Westerville City Schools
Materials Science
Course of Study
Course Number: SC431

Course Description

Recommended Grade Levels:	10, 11, 12
Course Length:	Year, 1 Period
Credit:	1.0 Advanced Science
Course Weighting:	1.0

Students in Materials Science learn about the nature of materials, specifically metals, ceramics, polymers, and composites through creative and artistic hands-on activities. Materials Science involves "learning by doing" and incorporates scientific practices such as inquiry, experimental design, the use of models, data analysis, critical thinking, and using evidence to construct and communicate explanations. A significant portion of the course is lab-based.

Course Rationale

To uphold the district's mission and foster lifelong skills, Materials Science provides opportunities to develop highly transferable skills in adaptability, collaboration, communication, critical thinking, and problem solving. This Materials Science curriculum will enhance students' content knowledge and inquiry-based problem solving skills while learning how Materials Science affects their daily lives. It will improve students' abilities to innovate, deepen math and science skills, strengthen students' communication abilities and academic literacy skills, and foster interest in future advanced science courses and career pathways.

Considerations for Cultural Relevancy, Inclusivity, and Diversity

Where possible teachers will create opportunities to incorporate the histories, values, beliefs and perspectives of people from different cultural backgrounds to meet the needs of all learners. Strategies for meeting the needs of all learners including gifted students, English Language Learners and students with disabilities can be found at this ODEW site.

Considerations for Intervention and Acceleration

This rigorous and highly relevant curriculum is built upon high quality, research-based instructional strategies.Teachers may need to provide targeted Tier II support (e.g., remediation of particular skills and concepts, as well as scaffolded or supplemental instruction) beyond the Tier I level of universal instruction to underachieving students. Intensive and individualized Tier III instruction (e.g., skill-specific intervention, one-on-one support).

Scope and Sequence

	Unit	Estimated Time (Weeks)
1	Introduction to Materials Science	1 - 2
2	Crystals	4 - 5
3	Metals	6 - 7
4	Corrosion	2 - 3
5	Chocolate (optional)	1 - 2
6	Ceramics/Glass	5 - 6
7	Polymers	4 - 5
8	Composites	2 - 3
9	Concrete	1 - 2

Expectations for Learning

The **5E Model of Instruction** promotes active learning. Students are involved in more than listening and reading; they learn to ask questions, observe, model, analyze, explain, draw conclusions, argue from evidence, and talk about their own understanding; and work collaboratively with peers to construct explanations, solve problems, and plan and carry out investigations. (Rodger Bybee)

Stage	Students . . .
Engage	● Ask questions such as, “Why did this happen?”, “What do I already know about this?”, “What can I find out about this?”, and “How can this problem be solved?”. ● Show interest in the topic through curiosity and expression of wonderings. ● Demonstrate engagement by expressing ideas, sharing observations, and creating initial models. ● Express current understanding of a concept or idea.
Explore	● Test predictions and hypotheses and/or form new predictions and hypotheses. ● Create and discuss problems and ideas with others. ● Plan and conduct investigations in which they observe, describe, and record data. ● Try different ways to solve a problem or answer a question. ● Create initial models.
Explain	● Show models, explanations, answers, or possible solutions to other students. ● Explain using evidence from investigations. ● Use labels, terminology, and formal scientific language. ● Compare current thinking with former thinking. ● Record ideas and current understanding. ● Adjust ideas, models, and explanations as new evidence or reasoning is presented.
Elaborate	● Apply new labels, definitions, explanations, and skills in new, but similar, situations. ● Use previous information to ask questions, propose solutions, make decisions, design experiments, or complete a challenge. ● Draw reasonable conclusions from evidence. ● Critique the models, explanations, or arguments made by others using evidence and reasoning. ● Make conceptual connections between new and previous experiences. ● Communicate understanding to others.
Evaluate	● Give feedback to other students. ● Evaluate progress or knowledge. ● Check work with a rubric or against established criteria. ● Assess progress by comparing current understanding with prior knowledge. ● Ask additional questions that go deeper into a concept or lead to additional learning. ● Demonstrate understanding of science content and practices. ● Answer open-ended questions by using observations, evidence, and previously accepted explanations.

Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge. It is a way of knowing about the world based on evidence from experimentation and observations. Science assumes that objects and events occur in consistent patterns that are understandable through measurement and observation. Scientific theories are based on a body of scientific evidence; science explanations can change based on new scientific evidence.

One goal of science education is to help students become scientifically literate citizens that are able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science, to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact not only themselves but others too.

Scientifically literate students

- know, use, and interpret scientific explanations of the natural world;
- generate and evaluate scientific evidence and explanations;
- understand the nature and development of scientific knowledge; and
- participate productively in scientific practices and discourse.

These four proficiencies link the content and practices of science. The standards statements, descriptions, elaborations and learning targets clarify the science *content* students should know and understand. The science practices describe the *skills, processes,* and *actions* of scientists; what scientists do and how science looks in an authentic setting.

Scientific practices include:
1. Asking questions
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

The scientific practices allow students to use science content they have acquired. They involve doing and learning something in such a way that the doing and learning cannot really be separated. Students learn how to do science while learning about science. When students engage in scientific practices, activities and lessons become the basis for learning about experiments, data and evidence, social discourse, models and tools, and mathematics and for developing the ability to evaluate knowledge claims, conduct empirical investigations, and develop explanations.

Unit 1: Introduction to Materials Science and Science & Engineering Practices

(approximately 1 week)

Though articulated as part of a unit, scientific and engineering practices are intentionally integrated throughout content units rather than taught or experienced as a stand-alone unit.

Essential Questions	● How do we study and make discoveries about the natural world using various processes and practices? ● What does it mean to be a materials scientist? ● How has materials science been a part of our everyday life?
Enduring Understandings	● Scientists study and compare materials, places, phenomena, and events to make sense of our world. ● Usage and relative importance of materials have changed over time due to accessibility, safety, and changes in technology.
Key Concepts/ Vocabulary	ceramic, composite, dependent variable, dilatant, glass, hypothesis, independent variable, life cycle analysis (LCA), non-newtonian fluid, materials science, metal, model (conceptual, physical), monomer, observation, polymer, prediction, probability, qualitative data, quantitative data, sustainability, thixotropic, variable, viscosity
Learning Targets	<u>How do we study and make discoveries about the natural world using various processes and practices?</u> 1. Ask questions ● Ask questions based on observations and/or other appropriate information of a scientific phenomenon. ● Generate, identify, and/or evaluate questions that can be systematically investigated (i.e., questions that are testable/investigable/scientific). 2. Develop and use models ● Describe components and characteristics of a model. ● Develop models consistent with prior evidence for theories to represent, explain, and/or describe a phenomenon. ● Use models to describe relationships between components, predict outcomes, and/or test ideas to explain a phenomenon. ● Compare and/or evaluate features and limitations of a model. ● Revise models based on additional evidence. 3. Plan and carry out investigations ● Plan an investigation to produce data to serve as evidence including: ○ Select appropriate tools to collect, record, analyze and evaluate data. ○ Identify control, variable, and constants. ○ Identify the control, constants, independent and dependent variables. ○ Explain how the sample size and repetition can affect the results. ○ Explain and follow basic safety rules to conduct an investigation.

	● Make predictions and/or hypotheses about the outcome of an investigation. ● Manipulate variables and collect/produce data. 4. Analyze and interpret data ● Clearly organize and display data. ● Analyze charts and graphs for patterns and trends. ● Use statistical techniques to analyze data. ● Interpret charts and graphs looking for evidence to support claims, make predictions, or draw conclusions. ● Evaluate the impact of new data on a working explanation and/or model of a process or system. 5. Use mathematics and computational thinking ● Use appropriate mathematics, tools and techniques to gather data and information. ● Use and interpret SI units of measurement. 6. Construct explanations ● Articulate a claim/explanation that is based on and consistent with available evidence. ● Identify and describe appropriate and sufficient evidence that support the claim/explanation. ● Describe the reasoning that connects the evidence to the claim/explanation using scientific ideas/principles. ● Revise a claim/explanation given new evidence. ● Recognize and analyze alternative explanations and predictions. 7. Engage in argument from evidence ● Compare,and critique two arguments based on the supporting evidence. ● Construct and/or refine an argument using evidence and reasoning to support a claim. ● Distinguish between scientific fact and speculation or opinion. ● Explain why it is important to examine data objectively and in an unbiased manner. ● Consider the limitations, constraints, and ethical issues of arguments. 8. Obtain, evaluate, and communicate information ● Read, summarize and/or compare scientific text and/or media to describe patterns in and/or evidence about the natural and designed world. ● Evaluate the credibility of scientific information from multiple sources. ● Integrate information within and across multiple formats (text and media) to convey scientific findings. ● Communicate scientific information through a variety of media. <u>What does it mean to be a materials scientist?</u> ● Describe the different types of research and work a materials scientist might do. ● Describe possible careers available to someone with an interest and/or expertise in materials science. <u>How is materials science a part of our everyday life?</u> ● Classify materials as metal, ceramic, glass, polymer, composite

	• Use content-specific adjectives (e.g., dilatant, thixotropic, viscous) to describe properties of various materials • Explain the importance of acquiring, using and disposing of materials in sustainable ways
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. • Materials ID Lab • Oobleck • White Powders • Toaster Project / Sustainability

Unit 2: Crystals

(approximately 4 - 5 weeks)

Essential Questions	Driving Question ● How do different crystal structures affect the properties of materials? Guiding Questions ● How do elements come together? ● In what ways do dislocations and defects within crystalline structure alter the property of materials? ● How does the structure of a material contribute to its properties? ● How do specific unit cells provide materials with different properties?
Enduring Understandings	● The periodic table provides information about microscopic properties and assists in predicting macroscopic properties of various materials. ● Crystalline structure is one of the most important factors in determining a material's properties.
Key Concepts/ Vocabulary	allotrope, alloy, amorphous, body-centered cubic (BCC), cold-working, covalent bonds, crystalline, crystals, defects dendrites, dipole force, dislocation, edge dislocation, elastic deformation, face-centered cubic (FCC), grain, grain boundary, hexagonal close packed (HCP), hydrogen bonding, imperfections, ionic bonds, line defect, London dispersion force, malleable, metallic bonding, nucleation, ore, point defect, polar bonds, plastic deformation, saturation, screw dislocation, seed crystal, simple-cubic (SC), slip plane, solute, solution, solvent, supersaturated, unit cell, unsaturated, vacancy, work-hardening
Learning Targets	● Use the periodic table to interpret and predict various characteristics of elements and compounds (e.g., atomic structure, properties, bonding, intermolecular forces) ● Compare the properties of various types of crystalline and amorphous solids ● Differentiate between Newtonian and non-Newtonian solids ● Provide evidence for how crystal structure and unit cells produce varying properties within a metal ● Identify how different imperfections alter the properties of metals (e.g. point defects, line defects, vacancies, dislocations) ● Describe multiples ways crystals form ● Explain how variations in physical and chemical properties result from allotropic forms of some elements
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Nuts & Bolts Activity ● Crystal Activity (copper in a tube, copper sulfate, silver nitrate + copper, sodium acetate, phenyl salicylate)

	• Unit Cell (building models) • Copper Wire Activity • https://www.teachengineering.org/lessons/view/uoh_matlsci_lesson01

Unit 3: Metals

(approximately 6 - 7 weeks)

Essential Questions	Driving Question ● How does the molecular structure of a metal dictate its function? Guiding Questions ● How do specific chemical and physical properties of metals produce unique applications? ● How are various characteristics of metals tested? ● How are metals manipulated and processed in industry? ● How has our understanding and manufacturing of metals impacted technology and society?
Enduring Understandings	● The variety of properties seen in different types of metals make the material extremely versatile. ● Knowledge of metals (and alloys) played major roles in technology, industry, and global expansion.
Key Concepts/ Vocabulary	alloy, anneal, casting, composition, conductivity, corrosion resistance, deformation, density, ductility, elasticity, eutectic point, extraction, failure point, fatigue, flexural strength, force, fracture point, hardness, heat treating, magnetism, malleability, melting point, plasticity, phase diagrams, precipitation hardening, quenching, reshape, resistivity, shear strength, steel, strain, stress, tempering, tensile strength, thermal expansion, thermal, toughness, torsion, work hardening, Young's modulus
Learning Targets	● Use the periodic table to interpret and predict various characteristics of metals (e.g., atomic structure, properties, bonding, intermolecular forces) ● Discuss extraction, testing, manufacturing, and casting methods for various metals ● Provide evidence for how crystal structure and unit cells produce varying properties within a metal ● Compare the properties of various types of crystalline and amorphous solids ● Explain ways mechanical properties of metals can be altered ● Differentiate among types of alloys ● Describe how heat treatments affect imperfections and defects within a metal ● Construct and interpret a stress-strain curve (i.e tensile strength, elastic limit, plastic deformation, fracture/failure point) ● Use phase diagrams to determine the melting points of individual metals and the eutectic point
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Iron Wire Demonstration ● Thermal Activities ● Heat Treatment (Bobby pin v paper clip)

	• Cost of a Penny • Drawing a Wire • Rolling a Coin • Lead/Tin Solder • Brassing a Penny • Enamel • Stress / Strain (cotton vs nylon and/or slinky) • Lost Wax Casting • Sand Casting • Nitinol

Unit 4: Corrosion

(approximately 2 - 3 weeks)

Essential Questions	Driving Questions ● How does the natural environment affect the process of corrosion in metals? ● How can metal corrosion be reduced and/or prevented?
Enduring Understandings	● Corrosion, a natural process, is the gradual deterioration of materials (usually a metal) by chemical or electrochemical reaction with their environment. ● Many industries focus on reducing corrosion to improve the lifespan and usability of materials.
Key Concepts/ Vocabulary	activity series, anode, cathode, corrosion, crevice, dealloying, electrolyte, environmental cracking corrosion, erosion corrosion, flow-assisted corrosion, fretting corrosion, galvanization, high temperature corrosion, intergranular corrosion, ore, oxidation, parameter, pitting corrosion, reduction, stress corrosion, uniform corrosion
Learning Targets	● Differentiate between the various forms of corrosion and explain their effects on engineering developments ● Identify the characteristics of commonly-encountered corrosive environments such as atmospheric, water and other electrolytes, soil and high temperature environments ● Explain methods and limits to control corrosion within various environments ● Give examples of how and when to use various corrosion control methods, such as material selection, modification of environment, protective coatings, and cathodic and anodic protection ● Discuss economic, environmental, and safety impacts of corrosion
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Etching ● Activity Series ● FRH ● Thermite ● Corrosion Exposure ● Polycoat Activity ● Copper sheet and propane demo ● Corrosion Inhibitor

Unit 5: Chocolate *optional

(approximately 1 - 2 weeks)

Essential Questions	Driving Question ● How does the molecular structure of chocolate dictate its function? Guiding Questions ● How do specific chemical and physical properties of chocolate produce unique applications? ● How are various characteristics of chocolate tested? ● How is chocolate manipulated and processed in industry? ● How has our understanding and manufacturing of chocolate impacted society?
Enduring Understandings	● Edible materials have many of the same properties and are manipulated in many of the same ways as nonedible materials. ● Chocolate has played a role in global expansion, trade, and economics.
Key Concepts/ Vocabulary	bloom, double-boiler, flavor, microstructure, mouth-feel, polymorph, scorching, seizing, snap, solidification, temper, texture
Learning Targets	● Describe the different polymorphs of chocolate and how they relate to physical properties (i.e, strength, melting point, texture) ● Compare the ingredients and properties of white, milk and dark chocolate ● Examine the influence of different microstructures on the strength of the chocolate bar ● Explain how heat treatments affect the microstructure of chocolate ● Explain the process, benefits, and outcomes of different tempering methods ● Describe the relationship between chocolate tempering and final melting temperature/”snap” of chocolate ● Evaluate the quality of chocolate processing for different brands and types based on taste, texture and fracture properties ● Compare the similarities between steel manufacturing and chocolate production ● Describe the origin of chocolate, its historical uses, and current role in today’s society
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Great Chocolate Experiment ● How Strong is Your Chocolate ● Anthony Thomas (field trip) ● Materials Science of Chocolate (G.L.A.M) ● Article readings: The Materials Science of Chocolate, Functional Materials in Food Nanotechnology

	• Chocolate Bar Life Cycle Analysis • Chocolate Formulation Lab

Unit 6: Ceramics/Glass

(approximately 5 - 6 weeks)

Essential Questions	Driving Question ● How does the molecular structure of a ceramics/glass dictate its function? Guiding Questions ● How do specific chemical and physical properties of ceramics/glass produce unique applications? ● How are various characteristics of ceramics/glass tested? ● How are ceramics/glass manipulated and processed in industry? ● How has our understanding and manufacturing of ceramics/glass impacted technology and society?
Enduring Understandings	● Ceramics, one of the oldest forms of human technology, can be seen in microscopic forms in electronics to macroscopic forms in building materials. ● More than half of the engineering marvels of the 20th century that made the greatest impact on the quality of life have relied on the exceptional properties and fabrication methods available with inorganic glass.
Key Concepts/ Vocabulary	abrasive, absorption, amorphous, brittle, conductivity, crystalline, fiber optic, firing, former, index of refraction, insulator, ion-exchange process, opaque, modifier, slip, thermal expansion, translucent, transparent
Learning Targets	● Use the periodic table to interpret and predict various characteristics of ceramics/glass (e.g., atomic structure, properties, bonding, intermolecular forces) ● Describe the historical components of ceramics ● Explain how the molecular structure of ceramics informs the physical and chemical properties of ceramic materials ● Explain why the types of bonds associated with ceramics are not good conductors of electricity ● Describe the differences between fired and unfired ceramics ● Describe the chemical reactions ceramics undergo during processing ● Compare metals and ceramics and the process in which a metal can become a ceramic ● Classify specific ceramics as either crystalline or amorphous ● Describe how various metal oxides affect the color of glass ● Describe the processes used to melt, pour, and anneal glass ● Explain the individually components which determine a specific glasses ability for thermal shock ● Describe the differences related to the various types of glass ● Describe the various applications and uses of glass (e.g, glass blowing, glass bending, fiber optics) ● Demonstrate the concept of oxidation-reduction reactions through the process of Raku

Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Aluminum vs Alumina ● Clay Beams ● Glass Blowing and Bending ● Fiber optics ● Piezoelectric ● Glass as a conductor ● Plaster ● Pouring Glass (stoichiometry) ● Prince Rupert's Drop ● Raku ● Shuttle Tiles

Unit 7: Polymers

(approximately 4 - 5 weeks)

Essential Questions	Driving Question ● How does the molecular structure of a polymer dictate its function? Guiding Questions ● How do specific chemical and physical properties of polymers produce unique applications? ● How are various characteristics of polymers tested? ● How are polymers manipulated and processed in industry? ● How has our understanding and manufacturing of polymers impacted technology and society?
Enduring Understandings	● Polymeric materials have many advantages, such as being lighter, faster, quieter, more durable, and more cost effective than other products, and innovative designs increasingly include the use of high-performance plastics. ● Continued development of new polymeric materials is crucial to fabrication of new innovative products as they are related to a safer and sustainable environment.
Key Concepts/ Vocabulary	addition polymerization, cross-link, glass-transition temperature, HDPE high density polyethylene, LDPE low density polyethylene, natural polymer, PET(E) polyethylene terephthalate, polyurethane, PP polypropylene, PS polystyrene, PVA polyvinyl alcohol, PVC poly vinyl chloride, resin, synthetic polymer, thermoplastics, thermoset
Learning Targets	● Use the periodic table to interpret and predict various characteristics of polymers (e.g., atomic structure, properties, bonding, intermolecular forces) ● Explain the variety of processes used to create polymers with different characteristics ● Describe how cross linking affects a polymer ● Evaluate the similarities and differences of flexible vs rigid polyurethane foams. ● Identify types of plastic based on physical and chemical properties (i.e. density, flexibility, reaction to heat, smoke color) ● Explain how the glass transition temperature alters the behavior of a polymer ● Classify polymers as either synthetic or natural
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Polymer Identification ● Slime vs Gak vs Latex ● Biopolymers ● Happy/Sad Balls

	• Fortune Telling Fish • Thermoplastics • Nylon • Shrinky Dinks • Water Absorbing Polymers • Flexible vs Rigid Polyurethane Foam • Expanding Polystyrene • Resin Clothespins • Packing Peanuts • Eurocasting • Poly Density Tube • Growing Animals

Unit 8: Composites

(approximately 2 - 3 weeks)

Essential Questions	Driving Question ● How do the properties of the materials in a composite contribute to and dictate its overall function? Guiding Questions ● How do specific chemical and physical properties of composites produce unique applications? ● How are composites different from other materials (ie metals, ceramics, glass, and polymers)? ● How are various characteristics of composites tested? ● How are composites manipulated and processed in industry? ● How has our understanding and manufacturing of composites impacted technology and society?
Enduring Understandings	● Properties of composites are defined by their components. ● By choosing an appropriate combination of reinforcement and matrix material, manufacturers can produce properties that exactly fit the requirements for a particular structure for a particular purpose.
Key Concepts/ Vocabulary	binder, composite, concrete, continuous filament, epoxy, fiber, hardener, interface, laminar, matrix, mold, reinforcement, resin, shear, shear strength, strain
Learning Targets	● Use the periodic table to interpret and predict various characteristics of composites (e.g., atomic structure, properties, bonding, intermolecular forces) ● Explain what a composite is and why they are formed ● Describe how a matrix differs between those found in metals and composites ● Describe the properties and complications associated with laminar composites ● Perform quality control tests on different composites
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. ● Diving Board Lab ● Hexcell Lab ● Laminates ● Battle of the Beams

Unit 9: Concrete

(approximately 1 - 2 weeks)

Essential Questions	Driving Question ● How do the properties of the materials in concrete contribute to and dictate its overall function? Guiding Questions ● How do specific chemical and physical properties of concrete produce unique applications? ● How are various characteristics of concrete tested? ● How is concrete manipulated and processed in industry? ● How has our understanding and manufacturing of concrete impacted technology and society?
Enduring Understandings	● Concrete, in the sense of a cement composite consisting of filler, binder, and water, is one of the main building materials of the past, as well as the modern history of mankind. ● Scientists and engineers continue to design processes and determine the materials to make concrete stand up to environmental and structural loads for long-term performance.
Key Concepts/ Vocabulary	aggregate, cantilever, cement, concrete, curing, density, hydration, organic, pH, retardant, silt, slump
Learning Targets	● Demonstrate the ways concrete can be reinforced ● Compare how various components affect the properties of concrete. ● Evaluate the properties and applications of concrete ● Using the knowledge learned regarding concrete, students will develop a barge that will float and hold mass as well as create a Frisbee that flies and not break when hitting the ground ● Perform quality control tests on different concrete mixtures
Instructional Strategies	Potential resources, instructional strategies, and assessments can be found in the Materials Science Curriculum Resources group in Schoology. Example hands-on investigations include: ● Silt Test ● Organic Material Test ● Slump Test ● Workability based on aggregates ● Temperature and pH of Curing Cement ● Density of concrete ● Concrete Pucks and Frisbees ● Concrete Barge

Ohio's Learning Standards for Literacy in Science

Teachers should incorporate Ohio's Learning Standards for Literacy in Science throughout the course.

Reading

By the end of the course, students should be reading, comprehending, and responding to science/technical texts in the appropriate grade level complexity band independently and proficiently.

Key Ideas

1. Cite specific textual evidence to support analysis of science and technical texts.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

1. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to high school texts and topics.
2. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g. force, friction, reaction force, energy).
3. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

1. Translate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph, or table) and translate information expressed visually or mathematically into words.
2. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
3. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Writing

Text Types and Purposes

1. Write arguments focused on discipline-specific content.
    a. Establish a clear and thorough thesis to present an argument.
    b. Introduce precise claim(s), distinguish claims from alternate or opposing claims, and create an organization that establishes clear relationships among the claims, counterclaims, reasons, and evidence.
    c. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
    d. Use words, phrases, and clauses to link major sections of text, create cohesion and clarify the relationships among claims, counterclaims, reasons, and evidence.
    e. Establish and maintain a formal style and objective tone.
    f. Provide a concluding statement or section that follows from and supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
    a. Establish a clear and thorough thesis to present information.
    b. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose, including graphics (e.g. charts, tables), formatting (e.g. headings), and multimedia when useful to aid in comprehension.
    c. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
    d. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
    e. Use precise language and domain-specific vocabulary to inform about or explain the topic.
    f. Establish and maintain a formal style and objective tone.
    g. Provide a concluding statement or section that follows from and supports the information or explanation presented.

Production and Distribution of Writing

1. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
2. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
3. Use technology to produce, publish, and update writing.

Research to Build and Present Knowledge

1. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
2. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
3. Draw evidence from informational texts to support analysis, reflection and research.
4. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Acknowledgements

With sincere thanks

Curriculum Adoption Team Member	Building
Jody Christy	Westerville Central HS
Tyler Rutledge	Westerville South HS
Lyndsey Manzo	Science & Engineering Curriculum Specialist