Unit 5: Simple Machines: Gear Systems

Content Area: **Applied Technology**
Course(s):
Time Period: **Marking Period 1**
Length: **3 Weeks**
Status: **Published**

Summary

Students will explore mechanical advantage, Simple and compound gear systems will be fabricated to alter the mechanical advantage of a system. Students will calculate gear ratios. Ultimately, students will apply engineering principles and use the design loop to make a weak motor move a heavy object.

Revision Date: July 2024

Essential Questions/Enduring Understandings

Essential Questions:

How do mechanical engineers solve problems?

How do we use the design loop to solve problems?

What is a mechanical advantage?

Enduring Understandings:

proper safety must be followed when soldering

that gear system systems can be used to create precise ratios

gear systems can be designed to provide more and less torque, relating directly to the concept of mechanical advantage.

systems are made of subsystems

Objectives

Students will know:

the components in a simple gear system.
types of gear systems and materials commonly used
the advantage of teeth in a gear system compared to wheels.
the components in a compound gear system.
unit vocabulary: gear, idler, teeth, mechanical advantage, torque, force, effort, compound gear system, simple gear, down-shift, system, subsystem.

Students will be skilled at:

how to apply the design loop to solve problems relating to mechanical advantage.

how to calculate gear ratios.

how to calculate the mechanical advantage of a gear system.

how to model gear systems in the robotics lab.

safety procedures when soldering.

Assessment

Formative Assessment:

meaningfully address the essential and guiding questions of this unit of study.

meaningfully participate in guided question and answer sessions, and group and individual discussions, and demonstrate an understanding of the purpose of the unit lesson(s) and the key terms and concepts.

successfully model and employ gears in the solutions of design problems.

demonstrate the ability to utilize the design loop as a problem-solving tool.

use unit vocabulary in a design log as it pertains to gear systems.

Summative Assessment:

written quizzes and tests on gear systems
complete a writing prompt. Example: "Clocks demonstrate how gears…"

Benchmark:

Final exam.

Alternate Assessment:

Report, practical on soldering

Learning Plan

Preview the essential questions and connect to learning throughout the unit.

Formative assessments will be conducted throughout the process using class discussion, student writing, and practice quizzes.

Lectures and lessons will be provided to help students discover how to calculate mechanical advantage in gear systems.

Provide on-line resources for unit topics.

Formative assessments will be conducted throughout the skills acquisition process.

A proposed design problem sequence: design and prototype a motor/gear subsystem, power supply subsystem, gear-wheels-car subsystem that employs down-shifting with a simple gear system, a compound gear system, and a fastest/lightest vehicle (less mechanical advantage, more speed). Soldering will be an activity during the fabrication of the motor subsystem.

Design logs will be maintained throughout the design problem sequence to document the process.

Summative assessments will be conducted throughout to evaluate skills acquisition.

Complete unit test and writing prompt.

Materials

Safety Glasses

Soldering irons and solder

On-line tutorials

Email and e-board

Websites

CAD and other software programs may be used to document the systems.

SmartBoard use for presentation and interactive lessons

Batteries

DC Motors

LEGO parts and gears

Wire

Standards

ELA.K-12.1	Developing Responsibility for Learning: Cultivating independence, self-reflection, and responsibility for one's own learning.
ELA.L.SS.9–10.1	Demonstrate command of the system and structure of the English language when writing or speaking.
ELA.K-12.4	Building Knowledge: Building strong content knowledge and connecting ideas across disciplines using a variety of text resources and media.
ELA.L.KL.9–10.2	Apply knowledge of language to make effective choices for meaning, or style, and to comprehend more fully when reading, writing, speaking or listening.
TECH.K-12.1.3	Knowledge Constructor
TECH.K-12.1.3.a	plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
TECH.K-12.1.4	Innovative Designer
	Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
TECH.K-12.1.4.a	know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
TECH.K-12.1.4.b	select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
ELA.R	Reading
TECH.K-12.1.4.c	develop, test and refine prototypes as part of a cyclical design process.
MATH.9-12.A.REI	Reasoning with Equations and Inequalities
MATH.9-12.A.REI.A	Understand solving equations as a process of reasoning and explain the reasoning
TECH.K-12.1.4.d	exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
TECH.K-12.1.5	Computational Thinker
	Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
TECH.K-12.1.5.a	formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
TECH.K-12.1.5.b	collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
TECH.K-12.1.5.c	break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

TECH.K-12.1.5.d	understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.
SCI.HS-ETS1	Engineering Design
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.
	Asking Questions and Defining Problems
	Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
	Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
SCI.HS.ETS1.A	Delimiting Engineering Problems
	Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
	Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
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.
	Constructing Explanations and Designing Solutions
	Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
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.
	Using Mathematics and Computational Thinking
	Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
	Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.
SCI.HS.ETS1.B	Developing Possible Solutions
	Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
	Systems and System Models
	Models (e.g., physical, mathematical, computer models)can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
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.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).
CS.9-12.8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
CS.9-12.ED	Engineering Design
WRK.9.2.12.CAP	Career Awareness and Planning
WRK.9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
TECH.9.4.12.CI	Creativity and Innovation
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT	Critical Thinking and Problem-solving
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.TL	Technology Literacy
TECH.9.4.12.TL.3	Analyze the effectiveness of the process and quality of collaborative environments.
	An individual's income and benefit needs and financial plan can change over time.
	Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.
	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
	Career planning requires purposeful planning based on research, self-knowledge, and informed choices.
	With a growth mindset, failure is an important part of success.
	Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems. Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization.
	Innovative ideas or innovation can lead to career opportunities.

Integrated Accommodation and Modifications, Special Education Students...

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