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 200-1; 272-3 INV: 5A	SE: Mapmaking and technology used to design maps, building breakwaters INV: Students construct a barometer
		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 200-1 TG: p 31 ANC: Biography 12.1	SE: Using technology to design maps TG: Students use models to design a new school ANC: The work of Charles Richter and Beno Gutenberg on the magnitude scale system for earthquakes (to better understand quakes and reduce risk)
		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 46-7, 94 INV: 15A	SE: The work of hydrogeologists, the importance of water conservation INV: Conserving natural resources
		These global challenges also may have manifestations in local communities.	SE: p 13-5, 46-7 TG: p 31	SE: The scientific method, hydrogeologists and environmental monitoring TG: Students meet an engineer and practice using models as a way to design a new school
		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 13-5, 39 TG: p 31 ANC: Skill and practice sheet 1.3	SE: The scientific method, models and engineering TG: Students meet an engineer and practice using models as a way to design a new school ANC: The scientific method
ETS1.B		**Developing Possible Solutions** ***What is the process for developing potential design solutions?***		

Core Ideas			SE, INV, TG, Ancillary (section, sheet, or investigation number or page number)	Notes
		Complicated problems may need to be broken down into simpler components in order to develop and test solutions.	SE: p 13-5, 71 TG: p 31 ANC: Skill and practice sheet 1.3	SE: The scientific method, civil engineers and canoe design TG: Students meet an engineer and practice using models as a way to design a new school ANC: The scientific method
		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 46-7, 298 TG: p 31	SE: The work of hydrogeologists and whether or not to build a landfill, students evaluate the first seismograph TG: Students use models to design a new school
		Testing should lead to improvements in the design through an iterative procedure.	SE: p 13-5, 71 INV: 5A ANC: Skill and practice sheet 1.3	SE: The scientific method, civil engineers and concrete canoe design INV: Students evaluating the design of a barometer they made ANC: The scientific method
		Both physical models and computers can be used in various ways to aid in the engineering design process.	SE: p 36-40, 148 INV: 2B TG: p 30-1	SE: Systems and models, computer models and weather forecasting INV: Students model a river TG: Teaching about systems and models
		Physical models, or prototypes, are helpful in testing product ideas or the properties of different materials.	SE: p 36-40 INV: 2B TG: p 30-1	SE: Systems and models INV: Students model a river TG: Teaching about systems and 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 116-7, 200-1, 236	SE: Hurricane hunters and technology, CAD technology and mapmaking, seismic tomography
ETS1.C		**Optimizing the Design Solution** ***How can the various proposed design solutions be compared and improved?***		

Core Ideas			SE, INV, TG, Ancillary (section, sheet, or investigation number or page number)	Notes
		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 71, 470-1 TG: p 31	SE: Civil engineers and concrete canoe design, mathematics and space engineering TG: Students meet with engineers and building contractor to learn about building design
		Optimization can be complex, however, for a design problem with numerous desired qualities or outcomes.	SE: p 71, 394, 453, 470-1	SE: Civil engineers and concrete canoe design, home design and insulation, X-ray telescope design, mathematics and space engineering
		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 17, 383-4	SE: Using the scientific method, evaluating energy resources
		The comparison of multiple designs can be aided by a trade-off matrix.	SE: p 383-4 INV: 5A TG: p 88-93	SE: Evaluating energy resources (evaluation chart) INV: Students make a barometer and evaluation their design TG: Teaching INV 5A
		Sometimes a numerical weighting system can help evaluate a design against multiple criteria.	SE: p 383 INV: 5A TG: p 88-93	SE: Evaluating energy resources INV: Students make a barometer and evaluation their design TG: Teaching INV 5A
		When evaluating solutions, all relevant considerations, including cost, safety, reliability, and aesthetic, social, cultural, and environmental impacts, should be included.	SE: p 46-7, 383	SE: Hydrogeologists and determining whether to build a landfill, evaluating energy resources
		Testing should lead to design improvements through an iterative process, and computer simulations are one useful way of running such tests.	SE: p 13-5, 17, 470-1 INV: 1B	SE: The scientific method, using the scientific method, mathematics and space engineering INV: Developing and testing a hypothesis
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 6, 13-5, 17, 470-1	SE: The fields of science, the scientific method, using the scientific method, mathematics and space engineering

Core Ideas			SE, INV, TG, Ancillary (section, sheet, or investigation number or page number)	Notes
		Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	SE: p 6, 13-5, 73	SE: The fields of science, scientific method, scientists and engineers teamed up to aid hot-air balloon flight around the world
		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 46-7, 381, 383	SE: The work of hydrogeologists and determining whether to build a landfill, nuclear energy and waste, evaluating energy resources
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 18-9, 73, 116-7, 383	SE: Technical and communications systems involved in studying volcanoes in space, hot-air balloons and technology used to study earth and space, hurricane hunters and technology, evaluating energy resources
		Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	SE: p 116-7, 470-1 TG: p 31	SE: Hurricane hunters and technology, mathematics and space engineering TG: Students meet with engineers and building contractor to learn about building design
		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 108, 430-1 ANC: Biography 17.1	SE: CFCs and the ozone layer, the invention of calendars and time keeping devices ANC: The work of Galileo
		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 108, 384, 451	SE: CFCs and the ozone layer, trade-offs and use of energy resources, the history of the telescope
		Analysis of costs, environmental impacts, and risks, as well as of expected benefits, is a critical aspect of decisions about technology use.	SE: p 113 & 115, 383-4, 424	SE: Increasing greenhouse gases in the atmosphere, trade-offs and use of energy resources, the invention of spacecraft