

Standards and Benchmarks for Introduction to Engineering Design

Unit 1.1

Standards for Technological Literacy

- Standard 8:** Students will develop an understanding of the attributes of design.
- BM B:** Design is a creative process.
- BM C:** The design process is a purposeful method of planning practical solutions to problems.
- BM H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
- Standard 9:** Students will develop an understanding of engineering design.
- BM C:** The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
- Standard 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- BM E:** The process of experimentation, which is common in science, can also be used to solve technological problems.
- BM G:** Invention is a process of turning ideas and imagination into devices and systems.
- BM H:** Some technological problems are best solved through experimentation.
- BM I:** Research and development is a specific problem-solving approach that is used intensively in business and industry.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
- BM J:** The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.
- BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

- **Systems, order, and organization**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

- **Abilities of technological design**

Principles and Standards for School Mathematics

Representation : Instructional programs from pre-kindergarten through grade 12 should enable all students to use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

- Standard 3:** Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and other texts, their word identification strategies, and their understanding of textual features (e.g. sound-letter correspondence, sentence structure, context, graphics).
- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 5:** Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.
- Standard 7:** Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

Unit 1.2

Standards for Technological Literacy

- Standard 9:** Students will develop an understanding of engineering design.
BM B: Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- Standard 11:** Students will develop the abilities to apply the design process.
BM E: The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
BM C: People use symbols when they communicate by technology.
BM G: Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.
BM K: The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
BM P: There are many ways to communicate information, such as graphic and electronic means.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop
Evidence, models, and explanation

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop
Abilities of technological design

Principles and Standards for School Mathematics

- Geometry:** Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.
- Connections:** Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and apply mathematics in contexts outside of mathematics.
- Representation:** Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; and use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 5:** Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.
- Standard 12:** Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 1.3

Standards for Technological Literacy

- Standard 1:** Students will develop an understanding of the characteristics and scope of technology.
- BM B:** All people use tools and techniques to help them do things.
- Standard 2:** Students will develop an understanding of the core concepts of technology.
- BM K:** Tools and machines extend human capabilities, such as holding,

- lifting, carrying, fastening, separating, and computing.
- Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- BM A:** The study of technology uses many of the same ideas and skills as other subjects.
- BM F:** Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
- Standard 7:** Students will develop an understanding of the influence of technology on history.
- BM E:** The design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
- BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

Change, constancy, and measurement

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop

Abilities necessary to do scientific inquiry

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

Abilities of technological design

Principles and Standards for School Mathematics

Number Operations: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.

Data Analysis and Probability: Instructional programs from pre-kindergarten through grade 12 should enable all students to formulate questions that can be addressed with data and collect, organize, and display relevant

data to answer them.

Representation: Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; and use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 8: Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standard 12: Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 1.4

Standards for Technological Literacy

Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

BM A: The study of technology uses many of the same ideas and skills as other subjects.

BM C: Various relationships exist between technology and other fields of study.

BM F: Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.

Standard 9: Students will develop an understanding of engineering design.

BM A: The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.

BM B: Expressing ideas to others verbally and through sketches and models is an important part of the design process.

BM D: When designing an object, it is important to be creative and consider all ideas.

BM F: Design involves a set of steps, which can be performed in different sequences and repeated as needed.

BM G: Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.

BM J: Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

Standard 11	Students will develop the abilities to apply the design process.
BM H:	Apply a design process to solve problems in and beyond the laboratory-classroom.
BM I:	Specify criteria and constraints for the design.
BM J:	Make two-dimensional and three-dimensional representations of the designed solution.
BM R:	Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
Standard 17	Students will develop an understanding of and be able to select and use information and communication technologies.
BM K:	The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
BM Q:	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop—

Change, constancy, and measurement

Form and function

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Principles and Standards for School Mathematics

Number Operations:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.
Algebra:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; and analyze change in various contexts.
Geometry:	Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and

develop mathematical arguments about geometric relationships; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.

Communication: Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; and communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Connections: Instructional programs from pre-kindergarten through grade 12 should enable all students recognize and apply mathematics in contexts outside of mathematics.

Standards for English Language Arts

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Standard 8: Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standard 12: Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 2.1

Standards for Technological Literacy

Standard 1: Students will develop an understanding of the characteristics and scope of technology.

BM D: Tools, materials, and skills are used to make things and carry out tasks.

Standard 2: Students will develop an understanding of the core concepts of technology.

BM I: Tools are used to design, make, use, and assess technology.

BM J: Materials have many different properties.

BM AA: Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.

- Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- BM C:** Various relationships exist between technology and other fields of study.
- BM F:** Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
- Standard 9:** Students will develop an understanding of engineering design.
- BM B:** Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- BM E:** Models are used to communicate and test design ideas and processes.
- Standard 11:** Students will develop the abilities to apply the design process.
- BM J:** Make two-dimensional and three-dimensional representations of the designed solution.
- BM P:** Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
- Standard 12:** Students will develop the abilities to use and maintain technological products and systems.
- BM P:** Use computers and calculators to access, retrieve, organize process, maintain, interpret, and evaluate data and information in order to communicate.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
- BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop—

Systems, order, and organization

Evidence, models, and explanation

Change, constancy, and measurement

Form and function

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop—

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Principles and Standards for School Mathematics

- Number Operations:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.
- Algebra:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; analyze change in various contexts.
- Geometry:** Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships; specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; use visualization, spatial reasoning, and geometric modeling to solve problems.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.
- Communication:** Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication.
- Connections:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand how mathematical ideas interconnect and build on one another to produce a coherent whole; recognize and apply mathematics in contexts outside of mathematics.
- Representation:** Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 8:** Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video)

to gather and synthesize information and to create and communicate knowledge.

Unit 2.2

Standards for Technological Literacy

- Standard 11:** Students will develop abilities to apply the design process.
BM R: Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
- Standard 12:** Students will develop the abilities to use and maintain technological products and systems.
BM G: Use common symbols, such as numbers and words, to communicate key ideas.
BM L: Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

National Science Education Standards

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Understandings about science and technology

Principles and Standards for School Mathematics

- Number Operations:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.
- Connections:** Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and use connections among mathematical ideas; recognize and apply mathematics in contexts outside of mathematics.

Standards for English Language Arts

- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 12:** Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 2.3

Standards for Technological Literacy

- Standard 1:** Students will develop an understanding of the characteristics and scope of technology.
- BM D:** Tools, materials, and skills are used to make things and carry out tasks.
- Standard 2:** Students will develop an understanding of the core concepts of technology.
- BM AA:** Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
- Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- BM F:** Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
- BM J:** Technological progress promotes the advancement of science and mathematics. Likewise, progress in science and mathematics leads to advances in technology.
- Standard 9:** Students will develop an understanding of engineering design.
- BM B:** Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- BM H:** Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.
- Standard 11:** Students will develop abilities to apply the design process.
- BM J:** Make two-dimensional and three-dimensional representations of the designed solution.
- Standard 12:** Students will develop the abilities to use and maintain technological products and systems.
- BM D:** Follow step-by-step directions to assemble a product.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
- BM K:** The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
- BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.
- Standard 19:** Students will develop an understanding of and be able to select and use manufacturing technologies.
- BM F:** Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning them.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

Systems, order, and organization

Evidence, models, and explanation

Change, constancy, and measurement

Form and function

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop—

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Principles and Standards for School Mathematics

- Number Operations:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.
- Algebra:** Instructional programs from pre-kindergarten through grade 12 should enable all students to represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships.
- Geometry:** Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships; and use visualization, spatial reasoning, and geometric modeling to solve problems.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.
- Communication:** Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; and analyze and evaluate the mathematical thinking and strategies of others.
- Presentation:** Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas.

Standards for English Language Arts

- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 5:** Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Unit 2.4

Standards for Technological Literacy

- Standard 2:** Students will develop an understanding of the core concepts of technology.
- BM AA:** Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
- Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- BM A:** The study of technology uses many of the same ideas and skills as other subjects.
- BM C:** Various relationships exist between technology and other fields of study.
- BM F:** Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
- Standard 6:** Students will develop an understanding of the role of society in the development and use of technology.
- BM A:** Products are made to meet individual needs and wants.
- Standard 8:** Students will develop an understanding of the attributes of design.
- BM H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
- Standard 9:** Students will develop an understanding of engineering design.
- BM A:** The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
- BM B:** Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- BM D:** When designing an object, it is important to be creative and consider all ideas.
- BM F:** Design involves a set of steps, which can be performed in different sequences and repeated as needed.
- BM G:** Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.

BM J:	Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
Standard 11	Students will develop the abilities to apply the design process.
BM E:	The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
BM I:	Specify criteria and constraints for the design.
BM J:	Make two-dimensional and three-dimensional representations of the designed solution.
BM R:	Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
Standard 17	Students will develop an understanding of and be able to select and use information and communication technologies.
BM Q:	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop—

Change, constancy, and measurement

Form and function

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Principles and Standards for School Mathematics

Number Operations:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates.
Algebra:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; and analyze change in various contexts.
Geometry:	Instructional programs from pre-kindergarten through grade 12 should enable all students to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;

specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.

Problem Solving Instructional programs from pre-kindergarten through grade 12 should enable all students to solve problems that arise in mathematics and in other contexts; apply and adapt a variety of appropriate strategies to solve problems.

Communication: Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; and communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Connections: Instructional programs from pre-kindergarten through grade 12 should enable all students recognize and apply mathematics in contexts outside of mathematics.

Standards for English Language Arts

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Standard 8: Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standard 12: Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 3.1

Standards for Technological Literacy

Standard 6: Students will develop an understanding of the role of society in the development and use of technology.

BM J: A number of different factors, such as advertising, the strength of the economy, the goals of a company and the latest fads contribute to shaping the design of and demand for various technologies.

Standard 8: Students will develop an understanding of the attributes of design.

- BM H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
- BM I:** Design problems are seldom presented in a clearly defined form.
- BM J:** The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
- BM K:** Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.
- Standard 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving
- BM I:** Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.
- BM K:** Not all problems are technological, and not every problem can be solved using technology.
- Standard 11:** Students will develop abilities to apply the design process.
- BM M:** Identify the design problem to solve and decide whether or not to address it.
- BM N:** Identify criteria and constraints and determine how these will affect the design process.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

Evidence, models, and explanation

Form and function

Science and Technology Content Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Understandings about science and technology

Principles and Standards for School Mathematics

- Number Operations:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
 - understand meanings of operations and how they relate to one another;
 - compute fluently and make reasonable estimates.

- Geometry:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;
 - specify locations and describe spatial relationships using coordinate geometry and other representational systems;
 - apply transformations and use symmetry to analyze mathematical situations;
 - use visualization, spatial reasoning, and geometric modeling to solve problems.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- understand measurable attributes of objects and the units, systems, and processes of measurement.
- Data Analysis and Probability:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;
 - develop and evaluate inferences and predictions that are based on data.
- Communication:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- organize and consolidate their mathematical thinking through communication;
 - communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- Connections:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- recognize and apply mathematics in contexts outside of mathematics.
- Representation:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- create and use representations to organize, record, and communicate mathematical ideas;
 - select, apply, and translate among mathematical representations to solve problems;
 - use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

- Standard 1:** Students read a wide range of print and non-print texts to build an understanding of texts of themselves, and of the cultures of the United States and the world; to acquire new information; to

- respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classical and contemporary works.
- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 6:** Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.
- Standard 7:** Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.
- Standard 8:** Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Standard 11:** Students participate as knowledgeable reflective, creative, and critical members of a variety of literacy communities.
- Standard 12:** Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 3.2

Standards for Technological Literacy

- Standard 2:** Students will develop an understanding of the core concepts of technology.
- BM M:** Technological systems include input, processes, output, and, at times, feedback.
- BM O:** An open-loop system has no feedback path and requires human intervention, while a closed-loop system uses feedback.
- Standard 7:** Students will develop an understanding of the influence of technology on history.
- BM D:** The specialization of function has been at the heart of many technological improvements.
- BM F:** In the past, an invention or innovation was not usually developed with the knowledge of science.
- Standard 8:** Students will develop an understanding of the attributes of design.
- BM D:** Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.
- BM E:** Design is a creative planning process that leads to useful products and systems.

Standard 11: Students will develop abilities to apply the design process.
BM R: Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

Systems, order, and organization

Evidence, models, and explanation

Change, constancy, and measurement

Form and function

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop—

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Principles and Standards for School Mathematics

Number Operations: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
compute fluently and make reasonable estimates.

Algebra: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
analyze change in various contexts.

Geometry: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
apply transformations and use symmetry to analyze mathematical situations;
use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
understand measurable attributes of objects and the units, systems, and processes of measurement;
apply appropriate techniques, tools, and formulas to determine measurements.

Problem Solving: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
build new mathematical knowledge through problem solving;
solve problems that arise in mathematics and in

other contexts;
apply and adapt a variety of appropriate strategies to solve problems.

Communication: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
organize and consolidate their mathematical thinking through communication;
communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
analyze and evaluate the mathematical thinking and strategies of others;
use the language of mathematics to express mathematical ideas precisely.

Connections: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
recognize and use connections among mathematical ideas;
understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
recognize and apply mathematics in contexts outside of mathematics.

Representation Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to—
create and use representations to organize, record, and communicate mathematical ideas;
select, apply, and translate among mathematical representations to solve problems;
use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

Standard 3: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

Standard 6: Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to

- communicate their discoveries in ways that suit their purpose and audience.
- Standard 8:** Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Standard 12:** Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 3.3

Standards for Technological Literacy

- Standard 8:** Students will develop an understanding of the attributes of design.
- BM J:** The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
- BM K:** Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.
- Standard 9:** Students will develop an understanding of engineering design.
- BM H:** Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

Systems, order, and organization

Evidence, models, and explanation

Change, constancy, and measurement

Evolution and equilibrium

Form and function

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop—

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Understandings about science and technology

Principles and Standards for School Mathematics

- Number Operations:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
 - understand meanings of operations and how they relate to one another;
 - compute fluently and make reasonable estimates.
- Algebra:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- represent and analyze mathematical situations and structures using algebraic symbols;
 - use mathematical models to represent and understand quantitative relationships.
- Geometry:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;
 - use visualization, spatial reasoning, and geometric modeling to solve problems.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
- understand measurable attributes of objects and the units, systems, and processes of measurement;
 - apply appropriate techniques, tools, and formulas to determine measurements.

Standards for English Language Arts

- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 5:** Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.
- Standard 12:** Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 3.4

Standards for Technological Literacy

- Standard 1:** Students will develop an understanding of the characteristics and scope of technology.
- BM G:** The development of technology is a human activity and is the result of individual or corporate needs and the ability to be creative.
 - BM H:** Technology is closely linked to creativity, which has resulted in innovation.
 - BM L:** Inventions and innovations are the results of specific, goal-directed research.
- Standard 2:** Students will develop an understanding of the core concepts of technology.
- BM L:** Requirements are the limits to designing or making a product or system.
 - BM AA:** Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
- Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- BM A:** The study of technology uses many of the same ideas and skills as other subjects.
 - BM G:** Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.
- Standard 4:** Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- BM B:** When using technology, results can be good or bad.
 - BM D:** The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use.
 - BM J:** Ethical considerations are important in the development, selection, and use of technologies.
- Standard 5:** Students will develop an understanding of the effects of technology on the environment.
- BM C:** The use of technology affects the environment in good and bad ways.
- Standard 6:** Students will develop an understanding of the role of society in the development and use of technology.
- BM I:** The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures.
- Standard 7:** Students will develop an understanding of the influence of technology on history.
- BM C:** Many inventions and innovations have evolved by using slow and methodical processes of tests and refinements.
 - BM D:** The specialization of function has been at the heart of many technological improvements.
 - BM G:** Most technological development has been evolutionary, the result of a series of refinements to a basic invention.
- Standard 8:** Students will develop an understanding of the attributes of design.

- BM A:** Everyone can design solutions to a problem.
- BM B:** Design is a creative process.
- BM C:** The design process is a purposeful method of planning practical solutions to problems.
- BM D:** Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.
- BM E:** Design is a creative planning process that leads to useful products and systems.
- BM F:** There is no perfect design.
- BM G:** Requirements for a design are made up of criteria and constraints.
- BM H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
- BM I:** Design problems are seldom presented in a clearly defined form.
- Standard 9:** Students will develop an understanding of engineering design.
- BM A:** The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
- BM B:** Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- BM D:** When designing an object, it is important to be creative and consider all ideas.
- BM F:** Design involves a set of steps, which can be performed in different sequences and repeated as needed.
- BM G:** Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.
- BM J:** Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
- Standard 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- BM D:** Invention and innovation are creative ways to turn ideas into real things.
- BM G:** Invention is a process of turning ideas and imagination into devices and systems.
- BM J:** Technological problems must be researched before they can be solved.
- Standard 11:** Students will develop abilities to apply the design process.
- BM C:** Investigate how things are made and how they can be improved.
- BM E:** The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
- BM I:** Specify criteria and constraints for the design.
- BM J:** Make two-dimensional and three-dimensional representations of the designed solution.
- BM L:** Make a product or system and document the solution.

- BM N:** Identify criteria and constraints and determine how these will affect the design process.
- BM Q:** Develop and produce a product or system using a design process.
- BM R:** Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
- Standard 12:** Students will develop the abilities to use and maintain technological products and systems.
 - BM F:** Use computers to access and organize information.
 - BM J:** Use computers and calculators in various applications.
 - BM P:** Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.
- Standard 13:** Students will develop the abilities to assess the impacts of products and systems.
 - BM B:** Determine if the human use of a product or system creates positive or negative results.
 - BM H:** Identify trends and monitor potential consequences of technological development.
 - BM K:** Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
 - BM E:** Information can be acquired and sent through a variety of technological sources, including print and electronic media.
 - BM N:** Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.
 - BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

Evidence, models, and explanation

Evolution and equilibrium

Form and Function

Science as Inquiry Standard A: As a result of activities in grades 9-12, all students should develop understanding of—

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

Abilities of technological design

Understandings about science and technology

Principles and Standards for School Mathematics

- Number Operations:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
understand numbers, ways of representing numbers, relationships among numbers, and number systems;
understand meanings of operations and how they relate to one another;
compute fluently and make reasonable estimates.
- Measurement:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
understand measurable attributes of objects and the units, systems, and processes of measurement;
apply appropriate techniques, tools, and formulas to determine measurements.
- Communication:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
organize and consolidate their mathematical thinking through communication;
communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
analyze and evaluate the mathematical thinking and strategies of others;
use the language of mathematics to express mathematical ideas precisely.
- Connections:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
recognize and apply mathematics in contexts outside of mathematics.
- Representation:** Instructional programs from pre-kindergarten through grade 12 should enable all students to—
use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

- Standard 4:** Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Standard 5:** Students employ a wide range of strategies as they write and

use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Standard 12: Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 4.1

Standards for Technological Literacy

- STL 1:** Students will develop an understanding of the characteristics and scope of technology.
- BM G:** The development of technology is a human activity and is the result of individual or corporate needs and the ability to be creative.
- BM H:** Technology is closely linked to creativity, which has resulted in innovation.
- BM I:** Corporations can often create demand for a product by bringing it onto the market and advertising it.
- BM L:** Inventions and innovations are the results of specific, goal-directed research.
- BM M:** Most development of technologies these days is driven by the profit motive and the market.
- STL 2:** Students will develop an understanding of the core concepts of technology.
- BM Z:** Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.
- STL 6:** Students will develop an understanding of the role of society in the development and use of technology.
- BM J:** A number of different factors, such as advertising, the strength of the economy, the goals of a company and the latest fads contribute to shaping the design of and demand for various technologies.
- STL 8:** Students will develop an understanding of the attributes of design.
- BM G:** Requirements for a design are made up of criteria and constraints.
- BM K:** Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.
- BM L:** The process of engineering design takes into account a number of factors.
- STL 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- BM I:** Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.
- BM J:** Technological problems must be researched before they can be solved.
- STL 11:** Students will develop abilities to apply the design process.
- BM J:** Make two-dimensional and three-dimensional representations of the designed solution.

- BM O:** Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.
- BM P:** Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
- BM Q:** Develop and produce a product or system using a design process.
- BM R:** Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
- STL 12:** Students will develop the abilities to use and maintain technological products and systems.
- BM L:** Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.
- BM P:** Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.
- STL 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
- BM P:** There are many ways to communicate information, such as graphic and electronic means.
- BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

Systems, order, and organization

Evidence, models, and explanation

Change, constancy, and measurement

Form and function

Science As Inquiry: As a result of activities in grades 9-12, all students should develop—

Abilities necessary to do scientific inquiry

Understandings about scientific inquiry

Principles and Standards for School Mathematics

Number Operations Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to compute fluently and make reasonable estimates.

Algebra Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to use mathematical models to represent and understand quantitative relationships.

Geometry Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to specify locations and describe spatial relationships using coordinate geometry and other representational systems; apply transformations and use symmetry to analyze mathematical situations; and use visualization, spatial reasoning, and geometric modeling to solve problems.
Measurement Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.
Problem Solving Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to build new mathematical knowledge through problem solving; solve problems that arise in mathematics and in other contexts; and apply and adapt a variety of appropriate strategies to solve problems.
Communication Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others; and use the language of mathematics to express mathematical ideas precisely.
Connections Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and use connections among mathematical ideas; understand how mathematical ideas interconnect and build on one another to produce a coherent whole; and recognize and apply mathematics in contexts outside of mathematics.
Representation Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; and use representations to model and interpret physical, social, and mathematical phenomena.

Standards for English Language Arts

Standard 4:	Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
Standard 5:	Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.
Standard 6:	Students apply knowledge of language structure, language

- conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.
- Standard 7:** Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.
- Standard 8:** Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Standard 12:** Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Unit 4.2

Standards for Technological Literacy

- Standard 1:** Students will develop an understanding of the characteristics and scope of technology.
- BM K:** The rate of technological development and diffusion is increasing rapidly.
- BM M:** Most development of technologies these days is driven by the profit motive and the market.
- Standard 4:** Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- BM H:** Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.
- BM I:** Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.
- BM J:** Ethical considerations are important in the development, selection, and use of technologies.
- BM K:** The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.
- Standard 5:** Students will develop an understanding of the effects of technology on the environment.
- BM I:** With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making.
- BM J:** The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.
- BM K:** Humans devise technologies to reduce the negative consequences of other technologies.
- BM L:** Decisions regarding the implementation of technologies involve the weighing of tradeoffs between predicted positive and negative effects on the environment.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- o Evidence, models, and explanation
- o Change, constancy, and measurement

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- o Understandings about science and technology

Science in Personal and Social Perspectives Standard F: As a result of activities in grades 9-12, all students should develop understanding of—

- o Natural resources
- o Environmental quality
- o Natural and human-induced hazards
- o Science and technology in local, national, and global challenges

Principles and Standards for School Mathematics

Number Operations Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to compute fluently and make reasonable estimates.

Data Analysis and Probability Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

Standards for English Language Arts

Standard 3: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and other texts, their word identification strategies, and their understanding of textual features (e.g. sound-letter correspondence, sentence structure, context, graphics).

Standard 4: Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources

(e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

Standard 12: Students use spoken, written and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information).

Unit 4.3

Standards for Technological Literacy

Standard 1: Students will develop an understanding of the characteristics and scope of technology.

BM B: All people use tools and techniques to help them do things.

BM D: Tools, materials, and skills are used to make things and carry out tasks.

BM F: Creative thinking and economic and cultural influences shape technological development.

BM G: The development of technology is a human activity and is the result of individual or corporate needs and the ability to be creative.

BM H: Technology is closely linked to creativity, which has resulted in innovation.

BM L: Inventions and innovations are the results of specific, goal-directed research.

Standard 2: Students will develop an understanding of the core concepts of technology.

BM B: Systems have parts or components that work together to accomplish a goal.

BM C: Tools are simple objects that help humans complete tasks.

BM D: Different materials are used in making things.

BM E: People plan in order to get things done.

BM H: Resources are the things needed to get a job done, such as tools and machines, materials, information, energy, people, capital, and time.

BM I: Tools are used to design, make, use, and assess technology.

BM K: Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.

BM L: Requirements are the limits to designing or making a product or system.

BM N: Systems thinking involves considering how every part relates to others.

BM Q: Malfunctions of any part of a system may affect the function and quality of the system.

BM R: Requirements are the parameters placed on the development of a product or system.

BM S: Trade-off is a decision process recognizing the need for careful compromises among competing factors.

BM W: Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.

BM Z: Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.

- BM AA:** Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
- BM EE:** Management is the process of planning, organizing, and controlling work.
- Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- BM A:** The study of technology uses many of the same ideas and skills as other subjects.
- BM C:** Various relationships exist between technology and other fields of study.
- Standard 6:** Students will develop an understanding of the role of society in the development and use of technology.
- BM A:** Products are made to meet individual needs and wants.
- Standard 8:** Students will develop an understanding of the attributes of design.
- BM A:** Everyone can design solutions to a problem.
- BM B:** Design is a creative process.
- BM C:** The design process is a purposeful method of planning practical solutions to problems.
- BM D:** Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.
- BM E:** Design is a creative planning process that leads to useful products and systems.
- BM G:** Requirements for a design are made up of criteria and constraints.
- BM H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.
- BM J:** The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.
- BM K:** Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.
- Standard 9:** Students will develop an understanding of engineering design.
- BM A:** The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
- BM B:** Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- BM C:** The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
- BM D:** When designing an object, it is important to be creative and consider all ideas.
- BM E:** Models are used to communicate and test design ideas and processes.
- BM F:** Design involves a set of steps, which can be performed in different

- sequences and repeated as needed.
- BM G:** Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.
- BM I:** Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.
- BM J:** Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
- BM L:** The process of engineering design takes into account a number of factors.
- Standard 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- BM A:** Asking questions and making observations helps a person to figure out how things work.
- BM C:** Troubleshooting is a way of finding out why something does not work so that it can be fixed.
- BM D:** Invention and innovation are creative ways to turn ideas into real things.
- BM F:** Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.
- BM G:** Invention is a process of turning ideas and imagination into devices and systems.
- BM J:** Technological problems must be researched before they can be solved.
- Standard 11:** Students will develop abilities to apply the design process.
- BM B:** Build or construct an object using the design process.
- BM E:** The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.
- BM I:** Specify criteria and constraints for the design.
- BM J:** Make two-dimensional and three-dimensional representations of the designed solution.
- BM K:** Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.
- BM L:** Make a product or system and document the solution.
- BM M:** Identify the design problem to solve and decide whether or not to address it.
- BM N:** Identify criteria and constraints and determine how these will affect the design process.
- BM P:** Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed.
- BM Q:** Develop and produce a product or system using a design process.
- BM R:** Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.
- Standard 12:** Students will develop the abilities to use and maintain technological products and systems.

- BM C:** Recognize and use everyday symbols.
 - BM E:** Select and safely use tools, products, and systems for specific tasks.
 - BM F:** Use computers to access and organize information.
 - BM G:** Use common symbols, such as numbers and words, to communicate key ideas.
 - BM H:** Use information provided in manuals, protocols, or by experienced people to see and understand how things work.
 - BM J:** Use computers and calculators in various applications.
 - BM K:** Operate and maintain systems in order to achieve a given purpose.
 - BM L:** Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.
 - BM P:** Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.
- Standard 13:** Students will develop the abilities to assess the impacts of products and systems.
- BM I:** Interpret and evaluate the accuracy of the information obtained and determine if it is useful.
- Standard 17:** Students will develop an understanding of and be able to select and use information and communication technologies.
- BM A:** Information is data that has been organized.
 - BM B:** Technology enables people to communicate by sending and receiving information over a distance.
 - BM C:** People use symbols when they communicate by technology.
 - BM D:** The processing of information through the use of technology can be used to help humans make decisions and solve problems.
 - BM E:** Information can be acquired and sent through a variety of technological sources, including print and electronic media.
 - BM F:** Communication technology is the transfer of messages among people and/or machines over distances through the use of technology.
 - BM G:** Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.
 - BM H:** Information and communication systems allow information to be transferred from human to human, human to machine, and machine to human.
 - BM J:** The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.
 - BM K:** The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.
 - BM M:** Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine.
 - BM N:** Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.
 - BM P:** There are many ways to communicate information, such as graphic and electronic means.
 - BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile

- stimuli.
- Standard 19:** Students will develop an understanding of and be able to select and use manufacturing technologies.
- BM B:** Manufactured products are designed.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes—

- o Systems, order, and organization
- o Evidence, models, and explanation
- o Change, constancy, and measurement
- o Form and Function

Science As Inquiry Standard A: As a result of activities in grades 9-12, all students should develop understanding of—

- o Abilities necessary to do scientific inquiry

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop—

- o Abilities of technological design
- o Understandings about science and technology

Principles and Standards for School Mathematics

Number Operations Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; compute fluently and make reasonable estimates.

Geometry Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to specify locations and describe spatial relationships using coordinate geometry and other representational systems; Use visualization, spatial reasoning, and geometric modeling to solve problems.

Measurement Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.

Problem Solving Standard: Instructional programs from pre-kindergarten through grade 12 should enable all students to solve problems that arise in mathematics and in other contexts; apply and adapt a variety of appropriate strategies to solve problems.

Communication Instructional programs from pre-kindergarten through grade 12

Standard:	should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others.
Connections Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and apply mathematics in contexts outside of mathematics.
Representation Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas.

Standards for English Language Arts

Standard 1:	Students read a wide range of print and nonprint texts to build an understanding of texts of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classical and contemporary works.
Standard 4:	Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
Standard 5:	Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes.
Standard 7:	Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g. print and nonprint texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.
Standard 8:	Students use a variety of technological and informational resources (e.g. libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
Standard 12:	Students use spoken, written and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information).