Unit 7: Work and Energy

Content Area: **Science**
Course(s):
Time Period: **Marking Period 4**
Length: **5 Weeks**
Status: **Published**

Summary

This unit explains the relationship between work and energy. Different types of energy are identified and examined. The transformation and transfer of energy is analyzed. The principle of conservation of energy is introduced and applied to everyday scenarios. Hooke's Law can be incorporated into this unit at any time, including before the unit.

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1	Make sense of problems and persevere in solving them
2	Reason abstractly and quantitatively
L.SS.11–12.1.A	Apply the understanding that usage is a matter of convention, can change over time, and place, and is sometimes contested.
3	Construct viable arguments and critique the reasoning of others
L.KL.11–12.2	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
4	Model with mathematics
5	Use appropriate tools strategically
9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
L.VL.11–12.3	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, including technical meanings, choosing flexibly from a range of strategies.
6	Attend to precision
RI.CR.11–12.1	Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.
RI.CI.11–12.2	Determine two or more central ideas of an informational text and analyze how they are developed and refined over the course of a text, including how they interact and build on one another to provide a complex account or analysis; provide an objective summary of the text.
8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
RL.PP.11–12.5	Evaluate perspectives/lenses from two or more texts on related topics and justify the more cogent viewpoint (e.g., different accounts of the same event or issue, use of different media or formats).
RL.MF.11–12.6	Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the author’s message).
W.AW.11–12.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).
9.4.12.IML.8	Evaluate media sources for point of view, bias, and motivations (e.g., NJSLSA.R6, 7.1.AL.IPRET.6).
9.4.12.IML.9	Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).
W.IW.11–12.2	Write informative/explanatory texts (including the narration of historical events, scientific procedures/experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
8.2.12.ED.5	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
W.WP.11–12.4	Develop and strengthen writing as needed by planning, revising, editing, rewriting, trying a new approach; sustaining effort to complete complex writing tasks; tracking and reflecting on personal writing progress (e.g., using portfolios, journals, conferencing); or consulting a style manual (such as MLA or APA Style), focusing on addressing what is most significant for a specific purpose and audience.
W.WR.11–12.5	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
W.SE.11–12.6	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation (MLA or APA Style Manuals).
W.RW.11–12.7	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes.
SL.PE.11–12.1.B	Collaborate with peers to promote civil, democratic discussions and decision-making, set clear goals and assessments (e.g., student developed rubrics), and establish individual roles as needed.
SL.II.11–12.2	Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
SL.ES.11–12.3	Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
SL.PI.11–12.4	Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.

8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.
SL.UM.11–12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
SL.AS.11–12.6	Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.
8.2.12.EC.1	Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
8.2.12.ETW.4	Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.
HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS3-2	Evaluate competing design solutions for developing, conserving, managing, and utilizing energy and mineral resources based on the associated economic, social, environmental, and geopolitical costs and risks, as well as benefits.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.
HS-PS3	Energy
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
	Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
	The availability of energy limits what can occur in any system.
HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
	Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.
PS3.A	Definitions of Energy
	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
	At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

	These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. Energy and Matter Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.
HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. Energy and Matter Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
PS3.B	Conservation of Energy and Energy Transfer Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. Systems and System Models When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

Essential Questions/Enduring Understandings

How is energy transformed, transferred, and conserved?

How does physics knowledge of energy influence current decisions about where to get energy for human use?

Conservation of energy is a fundamental law in physics.

Learning Plan

Students will start by developing the idea of work through experiments done in small groups.

Then, each form of energy to be discussed this unit (gravitational potential, kinetic, internal) will be derived in turn through investigative activites done in small groups.

Students will practice with each type of energy and its mathematical representation before moving on to the next.

As forms of energy and how they are changed by external work are introduced, bar charts and their application to analyzing situations will be introduced and developed.

Energy bar charts and conservation of energy will be related to momentum bar charts and conservation of momentum so that students can see the overall pattern in conservation laws in physics.

The Bouncing Balls Lab is an option to compare changes in momentum and changes in energy with different material objects hitting different material floors, i.e. a street hockey ball on a tile floor vs. a yoga mat.

Students will relate simple machines and modern sources of energy for society to work and energy. Power and efficiency will be defined and applied to machines and humans.

Students will complete either Muscle Up! or Stair Climbing Lab to compare their own power rating to other students in the class.

Assessment

Formative: Students will work in small groups throughout the unit analyzing situations, solving problems, and critiquing solutions using bar charts and equations. This allows time for student and teacher feedback. Students will complete frequent homework assignments that will be reviewed in class so that students can self-assess. Exit tickets will also be utilized

Summative: Quizzes and Unit Test on Work and Energy Project options include the Rube Goldberg Device and the Energy PSA. Muscle Up! or Stair Climbing Lab are lab options that involve collecting data from student activities, and the PhET simulations Energy Forms and Changes and Energy Skate Park can be used for informal labs. Formal Lab: Hooke's Law

Benchmark: This unit will be included in the final exam.

Alternative: Presentations on Work and Energy , Analysis of Rube Goldberg Simple Machines to identify key components

Materials

Computer with PowerPoint/Google Slides and internet access

Textbook Physics: Principles and Problems, Glencoe

Calculators, rulers, meter sticks, colored pencils, graph paper, Chromebooks for students, whiteboards for

collaborative work, dry erase markers and erasers for student groups, Power Surge video, chalk, bricks, string, simple machines set, spring scales, various floor covering materials, various droppable objects that may or may not bounce.

Integrated Accommodations and Modifications

Integrated Accommodation and Modifications, Special Education students, English Language Learners, At-Risk students, Gifted and Talented students, Career Education, and those with 504s

https://docs.google.com/spreadsheets/d/18XhAi7Rm-E8LJwO4uMQS7ZEh0dh3NxYbTFH2IoHLH7Y/edit?usp=sharing