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ODYSSEY Molecular Explorer

— Release 7.0 —

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

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

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

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

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

→ **D4** *Atoms* "Hydrogen Atom"

→ **D8** *Atoms* "Atomic Orbitals"

→ **D9** *Atoms* "Comparing Helium, Neon, and Argon"

→ **D14** *Atoms* "Orbitals of a Krypton Atom"

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.)

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

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)

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

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

⟶ **E2** *Periodicity* "Atomic Radii"

• Solids, liquids, and gases

⟶ **C6** *Chemical Matter* "States of Matter"

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

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).

⟶ **C4** *Chemical Matter* "Types of Compounds"

⟶ **F10** *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

⟶ **C12** *Chemical Matter* "Types of Properties"

• Substances and mixtures

⟶ **C4** *Chemical Matter* "Types of Compounds"

⟶ **C5** *Chemical Matter* "Types of Mixtures"

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

⟶ **C6** *Chemical Matter* "States of Matter"

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

⟶ **C13** *Chemical Matter* "Physical Changes"

⟶ **G1** *Gases* "Density of Gases and Liquids"

⟶ **H7** *Liquids & Solids* "Volume and Shape of Liquids"

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

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

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

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

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

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

- Covalent, ionic, and metallic bonding

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

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

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

- Polar and non-polar covalent bonding

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

  → **F12** *Chemical Bonding* "Dipole Moments"

  → **F13** *Chemical Bonding* "Classifying by Bond Polarity"

- Valence electrons and bonding atoms

  → **F11** *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).

→ **H11** *Liquids & Solids* "Intermolecular Forces"

→ **H14** *Liquids & Solids* "Elements with HydrogenBonding"

→ **H21** *Liquids & Solids* "Comparing 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)

  → **F14** *Chemical Bonding* "VSEPR Theory"

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

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).

→ **D3** *Atoms* "Isotopes"

→ **D8** *Atoms* "Atomic Orbitals"

→ **D14** *Atoms* "Orbitals of a Krypton Atom"

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

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

→ **D3** *Atoms* "Isotopes"

• Chemical characteristics of each region

→ **E1** *Periodicity* "Structures of the Elements"

→ **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"

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

→ **E2** *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

→ **C21** *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).

→ **G2** *Gases* "Volume of Gases"

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

→ **G14** *Gases* "Boyle's Law"

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

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

→ **L2** *Thermochemistry* "Thermal Energy"

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

→ **G19** *Gases* "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).

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

→ **G14** *Gases* "Boyle's Law"

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

→ **G21** *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

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

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

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

• Endothermic or exothermic changes

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

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

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

→ **I3** *Solutions* "Specifying the Molarity"

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

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

• Relationship of solute character

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

• Le Chatelier's Principle

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

→ **N3** *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

→ **K3** *Acids & Bases* "Halogen Oxoacids"

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

→ **K1** *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

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

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

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

• Isomerism in hydrocarbon compounds

→ **S1** *Organic Chemistry* "How Special is Carbon?"

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

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

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

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

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

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

• Lewis structures for organic molecules

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

• Bond angles

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

→ **S9** *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

→ **S15** *Organic Chemistry* "Functional Groups"

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

• Chemical and physical properties of compounds containing functional groups

→ **S15** *Organic Chemistry* "Functional Groups"

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

→ **U1** *Pharmaceutical Chemistry* "Top 10 Prescription Drugs"

→ **U2** *Pharmaceutical Chemistry* "Pain Medications"

→ **W4** *Solutions* "Soap"

• Petrochemical production

→ **Y1** *Industrial Chemistry* "Gasoline"

→ **Stockroom** *Mixtures* "Gas Phase Mixtures"

• Biologically active compounds in terms of functional group substrate interaction

→ **T17** *Biochemistry* "Myoglobin"

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

→ **Stockroom** *Inorganic* "Top 10 Inorganics"

→ **Stockroom** *Inorganic* "Fertilizers"

→ **Stockroom** *Organic* "Top 10 Organics"

→ **Stockroom** *Organic* "Solvents"