Materials Science Course of Study

Science Inquiry and Application

During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

- Identify questions and concepts that guide scientific investigations.
- Design and conduct scientific investigations.
- Use technology and mathematics to improve investigations and communications.
- Formulate and revise explanations and models using logic and evidence (critical thinking).
- Recognize and analyze explanations and models.
- Communicate and support a scientific argument.

Reading Standards

Key Ideas and Details:

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure:

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas:

7. Translate quantitative or technical information expressed in words in a

Writing Standards

Text Types and Purposes:

1. Write arguments focused on discipline-specific content.
   a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
   b. 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.
   c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
   d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
   e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical

text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. 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.
9. 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.

Range of Reading and Level of Text Complexity:

10. By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing:

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. 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.

Materials Science Course of Study

	6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. ***Research to Build and Present Knowledge:*** 7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. 8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. 9. Draw evidence from informational texts to support analysis, reflection, and research. ***Range of Writing:*** 10. 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.

Materials Science Course of Study

Topic: ***Solids***

Content Elaborations

This is the introductory unit in which students are exposed to the importance of Materials Science and Technology. They learn that solids are typically separated into four categories. They also study simple chemistry including chemical bonding, the periodic table, and oxidation-reduction. Crystal structures, physical properties, and how metals are claimed from their ores are areas of emphasis. The importance of maintaining a student journal and keeping good records is stressed.
Examples of experiments include:
Material Safety Data Sheets (MSDS), Identification of Materials, and Formation of Crystals

Learning Targets

- Students observe chemical bonding of water with sodium polyacrylate.
- Students evaluate properties of matter that can be used to organize and group similar materials.
- Identify and categorize materials into the four different groups of solids.
- Differentiate between dilatantic and thixotropic substances
- Students investigate growth of crystals.
- Differentiate among unsaturated, saturated, and supersaturated solutions.
- Distinguish between the three types of point defects.
- Explain allotrope and give examples that correlate to laboratory practices.
- Compare how the workability of a metal is affected by the crystal packing.
- Identify and describe four ways that atoms pack in crystals.
- Differentiate among crystals, dendrites, and grains.

Additional Resources

Pacing:
Approx. 9 weeks

Materials Science Course of Study

Content Vocabulary	Academic Vocabulary
• allotrope • alloy • amorphous • BCC • ceramics • composites • crystal • dendrites • dilatant • dislocation • ductility • fatigue • FCC • grain • grain boundary • HCP • interstitial defect • kevlar • line defect • malleable • material • metal • monoclinic • metalloid • nonmetal • non- newtonian • nucleation • point defect • polymers • rhombic • saturated • semi-conductors • slip plane • solid state phase change • solute • solvent	• alter • analogy • analyze • approximate • balanced • calculate • characteristic • cite • classify • coefficient • compare • comprised • consistent • control • correlate • criteria • directly proportional • distinguish • evaluate • exhibit • evidence • expand • explain • hypothesize • incorporate • infer • interact • interpret • inversely proportional • label • manipulate • mean • measure • objective • observe • opaque

Materials Science Course of Study

<table>
<tr>
<td>

- strength
- stress
- substitutional
- supersaturated
- thixotropic
- toughness
- unsaturated
- vacancy
- viscosity

</td>
<td>

- pattern
- perspective
- predict
- procedure
- produce
- propose
- qualitative
- quantitative
- rank
- revise
- significance
- subscript
- transition
- translucent
- transparent
- trend
- yields

</td>
</tr>
<tr>
<td>

Formative Assessments
Journal
Lab

</td>
<td>

Summative Assessments
Lab Completion
Lab Report
Quiz
Test

</td>
</tr>
<tr>
<td>

Resources

1. ASM Materials Education Foundation
2. MAST
3. NATIONAL: ITEA Standards for Technological Literacy (STL)

ATW.12.K-2.A (Advanced)	Discover how things work.
ATW.12.9-12.L (Advanced)	Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

</td>
<td>

Enrichment Strategies
Students will be instructed in the creation of a Material Science Journal, what is included in the journal and how it will be used throughout the term.

Field trips to local business.

</td>
</tr>
<tr>
<td>

Integrations

- **ELA:**
  CCSS.ELA-Literacy.W.11-12.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
  CCSS.ELA-Literacy.W.11-12.7 Conduct short as well as more sustained

</td>
<td>

Intervention Strategies
Many of the concepts covered can be modified for students with language or learning deficiencies. Modifications of vocabulary, math, and lab analyses can be incorporated. In group projects, some students can be given assignments that are not as challenging as others.

</td>
</tr>
</table>

research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. CCSS.ELA-Literacy.RI.11-12.2 Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text. CCSS.ELA-Literacy.RI.11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text. • **Math:** CCSS.Math.Content.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. CCSS.Math.Content.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • **Social Studies:** CCSS.ELA-Literacy.RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. CCSS.ELA-Literacy.RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. CCSS.ELA-Literacy.RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.	

Materials Science Course of Study

Topic: ***Metals***

Content Elaborations

In this unit, the students are introduced to many of the properties and historical developments of metals. Some of the mechanical properties of metals are investigated along with the effects of heat treating. Different types of alloys and alloying techniques are emphasized along with the study of phase diagrams. Techniques for testing metals and manufacturing processes are also studied. Examples of experiments include:
Destructive Testing, Activity Series of Metals, Oxidation/Reduction of Copper, Rolling a Coin, Drawing a Wire, Alloying Copper and Zinc, Cost of a Penny, Making Tin-Lead Solder, Heat Treating Metals, Work Hardening Metals, Making Sparklers, and Corrosion Labs.

Learning Targets

- Students investigate metals and their electrical, magnetic, and physical properties.
- Compare and contrast characteristics of metals and non-metals
- Students begin investigating annealing, miscible and alloying properties as metals change state from solid to liquid, then cooled to solid state again.
- Students make a useful alloy.
- Use phase diagrams to describe observations and data collected
- Students learn about the molecular structure and composition of alloys.
- Students describe through writing and discussion the process and results of experimentations.
- Discuss the significance of the iron wire demo.
- Explain and identify when a solid state phase change occurs.
- Explain the difference among annealing, quenching, and tempering metal.
- Explain what is meant by the terms, cold working and heat treating, and how they affect the properties of metals.
- Distinguish among the forces that can act on metals, such as tension, compression, torsion, and shear stress.
- Choose a heat treating process that would be most effective for a given application.
- Explain what a eutectic mixture, a solidus line, and a liquidus line are in a sample of Pb-Sn alloys.
- Interpret the Activity Series and be able to use it to predict the behavior of metals.
- List the factors affecting the rate of corrosion.

Materials Science Course of Study

Additional Resources

Pacing:
Approx. 9 weeks

Content Vocabulary

- acitivity series
- alloy
- annealing
- anode
- brittle
- cathode
- cathodic protection
- chemical property
- cold working
- compression
- corrosion
- dislocations
- ductile
- elasticity
- eutectic
- FCC
- failure
- fatigue
- fuel
- grain
- grain boundary
- hardness
- hardening
- heat capacity
- heat treating
- HCP
- malleable
- metallic bonding
- oxidation
- oxide
- oxidizer
- physical property
- plasticity

Academic Vocabulary

- alter
- analogy
- analyze
- approximate
- balanced
- calculate
- characteristic
- cite
- classify
- coefficient
- compare
- comprised
- consistent
- control
- correlate
- criteria
- directly proportional
- distinguish
- evaluate
- exhibit
- evidence
- expand
- explain
- hypothesize
- incorporate
- infer
- interact
- interpret
- inversely proportional
- label
- manipulate
- mean
- measure

Materials Science Course of Study

• quench • reduction • shear • solidus line • steel • strength • strain • stress • temper • tension • torsion • toughness • unit cell	• objective • observe • opaque • pattern • perspective • predict • procedure • produce • propose • qualitative • quantitative • rank • revise • significance • subscript • transition • translucent • transparent • trend • yields
Formative Assessments Journal Lab	**Summative Assessments** Lab Completion Lab Report Quiz Test
Resources 1. ASM Materials Education Foundation 2. MAST 3. NATIONAL: ITEA Standards for Technological Literacy (STL) ATW.12.K-2.A (Advanced) Discover how things work. ATW.12.9-12.L (Advanced) Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.	**Enrichment Strategies** Students will be instructed in the creation of a Material Science Journal, what is included in the journal and how it will be used throughout the term. Field trips to local business.
Integrations • **ELA:** CCSS.ELA-Literacy.W.11-12.2e Establish and maintain a formal style and	**Intervention Strategies** Many of the concepts covered can be modified for students with language or

objective tone while attending to the norms and conventions of the discipline in which they are writing. CCSS.ELA-Literacy.W.11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. CCSS.ELA-Literacy.RI.11-12.2 Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text. CCSS.ELA-Literacy.RI.11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text. • **Math:** CCSS.Math.Content.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. CCSS.Math.Content.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • **Social Studies:** CCSS.ELA-Literacy.RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. CCSS.ELA-Literacy.RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. CCSS.ELA-Literacy.RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.	learning deficiencies. Modifications of vocabulary, math, and lab analyses can be incorporated. In group projects, some students can be given assignments that are not as challenging as others.

Materials Science Course of Study

Topic: ***Ceramics/Glass***

Content Elaborations

In the ceramics unit, the students learn that most ceramics are crystalline solids that have properties related to the ionic or covalent bonds that hold them together. Students also learn that glass has different properties than most ceramics due to the amorphous structure of glass. A variety of processes used to manufacture ceramics are studied including a stained glass project and a Raku pottery project. Examples of experiments include:
Forming, Firing, and Glazing Clay, Thermal Shock, Glass Bending and Blowing, Glass Batching and Melting, Lantern Mantles, Light bulbs, and Dragon Dribble/Dragon Tears.

Learning Targets

- Students can explain how a light bulb works.
- Apply mole concept in determining molar masses.
- Use the mole concept in problem solving use equations.
- Students investigate how various metal oxides, melted with glass, produce glasses of varying color.
- Students melt, pour, air quench and anneal glass.
- Practice safe procedures for glass making.
- Students investigate properties of thermal conductivity, strength, and coefficient of expansion.
- Students investigate the presence of Silicon Dioxide and Anhydrous Borax when mixed in different proportions to make a sample of glass.
- Students form a low temperature glass and work with glass bending.
- Students will explore the applications of making a fiber optic and scoring/breaking glass.
- Investigate oxidation-reduction process utilizing Raku.

Additional Resources

Pacing:
Approx. 9 weeks

Materials Science Course of Study

Content Vocabulary	Academic Vocabulary
• amorphous • anneal • brittle • ceramic • component • conductivity • covalent bond • crystalline • crystal structure • elasticity • fiber optic • firing • fracture • glass • grain • grain boundary • hardness • heat capacity • imperfection • index of refraction • insulator • ionic bond • lattice • non crystalline • opaque • plasticity • reflection • refraction • resistance • semi-conductor • slip • strain • stress • super conductor • super cooled • tensile strength	• alter • analogy • analyze • approximate • balanced • calculate • characteristic • cite • classify • coefficient • compare • comprised • consistent • control • correlate • criteria • directly proportional • distinguish • evaluate • exhibit • evidence • expand • explain • hypothesize • incorporate • infer • interact • interpret • inversely proportional • label • manipulate • mean • measure • objective • observe • opaque

• thermal expansion • thermal expansion coefficient • toughness • translucent • transparent • unit cell	• pattern • perspective • predict • procedure • produce • propose • qualitative • quantitative • rank • revise • significance • subscript • transition • translucent • transparent • trend • yields
Formative Assessments Journal Lab	**Summative Assessments** Lab Completion Lab Report Quiz Test
Resources 1. ASM Materials Education Foundation 2. MAST 3. NATIONAL: ITEA Standards for Technological Literacy (STL) ATW.12.K-2.A (Advanced) Discover how things work. ATW.12.9-12.L (Advanced) Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.	**Enrichment Strategies** Students will be instructed in the creation of a Material Science Journal, what is included in the journal and how it will be used throughout the term. Field trips to local business.
Integrations • **ELA**: CCSS.ELA-Literacy.W.11-12.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. CCSS.ELA-Literacy.W.11-12.7 Conduct short as well as more sustained	**Intervention Strategies** Many of the concepts covered can be modified for students with language or learning deficiencies. Modifications of vocabulary, math, and lab analyses can be incorporated. In group projects, some students can be given assignments that are not as challenging as others.

research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. CCSS.ELA-Literacy.RI.11-12.2 Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text. CCSS.ELA-Literacy.RI.11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text. • **Math**: CCSS.Math.Content.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. CCSS.Math.Content.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • **Social Studies**: CCSS.ELA-Literacy.RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. CCSS.ELA-Literacy.RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. CCSS.ELA-Literacy.RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.	

Materials Science Course of Study

Topic: ***Polymers***

Content Elaborations

What synthetic polymers are and the chemistry involved with them is introduced in this unit. The classification of polymers is included along with how they are altered chemically or with additives. Concerns with recycling are emphasized along with the chemical changes brought about by cross- linking. Historical developments and manufacturing processes are also included.
Examples of experiments include:
Cross-Linking a Polymer, Slime, Polymer Identification, Making Nylon 6-10, Latex Rubber Ball, Polyurethane Resin Cast, and Bio plastics

Learning Targets

- Students learn about the construction of polymers by combining Polyvinyl Alcohol and Sodium Borate
- Describe how cross linking affects a polymer using models, drawing, and discussion.
- Students learn how two-part polyurethane foam solutions are mixed and how foam can be used for molding and insulation.
- Evaluate the similarities and differences of foams.
- Students demonstrate the ability to follow directions and learn how use rubber molds to cast products made from epoxy resin.
- Students learn to identify and sort several different plastics based on observation and categorization of thermoforming or thermosetting properties.
- Identify a plastic using simple test procedures of odor and flammability
- Students design and devise a bio plastic sample.
- Students can classify various polymers as thermosets, thermoplastics, and elastomers.

Additional Resources

Pacing:
Approx. 8 weeks

Content Vocabulary	**Academic Vocabulary**
• HDPE high density polyethylene	• alter
• LDPE low density polyethylene	• analogy
• PET polyethylene terephthalate	• analyze
• PP polyproplyne	• approximate
• PS polystyrene	• balanced

Materials Science Course of Study

- PVA polyvinyl alcohol
- PVC poly vinyl chloride
- addition polymerization
- amorphous
- branched polymer
- cellulose
- condensation polymer
- copolymer
- cross linking
- crystalline
- dimer
- elastomer
- free radical
- homopolymer
- initiation
- linear
- macromolecule
- material
- monomer
- nylon
- polyethylene
- polymer
- polymerization
- polystyrene
- propogation
- thermoplastic
- thermoset
- viscosity
- vulcanization

- calculate
- characteristic
- cite
- classify
- coefficient
- compare
- comprised
- consistent
- control
- correlate
- criteria
- directly proportional
- distinguish
- evaluate
- exhibit
- evidence
- expand
- explain
- hypothesize
- incorporate
- infer
- interact
- interpret
- inversely proportional
- label
- manipulate
- mean
- measure
- objective
- observe
- opaque
- pattern
- perspective
- predict
- procedure
- produce
- propose

	• qualitative • quantitative • rank • revise • significance • subscript • transition • translucent • transparent • trend • yields
Formative Assessments Journal Lab	**Summative Assessments** Lab Completion Lab Report Quiz Test
Resources 1. ASM Materials Education Foundation 2. MAST 3. NATIONAL: ITEA Standards for Technological Literacy (STL) ATW.12.K-2.A (Advanced) Discover how things work. ATW.12.9-12.L (Advanced) Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.	**Enrichment Strategies** Students will be instructed in the creation of a Material Science Journal, what is included in the journal and how it will be used throughout the term. Field trips to local business.
Integrations • **ELA**: CCSS.ELA-Literacy.W.11-12.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. CCSS.ELA-Literacy.W.11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. CCSS.ELA-Literacy.RI.11-12.2 Determine two or more central ideas of a text and analyze their development over the course of the text, including	**Intervention Strategies** Many of the concepts covered can be modified for students with language or learning deficiencies. Modifications of vocabulary, math, and lab analyses can be incorporated. In group projects, some students can be given assignments that are not as challenging as others.

how they interact and build on one another to provide a complex analysis; provide an objective summary of the text. CCSS.ELA-Literacy.RI.11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text. • **Math**: CCSS.Math.Content.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. CCSS.Math.Content.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • **Social Studies**: CCSS.ELA-Literacy.RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. CCSS.ELA-Literacy.RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. CCSS.ELA-Literacy.RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.	

Materials Science Course of Study

Topic: ***Composites***

Content Elaborations

Types of composites are described and categorized. Strength-to-weight ratios are emphasized including strength measuring, testing, and altering. Wood and concrete are two traditional composites used to introduce many concepts. An emphasis is placed on fiber reinforced composites including those containing graphite and Kevlar fibers.
Examples of experiments include: Plaster of Paris, Cement Beams, Cement Hockey Pucks, and Ice Pucks.

Learning Targets

- Students can describe a composite material, investigate the properties of different concrete mixtures and determine the role that different components contribute to the final concrete properties.
- Identify several composite materials used commonly in our lives.
- Students will actively participate in making concrete materials.
- Students perform quality control tests to measure the strength of different concrete mixtures.

Additional Resources

Pacing:
Approx. 1 week

Content Vocabulary
- composite
- concrete
- crack
- cure
- fiber
- material
- resin
- strength
- toughness

Academic Vocabulary
- alter
- analogy
- analyze
- approximate
- balanced
- calculate
- characteristic
- cite
- classify
- coefficient
- compare
- comprised
- consistent
- control

	• correlate • criteria • directly proportional • distinguish • evaluate • exhibit • evidence • expand • explain • hypothesize • incorporate • infer • interact • interpret • inversely proportional • label • manipulate • mean • measure • objective • observe • opaque • pattern • perspective • predict • procedure • produce • propose • qualitative • quantitative • rank • revise • significance • subscript • transition • translucent • transparent

Materials Science Course of Study

	• trend • yields
Formative Assessments Journal Lab	**Summative Assessments** Lab Completion Lab Report Quiz Test
Resources 1. ASM Materials Education Foundation 2. MAST 3. NATIONAL: ITEA Standards for Technological Literacy (STL) ATW.12.K-2.A (Advanced) Discover how things work. ATW.12.9-12.L (Advanced) Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.	**Enrichment Strategies** Students will be instructed in the creation of a Material Science Journal, what is included in the journal and how it will be used throughout the term. Field trips to local business.
Integrations • **ELA**: CCSS.ELA-Literacy.W.11-12.2e Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. CCSS.ELA-Literacy.W.11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. CCSS.ELA-Literacy.RI.11-12.2 Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text. CCSS.ELA-Literacy.RI.11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text. • **Math**: CCSS.Math.Content.HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and	**Intervention Strategies** Many of the concepts covered can be modified for students with language or learning deficiencies. Modifications of vocabulary, math, and lab analyses can be incorporated. In group projects, some students can be given assignments that are not as challenging as others.

interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. CCSS.Math.Content.HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. • **Social Studies**: CCSS.ELA-Literacy.RH.11-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. CCSS.ELA-Literacy.RH.11-12.2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. CCSS.ELA-Literacy.RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.	