Instructional Implications for Physical Science

To meet the goals of *Each Child, Our Future*, Ohio's strategic plan for education, schools and districts will find it essential to have appropriate local curricula supported by high-quality instructional materials. Science is part of providing well-rounded content for students, as well-rounded content is one of the four learning domains listed in the strategic plan.

Science is an essential subject for students in grades K-12. It is important to build a strong foundation in science in early elementary years so students are prepared for understanding more complex material in intermediate and middle grades. It is equally important to continue students' science instruction by offering more advanced courses at the high school level. This allows students to better compete for admission to college or other postsecondary programs, as well as jobs. Advanced science courses in high schools also help produce a more scientifically literate public.

This document outlines the most notable changes from the 2010 standards to the 2018 standards and offers insight into how teachers can best prepare their students using the revised content. **The document is merely an overview; it does not provide a comprehensive treatment of changes or take the place of the model curriculum or instructional resources.**

The document consists of tables containing three columns that show the 2010 standard, the 2018 standard and the implications of any significant shifts from 2010 to 2018. The document addresses only areas in which the focus of instruction has changed. Standards that say "No change to content focus" should continue to be taught with the same goals as the corresponding 2010 standards. For standards in which the instructional focus has shifted, only the changed content is included in the third column of the table. Portions of the standard unaffected by the changes may not appear here but should continue to be taught.

Educators should teach all content in the standards incorporating the science and engineering practices, and they should engage students in scientific thought processes. Where possible, instructors should use real-world data and both problem-based and project-based experiences. *Ohio's Cognitive Demands*, which Ohio initiated in the 2010 standards, are clarified in the 2018 standards, featuring additional *Visions into Practice* examples categorized by cognitive demand. These levels of knowledge relate to current understanding and research about the ways people learn, and they are important aspects of an overall understanding of science concepts. Educators should give their students opportunities to practice all four types of thinking. Please note, the *Visions into Practice* section of the Model Curriculum suggests ways to incorporate these levels into instruction, but the examples are not mandatory; they are simply ideas educators could implement or adapt to suit local curriculum.

Also, educators need to design lessons to incorporate the concepts described in the *Nature of Science* sections. The *Nature of Science* provides a way for increasing students' understanding of science as more than a body of knowledge about how the natural world works. It also is a process for gathering information and gaining deeper knowledge about the world. These concepts of science should not form a standalone unit or be additional course materials. They should be embedded in each area of the science classroom experience, including lessons, laboratory or field studies, and assessments.

2010 Content Statement	2018 Content Statement	Instructional implications of revisions
Study of Matter	**Study of Matter (PS.M)**	
Classification of matter Heterogeneous vs. homogeneous Properties of matter States of matter and its changes	**PS.M.1: Classification of matter** Heterogeneous vs. homogeneous Properties of matter States of matter and its changes	Content previously covered in grade 7 pertaining to pH has been moved to this standard. Discussions and experiments involving the determination of acids, bases and neutrals are pertinent to this standard. However, details of the pH scale and how it is determined by hydrogen and hydroxide concentrations will be covered in the chemistry course.
Atoms Models of the atom (components) Ions (cations and anions) Isotopes	**PS.M.2: Atoms** Models of the atom (components) Ions (cations and anions) Isotopes	An introduction to subatomic particles has been removed from the grade 7 physical science curriculum. This will be the first time students are introduced to this concept. Care must be given to present this material to students to ensure their understanding of the concepts, so they may build upon them when discussing ions and isotopes.
Periodic trends of the elements Periodic law Representative groups	**PS.M.3: Periodic trends of the elements** Periodic law Representative groups	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Bonding and compounds Bonding (ionic and covalent) Nomenclature	**PS.M.4: Bonding and compounds** Bonding (ionic and covalent) Nomenclature	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Reactions of matter Chemical reactions Nuclear reactions	**PS.M.5: Reactions of matter** Chemical reactions Nuclear reactions	Content about types of nuclear reactions and the use of nuclear reactions as an energy resource is now included in this content statement. This content previously had been covered in the chemistry course.
Energy and Waves	**Energy and Waves (PS.EW)**	
Conservation of energy Quantifying kinetic energy Quantifying gravitational potential energy Energy is relative	**PS.EW.1: Conservation of energy** Quantifying kinetic energy Quantifying gravitational potential energy	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Transfer and transformation of energy (including work)	**PS.EW.2: Transfer and transformation of energy** (including work)	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Waves Refraction, reflection, diffraction, absorption, superposition Radiant energy and the electromagnetic spectrum Doppler shift	**PS.EW.2: Transfer and transformation of energy** (including work)	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.

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Waves Refraction, reflection, diffraction, absorption, superposition Radiant energy and the electromagnetic spectrum Doppler shift	**PS.EW.3: Waves** Refraction, reflection, diffraction, absorption, superposition Radiant energy and the electromagnetic spectrum Doppler shift	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Thermal energy	**PS.EW.4: Thermal energy**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Electricity Movement of electrons Current Electric potential (voltage) Resistors and transfer of energy	**PS.EW.5: Electricity** Movement of electrons Current Electric potential (voltage) Resistors and transfer of energy	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Forces and Motion	**Forces and Motion (PS.FM)**	
Motion Introduction to one-dimensional vectors Displacement, velocity (constant, average and instantaneous) and acceleration Interpreting position vs. time and velocity vs. time graphs	**PS.FM.1: Motion** Introduction to one-dimensional vectors Displacement, velocity (constant, average and instantaneous) and acceleration Interpreting position vs. time and velocity vs. time graphs	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Forces Force diagrams Types of forces (gravity, friction, normal, tension) Field model for forces at a distance	**PS.FM.2: Forces** Force diagrams Types of forces (gravity, friction, normal, tension) Field model for forces at a distance	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Dynamics (how forces affect motion) Objects at rest Objects moving with constant velocity Accelerating objects	**PS.FM.3: Dynamics** (how forces affect motion) Objects at rest Objects moving with constant velocity Accelerating objects	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.

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Universe	**Universe (PS.U)**	
History of the universe	**PS.U.1: History of the universe**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Galaxy formation	**PS.U.2: Galaxies**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Stars Formation; stages of evolution Fusion in stars	**PS.U.3: Stars** Formation; stages of evolution Fusion in stars	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.