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 ANC: Biography 18.1	SE: The Boston Retinal Implant Project ANC: The work of Dr. Charles Drew during WWII
		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 22-3, 150-1	SE: The Boston Retinal Implant Project, organ transplant work
		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 97 INV: 5B TG: p 82-6	SE: Industry produces pollutants which harm our environment INV: Testing pollutants TG: Teaching the lesson related to INV 5B (i.e., students learn about the EPA)
		These global challenges also may have manifestations in local communities.	SE: p 24, 121	SE: Global population and resources, trees and global climate
		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 245-8, 250-1	SE: Genetic engineering and DNA and technology, the human genome project
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 22-3 INV: 1B	SE: The Boston Retinal Implant Project INV: Variable in an experiment (designing an experiment)
		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.	INV: p 98-100, 128-9 INV: 5B, p 124-126	INV: Toxins in the food chain and water quality testing, impact of forest fires INV: Testing pollutants, safety skills
		Testing should lead to improvements in the design through an iterative procedure.	SE: p 22-3 ANC: Biography 18.1, skill and practice sheet 1.2	SE: The Boston Retinal Implant Project ANC: The work of Dr. Charles Drew during WWII, the scientific method

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		Both physical models and computers can be used in various ways to aid in the engineering design process.	SE: p 13, 152, 422 ANC: Biography 12.1	SE: Designing experiments, building a scale model of a cell, computers and prosthetic leg technology ANC: DNA models (Watson and Crick)
		Physical models, or prototypes, are helpful in testing product ideas or the properties of different materials.	SE: p 422-3, 424, 452	SE: Prosthetic leg design and technology, students model how a leg works, human ear model
		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 22-3, 82 (#3), 422 INV: 10B	SE: Developing retinal implants, students design an advertising campaign about the importance of good nutrition, computers and prosthetic leg technology INV: Students simulate mitosis and meiosis (using basic materials)
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 22-3, 422-3 ANC: Biography 18.1	SE: The Boston Retinal Implant Project, developing prosthetic legs ANC: The work of Dr. Charles Drew during WWII, the scientific method
		Optimization can be complex, however, for a design problem with numerous desired qualities or outcomes.	SE: p 346, 416, 418 INV: 19A and 19B	SE: Students design a pollinator, designing systems of ropes and pulleys, mechanical advantage and levers INV: Mechanical advantage and levers
		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 346, 416, 418 INV: 19A and 19B	SE: Students design a pollinator, designing systems of ropes and pulleys, mechanical advantage and levers INV: Mechanical advantage and levers
		The comparison of multiple designs can be aided by a trade-off matrix.	SE: p 346, 416, 418 INV: 19A and 19B	SE: Students design a pollinator, designing systems of ropes and pulleys, mechanical advantage and levers INV: Mechanical advantage and levers NOTES: The text does not present 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 346, 416, 418 INV: 19A and 19B	SE: Students design a pollinator, designing systems of ropes and pulleys, mechanical advantage and levers INV: Mechanical advantage and levers NOTES: The text does not present 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, 422-3 ANC: Biography 6.3	SE: The Boston Retinal Implant Project, developing prosthetic legs ANC: The work of Wangari Maathai toward solving social and environmental problems in Kenya
		Testing should lead to design improvements through an iterative process, and computer simulations are one useful way of running such tests.	SE: p 13, 422 ANC: Biography 12.1	SE: Designing experiments, computers and prosthetic leg technology ANC: DNA models (Watson and Crick)
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 22-3 ANC: Biography 18.1, skill and practice sheet 1.2	SE: The Boston Retinal Implant Project ANC: The work of Dr. Charles Drew during WWII, the scientific method
		Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	SE: p 22-3 ANC: Biography 12.1	SE: The Boston Retinal Implant Project ANC: The work of Watson and Crick (and others) who contributed to solving the structure of DNA
		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 31, 300	SE: Nuclear energy described, radioactivity and half-life described NOTE: LSN2 does not present the issues associated with nuclear waste, but it does present other examples of teams of professionals working together.

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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 22-3 ANC: Biographies 6.3, 16.1	SE: Technological systems are used to develop retinal implants ANC: Wangari Maathai's work to put basic systems in place in rural Kenya (Green Belt Movement), agriculture scientific work of George Washington Carver
		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 ANC: Biography 18.1	SE: The Boston Retinal Implant Project ANC: The work of Dr. Charles Drew during WWII
		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 38-9, 137, 450-1	SE: Technology and the ability to study life on Mars, the invention of the microscope and its role in the progress of life science, technology involved in eye care
		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 38-9, 137, 250-1 INV: 5B	SE: Technology and the ability to study life on Mars, the invention of the microscope and its role in the progress of life science, the human genome project INV: Testing pollutants
		Analysis of costs, environmental impacts, and risks, as well as of expected benefits, is a critical aspect of decisions about technology use.	SE: p 38-9, 250-1	SE: Technology and the ability to study life on Mars, the human genome project