LAKEWOOD CITY SCHOOL DISTRICT STANDARDS-BASED SCIENCE CURRICULUM
FOURTH GRADE

GRADE BAND THEME
INTERCONNECTIONS WITHIN SYSTEMS – This theme focuses on helping students recognize the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

Units: 1. Earth Science (Earth's Surface) 2. Physical Science (Heat/Electricity) 3. Life Science (Earth's Living History)
NOTE: The Earth's Surface unit correlates with the Extreme Weather reading unit.

Unit length: 12 weeks each if taught alongside SS or 6 weeks each if alternated by unit with SS

FOURTH GRADE
SCIENCE INQUIRY AND APPLICATION (SIA) – These scientific process skills should be integrated into the following grade level content units.

Bolded and starred statements come directly from the standards. Bulleted statements are clarifications for teachers from the ODE Model Curriculum.

Science Inquiry and Application	Resources from 2017-18 Update	Resources linked from LKWD 2012 Course of Study
Science Inquiry and Application During the years of PreK-4, all students must become proficient in the use of the following scientific processes, with appropriate laboratory safety techniques, to construct their knowledge and understanding in all science content areas: ✶ Observe and ask questions about the natural environment; ✶ Plan and conduct simple investigations; ✶ Employ simple equipment and tools to gather data and extend the senses; ✶ Use appropriate mathematics with data to construct reasonable explanations; ✶ Communicate about observations, investigations and explanations; and ✶ Review and ask questions about the observations and explanations of others.	Current guidance is to teach Science Inquiry and Application through the units described below, rather than as a stand-alone unit.	**4th Houghton Mifflin DiscoveryWorks –** Think Like a Scientist; pp. S1-S15 **Instructional Websites:** http://sciencespot.net/Media/scimethodwkst.pdf

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FOURTH GRADE
EARTH'S SURFACE
Earth and Space Science Strand (ESS)

Content Statements	Content Elaboration and Clarification	Resources from 2017-18 Update	Resources linked from LKWD 2012 Course of Study
Earth and Space Science ✶ **Earth's surface has specific characteristics and landforms that can be identified. (4)** ● About 70 percent of Earth's surface is covered with water and most of that is the ocean. Only a small portion of Earth's water is freshwater, which is found in rivers, lakes and groundwater. ● Earth's surface can change due to erosion and deposition of soil, rock or sediment. Catastrophic events such as flooding, volcanoes and earthquakes can create landforms.	**Earth's Surface** ✶ **Earth is known as the Blue Planet because about 70 percent of Earth's surface is covered in water. Freshwater is a small percentage of the overall water found on Earth; the majority is oceanic.** ● Water is found almost everywhere on Earth; as vapor; as fog or clouds in the atmosphere; as rain or snow falling from clouds; as ice, snow, and running water on land and in the ocean; and as groundwater beneath the surface. The downhill movement of water as it flows to the ocean shapes the appearance of the land. Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (F) ● Of the 70% of water that covers the earth, 97% is salt water. 2% is glacier ice, which is frozen from freshwater. Less than 1% is freshwater (e.g., lakes, rivers, streams, ponds, etc.). ● Recognize that 70 percent of Earth's surface is water, which is why Earth is known as the Blue Planet. (V) ✶ **There are many different processes that continually build up or tear down the surface of Earth. These processes include erosion, deposition, volcanic activity, earthquakes, glacial movement and weathering.** ● Identify the processes that can change the surface of Earth (e.g., erosion, deposition, volcanic activity, earthquakes, glacial movement, weathering, etc.). (V) ✶ **Beginning to recognize common landforms or features through field investigations, field trips, topographic maps, remote sensing data, aerial photographs, physical geography maps and/or photographs (through books or virtually) are important ways to understand the formation of landforms and features.** ● The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features where people live and in other areas of Earth. (F) ● View landforms and surface geology from satellite photographs and remote sensing to illustrate landforms	Common Summative Assessments **RESOURCES:** DSCR-Erosion and Weathering, Red, 8-Pack DSCR-Erosion and Weathering, Purple, 8-Pack Teachers Guide & Flash Drive – ConceptLinks Literacy eBooks – Volcanoes and Earthquakes Volcanoes and Earthquakes Student Book Orange Level: Different Types,	**4th grade Houghton Mifflin DiscoveryWorks** - Unit A Earth's Land (soft bound) pp. A2 – A25 (for entire unit) **Bill Nye videos** – Earth's Crust, Rocks and Soil, Rivers and Streams, Earthquakes, Volcanoes, Caves **PreK-5 Common Share Materials** ● Videos and accompanying flipcharts (For entire unit standards) Pre-K-5 Common Share→ 4th Grade→ Science → Videos and Flipcharts Reading A-Z book and materials (For entire unit standards)

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	in different part of the world and conditions that exist for formation. ✶ **Common landforms and features include streams, deltas, flood plains, hills, mountains/mountain ranges, valleys, sinkholes, caves, canyons, glacial features, dunes, springs, volcanoes and islands.** ● Canyons are deep valleys with steep sides. ● Caves are underground, hollow areas created by weathering. ● Deltas are low plains that form where rivers enter oceans. ● Dunes are sand hills or sand ridges formed by wind, usually located in desert regions or near lakes and oceans. ● Floodplains are nearly flat plains along the paths of streams or rivers that are naturally subject to flooding. ● Glaciers are huge masses of ice formed from snow falling and accumulating over time. They flow very slowly over landmasses, either descending from high mountains, as in valley glaciers, or moving outward from centers of accumulation, as in continental glaciers. ● Hills are natural elevations of the earth's surface that are smaller than mountains (i.e., less than 2000 feet above sea level). ● Islands are areas of land surrounded by water. ● Mountains and mountain ranges are natural elevations of the earth's surface. They rise to summits, which are greater than 2000 feet above sea level. They are the tallest of Earth's landforms. ● Sinkholes appear when land above weathered rock sinks into holes in the ground. ● Springs are natural outflows of groundwater. ● Streams are natural bodies of running water flowing on or under the earth. ● Valleys are long, narrow regions of lowland between ranges of mountains or hills. ● Volcanoes are openings, called vents, in the earth's crust through which hot ash, steam, gases and molten rock or lava escape from deep inside Earth. They are located on hills or mountains. ● Identify common landforms from maps or graphics. (V) ✶ **Connecting the processes that must occur to the resulting landform, feature or characteristic should be emphasized. This can be demonstrated through experiments, investigations (including virtual experiences) or field observations.** ● Landforms formed by erosion and deposition include streams, deltas, flood plains, valleys, canyons, dunes, meanders, tributaries, etc. ● Landforms formed by weathering include sinkholes, caves, buttes, natural arches or bridges, etc. ● Landforms also can be formed by a combination of the processes of weathering, erosion and deposition (e.g., hills, mountains, mountain ranges, mesas, etc.). ● Plan, build and use a model (such as a small-scale stream table) that can demonstrate the formation of a landform or feature that formed through contact with water (e.g., alluvial fan, sinkhole, mid-channel bar,	6-Pack Volcanoes and Earthquakes Student Book Blue Level: A Moving Crust, 6-Pack Volcanoes and Earthquakes Student Book Green Level: Sudden Changes, 6-Pack Volcanoes and Earthquakes Student Book Purple Level: Plate Tectonic Theory, 6-Pack	Pre-K-5 Common Share→ 4th Grade→ Science → Earth's Land ● Science A-Z Materials – Pre-K-5 Common Share→ 4th Grade→ Science → Leveled Readers and Vocabulary Changing Landforms leveled readers and vocabulary cards **Instructional Websites:** http://cse.ssl.berkeley.edu/SegwayEd/lessons/third_from_sun/index.htm http://www.usgs.gov/ http://www.iris.washington.edu/gifs/slides/erosion/slideshow/index.htm

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	canyon, valley, depositional islands, etc.). Ask: *What factors accelerate the processes? What factors must exist for the landform to form?* Share findings with the class. (V) ● Using LANDSAT data, research and locate a specific major landform or geographical feature on Earth that formed through erosion or deposition. Represent findings graphically or orally to the class. (V) ● Landforms formed by glaciers include moraines, terminal moraines, arêtes, etc. Glacial grooves (i.e., deep scratches in bedrock) and erratics (i.e., large boulders) are left behind by glaciers as they slowly "move" across Earth's crust. ● Using topographic or aerial maps, locate areas that have been formed through deposition and erosion. Include areas of Ohio that have been impacted by glacial ice or movement. Discuss findings with the class. (V) ✶ **Technology can help illustrate specific features that are not found locally or demonstrate change that occurred (e.g., using satellite photos of an erosion event such as flooding).**		
Earth and Space Science ✶ **The surface of Earth changes due to weathering. (4)** ● Rocks change shape, size and/or form due to water or ice movement, freeze and thaw, wind, plant growth, gases in the air, pollution and catastrophic events such as earthquakes, mass wasting, flooding and volcanic activity. ● Note: The ice movement (above) refers to large bodies of ice, such as glaciers that can break large rocks into small ones.	**Weathering** ✶ **Different types of rock weather at different rates due to specific characteristics of the rock and the exposure to weathering factors (e.g., freezing/thawing, wind, water). Weathering is defined as a group of processes that change rock at or near Earth's surface.** ● Weathering is the wearing away of bedrock or large rocks into smaller pieces of rock. ● Earth materials change over time due to two different classifications of weathering, mechanical (i.e., physical) and chemical. Mechanical or physical weathering involves the breakdown of minerals, rocks, soil and other Earth materials through direct contact with heat, water, ice, pressure, etc. Chemical weathering involves the breakdown of Earth materials when they experience chemical changes through direct contact with chemicals. ● Examples of mechanical or physical weathering may include, but are not limited to: ° Animals burrowing through soil ° Large bodies of glacial ice breaking down Earth materials as they melt slowly ° Plants growing through rock ° Sinkholes forming underneath the ground (which can also be caused by chemical weathering) ° Tree roots fracturing bedrock, pavement or sidewalks ° Water freezing and ice melting or thawing within rock ° Wind wearing away sedimentary rock ● Describe how freezing, thawing and plant growth reshape Earth's surface by causing physical or mechanical weathering of rock. ● Examples of chemical weathering may include, but are not limited to:		**Instructional Websites:** http://walrus.wr.usgs.gov/infobank/programs/html/school/moviepage/14.01.07.html

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	° Biological weathering (e.g., by lichens, moss, etc.) ° Effects of oxidation or rusting on metal (e.g., rusting of an old car, oxidation of copper on the Statue of Liberty, etc.) ° Effects of years of precipitation or acid rain on objects (e.g., on a marble statue, on a cemetery monument, on the Statue of Liberty, etc.) ° Formation of caves (especially limestone), caverns, stalagmites and stalactites ● Compare and contrast mechanical or physical weathering (e.g., plant growth, freeze-thaw cycles, etc.) and chemical weathering (e.g., acid rain, oxidation or rusting, etc.). ● Recognize that water, wind, pollution/gases in the air, ice movement, earthquakes, volcanoes, freezing/thawing and plant action can all weather rock and soil. (V) ● The three types of rock have distinct properties (e.g., color, texture, etc.) and special characteristics depending upon the environment in which they were formed including (Review from Third Grade): ° Igneous - normally contains no fossils, rarely reacts with an acid, usually has no layering, usually made up of two or more minerals, may be light or dark colored, usually made up of mineral crystals of different sizes, sometimes has openings or glass fibers, may be fine-grained or glassy ° Metamorphic - rarely has fossils, may react with an acid, may have alternate bands of light and dark minerals, may be composed of one mineral (e.g., marble, quartzite, etc.), may have layers of visible crystals, usually made up of minerals of different sizes, rarely has pores or openings, may have bent or curved foliation (i.e., layers) ° Sedimentary - often contains fossils, may react with an acid, often has layers that are flat or curved, usually composed of pieces of sediment cemented or pressed together, has great color variety, particle size may be the same or vary, usually has pores between pieces ● Identify weathering as processes that change rock at or near Earth's surface. (V) ● Different types of rock weather at different rates due to specific characteristics including, but not limited to: ° Layering - sedimentary rock layers may be poorly cemented together or porous allowing for disintegration by freezing, moving water or dissolution of the minerals cementing them together (e.g., sandstone, conglomerate, shale, etc.) ° Method of Formation - some rocks are not as compact as others, therefore they are looser and erode faster than tightly packed rocks (e.g., granite, an igneous rock that slowly solidified from magma, is impermeable to fluids and their weathering effects, etc.) ° Mineral Hardness - different rocks weather at different rates based upon their hardness (e.g., quartzite, a metamorphic rock that is largely made up of the mineral quartz which is a 7 on Mohs Scale of Hardness, could be expected to weather much more slowly than shale, a sedimentary rock composed		

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	mainly of clay minerals which are easily weathered by abrasion, etc.) ° Reaction With Acids - sedimentary and metamorphic rocks react with acids from acid rain or other sources (e.g., limestone, etc.), igneous rocks rarely react with acids ✶ **Some weathering processes take a long time to occur, while some weathering processes occur quickly.** ● Plan an experiment to model and compare different types of weathering and/or rates of weathering that can occur. (V) ● Recognize that weathering can occur at different rates. (V) ✶ **The weathering process must be observed in nature, through classroom experimentation or virtually. Seeing tree roots fracturing bedrock or the effect of years of precipitation on a marble statue can illustrate ways that rocks change shape over time. Investigations can include classroom simulations, laboratory testing and field observations.** ● Using geologic, topographic or aerial maps, research areas in the U.S. that are impacted by natural sinkholes, caverns or caves. Collect data regarding the characteristics of these regions. Compare and contrast the data to determine common characteristics that are present in each area. Represent findings graphically. (V) ● Research a specific weathering feature (e.g., sinkhole, cave, etc.). Evaluate the risk of collapse and methods of prevention of collapse (using actual data) and recommend one solution based on the scientific data. Create a model (virtual, graphic or 3-D) of the actual cave or sinkhole and demonstrate the risk of collapse and how the suggested preventative measure or solution impacts that risk. (V)		
<u>Earth and Space Science</u> ✶ **The surface of Earth changes due to erosion and deposition. (4)** ● Water, wind and ice physically remove and carry (erosion) rock, soil and sediment and deposit the material in a new location. ● Gravitational force affects movements of water, rock and soil.	**<u>Erosion and Deposition</u>** ✶ **Erosion is a process that transports rock, soil or sediment to a different location. Weathering is the breakdown of large rock into smaller pieces of rock. Erosion is what carries the weathered material to a new location.** ● Identify erosion as a process that transports rock, soil or sediment to a new location. (V) ● Differentiate between weathering and erosion. (V) ✶ **Gravity plays an important role in understanding erosion, especially catastrophic events like mass wasting (e.g., mudslides, avalanches, landslides) or flooding.** ● Mass wasting, also known as slope movement or mass movement, is a process by which soil, sand and rock move down a sloped area under the force of gravity. According to the National Park Service, types of mass wasting may include creep, slumps, landslides, rock topple, mud and debris flows, earth flows, rock and debris avalanches, rockslides and rockfalls. Each type of mass wasting has its own characteristic features.		**Bill Nye video -** Erosion

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	● Mass wasting may occur at a very slow rate, particularly in areas that are very dry or those areas that receive sufficient rainfall such that vegetation has stabilized the Earth's surface. It may also occur at very high speeds, such as in rockslides, mudslides, avalanches or landslides. Mass wasting may have disastrous consequences (e.g., destruction of homes, flooding resulting from blocked rivers and/or the formation of landslide dams, death of wildlife, etc.). ● Many factors affect the potential for mass wasting to occur (e.g., a change in the steepness of a slope, the weakening of Earth material by weathering, increased water content in soil, drastic freeze and thaw cycles, the amount of vegetation covering the ground, etc.). ✶ **Erosion is a "destructive" process and deposition is a "constructive" process.** ● Destructive processes are forces that destroy or break down part of Earth's surface. Processes that tear down Earth's surface include, but are not limited to: ° Erosion - pieces of rock are moved by water, wind or moving ice (e.g., wind erodes and carries away sand from sand dunes or beaches, running water from rainstorms and/or floods carries away earth materials from one area to another, etc.) ° Ice Movement - huge masses of slow-moving ice or glaciers form over land masses, break up large rocks into smaller ones and carry away earth materials as they flow ° Mass Wasting - the breaking apart of Earth materials, caused by gravity, which transports sediments ° Earthquakes - violent shaking and destruction of Earth's crust as built-up energy is released ° Volcanic Eruptions - opening in Earth's crust from which ash, gas and lava flow and then tear apart Earth's surface (however, can be constructive, as well) ° Earth Processes Related to Severe Weather - natural weather hazards that damage Earth's surface (e.g., flooding, tornadoes, hurricanes, tsunamis, etc.) ● Constructive processes are forces that build up or add to Earth's surface. Processes that build up Earth's surface include, but are not limited to: ° Volcanic Eruptions - hardened ash and lava build up the land around a volcano, making the elevation higher or even forming mountains ° Deposition - when rock, soil and/or sediment are moved by water, wind and/or ice from one area and are deposited in another (e.g., when sand is dumped onto a river bank by running water, the sand builds up the river bank, making it higher, etc.) ° Mountain Building - mountains are created when rocks are pushed upwards by the movement of giant rock plates that make up Earth's crust, many mountain ranges have been built up and have eroded away since Earth was formed ● Identify deposition as the settling or coming to rest of transported rock, soil or sediment. (V) ● Compare and contrast erosion and deposition. (V)		

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	● Humans also affect processes that shape the earth. Sometimes humans cause Earth's surface to erode or to be destroyed more quickly. For example, farming could be considered a destructive process, because soil has to be dug up and moved around in order to grow plants. Mining could also be considered another destructive process, because parts of Earth's surface and/or caves are drilled into, or mined using explosives, to gain access to the resources. ● Explain how destructive and constructive processes may happen slowly or rapidly. Classify changes on Earth's surface in terms of slow processes (e.g., erosion, weathering, mountain building, deposition, etc.) and rapid processes (e.g., volcanic eruptions, earthquakes, landslides, etc.). ● Describe evidence of changes on Earth's surface in terms of destructive processes (e.g., erosion, weathering, landslides, earthquakes, etc.), constructive processes (e.g., mountain building, deposition, etc.) and processes that can be classified as both (e.g., volcanic eruptions, etc.). ✶ **Erosion and deposition directly contribute to landforms and features formation that are included in grade 4.** ● Describe how wind, water and ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas producing characteristic landforms (e.g., dunes, deltas, glacial moraines, canyons, etc.). ● Use actual geologic data from a specific location, such as the Grand Canyon. Research the formation of the canyon. Ask: *Why does some rock weather and erode faster than others? What caused the weathering and erosion in the canyon? How can the age of the canyon be estimated?* Use the research data to make a geologic cross section (3-D or virtual model or a graphic) to model the canyon. (V) ✶ **Topographic maps and aerial photographs can be used to locate erosional and depositional areas in Ohio.** ✶ **Surficial geology maps also can illustrate the patterns of glacial erosion and deposition that have occurred.** ● The three main layers of soil include topsoil, subsoil and bedrock, the bottom layer which is made up of solid rock. (Review from Third Grade) ● Geologic processes, such as weathering and erosion, break bedrock down into smaller particles of sediment. Sediments such as clay, silt, sand, gravel and other loose deposits which lie on top of bedrock are grouped together in the general category of "surficial materials." These materials are not soils; they are the deeper Earth materials that lie between the soil zone and the underlying bedrock. Soils commonly develop by the weathering of the uppermost part of these materials. ● A surficial geology map shows the distribution of all the loose materials such as clay, sand, gravel or till (commonly called hardpan), which overlie bedrock. Most of the surficial materials are deposits formed by glacial processes during the last stage of continental glaciation, which began about 35,000 years ago. The		

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	rest of the surficial deposits are the products of postglacial geologic processes, such as river flood plains, or are attributed to human activity, such as road fill. ● Using a surficial geology map of Ohio, trace the patterns of glacial movement that can be recognized by a variety of glacial deposits or erosion. Build a model to investigate the movement of glacial ice that creates a similar pattern. Ask: *What factors must exist to support the movement of glaciers? Why is glacial movement erosional and depositional?* (V) ✶ **Field trips and field investigations (may be virtual) are recommended as erosional and depositional features that can be seen locally or within the state can help to connect the concept of erosion and deposition to the real world.** ● Observe and identify the effects of weathering, erosion, deposition and other geological activity in the local area (e.g., near buildings, sidewalks, cemeteries, playgrounds, rivers, etc.) as well as in the reports of world events (e.g., thunderstorms, floods, droughts, volcanic eruptions, earthquakes, landslides, tsunamis, etc.). ● Identify evidence of changes in the earth's surface from analyzing: ° "Before and after" illustrations of the earth's surface ° Descriptions of events that may cause or have caused weathering, erosion, deposition, etc. ° Fossil record (See "Earth's Living History" unit.) ● Compare and contrast the causes of changes in Earth's surface due to: ° Gravity ° Ice (e.g., glaciers, freeze-thaw cycles, etc.) ° Plant or animal activity (e.g., farming, overgrazing, earthworm activity, plant roots growing through soil, etc.) ° Water ° Wind ● Research methods used locally and nationally to prevent weathering and erosion. Design an experiment and/or gather scientific data to determine the effectiveness of the strategies being utilized. For example: ° Sediment fences are often placed around construction sites to help control sediment from moving offsite (erosion) into the surrounding environment (deposition). Design and construct a model of one specific sediment-control measure (using scientific research). Evaluate and test it using different types of materials. Different groups in the class should model different methods of control. Each group should present findings and demonstrate the models. (V) ° Conduct an investigation to determine if removing or adding plants to an area increases or decreases erosion. *Ask: How does this impact other organisms in that environment?* (V) ● Summarize the processes that shape Earth's surface and describe evidence of those processes seen locally		

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	or nationally.		

FOURTH GRADE
ELECTRICITY AND HEAT
Physical Science Strand (PS)

Content Statements	Content Elaboration and Clarification	Resources from 2017-18 Update	Resources linked from LKWD 2012 Course of Study
Physical Science ✶ **Heat, electrical energy, light, sound and magnetic energy are forms of energy. (3-See "Important Note" under Strategies for Teaching and Learning.)** ● There are many different forms of energy. Energy is the ability to cause motion or create change. ● Note: The different forms of energy that are outlined at this grade level should be limited to familiar forms of energy that a student is able to observe. **Important Note:** ● The Physical Science Third Grade Content Statement "Heat, electrical energy, light, sound and magnetic energy are	**Forms of Energy (As Related to Electricity and Heat)** ● According to the American Association for the Advancement of Science (AAAS), at the simplest level, energy can be thought of as "something needed to make things go, run, or happen". ● Energy is present whenever there are moving objects, sound, light or heat. (F) ● The faster a given object is moving, the more energy it possesses. Energy can be moved from place to place by moving objects or through sound, light or electric currents. (Boundary: At this grade level, no attempt is made to give a precise or complete definition of energy.) (F) ● When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (F) (Taught at Fifth Grade) ● Light also transfers energy from place to place. For example, energy radiated from the sun is transferred to Earth by light. When this light is absorbed, it warms Earth's land, air and water and facilitates plant growth. (F) (Taught at Fifth Grade) ● Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy (e.g., moving water driving a spinning turbine which generates electric currents, etc.). (F) ● Identify different forms of energy including: ° Acoustic (i.e., sound) (Taught at Fifth Grade) ° Chemical (Taught at Middle School) ° Electrical ° Mechanical (Taught at Fifth Grade) ° Nuclear (Taught at Middle School)	Common Summative Assessments **RESOURCES:** DSCR-Electricity and Magnetism, Red, 8-Pack DSCR-Electricity and Magnetism, Purple, 8-Pack Big Bang Science Experiments-Hot Stuff (Rosen) Investigating Heat by Sally Walker (Lerner)	

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forms of energy" has been integrated with this Fourth Grade energy content. ● The Physical Science Fourth Grade Content Statement "The total amount of matter is conserved when it undergoes a change" was integrated with the Third Grade matter content. See the Matter unit at Third Grade. The content statement is reviewed in this unit.	° Radiant (e.g., light, solar, etc.) (Taught at Fifth Grade) ° Thermal (i.e., often referred to as "heat", but heat is really the transfer of thermal energy) ✶ **Examples of energy causing motion or creating change include a falling rock causing a crater to form on the ground, heating water causing water to change into a gas, light energy from the sun contributing to plant growth, electricity causing the blades of a fan to move, electrically charged objects causing movement in uncharged objects or other electrically charged objects, sound from a drum causing rice sitting on the drum to vibrate, and magnets causing other magnets and some metal objects to move.** ● Explore examples of energy causing motion or creating change that relate only to heat, electricity and magnetism. Examples related to sound, light and motion will be taught at fifth grade. ✶ **Investigations (3-D or virtual) must be used to demonstrate the relationship between different forms of energy and motion.** ✶ **Note 1: It is not appropriate at this grade to explore the different types of energy in depth or use wave terminology when discussing energy. These will be developed at later grades.** ✶ **Note 2: There often is confusion between the concepts of force and energy. Force can be thought of as a push or pull between two objects and energy as the property of an object that can cause change. If forces actually push or pull something over a distance, then there is an exchange of energy between the objects. The differences between force and energy will be developed over time and are not appropriate for this grade level.** ✶ **Note 3: The word "heat" is used loosely in everyday language, yet has a very specific scientific meaning. Usually what is called heat is actually "thermal or radiant energy." An object has thermal energy due to the random movement of the particles that make up the object. Radiant energy is that which is given off by objects through space (e.g., warmth from a fire, solar energy from the sun). "Heating" is used to describe the transfer of thermal or radiant energy to another object or place. Differentiating between these concepts is inappropriate at this grade. This document uses the same conventions as noted in the NAEP 2009 Science Framework (see page 29) where "heat" is used in lower grades. However, the word "heat" has been used with care so it refers to a *transfer* of thermal or radiant energy. The concept of thermal energy, as it relates to particle motion, is introduced in grade 6.**		
<u>Physical Science</u> ✶ **Energy can be transformed from one form to another or can be**	**<u>Heat</u>** ✶ **The addition of heat may increase the temperature of an object. The removal of heat may decrease the temperature of an object.** ● Temperature is defined as a measurement of the movement of particles in matter. (Enrichment, Taught at		**4th Houghton Mifflin DiscoveryWorks** - Unit C Matter, Energy, and Forces

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transferred from one location to another. (4) ● Energy transfers from hot objects to cold objects as heat, resulting in a temperature change. ● Electric circuits require a complete loop of conducting materials through which an electrical energy can be transferred. ● Electrical energy in circuits can be transformed to other forms of energy, including light, heat, sound and motion. ● Electricity and magnetism are closely related.	Middle School) ● Measure the temperature of a variety of materials either qualitatively (e.g., observing changes in matter that indicate temperature changes, feeling the temperature of objects or substances as long as safety has been taken under consideration, etc.) or quantitatively (e.g., using alcohol thermometers, digital thermometers, temperature probes, fever strips, etc.). ● Compare ways the temperature of an object can be raised (e.g., rubbing, burning, bending, cutting, heating, etc.). ● Explore and demonstrate how the removal of heat may decrease the temperature of an object (e.g., heat water on a hot plate and then turn off the hot plate and measure the decreasing temperature of the water, melt chocolate and then put the melted chocolate in a freezer, melt a popsicle and then re-freeze the liquid, etc.). ● Identify ways the temperature of an object can be changed (e.g., rubbing, heating, bending of metal, etc.). (V) ● Recognize that an increase in temperature indicates an increase in heat energy and a decrease in temperature indicates a decrease in heat energy. (V) ● Explain the relationship between heat and temperature. ● Investigate the transfer of heat energy. (V) ● Describe how a warmer object can warm a cooler one, by contact or at a distance, through the three methods of heat transfer (i.e., conduction, convection and radiation). ● Plan and implement an experiment to investigate the energy transfer between hot (but not hot enough to burn) and cold water. Formulate a conceptual model that can account for the trends observed in the results. (V) ● Summarize the way changes in temperature can be produced and thermal energy is transferred. ✶ **There are materials in which the entire object becomes hot when one part of the object is heated (e.g., in a metal pan, heat flows through the pan on the stove transferring the heat from the burner outside the pan to the food in the pan).** ● These materials are known as thermal conductors. ● Explain how some materials conduct heat much better than others do (e.g., metal versus wood, glass, water, etc.). ● Trace how thermal energy can transfer from one object to another by conduction. ✶ **There are other objects in which parts of the object remain cool even when another part of the object is heated (e.g., in a Styrofoam® cup, very little of the warmth from hot liquid inside the cup is transferred to the hand holding the cup).** ● These materials are known as thermal insulators.		**5th McGraw Hill** – Unit E Interactions of Matter and Energy; Chapters 10 and 11 **FOSS Kit:** Magnetism and Electricity (5th grade) **Bill Nye videos** – Electrical Current, Magnetism, Static Electricity, Heat, Energy **PreK-5 Common Share Materials** ● Science A-Z Materials – Pre-K-5 Common Share→ 4th Grade→ Science → Leveled Readers and Vocabulary Electricity and Magnetism leveled readers and vocabulary cards ● Additional Matter Materials - Pre-K-5 Common Share→ 4th Grade→ Science → Electricity

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	● Compare and contrast a variety of types of thermal insulators (e.g., plastic, wood, glass, rubber, air, Styrofoam®, etc.). ● Contrast thermal conductors and thermal insulators. (V) ● Research connections to everyday materials that have been designed and engineered using thermal conductors and insulators (e.g., picnic coolers, ovens, fireplaces, etc.). **Electricity** ● Important Note: At this grade level, electricity is only referred to as the "flow of energy" through materials. Therefore, it is not necessary to understand the parts of an atom, including protons, electrons and neutrons before learning about electricity. The study of electricity as the flow of electrons that can move from one atom to another by a change in energy is taught at middle school. ● Trace how electrical current travels by creating a simple electric circuit that will light a bulb. ● Pictorially represent ways to assemble the circuit and note which are able to light the bulbs and which are not. (V) ● Compare and contrast circuits that light the bulbs with circuits that do not light the bulbs. (V) ● Design and construct a switch that can turn a light on and off in a circuit. (V) ● Construct, diagram and label open and closed circuits (e.g., battery, bulb and wire, etc.) with and without switches. ● Analyze the differences between working and nonworking circuits and determine patterns and trends in the experimental evidence. (V) ✶ **Electrical conductors are materials through which electricity can flow easily. Electricity introduced to one part of the object spreads to other parts of the object (e.g., copper wire is an electrical conductor because electricity flows through the wires in a lamp from the outlet to the light bulb and back to the outlet).** ✶ **Electrical insulators are materials through which electricity cannot flow easily. Electricity introduced to one part of the object does not spread to other parts of the object (e.g., rubber surrounding a copper wire is an electrical insulator because electricity does not flow through the rubber to the hand holding it).** ✶ **Electrical conductivity must be explored through testing common materials to determine their conductive properties.** ● Identify solids and liquids or solutions that can be used as insulators or conductors. ● Contrast electrical conductors and electrical insulators. (V) ● Research connections to everyday materials that have been designed and engineered using electrical conductors and insulators (e.g., appliance cords have metal cores as electrical conductors but they are		**Instructional Websites:** http://teachers.egfi-k12.org/brown-bag-electricity/ http://www.eia.gov/kids/energy.cfm?page=activities_career_corner

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	wrapped in rubber or plastic insulators for safety, etc.). ● Distinguish between safe and unsafe practices when encountering or experimenting with heat and electrical energy in everyday life. ✶ **In order for electricity to flow through a circuit, there must be a complete loop through which the electricity can pass. When an electrical device (e.g., lamp, buzzer, motor) is not part of a complete loop, the device will not work. Electric circuits must be introduced in the laboratory by testing different combinations of electrical components.** ● Pictorially represent the flow of energy in a circuit in which a battery is used to light a bulb. (V) ● Outline the functions of the components of a simple electric circuit (e.g., conductor, insulator, energy source, light bulb, switch, etc.). (V) ● Recognize that a working circuit requires a continuous loop of electrical conductors. (V) ● Formulate a conceptual model of a working circuit based upon the trends in the experimental evidence. (V) ● Build a circuit that contains two light bulbs. (V) ● Construct, diagram and compare parallel and series circuits. ✶ **When an electrical device is a part of a complete loop, the electrical energy can be changed into light, sound, heat or magnetic energy. Electrical devices in a working circuit often get warmer.** ● Identify different types of energy conversions within an electrical circuit. (V) ● Design and construct simple electrical devices or models that illustrate how electrical current in a circuit can produce light, heat, sound, motion and/or magnetic forces (e.g., flashlights, motors, doorbells, models of filament light bulbs and sockets, models of fuses, electromagnets, etc.). ● Describe how objects gain static charges, i.e., static electricity (Enrichment). ✶ **When a magnet moves in relation to a coil of wire, electricity can flow through the coil. When a wire conducts electricity, the wire has magnetic properties and can push and/or pull magnets. The connections between electricity and magnetism must be explored in the laboratory through experimentation.** ● Investigate magnets to determine their unique properties. ● Design and construct an electromagnet. ● Explore everyday examples of devices that convert electrical energy into light, heat, sound, motion and/or magnetism (e.g., radios, toasters, lamps, computers, televisions, speakers that use electromagnets to move their coils, etc.). ● Trace how electrical energy flows through electrical devices and is transformed into other forms such as light, heat, sound, motion and/or magnetic forces. ● Recognize that energy can cause motion or create change. (V) ✶ **Note 1: Exploring heat transfer in terms of moving submicroscopic particles is not appropriate**		

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	at this grade. ✶ **Note 2: See Note 3 under "Forms of Energy" above.** ✶ **Note 3: Knowing the specifics of electromagnetism is not appropriate at this grade level. At this point, the connections between electricity and magnetism are kept strictly experiential and observational.** ✶ **Note 4: Energy transfer (between objects or places) should not be confused with energy transformation from one form of energy to another (e.g., electrical energy to light energy).**		
Physical Science ✶ **The total amount of matter is conserved when it undergoes a change. (4-See "Important Note" under Strategies for Teaching and Learning.)** ● When an object is broken into smaller pieces, when a solid is dissolved in a liquid or when matter changes state (solid, liquid, gas), the total amount of matter remains constant. ● Note 1: At this grade, the discussion of conservation of matter should be limited to a macroscopic, observable level. ● Note 2: States of matter are found in PS grade 3. Heating and cooling is one way to change the state of matter.	**Conservation of Matter (As Applied to Electricity and Heat)** ● The states of matter, phase changes of matter and conservation of matter were taught at third grade. The following content may be reviewed at fourth grade, focusing primarily on heat and its relationship to changes in temperature and matter. ✶ **Some properties of objects may stay the same even when other properties change. For example, water can change from a liquid to a solid, but the mass* of the water remains the same. Parts of an object or material may be assembled in different configurations, but the mass* remains the same. The sum of all parts in an object equals the mass* of the object.** ✶ **When a solid is dissolved in a liquid, the mass* of the mixture is equal to the sum of the masses* of the liquid and solid.** ● The phase of matter or temperature of a material can change with the addition or removal of heat. Examples of changes where some properties of materials may stay the same even when other properties change, related to the addition or removal heat, may include, but are not limited to: ° Bending, breaking, crumpling, cutting or tearing a substance (e.g., cutting or tearing or crumpling a piece of paper, breaking glass, etc.) ° Boiling a liquid into a gas ° Condensing a gas into a liquid ° Evaporating a liquid into a gas ° Freezing a liquid into a solid (e.g., freezing fruit juice into popsicles, etc.) ° Melting a solid into a liquid (e.g., melting butter, melting chocolate, etc.) ● Investigate changes that illustrate how energy and the total amount of matter are conserved in everyday situations. ● Recognize that the amount of matter stays constant during any change. (V) ✶ **At this grade level, the discussion of conservation of matter should be limited to a macroscopic, observable level. Conservation of matter must be developed from experimental evidence collected in the classroom.**		**4th Houghton Mifflin DiscoveryWorks** - Unit B Properties of Matter **5th McGraw Hill** – Unit E Interactions of Matter and Energy; Chapter 9 **DELTA Kit**: States of Matter **Bill Nye videos –** Chemical Reactions, Phases of Matter **Instructional Websites:** http://www.bbc.co.uk/bitesize/ks2/science/materials/keeping_warm/play/ http://sciencenetlinks.com/lessons/water-3-melting-and-freezing/

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	✶ **After the concept has been well established with experimental data and evidence, investigations can include interactions that are more complex where the mass* may not appear to stay constant (e.g., fizzing tablets in water).** ✶ **Note: Mass* is an additive property of objects and volume is usually an additive property for the same material at the same conditions. However, volume is not always an additive property, especially if different substances are involved. For example, mixing alcohol with water results in a volume that is significantly less than the sum of the volumes.**		

FOURTH GRADE
EARTH'S LIVING HISTORY
Life Science Strand (LS)

Content Statements	Content Elaboration and Clarification	Resources from 2017-18 Update	Resources linked from LKWD 2012 Course of Study
Life Science ✶ **Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful. (4)** ● Ecosystems can change gradually or dramatically. When the environment changes, some plants and animals survive and reproduce and others die or move to new locations. An animal's patterns of behavior are related to the environment. This includes	**Changes in an Environment** ✶ **Ecosystems are based on interrelationships among and between biotic and abiotic factors.** ● Plants and animals require resources from the environment. Animals depend on their surroundings to get what they need, including food, water, and shelter or cover from predators and weather or seasonal changes. Animals depend on plants or other animals for food. Plants depend on air, water, minerals from the soil and light to grow. Animals can move around, but plants cannot, so they often depend on animals for pollination or to move their seeds around. Different plants survive better in different settings because they have varied needs for water, minerals and sunlight. Plants and animals require basic resources as components of their habitats, including food, water, cover or shelter and space in a suitable arrangement, i.e., amount. The amount and distribution of these basic components will influence the types of organisms that can survive in an area. Organisms can survive only in environments in which their needs are met. ● Biotic resources are living materials obtained from the environment, including plants and animals and the organic materials that originate from them (e.g., fruits, nuts, paper, medicines, meat, clothing made from cotton or wool or other natural fibers, products made from wood, bread, etc.). Fossil fuels, such as coal and petroleum, are also included in this category because they are formed from decayed organic	Common Summative Assessments **RESOURCES:** Habitat Survival-Deserts (Capstone-Raintree Perspective) Habitat Survival-Grasslands (Capstone-Raintree Perspective)	**PreK-5 Common Share Materials** ● Videos and accompanying flipcharts (For entire unit standards) Pre-K-5 Common Share→ 4th Grade→ Science → Videos and Flipcharts

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the kinds and numbers of other organisms present, the availability of food and resources, and the physical attributes of the environment.	matter. ● For a resource to be classified as biotic, it had to have been considered a living thing at one point in time. Review characteristics that can identify a thing as living including: ° Ability to grow and change ° Ability to react to its environment ° Ability to reproduce ° Made up of cells (Taught at Middle School) ° Need for food or another source of energy ° Take in gases for respiration (e.g., breathing, etc.) ● Abiotic resources are nonliving, non-organic materials obtained from the environment. Examples of abiotic resources include land or soil, water, air, rocks and minerals, including ores such as gold, iron, copper, silver, etc. ● Ecosystems include all the living and nonliving things, biotic and abiotic resources, in an area where organism live. Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. Rainfall helps shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. Human activities affect Earth's systems and their interactions at its surface. (F) ● Biotic and abiotic factors in the environment interact and influence how organisms live in their communities (e.g., plants provide food and shelter for living things, animal wastes make soil richer, decomposing animals and plants add nutrients to soil, too many of one kind of animal can deplete plants in an area, non-native species can invade and take over an area, too little water causes poor growing conditions for some plants, humans impact air pollution by burning fuels, humans overuse pesticides and insecticides which can poison food sources of animals, humans destroy resources through land development and construction, etc.). ● Read a firsthand description, view drawings of Ohio ecosystems as first observed by explorers and compare the historical environmental descriptions to the current environment. Explain the changes that occurred in the biotic and abiotic components of the ecosystem. (V) ✶ **Ohio has experienced various weather patterns. Some parts of Ohio hosted glaciers and other parts of Ohio were submerged with water.** ● Earth has changed over time. Understanding how landforms develop, are weathered (broken down into	Habitat Survival-Oceans (Capstone-Raintree Perspective) Habitat Survival-Polar Regions (Capstone-Raintree Perspective) Animals Student Book Green Level: Classification, 6-Pack Fossilworks Fossil Molding Kit Go Facts-Flowers, 6-Pack Go Facts-Trees, 6-Pack Go Facts-Set 8, Classroom Set: 24 Student Books (6 Each of Mammals, Reptiles, Birds and Insects)	**Bill Nye videos –** Mammals, Amphibians

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	smaller pieces), and erode (get transported elsewhere) can help infer the history of the current landscape. Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. Patterns of tree rings and ice cores from glaciers can help reconstruct Earth's recent climate history. (F) ● Geologists have divided Earth's history into a series of time intervals. These time intervals are not equal in length like the hours in a day. Instead the time intervals are variable in length. Geologists refer to these intervals as the "geologic time scale" because time is divided using significant events in the history of Earth. These intervals are known, from largest to smallest, as eons, eras, periods and epochs. (Introduced, Taught at Middle School) ● The Ohio Department of Natural Resources, Division of Geological Survey provides "A Brief Summary of the Geologic History of Ohio" divided by geologic periods, from most recent to oldest: ° Quaternary - Two-thirds of Ohio was covered by mile-thick ice during glacial periods. ° Mesozoic and Tertiary - Ohio was above sea level and weathering, erosion and nondeposition (i.e., no deposition) prevailed. ° Permian - In early Permian time, southeastern Ohio was a coastal-plain swamp. Ohio lay about 5° north of the Equator. The swamp eventually was filled by an influx of sand and mud. Later Permian time was characterized by uplift and erosion. ° Pennsylvanian - Ohio in Pennsylvanian time was relatively flat coastal-plain swamp in equatorial latitudes. Fluctuations in sea level resulted in alternating terrestrial, freshwater and marine deposits. ° Mississippian - In latest Devonian and early Mississippian time, dark organic muds gave way to silts and sands. Ohio lay in equatorial latitudes. In late Mississippian time, a shallow sea deposited limy sediments. During latest Mississippian time, the seas retreated, leaving a sparse rock record. ° Devonian - Most of Ohio was dry land during early Devonian time, although the sea still covered eastern Ohio. Ohio was in equatorial latitudes. In Middle Devonian time, warm, shallow seas deposited limy sediments. Layers of muddy sediments and some volcanic ash in late Middle Devonian time signaled renewed volcanic activity and mountain building east of Ohio. In late Devonian time, the Ohio sea became stagnant; circulation was poor and the water was generally anoxic (i.e., lacking oxygen). Thick layers of black, organic-rich, uranium-bearing mud were deposited in these "stinking seas." ° Silurian - At the beginning of Silurian time, Ohio was dry land subject to erosion. Then warm shallow seas returned. Ohio lay 20° south of the Equator. Middle Silurian seas were deeper and covered Ohio; reef environments were common. Late Silurian seas were shallower and formed evaporite (i.e., salt-bearing) basins in northern Ohio.		

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	° Ordovician - A warm, shallow sea (deeper in eastern Ohio) similar to the Bahamas covered Ohio, which lay 20° south of the Equator. The western part of Ohio, at times, emerged as low, muddy islands. Limy sediments were dominant. Volcanic activity and mountain building to the east of Ohio produced periodic layers of ash over the entire state and muddy sediments in eastern Ohio. The sea deepened in later Ordovician time, covering all of the state. At the close of the Ordovician time, continental glaciation in the southern hemisphere lowered sea level and the seas retreated. ° Cambrian - Marine seas gradually flooded the Precambrian land surface and covered Ohio by late Cambrian time, initially depositing sands, then silts, muds and limy muds. Ohio lay 10° south of the Equator. Toward the end of Cambrian time, limy sediments accumulated in a shallow marine sea in an arid climate. ° Precambrian - Between 1.4 and 990 million years ago, volcanic activity, crustal rifting and filling of basins formed by rifting took place. Between 990 and 880 million years ago, a mountain range formed in eastern Ohio. Between 880 and 544 million years ago, these mountains were eroded, reducing the landscape to a gently rolling surface. ● Ohio generally has a mild climate, but also has a history of severe weather events (e.g., droughts, heat waves, flooding, tornadoes, blizzards, windstorms, etc.). ✶ **Ecosystems can change rapidly (e.g., volcanoes, earthquakes, or fire) or very slowly (e.g., climate change). Major changes over a short period of time can have a significant impact on the ecosystem and the populations of plants and animals living there. The changes that occur in the plant and animal populations can impact access to resources for the remaining organisms, which may result in migration or death.** ● Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well and some cannot survive at all. (F) ● When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment and some die. (F) ● Examples of major environmental changes that can have a significant impact on ecosystems may include, but are not limited to: ° Changes caused by human interactions (e.g., hunting or trapping, killing animals for profit or wildlife poaching, overpopulation, farming, housing/commercial land development or construction, overharvesting, destruction of habitat by human-caused forest fires, deforestation of temperate and rain forests, overdevelopment or urbanization, strip mining, production of acid rain caused by the burning of fossil fuels, overuse of insecticides and pesticides which poisons food chains, etc.).		

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	° Changes in temperature, weather or climate (e.g., blizzards, heat waves, seasonal changes, global warming, amount of rainfall, temperature fluctuations, etc.) ° Competition among species for resources (e.g., light availability, food availability, space, etc.) ° Introduction of non-native species or reintroduction of native species ° Natural disasters on a local or global scale, including weather catastrophes (e.g., forest fires, floods, tornadoes, droughts, volcanic eruptions, oil spills, hurricanes, earthquakes, tsunamis, etc.) ° Pollution of air, water and soil ● A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions, severe weather, floods, coastal erosion, etc.). Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (F) ● When major environmental changes occur, some plants and animals will adapt to the changes while others will die off or move to new locations (e.g., mosses are one of the first organisms to grow back after a forest fire or volcanic eruption, etc.). When an environment changes, the behavior patterns of living things may also change (e.g., overpopulation of deer often results in a lack of available food for the deer, which forces them to invade human space, such as people's gardens, to meet their basic needs, etc.). ● Compare and contrast how organisms, at a population or individual level, react to major environmental changes and their effects on ecosystems. ● Research a major geologic event (e.g., Mount St. Helens volcanic eruption, tsunami, etc.). Develop a timeline depicting the environment before the event, immediately after the event and in designated time intervals until a stable community is established (e.g., 30 or more years). (V) ● Describe the immediate consequences of rapid ecosystem change for organisms within an ecosystem and describe the consequences this change will have on an ecosystem a decade or more later (e.g., flooding, wind storms, snowfall, volcanic eruptions, etc.). (V) ● Explain how changes in the ecosystems of organisms may affect their survival which may, in turn, lead to their endangerment or extinction. ● Investigate various species that are threatened or endangered due to environmental changes and examine efforts to reestablish and support their populations (e.g., migration tracking, reintroduction of species to an area, zoos, etc.). ● Critique plans (written or oral) from different organizations to reintroduce a species into an Ohio environment. Write a newspaper article in support or against the reintroduction of the species based upon scientific facts. (V) ✶ **The fossil record provides evidence for changes in populations of species.** ● The Ohio Department of Natural Resources, Division of Geological Survey provides "A Brief Summary		**4th Houghton Mifflin DiscoveryWorks** - Unit E Weather and Climate pp. E88-89 **Bill Nye videos** – Archeology, Fossils **Instructional Websites:** http://evolution.berkeley.edu/ http://www.ucmp.berkeley.edu/education/explor

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	of the Geologic History of Ohio." The following summary provides a history of life forms according to the fossil record found in Ohio, from most recent to oldest, divided by geologic periods: ° Quaternary - many large mammals such as mastodons, mammoths, giant beavers and ground sloths, as well as modern plants and animals, including humans ° Mesozoic and Tertiary - no known record, but dinosaurs probably roamed Ohio during the Mesozoic period ° Permian - sparse freshwater fossils such as snails, clams, fish; marine fossils rare; sparse land fossils include plants, amphibians and reptiles ° Pennsylvanian - land plants abundant; terrestrial and freshwater life included amphibians, reptiles and freshwater clams; marine life included crinoids, snails, cephalopods, brachiopods and fish; trilobites rare ° Mississippian - brachiopods, clams, crinoids and fish; land plants increasingly abundant ° Devonian - coral reefs, bryozoans, brachiopods, trilobites, cephalopods, clams, crinoids and ostracodes; first major appearance of sharks and bony fish in Middle Devonian; true land plants appear ° Silurian - coral reefs abundant; also echinoderms, clams, brachiopods and cephalopods ° Ordovician - bryozoans abundant; cephalopods, trilobites, horn corals, snails, clams, echinoderms and graptolites ° Cambrian - marine life abundant, but few fossils known from Ohio because knowledge is limited to core samples; trilobites reached their peak diversity in the late Cambrian ° Precambrian - none known from Ohio; algae and lower invertebrates found in areas other than Ohio ✶ **Researching and investigating specific areas in Ohio (e.g., Cedar Bog, Lake Erie, Hocking Hills, Caesar Creek, Kelleys Island) via field studies, virtual field trips or other references must be used to explore the relationships between previous environments, changes that have occurred in the environments and the species that lived there.** ● Describe major changes in Ohio's environments over time and the organisms supported in each (e.g., oceanic, glacial, wetlands, forests, etc.). (V) ✶ **Note: Grade 4 ES focuses on changes to Earth's surface due to erosion, deposition of soil, rock sediment, flooding, volcanoes and earthquakes that can be taught along with this content.**		ations/tours/stories/middle/C3.html
Life Science ✶ **Fossils can be compared to one another and to present-day organisms**	**Fossils** ✶ **Fossils provide evidence that many plant and animal species are extinct and that many species have changed over time. The types of fossils that are present provide evidence about the nature of the environment at that time. As the environment changed so did the types of organisms that could**	Find-A-Fossil Kit w/Booklet Fossils Tell Stories	**4th Houghton Mifflin DiscoveryWorks** - Unit E Weather and Climate pp. E88-89

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according to their similarities and differences. (4) ● The concept of biodiversity is expanded to include different classification schemes based upon shared internal and external characteristics of organisms. ● Most types of organisms that have lived on Earth no longer exist. ● Fossils provide a point of comparison between the types of organisms that lived long ago and those existing today.	**survive in that environment.** ● A fossil is a preserved clue that provides evidence of life on Earth long ago. ● Fossils provide evidence about the types of organisms (both visible and microscopic) that lived long ago and also about the nature of their environments. Fossils can be compared with one another and to living organisms according to their similarities and differences. (F) ● Differentiate between the two principal fossil types: ° Body fossils are preserved remains of the bodies of plants and animals (e.g., bones, shells, leaf impressions, teeth, etc.). ° Trace fossils are preserved "traces" of animal activity and changes that long-dead animals made into their surroundings (e.g., tracks, burrows, droppings, worm holes, etc.). ● Fossils also can be categorized by how the organism was preserved. For example, a mold fossil is an imprint made by the external shape of a dead plant or animal. A mold fossil is formed when water slowly washes the remains of an organism out of rock and the space left behind in the rock layer outlines the shape of the once-living thing. A cast fossil is formed when an impression (i.e., a mold) fills with sediment or mineral materials and hardens into a replica of the original organism. A cast fossil has the same outside shape as the original living thing. ● Experiment with making fossils to determine some of the necessary (living and nonliving) conditions for making fossils and to determine if similar conditions exist today. Materials used should include clay, dough, sand, mud, etc. Conditions could include moist, wet and dry. Representations of living organisms used should include those with hard body parts (e.g., exoskeletons, bones, etc.) and those with soft body parts (e.g., plants, etc.). (V) ● Propose and test multiple ways that living things with soft body parts can leave fossil evidence. (V) ● Explore and observe how fossils provide evidence about organisms that lived long ago and the nature of their environments at that time. ● From observation of fossils in rock layers, infer the environmental conditions that existed when the fossils were formed (e.g., fish fossils would indicate a body of water existed at the time the fossils formed, etc.). (V) ● Most types of organisms that have lived on Earth no longer exist; they are extinct. For example, according to the Ohio Division of Wildlife: ° Extinct Ohio birds include the passenger pigeon and the Carolina parakeet. ° Extinct Ohio fish include the harelip sucker and the blue pike. ° Extinct Ohio mollusks include the leafshell, forkshell, round snuffbox, Cincinnati riffleshell and the Scioto pigtoe, which are all varieties of clams. ● According to the U.S. Fish and Wildlife Service, the Eastern Elk (mammal), longjaw cisco (fish), round	(Lerner)	**Bill Nye videos –** Archeology, Fossils **Instructional Websites:** http://evolution.berkeley.edu/ http://www.ucmp.berkeley.edu/education/explorations/tours/stories/middle/C3.html http://movies.nationalgeographic.com/movies/ http://www.ucmp.berkeley.edu/education/explorations/tours/intro/Introkto4b/tour1nav.php

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	combshell (mollusk-clam) and the Tennessee riffleshell (mollusk-clam) also may have lived in the Ohio area but are now extinct. ● Examples of extinct animals that resemble currently living plants and animals may include, but are not limited to: ° Aurochs bour similar to domestic cattle ° Blue pike/blue walleye similar to the northern pike/yellow walleye ° Dodo bird similar to the passenger pigeon or dove ° Ferns from the Triassic period similar to typical ferns in Ohio or other states ° Megalodon similar to the great white shark ° Quagga similar to the zebra ° Rugosa coral similar to brain coral ° Sphenopsids similar to Equisetum (also called horsetails, puzzle grass or snake grass) ° Woolly mammoth or mastodon similar to the elephant ● Using examples of extinct organisms, explain how organisms that are still alive today may resemble organisms that are no longer in existence. ● Identify evidence that can be used to determine the existence of an organism. (V) ✶ **The opportunity to learn about an increasing variety of living organisms, both the familiar and the exotic, should be provided. The observations and descriptions of organisms should be more precise in identifying similarities and differences based upon observed structures. Emphasis can still be on external features; however, finer detail than before should be included.** ✶ **Hand lenses and microscopes should be routinely used. Microscopes are used not to study cell structure but to begin exploring the world of organisms that cannot be seen by the unaided eye.** ✶ **Non-Linnaean classification systems should be developed that focus on gross anatomy, behavior patterns, habitats and other features.** ● Scientists have identified and classified many plants and animals. Populations of organisms live in a variety of habitats, and change in those habitats affects the organisms living there. Humans, like all other organisms, obtain living and nonliving things from their environments. (F) ● Taxonomy is the science of classifying organisms. Organisms were once classified into two categories, plants and animals. Scientists no longer classify this way. One system commonly used by taxonomists is called the Linnaean taxonomic system, in honor of the Swedish biologist, Carolus Linnaeus. The Linnaean system arranges organisms into seven major divisions, called taxa. These seven divisions are kingdom, phylum, class, order, family, genus and species. As scientists learn more about organisms, classification systems change. (Enrichment, Taught at Middle School) ● A general way to classify organisms is to use a classification scheme. A classification scheme is used to		

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	sort living things into groups according to their various features and to decide which living things belong to a particular group based on what they have in common. ● Organisms can be classified by their gross anatomy. Gross anatomy, also called macroscopic anatomy, includes the organs, body parts and structures of an organism that are visible to the naked eye. ● Create non-Linnaean classification systems, i.e., classification schemes, that classify fossils and/or living organisms according to, but not limited to: ° Behavioral patterns (e.g., organisms that migrate, hibernate, become dormant, etc.) ° Coverings (e.g., fur, feathers, scales, skin, etc.) ° General classification (i.e., reptiles, birds, amphibians, insects, mammals or fish) ° Habitats (e.g., land, water, etc.) ° Invertebrates or vertebrates ° Structures or appendages and their functions (e.g., leaves, roots, stems or trunks, thorns, arms, legs, heads, fins, horns, tails, talons, antennae, webbed feet, wings, etc.) ● Observe fossils and compare them to similar plants and animals that live today, using simple classification schemes. (V)		

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