Unit 5: Electrical Engineering and Speakers

Content Area: **Applied Technology**
Course(s):
Time Period: **Marking Period 2**
Length: **3-4 weeks**
Status: **Published**

Summary

Introduction:

Students will explore the patents for the first speakers in the 20th century and make a speaker using a coil, permanent magnet and cone. Students will have a design objective to make a louder speaker and will apply the properties of conductors, Ohm's law, Kirchoff's law, and properties of waves to accomplish their goal.

Revision Date: July 2025

Essential Questions/Enduring Understandings

Essential Questions:

What systematic process do electrical engineers use to approach and solve complex problems, from initial concept to a working prototype?

How do scientific principles, particularly those of acoustics and materials science, govern the performance and sound quality of a speaker?

How does Ohm's Law provide the fundamental framework for matching a speaker to an amplifier, ensuring the system operates safely and effectively? □

What are the practical implications of resistance, voltage, and current (as defined by Ohm's Law) on a speaker's power handling, efficiency, and overall sound reproduction?

Enduring Understandings:

The design loop ends with a new beginning: redesign and reimplementation.

Electrical engineers use a range of science and math-based strategies to improve a design.

Patents are used to protect intellectual property.

Electrical engineers make technical drawings to communicate solutions.

Objectives

Students will know:

Safety practices when using electrical components.

how science is applied to the acoustic design of a device like a speaker

how to apply research skills to a design problem.

historical background information regarding speaker design.

What an actual patent looks like.

how to use mathematical equations relating waves, frequency, and period.

key terms and vocabulary: sones, decibels, rms (root mean square or quadratic mean), wavelength, frequency, amplitude, phase, period, sinusoidal wave, electromagnetic waves, Ohm's law, Kirchhoff's law, power, current, resistance, gauge, units of measure, and conversions (metric/imperial).

Students will be skilled at:

Practicing safety in the electronics lab.

Safely using a soldering iron.

Prototyping a speaker.

Documenting work in a design log.

Critically making choices about improving a design.

Learning Plan

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

Lectures and a quiz on safety and using electronics in the unit.

Lecture and quiz on safely using a soldering iron.

Lectures and lessons will be provided to develop an understanding of the properties of waves.

Lectures and lessons will be provided to develop an understanding of Ohm's law, Kirchhoff's law.

Lectures and lessons will be provided to develop an understanding of the properties of wire, including resistance, current, and gauge.

Problem-based learning: In groups of 2 students, students will perform research on patents on speakers

(Kellogg and Rice). Students will complete worksheets related to the properties of materials and Laws. Students will view online tutorials and demonstrations of how to make a rudimentary speaker. Students will make a rudimentary speaker and test it. Students will apply principles discussed in class and make improvements. Work will be documented in design logs and with phones. Students will make a presentation that shows the application of the design loop to make a louder speaker.

Activity option: Students may build a Bluetooth Speaker system or a passive speaker system that explores technology.

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.

Summative assessment will be conducted by the student and teacher using a rubric specific to the design problem.

Complete writing prompt.

Assessment

Formative Assessments:

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

Assess students' previous design logs and provide feedback

exit tickets

participation in class discussions on properties of wire, including resistance, current, and gauge, properties of waves, etc

Summative assessments:

use the design loop and develop solutions to a design problem, like the design of a speaker. enclosure. The design process and solution will be graded using project-specific rubrics.

demonstrate the ability to methodically document solutions to the problem.

demonstrate the ability to perform calculations related to waves in their projects and on worksheets, quizzes or tests.

complete written tests and quizzes

complete writing prompts: explain what scientific principle was applied to make the speaker louder. (i.e. heavier gauge wire, wave analysis, multiple wires) Explain how coils in parallel affect impedance requirements.

answer the essential questions.

Alternate Assessment:

document various steps of speaker design and assembly using video, audio, and pictures

Benchmark assessment: Final exam

Materials

Copper magnet wire of various gauges: 28, 30, 36, 38.

Multimeter

Tape, paper

Permanent magnets

Receiver (music source with amplifier)

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

Standards

9.2.12.CAP	Career Awareness and Planning
L	Language
9.4.12.CI	Creativity and Innovation
L.SS.9–10.1	Demonstrate command of the system and structure of the English language when writing or speaking.
	Innovative ideas or innovation can lead to career opportunities.
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).
	Career planning requires purposeful planning based on research, self-knowledge, and informed choices.

9.4.12.CT	Critical Thinking and Problem-solving
PS1.A	Structure and Properties of Matter
	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
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).
	Integration of Knowledge and Ideas
LA.RH.9-10.7	Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text, to analyze information presented via different mediums.
LA.RH.9-10.8	Assess the extent to which the reasoning and evidence in a text support the author's claims.
9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
LA.RST.9-10	Reading Science and Technical Subjects
	Key Ideas and Details
LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
TECH.K-12.1.4	Innovative Designer
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
	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.
	Craft and Structure
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.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
TECH.K-12.1.4.c	develop, test and refine prototypes as part of a cyclical design process.
TECH.K-12.1.4.d	exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
	Integration of Knowledge and Ideas
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
A.REI.B	Solve equations and inequalities in one variable
ED	Engineering Design
	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.

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.
8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback.
	Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.
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).
HS-PS4	Waves and Their Applications in Technologies for Information Transfer
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
	Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the earth.
	Using Mathematics and Computational Thinking
PS4.A	Wave Properties
	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
PS4.B	Electromagnetic Radiation
HS-ETS1	Engineering Design
	Asking Questions and Defining Problems
ETS1.A	Delimiting Engineering Problems
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
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.

Integrated Accommodation 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