Colorado Teacher-Authored Instructional Unit Sample

Science
High School – Physics

Unit Title: Forms and Transformations of Energy

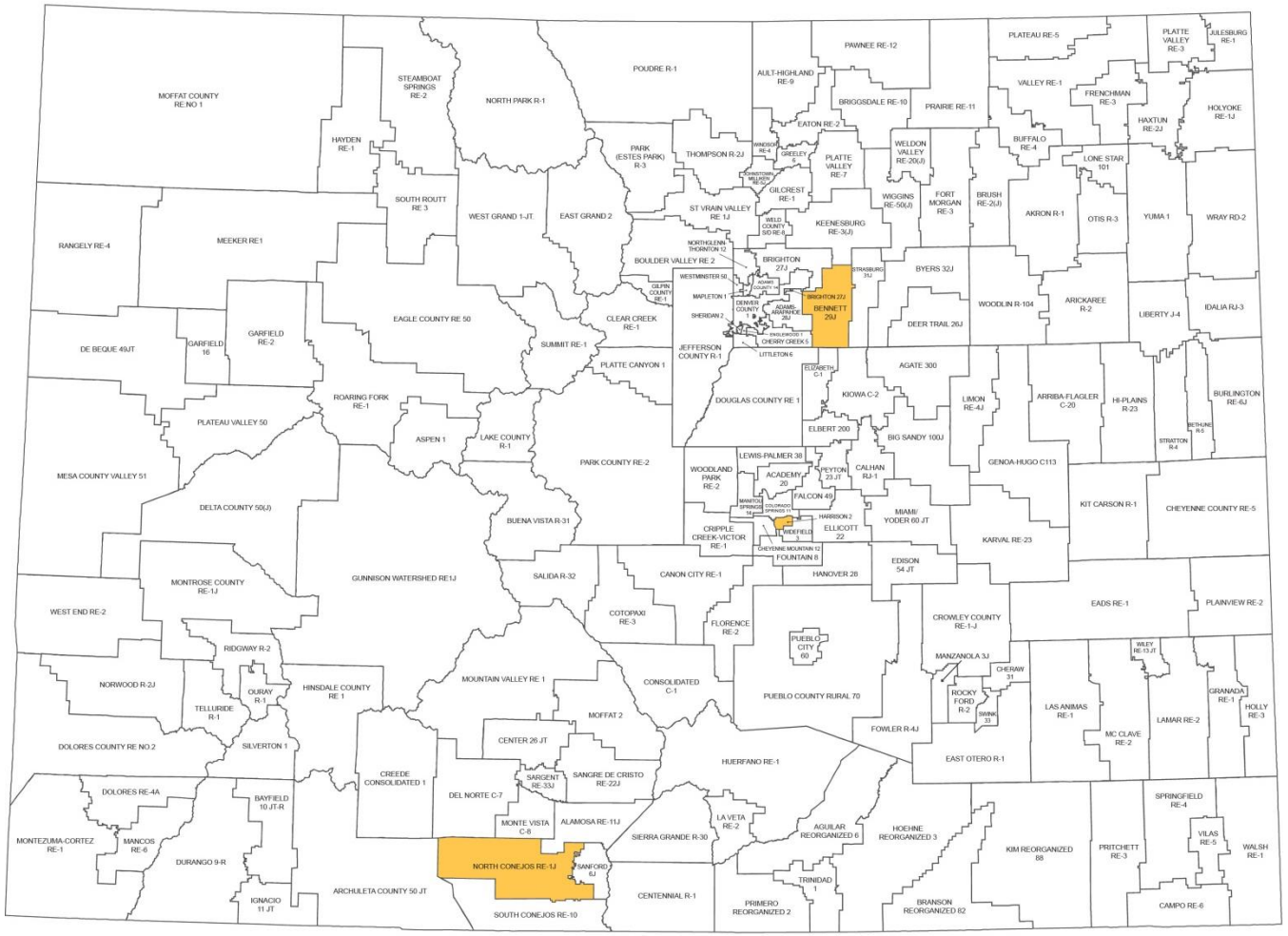
INSTRUCTIONAL UNIT AUTHORS

Harrison School District
- Beth Kochevar
- Beth Danjuma
- Phil Herfendal
- Brian Duchemin
- Kyle Cooper
- Noel Mercado

BASED ON A CURRICULUM OVERVIEW SAMPLE AUTHORED BY

Bennett School District
- Meg Hayne

North Conejos School District
- Mark Parrish
- Stephanie Parrish



This unit was authored by a team of Colorado educators. The template provided one example of unit design that enabled teacher-authors to organize possible learning experiences, resources, differentiation, and assessments. The unit is intended to support teachers, schools, and districts as they make their own local decisions around the best instructional plans and practices for all students.

DATE POSTED: MARCH 31, 2014

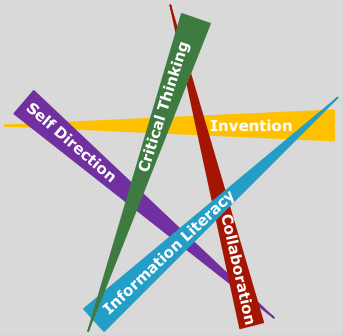
Colorado Teacher-Authored Sample Instructional Unit

Content Area	Science	**Grade Level**	High School
Course Name/Course Code	Physics		

Standard	**Grade Level Expectations (GLE)**	**GLE Code**
1. Physical Science	1. Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion – but have limitations	SC09-GR.HS-S.1-GLE.1
	2. Matter has definite structure that determines characteristic physical and chemical properties	SC09-GR.HS-S.1-GLE.2
	3. Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy	SC09-GR.HS-S.1-GLE.3
	4. Atoms bond in different ways to form molecules and compounds that have definite properties	SC09-GR.HS-S.1-GLE.4
	5. Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined	SC09-GR.HS-S.1-GLE.5
	6. When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases	SC09-GR.HS-S.1-GLE.6
2. Life Science	1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem	SC09-GR.HS-S.2-GLE.1
	2. The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem	SC09-GR.HS-S.2-GLE.2
	3. Cellular metabolic activities are carried out by biomolecules produced by organisms	SC09-GR.HS-S.2-GLE.3
	4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken.	SC09-GR.HS-S.2-GLE.4
	5. Cells use the passive and active transport of substances across membranes to maintain relatively stable intracellular environments	SC09-GR.HS-S.2-GLE.5
	6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments	SC09-GR.HS-S.2-GLE.6
	7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins	SC09-GR.HS-S.2-GLE.7
	8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome	SC09-GR.HS-S.2-GLE.8
	9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment	SC09-GR.HS-S.2-GLE.9

3. Earth Systems Science	1. The history of the universe, solar system and Earth can be inferred from evidence left from past events	SC09-GR.HS-S.3-GLE.1
	2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways	SC09-GR.HS-S.3-GLE.2
	3. The theory of plate tectonics helps to explain geological, physical, and geographical features of Earth	SC09-GR.HS-S.3-GLE.3
	4. Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere	SC09-GR.HS-S.3-GLE.4
	5. There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources	SC09-GR.HS-S.3-GLE.5
	6. The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes	SC09-GR.HS-S.3-GLE.6
	7. Natural hazards have local, national and global impacts such as volcanoes, earthquakes, tsunamis, hurricanes, and thunderstorms	SC09-GR.HS-S.3-GLE.7

Colorado 21st Century Skills



Critical Thinking and Reasoning: *Thinking Deeply, Thinking Differently*

Information Literacy: *Untangling the Web*

Collaboration: *Working Together, Learning Together*

Self-Direction: *Own Your Learning*

Invention: *Creating Solutions*

Reading & Writing Standards for Literacy in Science and Technical Subjects 6 - 12

Reading Standards

- Key Ideas & Details
- Craft And Structure
- Integration of Knowledge and Ideas
- Range of Reading and Levels of Text Complexity

Writing Standards

- Text Types & Purposes
- Production and Distribution of Writing
- Research to Construct and Present Knowledge
- Range of Writing

Unit Titles	Length of Unit/Contact Hours	Unit Number/Sequence
Forms and Transformations of Energy	8-9 weeks	4

Unit Title	Forms and transformations of energy		**Length of Unit**	8-9 weeks
Focusing Lens(es)	Change	**Standards and Grade Level Expectations Addressed in this Unit**	SC09-GR.HS-S.1-GLE.5 SC09-GR.HS-S.1-GLE.6	
Inquiry Questions (Engaging-Debatable):	• What are the advantages and disadvantages of using various energy sources? • What are the potential implications of current energy studies on science and our society? • How do the media influence perceptions of the use of different energy forms? • How do politics play a role in shaping energy policies?			
Unit Strands	Physical Science			
Concepts	Energy, Forms, Transformation, Conservation, Work			

Generalizations **My students will Understand that…**	**Guiding Questions** **Factual**	**Conceptual**
The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems. (SC09-GR.HS-S.1-GLE.5-EO.a,c,d;RA.1,3) and (SC09-GR.HS-S.1-GLE.6-EO.a,d;RA.1)	What are the most common forms of energy in our physical world? What is the difference between potential and kinetic energy? What is mechanical energy? What are the different forms of potential energy? What measurements are necessary to calculate the energy in a system? What are the forms of energy in a space shuttle What is the relationship between work and energy?	Is thermal energy the same as heat energy? Which has more energy, a bathtub full of an unknown liquid or a teacup filled with boiling water? How does energy play a role in living systems? What makes some forms of energy hard to measure? How far can an electric car travel on the energy contained in 1kg of coal?
Energy is transformed in order to be available for a variety of work. (SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e; N.2,3)	How can energy be quantified and experimentally determined? Why is it necessary to transform energy? What makes an energy form renewable or nonrenewable? What role does energy play in living systems? How does energy in the Earth drive plate tectonics. How does solar energy from the sun drive weather? (SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e;N.2,3) What type of energy can you get from a book sliding across a table?(SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e;N.2,3)	How many energy transformations occur from the burning of a fossil fuel to turning a light on in your home? Why is an understanding of energy transformations necessary in designing clean energy systems? How is energy transformed throughout the duration of a roller coaster ride?

Because energy can only be transformed, not created (i.e., the amount of energy in the universe is constant) it must be conserved. (SC09-GR.HS-S.1-GLE.5;RA.2) and (SC09-GR.HS-S.1-GLE.6-EO.a,b,c;RA.1,2;N.1,2,3)	How is energy conserved in transforming one form of energy to another? How is the amount of energy available to do work changed when some energy is lost as heat during transformation?	How does the law of conservation of energy help us solve problems involving complex systems? Why is it incorrect to say that energy is 'lost' in a transformation?

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• That energy exists in different forms (potential, kinetic, mechanical, chemical, electrical, radiant, thermal, nuclear, etc.). (SC09-GR.HS-S.1-GLE.5-a,c,d-RA.1,3) (SC09-GR.HS-S.1-GLE.6-a,d-RA.1) • How/why energy is conserved. (SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e-N.2,3) • How/why energy is transformed. (SC09-GR.HS-S.1-GLE.5-RA.2) (SC09-GR.HS-S.1-GLE.6-EO.a,b,c-RA.1,2-N.1,2,3)	• Identify the difference between potential and kinetic energy (SC09-GR.HS-S.1-GLE.5-EO.a,c,d-RA.2) • Develop, communicate, and justify and evidence-based scientific explanation regarding the potential and kinetic nature of mechanical energy. (SC09-GR.HS-S.1-GLE.5-EO.a,b-RA.2) • Measure, calculate, and graph the amount of energy in a system. (SC09-GR.HS-S.1-GLE.5-EO.a,b) • Identify different forms of energy (mechanical, chemical, electrical, radiant, thermal, and nuclear. (SC09-GR.HS-S.1-GLE.5-a,c,d-RA.1,3) (SC09-GR.HS-S.1-GLE.6-a,d-RA.1) • Use direct and indirect evidence to develop and support claims about the conservation of energy in a variety of systems. (SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e-N.2,3) • Describe energy transformations both quantitatively and qualitatively. (SC09-GR.HS-S.1-GLE.5-RA.2) (SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e-N.2,3) • Examine energy conservation and loss. (SC09-GR.HS-S.1-GLE.6-EO.a,b,c,e-N.2,3)

Critical Language: includes the Academic and Technical vocabulary, semantics, and discourse which are particular to and necessary for accessing a given discipline.
EXAMPLE: A student in Language Arts can demonstrate the ability to apply and comprehend critical language through the following statement: *"Mark Twain exposes the hypocrisy of slavery through the use of satire."*

A student in _____ can demonstrate the ability to apply and comprehend critical language through the following statement(s):	The amount of energy in the universe is constant but can be transformed. Everything that has mass possesses potential energy that can be converted into other forms of energy.
Academic Vocabulary:	justify, develop, communicate, calculate, evidence-based, qualitative, quantitative, direct, indirect, transformation, conservation
Technical Vocabulary:	potential, kinetic, mechanical, chemical, electrical, radiant, thermal, nuclear, energy, elastic, gravitational, work, joules, conduction, convection, kilogram, Newtons, Kelvin, Celsius, heat, temperature, friction,

Unit Description:	This unit focuses on forms of energy and how those forms are transformed and conserved in a variety of situations. Beginning with the foundation of energy conservation, students explain and calculate how various types of energy (kinetic, potential, mechanical, thermal, chemical, nuclear, electrical, and radiant, etc.) are used in real life scenarios. They identify efficient forms of energy used to do work and recognize that the transformations involved conserve instead of "lose" energy. The unit culminates in a performance assessment that asks students to investigate ways top decrease energy consumption for their school and present a report to their local school board.
Considerations:	**Consideration**: Teachers need to consider that the timing of the unit may not coincide with the original intention of the unit creators due to district high school scheduling differences. **Possible misconceptions**: Energy that is renewable is efficient. Energy is lost not transformed.
Unit Generalizations	
Key Generalization:	Because energy can only be transformed, not created (i.e., the amount of energy in the universe is constant) it must be conserved
Supporting Generalizations:	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems
	Energy is transformed in order to be available for a variety of work

Performance Assessment: *The capstone/summative assessment for this unit.*	
Claims: (Key generalization(s) to be mastered and demonstrated through the capstone assessment.)	Because energy can only be transformed, not created (i.e., the amount of energy in the universe is constant) it must be conserved.
Stimulus Material: (Engaging scenario that includes role, audience, goal/outcome and explicitly connects the key generalization)	You have been asked by your local school board to investigate four scenarios around decreasing energy consumption across the district in order to conserve energy and to create a report recommending two of the four for consideration. In your investigation you must calculate efficiency and total energy used, compare current energy usage to the proposed options, explain why there is not 100% efficiency for any option, and what happens to the unusable energy. In your report you must recommend two options that lead to decreased energy consumption, provide written rationale based on data collected, and support recommendations using graphical representation of data. Scenarios: • Replace 50,000 inefficient light bulbs with high efficiency L.E.D. bulbs. • Replace school's current gas-powered lawnmower with electrical lawnmower. • Replace current computer screens with newer models. • Replace soda machines with candy machines.

	Before				After				Total input energy saved with "After" option
	Old Option	*Energy Input Per Month*	*Useful Energy Output Per Month*	*Efficiency*	*New Option*	*Energy Input Per Month*	*Useful Energy Output Per Month*	*Efficiency*	
	Old light bulbs	33,000	3,300	10%	New light bulbs	9,430	3,300	35%	23,570
	Gas-powered lawnmower	3,300	396	12%	Electric-powered lawnmower	660	396	60%	2,640
	Old computer screens	6,600	330	5%	New computer screens	550	330	60%	6,050
	Coke machines	1,550	465	30%	Candy machines	78	70	90%	1,472

Data table should not be provided in full. Students should be asked to calculate efficiency, input, or output given the other two. The entire final column should be blank.

Product/Evidence:
(Expected product from students)

Students will produce a report to their local school board based on their recommendations for decreasing energy consumption using energy efficiency as a consideration. They must complete necessary calculations to fill in a data table, compare and contrast current usage and proposed options in a graphical format, provide written rationale/justification for the two selected options using data and graphs, and explain why there is not 100% efficiency with any energy usage and what happens to the unusable energy

Differentiation:
(Multiple modes for student expression)

- The teacher may incorporate accommodations/modifications of IEP such as extended time, oral presentation, use of dictionaries, etc.
- The teacher may reduce the number of options proposed
- The teacher may scaffold report, providing the structure of the report (e.g., data table calculation, graph axes, stems or prompts for rationale
- The teacher may provide opportunity to produce a report using alternative modes of communication
- The teacher may provide defined independent and dependent variables for graphs and have student fill in label blanks on graph, or provide skeleton graph as a prompt
- The teacher may provide appropriate formulas for use during calculation

- To extend this work, students may research options to collect own data. Have students also research cost-effectiveness of each option and reevaluate best options in light of new information. Have students generate own options to propose, research and evaluate.

Texts for independent reading or for class read aloud to support the content

Informational/Non-Fiction	Fiction
What Einstein Told His Barber and *What Einstein Didn't Know*– Robert L. Wolke [lexile level 1150-1220] *Ferguson's Careers in Focus: Energy* – Ferguson [lexile level 1150-1220]	*Exploring Energy* – Scholastic Books, Gallimard Jeunesse (1995) [lexile level 1150-1220] *Out of Gas – The End of the Oil Age* – David Goodstein (2005) [lexile level 1150-1220]

Ongoing Discipline-Specific Learning Experiences				
1.	Description:	Thinking like a scientist: Provide written summary/justification of data	Teacher Resources:	http://cfahs-science.wikispaces.com/Claim,+Evidence+and+Reasoning+(CER) (Format for how to write a summary and support with evidence) http://science.dadeschools.net/middleSchool/documents/professionalDevelopment/feb12/grade6/NSTA_resource[1].pdf (Power Point rolling out claim, evidence and reasoning)
			Student Resources:	http://school.discoveryeducation.com/sciencefaircentral/Science-Fair-Projects/Investigation-Analyze-Data-and-Draw-Conclusions.html (Walks students through the analysis of a data set in order to draw conclusions) http://www.csef.colostate.edu/Resources/Conclusion.pdf (A step-by-step guide to writing up a conclusion based on data from a scientific investigation) A guide (Writing up a conclusion to a scientific investigation) http://www.sophia.org/concepts/drawing-conclusions-based-on-data (Video presentations overviewing the process of drawing conclusions from data)
	Skills:	Identify position based on point of view Evaluate data to find conclusion Verbally or in writing, explain how data supports conclusion given a frame of reference	Assessment:	Students will be assessed within learning experiences
2.	Description:	Work like a scientist: Create and analyze graphs	Teacher Resources:	Power Point presentation (Dealing with identification of dependent and independent variables) http://professionaldevelopment.ibo.org/files/ocd/TaughtPractice%20with%20%20identifying%20variables.pdf (Practice worksheet for identifying dependent and independent variables) http://www.clemson.edu/ces/phoenix/tutorials/graph/index.html (Rules for graphing) http://www.wtamu.edu/academic/anns/mps/math/mathlab/beg_algebra/beg_alg_tut9_bar.htm#line3 (Teaches how and why to use different graphs and also teaches how to read a graph) http://www.teachervision.fen.com/skill-builder/graphs-and-charts/48946.html?page=1&detoured=1 (Provides questions to ask students as they analyze a graph) http://nces.ed.gov/nceskids/createagraph/default.aspx (Online way to create different types of graphs)
			Student Resources:	http://nces.ed.gov/nceskids/createagraph/default.aspx (Online way to create different types of graphs)

	Skills:	Label and title axes Identify dependent and independent variables Determine the appropriate type of graph Identify trends in graphs and tables Read different types of graphs Compare two or more sets of data to relate and draw conclusions Synthesize given information in graphic organizer	Assessment:	Students will create graphs using data from learning experiences in order to analyze relationships between variables. (Teachers may make real-time observations and provide feedback for students on their ability to set up a graph correctly.)
3.	Description:	Reading like a scientist: Read critically and extract main ideas	Teacher Resources:	http://www.phschool.com/eteach/language_arts/2002_12/essay.html (Strategies to help develop reading comprehension skills) http://www.readingrockets.org/article/3479/ (7 tips with resources to help students' reading comprehension)
			Student Resources:	http://www.brainpop.com/english/studyandreadingskills/readingskills/ (Reading comprehension movie and quiz) http://www.brainpop.com/english/writing/mainidea/ (Main idea movie and quiz) http://www.brainpop.com/math/dataanalysis/graphs/preview.weml (Analyzing graphs movie and quiz)
	Skills:	Comprehension of academic vocabulary Identify key points and themes Identify faults in research methods, logic, and statistical findings Scrutinize credibility of sources	Assessment:	Students will read existing text (journal article, newspaper, website, etc.) and/or analyze work of others to identify faults, logic, and statistical findings. (Teachers may assess academic language through observations of engagement with scientific discourse). (Teacher may provide a scientific procedure so that the students can identify faults).
4.	Description:	Thinking like a scientist: Scientific method and experimentation	Teacher Resources:	http://www.brainpopjr.com/science/scienceskills/scientificmethod/grownups.weml (Near middle of page teacher resources page with activities) http://undsci.berkeley.edu/teaching/misconceptions.php (A list of common misconceptions about the nature of science) http://undsci.berkeley.edu/teaching/ (Tips for introducing and teaching scientific method and experimentation) http://www.livescience.com/6727-invisible-gorilla-test-shows-notice.html (Video in which most people fail to observe large "gorilla" moving across room) http://www.shodor.org/succeed-1.0/forensic/teacher/lessons/observation.html (Lesson plan devoted to developing observation skills) http://blogs.loc.gov/teachers/2011/06/look-again-challenging-students-to-develop-close-observation-skills/ (Library of Congress brief of tools for helping students develop observation skills)

			Student Resources:	http://www.brainpopjr.com/science/scienceskills/scientificmethod/grownups.weml (At top of page student link for movie and activities about scientific method) http://www.glencoe.com/sites/common_assets/science/virtual_labs/E16/E16.html (Virtual lab to practice use of scientific method and experimentation) http://www.brainpop.com/science/scientificinquiry/scientificmethod/preview.weml (Movie and quiz for scientific method/inquiry) http://lifehacker.com/5960811/how-to-develop-sherlock-holmes+like-powers-of-observation-and-deduction (Explanation of tools to increase observation skills with hook related to Sherlock Holmes)
	Skills:	Write a testable question to be answered in an experiment Design an experiment that controls for independent and dependent variables Analyze experimental results with respect to their support of the hypothesis Identify possible sources of error Critique research methodology of scientists or other students	Assessment:	Students will be assessed within learning experiences
5.	Description:	Working like a scientist: Collect and organize data	Teacher Resources:	https://drive.google.com/templates# (Google Drive templates) http://www.mathgoodies.com/lessons/toc_vol11.html (Students learn how develop data collection and create graph)
			Student Resources:	https://drive.google.com/templates# (Variety of different templates to capture data and create a spreadsheet) http://nces.ed.gov/nceskids/createagraph/ (Students able to create a diverse range of graphs)
	Skills:	Identify independent and dependent variable in experiment Identify what data needs to be collected Set up appropriate data table Recognize sources of error in data collection	Assessment:	Students may set up their own data table in order to identify the dependent and independent variables. Students may analyze data collected and recognize outliers.
6.	Description:	Working like a scientist: Practice laboratory safety skills	Teacher Resources:	http://www.flinnsci.com/teacher-resources/safety/general-laboratory-safety.aspx (General lab safety guidelines and procedures) http://www.flinnsci.com/media/396480/safety_contract_ms.pdf (Safety Contract) http://sciencewithsandy.com/safety/teacher.htm (Guidelines for teaching safety skills and activities to use with students)

			Student Resources:	http://www.youtube.com/watch?v=em23H5a9iqQ (Can you identify the safety mistakes in this video) http://www.youtube.com/watch?v=hnfiS28ANsU (Lab safety video)
	Skills:	Explain safety concerns Identify lab safety equipment	Assessment:	Students will demonstrate their understanding of laboratory safety or quiz students on safety practices or pre-assess understanding of safety prior to lab/activity.

Prior Knowledge and Experiences

Students must have an understanding of the scientific method, the metric system (including prefixes and conversions), algebra, use of a scientific calculator, graphing (including setting up the axes, appropriate scale, labeling, and identifying dependent and independent variables).

Vertical Articulation: The last time students have seen these concepts related to this unit was in 8th and 4th grades.

Learning Experiences # 1 – 3
Instructional Timeframe: Week 1

Learning Experience # 1

The teacher may provide concrete interactive examples of different forms of energy so that students can explore, observe and generate their own thoughts and definitions of energy (e.g., slinky or rope for waves, weight and pulley, generation of heat, chemical reaction).

Generalization Connection(s):	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems
Teacher Resources:	http://www.csun.edu/science/ref/laboratory/safety/safety_contract.html (Safety Contract) www.youtube.com/watch?v=xJG0ir9nDtc (Lab Safety Rap video) http://energyquest.ca.gov/story/index.html (Background information about energy and the most common types) http://www.glencoe.com/sites/common_assets/science/virtual_labs/E04/E04.html (Background information on energy basics and forms) http://mrdispenza.com/yahoo_site_admin/assets/docs/observation.308111416.pdf (Presentation on observation skills with numerous examples of observing suitable details)
Student Resources:	http://www.brainpop.com/science/energy/energysources/preview.weml (Video about definition of energy, alternative energies and the types of energy Americans use) http://www.mentormob.com/categories/search?search=energy (Multiple videos about energy) http://www.eia.gov/kids/energy.cfm?page=1 (Provides multiple links to student friendly information about energy, units of energy as well as conversion) http://www.scientificamerican.com/alternative-energy-technology (High interest articles relating to real life energy applications) http://tiki.oneworld.net/energy/energy.html (Student friendly guide to the basics of energy and what we use it for)

<table>
<tr><td>Assessment:</td><td colspan="2">Students will produce an exit ticket that describes the role of energy in a given interaction.

http://exitticket.org/?gclid=CMKZt6Xsir0CFQ5qfgod_YEAFw (Online exit tickets)</td></tr>
<tr><td rowspan="2">Differentiation:
(Multiple means for students to access content and multiple modes for student to express understanding.)</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may provide steps for each observed LAB station
The teacher may provide questions written/verbal to guide understanding
The teacher may make final GOAL/OUTCOME specific at the beginning of the lab
www.khanacademy.org (Offers short/brief videos, and practice concepts to check for understanding)
www.pcieducation.com (Offers different teaching strategies and scaffold lab techniques)
http://www.eschooltoday.com/what-is-energy-for-children.html (The Energy Story – explanation of energy forms in game format)</td><td>The student may use multiple choice answers to define what “ENERGY” is
The student may fill in the blank to select appropriate definition with or without word bank
The student may provide verbal answer
The student may complete a diagram including other examples of “ENERGY”</td></tr>
<tr><td rowspan="2">Extensions for depth and complexity:</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>www.Engineeringtoolbox.com (Site that provides conversion factors for an abundance of units)
http://www.pbs.org/wgbh/nova/zero/ (Videos, interactive virtual experiment, and reading on absolute zero)
http://science.howstuffworks.com/life/human-biology/calorie1.htm (Explanation of calorie as measure of potential energy, examples of energy amounts stored in foods)</td><td>The student may identify different forms of energy from intangible opportunities
The student may extend understanding of unit conversion (kilocalories to joules)
The student may relate kilocalories to nutrition and exercise</td></tr>
<tr><td>Critical Content:</td><td colspan="2">• What is energy?
• Different units of energy
• Energy is the ability to do work
• Energy is required for all actions (natural and artificial)
•</td></tr>
<tr><td>Key Skills:</td><td colspan="2">• Observation
• Basic laboratory safety</td></tr>
<tr><td>Critical Language:</td><td colspan="2">Energy, work, joules, kilowatt hours, calories, kilocalories, observe, describe</td></tr>
</table>

Learning Experience # 2		
The teacher may provide interactive examples of different forms of energy (kinetic, potential, mechanical, nuclear, electrical, chemical, thermal, radiant) so that students can identify variables that affect the amount of energy within a system (e.g., dropping objects of different masses from the same height, dropping objects of the same mass from different heights, moving an object through the use of waves).		
Generalization Connection(s):	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems	
Teacher Resources:	http://Khanacademy.org (Provides videos that overview content) http://www.teachengineering.org/view_activity.php?url=collection/cla_/activities/cla_activity1_forms_states/cla_activity1_forms_states.xml (Examples of energy demonstrations for activity) http://www.mrfizix.com/home/energy.htm (Provides an outline for a lesson plan including a demonstration of energy)	
Student Resources:	http://phet.colorado.edu/en/simulation/energy-skate-park (Simulation of the interaction between potential and kinetic energy)	
Assessment:	Students will generate a list of variables which affect each form of energy as an exit ticket. http://exitticket.org/?gclid=CMKZt6Xsir0CFQ5qfgod_YEAFw (Online exit tickets)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide more explicit step by step procedure for experience The teacher may allow students to view simulations of different forms of energy at work The teacher may provide multiple choices for variables http://phet.colorado.edu/en/simulation/energy-skate-park (Simulation of the interaction between potential and kinetic energy)	The student may answer verbally rather than in writing
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may make the experience inquiry based with little guidance for process http://www.glencoe.com/sec/teachingtoday/subject/using_inquiry_sci.phtml (Provides an overview of inquiry based learning activities) http://bowlesphysics.com/images/01Honors_Physics_-_Direct_and_Inverse_Relationships.pdf (Slideshow overviewing direct and inverse relationships between variables in physics)	The student may determine the relationship between variables (direct or inverse) in addition to identifying them

Critical Content:	• Forms of energy (kinetic, potential, mechanical, nuclear, electrical, chemical, thermal, radiant) • Some forms of energy can be transmitted through waves (mechanical and electromagnetic)
Key Skills:	• Compare and contrast forms of energy • Compare and contrast mechanical and electromagnetic waves • Identify and provide examples of the forms of energy (kinetic, potential, mechanical, nuclear, electrical, chemical, thermal, radiant)
Critical Language:	Energy, kinetic, potential, mechanical, nuclear, electrical, chemical, thermal, radiant, waves (mechanical and electromagnetic), variable, compare, contrast, identify

Learning Experience # 3	
The teacher may provide opportunities to measure potential, kinetic, and mechanical energy so that students can understand the steps to quantify an amount of energy in a system.	
Generalization Connection(s):	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems
Teacher Resources:	http://Khanacademy.org (Provides videos that overview content) http://www.studygs.net/pemdas/ (Presents PEMDAS and demonstrates its use to solve a complex expression) http://www.khanacademy.org/math/algebra/solving-linear-equations-and-inequalities/solving_for_variable/v/rearrange-formulas-to-isolate-specific-variables (Video tutorials on rearranging equations to solve for specific variables) http://serc.carleton.edu/mathyouneed/equations/ManEqInstructor.html (Instructions for guiding students through manipulating equations)
Student Resources:	http://www.cposcience.com/home/Portals/2/Media/post_sale_content/FPS%203rd/Ancillaries/U3/U3_Skill_and_Practice_Sheets/FPS_U3_SS.pdf (Handout providing definitions, equations, examples of problems worked out, and practice problems for calculating kinetic, potential, and mechanical energy) http://www.math.com/school/subject2/lessons/S2U1L2GL.html (Walks students through order of operations problems step-by-step checking for understanding along the way) http://www.algebrahelp.com/worksheets/view/simplifying/oops.quiz (Online order of operations worksheet with a worked out example and step-by-step instructions available for each problem) http://www.coolmath.com/prealgebra/05-order-of-operations/01-order-of-operations-why-01.htm (Slide show overview order of operations including worked out examples and practice problems)
Assessment:	Given word problems, students will calculate kinetic, potential, and mechanical energy as an exit ticket. http://exitticket.org/?gclid=CMKZt6Xsir0CFQ5qfgod_YEAFw (Online exit tickets) http://chs.kcsdschools.com/download.axd?file=753ad4ef-6807-45f8-8e71-f9c24df53974&dnldType=Resource (Word problems for potential and kinetic energy)

Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide worked out examples of calculations The teacher may allow students to use an online calculator to check their answers and practice identifying variables and unknown The teacher may provide variables The teacher may provide equations for problem solving The teacher may scaffold the process of problem solving (step by step) http://www.cposcience.com/home/Portals/2/Media/post_sale_content/FPS%203rd/Ancillaries/U3/U3_Skill_and_Practice_Sheets/FPS_U3_SS.pdf (Handout providing definitions, equations, examples of problems worked out, and practice problems for calculating kinetic, potential, and mechanical energy) http://easycalculation.com/physics/classical-physics/kinetic-energy.php (an online calculator for potential and kinetic energy)	The student may answer shorter word problems with less distractors The student may answer multiple choice options for possible answers
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://engineeringtoolbox.com (Site that provides conversion tools)	The student may extend understanding of unit conversions (ex. Grams to kilograms) The student may add distractor variables into word problems
Critical Content:	• Formulas for kinetic, potential, and mechanical energy	
Key Skills:	• Solve for an unknown variable in the mechanical, potential, and kinetic energy equations • Identify variables and units in word problems • Plug variables into an equation • Rearrange equations to solve for an unknown variable • Follow order of operations (PEMDAS)	
Critical Language:	Energy, kinetic energy, potential energy, mechanical energy, mass (kilograms), gravity (meters/second^2), velocity or speed (meters/second), height (meters), identify, solve, rearrange, calculate	

Learning Experiences # 4 – 5
Instructional Timeframe: Weeks 1-2

Learning Experience # 4		
The teacher may provide tangible demonstrations of energy transformations so that students can comprehend that energy is conserved in all interactions. (e.g., measure potential energy before and kinetic after a free-fall interaction, pendulum, Newton's cradle).		
Generalization Connection(s):	Energy is transformed in order to be available for a variety of work	
Teacher Resources:	http://dacc.edu/~ksturgeon/106labsampleDB.pdf (Overview of lab demonstrating conservation of energy in a transformation; requires photogate timer) http://science.howstuffworks.com/newtons-cradle4.htm (Explanation of Newton's Cradle and relationship to law of conservation of energy)	
Student Resources:	http://www.pbs.org/opb/circus/classroom/circus-physics/conservation-energy/ (Video of acrobats related to mechanical energy transformation)	
Assessment:	Students will describe (in science notebooks or verbally) several interactions, identifying input and output energies and explaining that input and output are equal.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow students to provide written rather than visual descriptions of motion in a transformation http://science.howstuffworks.com/newtons-cradle4.htm (Explanation of Newton's Cradle and relationship to law of conservation of energy)	The student may provide written description of changing energy The student may be given a problem requiring calculation of energy at points in transformation The student may provide a verbal explanation of student-led demonstration
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://physicsnet.co.uk/wp-content/uploads/2010/05/shm-energy-graph.jpg (ME, KE, PE vs. time graph for pendulum)	The student may graph potential and kinetic energy at each point in time for an interaction and interpret the results with respect to mechanical energy
Critical Content:	• Energy is not lost, only transferred • The energy society uses must be captured or extracted from somewhere, not created • All of the current energy in the universe can be traced back to the Big Bang • Input energy provides the energy necessary for an interaction, while output energy results	
Key Skills:	• Identify forms of energy involved in an interaction • Observation	
Critical Language:	Energy, transformation, input energy, output energy, conservation of energy, describe, identify, observe	

Learning Experience # 5		
The teacher may provide opportunities to observe and measure transformations that involve heat "loss" so that students can begin to understand that some energy is "lost" to heat in all interactions (e.g., feeling heat created by friction, calorimetry experiments, observing thermal loss in an incandescent light bulb versus fluorescent).		
Generalization Connection(s):	Energy is transformed in order to be available for a variety of work	
Teacher Resources:	http://www.physicsclassroom.com/Class/energy/ (General background information on energy transformations) http://www.learner.org/workshops/chemistry/support/act6_d1.pdf (Heat given off by burning a peanut – calorimetry experiment) http://homeguides.sfgate.com/energyefficient-bulbs-halogen-vs-fluorescent-vs-incandescent-78832.html (Comparing energy efficiency of different types of bulbs) http://www.studygs.net/pemdas/ (Presents PEMDAS and demonstrates its use to solve a complex expression) http://www.khanacademy.org/math/algebra/solving-linear-equations-and-inequalities/solving_for_variable/v/rearrange-formulas-to-isolate-specific-variables (Video tutorials on rearranging equations to solve for specific variables) http://serc.carleton.edu/mathyouneed/equations/ManEqInstructor.html (Instructions for guiding students through manipulating equations)	
Student Resources:	http://www.media.pearson.com.au/schools/cw/au_sch_derry_ibcsl_1/int/bombCalorimetry/0607.html (Calorimetry simulation) http://phet.colorado.edu/en/simulation/friction (Investigate heat produced by friction)	
Assessment:	Students will explain why the input energy is greater than useful output energy for a variety of scenarios (a ball bouncing on the ground, wind turning a turbine, combustion engine, hydroelectric power, light bulb) and that one result is an output of thermal energy. Students will explain that thermal energy output is not the destruction of energy but rather a decrease in useful energy. Students can write a cohesive paragraph that provides supporting details to justify their response, or diagram a scenario and write captions explaining their response) http://www.educationoasis.com/curriculum/GO/GO_pdf/causeeffect_events.pdf (Cause and effect graphic organizer)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://eol.plymouth.k12.in.us/Lincoln/science7/chap13.pdf (Background on energy including short answer and multiple choice style questions)	The student may answer multiple choice answers to explain the "loss" of energy
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://www.chaostoy.com/cd/html/lost_e.htm (Experiment testing energy "lost" to friction) http://www.physicsclassroom.com/class/thermalP/u18l2c.cfm (Details about calculating values for calorimetry experiments) https://www.khanacademy.org/science/physics/work-and-energy/work-and-energy-tutorial/v/work-energy-problem-with-friction (Explanation of how to use the work-kinetic energy theorem)	The student may design their own experiments to determine how much heat is "lost" to friction or calorimetry experiments The student may design ways to make a calorimetry experiment more energy efficient The student may calculate the amount of energy "lost" using the work-kinetic energy theorem

Critical Content:	• Friction results in thermal energy output or "loss" to heat • Energy is not truly lost (it is not destroyed); it transfers and transforms
Key Skills:	• Observation • Lab measurements (e.g., temperature)
Critical Language:	Energy, friction, thermal energy, heat, transfer, transform, observe, measure, design, calculate

Learning Experiences # 6 – 7
Instructional Timeframe: Weeks 2-3

Learning Experience # 6		
The teacher may provide opportunities to observe and measure energy transformations so that students can explain that total energy remains constant even as energy changes forms. (e.g., pendulum, roller coaster, emergency light bulbs, emergency radios, fires, engines).		
Generalization Connection(s):	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems Energy is transformed in order to be available for a variety of work	
Teacher Resources:	http://examples.yourdictionary.com/law-of-conservation-of-energy-examples.html (Examples of various energy transformations) http://electronics.howstuffworks.com/gadgets/travel/hand-powered-generators.htm (Explanation of how hand held generators work)	
Student Resources:	http://www.passmyexams.co.uk/GCSE/physics/energy-transfer.html (Energy transformation diagrams and explanation) http://www.math.com/school/subject2/lessons/S2U1L2GL.html (Walks students through order of operations problems step-by-step checking for understanding along the way) http://www.algebrahelp.com/worksheets/view/simplifying/oops.quiz (Online order of operations worksheet with a worked out example and step-by-step instructions available for each problem) http://www.coolmath.com/prealgebra/05-order-of-operations/01-order-of-operations-why-01.htm (Slide show overview order of operations including worked out examples and practice problems)	
Assessment:	Students will describe a variety of energy transformations in terms of the forms and values of their input energy and output energy. (For example, a product made on a production line, the operation of an appliance, an engine, a fire, etc. and/or students can write a letter from the viewpoint of a production line manager detailing the transformations and input/output energy.)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide consistent steps to complete when analyzing a transformation The teacher may provide word bank to complete analysis of energy transformation The teacher may provide diagrams of transformations for	The student may diagram transformations of energy

	students to fill in forms of energy http://www.bbc.co.uk/bitesize/ks3/science/energy_electricity_forces/energy_transfer_storage/revision/3/ (Diagrams of energy transfer in various everyday objects)	
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://www.education.com/science-fair/article/converting-motion-into-energy/ (Simple device design experiment) http://www.ptc.com/company/community/education/schools/students/real-world-design-challenge/ (Competition high school students can enter for energy design challenges) http://pbskids.org/designsquad/parentseducators/resources/ (Ideas for numerous design challenge devices)	The student may design a device that accomplishes an everyday task around the home, utilizing different energy transformations.
Critical Content:	• Total input energy = total output energy • Common transformations (e.g., mechanical to electrical, chemical to thermal, potential to kinetic)	
Key Skills:	• Identifying forms of energy • Differentiating input and output energy	
Critical Language:	Energy, transformation, input, output, constant, identify, differentiate, design, describe	

Learning Experience # 7	
The teacher may provide opportunities to observe and measure mechanical energy transformations so that students can calculate values for mechanical, kinetic, and potential energy in order to understand their mathematical factors during a transformation (e.g., students can find the velocity of a pendulum at its lowest point given its original potential energy and its mass).	
Generalization Connection(s):	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems Energy is transformed in order to be available for a variety of work
Teacher Resources:	http://www.physicsclassroom.com/mmedia/energy/pe.cfm (Animated GIF of pendulum transformation with energy quantities, table to be filled in from calculations) http://phet.colorado.edu/en/simulation/energy-skate-park (Simulation of skateboarder undergoing mechanical energy transformation) http://www.stanford.edu/group/lpchscience/cgi-bin/wordpress/images/2012/11/Potential-and-Kinetic-Energy-BS.pdf (Guidelines for students to construct a rollercoaster and relate energy transformations) https://njctl.org/courses/science/algebra-based-physics/energy/work-and-energy-chapter/ (Background on energy and calculations)
Student Resources:	http://phet.colorado.edu/en/simulation/energy-skate-park (Simulation of skateboarder undergoing mechanical energy transformation) http://www.physicsclassroom.com/mmedia/energy/ie.gif (Animated GIF of energy transformation with energy values)

<table>
<tr><td></td><td colspan="2">http://phet.colorado.edu/en/simulation/energy-skate-park (Investigate changes in skateboard ramps and their effect on height or velocity of the skateboarder)
http://www.math.com/school/subject2/lessons/S2U1L2GL.html (Walks students through order of operations problems step-by-step checking for understanding along the way)
http://www.algebrahelp.com/worksheets/view/simplifying/oops.quiz (Online order of operations worksheet with a worked out example and step-by-step instructions available for each problem)
http://www.coolmath.com/prealgebra/05-order-of-operations/01-order-of-operations-why-01.htm (Slide show overview order of operations including worked out examples and practice problems)</td></tr>
<tr><td>Assessment:</td><td colspan="2">Given an observed or written description of a mechanical energy transformation, students will solve for unknown variables (ME, KE, PE, m, h, v). (Teacher note: Students can be given 5 multiple choice style questions to solve and explain the steps they used to arrive at the correct answer.)</td></tr>
<tr><td rowspan="2">Differentiation:
(Multiple means for students to access content and multiple modes for student to express understanding.)</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The G.U.E.S.S. Problem Solving Method (ppt)</td><td>The student may use GUESS method for using algebra to solve word problems
The student may fill in answers in boxes on diagram of an energy transformation showing specific points in time rather than with only a word problem as a stimulus</td></tr>
<tr><td rowspan="2">Extensions for depth and complexity:</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>http://www.physicsclassroom.com/mmedia/energy/ce.cfm (Conceptual explanation of each energy value in a mechanical transformation)</td><td>The student may use new equations to describe transformations. E.g., falling object can be described by $PE_{initial} = KE_{final}$
• initial mgh = final ½mv^2
• initial gh = final ½v^2
The student may create and justify fuller ME equation (ME = mgh + ½mv^2)
The student may identify their own mechanical energy transformation scenarios and reason through calculating each of the variables by making assumptions about some of them (e.g., estimate an object's mass, KE is 0 while it is stationary, estimate its height for free-fall)</td></tr>
<tr><td>Critical Content:</td><td colspan="2">• ME = KE + PE
• PE = mgh
• KE = ½mv^2</td></tr>
<tr><td>Key Skills:</td><td colspan="2">• Use algebra to solve for unknown variables describing a situation
• Identify variables (e.g., PE, m, v) in a written or observed scenario</td></tr>
<tr><td>Critical Language:</td><td colspan="2">Energy, transformation, mechanical energy, kinetic energy, potential energy, variable, gravity, mass, velocity, height, calculate, identify, solve</td></tr>
</table>

Learning Experiences # 8 – 9
Instructional Timeframe: Weeks 3-4

Learning Experience # 8		
The teacher may provide concrete interactive examples of biological processes so that students can identify the forms of energy involved in transformations in living systems (e.g., calorimetry, measuring heat from human respiration).		
Generalization Connection(s):	Because energy can only be transformed, not created (i.e., the amount of energy in the universe is constant) it must be conserved The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems Energy is transformed in order to be available for a variety of work	
Teacher Resources:	http://www.mayoclinic.com/health/exercise/SM00109 (Explanation of calorie counting in weight gain and loss, list of calories burned by different activities) http://www.chymist.com/energy%20of%20a%20peanut.pdf (Sample calorimetry lab) http://topics.nytimes.com/top/reference/timestopics/subjects/e/energy_efficiency/index.html (New York Times articles relating to energy resources) http://www.glencoe.com/sec/teachingtoday/subject/finding_science.phtml (Ideas to help build connections between classroom content and real life)	
Student Resources:	http://phet.colorado.edu/en/simulation/eating-and-exercise (Interactive simulation of results of certain diet and exercise habits) http://www.nytimes.com/2013/04/30/science/exercise-versus-calories-on-menu-lists.html?_r=0 (Real-world application of relationship between exercise and diet in weight loss)	
Assessment:	Students will explain how energy drives living processes like photosynthesis, identifying input and output energies and explaining that energy is conserved in those processes. Students can create a diagram or comic strip of a process and include captions for their explanation. http://www.printablepaper.net/category/storyboard (Storyboard graphic organizer)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow students to observe physical phenomena The teacher may allow students to predict how physical processes work given their requirement for energy The teacher may provide demonstrations of human need for energy http://phet.colorado.edu/en/simulation/eating-and-exercise (Interactive simulation of results of certain diet and exercise habits)	The student may provide written description of energy transforming in a living system The student may answer problem requiring calculation of input and output energies given conservation of energy

Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://www.chymist.com/energy%20of%20a%20peanut.pdf (Sample calorimetry lab with calculations)	The student may calculate thermal energy from calorimetry or human respiration rather than simply observing that thermal energy increases
Critical Content:	• Photosynthesis transforms electromagnetic energy into chemical energy. • Cellular respiration transforms chemical energy into other forms and allows organisms to do work. • Energy is conserved in living systems. • Food contains chemical energy and allows humans and animals to do work.	
Key Skills:	• Identify forms of energy involved in interactions	
Critical Language:	Energy, transformation, photosynthesis, cellular respiration, biological processes, food chain, electromagnetic energy, chemical energy, work, conservation, identify, calculate	

Learning Experience # 9	
The teacher may provide concrete examples of processes on earth so that students can identify the forms of energy involved in transformations in earth systems (e.g., plate tectonics, seismic activity, geothermal energy, weather systems).	
Generalization Connection(s):	Because energy can only be transformed, not created (i.e., the amount of energy in the universe is constant) it must be conserved The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems Energy is transformed in order to be available for a variety of work
Teacher Resources:	http://www.slideshare.net/Teach5ch/weather-energy-and-heat-transfer (Background information on energy and weather systems) http://www.nasa.gov/pdf/535744main_Energy_Budget_P1.pdf (Energy in earth systems) http://earthobservatory.nasa.gov/Features/EnergyBalance/page4.php (Earth's energy budget) http://topics.nytimes.com/top/reference/timestopics/subjects/e/energy_efficiency/index.html (New York Times articles relating to energy resources) http://www.glencoe.com/sec/teachingtoday/subject/finding_science.phtml (Ideas to help build connections between classroom content and real life)
Student Resources:	http://geothermal.marin.org/geopresentation/sld001.htm (Slideshow on how energy is transferred throughout earth systems)
Assessment:	Students will explain how energy drives earth processes like plate tectonics or weather, identifying input and output energies and explaining that energy is conserved in those processes. Students can write a cohesive paragraph including details to help justify their response. http://teachers.colonelby.com/arbogastn/eng%201D/Writing/How%20to%20Write%20an%20Expository.htm (Expository paragraph)

Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow students to work in pairs or groups to research energy changes in various earth systems then share with classmates http://learning.instructure.com/2012/12/smart-student-presentations/ (Guidelines for classroom presentations) http://www.ncsu.edu/midlink/rub.pres.html (Student presentation rubric)	The student may create a diagram that explains how energy drives processes
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	http://www.mpoweruk.com/energy_efficiency.htm (Comparison of electricity generation efficiency)	The student may research different ways to obtain energy from earth systems and compare their efficiency
Critical Content:	• Earth's core transmits thermal energy, which transforms into kinetic energy. • Electromagnetic energy from the sun transforms into thermal energy and drives weather processes. • Kinetic energy travels through the earth's interior in seismic activity.	
Key Skills:	• Identify forms of energy involved in interactions	
Critical Language:	Energy, core, thermal energy, seismic, kinetic energy, electromagnetic energy, weather, plate tectonics, geothermal energy, identify, compare	

Learning Experiences # 10 – 11
Instructional Timeframe: Weeks 4-5

Learning Experience # 10	
The teacher may provide a concrete system of energy transfer as an interactive experience so that students can observe and collect data on input and output energies to calculate the efficiency of the system.	
Generalization Connection(s):	The diversity of forms of energy in our physical world plays a significant role in living systems and Earth's systems Because energy can only be transformed, not created, it must be conserved
Teacher Resources:	http://www.ei.lehigh.edu/eli/energy/resources/handouts/labs/efficiency_lab_teacher.pdf (Teacher guide for light bulb efficiency lab) http://www.ase.org/resources/lightbulb-energy-efficiency-lab-lesson-plan (Guide to light bulb lab with applications to societal impacts of energy conservation) http://www.studygs.net/pemdas/ (Presents PEMDAS and demonstrates its use to solve a complex expression) http://www.khanacademy.org/math/algebra/solving-linear-equations-and-inequalities/solving_for_variable/v/rearrange-formulas-to-isolate-specific-variables (Video tutorials on rearranging equations to solve for specific variables) http://serc.carleton.edu/mathyouneed/equations/ManEqInstructor.html (Instructions for guiding students through manipulating equations)

Student Resources:	http://phet.colorado.edu/en/simulation/energy-forms-and-changes (Phet simulation on energy transformations) http://www1.eere.energy.gov/femp/technologies/eep_eccalculators.html (Energy efficiency calculator)	
Assessment:	Given data on input and output energies for an older device (i.e., furnace, washer, dryer) as well as a newer model, students will calculate efficiencies of both models, display results graphically and compile a mini report justifying which model is more energy efficient. Students can be given 2 devices with data and complete the calculations as well as explaining the steps they used. http://www.mathgoodies.com/lessons/toc_vol11.html (Students learn how develop data collection and create graph)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide concrete/scaffolding of instructions regarding procedure during lab and data collection The teacher may provide data table for data collection The teacher may provide formulas for calculations The teacher may provide prompts/stems for written portions of assessment	The student may provide an oral presentation of procedure/assessment directions
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may have students research efficiency data for assessment on their own For assessment, the teacher may have students calculate the efficiency of more than one device being replaced and recommend the best option	The student may calculate power and/or work The student may convert units of measurement (i.e. kilocalories to joules)
Critical Content:	• Efficiency= useful output/input	
Key Skills:	• Calculate energy output given efficiency. • Calculate efficiency given Input and Output.	
Critical Language:	Input, output, energy, joules, kilowatts, efficiency, inefficiency, friction, heat loss, energy transfer, systems, calculate, observe, describe	

Learning Experience # 11	
The teacher may provide information about the efficiency and cost of various energy sources (e.g., solar, wind, natural gas) so that students can begin drawing conclusions about the costs/benefits of the use of renewable vs nonrenewable resources as a major energy source.	
Generalization Connection(s):	Energy is transformed in order to be available for a variety of work Because energy can only be transformed, not created, it must be conserved

Teacher Resources:	http://www.infoplease.com/encyclopedia/science/power-electric-sources-electrical-energy.html (Explanation of typical efficiency by energy source) http://www.epa.gov/cleanenergy/energy-resources/renewabledatabase.html (Federal renewable energy cost database) http://topics.nytimes.com/top/reference/timestopics/subjects/e/energy_efficiency/index.html (New York Times articles relating to energy resources) http://www.glencoe.com/sec/teachingtoday/subject/finding_science.phtml (Ideas to help build connections between classroom content and real life)	
Student Resources:	http://energy.gov/energysaver/articles/estimating-appliance-and-home-electronic-energy-use (Information on typical costs to run everyday appliances and on methods for calculating costs) http://www.nature.org/greenliving/carboncalculator/index.htm (Carbon footprint calculator, useful for intro to externalities related to certain types of energy consumption)	
Assessment:	Using persuasive writing (e.g., a letter to the editor), students will inform the reader on renewable vs nonrenewable energy as a major energy source, justifying with examples of pros and cons for both types of energy. http://www.readwritethink.org/files/resources/printouts/persuasion%20map.pdf (Persuasive template)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may have students analyze 2 sets of data, one renewable and one nonrenewable example The teacher may scaffold data presentation The teacher may provide scaffold persuasive writing template for the assessment The teacher may provide graphic organizers to help facilitate drawing conclusions	The student may provide an oral presentation using persuasive speech
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may have students research to collect efficiency and cost data	The student may provide efficiency and cost data in paragraph format for students to extract
Critical Content:	• Renewable vs Nonrenewable resources	
Key Skills:	• Weighing costs and benefits	
Critical Language:	Renewable, nonrenewable, resources, costs, benefits, analysis, efficiency, solar energy, wind energy, natural gas, inform, justify, draw conclusions	