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 536-7 INV: 15.3	SE: Developing retinal implants INV: Making a model maglev train
		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 96-7, 265	SE: Forensic engineering (studying cars and collisions, improving car safety), criteria and constraints for managing and storing nuclear waste
		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 208-9, 332-3	SE: On-going effort to harvest energy from tidal power (design structures that work with the environment), developing the future of transportation
		These global challenges also may have manifestations in local communities.	SE: p 186-7 TG: p 309	SE: Designing windmills and providing wind power for communities in Africa TG: Students meet with local experts who are involved in providing electricity and power to their community
		But whatever the scale, the first things that engineers do is define the problem and specify the criteria and constraints for potential solutions.	INV: 15.3 TG: p 353-5	INV: Making a model maglev train and the engineering cycle TG: Teaching INV 15.3 (making a model maglev train and the engineering cycle)
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 20, 92, 440-1	SE: Solving physics problems, problem solving steps, solving engineering problems related to tall buildings
		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 266-7, 440-1	SE: New technology (remote sensing) allows archeologists to work and respect local culture, engineering problems related to tall buildings

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		Testing should lead to improvements in the design through an iterative procedure.	INV: 15.3 TG: p 353-5	INV: Making a model maglev train and the engineering cycle TG: Teaching INV 15.3 (making a model maglev train and the engineering cycle)
		Both physical models and computers can be used in various ways to aid in the engineering design process.	SE: p 376-7, 558-9	SE: Using MRI and computer technology to create 2-D or 3-D models of the human body, the use of 3-D imaging in the movie industry and science
		Physical models, or prototypes, are helpful in testing product ideas or the properties of different materials.	INV: 15.3 TG: p 353-5	INV: Making a model maglev train and the engineering cycle TG: Teaching INV 15.3 (making a model maglev train and the engineering cycle)
		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 376-7, 558-9	SE: Using MRI and computer technology to create 2-D or 3-D models of the human body, the use of 3-D imaging in the movie industry and science
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 20, 92, 440-1	SE: Solving physics problems, problem solving steps, solving engineering problems related to tall buildings
		Optimization can be complex, however, for a design problem with numerous desired qualities or outcomes.	SE: p 126-7, 440-1	SE: Development of architecture over time, Solving engineering problems related to tall buildings
		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: 332-3, 440-1	SE: Developing the future of transportation, building skyscrapers involves developing strategies to keep the building stable
		The comparison of multiple designs can be aided by a trade-off matrix.	SE: p 126-7, 440-1	SE: Development of architecture over time, solving engineering problems related to tall buildings Note: 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 208-9 INV: 8.1	SE: Developing technology to harness ocean energy INV: Design experiments to test ideas for improving energy efficiency 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 536-7 INV: 15.3	SE: Developing retinal implants INV: Making a model maglev train
		Testing should lead to design improvements through an iterative process, and computer simulations are one useful way of running such tests.	INV: 4.2, 15.3	INV: Testing predictions to understand the law of conservation of energy, making a model maglev train and the engineering cycle
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 266-7, 512-3	SE: Teams of experts working together and using technology to make archeological discoveries, invention and uses of the CCD
		Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	SE: p 266-7, 512-3	SE: Teams of experts working together and using technology to make archeological discoveries, invention and uses of the CCD
		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 264, 265	SE: Nuclear power, managing and storing nuclear waste

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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 208-9, 418-9	SE: Energy from ocean power, studying magnetic storms to protect communications systems
		Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	SE: p 96-7, 332-3	SE: Forensic engineering (studying cars and collisions, improving car safety), development of future, energy-efficient cars
		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 116, 265	SE: Weigh station is to monitor trucks to make sure their weight doesn't exceed safety limits, the role of government in managing nuclear waste
		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 96-7, 265	SE: Forensic engineering (studying cars and collisions, improving car safety), criteria and constraints for managing and storing nuclear waste
		Analysis of costs, environmental impacts, and risks, as well as of expected benefits, is a critical aspect of decisions about technology use.	SE: p 46-7, 208-9	SE: Computers used to trace and map seal migrations and reduce environmental impact of fisheries, on-going effort to harvest energy from tidal power (design structures that work with the environment)