Draft for

MCPS High School Science

Matter & Energy Framework

Matter & Energy Curriculum Revision Team

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This draft Framework was created by teachers as a first step in the current revision of the course curriculum. Its purpose is to serve as a vehicle for review, discussion, and critique by concerned stakeholders who are encouraged to provide written feedback to the Science Office for specific improvements and change. Comments will be collected and reviewed and appropriate changes will be made. This will lead to the new course curriculum, which will align with and exceed the Maryland Learning Outcomes.

Frameworks are intended to provide the underlying structure of a course and contain two major components: 1) the Rationale and 2) the Scope and Sequence. The Rationale contains the goal, enduring understandings, content description, and instructional approach description of the course. The Scope and Sequence is a collection of the course indicators. This course Framework will lead to course Blueprints which will describe the "why, what and how" for each unit. Blueprints will lead to the Curriculum Guide, which will contain concept maps, model lesson plans, model assessments, and other course resources.

Matter and Energy Rationale

Goal

The goal of Matter and Energy is for students to become effective science learners by developing skills in scientific inquiry, creating and using data analysis tools, and supporting their understanding with valid scientific evidence.

Enduring Understandings

1. Energy and matter are conserved and transformed.
2. The basic building blocks combine and recombine in a variety of ways to make all matter from the simple to the complex.
3. The laws of physics and chemistry predict outcomes that impact and apply to daily life.
4. Systematic patterns and relationships exist at many levels of organization in the physical world.
5. Problems can be solved and knowledge gained in a systematic way; solutions to one problem can create new questions and problems.
6. Physical science concepts are always changing and expanding based on the acquisition of new information.
7. Sound decisions require critical analysis of valid and relevant data.

Content

Physical science strives to further our understanding of the composition and behavior of matter and how matter and energy are related, transferred, and conserved. It uses practical applications and technology to illustrate physics and chemistry concepts. The primary vehicle for learning is investigations carried out using the processes of scientific inquiry. Like other science disciplines, physical science relies on objectivity and the critical analysis of data, based on quantitative and qualitative observations, to acquire knowledge. Laws and theories developed or furthered can be applied at the micro- and macro- level, from the simple to the complex, from the laboratory to the universe. Mathematical relationships and tools provide the underlying foundation for the articulation of these laws and theories. The course builds the foundation of process skills, using the content of physics and chemistry, to enhance success in subsequent science courses and on end of course assessments at the county and state level.

Instructional Approach

Instruction and learning are organized around the 5E's Inquiry Model. The teacher functions as facilitator or coach to nurture the students' growth to become independent learners. A variety of teaching strategies are used to promote inquiry, including laboratory experiments, demonstrations, direct instruction, current events, visual presentations and cooperative learning, as appropriate to the lesson and prior knowledge of the students. Time is provided to ensure that problem analysis, as well as solution strategies, are addressed. Students synthesize unifying principles from the course of study, make interdisciplinary connections, and apply these understandings to real world situations. The teacher provides opportunities for students to use technology and apply their knowledge and skills to projects and learning experiences. Teachers engage students in effective techniques of reading, writing, and mathematics to extend their

understandings of the content. Assessment is frequent, ongoing, and embedded in student learning experiences. Methods of evaluation incorporate rubrics and include pre-, formative, and summative assessment to evaluate teaching and learning. Teachers set high standards with challenging and rigorous expectations for all students and provide differentiation of instruction and learning as appropriate.

Matter & Energy Scope and Sequence

The Scope and Sequence is identified by numbered goals, expectations, and indicators. The indicators from the Maryland State Performance Program Core Learning Goal 1 are shown here. These are used throughout the course. All concept indicators from Goal 7 are addressed by using Goal 1 indicators as the primary vehicles of instruction. Their placement at the beginning of this document does not imply that they are taught first or that they are taught only at the beginning of the course.

Skills and Processes Indicators
The student will:

HS1.1.1 recognize that real problems have more than one solution and decisions to accept one over another are made on the basis of many issues.
HS1.1.2 modify or affirm scientific ideas according to accumulated evidence.
HS1.1.3 critique arguments that are based on faulty, misleading data or on the incomplete use of numbers.
HS1.1.4 recognize data that are biased.
HS1.1.5 explain factors that produce biased data (incomplete data, using data inappropriately, conflicts of interest, etc.).
HS1.2.1 identify meaningful, answerable scientific questions.
HS1.2.2 pose meaningful, answerable scientific questions.
HS1.2.3 formulate a working hypothesis.
HS1.2.4 test a working hypothesis.
HS1.2.5 select appropriate instruments and materials to conduct an investigation.
HS1.2.6 identify appropriate methods for conducting an investigation (independent and dependent variables, proper controls, repeat trials, appropriate sample size, etc.).
HS1.2.7 use relationships discovered in the lab to explain phenomena observed outside the laboratory.
HS1.2.8 defend the need for verifiable data.
HS1.3.1 develop and demonstrate skills in using lab and field equipment to perform investigative techniques.
HS1.3.2 recognize safe laboratory procedures.
HS1.3.3 demonstrate safe handling of the chemicals and materials of science.
HS1.3.4 learn the use of new instruments and equipment by following instructions in a manual or from oral direction.
HS1.4.1 organize data appropriately using techniques such as tables, graphs, and webs (for graphs: axes labeled with appropriate intervals, independent and dependent variables on correct axes and appropriate title).
HS1.4.2 analyze data to make predictions, decisions, or draw conclusions.
HS1.4.3 use experimental data from various investigators to validate results.
HS1.4.4 determine the relationships between quantities and develop the mathematical model that describes these relationships.
HS1.4.5 check graphs to determine that they do not misrepresent results.

HS1.4.6 describe trends revealed by data.
HS1.4.7 determine the sources of error that limit the accuracy or precision of experimental results.
HS1.4.8 use models and computer simulations to extend his/her understanding of scientific concepts.
HS1.4.9 use analyzed data to confirm, modify, or reject an hypothesis.
HS1.5.1 demonstrate the ability to summarize data (measurements/observations).
HS1.5.2 explain scientific concepts and processes through drawing, writing, and/or oral communication.
HS1.5.3 use computers and/or graphing calculators to produce the visual materials (tables, graphs, and spreadsheets) that will be used for communicating results.
HS1.5.4 use tables, graphs, and displays to support arguments and claims in both written and oral communication.
HS1.5.5 create and/or interpret graphics. (scale drawings, photographs, digital images, field of view, etc.)
HS1.5.6 read a technical selection and interpret it appropriately.
HS1.5.7 use, explain, and/or construct various classification systems.
HS1.5.8 describe similarities and differences when explaining concepts and/or principles.
HS1.5.9 communicate conclusions derived through a synthesis of ideas.
HS1.6.1 use ratio and proportion in appropriate situations to solve problems.
HS1.6.2 use computers and/or graphing calculators to perform calculations for tables, graphs, or spreadsheets.
HS1.6.3 express and/or compare small and large quantities using scientific notation and relative order of magnitude.
HS1.6.3.A select appropriate units to describe quantities.
HS1.6.4 manipulate quantities and/or numerical values in algebraic equations.
HS1.6.5 judge the reasonableness of an answer.
HS1.7.1 apply the skills, processes, and concepts of the course to societal issues.
HS1.7.2 identify and evaluate the impact of scientific ideas and/or advancements in technology on society.
HS1.7.3 describe the role of science in the development of literature, art, and music.
HS1.7.4 recognize mathematics as an integral part of the scientific process.
HS1.7.5 investigate career possibilities in the various areas of science.
HS1.7.6 explain how development of scientific knowledge leads to the creation of new technology and how technological advances allow for additional scientific accomplishments.

Goal 7
The student will demonstrate an understanding of the composition and behavior of matter and how matter and energy are related, transferred, and conserved.

Expectation 1
The student will describe relationships between force and motion.

Indicators
HS7.1.1 describe motion in one dimension (linear motion, speed, velocity, acceleration, constant, changing).
HS7.1.2 describe the relationship between velocity and acceleration (acceleration = change in velocity/change in time).

HS7.1.3 determine the velocity of an object (v=d/t).
HS7.1.4 compare mass and weight (tools of measurement; units; definitions).
HS7.1.5 describe the effect of gravity on an object (strength of force vs. distance; direction; free fall is an acceleration).
HS7.1.6 describe Newton's Second Law (relationship among F, m, and a; qualitative and quantitative).
HS7.1.7 describe the sources and effects of friction in a system.
HS7.1.8 describe Newton's First Law (net force, balanced force, unbalanced force; effects of force on motion; inertia).
HS7.1.9 describe the properties of magnetic force (poles, field, strength of force vs. distance).
HS7.1.10 describe the properties of electrical force (charge, conduction, induction, field, strength of force vs. distance, electric potential, volt, voltage, current).

Expectation 2
The student will demonstrate an understanding that energy exists in different forms, can be transformed, and is conserved.

Indicators
HS7.2.1 describe the relationship between energy and work.
HS7.2.2 describe work (relationship among W, F, and d; qualitative and quantitative).
HS7.2.3 describe kinetic energy and potential energy (qualitative only).
HS7.2.4 describe different forms of energy (radiant (light, solar, sound, heat), electrical, magnetic, chemical, nuclear, mechanical (potential, kinetic)).
HS7.2.5 describe energy transformation in a system (e.g., electromagnetic, heat, mechanical, potential, kinetic, chemical, solar).
HS7.2.6 describe the relationship between electric current and a magnetic field.
HS7.2.7 compare heat energy and temperature (PE vs. KE changes, phase change diagram; molecular motion).
HS7.2.8 describe the Law of Conservation of Energy.
HS7.2.9 explain how changes in energy can result in physical changes in matter (density, volume, pressure).
HS7.2.10 explain how differentials in energy can result in energy transfer (gravitational potential energy, electrical potential energy; heat).
HS7.2.11 explain how differences in concentration can result in diffusion (concentration gradient).

Expectation 3
The student will demonstrate an understanding of the structure of matter, the properties of matter, and how the structure of matter determines the properties of matter.

Indicators
HS7.3.1 describe atomic structure (dense central nucleus surrounded by orbiting electrons).
HS7.3.2 describe properties of electrons, protons, and neutrons (mass, charge, location).
HS7.3.3 describe the structure of atoms using Bohr models (first three orbitals; importance of the outer orbital; elements 1-18).
HS7.3.4 describe the relationship between the number of valence electrons and the properties of atoms (charge, reactivity, oxidation number).
HS7.3.5 determine the number of valence electrons in an atom from its location on the periodic table (Groups 1, 2, 13-18).
HS7.3.6 determine the number and type of atoms in a molecular model (including ratios of

elements).
HS7.3.7 predict the names and formulas for compounds based on the oxidation number of their elements.
HS7.3.8 describe an ion (difference in numbers of protons and electrons; positive and negative charge; cation, anion).
HS7.3.9 describe ionic and covalent bonds (transfer of electrons, sharing of electrons).
HS7.3.10 predict the type of bond that will form between two elements (ionic, covalent; location of elements on the periodic table).
HS7.3.11 interpret a chemical formula (coefficient, subscript; number of atoms; number of elements).
HS7.3.12 describe how the shape of a compound or molecule affects its properties (H2O, polar/non-polar, attraction to other molecules).
HS7.3.13 describe a solution (solvent, solute, concentration).
HS7.3.14 describe solubility (like dissolves like: polar dissolves polar, nonpolar dissolves nonpolar).
HS7.3.15 interpret the pH scale (acid, neutral, base).
HS7.3.16 describe the relationship between monomers and polymers (atoms, molecules, monomers are basic units of polymers).

Expectation 4
The student will describe changes in matter.

Indicator
HS7.4.1 explain that chemical equations represent chemical reactions (new substances are formed).
HS7.4.2 interpret a chemical equation (symbols: arrows, +; subscripts; coefficients; l, g, s, aq; reactant, product).
HS7.4.3 describe types of chemical reactions (single displacement, double displacement, synthesis, decomposition).
HS7.4.4 relate conservation of matter to balanced equations (e.g., apply subscripts and coefficients to count atoms in a chemical equation).
HS7.4.5 describe evidence of a chemical change (color, bubbles, light, changes in heat).
HS7.4.6 describe temperature as a measure of the molecular motion of gases, liquids, and solids.
HS7.4.7 explain the role of energy in phase changes.
HS7.4.8 explain that matter is conserved in phase change.
HS7.4.9 explain that chemical bonds store energy.
HS7.4.10 describe factors that affect reaction rates (temperature, pressure, concentration, catalyst).
HS7.4.11 define the role of a catalyst (speeds up a reaction; not consumed in the reaction)
HS7.4.12 describe types of nuclear reactions (fusion, fission).
HS7.4.13 explain that variations in the number of neutrons of an element result in isotopes.
HS7.4.14 describe the half-life of an isotope.
HS7.4.15 identify common forms of radiation and their uses (alpha, beta, gamma).

Explanation of Codes Used in Indicators

HS1 refers to MSPP Core Learning Goal #, 1= Process Skills, 2=Earth Science, 3= Biology, 4=Chemistry, 5=Physics, 6=Environmental Science

Second decimal place refers to MSPP expectation related to the goal.
Third decimal place refers to MSPP indicator related to the expectation.
Fourth decimal place refers to MSPP assessment limit or "at least item" related to the indicator.
Any additional decimal places refer to MCPS extensions added to MSPP "assessment limit" or "at least item."

Small letters such as "a," or "b" identify an MSPP indicator that is subdivided into separate MCPS indicators.

Italics identify the wording or intent of the MSPP Core Learning Goal.
Capital Letters identify a MCPS indicator that is not an MSPP indicator.
(H) identifies an indicator that will be assessed in MCPS Honors level courses.

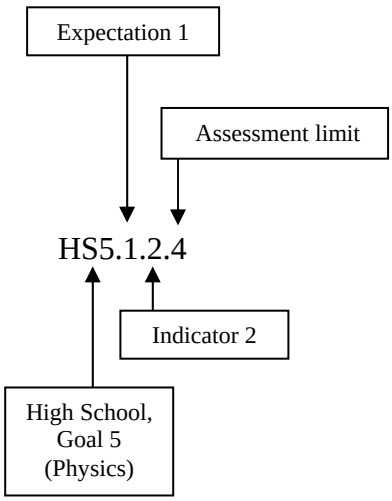
Explanation of Codes

Items that appear in MCPS High School Curriculum documents are numbered according to the sequence

HSG.E.I.A (for example: HS5.1.2.4)

HS	=	High School
G	=	the goal as it occurs in the MSPP document (1 = Skills and Processes, 2 = Earth Science, 3 = Biology, 4 = Chemistry, 5 = Physics, 6 = Environmental Science)
E	=	the expectation; written in italics if it is from the MSPP document
I	=	the indicator; written in italics if it is from the MSPP document
A	=	the assessment limit written as a number; a Goal 1 item combines the indicator and assessment limit and, therefore, does not have a number in this position; written in italics if it is from the MSPP document

Example



- Additional decimal places refer to MCPS extensions to the HSPP assessment limit or “at least” item.
- Italics identify the wording or intent of the HSPP Core Learning Goal.
- Capital Letters identify MCPS expectations, indicators, or assessment limits that are not found in the MSPP Core Learning Goals. Small letters, such as “a” or “b,” identify a MSPP indicator that is divided into separate MCPS indicators.
- (H) identifies an item that is assessed in Honors level courses.

Maryland School Performance Program Core Learning Goals

Goal 1: Skills and Processes
The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information.

Goal 2: Concepts of Earth/Space Science
The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain the physical behavior of the environment, Earth, and the universe.

Goal 3: Concepts of Biology
The student will demonstrate the ability to use the scientific skills and processes (Core Learning Goal 1) and major biological concepts to explain the uniqueness and interdependence of living organisms, their interactions with the environment, and the continuation of life on earth.

Goal 4: Concepts of Chemistry
The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter in the world in which we live.

Goal 5: Concepts of Physics
The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain and predict the outcomes of certain interactions that occur between matter and energy.

Goal 6: Environmental Science
The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) and major environmental science concepts to understand interrelationships of the natural world and to analyze environmental issues and their solutions.