

Howard County Public School System Essential Curriculum for Middle School Science

(Adapted from the Maryland Voluntary State Curriculum for Science 6-8)

GRADE 8

Physical Science -- Students will use scientific skills and processes to explain the interactions of matter and energy and the energy transformations that occur and processes to explain the composition, structure, and interactions of matter in order to support the predictability of structure and energy transformations.

UNIT I: Investigating Forces and Motion

Goal 1. Develop an explanation of motion using the relationships among time, distance, velocity, and acceleration.

- a. Observe, describe, and compare the motions of objects using position, speed, velocity, and the direction.
- b. Based on data given or collected, graph and calculate average speed using distance and time.
 - Use appropriate tools to measure length (meter stick), mass (balance), speed (stop watch), and force (spring scale) measurements.
 - Graph, interpret, and calculate distance versus time measurements.
- c. Compare accelerated and constant motions using time, distance, and velocity.
- d. Describe and calculate acceleration using change in the speed and time.
 - Interpret an acceleration graph. [G/T]
 - Examine the acceleration of falling objects. [G/T]

Goal 2. Identify and relate formal ideas (Newton's Laws) about the interaction of force and motion to real world experiences.

- a. State Newton's Laws of Motion.
- b. Investigate and explain the interaction of force and motion that causes objects that are at rest to move.
 - Define and give examples of inertia, action and reaction, and balanced and unbalanced forces.
- c. Demonstrate and explain, through a variety of examples, that moving objects will stay in motion at the same speed and in the same direction unless acted on by an unbalanced force.
 - Explain the effects of inertia on moving and stationary objects.
- d. Investigate and collect data from multiple trials, about the motion that explain the motion that results when the same force acts on objects of different mass; and when different amounts of force act on objects of the same mass.
- e. Based on data collected and organized, explain qualitatively the relationship between net force applied to an object and its mass for a given acceleration.
 - Plan, design, construct, test, and evaluate a vehicle (e. g., Newton car or roller coaster) to demonstrate Newton's laws.

- f. Calculate the net force given the mass and acceleration.
- g. Explain how momentum is a property of moving objects. [GT]

Goal 3. Recognize and explain that every object exerts gravitational force on every other object.

- a. Explain the difference between mass and weight.
 - Mass is a measure of inertia.
 - Weight is a measure of the force of gravity.
- b. Describe the relationship between the gravitational force and the masses of the attracting objects.
- c. Describe the relationship between the gravitational force and the distance between the attracting objects.
- d. Recognize and cite examples showing that mass remains the same in all locations while weight may vary with a change in location (weight on Earth compared to weight on moon).
- e. Recognize that gravity is the force that holds planets, moons, and satellites in their orbits.

Goal 4. Recognize and explain that energy can neither be created nor destroyed; rather it changes form or is transferred through the action of forces.

- a. Observe and describe the relationship between the distance an object is moved by a force and the change in its potential energy or kinetic energy, such as in a slingshot, in mechanical toys, the position of an object and its potential energy.
 - Recognize and describe that energy is a property of objects.
 - Recognize and describe that potential energy may be converted to kinetic energy and vice – versa.
 - Compare the potential energies of two objects with the same mass at different distances from a given point, and the same distance from a given point with different masses.
 - Compare the kinetic energies of two objects of the same mass with different velocities and two objects of the same velocity with different masses.
- b. Identify the relationship between the amount of energy transferred (work) to the product of the applied force and the distance moved in the direction of that force.
 - Identify and describe that when a force is moved through a distance, work is done.
 - Describe how the Law of Conservation of Energy can be applied to real life situations such as, the operation of machines and the motion of people.
- c. Identify and describe that simple machines (levers and inclined planes) may reduce the amount of effort required to do work.
 - Describe how levers and inclined planes function.
 - Calculate input and output work using force and distance.
 - Demonstrate that input work is always greater than output work.

Goal 5. Describe and cite evidence that heat can be transferred by conduction, convection, and radiation.

- a. Based on observable phenomena, identify and describe examples of heat being transferred through conduction and through convection.
- b. Based on observable phenomena, identify examples to illustrate that radiation does not require matter to transfer heat energy.
- c. Research and identify the types of insulators that best reduce heat loss through conduction, convection, or radiation.

Goal 6. Identify and explain that heat energy is a product of the conversion of one form of energy to another.

- a. Identify and describe the various forms of energy that are transformed in order for systems (living and non-living) to operate.
 - Chemical - Flashlight-Light
 - Mechanical – Pulleys-Motion
 - Solar/Radiant - Solar calculator Mechanical
 - Chemical - Plant cells
 - Nuclear – Power plants – thermal
- b. Explain that some heat energy is always lost from a system during energy transformations.
 - Identify methods (e. g., using insulation) that can reduce heat loss.
- c. Identify the energy transformations that must occur in order for work to be done by various common devices, such as home appliances, flashlights, and cars.

UNIT II: Investigating Energy and Waves

Goal 1. Cite evidence supporting that electrical energy can be produced from a variety of energy sources and can *itself* be transformed into almost any other form of energy.

- a. Research and identify various energy sources and the energy transforming devices used to produce electrical energy.
 - Wind (generators, wind mills)
 - Sun (solar cells)
 - Water (turbines)
 - Fossil fuels (engines)
- b. Cite examples that demonstrate the transformation of electrical energy into other forms of energy.
 - Illustrate how energy is transformed and distributed in various electricity-generating systems, such as a coal burning or a hydroelectric power plant.
- c. Investigate and describe that some materials allow the quick, convenient, and safe transfer of electricity (conductors), while others prevent the transfer of electricity (insulators).
- d. Identify and describe the energy transformations in simple electric circuits.
 - Identify the tools of scientific measurement for electricity.
 - Demonstrate competence in using a voltmeter to measure voltage.
 - Design, construct, and explain a simple circuit.
 - Compare a circuit model to the circuitry found in the home.
 - Identify and describe how various types of electrical circuits (i. e., parallel) provide a means of transferring and using electrical energy to produce heat, light, sound, and chemical changes.
 - Recognize and compare how removing or short-circuiting a light bulb affects the movement of electricity in a series and a parallel circuit.
 - Manipulate Ohm’s Law to solve for current resistance, and voltage. [G/T]
 - Explain variable resistors (e. g., dimmer switch). [G/T]

Goal 2. Identify and describe magnetic fields and their relationship to electric current.

- a. Investigate and describe the magnetic fields surrounding various types of magnets using materials, such as iron filings and small compasses:
 - A single bar magnet
 - Two bar magnets with like poles facing

- Two bar magnets with opposite poles facing
 - A horseshoe magnet.
 - Explain how magnetic force depends on the distance between the magnet and the object.
- b. Investigate and explain ways to change the strength of a simple electromagnet by varying the number of coils wrapped, the amount of electricity in the wire, the number of batteries used, and whether or not an iron core is used.
- c. Describe how the electromagnet demonstrates the relationship of magnetism and electricity and identify common devices that demonstrate application of this relationship.
- Electric motors (fans, hair dryers, can openers)
 - Electrical generators (turbine)
- d. Based on investigations describe that electricity moving through a wire produces a magnetic force on materials placed near the wire.
- Iron filings
 - Compasses

Goal 3. Identify and describe the relationships among the various properties of waves.

- a. Cite examples to show that waves transfer energy from one place to another.
- Light
 - Sound
 - Earthquake waves
- b. Measure and describe the wavelength, frequency, and amplitude of waves using:
- Water
 - Ropes
 - Springs.
- c. Measure and describe the relationship between the frequency and the wavelength of a wave.
- d. Identify and compare longitudinal and transverse waves.

Goal 4. Provide evidence to demonstrate the relationship among the properties of waves using sound.

- a. Investigate and describe that the pitch of sounds can be varied by changing the rate of vibration (i. e., frequency).
- b. Identify and describe the relationship among frequency, wavelength, and pitch.
- c. Observe and describe the relationship between amplitude and loudness.
- d. Cite evidence that sound waves transfer energy using observation of sympathetic tuning forks, tuned guitar strings, etc.

Goal 5. Investigate and cite the rules that govern behaviors of light.

- a. Based on data, generalize the law of reflection.
- Explain why the angle of reflection for light is equal to the angle of incidence.
- b. Cite evidence from observations and research to support the fact that something can be “seen” when light waves emitted or reflected by it enter the eye.
- Diagram and label the human eye.
 - Illustrate the path of a light ray through the eye and describe how the brain interprets the image.
 - Describe the difference between near sightedness and farsightedness.
 - Illustrate how vision is corrected (e.g., lenses, surgery) using ray diagrams. [G/T]

- c. Based on observations predict the change in the direction (refraction) of light as it travels from one material to another.
 - Identify and describe the refraction of light as it moves from one medium to another, such as, from air to water or air to glass.
- d. Cite evidence that the amount of light energy absorbed or reflected depends on the color of the object illuminated.
 - Cite evidence that the color of an object depends on the amount and wavelength of energy absorbed or reflected from the light with which it is illuminated.
 - Identify and describe how a prism disperses white light into its component colors.
- e. Locate and diagram visible light on the electromagnetic spectrum. [G/T]
- f. Identify applications of the entire electromagnetic spectrum. [G/T]

UNIT III: Basic Chemistry

Goal 1. Cite evidence to support the fact that some substances can be separated into the original substances from which they were made.

- a. Investigate and identify ways to describe and classify mixtures using the observable and measurable properties of their components.
 - Magnetism
 - Boiling point
 - Solubility in water
- b. Based on data gathered, identify and describe various processes used to separate mixtures.
 - Filtration
 - Evaporation
 - Paper chromatography
- c. Use data gathered to provide a reasonable explanation for the idea that the mass of a mixture is equal to the sum of the masses of its components.

Goal 2. Compare compounds and mixtures based on data from investigations and research.

- a. Cite evidence from investigations to explain how the components of mixtures can be separated.
- b. Use evidence from data gathered to explain why the components of compounds cannot be separated using physical properties.
- c. Analyze the results of research completed to develop a comparison of compounds and mixtures.
 - Define mixture, element, and compound.
 - Give examples of compounds and the methods needed to separate them, such as hydrolysis and distillation.

Goal 3. Cite evidence and give examples of chemical properties of substances.

- a. Define and identify physical properties of matter (e.g., solubility, density, states of matter, texture, color, hardness, malleability, ductility, luster, magnetism, boiling point, and conductivity).
- b. Identify unknown substances by observing physical properties. [G/T]
- c. Based on data from investigations and research, identify and describe chemical properties of common substances.
 - Reacts with oxygen (rusting/tarnishing and burning)
 - Reacts with acids

- Reacts with bases
- d. Use information gathered from investigations using indicators to classify materials as acidic, basic, or neutral.
 - Classify substances using the pH scale.
 - Identify the products of an acid-base reaction.
 - Explain the effect of antacids on stomach acids.
- e. List and describe physical properties of metals, metalloids, and nonmetals.
- f. List and describe chemical properties of metals, metalloids, and nonmetals.

Goal 4. Provide evidence to support the fact that common substances have the ability to change into new substances.

- a. Investigate and describe the occurrence of chemical reactions using the following evidence:
 - Color change
 - Formation of a precipitate or gas
 - Release of heat or light
 - Formation of a new substance
 - Change in temperature
 - Changes in indicators.
- b. Use evidence from observations to identify and describe factors that influence reaction rates.
 - Change in temperature
 - Acidity
- c. Identify the reactants and products involved in a chemical reaction given a symbolic equation, a word equation, or a description of the reaction.
 - Explain what chemical symbols and chemical formulas represent: hydrogen (H), oxygen (O), sodium (Na), and chlorine (Cl) are elements; water (H₂O) and salt (NaCl) are compounds; and NaCl (salt) + H₂O (water) is a mixture.
 - Recognize and explain that substances react chemically with other substances to form new substances (compounds) with different characteristic properties.
 - Identify and compare the properties of a compound with the properties of the elements of which it is composed.
 - Recognize that compounds can be represented by symbols.
- d. Provide data from investigations to support the fact that energy is transformed during chemical reactions.
- e. Provide examples to explain the difference between a physical change and a chemical change.

Goal 5. Provide evidence and examples illustrating that many substances can exist as a solid, liquid, or gas depending on temperature.

- a. Use evidence from investigations to describe the effect that adding heat energy to different types of matter has on the rate at which the matter changes from one state to another.
- b. Based on data from investigations describe the effect that removing heat energy from different types of matter has on the rate at which the matter changes from one state to another.
- c. Analyze data gathered and formulate a conclusion on the effects of temperature change on most substances.

- Goal 6. Describe how the motion of atoms and molecules in solids, liquids, and gases changes as heat energy is increased or decreased.**
- Based on data from investigations and video technology, describe and give reasons for what happens to a sample of matter when heat energy is added to it (most substances expand).
 - Describe what the temperature of a solid, or a liquid, or a gas reveals about the motion of its atoms and molecules.
 - Identify the properties of and differentiate among solids, liquids, and gases.
 - State the kinetic theory of matter and explain how it relates the motion of particles to temperature.
 - Construct a model of the kinetic theory.
 - Interpret a phase diagram. **[G/T]**
 - Formulate an explanation for the different characteristics and behaviors of solids, liquids, and gases using an analysis of the data gathered on the motion and arrangement of atoms and molecules.
 - Demonstrate and explain that heat can be transferred through materials by collisions of atoms (i.e., conduction, convection) or across space by means of radiation.
 - Define and provide examples of states of equilibrium.
 - Identify modern devices or situations that model the flow of heat from warmer objects to cooler objects.
 - Label and illustrate the flow of energy from warmer objects to cooler objects.
- Goal 7. Cite evidence to support the fact that all matter is made up of atoms, which are far too small to see directly through a microscope.**
- Recognize and describe that the atoms of each element are alike but different from atoms of other elements.
 - Recognize and explain that all known materials are made of the elements presently known to scientists.
 - Recognize that few elements are found in their pure form in nature.
 - Explain the basic structure of an atom (i.e., protons, electrons, neutrons).
 - Describe the general structure of the periodic table, such as states of matter, groups, periods, metals, metalloids, and nonmetals.
 - Explain the information that is provided about an atom of an element in a box on the periodic table (e.g., symbol, name, atomic number, average atomic mass).
 - Recognize and describe that different arrangements of atoms into groups compose all substances.
 - Provide evidence from the periodic table, investigations, and research to demonstrate that elements in the following groups have similar properties:
 - Highly reactive metals, such as magnesium and sodium
 - Less-reactive metals, such as gold and silver
 - Highly reactive non-metals, such as chlorine, fluorine, and oxygen
 - Almost non-reactive gases, such as helium and neon.
 - Provide examples to illustrate that elements are substances that do not break down into smaller parts during normal investigations involving heating, exposure to electric current or reactions with acids.
 - Cite evidence to explain that all living and non-living things can be broken down to a set of known elements.
- Goal 8. Provide evidence to explain how compounds are produced. (No electron transfer)**

- a. Classify matter into elements (atoms), compounds (molecules), and mixtures (solutions).
- b. Describe how elements form compounds and molecules.
- c. Investigate and describe what happens to the properties of elements when they react chemically with other elements.
- d. Based on data from investigations and research compare the properties of compounds with those of the elements from which they are made.

Goal 9. Provide evidence to support the fact that the idea of atoms explains conservation of matter.

- a. Use appropriate tools to measure temperature (thermometer), mass (balance), length (meter stick), volume (graduated cylinder), and density.
- b. Use appropriate tools to gather data and provide evidence that equal volumes of different substances usually have different masses.
- c. Cite evidence from investigations that the total mass of a system remains the same throughout a chemical reaction because the number of atoms of each element remains the same.
 - State the Law of Conservation of Matter.
 - Apply the Law of Conservation of Matter to demonstrate that no mass is lost during a state change.
 - Balance simple chemical equations to satisfy the Law of Conservation of Matter.
- d. Give reasons to justify the statement, “If the number of atoms stays the same no matter how the same atoms are rearranged, then their total mass stays the same.”

UNIT IV: ADVANCED CHEMISTRY

Goal 1. Predict reactions using groupings of matter (i.e., metals/metalloids/nonmetals, reactive/nonreactive).

- a. Use patterns (i.e., families and periods) on the periodic table to predict reactions.
- b. Classify an element according to its location on the periodic table (i.e., metals, metalloids, nonmetals).
- c. Define isotopes and identify isotopes of common elements. [G/T]
- d. Explain how isotopes are related to average atomic mass. [G/T]

Goal 2. Describe that elements combine in whole number ratios to form other substances called compounds (e.g., H₂O, CO₂, CO).

- a. Explain how ions are formed when atoms lose or gain electrons. Identify the ion patterns formed based on location of families on the periodic table.
- b. Describe basic types of ionic and covalent bonds of common salts and life molecules, such as NaCl, CO₂, H₂O, CO, and the diatomic molecules.
- c. Predict and write the chemical formulas of simple compounds such as NaCl, MgO, CO₂, H₂O, and the diatomic atoms, such as H₂ and O₂.
- d. Explain how the structure and bonds of the water molecule affect how water behaves and interacts with other substances.
 - Describe the three-dimensional arrangement of atoms in a water molecule.
 - Identify the polarity of the bonds in a water molecule.
 - Compare the arrangement of water molecules in each state of matter with the typical arrangement of molecules of other substances in each state.
 - Compare the density of water at each state with typical trends in density for other

substances.

- Explain why water is a universal solvent.
- e. Construct Lewis dot diagrams for the reacting elements (i.e., Family 1, 2, 16, 17, 18).

Goal 3. Explain that matter cannot be created or destroyed but instead can be changed from one form into another.

- a. Model and explain how the conservation of matter applies to a simple chemical reaction (e.g., $2\text{Na} + \text{S} \rightarrow \text{Na}_2\text{S}$, $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$).
- b. Balance simple chemical reactions to verify the Law of Conservation of Matter.
- c. Identify factors that influence reaction rates.
- Addition of energy
 - Putting reactants in solution
 - Changing pH (acidity)
- d. Recognize that energy is transformed during chemical reactions.
- e. Differentiate among four types of chemical reactions (e.g., synthesis, decomposition, single replacement, double replacement). [G/T]

Goal 4. Identify that nuclear fission and fusion are alternate forms of energy.

- a. Define nuclear fission and fusion.
- b. Identify nuclear fission and fusion as alternative forms of energy.