ETS1.A: Defining and Delimiting an Engineering Problem

Grade/Course	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
K	• A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (K-PS2-2) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary) (K-ESS3-2) • Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-ESS3-3)
4	• Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (secondary) (4-PS3-4)
6	• The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (6-PS3-3)
Physics	• Criteria may include satisfying cost, safety, reliability, aesthetics requirements and taking into account constraints regarding social, cultural, and environmental impacts. (P-PS2-3) (P-PS3-3)
Earth and Space Science	• Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (E-ESS3-2)

This page intentionally blank.

ETS1.B: Developing Possible Solutions

Grade/Course	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
K	• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-PS3-2)
1	• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (1-LS1-1) • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. To design something complicated, one may need to break the problem into parts and attend to each part separately, then bring the parts together to test the overall solution. (1-PS4-4)
2	• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (2-LS2-2) (2-ESS3-1)
3	• Testing a solution involves investigating how well it performs under a range of likely conditions. (3-PS2-4)
4	• At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (secondary) (4-PS3-4) • Testing a solution involves investigating how well it performs under a range of likely conditions. Communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (4-ESS3-2)
5	• Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (5-ESS3-1)

K-12 Conceptual Vertical Articulation of ETS1 – Engineering Design

Grade/Course	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
6	• A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (6-PS3-3)
7	• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (7-PS1-6) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary) (7-LS2-5)
8	• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (secondary) (8-PS2-1)
Biology	• When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability, and aesthetics and to consider social, cultural, and environmental impacts. (secondary) (B-LS2-7) • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary) Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary) (B-LS4-6)
Physics	• The aim of engineering is to design the best solution under clearly defined constraints and criteria, but there is often no one best solution. (P-PS2-3) (P-PS3-3) (P-PS4-2)
Earth and Space Science	• When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Testing should lead to improvements in the design through an iterative procedure. (secondary) (E-ESS3-2) (E-ESS3-4)

ETS1.C: Optimizing the Design Solution

Grade/Course	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
2	• Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (2-ESS2-1)
3	• Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-LS4-4) • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-ESS3-1)
4	• Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (4-PS4-3)
7	• Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (7-PS1-6)
Chemistry	• Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade- offs) may be needed. (secondary) (C-PS1-6) • Determining what constitutes “best,” however, requires value judgments, given that one person’s view of the optimal solution may differ from another’s. (secondary) (C-PS2-6)

K-12 Conceptual Vertical Articulation of ETS1 – Engineering Design

Grade/Course	Disciplinary Core Idea Statement with 2021 Performance Expectation Linked
Physics	• Criteria may need to be broken down into simpler ones that can be approached systematically. Trade-offs among the criteria will need to be analyzed, and certain criteria may need to be prioritized over others. (P-PS2-3) (P-PS3-3)

Adapted from *The Framework for K-12 Science Education* and the *Next Generation Science Standards.*

References:

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

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States (Appendix I: Engineering Design in the NGSS)*. Retrieved from https://www.nextgenscience.org/