Core Ideas			SE, INV, TG, Ancillary (section, sheet, or investigation number or page number)	Notes
ETS1		**ENGINEERING DESIGN** ***How do engineers solve problems?***		
ETS1.A		**Defining and Delimiting an Engineering Problem** ***What is a design for? What are the criteria and constraints of a successful solution?***		
		Design criteria and constraints, which typically reflect the needs of the end-user of a technology or process, address such things as the product's or system's function (what job it will perform and how), its durability, and limits on its size and cost.	SE: p 22-3, 39, 91	SE: Developing hybrid car technology, how to solve design problems, tires designed for bad weather
		Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.	SE: p 7, 148-9	SE: Science and technology and risks, developing technology for harvesting wind energy
		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.	SE: p 8, 148-9	SE: Different fields of engineering, wind energy technology
		These global challenges also may have manifestations in local communities.	SE: p 134 ANC: Ch16 activity	SE: Students research energy conservation in their community ANC: Studying the effects of acid rain
		But whatever the scale, the first things that engineers do is define the problem and specify the criteria and constraints for potential solutions.	SE: p 8, 38-9, 148-9	SE: Different fields of engineering, solving science and design problems, engineers working to find ways to use wind as an energy source
ETS1.B		**Developing Possible Solutions** ***What is the process for developing potential design solutions?***		
		Complicated problems may need to be broken down into simpler components in order to develop and test solutions.	SE: p 38-9 INV: 2A TG: p 26-7	SE: Solving science and design problems INV: Inquiry and scientific evidence TG: Teaching INV 2A
		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.	SE: p 22-3, 33, 148-9	SE: Developing hybrid car technology, invention of modern paper (a cost-saving discovery), developing wind energy technology
		Testing should lead to improvements in the design through an iterative procedure.	SE: p 7, 39, 149 INV: 2B	SE: The design cycle, solving design problems, testing wind turbines INV: Designing motion experiments INV: Inquiry and scientific evidence

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		Both physical models and computers can be used in various ways to aid in the engineering design process.	SE: p 7, 8, 32, 63	SE: The design cycle, the role of engineers, models, graphical models
		Physical models, or prototypes, are helpful in testing product ideas or the properties of different materials.	SE: p 7, 8, 32, 63	SE: The design cycle, the role of engineers, models, graphical models
		Computers are useful for a variety of purposes, such as in representing a design in 3-D through CAD software; in troubleshooting to identify and describe a design problem; in 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.	SE: p 7, 8, 56 ANC: Skill and practice sheet 6.3	SE: Science and technology, engineers and computers, computers used in space ANC: Using computer spreadsheets
ETS1.C		**Optimizing the Design Solution** ***How can the various proposed design solutions be compared and improved?***		
		The aim of engineering is not simply to find a solution to a problem but to design the best solution under the given constraints and criteria.	SE: p 240-1 ANC: Biography 8.1	SE: Noise reduction technology ANC: Lewis Latimer (inventor; invented carbon fibers for light bulbs making them more affordable)
		Optimization can be complex, however, for a design problem with numerous desired qualities or outcomes.	SE: p 35 ANC: Biographies 8.1, 8.2	SE: The design cycle ANC: Lewis Latimer (inventor and innovator), George Westinghouse (inventor and innovator)
		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.	SE: p 111, 113 INV: 12B	SE: Designing light-weight vehicles, trade-offs between performance and battery life INV: Designing a clay boat
		The comparison of multiple designs can be aided by a trade-off matrix.	SE: p 111, 113 INV: 12B	SE: Designing light-weight vehicles, trade-offs between performance and battery life INV: Designing a clay boat NOTE: The text addresses trade-offs but not trade-off matrices.

Core Ideas			SE, INV, TG, Ancillary (section, sheet, or investigation number or page number)	Notes
		Sometimes a numerical weighting system can help evaluate a design against multiple criteria.	SE: p 39 TG: p 5	SE: Solving design problems TG: Students examine the structure, design, and function of everyday appliances and devices NOTE: The text addresses design but not numerical weighting systems.
		When evaluating solutions, all relevant considerations, including cost, safety, reliability, and aesthetic, social, cultural, and environmental impacts, should be included.	SE: p 22-3, 33, 148-9	SE: Developing hybrid car technology, invention of modern paper (a cost-saving discovery), developing wind energy technology
		Testing should lead to design improvements through an iterative process, and computer simulations are one useful way of running such tests.	SE: p 7, 8, 56 INV: 12B	SE: Science and technology, engineers and computers, computers used in space INV: Designing a clay boat
ETS2		**LINKS AMONG ENGINEERING, TECHNOLOGY, SCIENCE, AND SOCIETY** ***How are engineering, technology, science, and society interconnected?***		
ETS2.A		**Interdependence of Science, Engineering, and Technology** ***What are the relationships among science, engineering, and technology?***		
		Science and engineering complement each other in the cycle known as research and development (R&D).	SE: p 38-9, 148-9 ANC: Biography 7.3	SE: Solving science and design problems, engineers working to find ways to use wind as an energy source ANC: Arthur Walker (pioneer in space-based research tools)
		Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	SE: p 8, 148-9 ANC: Biography 8.1	SE: Different fields of engineering, engineers working to find ways to use wind as an energy source ANC: Lewis Latimer (collaborated with Thomas Edison)
		For example, developing a means for safely and securely disposing of nuclear waste will require the participation of engineers with specialties in nuclear engineering, transportation, construction, and safety; it is likely to require as well the contributions of scientists and other professionals from such diverse fields as physics, geology, economics, psychology, and sociology.	SE: p 339 ANC: Biographies 13.1 and 13.2	SE: Work of Dr. Shirley Ann Jackson as chairman of the U.S. Nuclear Regulatory Commission ANC: Work of Marie and Pierre Curie, work of Albert Einstein

Core Ideas			SE, INV, TG, Ancillary (section, sheet, or investigation number or page number)	Notes
ETS2.B		**Influence of Engineering, Technology and Science on Society and the Natural World** ***How do science, engineering, and the technologies that result from them affect the ways in which people live? How do they affect the natural world?***		
		Modern civilization depends on major technological systems, including those related to agriculture, health, water, energy, transportation, manufacturing, construction, and communications.	SE: p 8, 38-9, 148-9	SE: Different fields of engineering, solving science and design problems, engineers working to find ways to use wind as an energy source
		Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	SE: p 22-3, 33, 148-9	SE: Developing hybrid car technology, invention of modern paper (a cost-saving discovery), developing wind energy technology
		Widespread adoption of technological innovations often depends on market forces or other societal demands, but it may also be subject to evaluation by scientists and engineers and to eventual government regulation.	SE: p 122, 148-9 ANC: Biography 13.1	SE: Work of Robert Goddard and rocket science, development of wind turbine technology ANC: Work of Rosalyn Sussman Yalow (radioimmunoassay; she did not seek a patent)
		New technologies can have deep impacts on society and the environment, including some that were not anticipated or that may build up over time to a level that requires attention or mitigation.	SE: p 7, 46-7, 148-9 ANC: Biography 13.1	SE: Science and technology, infrared technology, development of wind turbine technology ANC: Work of Rosalyn Sussman Yalow (radioimmunoassay; she did not seek a patent)
		Analysis of costs, environmental impacts, and risks, as well as of expected benefits, is a critical aspect of decisions about technology use.	SE: p 134, 401 ANC: Ch16 activity	SE: Students research energy conservation in their community, students research acid rain ANC: Studying the effects of acid rain