# Unit 1 Energy and Power

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| Content Area: | **Science** |
| Course(s): | **Prin of Enginee** |
| Time Period: | **Semester 1** |
| Length: | **20 weeks** |
| Status: | **Published** |

## Standards

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| SCI.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. |
| SCI.HS.PS3.B | Conservation of Energy and Energy Transfer |
| SCI.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). |
| SCI.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. |
| SCI.HS.PS3.A | Definitions of Energy |
| SCI.HS.PS3.B | Conservation of Energy and Energy Transfer |
| | Systems and System Models |
| | Energy and Matter |
| SCI.HS-ETS1-1 | Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. |
| SCI.HS.ETS1.A | Delimiting Engineering Problems |
| SCI.HS-ETS1-2 | Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. |
| SCI.HS.ETS1.C | Optimizing the Design Solution |
| SCI.HS-ETS1-3 | Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. |
| SCI.HS.ETS1.B | Developing Possible Solutions |
| SCI.HS-ETS1-4 | Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. |
| CS.9-12.8.1.12.AP.5 | Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. |
| CS.9-12.8.1.12.DA.1 | Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. |
| CS.9-12.8.1.12.IC.1 | Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. |
| CS.9-12.8.2.12.ED.1 | Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. |
| CS.9-12.8.2.12.ED.2 | Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback. |

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| CS.9-12.8.2.12.ED.3 | Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. |
| CS.9-12.8.2.12.ED.4 | Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience. |
| CS.9-12.8.2.12.NT.1 | Explain how different groups can contribute to the overall design of a product. |
| CS.9-12.8.2.12.NT.2 | Redesign an existing product to improve form or function. |
| CS.9-12.8.2.12.ETW.1 | Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product. |
| CS.9-12.8.2.12.ETW.2 | Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment. |
| CS.9-12.8.2.12.ETW.3 | Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution. |
| CS.9-12.8.2.12.ITH.1 | Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints. |

## Enduring Understandings

*Students will understand that …*

1. Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems.
2. Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals.
3. Technical communication can be accomplished in oral, written, and visual forms and must be organized in a clear and concise manner.
4. Most mechanisms are composed of gears, sprockets, pulley systems, and simple machines.
5. Mechanisms are used to redirect energy within a system by manipulating force, speed, and distance.
6. Mechanical advantage ratios mathematically evaluate input work versus output work of mechanisms.

## Essential Questions

*Students will keep considering …*

1. What are some different types of occupations within the engineering pathway?
2. What are some common responsibilities of engineers?
3. Identify a mechanism in your household. Why do you think that particular mechanism is designed the way it is?
4. What are some strategies that can be used to make everyday mechanisms more efficient?
5. Describe one situation in which an engineer would want to include a mechanism with a mechanical advantage greater than one? What is the advantage in this case?
6. How could designing a solution to a mechanical problem without regard to efficiency be problematic?

## Knowledge and Skills

*Students will …*

- Differentiate between engineering and engineering technology.
- Conduct a professional interview and reflect on it in writing.
- Identify and differentiate among different engineering disciplines.
- Measure forces and distances related to mechanisms.
- Distinguish between the six simple machines, their attributes, and components.
- Calculate mechanical advantage and drive ratios of mechanisms.
- Design, create, and test gear, pulley, and sprocket systems.
- Calculate work and power in mechanical systems.
- Determine efficiency in a mechanical system.
- Design, create, test, and evaluate a compound machine design.

## Resources

# Activity 1.1.1 Simple Machines – Lever, Wheel and Axle, and Pulley Presentation

This presentation provides students an introduction to equations relating to simple machines, specifically the lever, wheel and axle, and pulley. The presentation includes examples of simple machines and an introduction to mechanical advantage, including the difference between ideal and actual mechanical advantage.

# Activity 1.1.1 Simple Machines – Inclined Plane, Wedge, and Screw Presentation

This presentation provides students an introduction to equations relating to simple machines, specifically the inclined plane, wedge, and screw. The presentation includes examples of simple machines and an introduction to mechanical advantage, including the difference between ideal and actual mechanical advantage of the inclined plane, wedge, and screw.

# Activity 1.1.2 Simple Machines Practice Problems

These problems deal with ideal mechanical advantage rather than actual mechanical advantage. It is important to tell students that the formulas are designed for balanced loads. For example, if the effort force is calculated to lift an object, then it must have a value greater than the derived solution. This is also an appropriate time to discuss the factor of safety.

# Activity 1.1.2 Understanding Thread Notes

This resource provides information related to common thread classifications. The following web source provides additional information regarding thread notes:

Glossary of Terminology | Bolt Science

## Activity 1.1.3 Gears

This activity is designed to introduce students to the functions of gears and the associated ratios. They will apply that knowledge by building two types of gear systems.

You may choose to have students power their mechanical systems using motors, but the activity is intended to be conducted using cranking mechanics.

## Activity 1.1.3 Gears Answer Key

The provided answers use values that will not likely represent the data that students gather from their gear systems. The answers provide a method to solve each problem and are meant to show accurate examples of the process. Similarly, some of the conclusion questions may have different answers based on the examples used. Many of the conclusion questions have multiple correct answers. Use your judgment to determine the validity of alternate answers. Use such opportunities to create a learning dialogue with your students.

Below are some examples of VEX gear arrangements.

## Activity 1.1.4 Pulley Drives and Sprockets

This activity is not as detailed as the Gears document due to the fact that pulley and sprocket system calculations are not different from gear calculations. The activity does distinguish between gear systems, pulley and belt systems, and sprocket and chain systems.

## Activity 1.1.4 Pulley Drives and Sprockets Answer Key

The provided answers use values that will not likely represent the data that students gather from the gear systems that they build. The answers provide a method to solve each problem and are meant to show accurate examples of the process. Similarly, some of the conclusion questions may have different answers based on the examples used. Many of the conclusion questions have multiple correct answers. Use your judgment to determine the validity of alternate answers. Use such opportunities to create a learning dialogue with your students.

## Problem 1.1.6 Compound Machine Design

This problem provides an opportunity for students to design and build a mechanism that uses some of the mechanisms they have learned about. The mechanism will be designed to achieve a task of their choice. Some examples students may want to consider include:

- Lifting an object a certain distance
- Catapulting an object
- Covering an object
- Removing or placing a lid

Students should be able to derive additional creative tasks.

## Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

## Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing