STATE EDUCATION DEPARTMENT / THE UNIVERSITY OF THE STATE OF NEW YORK / ALBANY, NY 12234

OFFICE OF CURRICULUM AND INSTRUCTION
Room 860 EBA
Phone: (518) 474-5922
E-mail: emscurric@nysed.gov; Web: www.nysed.gov/curriculum-instruction

Science High School Course Maps for Physical Science: Chemistry Courses that will Culminate in a Corresponding Regents Examination in Science

Revised 11/20/19 -See footnote for changes.

Background

The New York State P-12 Science Learning Standards are based on guiding documents (*A Framework for K-12 Science Education*[1] and the Next Generation Science Standards[2]) grounded in the most current research in science and scientific learning. They reflect the importance of every student's engagement with natural scientific phenomena at the nexus of three dimensions of learning: Science and Engineering Practices, Disciplinary Core Ideas, and Cross-Cutting Concepts. Performance expectations are the way to integrate the three dimensions guiding student sense-making of science as discussed in the New York State P-12 Science Learning Standards Introduction.

Development Process

The four high school science course maps have been developed by the Department to assist school districts in developing specific courses at the local level that align to the high school level (grades 9-12) performance expectations included in the New York State P-12 Science Learning Standards. Each science course map (Life Science: Biology; Earth and Space Sciences; Physical Science: Chemistry; and Physical Science: Physics), delineates specific performance expectations for courses that culminate in a corresponding Regents examination in science.

The course maps were developed using a four course model to similar what is included in the Next Generation Science Standards Appendix K, Table 7. The first step in mapping performance expectations to courses was to examine the Science and Engineering Practices, Cross-Cutting Concepts, and component idea level of the Disciplinary Core Ideas from the *A Framework for K-12 Science Education*. The course the associated performance expectations (as noted in the foundation boxes of the New York State P-12 Science Learning Standards) align was then decided. New York State subject area teacher experts provided input and feedback delineating the overlaps for each of the performance expectations for proposed high school science Regent's exam courses. The decisions were made through a careful reading of the grade-band endpoints for each component idea in the Framework and were reviewed by multiple committees made up of New York State teachers and administrators.

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[1]National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press.

[2] National Research Council. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

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Important Considerations

It is important to note the performance expectations do not dictate curriculum, which is locally decided by school districts; rather, they were coherently developed to allow flexibility in classroom instruction. The New York State P-12 Science Learning Standards performance expectations reflect what a student should know and be able to do—they do not dictate the manner or methods by which the performance expectations are taught. The performance expectations are written in a way that expresses the concepts and skills to be performed by students. For example: HS-ESS2-6. is listed in both Earth and Space Sciences and Life Science: Biology. For Life Science: Biology only the biochemistry aspects of carbon cycling are eligible for testing on the Life Science: Biology exam. The remainder of HS-ESS2-6 concepts are within the Earth and Space Sciences course.

Program choices, instructional decisions and pathways for students will vary across schools and school systems, and educators should make every effort to meet the needs of individual students, based on their local curriculum and instruction should consider the variety of student learning needs. The course maps presented are the guide for courses that culminate in a corresponding Regents examination in science. The options presented do not preclude the offering of other courses or sequences of instruction.

Order of Performance Expectations

The order in which the performance expectations are presented in the course maps is not the order in which the performance expectations need to be taught. As performance expectations from various domains are connected, educators will need to determine the best overall design and approach, as well as the instructional strategies needed to support their learners to attain course expectations and the knowledge articulated in the performance expectations. For the performance expectations that appear in more than one course, each map outlines the context regarding the intent or specific concepts appropriate for the course.

It is recognized that the course maps will have different numbers of performance expectations. The focus was on associating performance expectations with the high school courses where three-dimensional teaching and learning of the content was most appropriate. Educators are encouraged to instruct beyond performance expectations where appropriate. For more information regarding the New York State P-12 Science Learning Standards and connections that can be made with diverse learner populations, such as English Language Learners/Multilingual Learners and Students with Disabilities, refer to the New York State P-12 Science Learning Standards Introduction.

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Key Notes: Diagram 1 provides visual representation

1. In order to eliminate potential redundancy, seek an appropriate grain size, and seek natural connections among the Disciplinary Core Ideas (DCIs) identified within A Framework for K-12 Science Education. New York State arranged the performance expectations into topics.
2. Student performance expectations (PEs) may be taught in any sequence or grouping within a course.
3. The highlighted performance expectations are performance expectations that are unique to New York State.
4. An asterisk (*) indicates an engineering connection to a practice, core idea, or crosscutting concept.
5. The Clarification Statements are examples and additional guidance for the instructor. (NYSED) or a highlight indicates New York specific statement/wording.
6. The Assessment Boundaries delineate content limits of concepts that may be assessed in large-scale assessments.
7. Within the standards, the section entitled "foundation boxes" is reproduced verbatim from *A Framework for K-12 Science Education*: Practices, Crosscutting Concepts, and Core Ideas, except for statements that contain (NYSED). The material is integrated and reprinted with permission from the National Academy of Sciences.
8. Within the standards, Three Connection Boxes (not shown in the diagram), located below the Foundation Boxes, are designed to support a coherent vision of the standards by showing how the performance expectations in each standard connect to other PEs in science, as well as to Common Core State Standards. The three boxes include:
    - Connections to other DCIs in this grade level. This box contains the names of science topics in other disciplines that have related disciplinary core ideas at the same grade level. For example, both Physical Science and Life Science performance expectations contain core ideas related to Photosynthesis and could be taught in relation to one another.
    - Articulation of DCIs across grade levels. This box contains the names of other science topics that either 1) provide a foundation for student understanding of the core ideas in this set of performance expectations (usually at prior grade levels); or 2) build on the foundation provided by the core ideas in this set of PEs (usually at subsequent grade levels).
    - Connections to the New York State Next Generation Learning Standards. This box contains the coding and names of New York State Next Generation Mathematics Learning Standards (2017), and New York State Next Generation English Language Arts Learning Standards (Revised 2017) that align to the performance expectations. An effort has been made to ensure that the mathematical skills students need for science were taught in a previous year where possible.

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Diagram 1: The New York State P-12 Science Learning Standards

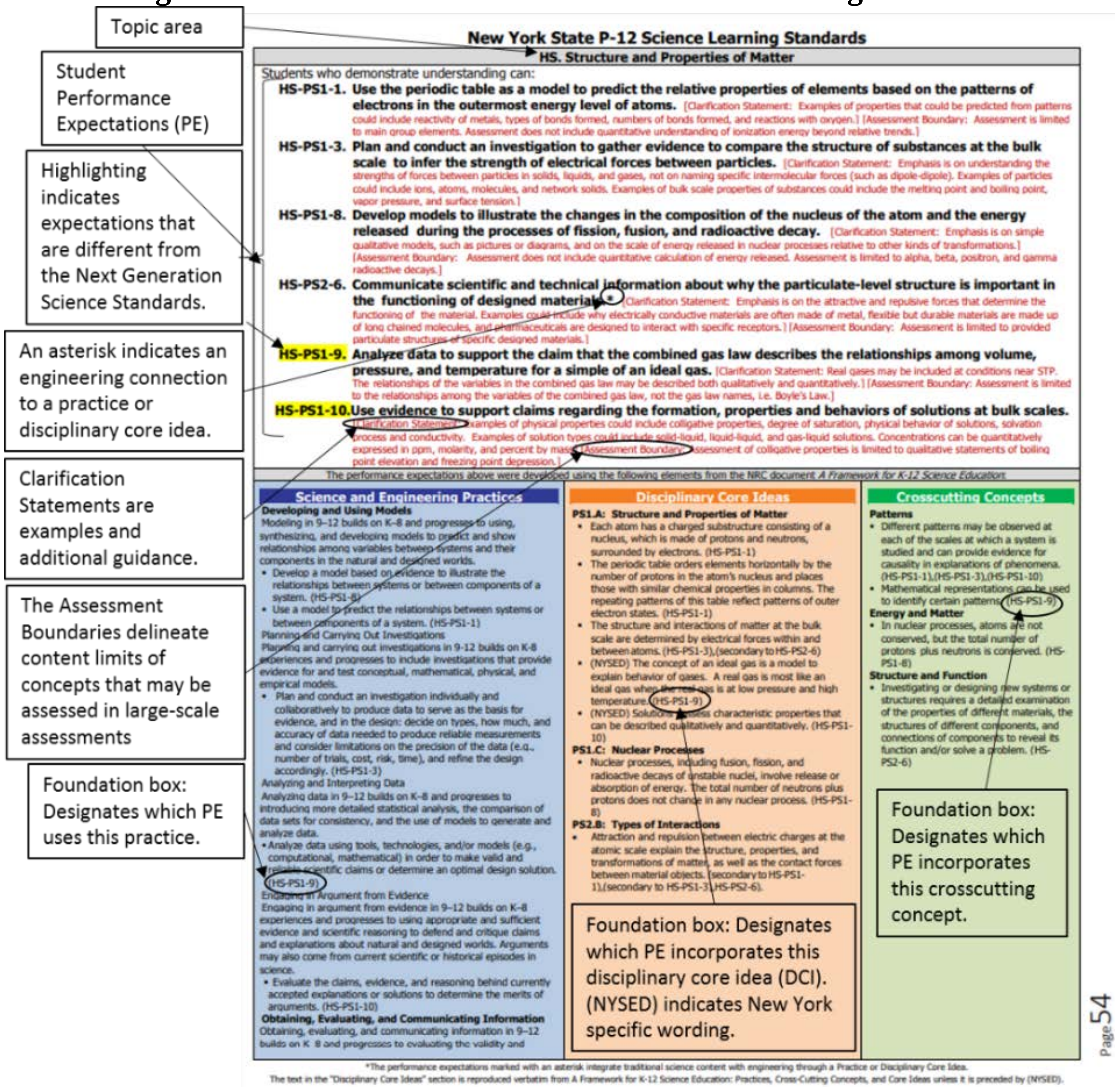

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Table I contains the recommended performance expectations for guiding curriculum, programming, and instruction within four high school science courses aligned to Regents examinations. Please note: no course sequences have been assumed in this model and the map does not preclude other performance expectations from being taught.

Example Course Map Information					
Topic	PE #	A Framework for K-12 Science Education: Scientific and Engineering Practices	A Framework for K-12 Science Education: Disciplinary Core Ideas	A Framework for K-12 Science Education: Crosscutting Concepts	For performance expectations that appear in more than one course the specific concepts for the performance expectation within this course are outlined.
Topic area the Performance expectation is categorized under.	Performance expectation number	Scientific and Engineering Practice that is a part of the Performance Expectation.	Disciplinary Core Idea that is a part of the Performance Expectation.	Crosscutting Concept that is a part of the Performance Expectation.	Information provided for ONLY performance expectations that appear in more than 1 high school course.

Table I

Physical Science: Chemistry -Instructional sequences are not assumed-					
Topic	PE #	K-12 Science Education Framework: Scientific and Engineering Practices	K-12 Science Education Framework: Disciplinary Core Ideas	K-12 Science Education Framework: Crosscutting Concepts	For performance expectations that appear in more than one course. The specific concepts for the performance expectation within this course are outlined.
HS. Structure and Properties of Matter	HS-PS1-1.	Developing and Using Models	PS1.A: Structure and Properties of Matter; PS2.B: Types of Interactions	Patterns	
HS. Structure and Properties of Matter	HS-PS1-3.	Planning and Carrying Out Investigations	PS1.A: Structure and Properties of Matter; PS2.B: Types of Interactions	Patterns	

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HS. Structure and Properties of Matter	HS-PS1-8.	Developing and Using Models	PS1.C: Nuclear Processes	Energy and Matter	Qualitative focus, understanding the conservation of mass and charge.
HS. Structure and Properties of Matter	HS-PS1-9.	Analyzing and Interpreting Data	PS1.A: Structure and Properties of Matter	Patterns	
HS. Structure and Properties of Matter	HS-PS1-10.	Engaging in Argument from Evidence	PS1.A: Structure and Properties of Matter	Patterns	
HS. Structure and Properties of Matter	HS-PS2-6.	Obtaining, Evaluating, and Communicating Information	PS2.B: Types of Interactions	Structure and Function	
HS. Chemical Reactions	HS-PS1-2.	Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter; PS1.B: Chemical Reactions	Patterns	
HS. Chemical Reactions	HS-PS1-4.	Developing and Using Models	PS1.A: Structure and Properties of Matter; PS1.B: Chemical Reactions	Energy and Matter	
HS. Chemical Reactions	HS-PS1-5.	Constructing Explanations and Designing Solutions	PS1.B: Chemical Reactions	Patterns	
HS. Chemical Reactions	HS-PS1-6.	Constructing Explanations and Designing Solutions	PS1.B: Chemical Reactions	Stability and Change	
HS. Chemical Reactions	HS-PS1-7.	Using Mathematics and Computational Thinking	PS1.B: Chemical Reactions	Energy and Matter; **Connections to Nature of Science** Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
HS. Chemical Reactions	HS-PS1-11.	Planning and Carrying Out Investigations	PS1.B: Chemical Reactions	Patterns	
HS. Chemical Reactions	HS-PS1-12.	Engaging in Argument from Evidence;	PS1.B: Chemical Reactions	Energy and Matter	

HS. Energy	HS-PS3-1.	Using Mathematics and Computational Thinking	PS3.B: Conservation of Energy and Energy Transfer; PS3.A: Definitions of Energy	Systems and Systems Models; **Connections to Nature of Science** Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Conservation of energy, thermal energy, endothermic and exothermic reactions.
HS. Energy	▫HS-PS3-5.	Developing and Using Models	PS3.C: Relationship between Energy and Forces	Cause and Effect	Atomic structure, interaction of subatomic particles, binding energy, bond formation, polarity, intermolecular forces, non-ideal gas behavior.
HS. Waves and Electromagnetic Radiation	HS-PS4-4.	Obtaining, Evaluating, and Communicating Information	PS4.B: Electromagnetic Radiation	Cause and Effect	
HS. Matter and Energy in Organisms and Ecosystems	HS-LS1-5.	Developing and Using Models	LS1.C*: Organization for Matter and Energy Flow in Organisms	Energy and Matter	Balancing chemical equations.
HS. Engineering Design	HS-ETS1-1.	Asking Questions and Defining Problems	ETS1.A: Defining and Delimiting Engineering Problems	**Connections to Engineering, Technology, and Applications of Science** Influence of Science, Engineering, and Technology on Society and the Natural World	
HS. Engineering Design	HS-ETS1-2.	Constructing Explanations and Designing Solutions	ETS1.C: Optimizing the Design Solution		
HS. Engineering Design	HS-ETS1-3.	Constructing Explanations and Designing Solutions	ETS1.B: Developing Possible Solutions	**Connections to Engineering, Technology, and Applications of Science** Influence of Science, Engineering, and Technology on Society and the Natural World	
HS. Engineering Design	HS-ETS1-4.	Using Mathematics and Computational Thinking	ETS1.B: Developing Possible Solutions	Systems and System Models	

▫Updated on 11/20/19 with the addition of HS-PS3-5.