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ODYSSEY Molecular Explorer

— Release 6.2 —

Correlation with the

2010 Mississippi Science Framework

High School

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Physical Science

4. Develop an understanding of the atom

a. Cite evidence to summarize the atomic theory (DOK 1).

• Models for atoms

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

• Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)

⟶ **LAB** *Atoms* "Nuclei and Electrons"

• Atomic orbitals (s, p, d, f) and their basic shapes

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

⟶ **LAB** *Atoms* "Atomic Orbitals"

⟶ **LAB** *Atoms* "s- and p-Orbitals"

⟶ **LAB** *Atoms* "d-Orbitals"

c. Research the history of the periodic table of the elements and summarize the contributions which led to the atomic theory (DOK 2).

• Experiments (e.g., gold-foil, cathode-ray, etc.)

⟶ **LAB** *Atoms* "Nuclei and Electrons"

d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter (DOK 2).

• Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)

⟶ **LAB** *Atoms* "Nuclei and Electrons"

• Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)

→ **Lab** *Periodicity* "Atomic Radii"

• Solids, liquids, and gases

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

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

5. Investigate and apply principles of physical and chemical changes in matter

a. Write chemical formulas for compounds comprising monatomic and polyatomic ions (DOK 1).

→ **Miscellaneous** *Chemical Matter* "The Types of Compounds"

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

Chemistry

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding

a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms (DOK 1).

• Physical properties (e.g., melting points, densities, boiling points) of a variety of substances

→ **Lab** *Chemical Matter* "Chemical and Physical Properties"

• Substances and mixtures

→ **Miscellaneous** *Chemical Matter* "The Types of Compounds"

→ **Miscellaneous** *Chemical Matter* "The Types of Mixtures"

• Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

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

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

→ **Lab** *Gases* "The Density of Liquids and Gases"

→ **Demonstration** *Liquids & Solids* "Do liquids have a definite volume or shape?"

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

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

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

c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles (DOK 2).

- Properties and interactions of the three fundamental particles of the atom
  - → **LAB** *Atoms* "Nuclei and Electrons"
  - → **LAB** *Atoms* "The Electron Cloud of an Argon Atom"

e. Compare the properties of compounds according to their type of bonding (DOK 1).

- Covalent, ionic, and metallic bonding
  - → **LAB** *Chemical Bonding* "Exploring Ionic Interactions"
  - → **LAB** *Chemical Bonding* "Electron Sharing in Molecules"
  - → **LAB** *Chemical Bonding* "Energetics of Covalent Bonding"
- Polar and non-polar covalent bonding
  - → **LAB** *Chemical Bonding* "Polar Bonds and Molecules"
  - → **LAB** *Chemical Bonding* "Classifying by Bond Polarity"
  - → **MISCELLANEOUS** *Chemical Bonding* "Dipole Moments"
- Valence electrons and bonding atoms
  - → **LAB** *Chemical Bonding* "Polar Bonds and Molecules"

f. Compare different types of intermolecular forces and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances (DOK 1).

- → **LAB** *Liquids & Solids* "Intermolecular Forces"
- → **MISCELLANEOUS** *Liquids & Solids* "Elements with HydrogenBonding"
- → **DEMONSTRATION** *Liquids & Solids* "How different are ice and liquid water?"

g. Develop a three-dimensional model of molecular structure (DOK 2).

- Lewis dot structures for simple molecules and ionic compounds
  - → *Many Stockroom Pages*
- Valence shell electron pair repulsion theory (VSEPR)

→ **Lab** *Chemical Bonding* "VSEPR Theory"

→ **Lab** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

3. Develop an understanding of the periodic table

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions (DOK 1).

→ **Lab** *Atoms* "Isotopes"

→ **Lab** *Atoms* "Atomic Orbitals"

→ **Lab** *Atoms* "d-Orbitals"

b. Analyze patterns and trends in the organization of elements in the periodic table and compare their relationship to position in the periodic table (DOK 2).

• Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements

→ **Lab** *Atoms* "Nuclei and Electrons"

→ **Lab** *Atoms* "Isotopes"

• Chemical characteristics of each region

→ **Lab** *Periodicity* "The Structures of the Elements"

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

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

→ **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"

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

• Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

→ **Lab** *Periodicity* "Atomic Radii"

d. Use stoichiometry to calculate the amount of reactants consumed and products formed (DOK 3).

- Empirical formula given the percent composition of elements

  → **LAB** *Chemical Matter* "Percent Composition"

4. Analyze the relationship between microscopic and macroscopic models of matter

a. Analyze the nature and behavior of gaseous, liquid, and solid substances using the kinetic molecular theory (DOK 3).

→ **LAB** *Thermochemistry* "Thermal Energy"

→ **DEMONSTRATION** *Gases* "Do gases have a definite volume?"

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

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

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

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

b. Use the ideal gas laws to explain the relationships between volume, temperature, pressure, and quantity in moles (DOK 2).

- Conditions that favor an ideal gas

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

c. Use the gas laws of Boyles, Charles, Gay-Lussac, and Dalton to solve problems based on the laws (DOK 2).

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

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

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

→ **LAB** *Gases* "Partial Pressure"

d. Explain the thermodynamics associated with physical and chemical concepts related to temperature, entropy, enthalpy, and heat energy (DOK 2).

- Specific heat as it relates to the conservation of energy

  → **LAB** *Thermochemistry* "Specific Heat"

- Amount of heat absorbed or released in a process, given mass, specific heat, and temperature change

→ **LAB** *Thermochemistry* "Specific Heat"

• Endothermic or exothermic changes

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

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

e. Describe and identify factors affecting the solution process, rates of reaction, and equilibrium (DOK 2).

• Concentration of a solution in terms of its molarity, using stoichiometry to perform specified dilutions

→ **LAB** *Solutions* "Specifying the Molarity"

• Chemical reaction rates affected by temperature, concentration, surface area, pressure, mixing, and the presence of a catalyst

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

• Relationship of solute character

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

• Le Chatelier's Principle

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

→ **LAB** *Equilibria* "Equilibrium and Pressure"

5. Compare factors associated with acid/base and oxidation/reduction reactions

a. Analyze and explain acid/base reactions (DOK 2).

• Properties of acids and bases, including how they affect indicators and the relative pH of the solution

→ **MISCELLANEOUS** *Acids & Bases* "Oxoacids"

• The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution

→ **LAB** *Acids & Bases* "Strong Acids"

Organic Chemistry

2. Demonstrate an understanding of the properties, structure and function of organic compounds

a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds (DOK 1).

- Structures of hydrocarbon compounds
  - → **Lab** *Organic Chemistry* "Straight-Chain Alkanes"
  - → **Lab** *Organic Chemistry* "Cyclic Hydrocarbons"
  - → **Lab** *Organic Chemistry* "Isomers of Alkenes and Alkynes"
- Isomerism in hydrocarbon compounds
  - → **Lab** *Organic Chem.* "Bonding Characteristics of Carbon"
  - → **Lab** *Organic Chemistry* "Isomers of the Alkanes"
  - → **Lab** *Organic Chemistry* "Isomers of Alkenes and Alkynes"

b. Relate structure to physical and chemical properties of hydrocarbon (DOK 1).

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

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

c. Apply principles of geometry and hybridization to organic molecules (DOK 2).

- Lewis structures for organic molecules
  - → **Lab** *Organic Chemistry* "Straight-Chain Alkanes"
- Bond angles
  - → **Lab** *Organic Chemistry* "Straight-Chain Alkanes"
  - → **Lab** *Organic Chemistry* "Isomers of Alkenes and Alkynes"

f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties (DOK 2).

- Structural formulas from functional group names and vice-versa
  - → **Lab** *Organic Chemistry* "Functional Groups"
  - → **Lab** *Organic Chemistry* "Comparing and Identifying Organic Compounds"
- Chemical and physical properties of compounds containing functional groups
  - → **Lab** *Organic Chemistry* "Functional Groups"
  - → **Lab** *Organic Chemistry* "Comparing and Identifying Organic Compounds"

3. Discuss the versatility of polymers and the diverse application of organic chemicals

a. Describe and classify the synthesis, properties, and uses of polymers (DOK 2).

• Common polymers

⟶ **STOCKROOM** *Organic* "Polyolefins"

⟶ **STOCKROOM** *Organic* "Rubber"

⟶ **STOCKROOM** *Organic* "Polyamides"

⟶ **STOCKROOM** *Organic* "Polycarbonates"

b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry (DOK 1).

• Common uses of polymers and organic compounds in medicine, drugs, and personal care products

⟶ **MISCELLANEOUS** *Pharmaceutical Chemistry* "Top 10 Prescription Drugs"

⟶ **MISCELLANEOUS** *Pharmaceut. Chem.* "Pain Medications"

⟶ **MISCELLANEOUS** *Solutions* "Soap"

• Petrochemical production

⟶ **MISCELLANEOUS** *Gases* "Natural Gas"

⟶ **MISCELLANEOUS** *Industrial Chemistry* "Gasoline"

• Biologically active compounds in terms of functional group substrate interaction

⟶ **MISCELLANEOUS** *Biochemistry* "Myoglobin"

c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.) (DOK 3).

⟶ **STOCKROOM** *Inorganic* "Top 10 Inorganic Chemicals"

⟶ **STOCKROOM** *Organic* "Top 10 Organic Chemicals"

⟶ **STOCKROOM** *Organic* "Common Solvents"

⟶ **STOCKROOM** *Inorganic* "Nitrogen Fertilizers"