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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.

        → **D2** *Atoms* "Distribution of Mass in Atoms"

    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.

        → **P1** *Main Groups & Transition Metals* "Alkali Metals"

        → **P2** *Main Groups & Transition Metals* "Alkaline Earth Metals"

        → **P3** *Main Groups & Transition Metals* "Boron Group"

        → **P4** *Main Groups & Transition Metals* "Carbon Group"

        → **P6** *Main Groups & Transition Metals* "Nitrogen Group"

        → **P7** *Main Groups & Transition Metals* "Oxygen Group"

        → **P10** *Main Groups & Transition Metals* "Halogens"

        → **P11** *Main Groups & Transition Metals* "Noble Gases"

        → **P12** *Main Groups & Transition Metals* "Elements of the d- and f-Blocks"

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.

→ **F7** *Chemical Bonding* "Electron Sharing"

→ **F8** *Chemical Bonding* "Energetics of Covalent Bonding"

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

→ **M2** *Kinetics* "Reactive Collisions"

→ **M3** *Kinetics* "Mechanism of a Reaction"

→ **N2** *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.

→ **C13** *Chemical Matter* "Physical Changes"

→ **H20** *Liquids & Solids* "Melting Transition"

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

→ **D5** *Atoms* "Electron Cloud of Argon"

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.

→ **F8** *Chemical Bonding* "Energetics of Covalent Bonding"

→ **G12** *Gases* "Mean Speed and Temperature"

→ **G13** *Gases* "Pressure-Volume Relationship"

→ **G16** *Gases* "Pressure and Temperature"

→ **G22** *Gases* "Distribution of Kinetic Energies"

→ **L4** *Thermochemistry* "Vibrating Diatomic Molecule"

→ **L6** *Thermochemistry* "Specific Heat"

→ **M3** *Kinetics* "Mechanism of a Reaction"

→ **N2** *Equilibria* "Equilibrium and Temperature"

→ **O4** *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.

→ **G6** *Gases* "Gas Pressure"

→ **G8** *Gases* "Temperature Scales"

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.

→ **P1** *Main Groups & Transition Metals* "Alkali Metals"

→ **P2** *Main Groups & Transition Metals* "Alkaline Earth Metals"

→ **P3** *Main Groups & Transition Metals* "Boron Group"

→ **P4** *Main Groups & Transition Metals* "Carbon Group"

→ **P6** *Main Groups & Transition Metals* "Nitrogen Group"

→ **P7** *Main Groups & Transition Metals* "Oxygen Group"

→ **P10** *Main Groups & Transition Metals* "Halogens"

→ **P11** *Main Groups & Transition Metals* "Noble Gases"

→ **P12** *Main Groups & Transition Metals* "Elements of the d- and f-Blocks"

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.

→ **F1** *Chemical Bonding* "The Attraction Between Ions"

→ **F11** *Chemical Bonding* "Polar Bonds and Molecules"

→ **F13** *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.

→ **C20** *Chemical Matter* "Naming Compounds"

→ **F10** *Chemical Bonding* "Polyatomic Ions"

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

→ **S2** *Organic Chemistry* "Straight-Chain Alkanes"

→ **S3** *Organic Chemistry* "Cyclic Hydrocarbons"

→ **S5** *Organic Chemistry* "Isomers of the Alkanes"

→ **S9** *Organic Chemistry* "Isomers of Alkenes and Alkynes"

→ **S16** *Organic Chemistry* "Identifying Compounds"

→ **T3** *Biochemistry* "Carbohydrates"

→ **T10** *Biochemistry* "Building a Model of a Protein"

→ **W10** *Consumer Chemistry* "Olestra"

→ **Stockroom** *Organic* "Solvents"

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).

→ **M2** *Kinetics* "Reactive Collisions"

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.

→ **M3** *Kinetics* "Mechanism of a Reaction"

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.

→ **I2** *Solutions* "Process of Dissolving"

→ **I6** *Solutions* "Concentration of a Dissolved Pesticide"

→ **I11** *Solutions* "Energetics of Solution Formation"

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

→ **M2** *Kinetics* "Reactive Collisions"

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).

        → **C6** *Chemical Matter* "States of Matter"

        → **C7** *Chemical Matter* "Comparing States Side-by-Side"

        → **H9** *Liquids & Solids* "Molecular Motion and Physical States"

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

        → **C13** *Chemical Matter* "Physical Changes"

        → **H20** *Liquids & Solids* "Melting Transition"

    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.

        → **G13** *Gases* "Pressure-Volume Relationship"

        → **G14** *Gases* "Boyle's Law"

        → **G16** *Gases* "Pressure and Temperature"

        → **G18** *Gases* "Avogadro's Law"

        → **G19** *Gases* "Universality of the Ideal Gas Law"

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

        → **G10** *Gases* "The Meaning of Temperature"

        → **G12** *Gases* "Mean Speed and Temperature"

        → **L2** *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.

        → **M2** *Kinetics* "Reactive Collisions"

        → **M3** *Kinetics* "Mechanism of a Reaction"

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.

→ **G6** *Gases* "Gas Pressure"

→ **I6** *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.

→ **D4** *Atoms* "Hydrogen Atom"

→ **D5** *Atoms* "Electron Cloud of Argon"

→ **F7** *Chemical Bonding* "Electron Sharing"

→ **F15** *Chemical Bonding* "Comparing Shapes"