

PRODUCTS IN MOTION



SCIENCE

6

GRADE 6

This guide links the *Products in Motion* unit to the Texas Essential Knowledge and Skills (TEKS) for sixth graders. *Products in Motion* is a science unit that allows students to study force, motion, and energy as well as practical applications through simple machines. *Products in Motion* also has interdisciplinary connections to English language arts and reading and social studies disciplines. For example, students will compose procedural and persuasive texts, as outlined in the English Language Arts and Reading TEKS, and describe ways in which technology influences human interactions with the environment, as described in the Social Studies TEKS. The following document includes the applicable TEKS and the details of the *Products in Motion* unit. The final section of this document presents the applicable Texas College and Career Readiness Standards adopted by the Texas Higher Education Coordinating Board (THECB) on January 24, 2008.

Description of Unit

In this task, students study force, motion and energy and the application of these scientific principles through simple machines. Students explore the differences between potential and kinetic energy, various sources of energy, the conversion and transfer of energy in a system/circuit and real-world applications (e.g. the technologies behind a warehouse/fulfillment logistics system such as that used by Amazon.com to move products from the distribution center to the buyer). Student learning culminates in the development of a machine that moves an object (product) from one point to another. Additionally, students learn about sustainable technology and renewable energy resources and investigate how they might utilize these in their designs.

Goals

Students will meet these goals in their explorations:

- Become familiar with the six types of simple machines
- Learn the science behind how simple machines work

Products in Motion (Grade 6)

1

- Understand the differences between potential and kinetic energy
- Explore force, motion, and energy, including the Law of Conservation of Energy
- Gain an awareness of the transfer of energy in a system and how energy can be converted from one form to another (e.g., from electricity into mechanical)
- Ask questions and explore theories
- Have opportunities to generate new ideas
- Research, design and build simple machines that move an object from an origin point to a destination point
- Use scientific observation, measurement skills, and vocabulary
- Develop the essential skills of communicating, creative problem solving, and logical thinking

Phase I. Learning Experiences

1. Introduce students to the unit by guiding them through a web exploration of simple machines. For example, students might begin by exploring the [Simple Machines Game by the Museum of Science and Industry Chicago](#).
2. Review the physical science concepts of force, motion, and energy as well as potential versus kinetic energy. You may wish to conduct a series of lab activities to help students experience the connections between the science principles (e.g., force, motion, and the Conservation of Energy) with their applications in simple machines. Some examples include:
 - [What is Energy?](#)
 - [Forces and Motion](#)
 - [Converting Energy](#)
 - [Transforming Energy \(Potential vs. Kinetic\)](#)
 - [Raceways](#)
 - [The Ultimate Roller Coaster Contest](#)
 - [Friction and Inertia](#)
 - [Simple Machines: Levers](#)
 - [Converting Mechanical Energy into Electrical Energy](#)

Additionally, students may study computer simulations such as those available from [Phet Interactive Simulations](#) (University of Colorado), in particular, the simulations entitled [The Ramp](#) and [The Energy Skate Park](#) (Note the system requirements as well as the update Java notice prior to running the simulations).

3. Ask students to conduct Internet research on the six simple machines, and discover how these form the basis for all machines. A possible starting place is the lesson [Inventor's Workshop](#) available through Discovery Education.
4. Explore the interactive site [Power Play](#) to experiment with combinations of simple machines in harnessing different energy types to do work.
5. Construct various machines that convert energy from one source to another. Examples include:

- [Build an Electric Motor](#)
 - [Mechanical Munchie Maker](#)
6. Additionally, students will explore how machines can harness renewable energy sources. Two example activities include:
- [Using Heat from the Sun](#)
 - [Build an Electric Turbine](#)
7. Invite a guest speaker or a [Virtual Scientist](#) into the classroom to talk about the opportunities and challenges involved in engineering for a high-tech world.
8. Once students have gained awareness and some experience with the practical applications that use these scientific principles—force, motion, and energy— introduce them to the product fulfillment and shipping logistics operation of Amazon.com.

Show them a video, such as [Inside One of Amazon’s Busiest Days](#), [Amazon’s Warehouse Processing](#), or [A Tour of Amazon’s Fulfillment System](#). Additionally, you may wish to share [this article](#) discussing the “chaotic storage system” that Amazon uses. In this system, the company randomly shelves items to maximize storage space, then, when an order is placed, workers called “pickers” use a radio-frequency scanner to locate the item. The “picked” item is placed in a bin and sent along to the next link in an enormously complex chain of people, technology, and processes that end with the item being shipped to the customer’s address.

Lead a large group discussion following the video. Ask students to try to break down and illustrate the steps they observe in a flow chart. In what ways is the logistics operation like a system? Encourage students to try to describe as many pieces of machinery or technology they saw in the video.

- What are some of the machines students see utilized in the system?
- How many examples of these machines might utilize combinations of simple machines?
- What are some ways the forces of motion and energy might be utilized in the system?
- What are some ideas as to the energy sources that might be harnessed to operate such a system?
- What are the roles of people in the system? How many different types of job functions might be needed to get a product from the creator to the buyer?

Phase II. Independent Research

A. Research process

1. Select a topic. Each student will select a “product” to be moved from his/her own personal collection. Objects might include CDs, books, dolls, video game packages or controllers, articles of clothing, or any other relatively small, singular object. Teachers will provide guidance on how far the object must be moved from point to point. Key

constraints include classroom size and time allotted to the development of the “product moving” machine.

2. Ask guiding questions. Students will first need to determine the physical properties of the object that might impact the design of its transport system. Then students will need to identify at least three to five guiding questions to explore during their research. Such questions include:
 - What is the shape of the object? What are its dimensions? What is its weight?
 - Will your “product mover” work only for this particular object, or will you design it so that it might transport other students’ products too?
 - Is the object fragile? If so, what might be some of the protective features you will need to incorporate into your system?
 - How quickly might you want the object to move from point to point?
 - How far must the object move? Will there be any changes in the incline between the origin and destination points?
 - What readily available materials will you use to create your system?
 - How might you power your system? What sources of energy might you use?
 - What might be some advantages to your system over other transport systems?
3. Create a research proposal. Create a research and development plan that identifies the following elements:
 - The name you will give to your transport system
 - The product it is designed to move
 - The energy source you will utilize to power your machine
 - The materials you plan to use in building your machine
 - A preliminary sketch illustrating how your transport system might work
 - Guiding questions for research in order to gain the knowledge you need to build the system
 - A timeline for how you will proceed with research and development
4. Conduct the research. Once the research and development plan is approved (and checked for feasibility within the scope of the class) by the teacher, students will begin research. Collaborate with local electronics specialists, librarians, and/or technical education specialists to guide student research and development of the products. As students finalize their research, they will need to refine their product plan to include
 - updates to the technical drawing (i.e., a more formalized, computer-rendered version might be created using a program such as Google SketchUp) ,
 - flowcharts that indicate how the energy transfers through each component,
 - an identification of the simple machines in each part of the system,
 - the location of the power source, and
 - a budget and plan for sourcing the materials to be used in building.
5. Develop the product. Using readily available materials, students implement their ideas with the help of the teacher and/or mentors, specialists, paraprofessionals, or parent

volunteers. Students should practice classroom safety procedures with regards to sharp tools, chemicals, electricity, or other potentially hazardous components.

6. Share findings. Each student gives a demonstration of the product transport system to the class. As an optional extension, students might also create a video describing the system, similar in feel to the Amazon tour.

B. The product

Students research, design, and build a machine that moves an object (the product) from one point to another in the classroom. These devices (product transport systems) utilize force, motion, and/or energy and transfer that energy through combinations of simple machines. Students may choose to power their machines using a variety of energy sources. Students should identify modifications they might make to power the system sustainably without using non-renewable sources.

C. Communication

Each student presents an overview of the research that led him/her to the design solution and gives a live demonstration of how the transport system works. Additionally, during an “Engineer’s Debrief,” students discuss in small groups the challenges they faced in building the system (and how they overcame any obstacles), modifications that might make it faster, more efficient, and greener, and possible alternative uses for the device.

D. A completed project consists of:

1. Notes from the *Phase I* laboratory experiments on force, motion, and energy
2. The final product research and development plan
3. Drawings and flowcharts describing the system
4. A promotional poster for the final product, including photographs and persuasive text
5. A video of the live demonstration and class presentation, including the question and answer session
6. The student’s summary of the “Engineer’s Debrief” small group discussion, including additional research questions for further study

Internet Resources

<http://www.energyeducation.tx.gov/>

<http://www.teachengineering.org/>

<http://www.msichicago.org/play/simplemachines/>

<http://littleshop.physics.colostate.edu/activities/atmos1/EnergyToys.pdf>

<http://www.discoveryeducation.com/teachers/free-lesson-plans/forces-and-motion.cfm>

<http://scienetlinks.com/lessons/converting-energy/>

<http://scienetlinks.com/lessons/transforming-energy/>

<http://www.miamisci.org/af/sln/mummy/raceways.html>

<http://www.discoveryeducation.com/teachers/free-lesson-plans/the-ultimate-roller-coaster-contest.cfm>

http://www.nasa.gov/offices/education/programs/national/summer/education_resources/physicalscience_grades4-6/PS_inertia.html
http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_simp_machines/cub_simp_machines_lesson03.xml
<http://www.pbs.org/tesla/tt/tt02.html>
<http://phet.colorado.edu/>
<http://www.discoveryeducation.com/teachers/free-lesson-plans/inventors-workshop.cfm>
<http://sciencenetlinks.com/tools/power-play/>
<http://www.msichicago.org/online-science/activities/activity-detail/activities/build-an-electric-motor/>
<http://www.instructables.com/id/How-20-PBJ-Mechanical-Munchie-Maker-1/#step1>
http://www.teachengineering.org/view_lesson.php?url=collection/duk_/lessons/duk_solaroven_tech_1_ess/duk_solaroven_tech_1_ess.xml
<http://www.msichicago.org/online-science/activities/activity-detail/activities/build-a-wind-turbine-1/browseactivities/0/>
<http://www.ssrvideo.com/virtualscientist.html>
<http://www.youtube.com/watch?v=Z2Bs0nqVvqs>
<http://www.youtube.com/watch?v=i6H7nfHjHtY>
http://www.youtube.com/watch?v=HOicZ_AgsSA
<http://www.ibtimes.com/inside-amazon-warehouse-photos-909410>
<http://www.ssi-schaefer.de/blog/en/order-picking/chaotic-storage-amazon/>

Texas Essential Knowledge and Skills

The unit may address the following TEKS:

English Language Arts and Reading:

- 6.1 Reads grade-level text with fluency and comprehension
- 6.2 Understands new vocabulary and uses it when reading and writing
- 6.7 Understands, makes inferences and draws conclusions about the varied structural patterns and features of literary nonfiction and provides evidence from text to support their understanding
- 6.9 Analyzes, makes inferences and draws conclusions about the author's purpose in cultural, historical, and contemporary contexts and provides evidence from the text to support their understanding
- 6.10 Analyzes, makes inferences and draws conclusions about expository text and provides evidence from text to support their understanding
- 6.12 Understands how to glean and use information in procedural texts and documents
- 6.13 Uses comprehension skills to analyze how words, images, graphics, and sounds work together in various forms to impact meaning
- 6.14 Uses elements of the writing process (planning, drafting, revising, editing, and publishing) to compose text
- 6.17 Writes expository and procedural or work-related texts to communicate ideas and information to specific audiences for specific purposes

- 6.18 Writes persuasive texts to influence the attitudes or actions of a specific audience on specific issues
- 6.19 Understands the function of and uses the conventions of academic language when speaking and writing
- 6.22 Asks open-ended research questions and develops a plan for answering them
- 6.23 Determines, locates, and explores the full range of relevant sources addressing a research question and systematically records the information they gather
- 6.24 Clarifies research questions and evaluates and synthesizes collected information
- 6.25 Organizes and presents their ideas and information according to the purpose of the research and their audience
- 6.26 Uses comprehension skills to listen attentively to others in formal and informal settings
- 6.27 Speaks clearly and to the point, using the conventions of language
- 6.28 Works productively with others in teams

Science:

- 6.1 For at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices
- 6.2 Uses scientific inquiry methods during laboratory and field investigations
- 6.3 Uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists
- 6.4 Knows how to use a variety of tools and safety equipment to conduct science inquiry
- 6.6 Knows matter has physical properties that can be used for classification
- 6.7 Knows that some of Earth's energy resources are available on a nearly perpetual basis, while others can be renewed over a relatively short period of time
- 6.8 Knows force and motion are related to potential and kinetic energy
- 6.9 Knows that the Law of Conservation of Energy states that energy can neither be created nor destroyed, it just changes form

Social Studies:

- 6.7 Understands the impact of interactions between people and the physical environment on the development and conditions of places and regions
- 6.8 Understands the factors of production in a society's economy
- 6.9 Understands the various ways in which people organize economic systems
- 6.10 Understands categories of economic activities and the data used to measure a society's economic level
- 6.15 Understands the similarities and differences within and among cultures in various world societies
- 6.18 Understands the relationship that exists between the arts and the societies in which they are produced
- 6.20 Understands the influences of science and technology on contemporary societies

Products in Motion (Grade 6)

- 6.21 Applies critical-thinking skills to organize and uses information acquired through established research methodologies from a variety of valid sources, including electronic technology
- 6.22 Communicates in written, oral, and visual forms
- 6.23 Uses problem-solving and decision-making skills, working independently and with others, in a variety of settings

Texas College and Career Readiness Standards

This unit may address the following Texas College and Career Readiness Standards:

English Language Arts:

- II.A.1 Uses effective reading strategies to determine a written work's purpose and intended audience
- II.A.2 Uses text features and graphics to form an overview of informational texts and to determine where to locate information
- II.A.4 Draws and supports complex inferences from text to summarize, draw conclusions, and distinguish facts from simple assertions and opinions
- II.A.5 Analyzes the presentation of information and the strength and quality of evidence used by the author, and judges the coherence and logic of the presentation and the credibility of an argument
- II.A.9 Identifies and analyzes the audience, purpose, and message of an informational or persuasive text
- III.A.1 Understands how style and content of spoken language varies in different contexts and influences the listener's understanding
- III.A.2 Adjusts presentation (delivery, vocabulary, length) to particular audiences and purposes
- III.B.1 Participates actively and effectively in one-on-one oral communication situations
- III.B.2 Participates actively and effectively in group discussions
- III.B.3 Plans and delivers focused and coherent presentations that convey clear and distinct perspectives and demonstrates solid reasoning
- IV.A.1 Analyzes and evaluates the effectiveness of a public presentation
- IV.A.2 Interprets a speaker's message; identifies the position taken and the evidence in support of that position
- IV.A.3 Uses a variety of strategies to enhance listening comprehension
- IV.B.1 Listens critically and responds appropriately to presentations
- IV.B.2 Listens actively and effectively in one-on-one communication situations
- IV.B.3 Listens actively and effectively in group discussions
- V.A.1 Formulates research questions
- V.A.2 Explores a research topic
- V.A.3 Refines research topic and devises a timeline for completing work

- V.B.1 Gathers relevant sources
- V.B.2 Evaluates the validity and reliability of sources
- V.B.3 Synthesizes and organizes information effectively
- V.C.1 Designs and presents an effective product
- V.C.2 Uses source material ethically

Mathematics:

- VI.A.1 Plans a study
- VI.B.1 Determines types of data
- VI.B.2 Selects and applies appropriate visual representations of data
- VI.B.3 Computes and describes summary statistics of data
- VII.C.1 Applies known function models
- VII.C.2 Develops a function to model a situation
- VIII.A.1 Analyzes given information
- VIII.A.2 Formulates a plan or strategy
- VIII.A.3 Determines a solution
- VIII.A.4 Justifies the solution
- VIII.A.5 Evaluates the problem-solving process
- VIII.B.1 Develops and evaluates convincing arguments
- VIII.B.2 Uses various types of reasoning
- VIII.C.3 Evaluates the problem solving process
- IX.A.3 Uses mathematics as a language for reasoning, problem solving, making connections, and generalizing
- IX.B.2 Summarizes and interprets mathematical information provided orally, visually, or in written form within the given context
- IX.C.1 Communicates mathematical ideas, reasoning, and their implications using symbols, diagrams, graphs, and words
- IX.C.2 Creates and uses representations to organize, record, and communicate mathematical ideas
- IX.C.3 Explains, displays, or justifies mathematical ideas and arguments using precise mathematical language in written or oral communications
- X.A.2 Connects mathematics to the study of other disciplines
- X.B.1 Uses multiple representations to demonstrate links between mathematical and real-world situations
- X.B.2 Understands and uses appropriate mathematical models in the natural, physical, and social sciences
- X.B.3 Knows and understands the use of mathematics in a variety of careers and professions

Science:

- I.B.1 Designs and conducts scientific investigations in which hypotheses are formulated and tested
- I.C.1 Collaborates on joint projects

- I.C.2 Understands and applies safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms
- I.C.3 Demonstrates skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures
- I.D.1 Demonstrates literacy in computer use
- I.D.2 Uses computer models, applications, and simulations
- I.D.3 Demonstrates appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data
- I.E.1 Uses several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic
- I.E.2 Uses essential vocabulary of the discipline being studied
- III.A.1 Uses correct applications of writing practices in scientific communication
- III.B.1 Reads technical and scientific articles to gain understanding of interpretations, apparatuses, techniques or procedures, and data
- III.B.2 Sets up apparatuses, carries out procedures, and collects specified data from a given set of appropriate instructions
- III.B.3 Recognizes scientific and technical vocabulary in the field of study and uses this vocabulary to enhance clarity of communication
- III.B.4 Lists, uses and gives examples of specific strategies before, during, and after reading to improve comprehension
- III.C.1 Prepares and represents scientific/technical information in appropriate formats for various audiences
- III.D.1 Uses search engines, databases, and other digital electronic tools effectively to locate information
- III.D.2 Evaluates quality, accuracy, completeness, reliability, and currency of information from any source
- IV.A.1 Recognizes how scientific discoveries are connected to technological innovations
- IV.B.1 Understands how scientific research and technology have an impact on ethical and legal practices
- IV.B.2 Understands how commonly held ethical beliefs impact scientific research
- IV.C.1 Understands the historical development of major theories in science
- IV.C.2 Recognizes the role of people in important contributions to scientific knowledge
- V.B.2 Knows the processes of energy transfer
- V.C.1 Recognizes patterns of change
- VII.H.1 Understands the Law of Conservation of Energy and processes of heat transfer
- VII.H.2 Understands energy changes and chemical reactions
- VII.I.1 Understands the behavior of matter in its various states: solid, liquid, and gas
- VII.I.2 Understands properties of solutions
- VIII.A.2 Understands states of matter and their characteristics

Products in Motion (Grade 6)

- VIII.A.3 Understands the concepts of mass and inertia
- VIII.A.5 Understands the concepts of gravitational force and weight
- VIII.C.1 Understands the fundamental concepts of kinematics
- VIII.C.2 Understands forces and Newton’s Laws
- VIII.C.3 Understands the concept of momentum
- VIII.D.1 Understands potential and kinetic energy
- VIII.D.2 Understands conservation of energy
- VIII.D.3 Understands the relationship of work and mechanical energy
- VIII.H.2 Understands the basic laws of thermodynamics
- IX.F.1 Describes matter and energy transfer in the Earth’s systems
- X.B.1 Understands energy transformations
- X.B.2 Knows the various sources of energy for humans and other biological systems
- X.C.1 Recognizes variations in population sizes, including human population and extinction, and describe mechanisms and conditions that produce these variations

Social Studies:

- I.A.2 Analyzes the interaction between human communities and the environment
- I.A.3 Analyzes how physical and cultural processes have shaped human communities over time
- I.A.4 Evaluates the causes and effects of human migration patterns over time
- I.A.5 Analyzes how various cultural regions have changed over time
- I.A.6 Analyzes the relationship between geography and the development of human communities
- I.E.2 Defines the concept of socialization and analyzes the role socialization plays in human development and behavior
- I.F.1 Uses a variety of research and analytical tools to explore questions or issues thoroughly and fairly
- I.F.2 Analyzes ethical issues in historical, cultural, and social contexts
- II.B.4 Evaluates how major philosophical and intellectual concepts influence human behavior or identity
- II.B.5 Explains the concepts of socioeconomic status and stratification
- II.B.6 Analyzes how individual and group identities are established and change over time
- IV.A.1 Identifies and analyzes the main idea(s) and point(s) of view in sources
- IV.A.2 Situates an informational source in its appropriate contexts
- IV.A.3 Evaluates sources from multiple perspectives
- IV.A.4 Understands the differences between a primary and secondary source and uses each appropriately to conduct research and construct arguments
- IV.A.5 Reads narrative texts critically
- IV.A.6 Reads research data critically
- IV.B.1 Uses established research methodologies

- IV.B.2 Explains how historians and other social scientists develop new and competing views of past phenomena
- IV.B.3 Gathers, organizes, and displays the results of data and research
- IV.B.4 Identifies and collects sources
- IV.C.1 Understands/interprets presentations critically
- IV.D.1 Constructs a thesis that is supported by evidence
- IV.D.2 Recognizes and evaluates counter-arguments
- V.A.1 Uses appropriate oral communication techniques depending on the context or nature of the interaction
- V.A.2 Uses conventions of standard written English
- V.B.1 Attributes ideas and information to source materials and authors

Cross-Disciplinary Standards:

- I.A.1 Engages in scholarly inquiry and dialogue
- I.A.2 Accepts constructive criticism and revises personal views when valid evidence warrants
- I.B.1 Considers arguments and conclusions of self and others
- I.B.2 Constructs well-reasoned arguments to explain phenomena, validate conjectures, or support positions
- I.B.3 Gathers evidence to support arguments, findings, or lines of reasoning
- I.B.4 Supports or modifies claims based on the results of an inquiry
- I.C.1 Analyzes a situation to identify a problem to be solved
- I.C.2 Develops and applies multiple strategies to solving a problem
- I.C.3 Collects evidence and data systematically and directly related to solving a problem
- I.D.1 Self-monitors learning needs and seeks assistance when needed
- I.D.2 Uses study habits necessary to manage academic pursuits and requirements
- I.D.3 Strives for accuracy and precision
- I.D.4 Perseveres to complete and master tasks
- I.E.1 Works independently
- I.E.2 Works collaboratively
- I.F.1 Attributes ideas and information to source materials and people
- I.F.2 Evaluates sources for quality of content, validity, credibility, and relevance
- I.F.3 Includes the ideas of others and the complexities of the debate, issue, or problem
- I.F.4 Understands and adheres to ethical codes of conduct
- II.A.1 Uses effective prereading strategies
- II.A.2 Uses a variety of strategies to understand the meanings of new words
- II.A.3 Identifies the intended purpose and audience of the text
- II.A.4 Identifies the key information and supporting details
- II.A.5 Analyzes textual information critically

- II.C.1 Understands which topics or questions are to be investigated
- II.C.2 Explores a research topic
- II.C.3 Refines research topic based on preliminary research and devises a timeline for completing work
- II.C.4 Evaluates the validity and reliability of sources
- II.C.5 Synthesizes and organizes information effectively
- II.C.6 Designs and presents an effective product
- II.C.7 Integrates source material
- II.C.8 Presents final product
- II.D.1 Identifies patterns or departures from patterns among data
- II.D.2 Uses statistical and probabilistic skills necessary for planning an investigation, and collecting, analyzing, and interpreting data
- II.D.3 Presents analyzed data and communicates findings in a variety of formats
- II.E.1 Uses technology to gather information
- II.E.2 Uses technology to organize, manage, and analyze information
- II.E.3 Uses technology to communicate and display findings in a clear and coherent manner
- II.E.4 Uses technology appropriately