometer. They redesign and recalibrate their thermometer, replacing the liquid with air.

1.1 Properties of Systems*:* Properties of Substances; Energy Sources and Kinds
1.2 Structure of Systems: Energy Transfer and Transformation; Systems
1.3 Changes in Systems: Physical and Chemical Change

CE - 3
FV
PE

Heating Pure Substances: The way a substance behaves when it is heated is a characteristic property of that substance. Applying heat causes matter to undergo physical or chemical changes. The kinetic-molecular theory of matter helps to explain the physical phase change caused by adding heat. Evaporation, condensation, and sublimation are caused when heat energy can overcome the forces that normally hold a solid together or keep a liquid in a fluid state. Heat is responsible for thermal decomposition reactions when a pure substance (a compound) breaks down into two or more simpler substances, each with different properties. When describing all chemical reactions or physical change, one thing remains constant: mass is conserved.

Lesson 6: Applying the Heat

Focus Question: What effect can heat have on solid substances?

Students heat a variety of pure substances and observe and classify changes they observe. They are introduced to the idea of reactants and products in simple chemical reactions.

Lesson 7: Just a Phase

*Focus Questions: What is meant by the terms **melting point** and **boiling point**? What role does heat play in phase changes?*

Students observe the phase changes of ice as it is heated. They determine that substances have melting and boiling points.

Lesson 8: Changing Matter and Mass

Focus Questions: What happens to the mass of water when it changes from solid to liquid? From liquid to solid?

Students design an investigation to determine what happens to the mass of ice when it melts. They then conduct an investigation to determine what happens to the mass of liquid water when it freezes.

1.1 Properties of Systems: Properties of Substances; Energy Sources and Kinds
1.2 Structure of Systems: Energy Transfer and Transformation
1.3 Changes in Systems: Physical/Chemical Change

AAAS ATLAS: Structure of Matter: Conservation of Matter (p. 57); States of Matter (p. 59); Chemical Reactions (p. 61)
AAAS Benchmarks: Energy Transformation (p. 85)

Lesson 9: The Mystery Object (A Performance Assessment)

Focus Question: How can density be used to identify unknown substances?

Students are given a "mystery object" and asked to design a procedure that will help them discover the identity of the substance that makes up this object.

Conceptual Story: STC/MS *PROPERTIES OF MATTER*

PART 2: MIXTURES AND SOLUTIONS

SP
FV
CE - 3

Lesson 10: Starting the Anchor Activity

Focus Question: Given a simple, manufactured object, what is it made from and why?

Students select a manufactured object and explain its function, identify the major materials that make up the object, why these materials were chosen, the origin of one of the materials, and history of the object.

1.1 Properties of Systems: Properties of Substances; Systems

AAAS ATLAS:
Design and Systems: Design Constraints (p. 33); Designed Systems (p. 35)
Issues in Technology: Decisions about Using Technology (p. 39)
Systems (p. 133)
AAAS Benchmarks:
Materials and Manufacturing (p. 190)

Properties of Mixtures: *Pure* substances include elements and compounds. *Mixtures* are made of two or more pure substances that are physically combined while each substance in the mixture maintains its own distinct properties. A *solution* is a homogeneous (well-mixed) mixture of a solute dissolved in a solvent and in which the different components are not readily distinguishable. Solutions can exist in all three states: solid (i.e., brass), liquid (salt water), and gas (air). Solubility, the ability of a substance to dissolve, is another characteristic property of matter. Soluble solids are able to pass through a filter while insoluble solids are not. *The particulate nature of matter helps to explain solubility and how mass, but not volume, is conserved.* Smaller particles can fit between larger particles.

Lesson 11: Pure Substance or Mixture

Focus Questions: What is meant by "pure substance"? How can you distinguish between pure substances and mixtures?

Students use various physical properties such as density, solubility and magnetism to determine if 8 objects are pure substances or mixtures.

Lesson 12: What Happens When Substances Are Mixed with Water?

Focus Question: What property of matter determines what type of mixture a pure substance will form when mixed with water?

Students observe what happens when they mix several pure substances with water. They observe that some substances dissolve while others are insoluble.

Lesson 13: How Much Solute Dissolves in a Solvent?

Focus Questions: What is a saturated solution? Are different substances equally soluble in water?

Students create a saturated sodium chloride solution. They then design an investigation to determine the relative solubility of two different chemicals.

Lesson 14: Mass, Volume and Dissolving

Focus Question: What happens to the mass and the volume of one type of matter when it is dissolved in another type of matter?

Students mass equal volumes of water and alcohol and predict what will happen to the mass and volume after mixing. They conduct an investigation to determine what happens to the mass of salt when it is dissolved in water.

1.1 Properties of Systems: Properties of Substances
1.3 Changes in Systems: Physical/Chemical Change; Structure of Matter

AAAS ATLAS:
Structure of Matter: Atoms & Molecules (p. 55); Conservation of Matter (p. 57)

SP (apply)
FV (apply)

Lesson 15: Separating a Soluble and an Insoluble Substance (Embedded Assessment)

Focus Question: What separation techniques can be used to separate the various soluble and insoluble components of a mixture such as rock salt?

Students use a filter to discover that soluble solids pass through while insoluble solids remain in the filter. They then design an investigation that would allow them to separate the soluble components of rock salt from the insoluble contaminates.

The Nature of Mixtures and Their Applied Use: The polar nature of water allows it to readily bond to polar molecules or ionic compounds, giving water the title of "universal solvent." However, when a mixture is non-polar, water is ineffective at dissolving any soluble solids. For example, some mixtures can stain and only be removed with non-polar chemical solvents that don't contain water. Using a solvent as a cleaner involves a physical change. The study of inks shows how a solution can contain more than one solute. Changing the amount of a solute in a solution can change the properties of the mixture.

Lesson 16: Researching Solvents

Focus Question: How effective are three different solvents in removing a variety of stains?

Students conduct their own investigation to determine the effectiveness of non-aqueous solvents at removing stains.

Lesson 17: Separating Solutes

Focus Question: What does the separation technique of paper chromatography indicate about an ink solution?

Students discover that solutions can contain more than one solute and that paper chromatography can be used to separate them. They become forensic scientists and compare the dyes (solutes) found in different colored inks.

Lesson 18: Changing Mixtures

Focus Question: How do the properties of a mixture differ from the properties of the individual components of the mixture?

Students investigate how adding salt affects the melting and boiling points of water. They investigate the melting points of three different tin alloys.

1.1 Properties of Systems: Properties of Substances
1.3 Changes in Systems: Physical/Chemical Change

Structure of Matter: Atoms & Molecules (p. 55); States of Matter (p. 59)
Design and Systems: Design Constraints (p. 33)
Issues in Technology: Decisions about Using Technology (p. 39)

Lesson 19: Assessing Our Progress (A Performance Assessment)

Focus Question: What are the physical properties of substances that make up a mixture?

Students are given a set of materials with which to investigate and separate a mixture of iron filings, powered drink mix, wax crystals, and white sand.

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PART 3: COMPOUNDS, ELEMENTS, AND CHEMICAL REACTIONS

HBS - 1, 2

Elements as Building Blocks for All Matter: The particulate nature of matter is able to explain how particles that make up all matter can be different sizes and therefore how smaller sized particles can fit between larger particles. Particles of water are large enough to physically allow alcohol or salt particles to fit between the water particles. But water can be chemically broken down through electrolysis into its elemental components (hydrogen and oxygen) in a *decomposition reaction*, each product having very different properties from water. *Elements*, the smallest of all particles, are each unique. They share properties with other elements but can be grouped according to these common properties. Elements can be combined through chemical reactions, resulting in new substances with new properties. Whether pure substances are broken down into elements, or elements are combined to form pure substances, mass is always conserved.

Lesson 20: Breaking Down a Compound

Focus Questions: What are the component parts that make up water? How is water physically and chemically different from the elements that make it up?

Students use electrolysis to decompose water into hydrogen and oxygen. They compare the physical and chemical properties of the reactant (water) and the products (hydrogen and oxygen) of this reaction.

Lesson 21: Examining and Grouping Elements

Focus Question: What are some characteristic properties of elements that can be used to group elements?

Students read about and perform simple tests on 25 element samples to gain information about their characteristic properties. They construct a classification scheme and compare it to how these elements are grouped on the Periodic Table.

Lesson 22.1 Combining Elements

Focus Question: What are the two main groups of elements?

Students examine two metals and two nonmetals and determine how these elements fit into two groups. They complete a Venn diagram, placing elements they have encountered throughout the module into two groups: metals and nonmetals.

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AAAS ATLAS:
Structure of Matter: Atoms & Molecules (p. 55); Conservation of Matter (p. 57); Chemical Reactions (p. 61)
Systems (p. 133)
Scientific Inquiry: Evidence & Reasoning in Inquiry (p. 17); Scientific Investigations (p. 19)
AAAS Benchmarks:
Energy Transformation (p. 85)

HBS - 2
SP
EMM - 1

Chemical Reactions of Elements: Chemical reactions involve reactants and result in products. In a *synthesis reaction*, two or more elements (reactants) chemically combine to form new substances (products) with properties that are different from the original elements. Some elements are more reactive than others. In all chemical reactions, mass is conserved.

Lesson 22.2: Combining Elements

Focus Question: How would you write an equation for the chemical reaction between iron and oxygen?

Students place steel wool in a test tube and invert it in a beaker of water. They observe the change in water level inside the test tube and the darker appearance of the steel wool. They conclude that a chemical reaction has occurred and a new substance (iron oxide compound) has formed.

Lesson 23: Chemical Reactions Involving Metals

Focus Question: Are some elements more reactive than others?

Students look for evidence of a chemical reaction between four metals and HCl and observe that reactivity of metals vary. They conduct an investigation to compare corrosion rates of different metals.

Lesson 24: Countering Corrosion

Focus Questions: What conditions are required for rusting to take place? How can rusting be prevented?

Students conduct an investigation to compare the effectiveness of five rust-prevention treatments.

Lesson 25: Mass and Chemical Reactions

Focus Question: What happens to the total mass of matter in a chemical reaction when one of the products is a gas?

Students determine whether the law of conservation of mass can be applied to chemical reactions. They measure mass before and after adding an effervescent tablet to water in an open and closed system.

Lesson 26: End-Of-Module Assessment

Focus Question: How can the conservation of mass be demonstrated during dissolving and chemical reactions?

Students engage in a performance assessment where they conduct an experiment to investigate the conservation of mass during the process of dissolving and during a chemical reaction.

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AAAS Benchmarks: