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 7

Grade 7 Course Goals:
Students in Grade 7 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 cycles and patterns of earth and the moon, conservation of mass, energy cycles of matter and flow of energy.

Strand Connections:
Systems can exchange energy and/or matter when interactions occur within systems and between systems. Systems cycle matter and energy in observable and predictable patterns.

EARTH AND SPACE SCIENCE (ESS)	
Topic: Cycles and Patterns of Earth and the Moon This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.	
Content Statement	**Content Elaboration**
7.ESS.1: The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere. Thermal energy is transferred as water changes state throughout the cycle. The cycling of water in the atmosphere is an important part of weather patterns on Earth. The rate at which water flows through soil and rock is dependent upon the porosity and permeability of the soil or rock.	The different aspects of the hydrologic cycle (e.g., properties of water, changes of state, relationships of water to weather, effects of water on Earth's surface) from the elementary grades are formally combined in grade 7 and applied to the components of the hydrologic cycle. The movement of water through the spheres of Earth is known as the hydrologic cycle. As water changes state and energy is transferred, it cycles from one sphere into another (e.g., water transfers from the hydrosphere to the atmosphere when evaporation occurs). Groundwater and surface water quality are components of the hydrologic cycle. The porosity and permeability of the rock and/or soil can affect the rate at which the water flows. The pattern of the cycling illustrates the relationship between water, energy and weather. The movement of water in the cycle can have both positive and negative impacts, such as nutrient and contaminant transport. Contamination can occur within any step of the hydrologic cycle. Groundwater is easily contaminated as pollution present in the soil or spilled on the ground surface moves into the groundwater and impacts numerous water sources. Relating water flow to geographic and topographic landforms and/or features leads to an understanding of where water flows and how it moves through the different

	spheres. Topographic and aerial maps (can be virtual) can be used to identify drainage patterns and watersheds that contribute to the cycling of water. Lab investigations or technology can be used to simulate different segments of the hydrologic cycle.
7.ESS.2: Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns. The sun is the major source of energy for wind, air and ocean currents and the hydrologic cycle. As thermal energy transfers occur in the atmosphere and ocean, currents form. Large bodies of water can influence weather and climate. The jet stream is an example of an atmospheric current and the Gulf Stream is an example of an oceanic current. Ocean currents are influenced by factors other than thermal energy, such as water density, mineral content (such as salinity), ocean floor topography and Earth's rotation. All of these factors delineate global climate patterns on Earth.	The earlier concepts of weather and the physical properties of air and water, and their changes are expanded in grade 7 to the relationship of atmospheric and oceanic currents and climate. Current and climate patterns on a global level should be studied using a variety of maps, models and technology (e.g., remote sensing, satellite images, LANDSAT). The causes of moving currents in the atmosphere and ocean are connected to thermal energy, density, pressure, composition and topographic/geographic influences (e.g., continental mountains, ocean ridges). Studies should also include specific current patterns in both the atmosphere and the ocean that are mapped and documented through data. Contemporary studies regarding global climate must be based on facts and evidence. This content statement is connected to the Life Science, grade 7 content pertaining to biomes and the climatic zones of Earth.
7.ESS.3: The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere. The atmosphere is held to the Earth by the force of gravity. There are defined layers of the atmosphere that have specific properties, such as temperature, chemical composition and physical characteristics. Gases in the atmosphere include nitrogen, oxygen, water vapor, carbon dioxide and other trace gases. Biogeochemical cycles illustrate the movement of specific elements or molecules (such as carbon or nitrogen) through the lithosphere, biosphere, hydrosphere and atmosphere. Note: The emphasis is on why the atmosphere has defined layers, not on naming the layers	The properties and composition of the layers of Earth's atmosphere are studied, as they are essential in understanding atmospheric currents, climate and biogeochemical cycles, which are seventh-grade concepts. Understanding the interactions between Earth's spheres (Earth Systems Science) and how specific elements and/or compounds move between them should be emphasized. This study includes standard greenhouse gases (including water vapor), ozone (in the atmosphere and at Earth's surface) and natural events/human activities that can change the properties of the atmosphere. Contemporary issues and technological advances should be included within this concept. Real-time scientific data pertaining to air quality and properties of air can be incorporated into the study of atmospheric properties and air quality.
7.ESS.4: The relative patterns of motion and	The role of gravitational forces and tides are introduced with relation to the position of

positions of Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon. The moon's orbit and its change of position relative to Earth and sun result in different parts of the moon being visible from Earth (phases of the moon). A solar eclipse is when Earth moves into the shadow of the moon (during a new moon). A lunar eclipse is when the moon moves into the shadow of Earth (during a full moon). Gravitational force between Earth and the moon causes daily oceanic tides. When the gravitational forces from the sun and moon align (at new and full moons) spring tides occur. When the gravitational forces of the sun and moon are perpendicular (at first and last quarter moons), neap tides occur.	Earth, moon and sun. Models and simulations (can be 3-D or virtual) are used to demonstrate the changing positions of the moon and Earth (as they orbit the sun) and lunar/solar eclipses, daily tides, neap and spring tides and the phases of the moon. Our solar system is a part of the Milky Way galaxy, which is part of the universe. The emphasis should not be on naming the phases of the moon or tides, but in understanding why the phases of the moon or tides are cyclical and predictable. Advances in scientific knowledge regarding patterns and movement in the solar system are included in this content statement.
7.ESS.5: The relative positions of Earth and the sun cause patterns we call seasons. Earth's axis is tilted at an angle of 23.5°. This tilt along with Earth's revolution around the sun, affects the amount of direct sunlight that the earth receives in a single day and throughout the year. The average daily temperature is related to the amount of direct sunlight received.	Each day, the total energy that a particular location on Earth receives from sunlight is directly related to the angle at which the sun's rays strike Earth and the amount of time the sun is above the horizon (i.e. the number of hours of sunlight). Seasonal change should be expanded to include regions of the world that experience specific seasonal weather patterns and natural weather hazards (e.g., hurricane season, monsoon season, rainy season, dry season). This builds upon making observations of the seasons throughout the school year in the earlier grades. Three-dimensional models are used to demonstrate that the tilt of Earth's axis is related to the amount of direct sunlight received and seasonal temperature changes.

PHYSICAL SCIENCE (PS)	
Topic: Conservation of Mass and Energy This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy.	
Content Statement	**Content Elaboration**
7.PS.1: Elements can be organized by properties. Elements can be classified as metals, nonmetals and metalloids, and can be organized by similar properties	All substances are composed of one or more elements. Elements are organized into groups based on their properties (including melting and/or boiling points). Elements with similar properties are grouped together on the periodic table. These groups

such as color, solubility, hardness, density, conductivity, melting point and boiling point, viscosity, and malleability. Note 1: This is the conceptual introduction of the Periodic Table of Elements and should be limited to classifications based on observable properties; it should not include the names of the families.	include metals, nonmetals and metalloids. Most metals are malleable, have high melting points, are usually solid at room temperature and are good conductors of heat and electricity. Nonmetals are poor conductors of heat and electricity and tend to be dull and brittle in the solid state. Depending on the element, they may be solid, liquid or gas at room temperature. Metalloids demonstrate some properties of both metals and nonmetals
7.PS.2: Matter can be separated or changed, but in a closed system, the number and types of atoms remains constant. When substances interact and form new substances the properties of the new substances may be very different from those of the original substances, but the amount of mass does not change. Physically combining two or more substances forms a mixture, which can be separated through physical processes. Note: Under these standards, classifying specific changes as chemical or physical is not appropriate.	Elements are basic building blocks of matter that are uniform and not further broken into simpler substances by chemical or physical means. Instruction on subatomic particles is reserved for high school. Compounds are composed of two or more different elements joined together chemically. Each compound has its own unique composition of type and number of elements and atoms. Molecules are the combination of two or more atoms that are joined together chemically. Molecules can be either elements or compounds (e.g., elemental hydrogen is a molecule containing two atoms of hydrogen; water is a molecule containing two atoms of hydrogen joined with one atom of oxygen). All particles of a pure substance have nearly identical mass. Particles of different substances usually have different masses, depending on their composition. Each element and compound has properties, some of which are independent of the amount of the sample. For any change in a closed system, the number and type of atoms stay the same, even if the atoms are rearranged. Therefore, the mass remains constant. Mass is always conserved in a closed system; this is not always the case for volume. Mixing isopropyl alcohol (90%) with water results in a volume that is less than the sum of the volumes. Heating liquid results in an increase in volume. The conservation of matter can be demonstrated using simple balanced equations with their chemical formulas or pictorial representations of the reactants and products. The equations for photosynthesis and cellular respiration can be used to demonstrate this concept. Energy input is required to break a molecule apart. When the separated atoms form new molecules, the output energy can be greater than or less than the original input energy. Mixtures are materials composed of two or more substances that retain their separate compositions, even when mixed (e.g., water and sugar can be mixed together thoroughly at the molecular level but the water particles and sugar particles remain separate). When a solid substance dissolves in water, the particles of the solid separate and move freely with the water particles. Types of mixtures include solutions, suspensions, and colloids.
7.PS.3: Energy can be transformed or transferred but is never lost. When energy is transferred from	A system is separated from its surroundings by either a physical or mental boundary. An isolated system is one that does not interact with its surroundings. Matter and

one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. When energy is transformed from one form to another, the total amount of energy remains the same.	energy cannot get into or out of an isolated system. Most systems on Earth are open systems. Matter and energy can be transferred into or out of an open system. If energy appears to be gained or lost, it has just transformed or transferred into a different system. Examples of systems include ecosystems, the atmosphere, the hydrosphere, the solar system and the human body. When energy transfers to a large system, it may be difficult to measure the effects of the added energy. Dissipated energy (energy that is transformed into thermal energy and released into the surroundings) is difficult or impossible to recapture. Some systems dissipate less energy than others, leaving more energy to use. Investigation, testing and experimentation are used to explore energy transfers and transformations. Observing the quantifiable energy changes in a virtual environment is recommended at this introductory level, as energy changes can be difficult to measure accurately.
7.PS.4: Energy can be transferred through a variety of ways. Mechanical energy can be transferred when objects push or pull on each other over a distance. Mechanical and electromagnetic waves transfer energy when they interact with matter. Thermal energy can be transferred through radiation, convection and conduction. An electrical circuit transfers energy from a source to a device. Note: Energy transfers should be experiential and observable at this grade level.	Mechanical energy is transferred when a force acts between objects to move one of the objects some distance with or against the force. The amount of energy transferred increases as the strength of the force and/or the distance covered by the object increases. This energy transfer (work) stops when the objects no longer exert forces on each other. Energy transfers should be experiential and observable at this grade level. Waves can be described by their speed, wavelength, amplitude and frequency. Vibrations cause wavelike disturbances that transfer energy from one place to another. Mechanical waves require a material (medium) in which to travel. The medium moves temporarily as the energy passes through it but returns to its original undisturbed position. Mechanical waves are classified as transverse or longitudinal (compressional) depending on the direction of movement of the medium. The energy of a mechanical wave depends on the material and increases with amplitude. While light and other electromagnetic waves do not require a medium and can travel through a vacuum, they can travel through some media, such as clear glass. A wave travels at a constant speed through a particular material as long as it is uniform (e.g., for water waves, having the same depth). The speed of the wave depends on the nature of the material (e.g., sound waves travel faster through most solids than gases). For a particular uniform medium, as the frequency (f) of the wave is increased, the wavelength (λ) of the wave is decreased. Gravitational potential energy is associated with the mass of an object and its height above a reference point (e.g., above ground level, above floor level). A change in the height of an object is evidence that the gravitational potential energy has changed. Elastic potential energy is associated with how much an elastic object has been stretched or compressed and how difficult such a compression or stretch is. A change in the amount of compression or stretch of an elastic object is evidence that the elastic potential energy has changed. Chemical potential energy is

	associated with the position and arrangement of the atoms within substances. Rearranging atoms into new positions to form new substances (chemical reaction) is evidence that the chemical potential energy has most likely changed. The energy transferred when a chemical system undergoes a reaction is often thermal energy. Electrical potential energy is associated with the position of electrically charged objects relative to each other and the amount of charge they have. A change in the position of charged particles relative to each other is evidence of a change in electrical potential energy. Generators convert mechanical energy into electrical energy and are used to produce electrical energy in power plants. Electric motors convert electrical energy into mechanical energy. For grade 7, investigation and experiments (3-D and virtual) are used to connect energy transfer and waves to the natural world. Real wave data (e.g., oceanic, seismic, light, sound) can be used. Heat is the transfer of energy from a warmer object to a cooler one. Thermal energy can be transferred when moving atoms collide. This energy transfer is conduction. Thermal energy can also be transferred by means of thermal currents in air, water or other fluids. As fluids are heated, they expand, decreasing the density. Cooler material with a greater density sinks while warmer material with less density rises, causing currents that transfer energy. This energy transfer is convection. Thermal energy can also be transformed into waves that radiate outward. This radiation can be absorbed by an object and transformed back into thermal energy. This energy transfer is radiation. Technology (e.g., virtual simulations, satellite imagery, remote sensing, accessing real-time temperature data) can be used to demonstrate the transfer of thermal energy on the surface or interior of Earth and within the solar system. An electric circuit exists when an energy source (e.g., battery, generator, solar cell) is connected to an electrical device (e.g., light bulb, motor) in a closed circuit. The energy source transfers energy to charges in the circuit. Charges flow through the circuit. Electric potential is a measure of the potential electrical energy of each charge. Differences in voltages can be measured with a voltmeter. The energy source does not create the charges; they were already present in the circuit. When the charges reach an electrical device, energy can be transformed into other forms of energy (e.g., light, sound, thermal, mechanical). The voltage drops after this energy transfer, but the charges continue to move through the circuit. In an open circuit, the charges stop flowing and energy is not transferred. Current is the rate of charge flow through conductors and can be measured with an ammeter. The degree to which current is opposed in a circuit is called resistance. Generally, for a particular energy source, the greater the resistance, the lower the current. The resistance through a wire depends upon the type of metal, the length of the wire and the diameter of the wire. Electrical devices can be connected in a series or as a parallel circuit. As the number of devices in a series loop increases, the current in the loop decreases. As

	loops are added in parallel, the current though the devices in each loop is the same as it would be if that loop were the only loop in the circuit. Many of the circuits used in modern devices involve arrangements of circuit elements that are much more complex than a simple series or parallel circuit. Testing and experimenting (3-D or virtually) with electrical circuits to observe results of energy transfers due to changes in resistance, current and voltage are encouraged. Note 2: The electromagnetic nature of electromagnetic radiation is not appropriate at this grade level nor are mathematical calculations of work or electricity.

LIFE SCIENCE (LS)	
Topic: Cycles of Matter and Flow of Energy This topic focuses on the impact of matter and energy transfer within the biotic component of ecosystems.	
Content Statement	**Content Elaboration**
7.LS.1: Energy flows and matter is transferred continuously from one organism to another and between organisms and their physical environments. Plants use the energy in light to make sugars out of carbon dioxide and water (photosynthesis). These materials can be used or stored for later use. Organisms that eat plants break down plant structures to release the energy and produce the materials they need to survive. The organism may then be consumed by other organisms for materials and energy. Energy can transform from one form to another in living things. Animals get energy from oxidizing food, releasing some of its energy as heat. The total amount of matter and energy remains constant, even though its form and location change. Note: Chemical reactions in terms of subatomic structures of atoms are not appropriate at this grade level. Chemical reactions are presented as the rearrangement of atoms in molecules.	The basic concepts for matter and energy flow were introduced in grades 3-5. The grades 3-5 concepts are expanded to include a comparison of photosynthesis and cellular respiration. The use of light energy to make food is called photosynthesis. The breakdown of food to release the stored energy is called respiration. General formulas are appropriate at this grade level, because atoms and molecules are taught in grade 6. Details of both processes are not grade appropriate. In grade 6, cellular organelles are introduced. It is appropriate to reinforce that the chloroplast (the plant cell organelle that contains chlorophyll) captures the sun's energy to begin the process of converting the energy from the sun into sugars and sugar polymers, such as starch. As matter is cycled within the environment, it promotes sustainability. The elements that make up the molecules of living things are continuously recycled. Energy-rich molecules that are passed from organism to organism are eventually recycled by decomposers back into mineral nutrients usable by plants. The emphasis is not on food webs, but on the transfer of matter and energy between organisms. The concepts of conservation of matter and conservation of energy are applied to ecosystems. Matter within an ecosystem is continually undergoing changes in form and location; however, as long as it remains within that ecosystem, the total amount of matter in the ecosystem remains constant. An energy pyramid graphic can illustrate the flow of energy. At each stage in the transfer of energy within an ecosystem, some energy is stored in newly synthesized molecules and some energy is transferred into

	the environment as heat produced by the chemical processes in cells. This dissipated energy is not easy to detect or recapture but continues to exist. New discoveries, technology and research are used to connect the concept of energy transfer and transformation within the ecosystem and between ecosystems. For example, the use of biomass as an alternative energy source for the local area can focus on different types of biomass, competition between human food crops and biomass crops, and biomass vs. other types of alternatives to fossil fuels energy.
7.LS.2: In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors. The variety of physical (abiotic) conditions that exist on Earth gives rise to diverse environments (biomes) and allows for the existence of a wide variety of organisms (biodiversity). Biomes are regional ecosystems characterized by distinct types of organisms that have developed under specific soil and climatic conditions. Ecosystems are dynamic in nature; the number and types of species fluctuate over time. Disruptions, deliberate or inadvertent, to the physical (abiotic) or biological (biotic) components of an ecosystem impact the composition of an ecosystem.	Biomes are defined by abiotic components of the environment – topography, soil types, precipitation, solar radiation and temperature. Comparing the different biomes found on Earth is the focus of this content statement. Examples of the Earth's biomes include aquatic (freshwater, brackish water and marine water), forest (tropical and temperate), desert (cold and hot), grassland, taiga and tundra. Biomes should be linked to climate zones on a global level by using a variety of maps, models and technology (e.g., remote sensing, satellite images, LANDSAT). An ecosystem is composed of linked and fluctuating interactions between biotic and abiotic factors. Given adequate resources and an absence of disease or predators, populations of organisms in ecosystems increase at rapid rates. Finite resources and other factors limit population growth. As one population proliferates, it is held in check by one or more environmental factors (e.g., depletion of food or nesting sites, increased loss to predators, invasion by parasites). If a natural disaster such as a flood or fire occurs, the damaged ecosystem is likely to recover in a succession of stages that eventually results in a system similar to the original one.