K-12 SCIENCE EDUCATION VISION

A K-12 Dublin City Schools science education engages *all students* in critical thinking and problem solving as they experience science and engineering. We believe that students can become scientifically literate citizens equipped with the knowledge and skills demanded by the ever-changing future, whether in the workforce or higher education.

We believe in developing our learners through high quality experiences that include:

- A challenging, collaborative and inquiry based environment.
- Opportunities to solve and investigate real-world problems that require critical and global thinking.
- Opportunities for students to build an identity as a scientist, able to interpret the natural world, participate productively in scientific practices and contribute to society in meaningful ways.
- Opportunities to research, generate and evaluate evidence and explanations that uphold or refute scientific data.

We believe these learning experiences will grow independent, confident students who will become creative, innovative adults that are capable of using informed scientific judgement to improve their world.

Instructional Agreements for Science Learning within the Dublin City Schools

1. Learning goals will be communicated to guide students through the expectations of science learning using a variety of instructional techniques and technology integration.
2. Teachers will ensure a safe, challenging learning environment focused on inquiry and science exploration.
3. Teachers will provide support to students as they learn to frame questions, assess and analyze data, and create and critique explanations – all important components of scientific and engineering practices.
4. Content standards will be learned in partnership with Ohio's Cognitive Demands for Science, Science and Engineering Practices and Nature of Science practices.

Nature of Science	
One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.	
Scientific Inquiry, Practice and Applications	All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.
Science is a Way of Knowing	Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.
Science is a Human Endeavor	Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.
Scientific Knowledge is Open to Revision in Light of New Evidence	Science is not static. Science is constantly changing as we acquire more knowledge.

Scientific and Engineering Practices:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Ohio's Cognitive Demands for Science	
Cognitive Demand	**Description**
DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	Requires students to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.
DEMONSTRATING SCIENCE KNOWLEDGE	Requires students to use scientific practices and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards)
INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.
RECALLING ACCURATE SCIENCE	Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

GRADE 6

Grade 6 Course Goals:

Students in Grade 6 will focus on using scientific inquiry to discover patterns, trends, structures and relationships that may be inferred from simple principles. These principles are related to the properties or interactions within and between systems. Students will learn about rocks, minerals, soil, matter and motion, and cellular to multicellular organization of life.

Strand Connections:

All matter is made of small particles called atoms. The properties of matter are based on the order and organization of atoms and molecules. Cells, minerals, rocks and soil are all examples of matter

EARTH AND SPACE SCIENCE (ESS)	
Topic: Rocks, Minerals and Soil This topic focuses on the study of rocks, minerals and soil, which make up the lithosphere. Classifying and identifying different types of rocks, minerals and soil can decode the past environment in which they formed.	
Content Statement	**Content Elaboration**
6.ESS.1: Minerals have specific, quantifiable properties. Minerals are naturally occurring, inorganic solids that have a defined chemical composition. Minerals have properties that can be observed and measured. Minerals form in specific environments. Note: The emphasis is on learning how to identify the mineral by conducting tests (not through memorization).	Most rocks are composed of one or more minerals. Minerals have specific properties that can be used for identification. The properties that can be used for testing minerals include luster, hardness, cleavage, streak, magnetism, fluorescence and/or crystal shape. At this grade level, common minerals (including those on Mohs hardness scale) are used in the identification process. A representative sample of minerals should be used so that different testing methods can be applied and demonstrated. Appropriate tools and safety procedures must be used when testing mineral properties. Technology can provide identification information and research materials to assist in mineral investigations. Mineral composition can help identify rocks. Minerals can indicate the type of environment in which the rock and/or mineral formed. Some minerals (e.g., feldspar varieties, magnetite, varieties of quartz) form in an igneous environment, some minerals (e.g., epidote) form in a metamorphic environment, and some form in a sedimentary environment (e.g., chalk, calcite). Some minerals (e.g., halite, varieties of gypsum, calcite) form through evaporation and a variety of chemical processes.
6.ESS.2: Igneous, metamorphic and sedimentary rocks have unique characteristics that can be	The purpose of rock identification is related to understanding the environment in which the rock formed. Rock identification and classification are experiential and

used for identification and/or classification. Most rocks are composed of one or more minerals, but there are a few types of sedimentary rocks that contain organic material, such as coal. The composition of the rock, types of mineral present, and/or mineral shape and size can be used to identify the rock and to interpret its history of formation, breakdown (weathering) and transport (erosion).	investigative. Common samples to use in identification should be representative of each type of rock. Igneous samples include varieties of granite, rhyolite, basalt, obsidian, pumice and andesite. Metamorphic samples include varieties of schist, gneiss, slate, marble, anthracite and phyllite. Sedimentary samples include varieties of limestone, sandstone, shale, conglomerate and breccia. Other rock samples such as bituminous coal, coquina and chert can also be included in identification investigations, but these may not always fall neatly into one specific rock category. Proper safety protocol and testing procedures must be used. It is important to use the identification of the minerals and quantifiable characteristics of the rock to identify the rock. Analysis of specific rock characteristics can be conducted in the classroom or in nature with rock samples. Technology can be used to research current identification methods and techniques to assist in determining the quantifiable characteristics of specific rocks.
6.ESS.3: Igneous, metamorphic and sedimentary rocks form in different ways. Magma or lava cools and crystallizes to form igneous rocks. Heat and pressure applied to existing rock forms metamorphic rocks. Sedimentary rock forms as existing rock weathers chemically and/or physically and the weathered material is compressed and then lithifies. Each rock type can provide information about the environment in which it was formed.	Rocks and minerals in rocks form in specific types of environments. The rock cycle can be used for a general explanation of the conditions required for igneous, metamorphic and sedimentary rocks to form, but additional information should be added for relevancy. For example, the typical pattern of coal formation is connected to energy in Ohio and should be included. Another example would be the formation of Ohio sandstone and limestone indicating that a shallow sea once covered Ohio. Ohio's geologic history and past environmental conditions play a role in understanding the existing bedrock in Ohio. Field investigations, virtual field trips, geologic maps, physical maps and topographic maps can be used to illustrate how types of geologic structures and features help identify the types of rock that may be found in specific areas. This should be connected to an understanding of the environmental conditions that existed during the formation.
6.ESS.4: Soil is unconsolidated material that contains organic matter and weathered rock. Soil formation occurs at different rates and is based on environmental conditions, types of existing bedrock and rates of weathering. Soil forms in layers known as horizons. Soil horizons can be distinguished from one another based on properties that can be measured. The terms dirt and soil are not synonymous, use the term "soil". Note: The emphasis should be on properties of soil rather than memorization.	Soil sampling and testing should be used to investigate soil. Soils form at different rates and has different measurable properties, depending on environmental conditions. Properties of soil that are useful in soil identification include texture, color, composition, permeability and porosity. Uses of soils depend upon their properties. For example, some soils may be recommended for agriculture, while others may be used for brick making or creating a pond. Observing and identifying soil horizons are based on understanding the different properties of soil and when the properties change. Soil sample testing methodology and equipment are included within this content statement. Soil maps combined with geologic, aerial or topographic maps can assist in local identification of soil formations. A connection can be made to environmental conditions, types of bedrock and soil properties. Appropriate tools and safety procedures must be used in all soil investigations.

6.ESS.5: Rocks, minerals and soils have common and practical uses. Nearly all manufactured material requires some kind of geologic resource. Most geologic resources are considered nonrenewable. Rocks, minerals and soil are examples of geologic resources that are nonrenewable.	Rocks, minerals and soils have specific physical properties that determine how they can be used. The different methods of extracting the resources can be included. Uses of the resources include construction (e.g., gypsum, metals, gravel, sand, lime, clay), energy (e.g., fossil fuels, radioactive materials), transportation (e.g., road salt, road materials), agriculture (e.g., lime, peat, minerals for fertilizers), domestic use (e.g., metals and gems for jewelry, clay for pottery or sculpting, natural dyes for clothing or paint) and technology (e.g., lithium, silica). The conservation of resources through their management is an important part of understanding the uses of rocks, minerals and soil. Aspects to consider include extraction methods and remediation of the sites and resource use, reuse, storage and disposal. Nonrenewable energy sources can also be included (such as fossil fuels).

LIFE SCIENCE (LS)	
Topic: Cells - Cellular to Multicellular This topic focuses on the study of the basics of Modern Cell Theory. All organisms are composed of cells, which are the fundamental unit of life. Cells carry on the many processes that sustain life. All cells come from pre-existing cells.	
Content Statement	**Content Elaboration**
6.LS.1: Cells are the fundamental unit of life. All living things are composed of cells. Different body tissues and organs are made of different kinds of cells. The ways cells function are similar in all living organisms. Note: Emphasis should be placed on the function and coordination of cell organelles as well as their roles in overall cell function. Specific information about the organelles that need to be addressed at this grade level will be found in the model curriculum.	The content statements for sixth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's foundational theories, Modern Cell Theory. It is recommended that the content statements be combined and taught as an integrated unit. For example, the energy needs of cells can be interwoven with the function of mitochondria. Modern Cell Theory states that all living things are made of cells. Cells are the basic unit of structure and function of all living things. Many organisms are single-celled and that one cell carries out all the basic functions of life. Other organisms are multicellular and the cells that form these organisms can be organized at various levels to carry out all the basic functions of life. Different body tissues and organs can be made up of different kinds of cells. The cells in similar tissues and organs in animals are similar. The tissues and organs found in plants differ slightly from similar tissues and organs in animals. Use Modern Cell Theory to exemplify how scientific theories are developed over time. The relationship between structure and function is a crosscutting theme for science and should be explored when investigating the structure and function of cellular organelles. Emphasis is placed on the function and coordination of these

	components, as well as on the overall cell function. Microscopes, micrographs, models and illustrations using appropriate safety procedures can be used to observe cells from many different types of organisms. The sizes and shapes of cells from single celled organisms, fungi, plants and animals can be observed and compared.
6.LS.2: All cells come from pre-existing cells. Cells repeatedly divide resulting in more cells and growth and repair in multicellular organisms. Note: This is not a detailed discussion of the phases of mitosis or meiosis. The focus should be on reproduction as a means of transmitting genetic information from one generation to the next, cellular growth and repair.	The content statements for sixth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's important foundational theories: Modern Cell Theory. It is recommended that the content statements be combined and taught as an integrated unit. Modern Cell Theory states that cells come from pre-existing cells. Individual organisms do not live forever. Therefore, reproduction is necessary for the continuation of every species. Traits are passed on to the next generation through reproduction. Single-celled organisms reproduce by processes such as mitosis, budding and binary fission. In this grade, mitosis is explored. In multicellular organisms, mitosis allows cells to multiply for the purpose of growth and repair. All cells contain genetic materials. At this grade level, the genetic material is described as chromosomes. Chromosomes are described as structures in cells that contain genetic material. The chemicals and chemical processes associated with chromosomes are reserved for high school biology. Microscopes, micrographs, models and illustrations can be used to observe cells from different organisms in the process of dividing. It is not appropriate to learn the names of the stages of mitosis. The focus is on observing cells dividing as evidence that cells come from pre-existing cells and genetic material is transmitted from parent cell to daughter cells. The misconception of spontaneous generation can be included in discussions on this topic. The experiments of Redi and Pasteur can be used to explain how evidence can lead to new knowledge, better explanations and spur new technology.
6.LS.3: Cells carry on specific functions that sustain life. Many basic functions of organisms occur in cells. Cells take in nutrients and energy to perform work, like making various molecules required by that cell or an organism. Every cell is covered by a membrane that controls what can enter and leave the cell. Within the cell are specialized parts for the transport of materials, energy capture and release, protein building, waste disposal, information feedback and movement. Note: Emphasis should be placed on the function and coordination of cell components, as	The content statements for sixth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's important foundational theories: Modern Cell Theory. In classrooms, it is recommended that the content statements be combined and taught as an integrated unit (e.g., the energy requirements of cells can be interwoven with the function of mitochondria). Cells have particular structures that are related to their functions. These functions are regulated and controlled (e.g., a cell membrane controls what can enter and leave the cell). The organization of living systems includes an explanation of the role of cells, tissues, organs and organ systems that carry out life functions for organisms. Connections are to be made between cellular organelles and processes. These roles include maintaining homeostasis, gas exchange, energy

well as on their roles in overall cell function.	transfers and transformation, transportation of molecules, disposal of wastes and synthesis of new molecules. Explore (3-D or virtually) conditions that optimize and/or minimize cellular function in a cell or an organism. Technology can also be used to run simulations to investigate specific outcomes and develop predictions about changes in functions.
6.LS.4: Living systems at all levels of organization demonstrate the complementary nature of structure and function. The level of organization within organisms includes cells, tissues, organs, organ systems and whole organisms. Whether the organism is single-celled or multicellular, all of its parts function as a whole to perform the tasks necessary for the survival of the organism. Organisms have diverse body plans, symmetry and internal structures that contribute to their being able to survive in their environments.	The content statements for sixth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's important foundational theories: Modern Cell Theory. It is recommended that the content statements be taught as an integrated unit (e.g., levels of organization can be interwoven with the concept of cells as the fundamental unit of life). Cells perform specialized functions in multicellular organisms. Groups of specialized cells form a tissue such as muscle. Different tissues are, in turn, grouped together to form larger functional units, called organs. Each type of cell, tissue and organ has a distinct structure and set of functions that serve the organism. Organisms have diverse body plans, symmetry and internal structures. General distinctions among organisms (e.g., internal structures, body systems, body plans, and symmetry) that support classifying them into a scientifically based system (a distinction of this grade level from Pre-K to 5) are explored. Organisms sorted into groups share similarities in external structures, internal structures and processes. The commonality of life can be investigated through observing tissues, organs, cell structures, systems and symmetry (an approximate balanced distribution of duplicate body parts) for plants and animals. Part of the exploration of the commonality of living systems can include a comparison of cells, types of tissues, organs and organ systems between organisms. View a variety of cells, tissues (e.g., xylem, phloem, connective, muscle, nervous) and organs (e.g., leaf, stem, flower, spore, ganglia, blood vessels, eyes) to compare their similarities and differences. Real-world applications (e.g., the presence of microbes in potable water), new technology and contemporary science can be explored. Inquiry and mathematical relationships should be drawn between cell size and the cell's ability to transport necessary materials into its interior. This link is critical for laying the foundation for the cell cycle in grade 8.Note: Living organisms are often organized in classification systems to assist in studying their similarities and differences. These classification systems change as new information emerges. The focus should not be on naming kingdoms rather on comparing internal structures, body systems, body plans and symmetry. Students should focus on how classification is useful as a tool rather than memorizing any particular system

PHYSICAL SCIENCE (PS)	
Topic: Matter and Motion This topic focuses on the study of foundational concepts of the particulate nature of matter, linear motion, and kinetic and potential energy.	
Content Statement	**Content Elaboration**
6.PS.1: Matter is made up of small particles called atoms. Matter has mass, volume and density and is made up of particles called atoms. Elements are a class of substances composed of a single kind of atom. Molecules are the combination of two or more atoms that are joined together chemically.	Matter is made of atoms, which are particles that are too small to be seen, even with a light microscope. Matter has properties of mass and volume. Mass measures the amount of matter in an object (e.g., a wood block) or substance (e.g., water), and volume measures the three-dimensional space that matter occupies. Mass can be measured with a balance. The volume of solids can be determined by water displacement or calculated from the dimensions of a regular solid. Equal volumes of different substances usually have different masses. Some materials, like lead or gold, have a lot of mass in a relatively small space. Other materials, like packing peanuts and air, have a small mass in a relatively large amount of space. This concept of comparing substances by the amount of mass the substance has in a given volume is known as density. While the mass and volume of a material can change depending upon how much of the material there is, the density generally remains constant, no matter how much of the material is present. Therefore, density can be used to identify a material. Mass vs. volume graphs can be constructed and interpreted to determine which material has the greater density. Mathematical calculations of density are not the focus at this grade level and should be delayed until students have a conceptual understanding of density. An element is a chemical substance that cannot be broken down into simpler substances. There are approximately 90 different naturally occurring elements that have been identified. There are additional elements that were made in a laboratory, but these elements are not stable. All atoms of any one element are alike but are different from atoms of other elements. Atoms of elements can join together to form molecules. Note: The structure of the atom, including protons, neutrons and electrons, is not the focus at this grade level; it is addressed in high school physical sciences.
6.PS.2: Changes of state are explained by a model of matter composed of particles that are in motion. Temperature is a measure of the average motion of the particles in a substance. Heat is a process of energy transfer rather than a type of energy. Energy transfer can result in a change in temperature or a phase change. When substances	Thermal energy can be thought of as the total amount of kinetic energy present in a substance or system through the random motion of its atoms and molecules. Thermal energy depends on the amount of the substance, whereas temperature does not depend on the amount of the substance. When two samples of the same material have the same mass, the sample having the higher temperature will have a greater thermal energy (e.g., a hot nickel has more thermal energy than a cold nickel). When two samples of the same material have the same temperature, the sample with the greater

undergo changes of state, atoms change their motion and position. Note: It is not the intent of this standard to encourage vocabulary identification (matching definitions with heat, temperature, and thermal energy). Instead, these are provided as conceptual tools for understanding the role of energy in physical, biotic, atmospheric, oceanic, and geologic systems covered in grade 6 and subsequent grades and courses.	mass will have the greater thermal energy (e.g., a bucket of water has more thermal energy than a cup of water at the same temperature). Solids, liquids and gases vary in the motion, spacing and attractions between particles. Solid particles are close together and held more rigidly in a space by the attractions between the particles. However, solid particles can still vibrate back and forth within this space. Liquid particles may be slightly farther apart but move with more speed than solid particles. In liquids, particles can move from one side of the sample to another. Gas particles are much farther apart and move with greater speed than liquid or solid particles. Because of the large spaces between the particles, gases are easily compressed into smaller volumes by pushing the particles closer together. Most substances can exist as a solid, liquid or gas depending on temperature. Generally, for a specific temperature, materials that exist as solids have the greatest attraction between the particles. Substances that exist as gases generally have the weakest attraction between the particles. During phase changes, both the temperature and the mass of the substance remain constant. Particles (atoms and molecules) are not created or destroyed. There is simply a change in the motion of and spacing between the particles. Experiments and investigations (3-D and virtual) are used to demonstrate phase changes. Since moving atoms cannot be observed directly, provide the opportunity to experiment with temperature, phase changes and particle motion using virtual labs.
6.PS.3: There are two categories of energy: kinetic and potential. Objects and substances in motion have kinetic energy. Objects and substances can have energy as a result of their position (potential energy).	There are many forms of energy, but all can be put into two categories: kinetic and potential. Kinetic energy is associated with the motion of an object. The kinetic energy of an object changes when its speed changes. Potential energy is the energy of relative position between two interacting objects. Potential energy transforms to kinetic energy and vice versa as the distance between objects changes. Using the word “stored” to define potential energy is misleading. The word “stored” implies that the energy is kept by the object and not given away to another object. Therefore, kinetic energy also can be classified as “stored” energy. A rocket moving at constant speed through empty space has kinetic energy and is not transferring any of this energy to another object. Gravitational potential energy is associated with the height of an object above a reference position. The gravitational potential energy of an object changes as its height above the reference changes. Thermal energy can be thought of as the total amount of kinetic energy a substance has because of the random motion of its atoms and molecules. Sound energy is associated with the back and forth movement of the particles of the medium through which it travels. Opportunities to explore many types of energy should be provided. Virtual experiments that automatically quantify energy can be helpful since using measurements to calculate energy is above grade level.

6.PS.4: An object's motion can be described by its speed and the direction in which it is moving. An object's position and speed can be measured and graphed as a function of time. Note: Velocity and acceleration rates should not be included at this grade level; these terms are introduced in high school.	Speed can be calculated by dividing distance traveled by the elapsed time or can be found as the unit rate from a position versus time graph. This content aligns with mathematics standard 6.RP.3. When speed is calculated from a distance measurement, the distance is always measured from some reference point. To describe the motion of an object more thoroughly, the direction of motion can be indicated along with the speed. Experiments and graph creation/interpretation can be used to investigate motion. Plotting time on the horizontal (x) axis and position on the vertical (y) axis creates a graph that can be used to compare and analyze motion. On position versus time graphs, fast motion is represented by steep lines, slow motion is represented by lines that are less steep, and no motion is represented by horizontal lines. The relative speeds and positions of different objects can be determined by comparing their position vs. time graphs. At this grade level, position vs. time graphs are used to interpret motion data, not as a set of rules to be memorized. Motion detectors can be used to compare the graphs resulting from different types of motion. Note 2: Using the word "vector" and exploring other aspects of vectors are not appropriate at this grade level. This content is a precursor to the introduction of vectors. Note 3: At this grade level, interpretations of position vs. time graphs should be limited to comparing lines with different slopes to indicate whether objects are moving relatively fast, relatively slow or not moving at all. Calculation of slope is not appropriate at this grade level. More complex interpretations of position vs. time graphs will be made at higher grade levels.