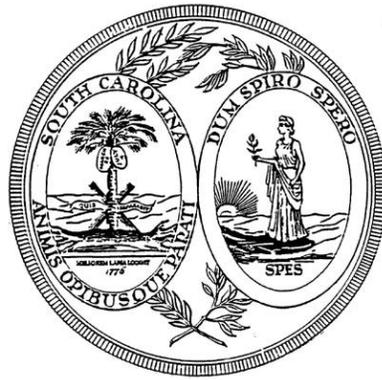


# South Carolina Academic Standards and Performance Indicators for Science 2014



**Instructional Unit Resource**

**6<sup>th</sup> Grade**

# ***South Carolina Academic Standards and Performance Indicators for Science 2014***

## ***Sixth Grade Science Instructional Unit Resource***

As support for implementing the *South Carolina Academic Standards and Performance Indicators for Science 2014*, the standards for Sixth Grade have been grouped into possible units. In the Overview of Units below, the titles for those possible units are listed in columns. Refer to the Overview document to note these unit titles and how Standards, Conceptual Understandings, Performance Indicators, Science and Engineering Practices, and Crosscutting Concepts align. Following the Overview of Units, an Instructional Unit document is provided that delivers guidance and possible resources in teaching our new *South Carolina Academic Standards and Performance Indicators for Science 2014*. The purpose of this document is to provide guidance as to how all the standards in this grade may be grouped into units and how those units might look. Since this document is merely guidance, districts should implement the standards in a manner that addresses the district curriculum and the needs of students. This document is a living document and instructional leaders from around the state will continuously update and expand these resource documents. These documents will be released throughout the 2016-2017 school year with the intentionality of staying ahead of instruction. Teachers should also note that links to the Standards document, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, the SEP Support Document, and the Support Document 2.0 are embedded throughout the Instructional Unit format for reference.

### **Acknowledgments**

Jean Baptiste Massieu, famous deaf educator, made a statement that is now considered a French proverb. “Gratitude is the memory of the heart. Indeed, appreciation comes when you feel grateful from the depths of your heart. The head keeps an account of all the benefits you received and gave. But the heart records the feelings of appreciation, humility, and generosity that one feels when someone showers you with kindness.” It is with sincere appreciation that we humbly acknowledge the dedication, hard work and generosity of time provided by teachers and instructional leaders across the state that have made and are continuing to make the Instructional Unit Resources possible.

### Grade 6 Overview of Units

| Unit 1   |          | Unit 2   |          | Unit 3  |          | Unit 4   |          |
|--|----------|--|----------|---|----------|--|----------|
| EARTH SCIENCE:<br>EARTH'S WEATHER<br>AND CLIMATE |          | PHYSICAL SCIENCE:<br>ENERGY TRANSFER AND<br>CONSERVATION |          | LIFE SCIENCE<br>DIVERSITY OF LIFE –<br>CLASSIFICATION AND ANIMALS |          | LIFE SCIENCE: DIVERSITY OF LIFE-<br>PROTISTS, FUNGI AND PLANTS |          |
| Standard   |          | Standard   |          | Standard  |          | Standard   |          |
| 6.E.2  |          | 6.P.3  |          | 6.L.4   |          | 6.L.5  |          |
| Conceptual Understanding                         |          | Conceptual Understanding                                 |          | Conceptual Understanding  |          | Conceptual Understanding                                       |          |
| 6.E.2A   | 6.E.2B   | 6.P.3A   | 6.P.3B   | 6.L.4A  | 6.L.4B   | 6.L.5A   | 6.L.5B   |
| Performance Indicators                           |          | Performance Indicators                                   |          | Performance Indicators  |          | Performance Indicators   |          |
| 6.E.2A.1   | 6.E.2B.1 | 6.P.3A.1   | 6.P.3B.1 | 6.L.4A.1  | 6.L.4B.1 | 6.L.5A.1   | 6.L.5B.1 |
| 6.E.2A.2   | 6.E.2B.2 | 6.P.3A.2   | 6.P.3B.2 | 6.L.4A.2  | 6.L.4B.2 | 6.L.5A.2   | 6.L.5B.2 |
| 6.E.2A.3   | 6.E.2B.3 | 6.P.3A.3   |          |   | 6.L.4B.3 |  | 6.L.5B.3 |
|  | 6.E.2B.4 | 6.P.3A.4   |          |   | 6.L.4B.4 |  | 6.L.5B.4 |
|  |          | 6.P.3A.5   |          |   | 6.L.4B.5 |  | 6.L.5B.5 |
|  |          | 6.P.3A.6   |          |   |          |  |          |
| *Science and Engineering Practices               |          | *Science and Engineering Practices                       |          | *Science and Engineering Practices                                |          | *Science and Engineering Practices                             |          |
| 6.S.1A.2   |          | 6.S.1A.1   |          | 6.S.1A.2  |          | 6.S.1A.2   |          |
| 6.S.1A.4   |          | 6.S.1A.2   |          | 6.S.1A.4  |          | 6.S.1A.3   |          |
| 6.S.1A.6   |          | 6.S.1A.3   |          | 6.S.1A.6  |          | 6.S.1A.4   |          |
| 6.S.1A.7   |          | 6.S.1A.4   |          | 6.S.1A.8  |          | 6.S.1A.6   |          |
|  |          | 6.S.1A.6   |          |   |          |  |          |
|  |          | 6.S.1B.1   |          |   |          |  |          |
| *CrossCutting Concepts                           |          | *CrossCutting Concepts                                   |          | *CrossCutting Concepts  |          | *CrossCutting Concepts   |          |
| 1, 2, 4, 5, 7                                    |          | 1, 2, 3, 4, 5, 7   |          | 1, 2, 3, 4, 5, 6, 7   |          | 1, 2, 3, 4, 5, 6, 7  |          |

\* Teachers have the discretion to enhance the selected SEPs and CCCs.

|   |
|---|
| <b>Unit Title</b>   |
| Energy Transfer and Conservation  |
| <b>Standard</b>   |
| <a href="http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf">http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf</a> |
| 6.P.3 The student will demonstrate an understanding of the properties of energy, the transfer and conservation of energy, and the relationship between energy and forces.   |

**Conceptual Understanding**  
 6.P.3A. Energy manifests itself in multiple forms, such as mechanical (kinetic energy and potential energy), electrical, chemical, radiant (solar), and thermal energy. According to the principle of conservation of energy, energy cannot be created nor destroyed, but it can be transferred from one place to another and transformed between systems.

**New Academic Vocabulary**  
 Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (<http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/>) and further inquiry into the terms can be found there.

|                  |                                |                        |                         |                          |
|------------------|--------------------------------|------------------------|-------------------------|--------------------------|
| Chemical energy  | Conduction                     | Conservation of energy | Convection              | Elastic potential energy |
| Generator        | Gravitational potential energy | Kinetic energy         | Magnetic field          | Mechanical energy        |
| Potential energy | Radiation                      | Radiant (solar energy) | Simple electrical motor | Thermal energy           |

**Performance Indicators**  
 Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's

6.P.3A.1 *Analyze and interpret data* to describe the properties and compare sources of different forms of energy (including mechanical, electrical, chemical, radiant, and thermal).

6.P.3A.2 *Develop and use models* to exemplify the conservation of energy as it is transformed from kinetic to potential (gravitational and elastic) and vice versa.

6.P.3A.3 Construct explanations for how energy is conserved as it is transferred and transformed in electrical circuits.

6.P.3A.4 Develop and use models to exemplify how magnetic fields produced by electrical energy flow in a circuit is interrelated in electromagnets, generators, and simple electrical motors.

6.P.3A.5 Develop and use models to describe and compare the directional transfer of heat through convection, radiation, and conduction.

6.P.3A.6 Design and test devices that minimize or maximize heat transfer by conduction, convection, or radiation.

#### **\*Science and Engineering Practices**

Support for the guidance, overviews of learning progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc

([http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete\\_2014SEPsGuide\\_SupportDoc2\\_0.pdf](http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

6.S.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge claims.

6.S.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

6.S.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

6.S.1A.4 Analyze and interpret data from informational texts, observations, measurements, or investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning or (2) support hypotheses, explanations, claims, or designs.

6.S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

6.S.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results

#### **\*Cross Cutting Concepts** (<http://www.nap.edu/read/13165/chapter/8>)

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in **blue** and italicized/underlined below provides a brief explanation of how the specific content ties to the CCC's.

2. **Cause and effect:** The National Research Council states “Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts” (p. 84). [\*The Law of Conservation of Energy describes the relationship of energy transformation. The processes of convection, conduction and radiation explain the causes and effects of the transfer of heat energy. Energy transformations within electric circuits and between forms of energy involve a pattern of loss of energy as heat.\*](#)
3. **Scale, proportion, and quantity:** The National Research Council states “In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system’s structure or performance” (p. 84). [\*Energy transformations and the ability to do work are dependent upon scale, proportion and quantity of input energy.\*](#)
4. **Systems and system models:** The National Research Council states that this includes “defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering” (p. 84). [\*Energy transformations follow the Law of Conservation of Energy and therefore follow a system model of inputs and outputs.\*](#)
5. **Energy and matter:** The National Research Council states that this includes “Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems’ possibilities and limitations.”(p. 84) [\*Energy cycles and is conserved through transformations and forces within systems.\*](#)
7. **Stability and change.** The National Research Council states that this includes “For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.”(p. 84) [\*As energy is transferred and transformed it remains stable, however as the transformation takes place the energy can change form.\*](#)

*\*Teachers have the discretion to enhance the selected SEP’s and CCC’s.*

#### **Prior Knowledge**

- 3.P.3.A.1 Electricity transformed into other forms of energy (including light, heat, and sound)
- 3.P.3B Properties of magnets and electromagnets.
- 3.P.2A Students explained how heat moves easily from one object to another through direct contact in some materials (called conductors) and not so easily through other materials (called insulators).

#### **Subsequent Knowledge**

- H.P.3.A: Work, Work-Energy Theorem, Power, Efficiency, Elastic and Inelastic Collisions, Efficiency
- H.P.3.B: Conservation of Energy, Periodic Motion and Energy, Gravitational Potential Energy
- H.P.3C: Heat Transfer, Thermal Conductivity, Conduction, Convection and Radiation.
- H.P.3D: Mechanical Waves, Wave Interference, Principle of Superposition, Doppler Effect, Properties of Waves
- H.P.3E: Ohm’s Law, Circuits, Electrical Power, Series and Parallel Circuits, Electromagnetic Induction

## Possible Instructional Strategies/Lessons

Strategies and lessons that will enable students to master the standard and/or indicator.

- 6.P.3A.1 Experiments with Different Forms of Energy - Students will conduct various experiments to analyze and interpret data to describe and compare different forms of (mechanical, electrical, chemical, radiant, and thermal) energy. Some resources are:  
R.E.A.C.T. Renewable Energy Activities- <http://www.nrel.gov/docs/gen/fy01/30927.pdf>  
  
Radiant(Solar) Energy Activities- [http://www1.eere.energy.gov/education/pdfs/solar\\_exploringsolarenergystudent.pdf](http://www1.eere.energy.gov/education/pdfs/solar_exploringsolarenergystudent.pdf)  
  
Experiments on Mechanical Engineering for Kids- [http://www.ehow.com/info\\_10067494\\_experiments-mechanical-energy-kids.html](http://www.ehow.com/info_10067494_experiments-mechanical-energy-kids.html)
- 6.P.3A.2 Gravitational and Elastic Energy  
Skate Park Design (See appendices) Students will investigate the conservation of energy as it transforms from gravitational potential to kinetic energy using different marbles and ramps. Students will then develop a hill for a skate park that will give the most kinetic energy within a given space.  
  
Marshmallow Catapult Design Students will investigate the idea of elastic potential energy with rubber bands. Students will then develop a catapult for marshmallows. <http://teachers.egfi-k12.org/activity-build-a-simple-catapult/>
- 6.P.3A.3 Energy Transformation in Electric Circuits  
Learning Circuits Flashmain- Students will practice using electric circuits. Then students will describe the transformations of energy occurring within the circuits and write explanations for these transformations as well as the resulting energy transformed into heat released to the environment. This resource can be found here: <http://www.learningcircuits.co.uk/flashmain.htm>.  
  
Appliance deconstruction- Use real world examples and/or cross-section images to analyze and describe the energy transformations present within the electric circuits and mechanical actions of household appliances (toasters, vacuum, blender).  
  
Energy Efficient House- Design, build and test materials for maximum insulation efficiency. Design a “house” that will maintain the coolest internal temperature (or prevent an ice cube from melting) when placed in front of a heat lamp. Students will compete to design the most energy efficient house.

Squishy Circuits- Conductive Play Dough Make conductive and insulated play dough. Analyze and interpret the flow of electrical energy through the play dough when used to make electric circuits.

<http://courseweb.stthomas.edu/apthomas/SquishyCircuits/conductiveDough.htm>

- 6.P.3A.4 Models of Magnetic Fields and Electrical Energy

Build a generator DIY Electric Generator, how it works [http://amasci.com/coilgen/generator\\_2.html](http://amasci.com/coilgen/generator_2.html)

Build an electromagnet [https://www.teachengineering.org/activities/view/cub\\_mag\\_lesson2\\_activity1](https://www.teachengineering.org/activities/view/cub_mag_lesson2_activity1)

Build a simple electric motor How to Make a Simple Electric Motor that demonstrates the interactions of electricity and magnetic fields. <http://www.education.com/science-fair/article/no-frills-motor/>

- 6.P.3A.5 Models of Heat Transfer

Exploring Heat Transfer-Sally Ride Science Students will explore the three processes of heat transfer.

<https://sallyridescience.com/stem-central/7206-exploring-how-heat-moves>

Heat transfer activities <http://www.cs.cmu.edu/~rapidproto/students.03/tuanl/project3/heattransferhandout.pdf>

- 6.P.3A.6 Design Devices that Minimize or Maximize Heat Transfer

Heat experiments - <http://bpes.bp.com/primary-resources/science/ages-7-to-9/materials/thermal-conductors-and-insulators-online-experiment>

Insulation Simulation- <http://www.sciencekids.co.nz/gamesactivities/keepingwarm.html>

## Resources

- Kids.gov - Energy Lesson Plans and Activities <http://energy.gov/eere/education/teach-and-learn>

- Science-Class.net- Energy <http://science-class.net/archive/science-class/Physics/energy.htm>

- Energy lesson plans and lab activities [Tryengineering.org](http://tryengineering.org) <http://tryengineering.org/>

- Heat Transfer- Conduction, Convection, Radiation Video <https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer-conduction-convection-radiation>
- NEED Project Lesson plans and activities on Energy, intermediate level <http://www.need.org/intermediate>
- enLIGHTenSC Energy lesson plans and activities, link to energy websites. <http://www.enlightensc.org/lesson-plan/6th-grade/>

### Sample Formative Assessment Tasks/Questions

Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc ([http://ed.sc.gov/scdoe/assets/File/Instruction/standards/Science/Support%20Documents/Complete\\_2014SEPsGuide\\_SupportDoc2\\_0.pdf](http://ed.sc.gov/scdoe/assets/File/Instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf))

- Analyze various images to determine the source of energy and explain how the device transforms one type of energy into another (including mechanical, electrical, chemical, radiant, and thermal).
- Develop a model to demonstrate how a slingshot could be manipulated to support the law of conservation of energy through the transfer from potential to kinetic energy.
- Analyze and describe the energy transformations present in an electric doorbell.
- Design a solar oven that will collect solar energy and reduce the amount of heat energy lost over time.
- Design an experiment or demonstration that illustrates the three forms of heat transfer.
- Design a device that would minimize the heat loss in a cup of hot chocolate or other heated object. Another variation would be to design a device to keep a cold object from gaining heat. Students will collect data by recording temperature rates over a period of time.

### Unit Title

Energy Transfer and Conservation

### Standard

[http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South\\_Carolina\\_Academic\\_Standards\\_and\\_Performance\\_Indicators\\_for\\_Science\\_2014.pdf](http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf)

6.P.3 The student will demonstrate an understanding of the properties of energy, the transfer and conservation of energy, and the relationship

between energy and forces.

### Conceptual Understanding

6.P.3B. Conceptual Understanding: Energy transfer occurs when two objects interact thereby exerting force on each other. It is the property of an object or a system that enables it to do work (force moving an object over a distance). Machines are governed by this application of energy, work, and conservation of energy.

### New Academic Vocabulary

Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (<http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/>) and further inquiry into the terms can be found there.

|                 |                |                |                       |              |
|-----------------|----------------|----------------|-----------------------|--------------|
| Complex machine | Efficiency     | Inclined plane | Input energy (effort) | Lever        |
| Pulley          | Screw          | Simple machine | Spring Scale          | Output Force |
| Wedge           | Wheel and axle | Work           |                       |              |

### Performance Indicators

Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's

6.P.3B.1 *Plan and conduct controlled scientific investigations* to provide evidence for how the design of simple machines (including levers, pulleys, inclined planes) helps transfer mechanical energy by reducing the amount of force required to do work.

6.P.3B.2 *Design and test solutions* that improve the efficiency of a machine by reducing the input energy (effort) or the amount of energy transferred to the surrounding environment as it moves an object.

### \*Science and Engineering Practices

Support for the guidance, overviews of learning progressions, and explicit details of each SEP can found in the Science and Engineering Support Doc ([http://ed.sc.gov/scdoe/assets/File/Instruction/standards/Science/Support%20Documents/Complete\\_2014SEPsGuide\\_SupportDoc2\\_0.pdf](http://ed.sc.gov/scdoe/assets/File/Instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

6.S.1A.1 *Ask questions to* (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or *designs*, or (3) extend the results

of investigations or challenge claims.

**6.S.1A.2 Develop, use, and refine models** to (1) understand or represent phenomena, processes, and relationships, (2) **test devices or solutions**, or (3) communicate ideas to others.

**6.S.1A.3 Plan and conduct controlled scientific investigations** to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

**6.S.1B.1 Construct devices or design solutions** using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results

**\*Cross Cutting Concepts** (<http://www.nap.edu/read/13165/chapter/8>)

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in **blue** and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.

1. **Patterns:** The National Research Council states “Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them” (p. 84). *The efficiency of simple and complex machines follows a pattern of reducing input force required to do work.*

2. **Cause and effect:** The National Research Council states “Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts” (p. 84) *The design of simple and complex machines determines their efficiency and ability to reduce the input force required to do work.*

3. **Scale, proportion, and quantity:** The National Research Council states “In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system’s structure or performance” (p. 84) *The ability of simple and complex machines to reduce the input force required to do work is dependent upon the design of each machine and scale, proportion and quantity of input energy.*

4. **Systems and system models:** The National Research Council states that this includes “defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering” (p. 84). *All machines form a system of energy inputs and outputs and can be described using a systems model.*

5. **Energy and matter:** The National Research Council states that this includes “Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems’ possibilities and limitations.”(p. 84) [Energy cycles and is conserved through transformations and forces within machines.](#)

*\*Teachers have the discretion to enhance the selected SEP’s and CCC’s.*

#### Prior Knowledge

- N/A

#### Subsequent Knowledge

- H.P.3A: Work, Work-Energy Theorem, Power, Elastic and Inelastic Collisions, Efficiency
- H.P.3B: Periodic Motion and Energy, Conservation of Energy, Gravitational Potential Energy.

#### Possible Instructional Strategies/Lessons

Strategies and lessons that will enable students to master the standard and/or indicator.

- 6.P.3B.1- Conduct Investigations with Simple Machines that prove that they reduce the input force needed to perform work:

Activities with simple machines- This resource can be found here [http://science-class.net/archive/science-class/Physics/simple\\_machines.htm](http://science-class.net/archive/science-class/Physics/simple_machines.htm)

Simple Machine Centers <http://www.nsta.org/publications/news/story.aspx?id=53295>

- 6.P.3B.2- Design and test solutions to improve the efficiency of a machine.

Improve the efficiency of a machine- Modify the design of a machine (ex: change the angle of an inclined plane, use screw with different threads, change the fulcrum placement on a lever, use various configurations of pulleys, diameter of wheel in wheel and axle, use three different wedge sizes cut out of cardboard to separate a substance (clay, play dough)) to perform work using less input force, i.e to demonstrate how to increase the efficiency of a machine.

Design and build a Rube Goldberg machine to perform a simple task using a required number of simple machines. *Rube Goldberg machines were inspired by a cartoonist who created elaborate machines to perform simple tasks (ie hammering a nail; his legacy continues in an annual contest and promotes the combining of multiple simple machines to accomplish a single task.)*

<https://www.rubegoldberg.com/>

## Resources

- IEEE Energy lesson plans [www.tryengineering.org](http://www.tryengineering.org)
- Wind With Miller \* Choose “Crash Course” <http://xn--drmsttre-64ad.dk/wp-content/wind/miller/windpower%20web/en/kids/index.htm>
- Rube Goldberg Machines <https://www.rubegoldberg.com/>
- Honda Commercial (Rube Goldberg example) <https://youtu.be/YWk9N92-wvg>
- Rube Goldberg Machine Cool Video <https://www.youtube.com/watch?v=qybUFnY7Y8w>
- Solar Energy [www.solarschools.net/resources/stuff/power\\_station\\_to\\_us.aspx](http://www.solarschools.net/resources/stuff/power_station_to_us.aspx)

## Sample Formative Assessment Tasks/Questions

Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc ([http://ed.sc.gov/scdoe/assets/File/Instruction/standards/Science/Support%20Documents/Complete\\_2014SEPsGuide\\_SupportDoc2\\_0.pdf](http://ed.sc.gov/scdoe/assets/File/Instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf))

- Provided with a scenario of a job that needs to be done. Students will explain what simple machine they would choose to make the job more efficient. Students will justify their solution citing evidence from experiments conducted in class.
- Design a musical instrument which contains at least three simple machines. Have a class “performance”!
- Improve upon the design of a machine by reducing the input force needed to complete work. Support the improved design with data analysis.

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## 6th Grade – Energy Transfer and Conservation

### Skate Park Design Pre-Activity

#### Materials:

1. large marble, ball bearing, or ball
2. Two meter sticks
3. Tape
4. Set of uniform books/workbooks
5. Tape measure
6. Stop Watch
7. Ruler or piece of wood to hold the sphere before release
8. OPTIONAL : pool noodle or pipe insulation cut in half to form a track for the sphere when it rolls off of the ramp

**Key Vocabulary:** Gravitational potential energy, Kinetic energy

#### Investigation:

1. Attach the two meter sticks together side by side to form a trench for the sphere to travel down.  
*Teacher may want to do this step ahead of time.*
2. Prop the “0” side of the meter stick on a book (have the class decide on what measurement mark should be at the edge of the book stack so that the ramp is uniformly placed).
3. Measure the height of the book and record it in your data table.
4. Place the sphere at the 10 cm mark and hold there with a ruler or small board.
5. Release the ball. A. Measure the length that the ball rolls past the ramp using the tape measure.. Record the measurement in your data table.
6. Repeat steps 2 -5, adding a book each time.

## 6th Grade – Energy Transfer and Conservation

### Skate Park Design Pre-Activity

#### Student Lab Sheet:

|                | Length Traveled (Beyond Ramp) |         |         |         |
|----------------|-------------------------------|---------|---------|---------|
| Height of Ramp | Trial 1                       | Trial 2 | Trial 3 | Average |
|                |                               |         |         |         |
|                |                               |         |         |         |
|                |                               |         |         |         |
|                |                               |         |         |         |
|                |                               |         |         |         |
|                |                               |         |         |         |
|                |                               |         |         |         |

#### Analysis Questions:

1. What type of energy did the sphere on the top of the ramp have?
2. What type of energy was demonstrated as the sphere rolled down the ramp?
3. What happened as you increased the height from which the sphere rolled?
4. Predict what would happen if you increased the height of the ramp by 50 more cm?

Claim: Write a statement about the transfer of gravitational potential energy to kinetic energy.

Evidence: What evidence do you have to support your claim?

Reason: What scientific concepts explain the claim?

**Skate Park Challenge:** As a class, discuss what they notice about the sphere on the ramp experiment. Introduce the idea that they will be designing ramps for a skate park. They must take their knowledge of gravitational potential energy and the conversion to kinetic energy to create ramps that provide skaters with the opportunity for fun and exciting jumps.

## 6th Grade – Energy Transfer and Conservation

### Skate Park Design Pre-Activity

#### Standard

**6.P.3** The student will demonstrate an understanding of the properties of energy, the transfer and conservation of energy, and the relationship between energy and forces.

#### Conceptual Understanding

6.P.3A. Energy manifests itself in multiple forms, such as mechanical (kinetic energy and potential energy), electrical, chemical, radiant (solar), and thermal energy. According to the principle of conservation of energy, energy cannot be created nor destroyed, but it can be transferred from one place to another and transformed between systems.

#### Performance Indicators:

**6.P.3A.2** *Develop and use models* to exemplify the conservation of energy as it is transformed from kinetic to potential (gravitational and elastic) and vice versa.

#### Science and Engineering Practices:

**6.S.1A.2** *Develop, use, and refine models* to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

#### Cross Cutting Concepts

2. **Cause and effect:** The National Research Council states “ Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts” (p. 84). [\*The Law of Conservation of Energy describes the relationship of energy transformation. The processes of convection, conduction and radiation explain the causes and effects of the transfer of heat energy.\*](#)

3. **Scale, proportion, and quantity.** The National Research Council states “In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system’s structure or performance” (p. 84). [\*Energy transformations and the ability to do work are dependent upon scale, proportion and quantity of input energy.\*](#)

4. **Systems and system models.** The National Research Council states that this includes “defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering” (p. 84). [\*Energy transformations follow the Law of Conservation of Energy and therefore follow a system model of inputs and outputs.\*](#)

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