

Springfield Public Schools
Springfield, New Jersey 07081

Principles of Engineering
Grades 11 & 12

Curriculum Guide

2026

This curriculum may be modified through varying materials, techniques, and strategies as per an individual student's IEP.

Springfield Board of Education
Approved July 27, 2026

Springfield Public Schools

Cultivating compassionate and extraordinary learners!

EXTRACT OF THE MINUTES OF A MEETING OF
THE BOARD OF EDUCATION OF
THE TOWNSHIP OF SPRINGFIELD
COUNTY OF UNION, NEW JERSEY
AS RECORDED IN THE OFFICIAL MINUTE BOOK

Resolution: 21

Introduced By: Mrs. Gamarekian

Seconded By: Vice President Rinaldi

Adopted: July 27, 2026

Curriculum Adoption

To approve the following new and revised curriculum and courses for the 2026-2027 school year:

1. High School Courses

- a. AP Cybersecurity (new course)
- b. AP Business with Personal Finance (new course)
- c. AP Biology
- d. AP Chemistry
- e. AP Physics 1
- f. PLTW Robotics and Automation
- g. PLTW Introduction to Engineering Design
- h. PLTW Principles of Engineering
- i. Biology
- j. Biology Honors
- k. Chemistry
- l. Chemistry Honors
- m. Conceptual Physics
- n. Physics
- o. Environmental Science
- p. Forensics
- q. Human Anatomy and Physiology
- r. Oceanography
- s. Science 8
- t. Molecular Biology Research Lab (new course)

2. Middle School Courses

- a. Science 6
- b. Science 7

3. Elementary School Courses

- a. Kindergarten Science
- b. Grade 1 Science
- c. Grade 2 Science

Michelle Calas, School Business Administrator/Board Secretary

(continued)

I, Michelle Calas, School Business Administrator/ Board Secretary of the Springfield Board of Education, hereby certify that the extract from the minutes of a meeting of the Board of Education duly called and held on July 27, 2026 has been compared by me with the original minute book of said Board of Education, and is a true, complete and exact copy thereof, as far as the same relates to the subject matter to on said extract.

In WITNESS THEREOF, I have hereunto set my hand and seal of the Springfield Board of Education, this 28th day of July 2026.

SEAL



Michelle Calas
School Business Administrator/ Board Secretary



SPRINGFIELD PUBLIC SCHOOLS
ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

**Springfield Public Schools
Springfield, New Jersey**

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Superintendent of Schools**

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Course Standards

New Jersey Student Learning Standards for Science:

HS-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-3 Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-6 Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

HS-PS2-2 Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

HS-PS2-5 Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.



HS-PS3-4 Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

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.

HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

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.

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2 Evaluate competing design solutions for developing, conserving, managing, and utilizing energy and mineral resources based on the associated economic, social, environmental, and geopolitical costs and risks, as well as benefits.

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.



Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2), (HS-LS2-5)

Planning and Carrying Out Investigations

Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3), (HS-PS2-5), (HS-PS3-4)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)
- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3), (HS-ETS1-2), (HS-ESS3-4)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS3-1)

Analyzing and Interpreting Data



Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS2-1)
- Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 9–12 builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena to describe explanations. (HS-PS2-2)
- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)
- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6), (HS-PS4-5)

Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.



- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Disciplinary Core Ideas (DCIs):

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1)
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6)

PS1.B: Chemical Reactions

- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)

PS2.A: Forces and Motion

- Newton's second law accurately predicts changes in the motion of macroscopic objects. (HS-PS2-1)
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. (HS-PS2-2)
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-2)

PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), (secondary to HS-PS1-1), (secondary to HS-PS1-3)
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-5)

PS3.A: Definitions of Energy

- "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. (secondary to HS-PS2-5)



- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1), (HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)

PS3.B: Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HSPS3-1), (HS-PS3-4)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)
- The availability of energy limits what can occur in any system. (HS-PS3-1)
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3), (HS-PS3-4)
- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (secondary to HS-PS4-5)
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)

PS4.A: Wave Properties

- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-5)



PS4.B: Electromagnetic Radiation

- Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS-PS4-5)

PS4.C: Information Technologies and Instrumentation

- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)

ETS1.A: Defining and Delimiting Engineering Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1), (secondary to HS-PS3-3)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3), (secondary to HS-ESS3- 2), (secondary HS-ESS3-4)
- 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. (HS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (HS-ETS1-2), (secondary to HS-PS1-6)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems



- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (HS-ESS3-1) All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

ESS3.C: Human Impacts on Earth Systems

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-3)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Cause and Effect



- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-1), (HS-PS2-5), (HS-ESS3-1)
- Systems can be designed to cause a desired effect. (HS-PS4-5)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5), (HS-ETS1-4)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3)
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Theories and laws provide explanations in science. (HS-PS2-1)
- Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1)

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

Science Addresses Questions About the Natural and Material World



- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)
- Science knowledge indicates what can happen in natural systems— not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) New technologies advance scientific knowledge. (HS-ESS3-5)

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based on empirical evidence. (HS-ESS3-5)
- Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3), (HS-PS4-5), (HS-ESS3-1)
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1), (HS-ETS1-3)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2), (HS-ESS3-4)
- Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)



Design Thinking (Standard 8):

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.

8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.

8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.

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).

8.2.12.ITH.1: Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

8.2.12.NT.2: Redesign an existing product to improve form or function.

8.2.12.ETW.1: Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.

8.2.12.ETW.4: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.



Career Readiness (Standard 9):

9.2.12.CAP.3 Investigate how continuing education contributes to one's career and personal growth.

9.2.12.CAP.4 Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

9.2.12.CAP.5 Assess and modify a personal plan to support current interests and postsecondary plans.

9.2.12.CAP.6 Identify transferable skills in career choices and design alternative career plans based on those skills.

9.2.12.CAP.7 Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest.

9.2.12.CAP.8 Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors.

9.4.12.CI.2 Identify career pathways that highlight personal talents, skills, and abilities.

9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.

9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

9.4.12.CT.3 Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

9.4.12.CT.4 Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

9.4.12.DC.7 Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society.

9.4.12.DC.8 Explain how increased network connectivity and computing capabilities of everyday



objects allow for innovative technological approaches to climate protection.

9.4.12.TL.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

9.4.12.TL.2 Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.3 Analyze the effectiveness of the process and quality of collaborative environments.



Explore how modern engineers are helping improve the world through diverse engineering fields such as product design, robotics, mechanical design, infrastructure, and sustainability. Learn the principles of engineering as well as the cutting-edge tools of robotics, 3D modeling, programming, and prototyping that engineers are using to solve problems today and for the future!

PLTW Principles of Engineering (POE) is a full-year course designed to be a high school student's second exposure to the PLTW Engineering pathway and is appropriate for students in grades 9–12. In Principles of Engineering, students explore a broad range of engineering disciplines and careers, and design and solve real-world engineering problems.

This course introduces students to engineering concepts that are applicable to a variety of engineering disciplines and empowers them to develop technical skills through the use of engineering tools such as 3D modeling software, hands-on prototyping equipment, programming software, and robotics hardware to bring their solutions to life. Students apply the engineering design process to solve real-world problems across a breadth of engineering fields such as mechanical, robotics, infrastructure, environmental sustainability, and product design and development.

Using PLTW's activity-, project-, and problem-based (APB) instructional approach, students advance from completing structured activities to solving open-ended projects and problems that provide opportunities to develop planning and technical documentation skills, as well as in-demand, transferable skills such as problem solving, critical thinking, collaboration, communication, and ethical reasoning. The last is particularly important as the course encourages students to consider the impacts of engineering decisions.

Through individual and collaborative team activities, projects, and problems, students create solutions to problems as they practice common engineering design and development protocols, such as experimental design, testing, project management, and peer review.

The following is a summary of the units of study that are included in the course. The course requires a rigorous pace and contains more material than a skilled teacher new to the course will be able to complete in the first iteration. Giving students exposure to various engineering disciplines, developing their enthusiasm for engineering, and understanding the role, impact, and practice of engineering are primary goals of the course.



POE Unit Summary

Unit 0	Introduction to Product Design and Development
Unit 1	Mechanical Design
Unit 2	Applications of Robotics
Unit 3	Energy in Action
Unit 4	Designing Infrastructure and Developing Sustainability

Unit 0: Introduction to Product Design and Development

This optional introductory unit creates space for schools who begin their PLTW Engineering pathway with Introduction to Engineering Design or Engineering Essentials to quickly review familiar topics and challenge students to reach new levels of understanding and application. It also allows schools that are new to the pathway to build upon strong fundamental skills. In the unit, students explore different careers while applying modern collaborative modeling tools to create new products that meet real needs. Student teams take on the role of a product development team using the engineering design process to solve problems and create value for others.

Students gain enduring understandings of key principles of engineering such as modeling, material selection, statistics, tolerance analysis, and testing design and analysis. Through these challenges, students apply and develop project management, communication, and other pivotal transferable skills to solve problems.

Introduction to Product Design and Development Lesson Summary

Lesson 0.1	Engineering Design Process
Lesson 0.2	Collaborative Modeling and Modern Product Design
Lesson 0.3	Material Choice and Testing
Lesson 0.4	Designing a Shoe for You

Lesson 0.1 Engineering Design Process

In Lesson 0.1, students review and apply their understanding of the engineering design process to design a shoe to meet the specific needs of a customer. They use information gathered in interviews to learn about their client, develop a detailed problem statement, apply different brainstorming techniques, visualize their solution through concept sketches, and create a decision matrix to select the best solution for their client's needs. Students build a prototype and create a testing plan to test and iterate their design and share their results in a detailed presentation.



Lesson 0.2 Collaborative Modeling and Modern Product Design

In Lesson 0.2, students use 3D modeling software to learn different tools used to develop a detailed solution and are introduced to basic manufacturing techniques and practices. Students use 3D modeling software to modify an existing shoe model. Students learn manufacturing techniques and apply their knowledge to optimize a shoe design process.

Lesson 0.3 Material Choice and Testing

In Lesson 0.3, students experiment with different material options to determine which material properties are best paired with specific use cases and why. They design a test to gather meaningful data for a material that can be replicated consistently to cause an object to fail or break in a consistent manner. Students also model a shoe sole custom sized for their foot, and choose a material that best meets the needs of a desired shoe application of their choice.

Lesson 0.4 Designing a Shoe for You

In the final lesson, students apply their knowledge gained through the entire unit to identify a client with a specific footwear need to design and develop a solution. They interview their client, document their engineering design process, create a 3D model, develop a physical prototype, and iterate with their client to design a shoe tailored to their needs.

Unit 1: Mechanical Design

In Unit 1, students explore the foundational elements that make up complex mechanical devices and systems. They work collaboratively to solve real-world problems using their understanding of mechanical designs and motion to develop complex mechanisms. Students end the unit by working collaboratively and applying their knowledge to solve a real-world agricultural problem.

Students gain understanding of mechanical engineering concepts such as simple machines, energy, work, power, and mechanisms and apply them to solve engineering problems. Students continue to apply their project management, collaboration, communication, and additional key transferable skills throughout the unit. They continue to explore future career opportunities by conducting an interview of a professional of their choice.

Mechanical Design Lesson Summary

Lesson 1.1	Simple and Compound Machines
Lesson 1.2	Mechanisms
Lesson 1.3	Agricultural Solutions



Lesson 1.1 Simple and Compound Machines

In Lesson 1.1, students explore simple machines, where they are found, how they are used, and why they are the foundation of mechanical devices. They explore the fundamentals of energy, work, and power, and then apply their understanding to maximize efficiency and power. Students then investigate the factors that impact pulley systems and how to maximize the efficiency of pulleys, and design their own pulley system in a simulation. Students discover the benefits and drawbacks of different gears and gear trains as well as how to optimize speed or torque through gear ratios. Finally, students use force and acceleration sensors and their understanding of simple machines to design a robot that can pull with the greatest force.

Lesson 1.2 Mechanisms

Students begin Lesson 1.2 by examining the four types of motion as well as their application in different mechanical devices. They apply their understanding of motion by designing and building a latch mechanism to fix a broken door. Students continue their understanding of motion by creating a variety of different mechanisms and explore how they convert one type of motion to another. The lesson ends with a motion conversion challenge where students work collaboratively to design, build, and test individual segments of a machine and combine their machines to make a large-scale device to solve a problem.

Lesson 1.3 Agricultural Solutions

In this unit problem, students apply their understanding of simple machines, compound machines, mechanisms, and motion to choose a real-world agricultural problem, and then design, test, and build a compound machine that solves the identified problem. They then pitch their solution to a team of potential investors in an informative and persuasive presentation.

Unit 2: Applications of Robotics

In Unit 2, students explore the world of robotics and programming. They use their understanding of mechanical design, robotics, and programming to work collaboratively to develop solutions to real-world problems. Students continue their career exploration through investigating different pathways to higher education and determine their best course of action to make themselves good candidates for postsecondary education opportunities.

Students learn concepts such as programming, using and applying sensors, and artificial intelligence. Students use their collaboration, communication, project management, and additional transferable skills throughout the unit to solve in-depth problems.

Application of Robotics Lesson Summary

Lesson 2.1	Introduction to Robotics
Lesson 2.2	Robots in Action
Lesson 2.3	Artificial Intelligence
Lesson 2.4	An Electronic Ensemble



Lesson 2.1 Introduction to Robotics

In this lesson, students begin their introduction to robotics by creating their own robot that moves forward without the use of wheels. They then investigate what constitutes a robot compared to other programmable mechanical devices. Students conclude this lesson with detailed research in the history of robotics and predict opportunities for the future of the field.

Lesson 2.2 Robots in Action

In Lesson 2.2, students develop best coding practices, differentiate between open- and closed-loop systems, apply conditional statements, use a variety of different sensors, and apply their understanding to solve a problem. Students build and program a simple robot vehicle that can drive as close as possible to an obstacle without the use of sensors. Students are then introduced to bumper and limit switches, a potentiometer, a servo motor, and optical sensors, and they program each device to solve different problems. They conclude this unit by applying their understanding of programming to design and build a robot that replicates an animal's behavior.

Lesson 2.3 Artificial Intelligence

Students continue their exploration of robotics with artificial intelligence and machine learning. They design and build a robot, using a supervised machine learning algorithm, a distance sensor, and a bumper switch to train their robot to give a physical greeting. Students then investigate ethical concerns involved in the implementation of artificial intelligence and conduct research to determine the best course of action in a given scenario. To finish this unit, students apply their understanding of artificial intelligence to design and build a robot that can help someone.

Lesson 2.4 An Electronic Ensemble

In this unit problem, students create a robotic system that can perform a piece of music. They research different instruments from around the world, construct a functional prototype of their chosen instrument, and then design, build, and program a robot that can play their instrument. Students coordinate and collaborate with their individual robots and each other to create a system of robots that can play a piece of music.

Unit 3: Energy in Action

In this unit, students explore energy more deeply and useful applications of it through electrical circuits, fluids, and kinematics. They begin the unit by exploring the relationships between circuit components, deriving formulas, and applying their understanding to solve problems. Students then move into the world of fluids and the deep mathematical principles that govern them, and apply their knowledge to design their own fluid power system. They end the unit implementing their understanding of energy in motion through kinematics. Students also continue their career exploration journey by examining the financial aspects of attending a postsecondary institution.



Energy in Action Lesson Summary

Lesson 3.1	Electrical Circuits
Lesson 3.2	Fluid Power
Lesson 3.3	Kinematics
Lesson 3.4	Integration of Circuits, Fluid Power, and Kinematics

Lesson 3.1 Electrical Circuits

In Lesson 3.1, students explore the basic components of electrical circuits and model them through a hands-on introduction. They then explore the basic elements of electricity and electrical circuits and build simple circuits with breadboards and online simulations. Students collect data to derive the formula for Ohm's law then apply their understanding of Ohm's law to solve problems. They then move into a comparison between series and parallel circuits and explore their similarities and differences. Students continue hands-on breadboarding and simulations to derive Kirchhoff's voltage and current laws. They end the lesson with a final project that applies all the skills acquired to design and build their own functional safe.

Lesson 3.2 Fluid Power

In this lesson, students learn the fundamentals of hydraulic and pneumatic fluid power. They begin by exploring the differences between hydraulic and pneumatic systems as well as common mathematical formulas that support fluid power engineering. Students then apply these concepts to complete a problem set surrounding fluid power mathematics. This lesson concludes with students designing and building their own working hydraulic system.

Lesson 3.3 Kinematics

In Lesson 3.3, students explore the physics of moving objects. They begin by experimentally measuring the gravitational constant. Then students consider motion in vertical and horizontal directions and derive the equations that govern horizontal projectile motion. This lesson culminates with an engineering design challenge where students are challenged to design and build a zipline and calculate where an object will land when dropped.

Lesson 3.4 Integration of Circuits, Fluid Power, and Kinematics

In this unit problem, students combine their knowledge of electrical circuits and kinematics to design and build an automated golfer and a golf course. Students also create two targets that trigger an LED to illuminate and another to produce a sound. This problem requires deep understanding of series and parallel circuits, fluid power, and horizontal and vertical motion.



Unit 4: Designing Infrastructure and Developing Sustainability

In this unit, students investigate methods of designing infrastructure as well as various techniques to develop sustainable practices for the future. Students work collaboratively in teams to develop solutions to structural design problems, sustainable approaches, and transportation design needs that have a lasting impact on local and global communities.

Students gain an understanding of in-depth mathematical approaches to infrastructure design for static systems as well as apply statistical analysis and rigorous calculations to traffic and intersection design. They explore a variety of energy sources and a life cycle analysis to measure trade-offs in environmental dilemmas. Students continue to refine their project management, collaboration, communication, and additional key transferable skills to understand the impact of design choices on a large scale. Students conclude their career exploration by examining the future of different careers and how they will be affected by the adoption of artificial intelligence.

Designing Infrastructure and Developing Sustainability Lesson Summary

- 4.1 Statics
- 4.2 Renewable Energy
- 4.3 Transportation
- 4.4 Infrastructure Redesign

Lesson 4.1 Statics

In Lesson 4.1, students explore various aspects of static structures and apply mathematical approaches to solve structural problems. They begin the lesson by applying an engineering design process to design and test a cantilever beam. Students then compare materials and their properties that impact beam deflection; they also use 3D modeling software to analyze and investigate factors that impact beam deflection and solve an engineering design problem. Students analyze and solve systems through the use of free body diagrams, force vectors, moment calculations, and method of joints. They also explore internal forces in materials and the relationship between stress and strain. Students culminate their understanding to design their own bridge truss to support a given load at the lowest cost.

Lesson 4.2 Renewable Energy

In Lesson 4.2, students discover various sources of energy and research their effects on social, environmental, political, and economic systems to develop assertions and debate important environmental topics. They apply an engineering design process to design, construct, and test a device that converts the mechanical energy of falling water into electrical energy.



Lesson 4.3 Transportation

In Lesson 4.3, students examine and apply various mathematical tools to analyze traffic flow, capacity, and speed limits to solve transportation problems. They use hands-on experiments and spreadsheets to determine maximum traffic density and the traffic flow rate, and to calculate the optimal speed limit. Students also model traffic flow at various intersections and use critical lane volume to improve an existing intersection. Students conclude the lesson by applying an engineering design process to solve a transportation need for a client with different abilities.

Lesson 4.4 Infrastructure Redesign

In the unit problem, students determine a building that needs to be remodeled with a renewable energy source, a structural element, and a new intersection that serves the building. They calculate how much energy they can gather from their chosen renewable energy source and determine if it is sufficient to replace existing energy sources for their building. Students identify a structure to model with a free body diagram and calculate the forces of each member of their chosen structure. Students analyze a map of their chosen building location to determine the most effective renewable energy source. Finally, they redesign an intersection based on an increased flow rate traveling to and from their remodeled building.



Course resumes showcase the technical skills students obtain in each PLTW course. Each resume outlines the computational skills, analytical skills, and knowledge acquired in the course. Course resumes also detail student experience with tools, software, lab work, and engineering design. The detailed skills listed within course resumes illustrate the immediate, applicable contributions that students can make within a workplace.

Design Process Experience

- Solve a problem using an iterative engineering design process
- Work collaboratively on a team to design a product or solve a problem
- Document in detail the engineering design process used to solve a problem or design a product
- Develop a detailed and comprehensive design brief
- Brainstorm to generate creative ideas and potential solutions to a problem
- Carry out a plan to compare alternate solutions and select the best solution path
- Evaluate a design solution with respect to design requirements

Experimental Design and Testing Experience

- Design an experimental protocol to investigate a phenomenon
- Develop a test plan to compare alternate solutions
- Collect and analyze data to draw conclusions
- Accurately represent experimental data using visualization techniques and statistical models

Modeling Experience

- Create concept sketches to represent ideas
- Create technical drawings to represent solutions
- Create hand-drawn and scaled technical drawings
- Create and/or modify 3D solid computer models
- Develop models (including conceptual, graphical, mathematical, physical, and computer) and simulations to represent information, objects, systems, and processes.
- Use CAD software to develop parametric models, calculate beam deflection, determine life cycle and assessments, and analyze a pulley system.

Computational and Analytical Skills

- Use data to inform decisions and make predictions
- Apply abstraction to generalize a problem and solutions
- Collect, organize, and analyze data to help define a problem
- Use algorithms to create solutions
- Write programming code for a project involving a sequence or system of tasks
- Use a variety of methods for identifying and correcting errors in a program code



Project Management Experience

- Project scheduling and collaboration
- Act as a project lead to solve an engineering problem

Transportable Skills

- Team collaboration
- Peer review and feedback
- Project management
- Problem-solving
- Oral communication and presentation
- Technical writing
- Ethical reasoning

COURSE KNOWLEDGE

- Careers
 - Engineering career research
 - STEM careers related to engineering
 - Awareness of education and skills required for professional practice
 - Professional understanding of the need for multidisciplinary solutions to complex global challenges
 - Financial considerations of post-secondary education
 - Technology advancements and implications of AI in the workforce
 - Professional ethics
- Product Design
 - Technical Drawings and Modeling
 - Manufacturing techniques and optimization
 - Tolerance Analysis

- Material Choice and Testing
 - Material analysis
 - Failure testing
 - Statistics
 - Materials Choice
- Energy
 - Energy, work, and power fundamentals
 - Maximizing efficiency
 - Maximizing power
 - Energy sources and application
- Simple and Compound Machines
 - Mechanisms and simple machines
 - Mechanical advantage
 - Gear ratio
 - Compound gears
 - Types of motion
 - Converting types of motion
- Programming
 - Open and closed loop systems
 - Potentiometer, bumper and limit switch, distance sensor, servo motor, and optical sensors
 - Artificial intelligence and machine learning
- Electrical Circuits
 - Ohms law
 - Parallel and series circuits
 - Equivalent Resistance
 - Kirchhoff's law



- Fluid Power
 - Hydraulic systems
 - Pneumatic systems
 - Flow Rate
 - Pascal's Law
 - Fluid power
 - Flow velocity
 - Bernoulli's Principle
 - Absolute power
 - Absolute temperature
 - Boyle's Law
 - Charles' Law
 - Gay-Lussac's Law
- Kinematics
 - Displacement
 - Velocity
 - Acceleration
 - Vertical motion
 - Horizontal projectile motion
- Statics
 - Beam deflection
 - Free body diagrams
 - Force vectors
 - Stress and Strain
 - Tensile Testing
 - Moments
 - Method of joints
 - Material properties
- Transportation
 - Flow rate
 - Roadway capacity
 - Optimal speed limit
 - Critical lane volume



PLTW Principles of Engineering Unit 0 Framework

PLTW

PLTW Framework - Overview

PLTW Unit Frameworks provide an overview of the levels of understanding that each build upon the higher level: Knowledge and Skills, Objectives, Domains, and Competencies. The most fundamental level of learning is defined by course Knowledge and Skills statements. Each Knowledge and Skills statement reflects specifically what students will know and be able to do after they've had the opportunity to learn the course content. Students apply Knowledge and Skills to achieve learning Objectives, which are skills that directly relate to the workplace or applied academic settings. Objectives are organized by higher-level Domains.

Essential Questions

- 0.1 - 1 How does a design team know what problem to solve?
- 0.1 - 2 Why is empathy an important skill in engineering design?
- 0.1 - 3 How do engineers communicate designs and solutions?
- 0.1 - 4 What is a decision matrix and why is it used?
- 0.2 - 1 What techniques do engineers use to visually present design ideas?
- 0.2 - 2 What advantages does Computer-Aided Design (CAD) provide over traditional paper and pencil design?
- 0.2 - 3 What advantages does paper and pencil design provide over CAD?
- 0.2 - 4 What would happen if engineers did not follow accepted dimensioning standards and guidelines, but instead, used their own individual dimensioning methods?
- 0.2 - 5 What are the differences between manufacturing processes?
- 0.3 - 1 What properties should be considered when evaluating material choice for a product?
- 0.3 - 2 What data should be collected in a testing process?
- 0.3 - 3 How is material testing data useful?
- 0.3 - 4 How does an engineer predict the performance and safety of a selected material?
- 0.3 - 5 What is the difference between the independent variable and the dependent variable in experimental design?
- 0.4 - 1 What are two possible ways that a team could come to a consensus in a disagreement over a solution to a problem?
- 0.4 - 2 Why is it important for the team to come to a consensus on the issues that arise? What are some reasons that the team leader should not dictate the direction of the group?
- 0.4 - 3 How can you design a product that meets the needs of a user?



PLTW Principles of Engineering Unit 1 Framework



PLTW Framework - Overview

PLTW Unit Frameworks provide an overview of the levels of understanding that each build upon the higher level: Knowledge and Skills, Objectives, Domains, and Competencies. The most fundamental level of learning is defined by course Knowledge and Skills statements. Each Knowledge and Skills statement reflects specifically what students will know and be able to do after they've had the opportunity to learn the course content. Students apply Knowledge and Skills to achieve learning Objectives, which are skills that directly relate to the workplace or applied academic settings. Objectives are organized by higher-level Domains.

Essential Questions

- 1.1 - 1 How do engineers quantify the mechanical advantage of a system?
- 1.1 - 2 How do engineers apply their knowledge of simple machines to solve problems?
- 1.1 - 3 How do engineers quantify energy, work, and power?
- 1.1 - 4 How do engineers apply their knowledge of energy, work, and power to solve problems?
- 1.2 - 1 How are mechanisms used to convert one type of motion to another?
- 1.2 - 2 How do engineers manipulate motion to solve design problems?
- 1.3 - 1 How can you apply your understanding of machines and mechanisms to solve an authentic problem?



PLTW Principles of Engineering Unit 2 Framework



PLTW Framework - Overview

PLTW Unit Frameworks provide an overview of the levels of understanding that each build upon the higher level: Knowledge and Skills, Objectives, Domains, and Competencies. The most fundamental level of learning is defined by course Knowledge and Skills statements. Each Knowledge and Skills statement reflects specifically what students will know and be able to do after they've had the opportunity to learn the course content. Students apply Knowledge and Skills to achieve learning Objectives, which are skills that directly relate to the workplace or applied academic settings. Objectives are organized by higher-level Domains.

Essential Questions

- 2.1 - 1 What characteristics define a robot?
- 2.2 - 1 What practices do programmers use to write effective code?
- 2.2 - 2 How do engineers use sensors to solve design problems?
- 2.3 - 1 What is artificial intelligence, and how do engineers use it to solve problems?
- 2.3 - 2 What are some of the ethical implications of artificial intelligence?
- 2.4 - 1 How can you apply your understanding of mechanics and programming to solve a design problem?



PLTW Principles of Engineering Unit 3 Framework

PLTW

PLTW Framework - Overview

PLTW Unit Frameworks provide an overview of the levels of understanding that each build upon the higher level: Knowledge and Skills, Objectives, Domains, and Competencies. The most fundamental level of learning is defined by course Knowledge and Skills statements. Each Knowledge and Skills statement reflects specifically what students will know and be able to do after they've had the opportunity to learn the course content. Students apply Knowledge and Skills to achieve learning Objectives, which are skills that directly relate to the workplace or applied academic settings. Objectives are organized by higher-level Domains.

Essential Questions

- 3.1 - 1 How do you differentiate between circuit types?
- 3.1 - 2 How do you model electrical circuits?
- 3.1 - 3 How do you test circuit parameters?
- 3.1 - 4 What are the mathematical relationships between circuit parameters?
- 3.1 - 5 Why are Kirchhoff's Laws important to engineers and designers of electrical circuits?
- 3.2 - 1 What impact does fluid power have on our everyday lives?
- 3.2 - 2 What devices or systems might be improved with the use of fluid power?
- 3.2 - 3 What are the similarities and differences of mechanical advantage in simple machines?
- 3.2 - 4 Why are Pascal's Law, the perfect gas laws, Bernoulli's Principle, and other similar rules important to engineers and designers of fluid power systems?
- 3.3 - 1 How do we graph and analyze motion?
- 3.3 - 2 What equations govern how objects move?
- 3.3 - 3 How do we predict where projectiles will land?



PLTW Principles of Engineering Unit 4 Framework

PLTW

PLTW Framework - Overview

PLTW Unit Frameworks provide an overview of the levels of understanding that each build upon the higher level: Knowledge and Skills, Objectives, Domains, and Competencies. The most fundamental level of learning is defined by course Knowledge and Skills statements. Each Knowledge and Skills statement reflects specifically what students will know and be able to do after they've had the opportunity to learn the course content. Students apply Knowledge and Skills to achieve learning Objectives, which are skills that directly relate to the workplace or applied academic settings. Objectives are organized by higher-level Domains.

Essential Questions

- 4.1 - 1 What factors impact beam deflection?
- 4.1 - 2 Why is the value of beam deflection useful?
- 4.1 - 3 What are the properties of structural members and why are they useful?
- 4.1 - 4 What is a centroid and how is it applied in structural members?
- 4.1 - 5 Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design?
- 4.1 - 6 Why must designers and engineers calculate forces acting on bodies and structures?
- 4.1 - 7 What are the differences between stress and strain?
- 4.1 - 8 Why are stress and strain important factors to consider when designing?
- 4.1 - 9 How does the stress-strain curve help engineers during tensile testing?
- 4.1 - 7 What is a moment and how does it help solve problems in static structures?
- 4.1 - 8 When solving truss forces, why is it important to know that the structure is statically determinate?
- 4.1 - 9 How is the method of joints used to determine internal forces in trusses?
- 4.1 - 10 How do material properties affect structural stability, internal forces, and cost?
- 4.2 - 1 What are renewable and nonrenewable resources and how do humans use them?
- 4.2 - 2 In what innovative ways could the efficiency of electricity production using solar cells be maximized throughout the day?
- 4.3 - 1 What factors affect the rate of flow on a roadway?
- 4.3 - 2 How is the optimum speed limit determined for a roadway?
- 4.3 - 3 In your opinion, what type of intersection is prone to the most accidents? What can be done to maximize safety at this type of intersection?
- 4.4 - 1 What role does creativity have in the engineering design process?
- 4.4 - 2 What do engineers do to clearly document and communicate their work? Why is this important?
- 4.4 - 3 How are different elements of infrastructure related?
- 4.4 - 4 How do mass, friction, and gears



SPRINGFIELD PUBLIC SCHOOLS

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS

IEP AND 504 ACCOMMODATIONS AND MODIFICATIONS FOR EARLY CHILDHOOD AND ELEMENTARY SCHOOL STUDENTS:

Large print textbooks
Textbooks for at-home use
Additional time for assignments
Review of directions
Use of mnemonics
Have student restate information
Concrete examples
Adaptive writing utensils
Support auditory presentations with visuals
Use of a study carrel
Assistance in maintaining uncluttered space
Weekly home-school communication tools (notebook, daily log, phone calls or email messages)
Space for movement or breaks
Study sheets and teacher outlines
Extra visual and verbal cues and prompts
Math sheets with highlighted instructions
Graph paper to assist in organizing or lining up math problems
Use of computers and calculators
Books on tape
Graphic organizers
Quiet corner or room to calm down and relax when anxious
Preferential seating
Alteration of the classroom arrangement
Reduction of distractions
Answers to be dictated
Hands-on activities
Use of manipulatives
No penalty for spelling errors or sloppy handwriting
Follow a routine/schedule
Alternate quiet and active time
Teach time management skills
Rest breaks
Verbal and visual cues regarding directions and staying on task
Agenda book and checklists
Adjusted assignment timelines
Visual daily schedule



SPRINGFIELD PUBLIC SCHOOLS

**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Varied reinforcement procedures
Immediate feedback
Work-in-progress check
Personalized examples

TESTING AND ASSESSMENT ACCOMMODATIONS AND MODIFICATIONS:

Answers to be dictated
Frequent rest breaks
Additional time
Oral testing
Untimed tests
Choice of test format (multiple-choice, essay, true-false)
Alternate ways to evaluate (projects or oral presentations instead of written tests)
Accept short answers
Open-book tests
Read test and directions to student
Provide study outline prior to tests
Highlight key directions
Test in alternative site
Use of calculator
Extra credit option
Preview test procedures
Simplified test wording; rephrased test questions and/or directions

GENERAL ACCOMMODATIONS AND MODIFICATIONS:

Use of alternative books or materials on the topic being studied
Computerized spell-check support
Word bank of choices for answers to test questions
Provision of calculator and/or number line for math tests
Reworded questions in simpler language
Projects instead of written reports
Highlighting important words or phrases in reading assignments
Modified workload or length of assignments/tests
Modified time demands
Modified grades based on IEP

BEHAVIOR ACCOMMODATIONS MODIFICATIONS:



SPRINGFIELD PUBLIC SCHOOLS

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS

Breaks between tasks
Cue expected behavior
Daily feedback to student
Have contingency plans
Use de-escalating strategies
Use positive reinforcement
Use proximity/touch control
Use peer supports and mentoring
Model expected behavior by adults
Have parent sign homework
Have parent sign behavior chart
Set and post class rules
Chart progress and maintain data



SPRINGFIELD PUBLIC SCHOOLS

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS

IEP AND 504 ACCOMMODATIONS AND MODIFICATIONS FOR MIDDLE AND HIGH SCHOOL STUDENTS:

- Large print textbooks
- Textbooks for at-home use
- Additional time for assignments
- A locker with adapted lock
- Review of directions
- Review sessions
- Use of mnemonics
- Have student restate information
- Provision of notes or outlines
- Concrete examples
- Adaptive writing utensils
- Support auditory presentations with visuals
- Weekly or bi-weekly home-school communication
- Space for movement or breaks
- Study sheets and teacher outlines
- Extra visual and verbal cues and prompts
- Lab and math sheets with highlighted instructions
- Graph paper to assist in organizing or lining up math problems
- Use of tape recorder for lectures
- Use of Interactive notebook
- Use of a scribe
- Use of computers and calculators
- Books on tape
- Graphic organizers
- Quiet corner or room to calm down and relax when anxious
- Preferential seating
- Alteration of the classroom arrangement
- Reduction of distractions
- Answers to be dictated
- Hands-on activities
- Ability to type all assignments
- Follow a routine/schedule
- Teach time management and organizational skills
- Rest breaks
- Verbal and visual cues regarding directions and staying on task
- Agenda book and checklists
- Daily check-in with case manager or special education teacher
- Adjusted assignment timelines
- Visual daily schedule



SPRINGFIELD PUBLIC SCHOOLS

**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Varied reinforcement procedures
Immediate feedback
Work-in-progress check
Personalized examples

TESTING AND ASSESSMENT ACCOMMODATIONS AND MODIFICATIONS:

Answers to be dictated
Frequent rest breaks
Additional time
Oral testing
Choice of test format (multiple-choice, essay, true-false)
Alternate ways to evaluate (projects or oral presentations instead of written tests)
Accept short answers
Open-book or open-note tests
Read test and directions to student
Provide study guides prior to tests
Highlight key directions
Test in alternative site
Use of calculator
Extra credit option
Pace long-term projects
Preview test procedures
Simplified test wording; rephrased test questions and/or directions

GENERAL ACCOMMODATIONS AND MODIFICATIONS:

Allow outlining, instead of writing for an essay or major project
Use of alternative books or materials on the topic being studied
Computerized spell-check support
Word bank of choices for answers to test questions
Provision of calculator for math tests
Film or video supplements in place of reading text
Reworded questions in simpler language
Projects instead of written reports
Highlighting important words or phrases in reading assignments
Modified workload or length of assignments/tests
Modified time demands



SPRINGFIELD PUBLIC SCHOOLS

**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Pass/no pass option
Modified grades based on IEP

BEHAVIOR ACCOMMODATIONS FOR STUDENTS:

Breaks between tasks
Cue expected behavior
Daily feedback to student
Have contingency plans
Use de-escalating strategies
Use positive reinforcement
Use proximity/touch control
Use peer supports and mentoring
Model expected behavior by adults
Have parent sign homework
Set and post class rules
Chart progress and maintain data



SPRINGFIELD PUBLIC SCHOOLS

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS

Accommodations and Modifications for ESL Students

- Give tests orally
- Give instructions/directions in writing and orally
- Assign a peer tutor, same language or English speaking
- Allow use of bilingual/translation dictionary
- Provide summaries of text or study guides of particular chapters
- Allow errors in speaking
- Allow errors in writing
- Accept writing in first language
- Highlight key vocabulary
- Reduce amount of work required
- Assess comprehension through demonstration or other alternative means (gestures, drawings)
- Rephrase questions, directions, and explanations
- Reduce multiple choices on assessments
- Provide study guides and/ or outlines
- Shorten reading assignments
- Allow extended time for test/project completion
- Use of audio books
- Use of graphic organizers
- Use reduced text, so that print is not dense
- Use visuals/pictures throughout lesson/unit/assignment
- Adapt homework to reflect language proficiency/home support
- Adapt homework to reflect home support
- Provide hands-on activities and explanations
- Allow extended time to answer questions, and permit drawing, as an explanation
- Use of translation dictionaries to locate words in the native language
- Use anecdotal records and portfolio of work as forms of assessment
- Use story retellings to assess comprehension

What Does the Gifted and Talented Experience Look Like? *Springfield Public Schools*

Mission Statement

The Gifted and Talented Program of the Springfield Public Schools aims to provide a meaningful and rigorous education that instills the value of lifelong learning and empowers all students to reach their full potential and become self-fulfilled creative leaders in accordance with the comprehensive standards of our state. We accomplish this by offering challenging, real-world experiences in a student-centered environment.

We recognize that students come from diverse socioeconomic, cultural, and ethnic backgrounds, and the mission of the gifted and talented program is to provide opportunities for students to explore their intellectual, creative, and artistic gifts and talents within the classroom and with beyond-the-classroom experiences. It is essential to provide diverse, appropriate, and ongoing learning experiences and environments that incorporate students' academic, psychological, and social needs. Our responsibility is to provide students with educational alternatives that teach, challenge, and expand their knowledge, while simultaneously stressing the development of independent and self-directed learners who continuously generate questions, analyze, synthesize, and evaluate information and ideas.

New Jersey Administrative Code 6A:8-3.1 defines students who are gifted and talented as those students who possess or demonstrate high levels of ability in one or more content areas when compared to their chronological peers in the local district and who require modification of their educational program if they are to achieve in accordance with their capabilities.

Goals:

To support our mission, we have established the following goals to guide our work:

- To infuse into the general education program a broad range of activities for high-level learning that will challenge all students to perform at advanced levels, and provide extended opportunities, resources, and support in particular areas where student interest or talent is demonstrated.
- To provide a continuum of gifted education services that will strengthen the total school program, offer enriching and challenging learning opportunities for all students, and provide specialized learning experiences
- To promote achievement of students' best potentials and increased ability.

Through a productive and collaborative relationship among the building principals, classroom teachers, and the Gifted and Talented teacher, our schools can create programming that will enhance the learning experience for every student and serve the unique and specialized needs of students currently demonstrating gifted behaviors.

Elements of the Schoolwide Enrichment Model, W.I.N (What I Need), differentiated instruction, advanced classes, or individual programs into a student's regular instruction program are integral to this overarching framework for gifted education in the Springfield School District.

Reference Board Policy and Regulation 2464 – Gifted and Talented Pupils (M)

Early Childhood Center **Edward V. Walton**

Schoolwide Virtual Enrichment

All first and second grade students have access to the [Gifted and Talented Virtual Classroom](#). This virtual classroom is a space for students to complete various challenges and enrichment opportunities at their own pace. Students can receive feedback and additional adaptable resources to meet their individual learning needs. The virtual classroom design expands accessibility to enrichment resources and allows students to choose learning activities according to their unique interests and abilities. The purpose of the activities is to encourage problem-solving, develop critical thinking

skills, and expand curiosity and imagination. Activities are aligned to the New Jersey Student Learning Standards.

Gifted and Talented Teacher as a Resource

The Gifted and Talented teacher serves as a resource to all teachers within Edward V. Walton School. Teachers seeking resources for their high-ability learners will receive additional support from the Gifted and Talented teacher in various ways. This support may include additional units of study, challenging resources, and student projects.

Elementary Schools

James Caldwell

Thelma L. Sandmeier

The goal is to engage small groups of students in intensive learning experiences through standards-based, rigorous, and relevant units of study that supplement, not supplant, the grade-level curriculum and support students' unique learning needs.

Enrichment Experience Grade 3

Beginning in third grade, the G&T teacher will cycle through all classrooms to work on problem-solving and enrichment tasks with students. Driven by assessment data, academic performance, student interest, and teacher observation, small groups of students will meet with the G&T teacher during W.I.N. (What I Need) periods throughout the week that the teacher is assigned to their classroom teacher. Groupings will be flexible and monitored to best meet each student's needs throughout the school year. Activities will include brain teasers, puzzles, strategic thinking, problem-solving, and STEM challenges.

Targeted Gifted and Talented Programing Grades 4-5

Students may become identified as Gifted and Talented in fourth grade. Students that are identified may receive support from the G&T Teacher for up to five periods (200 minutes) a week during W.I.N. (What I Need) periods. Identified students will meet to explore grade-level content while incorporating depth and complexity in a student-centered, problem-based environment. The Gifted and Talented Program aims to provide students with various advanced and challenging learning experiences across content areas to promote independent thinking skills, refine critical thinking and communication skills, cultivate joy in learning, and expand student interests through problem-solving. The instruction that students receive incorporates 21st Century Skills and advanced content that is challenging, hands-on, and relevant to the real world.

Strategies and Practices that Support Gifted and Talented Students

- Adjusted Pace of Lessons
- Inquiry-Based Instruction
- Higher-Order Thinking Activities
- Interest-Based Content
- Real World Problem Solving/Problem Based Learning
- Independent Study/Passion Projects
- Units of Study with Like-Minded Peers

Schoolwide Virtual Enrichment

All JCS and TLS students have access to grade level-specific [Gifted and Talented Virtual Classrooms](#). These virtual classrooms are a space for students to complete various challenges and enrichment opportunities at their own pace. Students are able to receive feedback and additional opportunities based on their needs. The virtual classrooms have expanded the accessibility of enrichment resources directly to the students and allows for students to choose opportunities according to their interests and abilities. The purpose of the activities is to encourage problem solving, develop critical thinking skills, and expand curiosity and imagination in conjunction with the New Jersey Student Learning Standards.

Gifted and Talented Teacher as a Resource

In addition to classroom support, the Gifted and Talented teacher also serves as a resource to all teachers in the building. Teachers that are seeking resources for their high ability learners will receive additional support from the Gifted and Talented teacher in various ways. This may include additional units of study, challenging resources, student projects, and meeting with the G&T teacher as needed.

Additional Enrichment Opportunities

Across all grade levels 3-5, as recommended by the classroom teacher, students exhibiting a need for additional enrichment may have the opportunity to meet with the G&T teacher as the schedule allows. Groupings will be flexible and monitored to best meet the students' needs throughout the school year. Activities will include, brain teasers, puzzles, strategic thinking activities, problem-solving challenges, and STEM challenges. Students engage in an extended process of asking questions, using resources, and developing answers that lead to thinking about what and how they are learning. Students are held accountable for how they work and use their time by demonstrating their learning through products or presentations.

Students self-select to participate in individual and/or group projects based on interest and commitment. The classroom teacher and/or the enrichment teacher will help guide and monitor student exploration of chosen topics, facilitating their learning with resources and teaching of needed skills.

Secondary Schools
Florence M. Gaudineer Middle School
Jonathan Dayton High School

Grades 6-12: Access to specific content programs with higher levels of academic challenges (i.e. Pre-Algebra, Accelerated Communication Arts, and Advanced Placement Classes)

Dual Credit Courses provide students the opportunity to obtain high school credit, and college credit, simultaneously through partnerships with several institutions.

Project Lead the Way (PLTW) students become builders of technology by engaging in real world activities. Students are empowered as design thinkers collaborating on real world projects.

Gifted and Talented Identification Criteria

The Springfield Schools Gifted and Talented Program recognizes that students require differentiated learning experiences beyond the core curriculum being taught because of their advanced abilities in one or more content areas. These students may also have other cognitive qualities such as curiosity, creativity, motivation, leadership, and passion that require modifications to their academic experience.

Multiple Measures of Eligibility

Kindergarten through grade twelve identification process for gifted and talented students includes multiple measures. Multiple measures may include but are not limited to: achievement test scores; grades; student performance or products; intelligence testing; parent, student, and/or teacher recommendation; and other appropriate measures. The identification methodology is developmentally appropriate, non-discriminatory, and related to the programs and services offered by the Springfield School District. The identification procedures are reviewed annually.

According to N.J.A.C. 6A:8-3.1, all public school districts must have a board-approved gifted and talented identification process and provide services for identified students enrolled in the grades of that school district. The regulations require that identification and services be made available to students in grades K-12.

When students are recommended for the Gifted and Talented Program there are multiple measures that are considered to determine if services are necessary and appropriate. The assessments used are as follows:

- *Cognitive Abilities Test (CogAT)*
- *Classroom Performance/Student Portfolios*
- *DRA2 Level*
- *iReady Diagnostic Scores*
- *Gifted Indicators Checklist*
- *Start Strong/NJSLA Assessment Data*

The N.J.A.C. requires that students be compared to their chronological peers in the local school district. The New Jersey Department of Education has not established state-level criteria for identifying students who are gifted, such as mandated tests or assessments, grade point averages, or IQ scores. Local school districts must use multiple measures to identify students.

Procedures

<https://www.straussesmay.com/seportal/Public/DistrictPolicy.aspx?policyid=2464&id=b8a33a9f505e4998a6db3fb8e1de778b>

Gifted and Talented Program Identification Matrix

Minimum Score Required for Consideration: 14 Points

1 Point	2 Points	3 Points
Cogat Assessment Overall Stanine Score of a 7	Cogat Assessment Overall Stanine Score of an 8	Cogat Assessment Overall Stanine Score of a 9
iReady Math Assessment Just Below Current Grade Level	iReady Math Assessment On Grade Level	iReady Math Assessment ½ Year + Above Current Level
iReady ELA On Grade Level	iReady ELA ½ Year Above Current Level	iReady ELA One Full Grade Level + Above Current Level
NJSLA Math Approaching Expectations	NJSLA Math Met Expectations	NJSLA Math Exceed Expectations
NJSLA ELA Approaching Expectations	NJSLA ELA Met Expectations	NJSLA ELA Exceed Expectations
HOPE Teacher Rating Scale Raw Score: 11 - 29	HOPE Teacher Rating Scale Raw Score: 30 - 49	HOPE Teacher Rating Scale Raw Score: 50-66

Team meetings present the opportunity to review data and assess the educational needs of all students. Teacher provides examples of student work exhibiting above and beyond grade level expectations, creativity, leadership, critical and abstract thinking. Programs for gifted and talented students will be periodically evaluated for their continuing efficacy and adjusted accordingly. The parent of any student identified as gifted or talented shall be consulted regarding any program designed to address the student's particular needs.

Resource Links

https://riversideinsights.com/cognitive_abilities_test

<https://www.curriculumassociates.com/programs/i-ready-learning>

<https://www.nj.gov/education/assessment/resources/>

<https://www.routledge.com/HOPE-Teacher-Rating-Scale-Involving-Teachers-in-Equitable-Identification/Gentry-Pereira-Peters-McIntosh-Fugate/p/book/9781618214522#:~:text=The%20HOPE%20Teacher%20Rating%20Scale,making%20it%20easy%20to%20use.>

Gifted and talented student: The "[*Strengthening Gifted and Talented Education Act*](#)" defines a gifted and talented student as a "student who possesses or demonstrates a high level of ability in one or more content areas when compared to their chronological peers in the school district and who require modifications of their educational program if they are to achieve in accordance with their capabilities."

Twice-exceptional (2E) students: A twice-exceptional (2E) student is defined as "a student who is both gifted and a student with a disability. These students may also be referred to as having dual exceptionalities or as being gifted with learning disabilities (GT/LD). This also applies to students who are gifted with ADHD or gifted with autism" (New Jersey Association for Gifted Children, www.nagc.org).

Instructional adaptation: An adjustment or modification to instruction enabling a student who is gifted and talented to participate in, benefit from, and demonstrate knowledge and application of the New Jersey Student Learning Standards in one or more content areas at the instructional level of the student, not just the student's grade level.

Identifying gifted and talented students: The focus of identification is to provide programming and services in which students' specific learning needs and potential are appropriately addressed and met. In every New Jersey school district, there are students who require modifications to the general education curriculum if they are to achieve in accordance with their abilities. By identifying a student's general intellectual ability, creativity, or specific academic area aptitudes, we are acknowledging that they need programming and services outside of the general education/grade level curriculum to advance their learning.

NJDOE Fast Facts

<https://www.nj.gov/education/standards/gifted/>

<https://www.nj.gov/education/standards/gifted/legislation.shtml>

Supplemental Resources/Programming for Gifted Students

Edward V. Walton

- PETS Program – Primary Education Thinking Skills
- Group Solutions/Group Solutions 2 – Cooperative Logic Activities
- Lollipop Logic
- Beginning Thinking Skills
- AIMS Education Programming

James Caldwell and Thelma L. Sandmeier

Math/ELA

- Project M3: Mentoring Mathematical Minds
- Junior Great Books
- AIMS Education Programming
- Borenson Hands on Equations
- BizWorld
- Perplexors
- Advanced Math Explorations grade 3-5
- Challenging Units for Gifted Learners (ELA and Math)
- Creative Curriculum Extenders
- Differentiated Lessons & Projects
- Challenge Math Grades 4+
- Differentiating Instruction with Menus (All Content Areas)
- Jacob's Ladder
- Genius Hour/Passion Project
- Spatial Reasoning
- Logic Puzzles, Brain Games, Analogies

STEM

- Engineering is Elementary
- Engineer Throughout the Year
- PBS Design Squad
- DefinedSTEM
- Project Lead the Way (PLTW)

Enrichment Events

Experience for all students to be enriched through events related to the curricular or extracurricular activities. Examples include after school clubs, PTA-sponsored events, leadership opportunities, visual and performing arts, and community service opportunities.