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ODYSSEY Molecular Explorer

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Correlation with the

Minnesota Science Standards

High School

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Physical Science

Matter

1. The structure of the atom can be used to explain chemical properties of matter. The periodic table organizes the elements by increasing atomic number and illustrates how periodicity of the physical and chemical properties of the elements relates to atomic structure.

    1. Identify protons, neutrons and electrons as the major components of a neutral atom; their mass relative to one another; their arrangement; and their charge.

        → **LAB** *Atoms* "Nuclei and Electrons"

    2. Explain the relationship of an element's position on the periodic table to its atomic number and atomic mass; use the periodic table to identify regions, groups and periods.

        → **MISCELLANEOUS** *Main Groups* "Alkali Metals"

        → **MISCELLANEOUS** *Main Groups* "Alkaline Earth Metals"

        → **MISCELLANEOUS** *Transition Metals* "Elements of the d- and f-Blocks"

        → **MISCELLANEOUS** *Main Groups* "Boron Group"

        → **MISCELLANEOUS** *Main Groups* "Carbon Group"

        → **MISCELLANEOUS** *Main Groups* "Nitrogen Group"

        → **MISCELLANEOUS** *Main Groups* "Oxygen Group"

→ **MISCELLANEOUS** *Main Groups* "Halogens"

→ **MISCELLANEOUS** *Main Groups* "Noble Gases"

2. Chemical reactions involve the rearrangement of atoms as chemical bonds are broken and formed through transferring or sharing of electrons and the absorption or release of energy.

    1. Describe the role of valence electrons in the formation of chemical bonds.

    → **LAB** *Chemical Bonding* "Electron Sharing in Molecules"

    → **LAB** *Chemical Bonding* "Energetics of Covalent Bonding"

    2. Use temperature change in a chemical reaction to identify the reaction as exothermic or endothermic.

    → **LAB** *Kinetics* "Reactive Collisions Between Molecules"

    → **LAB** *Kinetics* "Examining a Reaction Mechanism"

    → **LAB** *Equilibria* "Equilibrium and Temperature"

Energy

2. Energy appears in different forms and can be transformed within a system or transferred to other systems or the environment.

    1. Use the kinetic molecular theory to explain the relationship between temperature and state.

    → **LAB** *Liquids & Solids* "The Melting Transition"

    → **DEMONSTRATION** *Chemical Matter* "Do physical changes affect the amount of matter?"

    3. Describe the static-electric charge on an object and its effect upon other objects in terms of electron distribution.

    → **LAB** *Atoms* "The Electron Cloud of an Argon Atom"

Human Interaction with Physical Systems

2. Physical and mathematical models are used to describe physical systems, and careful consideration of units is essential in any scientific work.

    1. Use equations and graphs to show the relationships between physical quantities.

→ **Lab** *Chemical Bonding* "Energetics of Covalent Bonding"

→ **Lab** *Gases* "The Distribution of Kinetic Energies"

→ **Lab** *Gases* "The Pressure-Volume Relationship"

→ **Lab** *Gases* "The Pressure-Temperature Relationship"

→ **Lab** *Gases* "Mean Speed and Temperature"

→ **Lab** *Thermochemistry* "Specific Heat"

→ **Demonstration** *Thermochemistry* "What is the energy of a vibrating diatomic molecule?"

→ **Lab** *Kinetics* "Examining a Reaction Mechanism"

→ **Lab** *Equilibria* "Equilibrium and Temperature"

→ **Lab** *Chemical Thermodynamics* "Entropy and the States of Matter"

2. Use unit conversions/dimensional analysis to solve problems and check results.

→ *Many Labs*

4. Demonstrate the conversion of units within the Systeme Internationale (SI, or metric) and estimate the magnitude of common objects and quantities using metric units.

→ **Lab** *Gases* "Gas Pressure"

→ **Lab** *Gases* "Temperature Scales in Chemistry"

Chemistry

Matter

1. The structure of the atom can be used to explain chemical properties and changes in matter. The periodic table organizes the elements by increasing atomic number and illustrates how periodicity of the physical and chemical properties of the elements relates to atomic structure.

2. Identify and compare trends on the periodic table, including reactivity and relative sizes of atoms and ions; use the trends to explain the properties of subgroups, metals, nonmetals, alkali metals, alkaline earth metals, halogens and noble gases.

→ **Miscellaneous** *Main Groups* "Alkali Metals"

→ **Miscellaneous** *Main Groups* "Alkaline Earth Metals"

→ **Miscellaneous** *Transition Metals* "Elements of the d- and f-Blocks"

→ **Miscellaneous** *Main Groups* "Boron Group"

→ **Miscellaneous** *Main Groups* "Carbon Group"

→ **Miscellaneous** *Main Groups* "Nitrogen Group"

→ **Miscellaneous** *Main Groups* "Oxygen Group"

→ **Miscellaneous** *Main Groups* "Halogens"

→ **Miscellaneous** *Main Groups* "Noble Gases"

2. Biological, chemical and physical properties of matter result from the ability of atoms to form bonds. Atoms bond with each other by transferring or sharing valence electrons.

    1. Explain how elements combine to form compounds through ionic and covalent bonding.

        → **Lab** *Chemical Bonding* "Exploring Ionic Interactions"

        → **Lab** *Chemical Bonding* "Polar Bonds and Molecules"

        → **Lab** *Chemical Bonding* "Classifying by Bond Polarity"

    2. Use the IUPAC system to write chemical formulas and name molecular compounds and ionic and compounds, including those that contain polyatomic ions ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.

        → **Lab** *Chemical Matter* "Naming Molecular Compounds"

        → **Lab** *Chemical Bonding* "Polyatomic Ions"

    3. Compare and contrast the structure, properties and uses of organic compounds including hydrocarbons, alcohols, sugars, fats and proteins.

        → **Lab** *Organic Chemistry* "Isomers of the Alkanes"

        → **Lab** *Organic Chemistry* "Straight-Chain Alkanes"

        → **Lab** *Organic Chemistry* "Isomers of Alkenes and Alkynes"

        → **Lab** *Organic Chemistry* "Cyclic Hydrocarbons"

→ **LAB** *Organic Chemistry* "Comparing and Identifying Organic Compounds"

→ **LAB** *Biochemistry* "Building a Model of a Protein"

→ **MISCELLANEOUS** *Biochemistry* "Carbohydrates"

→ **STOCKROOM** *Organic* "Common Solvents"

→ **MISCELLANEOUS** *Consumer Chemistry* "Olestra"

3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.

    1. Predict the products and whether a chemical reaction will take place using the drivers of a chemical reaction (formation of water, formation of a precipitate, evolution of a gas and changes in energy to the system).

    → **LAB** *Kinetics* "Reactive Collisions Between Molecules"

    4. Use the mole concept to describe and calculate relationships in a chemical reaction, including molarity, mole/mass relationships, mass/volume relations, limiting reactants and percent yield.

    → **LAB** *Kinetics* "Examining a Reaction Mechanism"

4. Chemical equilibrium is a dynamic process that directs chemical interactions.

    1. Describe the process by which solutes dissolve in solvents and calculate concentrations, including grams per liter, molarity and parts per million.

    → **DEMONSTRATION** *Solutions* "How do salts dissolve in water?"

    → **MISCELLANEOUS** *Solutions* "Energetics of Solutions"

    → **LAB** *Solutions* "Concentration of a Dissolved Pesticide"

    3. Describe the factors that affect the rate of a chemical reaction, including temperature, pressure, mixing, concentration, particle size, surface area and catalyst.

    → **LAB** *Kinetics* "Reactive Collisions Between Molecules"

5. States of matter can be described in terms of motion of molecules. The properties and behavior of gases can be explained using the Kinetic Molecular Theory and quantitatively, using the gas laws.

    1. Use kinetic molecular theory to explain how changes in energy content affect the state of matter (solid, liquid, gaseous phases).

→ **Lab** *Chemical Matter* "Comparing the States of Matter"

→ **Lab** *Chemical Matter* "Side-by-Side Comparison of Solids, Liquids, and Gases"

→ **Lab** *Liquids & Solids* "Molecular Motion in the States of Matter"

2. Explain the roles of pressure and temperature in changes of phase of matter.

→ **Lab** *Liquids & Solids* "The Melting Transition"

→ **Demonstration** *Chemical Matter* "Do physical changes affect the amount of matter?"

3. Explain and calculate changes in temperature, pressure, volume and number of particles of a gas in terms of the random motion of molecules in an ideal gas and using gas laws.

→ **Lab** *Gases* "The Pressure-Volume Relationship"

→ **Lab** *Gases* "The Pressure-Temperature Relationship"

→ **Demonstration** *Gases* "What is Boyle's Law?"

→ **Demonstration** *Gases* "What is Avogadro's Law?"

→ **Miscellaneous** *Gases* "The Universality of the Ideal Gas Law"

4. Relate the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.

→ **Lab** *Gases* "The Meaning of Temperature"

→ **Lab** *Gases* "Mean Speed and Temperature"

→ **Lab** *Thermochemistry* "Thermal Energy"

Energy

1. Conservation of mass and energy and the increases of entropy help explain physical, chemical and nuclear changes.

    1. Explain, at the particle level, the role of activation energy and the degree of randomness in chemical reactions.

→ **Lab** *Kinetics* "Reactive Collisions Between Molecules"

→ **Lab** *Kinetics* "Examining a Reaction Mechanism"

Human Interaction with Physical Systems

1. Physical and mathematical models are used to describe physical systems.

    1. Select and use appropriate numeric, symbolic, graphical and standard modes of representation (including SI units and traditional/IUPAC nomenclature) to communicate scientific ideas, plans and experimental results.

        ⟶ *Most Labs*

    2. Use an understanding of the accuracy and precision in scientific measurements to determine and express the uncertainty of a result using significant figures.

        ⟶ **LAB** *Gases* "Gas Pressure"

        ⟶ **LAB** *Solutions* "Concentration of a Dissolved Pesticide"

    3. Compare the strengths and weakness of various visual, mathematical and computer models in describing chemical atoms, molecules and interactions.

        ⟶ **LAB** *Atoms* "The Electron Cloud of an Argon Atom"

        ⟶ **DEMONSTRATION** *Atoms* "What does a hydrogen atom look like?"

        ⟶ **LAB** *Chemical Bonding* "Electron Sharing in Molecules"

        ⟶ **LAB** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

2. Developments in chemistry affect society and societal concerns affect the field of chemistry.

    2. Explain the political, societal and environmental impact of chemical products and technologies, such as use and disposal of material, pollution effects, change in the atmosphere, petroleum products and nano particles.

        ⟶ **MISCELLANEOUS** Section