Rockets Away!

Lessons at a Glance—Science

Education Standard	Lessons									
A Framework for K-12 Education: Practices, Crosscutting Concepts, and Core Ideas	1	2	3	4	5	6	7	8	9	10
The education standards cited here are from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) from the National Research Council. They are available in their entirety at **www.nap.edu**. *Rockets Away!*, which is flexible and can be taught at multiple grade levels, touches on science standards in grades K-8.										
Dimension 3: Disciplinary Core Ideas—Physical Sciences										
PS2.A: FORCES AND MOTION *How can one predict an object's continued motion, changes in motion, or stability?*										
By the end of grade 2. Objects pull or push each other when they collide or are connected. Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. An object sliding on a surface or sitting on a slope experiences a pull due to friction on the object due to the surface that opposes the object's motion.		X	X							
By the end of grade 5. Each force acts on one particular object and has both a strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) The patterns of an object's motion in various situations can be observed and measured; when past motion exhibits a regular pattern, future motion can be predicted from it.			X		X				X	

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By the end of grade 8. For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first but in the opposite direction (Newton's third law). The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. Forces on an object can also change its shape or orientation. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.					X	X	X		X	
PS2.B: TYPES OF INTERACTIONS *What underlying forces explain the variety of interactions observed?*										
By the end of grade 5. Objects in contact exert forces on each other (friction, elastic pushes and pulls). Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact—for example, magnets push or pull at a distance. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	X	X	X	X	X	X	X	X	X	
PS3.C RELATIONSHIP BETWEEN ENERGY AND FORCES *How are forces related to energy?*										
By the end of grade 2. A bigger push or pull makes things go faster. Faster speeds during a collision can cause a bigger change in shape of the colliding objects.				X						
By the end of grade 8. When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. For example, when energy is transferred to an Earth-object system as an object is raised, the gravitational field energy of the system increases. This energy is released as the object falls; the mechanism of this release is the gravitational force. Likewise, two magnetic and electrically charged objects interacting at a distance exert forces on each other that can transfer energy between the interacting objects.				X						

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Dimension 3: Disciplinary Core Ideas—Engineering, Technology, and Applications of Science										
ETS1.A: DEFINING AND DELIMITING AN ENGINEERING PROBLEM *What is a design for?* *What are the criteria and constraints of a successful solution?*										
***By the end of grade 5*.** 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.	X	X								
***By the end of grade 8*.** 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 are likely to limit possible solutions (e.g., familiarity with the local climate may rule out certain plants for the school garden).	X	X								
ETS1.B: DEVELOPING POSSIBLE SOLUTIONS *What is the process for developing potential design solutions?*										
***By the end of grade 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. To design something complicated, one may need to break the problem into parts and attend to each part separately but must then bring the parts together to test the overall plan.	X	X								
***By the end of grade 5*.** Research on a problem should be carried out—for example, through Internet searches, market research, or field observations—before beginning to design a solution. An often productive way to generate ideas is for people to work together to brainstorm, test, and refine possible solutions. Testing a solution involves investigating how well it performs under a range of likely conditions. Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. 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. There are many types of models, ranging from simple physical models to computer models. They can be used to investigate how a design might work, communicate the design to others, and compare different designs.	X	X								

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By the end of grade 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. In any case, it is important to be able to communicate and explain solutions to others. Models of all kinds are important for testing solutions, and computers are a valuable tool for simulating systems. Simulations are useful for predicting what would happen if various parameters of the model were changed, as well as for making improvements to the model based on peer and leader (e.g., teacher) feedback.	X	X								
ETS1.C: OPTIMIZING THE DESIGN SOLUTION *How can the various proposed design solutions be compared and improved?*										
By the end of grade 2. Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.	X									
By the end of grade 5. Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	X									
By the end of grade 8. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Comparing different designs could involve running them through the same kinds of tests and systematically recording the results to determine which design performs best. 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 those characteristics may be incorporated into the new design. This 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. Once such a suitable solution is determined, it is important to describe that solution, explain how it was developed, and describe the features that make it successful.	X									
ETS2.A: INTERDEPENDENCE OF SCIENCE, ENGINEERING, AND TECHNOLOGY *What are the relationships among science, engineering, and technology?*										
By the end of grade 2. People encounter questions about the natural world every day. There are many types of tools produced by engineering that can be used in science to help answer these questions through observation or measurement. Observations and measurements are also used in engineering to help test and refine design ideas.		X		X						

Lessons at a Glance—Mathematics

Education Standard	Lessons									
Principles and Standards for School Mathematics	1	2	3	4	5	6	7	8	9	10
The education standards cited here are from *Principles and Standards for School Mathematics* from the National Council of Teachers of Mathematics. They are available in their entirety at www.nctm.**org**. *Rockets Away!* touches on mathematics standards in grades 3-5.										
Grades 3-5: Measurement										
Understand measurable attributes of objects and the units, systems, and processes of measurement										
Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems	X									
Understand that measurements are approximations and how differences in units affect precision	X	X								
Grades 3–5: Data Analysis and Probability										
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them										
Design investigations to address a question and consider how data-collection methods affect the nature of the data set				X	X					
Collect data using observations, surveys, and experiments				X	X					
Represent data using tables and graphs such as line plots, bar graphs, and line graph				X						
Select and use appropriate statistical methods to analyze data										
Use measures of center, focusing on the median, and understand what each does and does not indicate about the data set	X									X