

RULES AND REGULATIONS

Title 22—EDUCATION

STATE BOARD OF EDUCATION

[22 PA. CODE CH. 4]

Academic Standards and Assessment

The State Board of Education (Board) amends Chapter 4 (relating to academic standards and assessment) to read as set forth in Annex A. Notice of proposed rule-making was published at 51 Pa.B. 3103 (June 5, 2021).

Statutory Authority

The Board is acting under the authority of sections 2603-B and 2604-B of the Public School Code of 1949 (24 P.S. §§ 26-2603-B and 26-2604-B).

Purpose

Chapter 4 sets forth requirements for State academic standards, State assessments and high school graduation for public schools across this Commonwealth, including school districts, area career and technical schools (ACTS), charter schools and cyber charter schools. This final-form rulemaking replaces the Academic Standards for Science and Technology and Environment and Ecology, as set forth in the current Appendix B, with the updated standards in the new Appendix B-1 and establishes a timeframe for implementation of updated standards. This final-form rulemaking also makes technical amendments unrelated to academic standards to align other provisions of the Chapter with changes to the Public School Code of 1949 (24 P.S. §§ 1-101—27-2702) enacted by, the act of June 21, 2017 (P.L. 200, No. 6) (Act 6 of 2017), the act of October 24, 2018 (P.L. 1146, No. 158) (Act 158 of 2018), the act of June 28, 2019 (P.L. 117, No. 16) (Act 16 of 2019) and the act of October 30, 2019 (P.L. 460, No. 76) (Act 76 of 2019) and the act of November 25, 2020 (P.L. 1294, No. 136) (Act 136 of 2020).

Background

Businesses and industries involved in Science, Technology, Engineering and Mathematics (STEM) are growing in this Commonwealth, driving a demand for skilled and well-educated workers who are prepared to be successful in the 21st century economy. Data from the United States Bureau of Labor Statistics shows that STEM-related occupations have remained resilient during the economic crisis ignited by the novel coronavirus (COVID-19) pandemic. Employment projections from the United States Bureau of Labor Statistics further show that STEM occupations are projected to grow by 8% through 2029, with an annual mean salary of \$89,000. This is nearly parallel to the Pennsylvania Workforce Needs Assessment 2016—2026 that shows STEM jobs are predicted to grow at a rate of approximately 9% through 2026, and that there are more than 13,000 unfilled computer science and software development jobs. Scholars in this Commonwealth need to be equipped with the knowledge, skills and experiences that prepare them to enter into and be successful in the workforce.

To best prepare students for the STEM economy and the 21st century workforce, the Department of Education's (Department) work is guided by a vision for equity, innovation and openness. The Department strives to establish a culture for learning across this Commonwealth that ensures every student can be included in high quality science education. Pennsylvania's Integrated

Standards for Science, Environment, Ecology, Technology and Engineering (K—5), Pennsylvania's Integrated Standards for Science, Environment and Ecology (6—12) and Pennsylvania's Technology and Engineering Standards (6—12) were established on the following foundational principles:

- Every student is capable of science, engineering, technological and environmental literacy.
- Science, engineering, technology, environment and ecology should be explored through an integrated and active learning process.
- Iteration and reflection are a critical component of the learning process.
- Success depends upon the partnerships between educators, students, families, postsecondary providers and institutions, legislators, businesses and industries.

The process for reviewing and revising the State's current science and technology and environment and ecology standards, which were adopted in 2002, was guided by the Department's vision for learning and grounded in these core principles.

The Board, in September 2019, directed the Department to begin the process of updating this Commonwealth's current Academic Standards for Science and Technology and Academic Standards for Environment and Ecology. Since their adoption in 2002, cognitive science has improved the understanding of how students learn and revealed the requirement for students to have a deeper knowledge of a complex and rapidly changing world. The Commonwealth's science standards must reflect this growing body of research so every student has a rigorous, responsive and just vision for science learning, equipping them with the skills to be successful in career and citizenry.

To begin the review process, the Department, in collaboration with the American Institutes for Research, held 14 stakeholder engagement sessions across this Commonwealth from February 2020 through March 2020 to gather feedback on updating the Commonwealth's academic standards for science. The stakeholder sessions were held both in person and virtually. More than 951 members of the public provided input at these sessions, including elementary and secondary educators (35 educators from grades PreK—2, 77 educators from grades 3—5, 157 educators from grades 6—8, and 214 educators from grade 9—12), 164 school administrators, 27 intermediate unit staff, 88 postsecondary educators and 131 business and industry representatives. Stakeholder sessions also were attended by student teachers, representatives of community not-for-profit organizations, parents and students.

In addition to the stakeholder sessions, the Department surveyed stakeholders and further collected data from surveys that organizations, including the Pennsylvania Science Teachers Association, conducted. Stakeholder feedback was captured in a report, "Science and Technology & Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback," that summarized the current research and best practices regarding science, environment, ecology, technology and engineering standards. That report was presented to the Board at a public meeting in May 2020 and, at the same time, was made available to members of the public.

In April 2020, the Department solicited applications from interested members of the public to serve on committees to review and revise the State's science standards. Applicants were nominated to serve on committees through a multi-reviewer process on the basis of their depth and breadth of expertise in: curriculum and standards development, understanding of the existing standards and current research, equity and access in education and meeting needs of diverse learners and overall education experience. Recommendations for individuals to serve on the Science Standards Content Committee and Steering Committee were considered by the Board at a public meeting and the Board approved nominees to serve on the committees in May 2020.

In June and July of 2020, the committees met to review the initial stakeholder input gathered by the Department, as well as research-based frameworks and guidelines, such as the National Research Council's A Framework for K—12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012), the North American Association for Environmental Education's K—12 Environmental Education: Guidelines for Excellence (2019), the Ecological Society of America's Four-Dimensional Ecology Education framework (2018), the International Technology and Engineering Educators Association's Standards for Technological and Engineering Literacy (2020), the International Society for Technology in Education's Standards for Students (2019), the National Council for Agricultural Education Agriculture Food and Natural Resources Career Cluster Content Standards (2015), and other National and international frameworks. Committee members also reviewed relevant information from Pennsylvania-specific documents, such as the Commonwealth's existing Academic Standards for Science and Technology and Academic Standards for Environment and Ecology, to inform the development of recommended revised standards. Committee members collaborated to identify key content within those research-informed frameworks and other key National and international standards in science, environment, ecology, technology, engineering and agriculture. They sought to identify cross-content connections while adding sustainability, Pennsylvania Career Ready Skills, and other Pennsylvania-specific contexts.

Over 9 full-day convenings, committee members discussed the essential elements of academic standards. Attention to equity and access surfaced as foundational in the development of the standards recommendations. Equity in the context of the standards can be defined as a foundation of knowledge and skills critical for and accessible to all students, as well as "a characteristic of the instructional environment that increases the capacity for everyone to participate in meaningful learning" as described by Windschitl, Thompson and Braaten in their 2018 publication *Ambitious Science Teaching*. This begins with standards that are crafted to allow for the individual and personalized experiences, knowledge and skills students bring with them to the classroom.

Following recommendations from current research to ensure equitable opportunities exist for all students, committee conversations and research indicating how students learn best, committee members worked over a series of 30 additional meetings to draft recommendations for revised State science standards. Interspersed throughout the drafting process, a series of focus groups engaged students, educators and business and industry representatives to garner additional input and feedback on the committees' work. Special care was made to ensure representatives of small business, along with students and educators from diverse backgrounds, were included in

the focus groups. An invitation to provide input was extended to representatives of small businesses to satisfy a standard established in the Regulatory Review Act (RRA) (71 P.S. §§ 745.1—745.14) that requires agencies to solicit ideas and comments from small businesses and to examine the impact of a proposal on these businesses. The outgrowth of these efforts resulted in a set of recommended standards drafted with an attention to the committees' commitment to equity and inclusivity to open doors to STEM fields for all students. Therefore, these socially mediated practices embedded in the standards provide an equitable on-ramp for all students as they transition their developing and experience-based notions of the scientific world to conceptions that are scientifically-based.

The committees' recommendations for updated standards—reflected in the Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K—5), Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12), and the Pennsylvania Technology and Engineering Standards (Grades 6—12)—were developed in parallel to ensure consistency, coherence and a cohesive K—12 integrated approach to science education in this Commonwealth.

These recommendations for updated science standards were considered and adopted by the Board at a public meeting on September 9, 2020. Drafts of the proposed standards were posted to the Board's web site in advance of the meeting so that members of the public could access the content that was the subject of the Board's deliberations.

In addition to the substantive effort to update the State's academic standards for science, the Board identified a need to review Chapter 4 for consistency with recent changes enacted to the Public School Code of 1949. This review identified five acts of the General Assembly, enacted since the most recent promulgation of Chapter 4—Act 6 of 2017, Act 158 of 2018, Act 16 of 2019, Act 76 of 2019 and Act 136 of 2020—that either added new sections or amended existing sections of the Public School Code of 1949 and address existing subject matter in Chapter 4. To address inconsistencies between the Public School Code of 1949 and Chapter 4 resulting from these acts, the Board undertook an effort to integrate a comprehensive set of technical amendments into the proposed rulemaking to conform Chapter 4 with changes to statute and to create consistency for affected parties. Technical amendments adopted in the Board's proposed rulemaking are maintained in this final-form rulemaking.

Technical amendments were presented at the same time the Board considered substantive amendments to science standards to create efficiency in the rulemaking process. Technical amendments address provisions governing high school graduation requirements, Keystone Exams, compulsory school age and terminology updates. The Board identified a need to amend requirements related to Keystone Exams and high school graduation requirements to conform to changes enacted by Act 6 of 2017 that scaled back the number of Keystone Exams to be developed and established a new pathway to satisfy graduation requirements for eligible students pursuing career and technical education.

The Board further identified a need to amend requirements established in Chapter 4 related to Keystone Exams and high school graduation requirements to conform to changes enacted by Act 136 of 2020 and Act 158

of 2018. Act 158 of 2018 put in place broad changes to graduation requirements that were not in concert with the existing provisions of Chapter 4, including creating additional pathways to satisfy State graduation requirements, extending the effective date for the use of Keystone Exams as part of graduation determinations, modifying requirements for administering and participating in both supplemental instruction and project-based assessment, establishing new parameters for issuing waivers to students who do not meet State graduation requirements and establishing new reporting requirements related to how students graduate. Act 136 of 2020 further delayed the use of Keystone Exams as a graduation requirement to the 2022-2023 school year.

The breadth of amendments enacted in Act 6 of 2017, Act 158 of 2018 and Act 136 of 2020 necessitated updates to Chapter 4 to ensure that students, parents, educators and school administrators have a clear understanding of the State's expectations for high school graduation and that Chapter 4 does not conflict with these provisions.

In Act 76 of 2019, the General Assembly adopted comprehensive terminology updates to the Public School Code of 1949 to replace the term "vocational-technical education" with "career and technical education" and to replace the term "Area vocational technical school" with "Area career and technical school." The Board identified a need to update the same terminology used throughout Chapter 4 to be parallel with terminology now used in statute.

Finally, Act 16 of 2019 enacted changes to the Public School Code of 1949 that included reducing the compulsory school age from 8 years of age to 6 years of age. A review of Act 16 of 2019 identified a need to update an existing provision of Chapter 4 pertaining to primary education to reflect the lowering of the compulsory school age.

The Board's proposed rulemaking was published at 51 Pa.B. 3103 for a 30-day public comment period. The Board received and considered comments from educators, environmental organizations, legislators, the Department of Conservation and Natural Resources, county conservation districts, professional associations and the public, as well as comments from the Independent Regulatory Review Commission (IRRC). Commentators raised concerns about whether certain content relevant to environment, ecology and agriculture either was omitted or weakly linked in the proposed new academic standards. Other commentators asked the Board to consider refinements to content addressed elsewhere in the proposed new standards.

The Board's Committee on Academic Standards/Chapter 4—the Standing Committee of the Board delegated responsibility for preparing revised regulations for recommendation to the Board—met on September 8, 2021, to consider the next steps on the proposed rulemaking in response to public comment. To address stakeholder concerns specific to the content of the proposed new standards and to facilitate building consensus surrounding those concerns, the Academic Standards/Chapter 4 Committee determined that it would be prudent to seek additional input from content experts. As such, the Academic Standards/Chapter 4 Committee directed the Department to reconvene the Science Standards Content Committee and Steering Committee, designated through action of the Board in May 2020, to develop additional recommendations for the Committee's consideration. The Academic Standards/Chapter 4 Committee adopted a detailed charge to the Science Standards Content and

Steering Committees requesting that those external advisory bodies review and formulate recommendations on how, or whether, all academic content-related concerns raised by stakeholders should be addressed in the proposed new standards.

The Science Standards Content and Steering Committees met extensively throughout the fall of 2021 to consider and respond to the charge presented to them. On December 1, 2021, the Academic Standards/Chapter 4 Committee held a special meeting to receive recommendations from the Content and Steering Committees on stakeholder concerns related to the academic content of the new proposed standards. Those recommendations were presented in an open public meeting, made publicly accessible on the Board's web site and considered closely by the Board over the next few weeks.

On January 13, 2022, the Board adopted final-form amendments to Chapter 4 as recommended by the Academic Standards/Chapter 4 Committee and the Council of Basic Education. These final-form amendments update the new science standards to reflect the recommendations developed by the Board's appointed advisory bodies of content experts. In response to stakeholder concerns, the Board has made changes in this final-form rulemaking to include the addition of a new fifth domain for "Environmental Literacy and Sustainability," which was added to the standards across all grade levels. That new fifth domain incorporates essential principles of environmental education organized under the following three core ideas: 1) Agricultural and Environmental Systems and Resources; 2) Environmental Literacy Skills; and 3) Sustainability and Stewardship. This final-form rulemaking also makes additional clarifying amendments in response to comments submitted by IRRC.

Need for the rule

Academic standards define what students should know and be able to do at specific grade levels. They establish goals for student learning. Academic standards do not represent a particular curriculum or instructional methodology. Rather, they provide a foundation for the development of local curriculum and serve as guideposts to which local curriculum should be aligned.

As it pertains to the State's academic standards for science, this final-form rulemaking is necessary for three reasons.

First, it is essential to set forth the academic standards that will serve as the substantive underpinning for high-quality instruction and assessment in the Commonwealth. Therefore, the Board is adopting the Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K—5), Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12), and the Pennsylvania Technology and Engineering Standards (Grades 6—12) as set forth in Appendix B-1.

Second, this final-form rulemaking is necessary for this Commonwealth to remain academically and economically competitive with other American public education systems and economies, including those in neighboring states. As of the 2020-2021 school year, this Commonwealth's current Science and Technology and Environment and Ecology Standards were 18 years of age. Since 2013, science standards have been updated in 44 states across the country according to data compiled by the American Institutes for Research. This final-form rulemaking's updates to Pennsylvania's standards are designed to provide

every student in this Commonwealth with the knowledge and skills to be successful in the 21st century global economy.

Third, it is critical that the standards are inclusionary and accessible for all students and educators in this Commonwealth. The standards have been designed to integrate the knowledge and skills core to the science, technology, engineering, environment and ecology disciplines while making explicit connections with Math, Language Arts and the Pennsylvania Career Ready Skills framework. The standards lay the foundation for students to apply knowledge and skills from known situations to novel contexts. The integrative nature of the standards makes explicit connections for educators and breaks down artificially created content “silos” to inspire connected student learning, preparing them for the workforce.

This final-form rulemaking is necessary to further address inconsistencies between statute and existing provisions of Chapter 4 caused by changes enacted to the Public School Code of 1949 by the General Assembly. Incorporating a comprehensive set of technical amendments to conform Chapter 4 with changes in statute will create alignment across State-level education policies and create consistency for affected stakeholders in understanding expectations.

Provisions of this Final-Form Rulemaking

This final-form rulemaking amends the following provisions in Chapter 4:

§ 4.3. *Definitions*

The existing definition of “AVTS—Area vocational-technical school” is being replaced with a definition for “ACTS—Area career and technical school.” Within the definition, the term “vocational-technical education” is being updated to refer to “career and technical education.” These revisions reflect technical amendments to align the regulation with parallel terminology updates that were made globally throughout the Public School Code of 1949 by Act 76 of 2019. Technical amendments are incorporated throughout relevant sections of this final-form rulemaking to make existing references to AVTSs consistent with final amendments to this definition.

This final-form rulemaking deletes the existing definition for “Vocational-technical education” and replaces it with a new definition for “Career and Technical Education.” Changes are not proposed to the narrative description of the definition as it appears under the existing definition of “Vocational-technical education.” The final amendments only replace the term being defined with the more current language (“career and technical education”) that was incorporated throughout the Public School Code of 1949 by Act 76 of 2019. Technical amendments are incorporated throughout relevant sections of this final-form rulemaking to replace existing references to “vocational-technical education” with “career and technical education,” making language consistent with final revisions to this definition and consistent with terminology now used in statute. This includes updating the terminology used in the existing definitions of “Cooperative vocational-technical education,” “Employment area,” “School entity” and “School organization,” as well as deleting the existing definition of “Vocational-technical education.”

§ 4.4. *General policies*

Cross-references to § 4.51b(j) (relating to Keystone Exams) are deleted from § 4.4(e)(1) and (3) (relating to general policies). Language in the original cross-reference

set forth a schedule for the development of Keystone Exams in English Composition, Civics and Government, Geometry, United States History, Algebra II, Chemistry and World History. However, Act 6 of 2017 amended section 121(a) of the Public School Code of 1949 (24 P.S. § 1-121(a)) to delete the requirement for the Department to develop Keystone Exams in those subjects. Therefore, language in the existing § 4.51b(j) is deleted from this final-form rulemaking for consistency with changes enacted to the Public School Code of 1949 and, as such, cross-references to that existing subsection are deleted throughout § 4.4.

§ 4.11. *Purpose of public education*

In § 4.11(g)(3) and (4) (relating to purpose of public education), the Board aligns the existing references to academic content areas with the structure of the new science standards established in § 4.12(a)(1)(ii) and (2)(ii) and (iii) (relating to academic standards). These revisions are presented to create consistency with the substantive changes to the academic standards in § 4.12(a)(1)(ii) and (2)(ii) and (iii).

§ 4.12. *Academic standards*

Final amendments to § 4.12(a)(1)(i) and (ii) and (2)(i)—(iii) sunset the current Academic Standards in Science and Technology and Environment and Ecology (published in Chapter 4 as Appendix B) on June 30, 2025, and establish three new sets of academic standards in science that take effect July 1, 2025. New science standards, which will be published in Chapter 4 as Appendix B-1, are organized as follows: Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K—5), Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12), and Pennsylvania Technology and Engineering Standards (Grades 6—12).

In the Board’s proposed rulemaking, current standards were set to sunset on June 30, 2024, and new science standards were to take effect on July 1, 2024. Final amendments to these sections extend the effective date for transitioning to new academic standards to July 1, 2025, to maintain a commitment to providing a 3-year window for implementation. The effective date set forth in final amendments establishes an expectation that new science standards will be fully integrated into classroom instruction by the 2025-2026 school year. Final amendments to these sections also include a narrative description of each set of new academic standards.

In § 4.12(i), the Board amends the 3-year timeframe for reviewing State academic standards and State assessments established in this section. Final revisions set forth that these reviews be conducted no sooner than every 5 years and no later than every 10 years. Conducting academic standards reviews every 3 years may not provide school entities adequate time to fully implement updated academic standards and gain experience in delivering instruction under those standards before commencing a review process that may result in additional modifications to those standards. The Board finds a range of 5 years to 10 years between reviews to be a more feasible timeframe.

§ 4.21. *Elementary education: primary and intermediate levels*

The Board amends § 4.21(a) (relating to elementary education: primary and intermediate levels) to reflect a change to the compulsory school age enacted by Act 16 of 2019. Act 16 of 2019 reduced the age at which compulsory school attendance is required in this Commonwealth from

8 years of age to 6 years of age. Language in this section speaks to the age at which children ordinarily complete a primary school program and currently references 8 years of age. This language is amended to align with the statutory change that lowered the age for compulsory attendance to 6 years of age, the age at which students now are required to begin attending a primary school program.

Existing requirements in § 4.21(e) set forth that planned instruction at the primary level shall align with State academic standards. Changes to § 4.21(e)(3) and (4) are editorial for consistency with the structure of new academic standards for science established in § 4.12.

Likewise, amendments to § 4.21(f)(3) and (4) also are editorial to create consistency with the structure of new academic standards for science. These editorial changes conform planned instruction topics for intermediate grades, set forth in this section, with the structure of the Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K—5) established in § 4.12(a)(1)(ii).

§ 4.22. Middle level education

Revisions to § 4.22(c)(3) and (5) (relating to middle level education) conform the planned instruction topics for middle level education, set forth in these sections, with the structure of the Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K—5), Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12) and Pennsylvania Technology and Engineering Standards (Grades 6—12) established in § 4.12(a)(1)(ii) and (2)(ii) and (iii). These editorial changes create consistency with substantive changes in § 4.12.

§ 4.23. High school education

Revisions to § 4.23(c)(3) and (5) (relating to high school education) conform the planned instruction topics for high school set forth in these sections with the structure of the Pennsylvania Integrated Standards for Science, Environment and Ecology (6—12) and the Pennsylvania Technology and Engineering Standards (grades 6—12) established in § 4.12(a)(2)(ii) and (iii). These editorial changes create consistency with substantive changes in § 4.12.

§ 4.24. High school graduation requirements

In Act 6 of 2017, Act 158 of 2018 and Act 136 of 2020, the General Assembly enacted various changes to State high school graduation requirements. Act 6 of 2017 established new graduation requirements for students who are defined in statute as “CTE Concentrators.” The graduation pathway for CTE Concentrators and the definition of students who qualify to use this standard to meet graduation requirements are set forth in section 121(c) and (d) of the Public School Code of 1949.

Act 158 of 2018 expanded the pathways that may be used to demonstrate readiness for graduation for general education students who are not CTE Concentrators. Act 158 of 2018 also delayed the effective date for use of the high school-level State assessments—Keystone Exams—as a graduation requirement. Among other changes, Act 158 of 2018 further established that students cannot be required to participate in a project-based assessment to satisfy graduation requirements, set forth that students who do not demonstrate proficiency on a Keystone Exam may be offered supplemental instruction but shall not be required to participate in this supplemental instruction and permitted the inclusion of Keystone Exam performance results on student transcripts at the discretion of each school entity.

Act 136 of 2020 further delayed the use of Keystone Exams as a graduation requirement to the 2022-2023 school year.

The amendments enacted to the Public School Code of 1949 by Act 6 of 2017, Act 158 of 2018 and Act 136 of 2020 supersede high school graduation policies established by the Board in Chapter 4. To the extent that the aforementioned amendments are in conflict with the existing regulation, the Board is making technical amendments to conform related provisions of Chapter 4 with the changes enacted by Act 6 of 2017, Act 158 of 2018 and Act 136 of 2020 to provide clarity and consistency between statute and regulation.

§ 4.24(a). High school graduation requirements

Technical amendments to this section extend the date by which local governing boards must approve, publish and distribute graduation requirements to no later than the beginning of the 2020-2021 school year. The deadline for this action is extended for consistency with the date now set forth for this action in section 121(c.10) of the Public School Code of 1949.

§ 4.24(b). High school graduation requirements

In its comments on the Board’s proposed rulemaking, IRRC noted that § 4.24(b) (relating to high school graduation requirements) set forth high school graduation requirements through the 2015-2016 school year and subsection (c) set forth high school graduation requirements beginning in the 2022-2023 school year. IRRC noted that graduation requirements for the 2016-2017 through the 2021-2022 school years were not specified in the regulation and asked the Board to clarify this section to include the graduation requirements for the omitted years. In response to IRRC’s request for clarity, the Board amends subsection (b) to specify that the high school graduation requirements set forth in that section remain in effect through the 2021-2022 school year. Consistent with the date established in Act 136 of 2020, graduation requirements that include Keystone Exams will take effect in the 2022-2023 school year as reflected in amendments to subsection (c).

§ 4.24(c) and (c)(1). High school graduation requirements

Technical amendments to these sections delay the effective date of the sections to the 2022-2023 school year. These revisions create consistency with amendments to section 121(b)(1) of the Public School Code of 1949 that states “. . .the use of Keystone Exams as a graduation requirement or as a benchmark for the need for participation in a project-based assessment shall be delayed until the 2022-2023 school year.”

§ 4.24(c)(1)(iii). High school graduation requirements

Existing Board policy requires students to demonstrate proficiency in the current Academic Standards for Science and Technology and Environment and Ecology to satisfy State high school graduation requirements. In addition, Federal accountability policies require high school students to participate in a uniform State assessment in science and Pennsylvania’s Keystone Exam in Biology has been approved by the United States Department of Education to satisfy this requirement. Final amendments to § 4.12(a)(1)(ii) and (2)(ii) and (iii) and Appendix B-1 replace the existing science standards cited in this section with new academic standards. Therefore, it is necessary to identify relevant content of the new standards that will be assessed for the purposes of high school graduation and Federal accountability. Amendments to this section make clear that future determinations related to high

school graduation will be based on a student demonstrating proficiency in the new high school-level Science and Environment and Ecology standards presented in Appendix B-1.

Further, in its comments on the Board’s proposed rulemaking, IRRC noted that the new standards contained in Appendix B-1 will not take effect immediately. As such, IRRC requested that the Board add clarity to this section by specifying the respective effective dates when the current science standards in Appendix B will sunset and when the new standards in Appendix B-1 will take effect to ensure that the timetables for compliance are accurately stated. Final amendments to this section specify that, for the purposes of high school graduation, students must demonstrate proficiency in the standards in Appendix B through June 30, 2025, and that, beginning July 1, 2025, students must demonstrate proficiency in the Science, Environment and Ecology standards in Appendix B-1.

§ 4.24(c)(1)(iii)(A). *High school graduation requirements*

Technical amendments to this section recognize that students may meet graduation requirements by attaining proficiency on Keystone Exams or by satisfying requirements of one of the pathways to graduation established by the General Assembly in section 121(c) and (c.1) of the Public School Code of 1949. Technical amendments to this section further remove reference to completion of a project-based assessment as a measure of proficiency to satisfy graduation requirements. Removal of the reference to project-based assessment conforms the regulation with section 121(c.5) of the Public School Code of 1949 that sets forth in statute that school entities may not be required to offer project-based assessments and that students may not be required to participate in or complete project-based assessments as established in § 4.51c.

§ 4.24(c)(1)(iii)(B)(I). *High school graduation requirements*

Existing language in this section sets forth that validated local assessments used for the purpose of demonstrating graduation requirements must align with Biology-related content in current State academic standards. As the Board is updating the academic standards for science in this final-form rulemaking, revisions to this section identify the relevant new standards in § 4.12(a)(2)(ii) that contain Biology-related content for alignment with this section.

Further, in its comments on the Board’s proposed rulemaking, IRRC identified the need to make a clarifying amendment to § 4.24(c)(1)(iii)(B)(I) to delete the reference to “Civics and Government.” This reference is no longer necessary or relevant as Act 6 of 2017 deleted the requirement for the Department to establish Keystone Exams in the academic standards related to Civics and Government. As proficiency in standards related to Civics and Government no longer will be determined through State assessments, it is irrelevant to continue referencing Civics and Government in this section of Chapter 4 that defines how validated local assessments can be used as alternatives to Keystone Exams for the purposes of assessing proficiency for graduation in various academic standards.

§ 4.24(c)(1)(iii)(B)(III). *High school graduation requirements*

Existing subsections (d)—(f) are deleted in this final-form rulemaking, necessitating technical updates to the identification of the remaining subsections. As a result, existing subsection (g) is relabeled sequentially as subsection (d). Technical amendments presented in subsection

(c)(1)(iii)(B)(III) update the existing cross-reference to refer to the appropriate subsection as it has been relabeled due to amendments elsewhere in this final-form rulemaking.

§ 4.24(c)(1)(iii)(C). *High school graduation requirements*

The use of Advanced (AP) and International Baccalaureate (IB) exams for satisfying high school graduation requirements was addressed by the General Assembly in the graduation pathways established by Act 158 of 2018. Pathways that include consideration of AP and IB exam scores are reflected in section 121(c.1) of the Public School Code of 1949. Use of these assessments for making graduation determinations, as defined by the General Assembly, is captured in the statutory reference presented in amendments to subsection (c)(1)(iii)(A) of this final-form rulemaking. Therefore, the Board deletes subsection (c)(1)(iii)(C) as it does not align with statutory amendments regarding the use of AP and IB exam scores as they pertain to high school graduation determinations and a cross-reference to the appropriate use of these exams as defined in statute is incorporated elsewhere in this final-form rulemaking.

§ 4.24(d) and (e). *High school graduation requirements*

Act 6 of 2017 deleted language from statute directing the development of Keystone Exams in English Composition, Algebra II, Geometry, United States History, Chemistry, Civics and Government, and World History. Therefore, the Board deletes these sections from the regulation to conform to changes reflected in section 121(a) of the Public School Code of 1949 that eliminate Keystone Exams in these content areas. Further, existing language in subsections (d) and (e) provides for a student to demonstrate proficiency in academic standards in English Language Arts (Composition) and Civics and Government through a pathway including a Keystone Exam. This pathway is no longer feasible due to the elimination of Keystone Exams in these content areas by Act 6 of 2017 and, as such, the Board deletes the language from Chapter 4 in this final-form rulemaking.

§ 4.24(f). *High school graduation requirements*

In Act 6 of 2017, the General Assembly established graduation requirements for students pursuing Career and Technical Education that are in conflict with the requirements for these students presented in subsection (f). Amendments to the Public School Code of 1949 established a definition for “CTE Concentrator” to define the population of students eligible to graduate under the pathway for CTE Concentrators set forth in section 121(c) of the Public School Code of 1949. Graduation requirements for CTE Concentrators are captured in the statutory reference presented in amendments to subsection (c)(1)(iii)(A) of this final-form rulemaking. Therefore, the Board deletes subsection (f) as its requirements do not align with statutory amendments regarding graduation measures for students who are CTE Concentrators and a reference to the graduation pathway for these students, as defined by the General Assembly, is incorporated elsewhere in this final-form rulemaking.

§ 4.24(d). (former subsection (g)) *High school graduation requirements*

Due to the deletion of existing subsections (d)—(f), existing subsection (g) is being relabeled as subsection (d) to maintain sequential order of the remaining sections. Amendments to the designation for each section are carried through the end of § 4.24 to update the remaining subsections with appropriate sequential references due to the deletion of existing subsections (d)—(f).

§ 4.24(f). (former subsection (i)) *High school graduation requirements*

The Board amends requirements for student transcripts set forth in this section to align with requirements as established in section 121(c.9) of the Public School Code of 1949. Current language in this section of the regulation requires performance levels attained on Keystone Exams, validated local assessments or project-based assessments to be recorded on student transcripts. The current language is in conflict with changes enacted by Act 158 of 2018 to the aforementioned section of the Public School Code of 1949 that permit, but do not require, performance levels demonstrated in each of the State academic standards, including the highest performance level attained on a Keystone Exam, to be included on a student's transcript. The changes enacted by Act 158 of 2018 grant discretion to each individual school entity to determine whether to present this information on transcripts and how this information may be included.

§ 4.24(h). (former subsection (k)) *High school graduation requirements*

Act 158 of 2018 established section 121(c.4) of the Public School Code of 1949 governing supplemental instruction offered to students who do not demonstrate proficiency on a Keystone Exam or locally validated assessment. This statutory provision allows school entities to offer supplemental instruction but prohibits required participation by students in supplemental instruction. Statutory language governing supplemental instruction further requires that these offerings not intrude on time for participation in Career and Technical Education programming or instruction related to a student's career, military or postsecondary education plans. Existing requirements for supplemental instruction established in § 4.24(h) are in conflict with the changes enacted by Act 158 of 2018 as the language of the current regulation requires schools to offer supplemental instruction to students who do not demonstrate proficiency on a Keystone Exam or locally validated assessment and also requires students to participate in supplemental instruction. Therefore, the Board amends this section to align with changes in statute which set forth that students are not required to participate in supplemental instruction and that schools may, but are not required, to offer supplemental instruction.

§ 4.24(i). (former section 4.24(l)) *High school graduation requirements*

Amendments to this section make technical edits to reflect the deletion of the existing subsections (d) and (e) as previously described. Amendments further align this section with language that addresses student transfers from an out-of-State school in section 121(c.8) of the Public School Code of 1949. Language in the current regulation that directs determinations of proficiency for out-of-State transfer students to be made "subject to guidance developed by the Secretary" is deleted as a parallel requirement does not exist in the aforementioned statutory provision that addresses these determinations.

§ 4.24(m). *High school graduation requirements*

The Board deletes subsection (m) as the transitions facilitated under it are no longer relevant. As discussed previously, Act 6 of 2017 deleted language from the Public School Code of 1949 directing the Department to develop Keystone Exams in additional content areas beyond the exams already administered in Literature, Algebra I and Biology. Subsections (d) and (e) are deleted to conform with that change in statute. Therefore, language in this

section that addresses successfully effectuating transitions to the existing requirements of subsections (d) and (e) is no longer relevant as Keystone Exams will not be developed in the academic standards identified in those sections. Further, language that addresses transition between subsections (b) and (c) is no longer relevant as it addresses requirements for the 2015-2016 and 2016-2017 school years that did not take effect due to delays in the implementation of Keystone Exams as amended in section 121(b)(1) of the Public School Code of 1949.

§ 4.24(i). *High school graduation requirements*

The Board adds subsection (i) to conform this final-form rulemaking with section 121.1 of the Public School Code of 1949 (24 P.S. § 1-121.1). This technical amendment addresses conditions set forth in statute that suspend State requirements for students to take Keystone Exams in a year where the Federal government waives testing and accountability and requirements and, alternatively, provides for a student to be deemed proficient for the purposes of meeting the high school graduation requirements set forth in § 4.24 by demonstrating successful completion of locally-established, grade-based requirements for the academic content areas associated with each Keystone Exam. Final amendments to subsection (i) also reflect a clarifying amendment requested by IRRC to include a citation to the Every Student Succeeds Act (20 U.S.C.A. §§ 6301—7981) following cross-reference to the Elementary and Secondary Education Act.

§ 4.31. *Career and technical education*

As described in amendments to § 4.3 (relating to definitions), updated terminology replacing "vocational-technical education" with "career and technical education" is presented throughout § 4.31 (relating to career and technical education) and other relevant sections of this final-form rulemaking.

§ 4.31(a). *Career and technical education*

Amendments made previously in this final-form rulemaking reorganize § 4.24(g) as § 4.24(d). Section 4.31(a) includes a technical amendment to refer to the appropriate cross-reference as it is relabeled elsewhere in this final-form rulemaking to maintain sequential ordering.

§ 4.51. *State assessment system*

§ 4.51(a)(6). *State assessment system*

Section 4.51 (relating to State assessment system) sets forth the purpose of the State assessment system and identifies the academic standards through which student proficiency is measured on a State assessment. State assessments aligned with current standards for Science and Technology and Environment and Ecology are administered at three points in a student's educational career—grade 4, grade 8 and following completion of coursework in Biology. Final amendments to § 4.12(a)(1)(ii) and (2)(ii) and (iii) will replace the standards to which these State assessments (the Pennsylvania System of School Assessment in Science and the Keystone Exam in Biology) are aligned. As such, the Board is amending § 4.51(a)(6) to align State assessments administered in science with the new science standards established in Appendix B-1 of this final-form rulemaking.

Further, in its comments on the Board's proposed rulemaking, IRRC noted that the new standards contained in Appendix B-1 will not take effect immediately. As such, IRRC requested that the Board add clarity to this section by specifying the dates when State assessments will transition from being aligned to the current science standards in Appendix B to the new standards in

Appendix B-1 to ensure that the timetables for compliance are accurately stated. In response to IRRC’s request for clarity, final amendments to § 4.51(a)(6) specify that State assessments in science will be aligned to the standards in Appendix B through June 30, 2025, and that, beginning July 1, 2025, State assessments in science will be aligned to the standards in Appendix B-1. These timeframes are consistent with the effective date for full implementation of the new standards in Appendix B-1 established in § 4.12(a)(1)(ii) and (2)(ii) and (iii) and clarify that updated State assessments aligned with new academic standards will not occur until the end of the implementation period for fully integrating new standards into instruction.

§ 4.51a. *Pennsylvania System of School Assessment*

Section 4.51a (relating to Pennsylvania System of School Assessment) sets forth requirements for the Pennsylvania System of School Assessment (PSSA). The PSSAs are State assessments administered in English Language Arts and Mathematics in grades 3 through 8 and in Science in grades 4 and 8.

Subsection (a) directs the Department to develop PSSA exams that are “standards-based and criterion referenced” and delineates the standards in which PSSAs are administered, including the current Academic Standards in Science and Technology and Environment and Ecology. As previously noted, in this final-form rulemaking the Board adds new academic standards for science. Amendments to § 4.51a(a) align references to academic standards for science with the structure of the new science standards in Appendix B-1 of this final-form rulemaking.

Further, in its comments on the Board’s proposed rulemaking, IRRC noted that the new standards contained in Appendix B-1 will not take effect immediately. As such, IRRC requested that the Board add clarity to § 4.51a(b) by specifying the dates when the grade 4 and grade 8 PSSAs in Science will transition from being aligned to the current science standards in Appendix B to the new standards in Appendix B-1 to ensure that the timetables for compliance are accurately stated. In response to IRRC’s request for clarity, final amendments to § 4.51a(b) specify that PSSAs in science will be aligned to the standards in Appendix B through June 30, 2025, and that, beginning July 1, 2025, the PSSAs in science will be aligned to the new standards in Appendix B-1. These timeframes are consistent with the effective date for full implementation of the new standards in Appendix B-1 established in § 4.12(a)(1)(ii) and (2)(ii) and (iii) and clarify that updated PSSAs aligned with new academic standards will not occur until the end of the implementation period for fully integrating new standards into instruction.

Final amendments to § 4.51a(c) are presented for consistency with earlier technical amendments to align references to the current Academic Standards in Science and Technology and Environment and Ecology with the structure of the new standards in Appendix B-1.

§ 4.51b. *Keystone Exams*

Section 4.51b contains requirements for Keystone Exams. The Keystone Exams are high school level State assessments administered in Algebra I, Literature and Biology. At present, content on these State assessments is aligned to the academic standards for Mathematics, English Language Arts, Science and Technology, and Environment and Ecology.

The Board makes technical amendments to conform subsection (a)(1)—(4) with changes enacted by Act 6 of

2017. Act 6 of 2017 deleted language from section 121(a) of the Public School Code of 1949 that directed the Department to develop Keystone Exams in additional content areas beyond the existing exams for Literature, Algebra I and Biology. Therefore, provisions in subsection (a)(1)—(4) that direct the Department to develop Keystone Exams in Algebra II, Geometry, Composition, American History, World History, and Civics and Government are in conflict with changes to statute. Amendments to these sections delete language directing the development of Keystone Exams in content areas that no longer are included in statute and update language for grammatical consistency.

In addition, amendments to subsection (a)(3) (former subsection (a)(4)) provide for the Keystone Exam in Biology to be updated to align to the new Pennsylvania Integrated Standards for Science, Environment and Ecology (grades 6—12) contained in Appendix B-1 of this final-form rulemaking. In its comments on the Board’s proposed rulemaking, IRRC noted that the new standards contained in Appendix B-1 will not take effect immediately. As such, IRRC requested that the Board add clarity to subsection (a)(3) by specifying the dates when the Keystone Exam in Biology will transition from being aligned to the current science standards in Appendix B to the new standards in Appendix B-1 to ensure that the timetables for compliance are accurately stated.

In response to IRRC’s request for clarity, final amendments to subsection (a)(3) specify that the Keystone Exam in Biology will be aligned to the standards in Appendix B through June 30, 2025, and that, beginning July 1, 2025, the Keystone Exam in Biology will be aligned to the new standards in Appendix B-1. These timeframes are consistent with the effective date for full implementation of the new standards for grades 6—12 in Appendix B-1 established in § 4.12(a)(2)(ii) and (iii).

Later in subsection (d), the Board makes technical amendments to conform with changes enacted by Act 158 of 2018. Through the addition of section 121(c.4) to the Public School Code of 1949, Act 158 of 2018 prohibits the required participation of students in supplementary instruction, which is inconsistent with existing language in subsection (d) that creates conditions regarding eligibility to retake a Keystone Exam that require successful completion of supplementary instruction as a prerequisite. Act 158 of 2018 further addressed the matter of Keystone Exam retakes in the addition of section 121(c.7) to the Public School Code of 1949. Statutory language in section 121(c.7) permits a student to retake a Keystone Exam only if the student or parent submits a written request. Existing language in subsection (d) does not specify that requests to retake a Keystone Exam must be submitted in writing. Therefore, revisions are being made to subsection (d) to align language in the regulation with relevant changes enacted by Act 158 of 2018 that address supplementary instruction and Keystone Exam retakes.

In subsection (f), the Board makes technical amendments to conform with statutory changes enacted by Act 158 of 2018. As previously noted, Act 158 of 2018 prohibits required participation of students in supplemental instruction, as set forth in section 121(c.4)(5) of the Public School Code of 1949. Therefore, language regarding the provision of supplemental instruction in this section is being amended to replace the term “shall” with the term “may” to recognize that a student cannot be required to participate in supplemental instruction offerings.

Additional amendments to subsection (f) are made to conform with section 121(c.5) of the Public School Code of 1949 which establishes that no school entities may be required to offer project-based assessments and students may not be required to participate in or complete a project-based assessment. Existing language in subsection (f) is inconsistent with these statutory changes as it would require a student to complete a project-based assessment if other conditions established in this subsection are not met. Therefore, the Board deletes language requiring students to complete a project-based assessment in certain circumstances to align subsection (f) with provisions governing project-based assessment as they now are set forth by the General Assembly in statute.

A technical amendment to the statutory cross-reference in subsection (f) is also made in this final-form rule-making to make the citation complete.

Subsections (j) and (k) are deleted to conform with changes enacted by Act 6 of 2017 that eliminated language directing the Department to develop Keystone Exams in Algebra II, Geometry, composition, civics and government, world history, United States history and chemistry. These sections are no longer relevant as Keystone Exams in these content areas will not be developed.

The Board amends § 4.51b(j) (former § 4.51(b)(1)) to recognize that the Federal Elementary and Secondary Education Act has been reauthorized as the Every Student Succeeds Act (20 U.S.C.A. §§ 6301—7981) and that Keystone Exams will continue to serve as the approved high school level accountability system under the Elementary and Secondary Education Act or its successor Federal statute. As requested by IRRC, final amendments to this section remove reference to the No Child Left Behind Act and, for clarity, replace that with reference to its current successor Federal statute—the Every Student Succeeds Act.

The Board also amends § 4.51b(j) (former § 4.51(b)(1)) by deleting language that speaks to prospective approval of the Algebra I, Literature and Biology Keystone Exams by the United States Department of Education as this approval already has been granted. This section also includes a technical amendment updating the term “AVTSS” to “ACTS,” consistent with parallel terminology changes that are incorporated throughout the chapter.

Finally, the citation for § 4.51b(l), along with citations for § 4.51b(k)—(n), are relabeled to maintain sequential order of provisions due to the deletion of existing subsections 4.51b(j)—(k).

§ 4.51c. Project-based assessment

Amendments to § 4.51c (relating to project-based assessment) conform the section with changes enacted by Act 6 of 2017 and Act 158 of 2018 and with a technical revision requested by IRRC.

The Board deletes language in the existing § 4.51c(a) that directs project-based assessments to be developed in composition and civics and government that are aligned to the modules of the Keystone Exams. Act 6 of 2017 eliminated the development of Keystone Exams in composition and civics and government. Thus, developing project-based assessments in those content areas is no longer relevant as there will be no Keystone Exam modules in those content areas to which a project-based assessment could be aligned.

The Board adds a reference to section 121(c.5) of the Public School Code of 1949 that governs participation in

project-based assessment for clarity in the permissible use of project-based assessment by school entities and alignment with statutory changes that do not require districts to administer project-based assessment and that prohibit the required participation of students in project-based assessment.

The Board deletes § 4.51c(b)—(g) to further conform the regulation with section 121(c.5) of the Public School Code of 1949. Language in these subsections sets forth requirements for the administration of project-based assessment and establishes criteria that may make a student eligible to participate in a project-based assessment, which is in conflict with section 121(c.5) of the Public School Code that does not require school entities to offer project-based assessments and prohibits required participation of students in project-based assessments.

Finally, as directed by IRRC, the Board deletes the subsection “(a)” designation from § 4.51c in accordance with § 2.1(e) (relating to arrangement of *Code*) of the *Pennsylvania Code and Bulletin Style Manual*.

§ 4.51d. Waivers

Act 158 of 2018 added section 121(c.3) to the Public School Code of 1949 that addresses the circumstances in which chief school administrators may grant waivers to demonstrations of proficiency required for high school graduation. Waiver provisions established in § 4.51d, including those related to the percentage of students who may qualify to receive a waiver, are inconsistent with the waiver requirements now established in statute. As such, the Board deletes language in § 4.51d(1)(i)—(iv) and (2) to create clarity surrounding waiver requirements by replacing this language with a reference to the waiver requirements established by the General Assembly in section 121(c.3) of the Public School Code of 1949.

The citation for existing § 4.51d(3) is reorganized as § 4.51d(1) to align with the deletion of the subsections preceding it. Within that section, the Board is incorporating an additional technical amendment to ensure annual reporting on the number of waivers issued to students is conducted in a manner consistent with the reporting requirements for waivers set forth in section 121(c.11)(6) of the Public School Code of 1949.

The Board also deletes § 4.51d(6) as it refers to action that would occur under § 4.51d(2) and this final-form rulemaking deletes paragraph (2).

Finally, within § 4.51d, as well as within §§ 4.24, 4.51b and 4.51c, the Board makes technical corrections to the *Purdon’s* citations to sections 121 and 121.1 of the Public School Code of 1949 as directed by IRRC. Throughout those sections, the citations are corrected to include the “1-” formatting that was omitted from each citation.

Appendix B-1. In this final-form rulemaking the Board publishes Appendix B-1 as a new Appendix. Appendix B-1 contains three sets of new academic standards for science as follows: Pennsylvania Integrated Standards for Science, Environment, Ecology, Environment and Engineering (Grades K—5); Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12); and Pennsylvania Technology and Engineering Standards (Grades 6—12).

As described previously, final amendments to § 4.12(a)(1)(ii) and (2)(ii) and (iii) set forth a July 1, 2025, effective date for the new standards in Appendix B-1. Final amendments to § 4.12(a)(1)(i) and (2)(i) address the current science standards published in Appendix B and set forth that those standards will no longer be in effect as of June 30, 2025.

The State's current Academic Standards for Science and Technology and Academic Standards for Environment and Ecology, adopted in 2002 and published as Appendix B within Chapter 4, were organized by topics of what students should know and be able to do by the end of fourth, seventh, tenth and eleventh grades. The new standards contained in Appendix B-1 of this final-form rulemaking reflect a shift to grade level expectations for kindergarten through fifth grade, allowing for clear learning progressions by grade in elementary school, and reflect a shift to grade bands for 6—8 and 9—12 allowing for greater flexibility in course design and progression at the middle and high school levels.

The current Academic Standards for Science and Technology and Academic Standards for Environment and Ecology, adopted in 2002, also were organized into two separate sets of standards. As they pertain to the earliest grades, the new standards presented in Appendix B-1 of this final-form rulemaking reflect integration of Environment, Ecology, Science, Technology and Engineering education for kindergarten through fifth grade. The integration of Science, Environment, Ecology, Technology and Engineering into one document for kindergarten through fifth grades systemically ensures equity of the content covered at these early grades and enables educators to expose students to the interconnected nature of Science, Environment, Ecology, Technology and Engineering at the earliest grades. Further, the integration of Science, Environment, Ecology, Technology and Engineering, along with their application, reflects how these disciplines are practiced in the real world.

The standards contained in Appendix B-1 of this final-form rulemaking also reflect a shift to the integration of Science with Environment and Ecology for grades 6—12, encouraging integration across the Science disciplines while promoting equity by ensuring the Environment and Ecology content is included in Science instruction for all students across all grades.

Finally, the State's current Academic Standards for Science and Technology and Academic Standards for Environment and Ecology, adopted in 2002, were organized into two separate sets of standards documents with Technology and Engineering integrated across each set of standards. The standards presented in Appendix B-1 of this final-form rulemaking separate Technology and Engineering standards from the Science, Environment and Ecology standards for grades 6—12. The Board determined to present Technology and Engineering standards for grades 6—12 as a standalone document to provide the necessary content depth and breadth for related courses and experiences in middle and high school programs. Further, organizing these standards by grade bands provides flexibility for school districts in high school course offerings that sometimes include mixed grade levels in a course.

The new standards presented in this final-form rulemaking are informed by seminal research in science, technology, environment and ecology education, such as the National Research Council's *A Framework for K—12 Science Education, Standards for Technology and Engineering Literacy* and the Environment and Ecology framework of the North American Association for Environmental Education. In addition, this final-form rulemaking considers the Commonwealth's context with clear connections to agriculture, career readiness and sustainability. This final-form rulemaking shifts away from a focus on the regurgitation of disciplinary content to a multi-dimensional approach for teaching and learning that

includes cross-content connections such as the understanding of "scale, proportion, and quantity" and "systems and system models," disciplinary core ideas such as "physical sciences" or "life sciences," and practices like "developing and using models" or "analyzing and interpreting data." This final-form rulemaking sets the conditions for students to work and learn across these multiple dimensions by better preparing students to apply skills and concepts in a novel context and demonstrating knowledge and skills gained through the learning experiences.

Within the previously described framework, the Board made numerous amendments to the standards in this final-form rulemaking in response to concerns raised by stakeholders during public comment.

To ensure that new academic standards reflect essential principles of environmental education, as suggested by stakeholders, the Board adds a new fifth domain for "Environmental Literacy and Sustainability" to the Pennsylvania Integrated Standards for Science, Environment, Ecology, Environment and Engineering (Grades K—5) and to the Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12). This fifth domain incorporates essential principles of environmental education across all grade levels organized under three core ideas: 1) Agricultural and Environmental Systems and Resources; 2) Environmental Literacy Skills; and 3) Sustainability and Stewardship. The addition of this fifth domain is responsive to stakeholder concerns indicating that certain content related to environment, ecology and agriculture either was omitted or weakly linked in the Board's proposed standards, and also is responsive to the Pennsylvania Environmental Education Act's charge to fully integrate environmental education into K—12 education.

Content in this new fifth domain was developed using standards and guidelines from relevant professional organizations, including the National Council for Agriculture, Food, and Natural Resources and North American Association of Environmental Educators, as well as Pennsylvania's current Environment and Ecology standards, environmental education research, and examples of how other states address environmental literacy and sustainability (including California, Louisiana, Maryland, Virginia, Washington and Wisconsin).

The Pennsylvania Integrated Standards for Science, Environment, Ecology Environment and Engineering (Grades K—5) presented in the Board's proposed rulemaking included grade band standards for "Environment and Ecology" for grades K—2 and for grades 3—5. The proposed K—2 and 3—5 grade band standards for "Environment and Ecology" each are reorganized in this final-form rulemaking under a new domain for "Environmental Literacy and Sustainability" for consistency with how this domain is presented in standards across all grade levels. In addition, content in the proposed K—2 grade band and in the proposed 3—5 grade band for "Environment and Ecology" also is revised in response to this reorganization to reflect content that stakeholders identified as weakly linked or omitted in the proposed standards, to reduce redundancy, to ensure standards are placed where they are developmentally appropriate for students, and to respond to stakeholder concerns that the proposed standards were not written using three-dimensional language.

The Board deletes a proposed K—2 standard that directed students to "examine and express their own view on environmental issues" in this final-form rulemaking. The standard was determined to be unnecessary as the overarching intent of the new fifth domain for "Environ-

mental Literacy and Sustainability” is to provide instruction for students in environmental literacy. As such, the ability to examine and express their own views on environmental issues is a skill students will develop through instruction provided in other related standards and it is unnecessary to include this as a standalone standard.

The Board deletes a proposed standard in the K—2 grade band for “Environment and Ecology—Decision-Making and Action Skills” that expected students to “determine whether action is needed on selected environmental issues and whether they should be involved” because it was determined to be more developmentally appropriate for students in grades 3—5. In the final-form amendments to Appendix B-1, the standard is rewritten and is now reflected in the Grade 3—5 standards for “Environmental Literacy and Sustainability” under the core idea for “Sustainability and Stewardship.” As amended, this Grade 3—5 band standard reads as follows, “Construct an argument to support whether action is needed on a selected environmental issue and propose possible solutions.”

A proposed standard in the K—2 grade band for “Environment and Ecology—Decision-Making and Action Skills” that expected students to “develop an action strategy or design a solution for a specific local environmental issue of their choosing” was determined to be redundant with another proposed K—2 standard. As such, the Board deletes it from the final-form amendments to the standards in Appendix B-1.

A proposed standard in the K—2 grade band for “Environment and Ecology—Decision-Making and Action Skills” that expected students to “identify environmental and social consequences of design solutions and civic actions, including their own actions” is rewritten in three-dimensional language as requested by stakeholders. As such, the Board deletes the proposed standard from this final-form rulemaking and replaces and reorganizes with a rewritten standard in the new grades 3—5 domain for “Environmental Literacy and Sustainability.” The rewritten standard is included under the core idea for “Agricultural and Environmental Systems and Resources” as follows, “Make a claim about the environmental and social impacts of design solutions and civic actions, including their own actions.”

The previously referenced new standard for grades 3—5 further reflects the combination of standards that were included in the Board’s proposed rulemaking for the 3—5 grade band. Standards in the proposed rulemaking for “Environment and Ecology—Decision Making and Action Skills,” expected students in grades 3—5 to, “Identify, justify, and clarify their views on environmental issues and alternative ways to address them” and to “Evaluate whether action is needed in specific solutions, using environmental, cultural/social, and economic criteria. They decide whether they should be involved in that action.” A standard in the proposed rulemaking for grades 3—5 in “Environment and Ecology—Personal and Civic Responsibility” expected students to, “Describe the broad environmental, social, and economic consequences of their personal and group actions and, as appropriate, accept responsibility for their actions.” Finally, a standard in the proposed rulemaking for grades 3—5 in “Environment and Ecology—Human Systems” expected students to, “Describe how economic systems and economic decision-making influence natural resource use and management as well as environmental and human well-being.” In this final-form rulemaking, the Board combines and amends

these standards to use three-dimensional language as requested by stakeholders and to strengthen connections to the new “Environmental Literacy and Sustainability” standards for grades 6—12. Concepts included in those proposed standards are reflected in the new final standard for grades 3—5 that expects students to, “Make a claim about the environmental and social impacts of design solutions and civic actions, including their own actions.”

The Board deletes the three proposed standards in the K—2 grade band for “Environment and Ecology—Personal and Civic Responsibility” from this final-form rulemaking due to a lack of clarity and because they were not written in a three-dimensional manner as requested by stakeholders. The Board replaces these proposed standards with a rewritten standard in the new domain for “Environmental Literacy and Sustainability” for grades 3—5. The rewritten standard is included under the grades 3—5 core idea for “Sustainability and Stewardship” as follows, “Examine ways you influence your local environment and community by collecting and displaying data.”

The previously referenced new standard for grades 3—5 also replaces the proposed standard for grades 3—5 in “Environment and Ecology—Decision-Making and Action Skills” that expected students to, “Use their research results to develop action strategies and design solutions at levels consistent with their maturity and preparation. As appropriate, they implement their plans.” In this final-form rulemaking, that proposed standard is edited to reflect three-dimensional language, as requested by stakeholders, and to strengthen connections to the standards presented in the new standards in the “Environmental Literacy and Sustainability” domain for grades 6—12. As previously referenced, the revised standard for grades 3—5 now reads, “Examine ways you influence your local environment and community by collecting and displaying data.”

The Board deletes a proposed standard in the K—2 grade band for “Environment and Ecology—Earth’s Physical and Living Systems” that expected students to “describe the characteristics of Earth’s physical systems, including air, water, and land” and to “explain how these systems interact with one another and identify changes in the physical environment over time” from this final-form rulemaking for redundancy. The proposed standard is redundant to the grade 5 standard for “Earth and Space Sciences—Earth’s Systems # 1” that expects student to, “Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.”

The Board deletes a proposed standard in the K—2 grade band for “Environment and Ecology—Earth’s Physical and Living Systems” that expected students to “identify basic similarities and differences among a wide variety of living organisms” and to “explain ways that living organisms, including humans, affect the environment in which they live, and how their environment affects them” from this final-form rulemaking to present the standard in three-dimensional language, as requested by stakeholders in public comment, and to strengthen its connection to Science and Engineering Practices and Disciplinary Core Ideas. The deleted proposed standard is replaced with a rewritten standard in the new domain for “Environmental Literacy and Sustainability” for grades 3—5. The rewritten standard is included under the grades 3—5 core idea for “Agricultural and Environmental Systems and Resources” as follows, “Analyze how

living organisms, including humans, affect the environment in which they live, and how their environment affects them.”

The previously referenced new standard for grades 3—5 also reflects revisions to the proposed standard for grades 3—5 that expected students to, “Explain ways that individual traits and group membership or affiliation influence perceptions of actions toward the environment. They describe how their environmental beliefs and values are shaped by their community and the larger society.” In the Board’s final revisions, the Board edits the proposed standard to increase the use of three-dimensional language, as requested by stakeholders, and to strengthen connections to the new “Environmental Literacy and Sustainability” standards for grades 6—12. The concepts in that proposed standard now are reflected in the final standard for grades 3—5 that expects students to, “Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.”

The Board deletes two proposed standards in the K—2 grade band for “Environment and Ecology—Human Systems” from this final-form rulemaking to reduce redundancy and to respond to stakeholder concerns that these standards were not written in a three-dimensional manner. These proposed standards are combined and rewritten in three-dimensional language in this final-form rulemaking. The revised standard is included in the new domain for “Environmental Literacy and Sustainability” for grades K—2 under the core idea for “Agricultural and Environmental Systems and Resources” as follows, “Examine how people from different cultures and communities, including one’s own, interact and express their belief about nature.”

A proposed standard in the K—2 grade band for “Environment and Ecology—Environment and Society” that expected students to “identify ways that people depend on, change, and are affected by the environment” is rewritten and the rewritten standard is moved to a new section in the Board’s final-form amendments to Appendix B-1.

The rewritten standard is presented in the new domain for “Environmental Literacy and Sustainability” for Grades 3—5 under the core idea for “Sustainability and Stewardship” as follows, “Critique ways that people depend on and change the environment.” As amended in this final-form rulemaking, the standard continues to include language from the proposed standard that expected students to identify “ways that people depend on and change the environment.” However, language from the proposed standard that also expected students to identify ways that people “are affected by the environment” is not included in this final-form rulemaking because that theme is repeated in other standards. As such, maintaining the language in the revised standard would be redundant. The Board also replaces the word “identify” used in the proposed standard with the word “critique” in the rewritten final standard to establish a standard that expects students to demonstrate a higher depth of knowledge. The standard, as rewritten, also responds to stakeholder requests to revise the proposed standards to use three-dimensional language.

The Board amends a proposed standard in the K—2 grade band for “Environment and Ecology—Environment and Society” that expected students to “describe ways people harvest, re-distribute and use natural resources.” The Board also reorganizes where the standard is included in Appendix B-1. The Board replaces the word

“describe” in the proposed standard with the word “categorize” in this final-form rulemaking. This amendment establishes a standard that expects students to demonstrate a higher depth of knowledge. The revised standard is reorganized as part of the new grades K—2 domain for “Environmental Literacy and Sustainability” under the core idea for “Agricultural and Environmental Systems and Resources.”

The Board makes an editorial amendment to a proposed standard in the K—2 grade band for “Environment and Ecology—Environment and Society” that expected students to “identify ways that places differ in their physical and human characteristics.” The Board also reorganizes where the standard is included in Appendix B-1. The standard is reworded to clarify the meaning of the term “places” as used in the proposed standard. The revised standard reads as follows, “Explain ways that places differ in their physical, their meaning, and their value and/or importance.” The final revised standard is included in the new grades K—2 domain for “Environmental Literacy and Sustainability” under the core idea for “Environmental Literacy Skills.”

The Board deletes a proposed standard in the K—2 grade band for “Environment and Ecology—Environment and Society” that expected students to “recognize that change is a normal part of individual and societal life” from this final-form rulemaking and replaces it with a rewritten standard in a different section of this final-form rulemaking. This proposed standard is reworded in response to stakeholder concerns regarding sufficiency of the content of the standards to better reflect the full spectrum of standards in the NAAEE K—12 Environmental Education: Guidelines for Excellence. The final revised standard reads as follows, “Investigate how perspectives over the use of resources and the development of technology have changed over time and resulted in conflict over the development of societies and nations.” As amended in this final-form rulemaking, the standard is reorganized as part of the new grades 3—5 domain for “Environmental Literacy and Sustainability” under the core idea for “Environmental Literacy Skills.”

The new standard for grades 3—5 referenced previously also reflects a revision to a standard proposed for grades 3—5 under “Environment and Ecology—Environment and Society.” The Board deletes the standard within that section of the Board’s proposed rulemaking that expected students to, “Explain that human social systems are dynamic and that conflicts sometimes arise over differing and changing viewpoints about the environment and natural resources use and management” from this final-form rulemaking. The Board edits the proposed standard to increase the use of three-dimensional language, as requested by stakeholders and to strengthen connections to the new “Environmental Literacy and Sustainability” standards for grades 6—12. As amended in this final-form rulemaking, concepts from the proposed standard now are reflected in the final standard that expects students in grades 3—5 to, “Investigate how perspectives over the use of resources and the development of technology have changed over time and resulted in conflict over the development of societies and nations.”

The Board rewrites a proposed standard in the K—2 grade band for “Environment and Ecology—Skills for Analyzing and Investigating Environmental Issues” that expected students to “identify and investigate issues in their local environment and community” in three-dimensional language as requested by stakeholders and reorganized in a different section of this final-form rule-

making. As such, the Board deletes the proposed standard from this final-form rulemaking and replaces it with a rewritten standard in the new K—2 domain for “Environmental Literacy and Sustainability.” The rewritten standard is included under the core idea for “Environmental Literacy Skills” as follows, “Plan and carry out an investigation to address an issue in their local environment and community.”

The Board amends the proposed standard in the K—2 grade band for “Environment and Ecology—Skills for Analyzing and Investigating Environmental Issues” that expected students to “use their knowledge of how ecological and human systems are interconnected to describe the environmental and social consequences of local environmental issues” in this final-form rulemaking to use three-dimensional language as requested by stakeholders. The revised standard also is reorganized in a different section in this final-form rulemaking. The proposed standard is revised as follows, “Develop a model to demonstrate how local environmental issues are connected to larger local environment and human systems.” As reorganized in this final-form rulemaking, the revised standard is included in the new grades 3—5 domain for “Environmental Literacy and Sustainability” under the core idea for “Environmental Literacy Skills.”

The new standard for grades 3—5 referenced previously also reflects a revision to the proposed standard for students in grades 3—5 for “Environment and Ecology—Skills for Analyzing and Investigating Environmental Issues” that expected students to, “Demonstrate active listening, tolerance, adaptability, and openness as they work with others to gather a range of perspectives and information.” That proposed standard is edited to increase the use of three-dimensional language, as requested by stakeholders, and to strengthen connections to the new “Environmental Literacy and Sustainability” standards for grades 6—12. As edited, the concepts in the proposed standard are now reflected in the final standard for grades 3—5 that expects students to, “Develop a model to demonstrate how local environmental issues are connected to larger local environment and human systems.”

Two proposed standards in the K—2 grade band for “Environment and Ecology—Skills for Analyzing and Investigating Environmental Issues” that expected students to “develop plans, including possible design solutions, for addressing selected local environmental issues” and to “demonstrate openness and receptivity while listening to and working with others who have perspectives about the environment that are different from their own” are combined with another standard in this final-form rulemaking. As such, the Board deletes those two proposed standards from this final-form rulemaking. This new combined standard is reflected in the final standard within the new grades K—2 domain for “Environmental Literacy and Sustainability” under the core idea for “Environmental Literacy Skills” that reads as follows, “plan and carry out an investigation to address an issue in their local environment and community.”

A standard in the proposed grades 3—5 domain for “Environment and Ecology—Environment and Ecology” under “Earth’s Physical and Living Systems” expected students to, “Describe the physical processes that shape Earth, including weather, climate, plate tectonics, and the hydrologic cycle. They explain how matter cycles and energy flows among the abiotic and biotic components of the environment. They describe how humans affect and are affected by Earth’s physical systems.” The Board deletes this standard from this final-form rulemaking due to a lack of clarity.

Other standards in the Board’s proposed rulemaking for grades 3—5 are deleted from this final-form rulemaking due to a lack of clarity and to revise the standards to use three-dimensional language as requested by stakeholders. These proposed standards are replaced by new standards. The proposed standards for students in grades 3—5 for “Environment and Ecology” that are deleted and replaced for these reasons are as follows: proposed standard # 4 under Decision-Making and Action Skills; proposed standards # 1 and # 2 under Personal and Civic Responsibility; proposed standard # 2 under Earth’s Physical and Living Systems; proposed standards # 2 and # 3 under Human Systems; proposed standards # 1, # 2 and # 3 under Environment and Society; and proposed standards # 1, # 2 and # 3 under Skills for Analyzing and Investigating Environmental Issues.

Alternatively, new standards for students in grades 3—5 are included in this final-form rulemaking to enhance clarity, to reflect three-dimensional language as requested by stakeholders, and to establish clear learning progressions relative to standards in the new fifth domain for students in grades 6—12. These standards are included in the new domain for “Environmental Literacy and Sustainability” for grades 3—5 under the core idea for “Sustainability and Stewardship.” The new standards included in this final-form rulemaking expect students to, “critique ways that people depend on and change the environment,” “examine ways you influence your local environment and community by collecting and displaying data,” and “construct an argument to support whether action is needed on a selected environmental issue and propose possible solutions.”

In this final-form rulemaking, the Board also amends the proposed Pennsylvania Integrated Standards for Science, Environment and Ecology (grades 6—12) to include a new domain on “Environmental Literacy and Sustainability” in both the grade band standards for grades 6—8 and in the grade band standards for grades 9—12. For consistency with how this domain is presented across all grade levels, the new fifth domain for “Environmental Literacy and Sustainability” for grades 6—8 and grades 9—12 also is organized under the following three core ideas: 1) Agricultural and Environmental Systems and Resources; 2) Environmental Literacy Skills; and 3) Sustainability and Stewardship. Adding a fifth domain to the standards for grades 6—12 that addresses content related to the environment, ecology and agriculture was suggested by multiple stakeholders as a way to satisfy stakeholder concerns surrounding the sufficiency of content in those areas.

In direct response to stakeholder concerns, the new domain added to the standards for grades 6—8 includes standards that expect students to develop models to describe how agricultural and food systems function, including sustainable use of natural resources and the production, processing and management of food, fiber and energy. Standards in the new domain also set forth expectations for students in grades 6—8 to analyze and interpret data about how different societies and cultures use and manage natural resources differently, address the roles and functions of watersheds and wetlands, create expectations for students in this Commonwealth to explore how local environmental issues affect our State’s human and natural systems, and establish requirements for instruction related to integrated pest management. Further, in response to stakeholder concerns, the final standards for students in grades 6—8 also expect students to receive instruction in how best management practices and environmental laws are designed to achieve

environmental sustainability, to design a solution to an environmental issue to gain knowledge related to environmental stewardship, and to construct an explanation that describes regional environmental conditions and their implications on environmental justice and social equity.

Standards included in the new “Environmental Literacy and Sustainability” domain for grades 9–12 in this final-form rulemaking also are created in direct response to stakeholder concerns about content that stakeholders identified as either omitted or weakly link in the Board’s proposed rulemaking. The standards adopted in this final-form rulemaking expect students at the high school level to receive instruction in agricultural systems to “analyze and interpret how issues, trends, technologies, and policies impact agricultural, food, and environmental systems and resources.” They further expect high school students to be able to “apply research and analytical skills to evaluate the conditions and motivations that lead to conflict, cooperation, and change among individual groups, and nations” as they pertain to environment and society. The new standards included in this final-form rulemaking also set forth expectations for high school-level instruction in watersheds and wetlands, for applying research and analytical skills to investigate local, regional or global environmental issues, and for planning and conducting investigations utilizing environmental data about a local environmental issue. The standards in the new “Environmental Literacy and Sustainability” domain for grades 9–12 also require instruction to be provided in integrated pest management. Students in grades 9–12 further are expected to be able to “analyze and evaluate how best management practices and environmental laws achieve sustainability of natural resources,” to “design and evaluate solutions in which individuals and societies can promote stewardship in environmental quality and community well-being,” and to “analyze and interpret data on a regional environmental condition and its implication on environmental justice and social equity.”

In addition to adding a new fifth domain for “Environmental Literacy and Sustainability” across all grade levels, the Board made other amendments to the standards in this final-form rulemaking that also are responsive to stakeholder concerns.

First, within the Kindergarten standards for Earth and Space Science, the Board amends the first standard under “Earth’s Systems.” In the Board’s proposed rulemaking, that standard expected students to, “Use observations of local weather conditions to describe patterns over time.” The phrase “and share” is added to the final standard in response to a stakeholder comment that communication is a critical part of three-dimensional learning and, as such, should be reflected in the standard.

Next, the Board makes editorial revisions to the grade 3 standard for Life Sciences—Ecosystems: Interactions, Energy and Dynamics. In the proposed rulemaking, that standard expected students to, “Construct an argument that some animals have physical and behavioral adaptations that help members survive.” A stakeholder raised concern that, as proposed, the standard did not match the title of the section in which it is included and that it already appeared appropriately under the grade 3 standard for Life Sciences—Biological Evolution: Unity and Diversity # 2 that addresses evolutionary adaptations. In response to that stakeholder’s concern, the standard is revised to read as follows in this final-form rulemaking, “Construct an argument that some animals form groups that help members survive.”

The Board also makes an editorial revision to the grade 5 standards for Physical Science—Matter and Its Interactions in response to a comment received from a stakeholder. The stakeholder questioned whether standard # 5 in that section is not three-dimensional and whether it is too similar to standard # 3 within that same section.

As proposed, the grade 5 standard for Physical Science—Matter and Its Interactions # 5 questioned by the commentator expected students to, “Interpret and analyze data and observations to make decisions about how to utilize materials based on their properties.” Standard # 3 in that section that expects students to, “Make and communicate observations and measurements to identify materials based on their properties.” The Board disagrees that standard # 5 is redundant to standard # 3. Rather, standard # 5 builds upon other standards. Standard # 3 in this section focuses on identifying materials based on their properties, while standard # 5 in this section focuses on synthesizing skills, interpreting and analyzing. To provide clarity between the intent of the two distinct standards, in this final-form rulemaking the Board deletes the phrase “and observations” from standard # 5. This final grade 5 standard now reads as follows, “Interpret and analyze data to make decisions about how to utilize materials based on their properties.”

Finally, following a recommendation from the Science Standards Content Committee and Steering Committee, the Board amends a middle school standard for Life Sciences—Natural Selection and Adaptations. As proposed, this standard within grade 6–8 band of the Pennsylvania Integrated Standards for Science, Environment and Ecology (grades 6–12) expected students to, “Analyze displays of pictorial data to compare patterns of similarities in embryological development across multiple species to identify relationships not evident in the fully formed anatomy.” The emphasis of this standard is on inferring general patterns of relatedness among structures of different organisms by comparing the appearance of diagrams or pictures. In addition, the Science Standards Content Committee and Steering Committee advised that the Recapitulation Theory (Biogenetic Principle) is no longer scientifically valid. Furthermore, the standard was found to be written in a manner that overlaps with curricular decisions, and the developmental appropriateness for younger middle school students was questioned.

In response to those considerations, in this final-form rulemaking the Board amends the grade 6–8 standard for Life Sciences—Natural Selection and Adaptations # 3 by replacing the term “embryological development” with “anatomical structures.” As amended, the final standard reads as follows, “Analyze displays of pictorial data to compare patterns of similarities in their anatomical structures across multiple species of similar classification levels to identify relationships.”

Affected Parties

This final-form rulemaking affects public school districts, ACTSs and charter and cyber charter schools in this Commonwealth and their employees and students, as well as educator preparation programs that prepare new teachers.

Cost and Paperwork Estimates

This final-form rulemaking will not impose any costs on students. Further, this final-form rulemaking is not anticipated to impose new costs on programs that train new educators. The updated academic standards will act as a guide for redesigning some courses educator preparation

programs deliver to individuals preparing to become teachers to ensure course content is aligned to current academic standards. This does not impose a new cost for additional coursework. Rather, the impact on educator preparation programs would shift the content of some existing courses, and the Department will provide educator preparation program faculty with access to implementation supports it will make available for updated science standards to support this work.

Further, the Department will update its program framework guidelines for educators in the science, technology, environment, ecology and engineering fields to align with the new standards. Outreach conducted with the Pennsylvania Association of Colleges and Teacher Educators, which includes educator preparation programs at private colleges and universities, State-related universities and the Pennsylvania State System of Higher Education (PASSHE), indicated that this final-form rulemaking will not impose a cost on the institutions. Educator preparation program updates occur through two basic means: as a part of faculty expectations or as Departmental service. Costs only would be incurred if updates occurred outside of the contract period (PASSHE faculty are 9-month employees), and approval for curriculum updates could take 12–18 months (2-3 semesters) at some institutions. The proposed rulemaking included a July 1, 2025, effective date for implementation of updated standards which should provide adequate time for educator preparation programs to make any necessary adjustments.

As part of the stakeholder engagement convened by the Department in developing recommended standards updates, science educators were asked to complete a survey that included strategic questions to discern what academic standards K–12 schools utilize when creating their curriculum. The results of the survey indicated that, as of the 2019-2020 school year, approximately 42% of respondents in this Commonwealth reported using National frameworks in designing learning experiences, while between 35–37% reported having curriculum aligned to National standards and frameworks. This presumably will necessitate fewer or more minor adjustments to curriculum to align with the updated standards in this final-form rulemaking since the revised standards are informed by current National standards frameworks in their development and incorporate some elements of the frameworks already referenced by educators in response to the Department's question.

For the purposes of this final-form rulemaking, school entities are considered local governments. To determine a specific estimate of the costs to local governments, the Board sought to determine the cost of implementing updated standards in the remaining school entities in this Commonwealth that did not report that they already are aligning their curriculum to current National standards and frameworks and, thus, would need to revise curriculum. School entities typically engage in curriculum review cycles every 5 to 6 years. Thus, the Board anticipates that efforts to implement the updated standards included in this final-form rulemaking will be reflected in school entities' existing budgetary practices for curriculum review and updates, therefore becoming part of a traditional cycle for updating school entity resources. As such, this final-form rulemaking does not add new costs in so much as it refines the focus of current instruction.

At the State level, the Board anticipates that this final-form rulemaking will cost approximately \$17,994,792 in total through Fiscal Year (FY) 2026-2027

to review and update the PSSA exams in Science, the Keystone Biology exam, the Pennsylvania Standards Aligned System resources, and to provide technical support for school entities. As a result of this final-form rulemaking, the Department anticipates a need to update the PSSA Science exams, administered in grades 4 and 8, and the Keystone Exam in Biology to align to the update to academic standards in science included in Appendix B-1 of this final-form rulemaking. To support implementation of the revised standards locally, the Department will provide educators with access to State-developed resources through the Standards Aligned System web site, professional learning, and on-going support and consultation. The Department will provide technical assistance supports through the expertise of its content advisors and additional professional learning supports through the Statewide System of Support deployed through collaboration with the existing network of regional Intermediate Units.

Through collaboration with the State's 29 Intermediate Units, the Department drives professional learning to support science, technology, environment and ecology education through the Statewide System of Support. Since 2016, the Department has been driving professional learning to educators and school entities aligned to robust research, practice and recent guidance outlined by "A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas," "Taking Science To School," and "Science Teacher's Learning: Enhancing Opportunities Creating Supportive Contexts." Since 2016, the Department has invested more than \$4.3 million in Federal and State funds to enhance educators' and school entities' ability to ensure all learners, especially those who have been historically underserved, are included in science, technology, engineering and environmental learning experiences. The investment has resulted in the development of an Open Education Resource STEM Toolkit, provision of research-aligned professional learning for thousands of educators across this Commonwealth, and school entities' building STEM Comprehensive plans. This upfront investment will support school entities in implementing the new standards included in this final-form rulemaking.

Continued annual investments of \$1.8 million in the Statewide System of Support will ensure each Intermediate Unit has a STEM Point of Contact with the expertise to deliver professional learning and technical assistance at no cost to school entities as they build towards implementation of the new Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (grades K–5), Pennsylvania Integrated Standards for Science, Environment and Ecology (grades 6–12) and the Pennsylvania Technology and Engineering Standards (grades 6–12).

In addition to the State-level investments in education infrastructure through the Intermediate Units, the Department employs content advisors who provide curriculum alignment supports for school entities across this Commonwealth. The Department has individual content advisors dedicated to science, technology, engineering, environment and ecology education with the expertise necessary to guide implementation for the field. Support for standards implementation by the Department, including updating, aligning and designing resources for school entities and educators, can be carried out with the current staff complement of content advisors. The resources developed by the Department will be curated on

the Department's Standards Aligned System web site for voluntary use by school entities at no cost to the school entities.

Following is an estimate of anticipated costs to the State to implement this final-form rulemaking on an annual basis through FY 2026-2027:

FY 2021-2022: The estimated State cost is \$1.827 million, which represents the annual investment in the Pennsylvania Statewide System of Support to deliver professional learning and technical assistance in Science, Technology, Engineering and Environment and Ecology education at no cost to educators. Professional learning and technical assistance delivered through this investment is provided through each of the State's 29 Intermediate Units.

FY 2022-2023: The estimated State cost is \$1.827 million, which represents the investment in the Pennsylvania Statewide System of Support that will support the creation of State-level resources to assist school entities and educators with implementation of the updated State academic standards in science. This investment will be directed toward work to redesign the professional learning and technical assistance made available at no cost to educators through the State's network of Intermediate Units to align with the new standards in this final-form rulemaking.

FY 2023-2024: The estimated State cost is \$9,258,797, which represents a sustained effort to support State-level resources to assist school entities and educators with implementation of the updated State academic standards in science and new work to revise State assessments administered in Science. Through an investment in the Pennsylvania Statewide System of Support, the State will continue to support efforts to redesign the content of professional learning and technical assistance made available at no cost to educators to align with the needs of school entities in implementing the new standards in this final-form rulemaking. The professional learning and technical assistance will be provided through the State's network of 29 Intermediate Units. The estimated cost also includes work necessary to revise State assessments administered in Science to align with the new standards in Appendix B-1 of this final-form rulemaking. Anticipated costs include aligning the State assessment question bank to reflect the content of the updated science standards in the regulation and modernizing the testing process towards technology-enhanced items. Updated performance-based academic standards will enable adjustments to State assessments that enable automated scoring.

FY 2024-2025: The estimated State cost is \$2,891,071, which reflects efforts to continue refining State assessment items and resources for educators to align with the new standards as previously described.

FY 2025-2026: The estimated state cost is \$1.827 million, and estimated savings are \$1,463,076, resulting in an estimated net cost of \$363,924. The estimated cost represents the investment in the Pennsylvania Statewide System of Support to redesign the professional learning and technical assistance available at no cost to educators to align with the needs of school entities in implementing the updated State academic standards in science. The professional learning and technical assistance will be provided by the State's network of 29 Intermediate Units. The estimated savings reflect a shift in assessment practices. The Department anticipates that updated State assessments will be administered for the first time begin-

ning in FY 2025-2026. Estimated savings are realized through the shift from hand-scored assessments to automated scoring, enabled by adopting updated performance-based standards. This estimate assumes a shift from hand-scored items to technology-enhanced items. Hand-scored items require the time and expertise of several professionals to score individual assessments. Technology-enhanced items do not require the time and expertise of several professionals. It is anticipated that this shift will result in annual savings in future years. Estimated savings are predicated on assumptions to changes in the State assessment design and are contingent on final determinations about the design of State assessments that will be completed through the Department's work to implement assessments aligned to the new standards.

FY 2026-2027: The estimated State cost is \$1.827 million, which represents the investment in the Pennsylvania Statewide System of Support to deliver professional learning and technical assistance aligned with the new standards in this final-form rulemaking to educators at no cost. The professional learning and technical assistance will be provided through the State's network of 29 Intermediate Units.

Estimated State costs take into account resources and collaborations, such as Federal grants, that will support implementation of this final-form rulemaking. Through collaborative efforts with the State's network of Intermediate Units, the Department has been working with the Stroud Watershed Research Center, the National Oceanic and Atmospheric Association, the Department of Conservation and Natural Resources, the Department of Environmental Protection and other collective impact partners through a multiyear Federal grant to build a robust network that is delivering professional learning and technical assistance in environmental, ecology and watershed education to school entities across this Commonwealth. The collaboration represents an upfront investment preparing educators and school entities for research-aligned supports and has established a foundation for implementing the new standards included in this final-form rulemaking. This Federally grant-funded program will continue through 2022 to support professional development for educators and environmental literacy for scholars across this Commonwealth.

Effective Date

This final-form rulemaking will take effect upon publication in the *Pennsylvania Bulletin*.

Sunset Date

The Board will review the effectiveness of Chapter 4 every 4 years in accordance with the Board's policy and practice respecting all of its regulations. Thus, no sunset date is necessary.

Regulatory Review

Under section 5(a) of the RRA (71 P.S. § 745.5(a)), on May 11, 2021, the Board submitted a copy of the notice of proposed rulemaking, published at 51 Pa.B. 3103, and a copy of a Regulatory Analysis Form to IRRC and to the Chairpersons of the House and Senate Committees on Education for review and comment.

Under section 5(c) of the RRA, the Board is required to submit to IRRC and the House and Senate Committees copies of comments received during the public comment period, as well as other documents when requested. In preparing the final-form rulemaking, the Board has considered all comments from IRRC, the House and Senate Committees and the public.

Under section 5.1(j.2) of the RRA (71 P.S. § 745.5a(j.2)), on May 18, 2022 the final-form rulemaking was deemed approved by the House and Senate Committees. Under section 5.1(e) of the RRA, IRRC met on May 19, 2022, and approved the final-form rulemaking.

The Office of Attorney General approved the final-form rulemaking as to form and legality on June 21, 2022.

Contact Person

Persons who require additional information about this final-form rulemaking may submit inquiries to Karen Molchanow, Executive Director, State Board of Education, 333 Market Street, 1st Floor, Harrisburg, PA 17126, ra-stateboardofed@pa.gov.

Findings

The Board finds that:

(1) Public notice of the proposed rulemaking was given under sections 201 and 202 of the act of July 31, 1968 (P.L. 769, No. 240) (45 P.S. §§ 1201 and 1202), referred to as the Commonwealth Documents Law and the regulations promulgated thereunder, 1 Pa. Code §§ 7.1 and 7.2 (relating to notice of proposed rulemaking required; and adoption of regulations).

(2) A public comment period was provided as required by law and all comments were considered in drafting this final-form rulemaking.

(3) This final-form rulemaking does not enlarge the purpose of the proposed rulemaking published at 51 Pa.B. 3103.

(4) This final-form rulemaking is necessary and appropriate for the administration of the Public School Code of 1949.

Order

The Board, acting under authorizing statute, orders that:

(a) The regulations of the Board, 22 Pa. Code Chapter 4, are amended by amending §§ 4.3, 4.4, 4.11, 4.12, 4.21—4.24, 4.31—4.35, 4.51, 4.51a, 4.51b, 4.51c, 4.51d, 4.52, and adding Appendix B-1 to read as set forth in Annex A, with ellipses referring to the existing text of the regulations.

(b) The Board shall submit this final-form rulemaking to the Office of General Counsel and the Office of Attorney General for review and approval as required by law.

(c) The Board shall submit this final-form rulemaking to IRRC and the House and Senate Committees as required by law.

(d) The Board shall certify this final-form rulemaking, as approved for legality and form, and shall deposit it with the Legislative Reference Bureau as required by law.

(e) This final-form rulemaking shall take effect upon publication in the *Pennsylvania Bulletin*.

KAREN MOLCHANOW,
Executive Director

(Editor's Note: See 52 Pa.B. 3294 (June 4, 2022) for IRRC's approval order.)

Fiscal Note: Fiscal Note 6-347 remains valid for the final adoption of the subject regulations.

Annex A

TITLE 22. EDUCATION

PART I. STATE BOARD OF EDUCATION

Subpart A. MISCELLANEOUS PROVISIONS

CHAPTER 4. ACADEMIC STANDARDS AND ASSESSMENT

GENERAL PROVISIONS

§ 4.3. Definitions.

The following words and terms, when used in this chapter, have the following meanings, unless the context clearly indicates otherwise:

ACTS—Area career and technical school—A public school that provides career and technical education to secondary school students, out-of-school youth and adults in a geographical area comprised and operated by one or more school districts and established under sections 1840—1853 of the School Code (24 P.S. §§ 18-1840—18-1853).

* * * * *

Board—The State Board of Education established under sections 2601-B—2606-B of the School Code (24 P.S. §§ 26-2601-B—26-2606-B).

Career and technical education—Programs under public supervision and control which provide an organized process of learning experiences designed to develop integrated academic and occupational skills, knowledge, attitudes, work habits and leadership ability for entry into and advancement within various levels of employment in occupational areas of agriculture, business, marketing and distribution, health, home economics and trade and industry and for participation in postsecondary education and training.

Chief school administrator—The superintendent of a school district, the superintendent of an ACTS or the chief executive officer of a charter school.

Cooperative career and technical education—A planned method of instruction developed through a signed cooperative arrangement among school representatives, students, parents and employers in the community to provide students with an opportunity to alternate in-school academic and career and technical instruction in entry-level paid employment in an occupational field, in which the student's total occupational work experience is planned, coordinated and supervised by the school in close cooperation with the employer.

* * * * *

Employment area—A geographic area where career and technical education program completers are most likely to be employed.

* * * * *

School entity—A local public education provider (for example, public school district, charter school, cyber charter school, ACTS or intermediate unit).

School organization—The organization of a school district's programs into kindergarten, primary, intermediate level, middle level and high school programs, including programs operated at ACTSs.

* * * * *

Tech-prep program—A combined secondary and postsecondary program which leads to an associate degree or certificate and employment by providing technical preparation in engineering technology, applied science, mechanical, industrial or practical art or trade, agriculture,

health or business, including development of competence in mathematics, science and communications through a sequential course of study.

§ 4.4. General policies.

* * * * *

(e) The Department will provide support to school districts, ACTSs and charter schools, including cyber charter schools, in developing educational programs that enable students to attain academic standards under § 4.12. Department support will include:

(1) Establishment of a voluntary model curriculum and diagnostic supports aligned with State academic standards in each of the content areas assessed by the Keystone Exams under § 4.51b(i) (relating to Keystone Exams).

(2) Assistance in the development of effective student tutoring, remediation and extended instructional time programs.

(3) Opportunities for continuing professional education designed to improve instruction in each of the content areas assessed by the Keystone Exams under § 4.51b(i).

(4) Technical guidance in developing local assessments that meet the requirements of § 4.24(c)(1)(iii)(B) (relating to high school graduation requirements), upon request.

(f) The Department may not, and the Board will not, require school entities to utilize a Statewide curriculum or Statewide reading lists.

ACADEMIC STANDARDS AND PLANNING

§ 4.11. Purpose of public education.

* * * * *

(g) Public schools provide instruction throughout the curriculum so that students may develop knowledge and skills in the following areas:

- (1) English language arts.
- (2) Mathematics.
- (3) Science and environment and ecology.
- (4) Technology and engineering.
- (5) Social studies (civics and government, geography, economics and history).
- (6) Arts and humanities.
- (7) Career education and work.
- (8) Health, safety and physical education.
- (9) Family and consumer science.

* * * * *

§ 4.12. Academic standards.

(a) School entities may develop, expand or improve existing academic standards in the following content areas:

- (1) The following apply:
 - (i) *Through June 30, 2025: Science and technology.* Study of the natural world and facts, principles, theories and laws in the areas of biology, chemistry, physics and earth sciences. Technology is the application of science to enable societal development, including food and fiber production, manufacturing, building, transportation and communication. Science and technology share the use of the senses, science processes, inquiry, investigation, analysis and problem solving strategies. The Pennsylvania Core Standards for Reading in Science and Technology and the Pennsylvania Core Standards for Writing in

Science and Technology will be an appendix to the Commonwealth’s academic standards for Science and Technology upon publication in the *Pennsylvania Bulletin*.

(ii) *Effective July 1, 2025: Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K–5).* Guide the elementary-level study of the natural and human-made world through inquiry, problem-solving, critical thinking and authentic exploration. The integration of these disciplines in the elementary grades highlights the interconnectedness of scientific study and the integral relationship between humans and the environment.

(2) The following apply:

(i) *Through June 30, 2025: Environment and ecology.* Understanding the components of ecological systems and their interrelationships with social systems and technologies. These components incorporate the disciplines of resource management, agricultural diversity, government and the impact of human actions on natural systems. This interaction leads to the study of watersheds, threatened and endangered species, pest management and the development of laws and regulations.

(ii) *Effective July 1, 2025: Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6–12).* Utilize a three-dimensional approach to guide the study of physical sciences, life sciences, and earth and space sciences at the middle and high school levels. The standards highlight the critical intersections of these disciplines with environmental science, ecology, and agriculture. These three-dimensional standards integrate disciplinary core ideas, practices in science and engineering, and crosscutting concepts into coherent learning progressions across the grade bands.

(iii) *Effective July 1, 2025: Pennsylvania Technology and Engineering Standards (Grades 6–12).* Define the knowledge, skills, and abilities necessary for establishing literacy in technology and engineering literacy. Students develop a practical understanding of how humans are influenced by science and technology. Four core disciplinary standards describe practices in technology and engineering and include specific benchmarks for students in grade bands 6–8 and 9–12.

(3) *Social studies.*

(i) *History.* Study of the record of human experience including important events; interactions of culture, race and ideas; the nature of prejudice; change and continuity in political systems; effects of technology; importance of global-international perspectives; and the integration of geography, economics and civics studies on major developments in the history of the Commonwealth, the United States and the world.

* * * * *

(5) *Career education and work.* Understanding career options in relationship to individual interests, aptitudes and skills including the relationship between changes in society, technology, government and economy and their effect on individuals and careers. Development of knowledge and skill in job-seeking and job-retaining skills and, for students completing career and technical education programs, the skills to succeed in the occupation for which they are prepared.

* * * * *

(i) No sooner than every 5 years and no later than every 10 years, the Board will review the State academic standards and State assessments under this section to

determine if they are appropriate, clear, specific and challenging, and will make revisions as necessary by revising this chapter.

(j) The Department may not expand the collection of student data and, in accordance with section 444 of the Family Educational Rights and Privacy Act of 1974 (20 U.S.C.A. § 1232g), regarding family educational and privacy rights, may not collect personal family data due to the implementation of Pennsylvania Core Standards in Appendix A-2.

CURRICULUM AND INSTRUCTION

§ 4.21. Elementary education: primary and intermediate levels.

(a) The primary program shall ordinarily be completed by children who are approximately 6 years of age. School districts, including charter schools, shall provide opportunities for individualized rates of learning and social and emotional development that reflect differing rates of development and learning styles of young children.

* * * * *

(e) Planned instruction aligned with academic standards in the following areas shall be provided to every student every year in the primary program. Planned instruction may be provided as separate course or other interdisciplinary activity.

(1) Language arts, integrating reading, writing, phonics, spelling, listening, speaking, literature and grammar, and information management, including library skills.

(2) Mathematics, including problem-solving and computation skills.

(3) Science, environment and ecology, involving active learning experiences for students.

(4) Technology and engineering education, involving active learning experiences for students.

* * * * *

(f) Planned instruction in the following areas shall be provided to every student every year in the intermediate level program. Planned instruction may be provided as a separate course or as an instructional unit within another course or other interdisciplinary instructional activity:

(1) Language arts, integrating reading, writing, spelling, listening, speaking, literature and grammar.

(2) Mathematics, including problem-solving and computation skills.

(3) Science, environment and ecology, including instruction about agriculture and agricultural science.

(4) Technology and engineering.

(5) Social studies (civics and government, economics, geography and history).

* * * * *

§ 4.22. Middle level education.

* * * * *

(c) Planned instruction aligned with academic standards in the following areas shall be provided to every student in the middle level program. Planned instruction may be provided as a separate course or as an instructional unit within a course or other interdisciplinary instructional activity:

(1) Language arts, integrating reading, writing, listening, speaking, literature and grammar.

(2) Mathematics, including mathematical reasoning, algebra and problem-solving.

(3) Science, environment and ecology, which involves active learning experiences and which may include laboratory experiments, instruction in agriculture and agricultural science, and political and economic aspects of ecology.

(4) Social studies (civics and government, economics, geography and history, including the history and cultures of the United States, the Commonwealth, and the world).

(5) Technology and engineering.

(6) Information skills, including access to traditional and electronic information sources, computer use and research.

(7) Health, safety and physical education, including instruction in concepts and skills which affect personal, family and community health and safety, nutrition, physical fitness, movement concepts, motor skill development, safety in physical activity settings, and the prevention of alcohol, chemical and tobacco abuse.

(8) The arts, including art, music, dance and theatre.

(9) Career education, including exposure to various career options and the educational preparation necessary to achieve those options.

(10) Technology education, emphasizing practical application of academic skills and problem-solving experiences facilitated by technology.

(11) Family and consumer science, including principles of consumer behavior and basic knowledge of child health and child care skills.

(d) This section does not preclude the teaching of other planned instruction designed to achieve a school entity's academic standards.

(e) School entities shall determine the most appropriate way to operate their middle level programs to achieve the purposes under subsection (b) and any additional academic standards as determined by the school entity.

§ 4.23. High school education.

* * * * *

(c) Planned instruction aligned with academic standards in the following areas shall be provided to every student in the high school program. Planned instruction may be provided as a separate course or as an instructional unit within a course or other interdisciplinary instructional activity:

(1) Language arts, integrating reading, writing, listening, speaking, literature and grammar.

(2) Mathematics, including problem-solving, mathematical reasoning, algebra, geometry and concepts of calculus.

(3) Science, environment and ecology, including scientific, social, political and economic aspects of ecology, participation in hands-on experiments and at least one laboratory science chosen from life sciences, earth and space sciences, chemical sciences, physical sciences and agricultural sciences.

(4) Social studies (civics and government, economics, geography and history, including the history and cultures of the United States, the Commonwealth and the world).

(5) Technology and engineering.

(6) The arts, including art, music, dance, theatre and humanities.

(7) Use of applications of microcomputers and software, including word processing, database, spreadsheets and telecommunications; and information skills, including access to traditional and electronic information sources, computer use and research.

(8) Health, safety and physical education, including instruction in concepts and skills which affect personal, family and community health and safety, nutrition, physical fitness, movement concepts, motor skill development, safety in physical activity settings, and the prevention of alcohol, chemical and tobacco abuse.

(9) Family and consumer science, including principles of consumer behavior and basic knowledge of child health, child care and early literacy skill development.

(d) The following planned instruction shall be made available to every student in the high school program:

(1) Career and technical education under §§ 4.3 and 4.31—4.35.

(2) Business education, including courses to assist students in developing business and information technology skills.

(3) World languages under § 4.25 (relating to languages).

(4) Technology education, incorporating technological problem-solving and the impacts of technology on individuals and society.

(e) College-level advanced placement courses may be offered as planned instruction in the high school curriculum.

(f) This section does not preclude the teaching of other planned instruction designed to achieve a school district's, including a charter school's, academic standards.

(g) School districts, including a charter school, shall determine the most appropriate way to operate their high school programs to achieve the purposes under subsection (a) and any additional academic standards as determined by the school entity.

§ 4.24. High school graduation requirements.

(a) *Approval.* High school graduation requirements and revisions to them shall be approved by a school entity's governing board no later than the beginning of the 2020-2021 school year, and a copy of the requirements shall be published and distributed to students, parents and guardians. Copies of the requirements also shall be available in each school building or on each school entity's publicly accessible web site. Changes to high school graduation requirements shall be published and distributed to students, parents and guardians and made available in each school building or on each school entity's publicly accessible web site immediately following approval by the governing board.

(b) *Requirements through the 2021-2022 school year.* Each school district, charter school (including a cyber charter school) and ACTS, if applicable, shall specify requirements for graduation. Requirements through the 2021-2022 school year must include course completion and grades, completion of a culminating project, results of local assessments aligned with the academic standards and a demonstration of proficiency in English Language Arts and Mathematics on either the State assessments administered in grade 11 or 12 or local assessments aligned with academic standards and State assessments under § 4.52 (relating to local assessment system) at the proficient level or better to graduate. The purpose of the culminating project is to assure that students are able to

apply, analyze, synthesize and evaluate information and communicate significant knowledge and understanding.

(c) *Requirements beginning in the 2022-2023 school year.*

(1) *General.* Beginning in the 2022-2023 school year, each school district, charter school (including a cyber charter school) and ACTS, if applicable, shall adopt and implement requirements for high school graduation that, at minimum, include:

(i) Course completion and grades.

(ii) Demonstration of proficiency as determined by the school district, charter school (including a cyber charter school) or ACTS, if applicable, in each of the State academic standards not assessed by a State assessment under § 4.51, § 4.51a or § 4.51b (relating to State assessment system; Pennsylvania System of School Assessment; and Keystone Exams).

(iii) Demonstration of proficiency or above in each of the following State academic standards: English Language Arts and Mathematics (Appendix A-2); through June 30, 2025, Science and Technology and Environment and Ecology (Appendix B), and, beginning July 1, 2025, Science, Environment and Ecology (Appendix B-1), as determined through any one or a combination of the following:

(A) Completion of secondary level coursework in English Language Arts (Literature), Algebra I and Biology in which a student demonstrates proficiency on the associated Keystone Exam or through a pathway established in section 121(c) or (c.1) of the School Code (24 P.S. §§ 1-121(c) or (c.1)).

(I) A school district, ACTS or charter school, including a cyber charter school, shall allow a student to take a Keystone Exam prior to taking the course associated with the exam's content provided that the student achieved a score of advanced on the most recent associated PSSA assessment administered to the student.

(II) A school district, ACTS or charter school, including a cyber charter school, shall allow a student who transfers from another state to take a Keystone Exam prior to taking the course associated with the exam's content, provided that the student achieved a score comparable to the PSSA's advanced performance level on a comparable assessment administered by another state.

(III) A school district, ACTS or charter school, including a cyber charter school, may allow a student who scores at the advanced level on a particular Keystone Exam prior to taking the course to be granted course credit for the course without having to complete the course.

(B) Locally approved and administered assessments, which shall be independently and objectively validated once every 6 years. Local assessments may be designed to include a variety of assessment strategies listed in § 4.52(c) and may include the use of one or more Keystone Exams. Except for replacement of individual test items that have a similar level of difficulty, a new validation is required for any material changes to the assessment. Validated local assessments must meet the following standards:

(I) Alignment with the following State academic standards: English Language Arts (Literature and Composition); Mathematics (Algebra I), and Science and Environment and Ecology (Biology).

(II) Performance level expectations and descriptors that describe the level of performance required to achieve proficiency comparable to that used for the Keystone Exams.

(III) Administration of the local assessment to all students, as a requirement for graduation, except for those exempted by their individualized education program under subsection (d), regarding special education students, or gifted individualized education plan as provided in § 16.32 (relating to GIEP).

(IV) Subject to appropriations provided by law, the cost to validate local assessments shall be evenly divided between the school district, ACTS or charter school, including a cyber charter school, and the Department. If the Department does not provide sufficient funding to meet its share, local assessments submitted for validation shall be deemed valid until a new validation is due to the Department.

(V) The Department will establish a list of entities approved to perform independent validations of local assessments in consultation with the Local Assessment Validation Advisory Committee as provided in § 4.52(f).

(VI) School boards shall only approve assessments that have been determined to meet the requirements of this subsection by an approved entity performing the independent validation. If a school district, ACTS or charter school, including a cyber charter school, uses a local assessment that has not been independently validated, the Secretary will direct the school entity to discontinue its use until the local assessment is approved through independent validation by an approved entity.

(d) *Special education students.* Children with disabilities who satisfactorily complete a special education program developed by an Individualized Education Program team under the Individuals with Disabilities Education Act and this part shall be granted and issued a regular high school diploma by the school district of residence, charter school (including cyber charter school) or ACTS, if applicable. This subsection applies if the special education program of a child with a disability does not otherwise meet the requirements of this chapter.

(e) *Demonstration of proficiency.* For purposes of this section, a student shall be deemed proficient in the State-assessed standards whenever the student demonstrates proficiency through any of the options in subsection (c)(1)(iii), regardless of the student's grade level or age.

(f) *Transcripts.* The performance level demonstrated by a student in each of the state academic standards, including the highest performance level demonstrated by a student on the associated Keystone Exam, may be included on a student's transcript as determined by each school entity.

(g) *Release of scores.* This section does not allow for the release of individual student PSSA or Keystone Exam scores to the Department or other Commonwealth entities in accordance with § 4.51(f) and (g).

(h) *Supplemental instruction.* A student who does not demonstrate proficiency on a Keystone Exam or a locally validated assessment specified in subsection (c) may be offered supplemental instructional support by the student's school district, ACTS or charter school, including a cyber charter school consistent with section 121(c.4) of the School Code.

(i) *Out-of-state transfers.* A school district, ACTS or charter school, including a cyber charter school, shall determine whether a student who transfers from an out-of-State school having demonstrated proficiency in coursework and assessments aligned with the academic standards assessed by each Keystone Exam may satisfy the requirements of subsection (c).

(j) *Waiver of testing and accountability requirements.* In any year in which the Federal government has waived the testing and accountability requirements of the Elementary and Secondary Education Act, as amended by the Every Student Succeeds Act (20 U.S.C.A. §§ 6301—7981), a student shall not be required to take a Keystone Exam for the purpose established in this section and shall be deemed proficient for purposes of this section by meeting the requirements set forth in section 121.1 of the School Code (24 P.S. § 1-121.1).

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CAREER AND TECHNICAL EDUCATION

§ 4.31. Career and technical education.

(a) Career and technical education courses shall be developed in the planned instruction format and be accessible to all high school students attending those grades in which career and technical education courses are offered. All students and their parents or guardians shall be informed of the students' rights to participate in career and technical education programs and courses and that students with disabilities enrolled in the programs are entitled to services under Chapter 14 (relating to special education services and programs). Students who complete approved career and technical education programs shall have their occupational competency assessed by completion of the appropriate assessment under the Pennsylvania Skills Certificate Program or by completion of another occupational competency assessment approved by the Department. A student with a disability shall be provided appropriate accommodations when provided for in the student's individualized education program. Students shall also demonstrate proficiency in meeting academic standards as required under § 4.24 (relating to high school graduation requirements), including § 4.12(f) (relating to academic standards) and § 4.24(d) for students with disabilities with an individualized education program.

(b) Career and technical education courses may be taught at ACTSs or other high schools.

(c) Career and technical education programs must consist of a series of planned academic and career and technical education courses that are articulated with one another so that knowledge and skills are taught in a systematic manner. When appropriate, career and technical education programs must adopt, in program areas for which they are available, industry recognized skills standards and may also include cooperative career and technical education and participation in career and technical student organizations to develop leadership skills.

(d) Career and technical education courses must include content based upon occupational analysis, clearly stated performance objectives deemed critical to successful employment and assessment of student competencies based upon performance standards.

(e) The record of a student enrolled in a career and technical education program must include the student's educational and occupational objectives and the results of the assessment of student competencies under subsection (d).

(f) Safety education, consisting of safety practices, accident prevention, occupational health habits and environmental concerns shall be integrated into the instruction and practices in career and technical education programs.

(g) School districts and ACTSs administering career and technical education programs shall develop written policies regarding admissions. Course announcements, guidance materials and other communications must convey the philosophy of equal access to students considering enrolling in ACTSs and include a description of admissions policies. The policies must assure that when admissions to ACTSs must be limited, the admissions shall be on a nondiscriminatory basis.

§ 4.32. Standards and reports.

(a) The Secretary is responsible for the promulgation of standards appropriate for implementing § 4.31 (relating to career and technical education). Present standards, to the extent that they are inconsistent, are superseded by this chapter.

(b) The Secretary will report annually to the Board on the status of career and technical education programs, including tech-prep and apprenticeship programs. Reports will include numbers and types of programs, numbers of students, post-program status of students, Statewide competency standards and assessment information.

§ 4.33. Advisory committees.

(a) A school district or ACTS administering or planning to administer career and technical education programs shall appoint a local advisory committee. Membership on the committee shall consist of business and industry representatives, public sector employers, agriculture, labor organizations, community organizations, postsecondary education institutions and the general public. The appointed advisory committee shall meet at least once each year and give advice to the board and the administration concerning the program of the school, including its general philosophy, academic and other standards, course offerings, support services, safety requirements and the skill needs of employers. An advisory committee may serve multiple institutions where employment areas overlap.

(b) An administrative committee, composed of chief school administrators representing participating school districts, shall be included in the organization of each ACTS. The committee shall advise the ACTS board and the administration concerning the educational program and policies of the school.

(c) An occupational advisory committee shall be established for each career and technical education program or cluster of related programs offered by a school district or ACTS. The committee shall be appointed by the board of directors, and a majority of the members of the committee shall be employees and employers in the occupation for which training is provided. The committee shall meet at least twice each year to advise the board, administration and staff on curriculum, equipment, instructional materials, safety requirements, program evaluation and other related matters and to verify that the programs meet industry standards and, if appropriate, licensing board criteria and that they prepare students with occupation related competencies.

§ 4.34. Programs and equipment.

(a) A satellite career and technical education program may be operated by an ACTS board in conformity with a memorandum of understanding adopted with the participating school district's board of school directors.

(b) Certified guidance personnel in each secondary school and ACTS shall be assigned responsibility to provide pupils with career and technical education guidance services.

(c) Equipment will be deemed appropriate if it is compatible, insofar as practical, to that used in occupations or households for which career and technical education is provided.

§ 4.35. ACTSs.

(a) ACTS attendance areas shall conform to the plan of the State Board of Career and Technical Education. Boards of school directors may petition the State Board of Career and Technical Education for attendance area assignment or reassignment.

(b) The following provisions apply to the establishment of ACTSs:

(1) Where more than one district constitutes an attendance area, the appropriate intermediate unit may, and upon the request of any school district shall, call for an election by the boards of school directors within the attendance area to determine if an ACTS shall be established.

(2) A school district within the attendance area may elect to participate in the establishment of the ACTS.

(3) Where a single school district constitutes an attendance area, the board of school directors of that district may establish and operate ACTSs and be considered an ACTS board.

(c) The following provisions apply to articles of agreement for the establishment and operation of ACTSs:

(1) The boards of school directors of the school districts electing to participate in the ACTS shall enter into a written agreement setting forth rights and obligations of the participating school districts.

(2) No change will be made in the articles of agreement under paragraph (1) without the consent of each participating school district by the affirmative vote of each board of school directors.

(3) No school district may withdraw from the articles of agreement under paragraph (1) without the consent of each participating school district.

ASSESSMENT

§ 4.51. State assessment system.

(a) The State assessment system shall be designed to serve the following purposes:

(1) Provide students, parents, educators and citizens with an understanding of student and school performance consistent with the Every Student Succeeds Act (Pub.L. No. 114-95).

(2) Determine the degree to which school programs enable students to attain proficiency of academic standards under § 4.12 (relating to academic standards).

(3) Provide information to State policymakers, including the General Assembly and the Board, on how effective schools are in promoting and demonstrating student proficiency of academic standards.

(4) Provide information to the general public on school performance.

(5) Provide results to school entities based upon the aggregate performance of all students, for students with an Individualized Education Program (IEP) and for those without an IEP.

(6) Assess student proficiency in the Academic Standards for English Language Arts (Appendix A-2), Mathematics (Appendix A-2), and, through June 30, 2025, Science and Technology and Environment and Ecology (Appendix B), and, beginning July 1, 2025, Science, Environment, Ecology and Technology and Engineering (Appendix B-1) for the purpose of determining, in part, a student's eligibility for high school graduation.

(b) The State assessment system must include PSSA assessments and Keystone Exams.

(c) Neither State assessments nor academic standards under § 4.12 may require students to hold or express particular attitudes, values or beliefs.

(d) The Department will make samples of State assessment questions, assessment formats and scoring guides available to the public after each administration of State assessments.

(e) To ensure that information regarding student performance is available to parents and teachers, State assessments developed under this section must include student names.

(f) Individual assessment results shall be used in planning instruction only by parents, teachers, administrators and guidance counselors with a need to know based upon local board policy on testing and in reporting academic progress.

(g) The Department and other Commonwealth entities are prohibited from collecting individual student test scores and may collect only aggregate test scores by school and district.

(h) The Board will authorize the expansion of the State assessment system through a revision of this chapter.

(1) The Board will not include National assessments as part of the State assessment system unless, upon consultation with teachers, counselors and parents representing students who have been identified under Chapter 14 (relating to special education services and programs), the Board determines the assessment is an appropriate means of assessing the academic progress of students identified under Chapter 14, or unless the General Assembly authorizes the use of a National assessment.

(2) Subject to paragraph (3), the Board will not, and the Department may not, be a governing state in any consortium for the development of a National assessment for the purpose of utilization as part of the State assessment system.

(3) The Department may continue to participate in a consortium to develop an alternate assessment to measure the academic progress of students identified under Chapter 14.

(i) The Department will implement provisions for security of the State assessment system, including the following:

(1) Action by a professional employee or commissioned officer that is willfully designed to divulge test questions, falsify student scores or in some other fashion compromise the integrity of the State assessment system as determined by the school district, ACTS or charter school, including a cyber charter school, shall be subject to disciplinary action under the Educator Discipline Act (24 P.S. §§ 2070.1a—2070.18c).

(2) Cheating by students or employees other than those covered in paragraph (1) shall be subject to disciplinary action by the school district, ACTS or charter school, including a cyber charter school.

(3) Cheating or breaches of assessment security shall be reported to the Secretary as soon as detected.

(j) The Secretary is authorized to establish guidelines for the administration of the State assessment system.

(k) The Secretary will report each September to the Board and the General Assembly information and pertinent data regarding the State assessment system. The Secretary also will provide each school entity information and pertinent data for the school entity and its students.

(l) Children with disabilities and children with limited English proficiency shall be included in the State assessment system as required by Federal law, with appropriate accommodations when necessary. As appropriate, the Commonwealth will develop guidelines for the participation of children with disabilities in alternate assessments for those children who cannot participate in the PSSA or Keystone Exams as determined by each child's individualized education program team under the Individuals with Disabilities Education Act and this part.

§ 4.51a. Pennsylvania System of School Assessment.

(a) All PSSA assessments administered in English Language Arts, Mathematics, and Science, Environment, Ecology, Technology and Engineering will be standards-based and criterion referenced and include essay or open-ended response items in addition to other item formats. The proportion of type of items will vary by grade level. The criteria for judging performance on PSSA assessments are as follows:

(1) Performance on PSSA English Language Arts assessments shall be demonstrated by students' responses to comprehension questions about age-appropriate reading passages, by their written responses to in-depth comprehension questions about the passages and by the quality of their written compositions on a variety of topics and modes of writing.

(2) Performance on PSSA mathematics assessments shall be demonstrated by students' responses to questions about grade-appropriate content and by the quality of their responses to questions that require a written solution to a problem.

(3) Performance on PSSA science assessments shall be demonstrated by students' responses to grade appropriate content and by the quality of their responses to questions that demonstrate knowledge of each category of the standards for science, environment, ecology, technology and engineering.

(4) Performance levels shall be advanced, proficient, basic and below basic. In consultation with educators, students, parents and citizens, the Department will de-

velop and recommend to the Board for its approval specific criteria for advanced, proficient, basic and below basic levels of performance.

(b) The Department will develop or cause to be developed PSSA assessments based on Pennsylvania Core Standards in Mathematics and English Language Arts under § 4.12 (relating to academic standards) and contained in Appendix A-2. Through June 30, 2025, the Department will develop or cause to be developed PSSA assessments based on academic standards in Science, Technology, Environment and Ecology under § 4.12 and contained in Appendix B. Beginning July 1, 2025, the Department will develop or cause to be developed PSSA assessments based on academic standards in Science, Environment, Ecology, Technology and Engineering under § 4.12 and contained in Appendix B-1. In developing PSSA assessments, the Department will consult with educators, students, parents and citizens regarding the specific methods of assessment.

(c) The PSSA assessments shall be administered annually and include assessments of the State academic standards in Mathematics and English Language Arts at grades 3 through 8, and in Science, Environment, Ecology, Technology and Engineering at grades 4 and 8.

§ 4.51b. Keystone Exams.

(a) The Department will develop or cause to be developed Keystone Exams as provided in this subsection. (This subsection is intended by the Board to be a continuation of § 4.51(f) (relating to State assessment system) as published at 40 Pa.B. 240 (January 9, 2010) and referenced in section 102 of the School Code (24 P.S. § 1-102).)

(1) One assessment aligned with the Mathematics standards, contained in Appendix A-2, that assesses the academic content traditionally included in an Algebra I course.

(2) One assessment aligned with select English Language Arts standards, contained in Appendix A-2 that assesses academic content traditionally included in a high school literature course.

(3) Through June 30, 2025, one assessment aligned with select standards for Science, Technology, Environment and Ecology, contained in Appendix B, that assesses academic content traditionally included in a high school level Biology course. Beginning July 1, 2025, one assessment aligned with select standards for Science, Environment and Ecology, contained in Appendix B-1, that assesses academic content traditionally included in a high school level Biology course.

(b) Keystone Exams shall be offered at least three times each year: once each in the fall, spring and summer.

(c) Keystone Exams shall be administered, reviewed and scored so that scores for candidates for graduation are provided to schools no later than 10 calendar days prior to graduation. A school district, ACTS or charter school, including a cyber charter school, may request the Department to approve alternative test administration and scoring time frames. The Department will publish guidelines and procedures for approving alternative test administration and scoring time frames on its web site. The guidelines will provide for approval of all requests unless the approval is contrary to standards of test validity and scoring.

(d) A student shall be permitted to retake any Keystone Exam, or Keystone Exam module, in which the

student did not score proficient or above at the next available testing date. There is not a limit on the number of times a student who did not score proficient on a Keystone Exam is permitted to retake the Keystone Exam or Keystone Exam module. A student who has achieved a score of proficient or advanced on a Keystone Exam shall be permitted to retake a Keystone Exam only if the student or parent submits a request in writing to the school entity.

(e) Each Keystone Exam will be designed in modules that reflect distinct, related academic content that is common to the traditional progression of coursework to allow students who do not score proficient or above to retake those portions of the test in which they did not score proficient or above.

(f) A student taking Keystone Exams, or Keystone Exam modules, who did not score proficient on a Keystone Exam, or Keystone Exam module, may be provided supplemental instruction consistent with the student's educational program by the student's school district, ACTS or charter school, including a cyber charter school, consistent with section 121(c.4) of the School Code (24 P.S. § 1-121(c.4)).

(g) Performance levels for Keystone Exams shall be set at the advanced, proficient, basic and below basic levels. In consultation with the Performance Level Advisory Committee, the Department will develop and recommend to the Board for its approval performance level descriptors and performance level cut scores for the Keystone Exams and any alternative assessments developed to assess students with disabilities as permitted by the Every Student Succeeds Act (Pub.L. No. 114-95). The Department will use widely-accepted psychometric procedures to establish the cut scores. Cut scores shall be presented at a public meeting of the Board for its review at least 2 weeks prior to scheduled Board action on the cut scores.

(h) The Department will provide guidance to school districts, ACTSs and charter schools, including cyber charter schools, as to the appropriate accommodations school entities shall provide to students with disabilities, students who are gifted and English language learners, when appropriate.

(i) Beginning in the 2012-2013 school year, Keystone Exams in the following subjects will be developed by the Department and made available for use by school districts, ACTSs and charter schools, including cyber charter schools, for the purpose of assessing high school graduation requirements in § 4.24(c)(1)(iii) (relating to high school graduation requirements):

Algebra I

Literature

Biology

(j) The Department will seek to have the Keystone Exams approved as the high school level single accountability system under the Every Student Succeeds Act (20 U.S.C.A. §§ 6301—7981) or its successor Federal statute. If the Keystone Exams receive approval as the high school level accountability measure, school districts, ACTSs and charter schools, including cyber charter schools, shall administer the Literature, Algebra I and Biology exams as end-of-course tests in the grade level in which students complete the relevant coursework.

(k) The 11th grade PSSA exams in Reading, Writing, Math and Science shall be discontinued upon implementation of the Keystone Exams as the approved assessment

system under section 1111(b)(2)(C) of the No Child Left Behind Act of 2001 (20 U.S.C.A. § 6311(b)(2)(C)).

(l) At least once every 5 years, the Department will contract with a qualified, independent research organization to perform a validity study of the Keystone Exams using generally accepted education research standards. These studies will determine, at a minimum, the degree to which the Keystone Exams and performance level cut scores are valid for the purposes for which they are used; aligned with State academic standards; aligned with performance levels of other states; internationally benchmarked; and predict college and career success. In addition, all Keystone Exams, performance level descriptors and cut scores will be subject to the best available forms of content, criterion and consequential validation.

(m) The Department will establish a State Assessment Validation Advisory Committee (Committee). The Committee will advise the Department on its plans to conduct the validity study and review and provide feedback on its findings.

(n) The Department and the Committee will investigate the use of a certificate based on industry approved standards and performance on an NOCTI exam as an alternative pathway to graduation and will make a report and recommendation to the Board by January 10, 2011.

§ 4.51c. Project-based assessment.

The Department will develop a project-based assessment system that is aligned with the modules for the Keystone Exams in Literature, Algebra I and Biology. School entities may utilize project-based assessments for students consistent with section 121(c.5) of the School Code (24 P.S. § 1-121(c.5)).

§ 4.51d. Waivers.

A chief school administrator, in his sole discretion, may waive the requirements in § 4.24 (relating to high school graduation requirements) consistent with section 121(c.3) of the School Code (24 P.S. § 1-121(c.3)). The following apply:

(1) The chief school administrator of each school district, ACTS and charter school, including a cyber charter school, shall annually report to the Department the number of waivers granted to students in the most recent graduating class consistent with section 121(c.11)(6) of the School Code, and the Department will annually report to the Board the number of waivers granted by each school district, ACTS and charter school, including a cyber charter school.

(2) The waiver process described in this section does not confer an individual right on any student.

(3) The decision of a chief school administrator concerning a waiver request is not an adjudication.

§ 4.52. Local assessment system.

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(e) Children with disabilities shall be included in the local assessment system, with appropriate accommodations, when necessary. As appropriate, the school district, including a charter school, including a cyber charter school, or ACTS shall develop guidelines for the participation of children with disabilities in alternate assessments for those children who cannot participate in the local assessment as determined by each child's Individualized Education Program team under the Individuals with Disabilities Education Act and this part.

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APPENDIX B-1

Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K—5)^{1, 2}

Kindergarten

Earth and Space Sciences

Earth and Human Activity

1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.

3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Earth's Systems

1. Use and share observations of local weather conditions to describe patterns over time.

2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

Life Science

From Molecules to Organisms: Structures and Processes

1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

Physical Science

Motion and Stability: Forces and Interactions

1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Energy

1. Make observations to determine the effect of sunlight on Earth's surface.

2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

Grade 1

Earth and Space Sciences

Earth's Place in the Universe

1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.

¹Across grades K—5, all of the core ideas in Table 1 are covered, but not every discipline or core idea is reflected at every grade.

²The language of the standards is adapted, informed by or taken from the: National Research Council. (2012). A framework for K—12 science education: Practices, crosscutting concepts, and core ideas. North American Association for Environmental Education (2019) K—12 environmental education: Guidelines for excellence; International Society for Technology in Education Standards. (2019). ISTE standards for students; International Technology and Engineering Educators Association (ITEEA) (2020); NGSS Lead States. (2013). Next generation science standards: For states, by states; Standards for technological and engineering literacy: The role of technology and engineering in STEM education. National Council for Agricultural Education. (2015); International Society for Technology in Education. (2019). ISTE Standards for students. Agriculture, food and natural resources (AFNR) career cluster content standards; Pennsylvania State Board of Education. (2002). Academic standards for science and technology; Pennsylvania Department of Education. (2002). Safety guidelines for elementary and technology education teachers; Pennsylvania Department of Education. (n.d.). Pennsylvania career ready skills continuum; Standards for Technological and Engineering Literacy. (2020); Pennsylvania Association for Environmental Educators. (September 2015). Pennsylvania environmental literacy plan Pennsylvania State Board of Education. (2002). Academic standards for environment and ecology. North American Association for Environmental Education. (2014). State environmental literacy plans: 2014 status report.

2. Make observations at different times of year to relate the amount of daylight to the time of year.

Life Science

From Molecules to Organisms: Structures and Processes

1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

Heredity: Inheritance and Variation of Traits

1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Physical Science

Waves and Their Applications in Technologies for Information Transfer

1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.

3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Grade 2

Earth and Space Sciences

Earth's Place in the Universe

1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

Earth's Systems

1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.

3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.

Life Science

Ecosystems: Interactions, Energy, and Dynamics

1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.

2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Biological Evolution: Unity and Diversity

1. Make observations of plants and animals to compare the diversity of life in different habitats.

Matter and its Interactions

1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Grade 3

Earth and Space Sciences

Earth's Systems

1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

2. Obtain and combine information to describe climates in different regions of the world.

Earth and Human Activity

1. Make a claim supported by evidence about the merit of a design solution that reduces the impacts of a weather-related hazard.

Life Science

From Molecules to Organisms: Structures and Processes

1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

Ecosystems: Interactions, Energy, and Dynamics

1. Construct an argument that some animals form groups that help members survive.

Heredity: Inheritance and Variation of Traits

1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

2. Use evidence to support the explanation that traits can be influenced by the environment.

Biological Evolution: Unity and Diversity

1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

4. Make a claim supported by evidence about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

Physical Science

Motion and Stability: Forces and Interactions

1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

2. Make and communicate observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

4. Define a simple design problem that can be solved by applying scientific ideas about magnets.

Grade 4

Earth and Space Sciences

Earth's Place in the Universe

1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Earth's Systems

1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

2. Analyze and interpret data from maps to describe patterns of Earth's features.

Earth and Human Activity

1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Life Science

From Molecules to Organisms: Structures and Processes

1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

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.

Physical Science

Waves and Their Applications in Technologies for Information Transfer

1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

3. Generate and compare multiple solutions that use patterns to transfer information.

Energy

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

2. Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

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

4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grade 5

Earth and Space Sciences

Earth's Place in the Universe

1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

Earth's Systems

1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Earth and Human Activity

1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

2. Generate and design possible solutions to a current environmental issue, threat, or concern.

Life Science

From Molecules to Organisms: Structures and Processes

1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Ecosystems: Interactions, Energy, and Dynamics

1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Physical Science

Matter and Its Interactions

1. Develop a model to describe that matter is made of particles too small to be seen.

2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

3. Make and communicate observations and measurements to identify materials based on their properties.

4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

5. Interpret and analyze data to make decisions about how to utilize materials based on their properties.

Motion and Stability: Forces and Interactions

1. Support an argument that the gravitational force exerted by Earth on objects is directed down.

Energy

1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.

Standards by Grade Band

Grades K—2: Environmental Literacy and Sustainability

Agricultural and Environmental Systems and Resources

1. Examine how people from different cultures and communities, including one’s own, interact and express their beliefs about nature.
2. Categorize ways people harvest, re-distribute, and use natural resources.

Environmental Literacy Skills

1. Explain ways that places differ in their physical characteristics, their meaning, and their value and/or importance.
2. Plan and carry out an investigation to address an issue in their local environment and community.

Grades K—2: Technology and Engineering

Applying, Maintaining, and Assessing Technological Products and Systems

1. Analyze how things work.
2. Identify and use everyday symbols.
3. Describe qualities of everyday products.

Core Concepts of Technology and Engineering

1. Illustrate how systems have parts or components that work together to accomplish a goal.
2. Safely use tools to complete tasks.
3. Explain that materials are selected for use because they possess desirable properties and characteristics.
4. Develop a plan in order to complete a task.
5. Collaborate effectively as a member of a team.

Design in Technology and Engineering Education

1. Apply design concepts, principles, and processes through play and exploration.
2. Demonstrate that designs have requirements.
3. Explain that design is a response to wants and needs.
4. Discuss that all designs have different characteristics that can be described.
5. Illustrate that there are different solutions to a design and that none are perfect.
6. Demonstrate essential skills of the engineering design process.
7. Apply skills necessary for making a design.

History of Technology

1. Discuss how the way people live and work has changed throughout history because of technology.

Impacts of Technology

1. Explain ways that technology helps with everyday tasks.
2. Illustrate helpful and harmful effects of technology.
3. Compare simple technologies to evaluate their impacts.
4. Select ways to reduce, reuse, and recycle resources in daily life.
5. Design new technologies that could improve their daily lives.

Influence of Society on Technological Development

1. Explain the needs and wants of individuals and societies.
2. Explore how technologies are developed to meet individual and societal needs and wants.
3. Investigate the use of technologies in the home and community.

Integration of Knowledge, Technologies, and Practices

1. Apply concepts and skills from technology and engineering activities that reinforce concepts and skills across multiple content areas.
2. Draw connections between technology and human experiences.

Nature and Characteristics of Technology and Engineering

1. Compare the natural world and human-made world.
2. Explain the tools and techniques that people use to help them do things.
3. Demonstrate that creating can be done by anyone.
4. Discuss the roles of scientists, engineers, technologists and others who work with technology.

Grades 3—5: Environmental Literacy and Sustainability

Agricultural and Environmental Systems and Resources

1. Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.
2. Make a claim about the environmental and social impacts of design solutions and civic actions, including their own actions.

Environmental Literacy Skills

1. Investigate how perspectives over the use of resources and the development of technology have changed over time and resulted in conflict over the development of societies and nations.
2. Develop a model to demonstrate how local environmental issues are connected to larger local environment and human systems.

Sustainability and Stewardship

1. Critique ways that people depend on and change the environment.
2. Examine ways you influence your local environment and community by collecting and displaying data.
3. Construct an argument to support whether action is needed on a selected environmental issue and propose possible solutions.

Grades 3—5: Technology and Engineering

Applying, Maintaining, and Assessing Technological Products and Systems

1. Follow directions to complete a technological task.
2. Use appropriate symbols, numbers and words to communicate key ideas about technological products and systems.
3. Identify why a product or system is not working properly.

4. Examine information to assess the trade-offs of using a product or system.

Core Concepts of Technology and Engineering

1. Describe how a subsystem is a system that operates as a part of another larger system.

2. Illustrate how, when parts of a system are missing, it may not work as planned.

3. Identify the resources needed to get a technical job done, such as people, materials, capital, tools, machines, knowledge, energy, and time.

4. Describe the properties of different materials.

5. Demonstrate how tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.

6. Describe requirements of designing or making a product or system.

7. Create a new product that improves someone's life.

Design in Technology and Engineering Education

1. Illustrate that there are multiple approaches to design.

2. Demonstrate essential skills of the engineering design process.

3. Evaluate designs based on criteria, constraints, and standards.

4. Interpret how good design improves the human condition.

5. Apply universal principles and elements of design.

6. Evaluate the strengths and weaknesses of existing design solutions, including their own solutions.

7. Practice successful design skills.

8. Apply tools, techniques, and materials in a safe manner as part of the design process.

History of Technology

1. Create representations of the tools people made, how they cultivated to provide food, made clothing, and built shelters to protect themselves.

Impacts of Technology

1. Describe the helpful and harmful effects of technology.

2. Judge technologies to determine the best one to use to complete a given task or meet a need.

3. Classify resources used to create technologies as either renewable or nonrenewable.

4. Explain why responsible use of technology requires sustainable management of resources.

5. Predict how certain aspects of their daily lives would be different without given technologies.

Influence of Society on Technological Development

1. Determine factors that influence changes in a society's technological systems or infrastructure.

2. Explain how technologies are developed or adapted when individual or societal needs and wants change.

Integration of Knowledge, Technologies, and Practices

1. Demonstrate how simple technologies are often combined to form more complex systems.

2. Explain how various relationships can exist between technology and engineering and other content areas.

Nature and Characteristics of Technology and Engineering

1. Compare how things found in nature differ from things that are human-made, noting differences and similarities in how they are produced and used.

2. Describe the unique relationship between science and technology, and how the natural world can contribute to the human-made world to foster innovation.

3. Differentiate between the role of scientists, engineers, technologists, and others in creating and maintaining technological systems.

4. Design solutions by safely using tools, materials, and skills.

5. Explain how solutions to problems are shaped by economic, political, and cultural forces.

Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6—12)

Standards for Grades 6—8^{3, 4}

Physical Science

Structure and Properties of Matter

1. Develop models to describe the atomic composition of simple molecules and extended structures.

2. Gather and make sense of information to describe how synthetic materials come from natural resources and impact society.

3. Develop a model that predicts and describes changes in the particle motion, temperature and state of a pure substance when thermal energy is added or removed.

Chemical Reactions

1. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

2. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

3. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*

Forces and Interactions

1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*

2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

³ The asterisk (*) indicates that the Performance Expectation is integrating Engineering Design.

⁴ The language of the standards is adapted, informed by or taken from the: National Research Council. (2012). A framework for K—12 science education: Practices, crosscutting concepts, and core ideas. North American Association for Environmental Education (2019) K—12 environmental education: Guidelines for excellence; International Society for Technology in Education Standards. (2019). ISTE standards for students; International Technology and Engineering Educators Association (ITEEA) (2020); NGSS Lead States. (2013). Next generation science standards: For states, by states; Standards for technological and engineering literacy: The role of technology and engineering in STEM education. National Council for Agricultural Education. (2015); International Society for Technology in Education. (2019). ISTE Standards for students. Agriculture, food and natural resources (AFNR) career cluster content standards; Pennsylvania State Board of Education. (2002). Academic standards for science and technology; Pennsylvania Department of Education. (2002). Safety guidelines for elementary and technology education teachers; Pennsylvania Department of Education. (n.d.). Pennsylvania career ready skills continuum; Standards for Technological and Engineering Literacy. (2020); Pennsylvania Association for Environmental Educators. (September 2015). Pennsylvania environmental literacy plan Pennsylvania State Board of Education. (2002). Academic standards for environment and ecology. North American Association for Environmental Education. (2014). State environmental literacy plans: 2014 status report.

3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Energy

1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass and speed of an object.

2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*

4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Waves and Electromagnetic Radiation

1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

2. Develop and use a model to describe how waves are reflected, absorbed, or transmitted through various materials.

3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

Life Science

Structure, Function, and Information Processing

1. Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells.

2. Develop and use a model to describe the function of a cell as a whole and the ways that parts of cells contribute to the function.

3. Use arguments supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

4. Gather and synthesize information about how sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Matter and Energy in Organisms and Ecosystems

1. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

2. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

3. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

4. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

5. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Interdependent Relationships in Ecosystems

1. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

2. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

Growth, Development, and Reproduction of Organisms

1. Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.

2. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

3. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

4. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Natural Selection and Adaptations

1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

2. Apply scientific ideas to construct an explanation for anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

3. Analyze displays of pictorial data to compare patterns of similarities in anatomical structures across multiple species to identify relationships not evident in the fully formed anatomy.

4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

5. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Earth and Space Science

Space Systems

1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

2. Develop and use a model to describe the role of gravity in the motion within galaxies and the solar system.

3. Analyze and interpret data to determine scale properties of objects in the solar system.

History of Earth

1. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions.

Earth's Systems

1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

2. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

3. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Weather and Climate

1. Collect data to provide evidence for how the motion and complex interactions of air masses result in changes in weather conditions.

2. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

3. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Human Impacts

1. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

2. Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.*

3. Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems.

Engineering, Technology, and Applications of Science

Engineering Design (Define Problems, Develop Solutions and Improve Designs)

1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Environmental Literacy and Sustainability

Agricultural and Environmental Systems and Resources

Agricultural Systems

1. Develop a model to describe how agricultural and food systems function, including the sustainable use of natural resources and the production, processing, and management of food, fiber, and energy.

Environment and Society

1. Analyze and interpret data about how different societies (economic and social systems) and cultures use and manage natural resources differently.

Watersheds and Wetlands

1. Develop a model to describe how watersheds and wetlands function as systems, including the roles and functions they serve.

Environmental Literacy Skills

Investigating Environmental Issues

1. Gather, read, and synthesize information from multiple sources to investigate how Pennsylvania environmental issues affect Pennsylvania's human and natural systems.

Environmental Experiences

1. Collect, analyze, and interpret environmental data to describe a local environment.

Evaluating Solutions

1. Obtain and communicate information on how integrated pest management could improve indoor and outdoor environments.

Sustainability and Stewardship

Environmental Sustainability

1. Obtain and communicate information to describe how best management practices and environmental laws are designed to achieve environmental sustainability.

Environmental Stewardship

1. Design a solution to an environmental issue in which individuals and societies can engage as stewards of the environment.

Environmental Justice

1. Construct an explanation that describes regional environmental conditions and their implications on environmental justice and social equity.

Standards for Grades 9—12^{5, 6}**Physical Science*****Structure and Properties of Matter***

1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

2. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

3. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

4. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*

Chemical Reactions

1. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

2. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

3. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

4. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*

5. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Forces and Interactions

1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

3. Apply scientific and engineering ideas to design, evaluate and refine a device that minimizes the force on a macroscopic object during a collision.*

⁵ The asterisk (*) indicates that the Performance Expectation is integrating Engineering Design.

⁶ The language of the standards is adapted, informed by or taken from the: National Research Council. (2012). A framework for K—12 science education: Practices, crosscutting concepts, and core ideas. North American Association for Environmental Education (2019) K—12 environmental education: Guidelines for excellence; International Society for Technology in Education Standards. (2019). ISTE standards for students; International Technology and Engineering Educators Association (ITEEA) (2020); NGSS Lead States. (2013). Next generation science standards: For states, by states; Standards for technological and engineering literacy: The role of technology and engineering in STEM education. National Council for Agricultural Education. (2015); International Society for Technology in Education. (2019). ISTE Standards for students. Agriculture, food and natural resources (AFNR) career cluster content standards; Pennsylvania State Board of Education. (2002). Academic standards for science and technology; Pennsylvania Department of Education. (2002). Safety guidelines for elementary and technology education teachers; Pennsylvania Department of Education. (n.d.). Pennsylvania career ready skills continuum; Standards for Technological and Engineering Literacy. (2020); Pennsylvania Association for Environmental Educators. (September 2015). Pennsylvania environmental literacy plan Pennsylvania State Board of Education. (2002). Academic standards for environment and ecology. North American Association for Environmental Education. (2014). State environmental literacy plans: 2014 status report.

4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

Energy

1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

3. Design, build and refine a device that works within given constraints to convert one form of energy into another form of energy.*

4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Waves and Electromagnetic Radiation

1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

2. Evaluate questions about the advantages of using digital transmission and storage of information.

3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model and that for some situations one model is more useful than the other.

4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

Life Science***Structure and Function***

1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Matter and Energy in Organisms and Ecosystems

1. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

2. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

3. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

4. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

5. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

6. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Interdependent Relationships in Ecosystems

1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

3. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

4. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

5. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

6. Create or revise a simulation to test a solution to mitigate the adverse impacts of human activity on biodiversity.*

Inheritance and Variation of Traits

1. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

2. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

3. Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

4. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Natural Selection and Evolution

1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

2. Construct an explanation based on evidence that the process of evolution primarily results from four factors:

(1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Earth and Space Science

Space Systems

1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.

2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, the motion of distant galaxies, and the composition of matter in the universe.

3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

History of Earth

1. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

2. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

3. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

Earth's Systems

1. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.

2. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

3. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

4. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

5. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Weather and Climate

1. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

2. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Human Sustainability

1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*

3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

4. Evaluate or refine a technological solution that reduces the impact of human activities on natural systems.*

5. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Engineering, Technology, and Applications of Science***Engineering Design (Define Problems, Develop Solutions and Improve Designs)***

1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Environmental Literacy and Sustainability***Agricultural and Environmental Systems and Resources******Agricultural Systems***

1. Analyze and interpret how issues, trends, technologies, and policies impact agricultural, food, and environmental systems and resources.

Environment and Society

1. Apply research and analytical skills to evaluate the conditions and motivations that lead to conflict, cooperation, and change among individuals, groups, and nations.

Watersheds and Wetlands

1. Analyze and interpret how issues, trends, technologies, and policies impact watersheds and water resources.

Environmental Literacy Skills***Investigating Environmental Issues***

1. Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those that are regional or global in scope.

Environmental Experiences

1. Plan and conduct an investigation utilizing environmental data about a local environmental issue.

Evaluating Solutions

1. Evaluate and communicate the effect of integrated pest management practices on indoor and outdoor environments.

Sustainability and Stewardship***Environmental Sustainability***

1. Analyze and evaluate how best management practices and environmental laws achieve sustainability of natural resources.

Environmental Stewardship

1. Design and evaluate solutions in which individuals and societies can promote stewardship in environmental quality and community well-being.

Environmental Justice

1. Analyze and interpret data on a regional environmental condition and its implications on environmental justice and social equity.

**Technology and Engineering Academic Standards⁷
Grades 6—8*****Nature and Characteristics of Technology and Engineering***

1. Consider historical factors that have contributed to the development of technologies and human progress.

2. Engage in a research and development process to simulate how inventions and innovations have evolved through systematic tests and refinements.

3. Differentiate between inputs, processes, outputs, and feedback in technological systems.

4. Demonstrate how systems thinking involves considering relationships between every part, as well as how the systems interact with the environment in which it is used.

5. Create an open-loop system that has no feedback path and requires human intervention.

6. Create a closed-loop system that has a feedback path and requires no human intervention.

7. Predict outcomes of a future product or system at the beginning of the design process.

8. Apply informed problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.

9. Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.

⁷ The language of the standards is adapted, informed or from the: International Technology and Engineering Educators Association (ITEEA). (2020). Standards for technological and engineering literacy: The role of technology and engineering in STEM education. Pennsylvania State Board of Education. (2002). Academic standards for science and technology; Pennsylvania Department of Education. (2002). Safety guidelines for elementary and technology education teachers; Pennsylvania Department of Education. (n.d.). Pennsylvania career ready skills continuum.

10. Compare how different technologies involve different sets of processes.

Integration of Knowledge, Technologies, and Practices

1. Compare, contrast, and identify overlap between the contributions of science, technology, engineering, and mathematics in the development of technological systems.

2. Analyze how different technological systems often interact with economic, environmental, and social systems.

3. Adapt and apply an existing product, system, or process to solve a problem in a different setting.

4. Demonstrate how knowledge gained from other content areas affects the development of technological products and systems.

Applying, Maintaining, Assessing and Evaluating Technological Products and Systems

1. Examine the ways that technology can have both positive and negative effects at the same time.

2. Analyze how the creation and use of technologies consumes renewable, non-renewable, and inexhaustible resources; creates waste; and may contribute to environmental challenges.

3. Consider the impacts of a proposed or existing technology and devise strategies for reducing, reusing, and recycling waste caused by its creation.

4. Analyze examples of technologies that have changed the way people think, interact, live, and communicate.

5. Hypothesize what alternative outcomes (individual, cultural, and/or environmental) might have resulted had a different technological solution been selected.

6. Analyze how an invention or innovation was influenced by the context and circumstances in which it is developed.

7. Evaluate trade-offs based on various perspectives as part of a decision process that recognizes the need for careful compromises among competing factors.

8. Research information from various sources to use and maintain technological products or systems.

9. Use tools, materials, and machines to safely diagnose, adjust, and repair systems.

10. Use devices to control technological systems.

11. Design methods to gather data about technological systems.

12. Interpret the accuracy of information collected.

13. Use instruments to gather data on the performance of everyday products.

Design Thinking in Technology and Engineering Education

1. Apply a technology and engineering design thinking process.

2. Develop innovative products and systems that solve problems and extend capabilities based on individual or collective needs and wants.

3. Illustrate the benefits and opportunities associated with different approaches to design.

4. Create solutions to problems by identifying and applying human factors in design.

5. Evaluate and assess the strengths and weaknesses of various design solutions given established principles and elements of design.

6. Refine design solutions to address criteria and constraints.

7. Defend decisions related to a design problem.

Grades 9–12

Nature and Characteristics of Technology & Engineering

1. Evaluate how technology and engineering have been powerful forces in reshaping the social, cultural, political, and economic landscapes throughout history.

2. Relate how technological and engineering developments have been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.

3. Identify and explain how the evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools, materials, and processes.

4. Analyze how the Industrial Revolution resulted in the development of mass production, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time.

5. Investigate the widespread changes that have resulted from the Information Age, which has placed emphasis on the processing and exchange of information.

6. Analyze the rate of technological and engineering development and predict future diffusion and adoption of new innovations and technologies.

7. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.

8. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.

9. Troubleshoot and improve a flawed system embedded within a larger technological, social, or environmental system.

10. Use project management tools, strategies, and processes in planning, organizing, and controlling work.

11. Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.

Integration of Knowledge, Technologies, and Practices

1. Assess how similarities and differences among scientific, technological, engineering, and mathematical knowledge and skills contributed to the design of a product or system.

2. Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.

3. Analyze how technology transfer occurs when a user applies an existing innovation developed for one function for a different purpose.

4. Evaluate how technology enhances opportunities for new products and services through globalization.

5. Connect technological and engineering progress to the advancement of other areas of knowledge and vice versa.

Applying, Maintaining, Assessing, and Evaluating Technological Products and Systems

1. Develop a solution to a technological problem that has the least negative environmental and social impact.
2. Develop a device or system for the marketplace.
3. Evaluate ways that technology and engineering can impact individuals, society, and the environment.
4. Critique whether existing or proposed technologies use resources sustainably.
5. Critically assess and evaluate a technology that minimizes resource use and resulting waste to achieve a goal.
6. Evaluate a technological innovation that arose from a specific society's unique need or want.
7. Evaluate how technology and engineering advancements alter human health and capabilities.
8. Evaluate a technological innovation that was met with societal resistance impacting its development.
9. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.
10. Synthesize data and analyze trends to make decisions about technological products, systems, or processes.
11. Interpret laws, regulations, policies, and other factors that impact the development and use of technology.

Design Thinking in Technology and Engineering Education

1. Apply a broad range of design skills to a design thinking process.

2. Implement and critique principles, elements, and factors of design.
3. Evaluate and define the purpose of a design.
4. Conduct research to inform intentional inventions and innovations that address specific needs and wants.
5. Analyze and use relevant and appropriate design thinking processes to solve technological and engineering problems.
6. Implement the best possible solution to a design using an explicit process.
7. Apply principles of human-centered design.
8. Optimize a design by addressing desired qualities within criteria and constraints while considering trade-offs.
9. Use a design thinking process to design an appropriate technology for use in a different culture.
10. Apply appropriate design thinking processes to diagnose, adjust, and repair systems to ensure precise, safe, and proper functionality.
11. Recognize and explain how their community and the world around them informs technological development and engineering design.
12. Safely apply an appropriate range of making skills to a design thinking process.

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