Grade 4 Science-Technology-Engineering

Introduction: The diocesan Science-Technology-Engineering curriculum guidelines are adapted from the *Next Generation Science Standards* (NGSS) http://www.nextgenscience.org/ and are based on the *2016 MA Science & Technology/Engineering Framework* (MA STE) [available: http://www.doe.mass.edu/frameworks/current.html and in separate sections along with other resources at: http://www.doe.mass.edu/stem/review.html] These resources should be explored since they include a wealth of information beyond the standards. The diocesan guidelines use the same numbering system for the standards in order to facilitate searches for lessons and other resources. The order of the standards does not imply a recommended instructional sequence. "Common Core Connections" from NGSS are included for grades K-5 to suggest ways to include science in other subjects (and vice versa.) "Assessment boundaries" indicate what may be included on future MCAS tests and are included here since they frequently offer further clarification of the performance expectations at that level. "Not included from NGSS", "Clarification statements" and the set of standards themselves are not intended to be restrictive in any way. A standard followed by an asterisk "*" indicates an engineering design practice.

Grades 3–5: Overview of Science and Engineering Practices

Upper elementary is a critical time to engage students in the science and engineering practices. Students form key identities with, or against, science and engineering as they leave elementary school that can shape their relationship to science in later education, and even postsecondary and career choices later in life. Students must be given opportunities to develop the skills necessary for a meaningful progression of development in order to engage in the scientific and technical reasoning so critical to success in civic life, postsecondary education, and careers. Inclusion of science and engineering practices in standards only speaks to the types of performance students should be able to demonstrate at the end of instruction at a particular grade; the standards do not limit what educators and students should or can be engaged in through a well-rounded curriculum.

Standards for grades 3 through 5 integrate all eight science and engineering practices. Some examples of specific skills students should develop in these grades include:

1. Ask questions and predict outcomes about the changes in energy when objects collide; distinguish between scientific (testable) and non-scientific (non-testable) questions; define a simple design problem, including criteria for success and constraints on materials or time.
2. Use graphical representations to show differences in organisms' life cycles; develop a model of a wave to communicate wave features; use a particulate model of matter to explain phase changes; identify limitations of models; use a model to test cause and effect relationships.
3. Conduct an investigation to determine the nature of forces between magnets; make observations and collect data about the effects of mechanical weathering; conduct an experiment on mixing of substances; evaluate appropriate methods for collecting data; make predictions about what would happen if a variable changes.
4. Use graphs and tables of weather data to describe and predict typical weather during a season; analyze and interpret maps of Earth's physical features; use data to evaluate and refine design solutions.
5. Graph and describe the amounts and percentages of fresh and salt water in various reservoirs; measure and graph weights of substances before and after a chemical reaction.
6. Use evidence to explain how variations among individuals can provide advantages in survival and reproduction; provide evidence to explain the effect of multiple forces on the motion of an object; test and refine a simple system designed to filter impurities out of water.
7. Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction; distinguish among facts, reasoned judgment based on data, and speculation in an argument.
8. Obtain and summarize information about the climate of different regions; gather information on possible solutions to a given design problem; obtain information about renewable and nonrenewable energy sources.

While presented as distinct skill sets, the eight practices intentionally overlap and interconnect. Skills such as those outlined above should be reflected in curricula and instruction that engage students in an integrated use of the practices.

Grade 4 Focus - Matter and Energy: In grade 4, students observe and interpret patterns related to the transfer of matter and energy on Earth, in physical interactions, and in organisms. Students learn about energy—its motion, transfer, and conversion—in different physical contexts. Grade 4 students interpret patterns of change over time as related to the deposition and erosion in landscape formation. They study today's landscapes to provide evidence for past processes. Students learn that animals' internal and external structures support life, growth, behavior, and reproduction. They work through the engineering design process, focusing on developing solutions by building, testing, and redesigning prototypes to fit a specific purpose. Each domain relates to the use of matter and energy over time and for specific purposes.

Grade 4: Earth and Space Sciences

ESS1. Earth's Place in the Universe

Students who demonstrate understanding can:

4-ESS1-1. Use evidence from a given landscape that includes simple landforms and rock layers to support a claim about the role of erosion or deposition in the formation of the landscape over long periods of time.

Clarification Statements: Examples of evidence and claims could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from deposition on land to deposition in water over time; and a canyon with rock layers in the walls and a river in the bottom, indicating that a river eroded the rock over time. Examples of simple landforms can include valleys, hills, mountains, plains, and canyons. Focus should be on relative time.

Assessment Boundary: Specific details of the mechanisms of rock formation or specific rock formations and layers are not expected in state assessment.

***Common Core Connections: ELA/Literacy – W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS1-1) **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS1-1) **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS1-1) **Mathematics – MP.2** Reason abstractly and quantitatively. (4-ESS1-1) **MP.4** Model with mathematics. (4-ESS1-1) **4.MD.A.1** Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS1-1)*

ESS2. Earth's Systems

4-ESS2-1. Make observations and collect data to provide evidence that rocks, soils, and sediments are broken into smaller pieces through mechanical weathering and moved around through erosion.

Clarification Statements: Mechanical weathering processes can include frost wedging, abrasion, and tree root wedging. Erosion can include movement by blowing wind, flowing water, and moving ice.

Assessment Boundary: Chemical processes are not expected in state assessment.

4-ESS2-2. Analyze and interpret maps of Earth's mountain ranges, deep ocean trenches, volcanoes, and earthquake epicenters to describe patterns of these features and their locations relative to boundaries between continents and oceans.

***Common Core Connections: ELA/Literacy – RI.4.7** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. (4-ESS2-2) **W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS2-1) **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS2-1) **Mathematics – MP.2** Reason abstractly and quantitatively. (4-ESS2-1) **MP.4** Model with mathematics. (4-ESS2-1) **MP.5** Use appropriate tools strategically. (4-ESS2-1) **4.MD.A.1** Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. (4-ESS2-1) **4.MD.A.2** Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale. (4-ESS2-1),(4-ESS2-2)*

ESS3. Earth and Human Activity

4-ESS3-1. Obtain information to describe that energy and fuels humans use are derived from natural resources and that some energy and fuel sources are renewable and some are not.

Clarification Statements: Examples of renewable energy resources could include wind energy, water behind dams, tides, and sunlight. Non-renewable energy resources are fossil fuels and nuclear materials.

4-ESS3-2. Evaluate different solutions to reduce the impacts of a natural event such as an earthquake, blizzard, or flood on humans.*

Clarification Statement: Examples of solutions could include an earthquake-resistant building or a constructed wetland to mitigate flooding.

***Common Core Connections: ELA/Literacy – RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-ESS3-2) **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-ESS3-2) **W.4.7** Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-ESS3-1) **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-ESS3-1) **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-ESS3-1) **Mathematics – MP.2** Reason abstractly and quantitatively. (4-ESS3-1),(4-ESS3-2) **MP.4** Model with mathematics. (4-ESS3-1),(4-ESS3-2) **4.OA.A.1** Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS3-1),(4-ESS3-2)*

Grade 4: Life Science

LS1. From Molecules to Organisms: Structures and Processes

4-LS1-1. Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction.

Clarification Statements: Animal structures can include legs, wings, fins, feathers, trunks, claws, horns, antennae, eyes, ears, nose, heart, stomach, lung, brain, and skin. Plant structures can include leaves, roots, stems, bark, branches, flowers, fruit, and seeds.

Assessment Boundary: State assessment will be limited to macroscopic structures.

Not included from NGSS: 4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

***Common Core Connections: ELA/Literacy – W.4.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (4-LS1-1) **SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-LS1-2) **Mathematics – 4.G.A.3** Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded across the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. (4-LS1-1)*

Grade 4: Physical Science

PS3. Energy

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Assessment Boundaries: State assessment will be limited to analysis of kinetic energy. Accounting for mass, quantitative measures of changes in the speed of an object, or any precise or quantitative definition of energy is not expected in state assessment.

4-PS3-2. Make observations to show that energy can be transferred from place to place by sound, light, heat, and electric currents.

Clarification Statement: Evidence of energy being transferred can include vibrations felt a small distance from a source, a solar-powered toy that moves when placed in direct light, warming a metal object on one end and observing the other end getting warm, and a wire carrying electric energy from a battery to light a bulb.

Assessment Boundary: Quantitative measurements of energy are not expected in state assessment.

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Clarification Statement: Changes in energy can include a change in the object's motion, position, and the generation of heat and/or sound.

Assessment Boundary: Analysis of forces or quantitative measurements of energy are not expected in state assessment.

4-PS3-4. Apply scientific principles of energy and motion to test and refine a device that converts kinetic energy to electrical energy or uses stored energy to cause motion or produce light or sound.*

Clarification Statement: Sources of stored energy can include water in a bucket or a weight suspended at a height, and a battery.

***Common Core Connections: ELA/Literacy – RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS3-1) **RI.4.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. (4- PS3-1) **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1) **W.4.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (4-PS3-1) W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2),(4-PS3-3),(4-PS3-4) **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-1),(4-PS3-2),(4-PS3-3),(4-PS3-4) **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1) **Mathematics – 4.OA.A.3** Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (4-PS3-4)*

PS4. Waves and Their Applications in Technologies for Information Transfer

4-PS4-1. Develop a model of a simple mechanical wave (including sound) to communicate that waves (a) are regular patterns of motion along which energy travels and (b) can cause objects to move.

Clarification Statement: Examples of models could include diagrams, analogies, and physical models.

Assessment Boundary: Interference effects, electromagnetic waves, or non-periodic waves are not expected in state assessment.

4-PS4-2. Develop a model to describe that light must reflect off an object and enter the eye for the object to be seen.

Assessment Boundary: Specific colors reflected and seen, the cellular mechanisms of vision, angles of incidence and reflection, or how the retina works are not expected in state assessment.

4-PS4-3. Develop and compare multiple ways to transfer information through encoding, sending, receiving, and decoding a pattern.*

Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1s and 0s representing black and white to send information about a picture, and using Morse code to send text.

***Common Core Connections: ELA/Literacy – RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS4-3) **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS4-3) **SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-PS4-1),(4-PS4-2) **Mathematics – MP.4** Model with mathematics. (4-PS4-1),(4-PS4-2) **4.G.A.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-PS4-1),(4-PS4- 2)*

Grade 4: Technology/Engineering

ETS1. Engineering Design

4.3-5-ETS1-3. Plan and carry out tests of one or more design features of a given model or prototype in which variables are controlled and failure points are considered to identify which features need to be improved. Apply the results of tests to redesign a model or prototype.*

Clarification Statement: Examples of design features can include materials, size, shape, and weight.

4.3-5-ETS1-5(MA). Evaluate relevant design features that must be considered in building a model or prototype of a solution to a given design problem.*

*Found in grade 3: 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3.3-5-ETS1-4(MA). Gather information using various informational resources on possible solutions to a design problem. Present different representations of a design solution.**

Common Core Connections: ELA/Literacy –W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-3) **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-3) **W.5.9** Draw evidence from literary or informational texts to support

analysis, reflection, and research. (3-5-ETS1-3) **Mathematics – MP.2** Reason abstractly and quantitatively. (3-5-ETS1-3) MP.4 Model with mathematics. (3-5-ETS1-3) **MP.5** Use appropriate tools strategically. (3-5-ETS1-3)