ARD Expanded Lesson Review

The following is a compiled listing of the concepts, performance objectives, standards alignment, and essential questions by lesson.

Lesson 1.1 Agricultural Advances

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Research and development of new ideas and innovations are used to solve problems, provide goods, and increase productivity in agriculture.	• Identify significant advances in agriculture and determine the need that drove the advance. (Activity 1.1.1) • Determine current needs and problems in agriculture. (Activity 1.1.1)
2. Documentation of plans and processes is used by researchers in the development of new ideas and products.	• Organize notebooks to record coursework and laboratory projects. (Activity 1.1.2)
3. Solving complex, real-world problems includes defining the problem, proposing a solution, developing a protocol, collecting and analyzing data, and communicating results.	• Identify the steps of the problem-solving process in a historical product as well as their specialization project. (Activity 1.1.3)

National AFNR Common Career Technical Core Standards Alignment

Agriculture, Food, and Natural Resources Career Cluster
1. Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster.
• AG 1.2: Describe current issues impacting AFNR activities.
• AG 1.6: Recognize the historical, social, cultural and potential applications of biotechnology on AFNR activities.
• AG.1.7: Demonstrate the application of biotechnology to AFNR activities.
Agribusiness Systems Career Pathway (AG-BIZ)
2. Use record keeping to accomplish AFNR business objectives, manage budgets and comply with laws and regulations.
• AG-BIZ 2.2: Prepare and maintain all files as needed for effective record keeping practices.

Next Generation Science Standards Alignment

Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
ETS1.A: Defining and Delimiting Engineering Problems	• 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.

Understandings about the Nature of Science	
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. • New technologies advance scientific knowledge. • Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Science is a Human Endeavor	• Scientific knowledge is a result of human endeavor, imagination, and creativity. • Individuals and teams from many nations and cultures have contributed to science and to advances in engineering. • Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings. • Technological advances have influenced the progress of science and science has influenced advances in technology.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Integration of Knowledge and Ideas	• **RST.11-12.7 –** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Research to Build and Present Knowledge	• **WHST.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. • **WHST.11-12.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How have advances in agricultural and related technologies influenced society today?
2. What historical inventions were significant to developing societies and agriculture?
3. What is the problem-solving process?
4. Why is a process used in research and development?

Lesson 1.2 Project Management

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Efficient project management is based on an awareness of personal strengths.	• Complete the Gallup StrengthsFinder survey and identify their talents. (Activity 1.2.1) • Develop a personal growth plan to strengthen their talents and determine how their talents will drive them in the course and future academic options. (Project 1.2.2)
2. Project management requires planning, scheduling, self-motivation, and prioritization skills.	• Perform a decision-making exercise. (Activity 1.2.3)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
1. Act as a responsible and contributing citizen and employee.
• CRP.01.02: Evaluate and consider the near-term and long-term impacts of personal and professional decisions on employers and community before taking action.
3. Attend to personal health and financial well-being.
• CRP.03.01: Design and implement a personal wellness plan.
• CRP.03.02: Design and implement a personal financial management plan.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
• CRP.04.03: Model active listening strategies when interacting with others in formal and informal settings.
9. Model integrity, ethical leadership and effective management.
• CRP.09.01: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).
• CRP.09.02: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).
10. Plan education and career path aligned to personal goals.
• CRP.10.02: Examine career advancement requirements (e.g., education, certification, training, etc.) and create goals for continuous growth in a chosen career.
• CRP.10.04: Identify, prepare, update and improve the tools and skills necessary to pursue a chosen career path.
Agriculture, Food, and Natural Resources Career Cluster
5. Describe career opportunities and means to achieve those opportunities in each of the AFNR career pathways.
• AG.5.2: Match personal interest and aptitudes to selected careers.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
Research to Build and Present Knowledge	• **WHST.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.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How does knowledge of personal strengths affect how you use the problem-solving process?
2. How do personal characteristics affect project management?
3. Why should you focus on building strengths instead of correcting weaknesses?
4. How does diversity contribute to the success of a group?
5. Why is project management critical in research?

6. How does prioritization improve project management?
7. How is a priority identified?
8. What criteria are used to determine priorities?

Lesson 2.1 Defining the Problem

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Agricultural researchers are faced with a multitude of local, national, and global issues.	• Research agricultural problems at local, regional, national, and global levels and select three to five subtopics to refine. (Problem 2.1.1)
2. Brainstorming is a technique used to define and refine topics and problem statements.	• Utilize brainstorming techniques to develop focused topics for potential research ideas. (Activity 2.1.2)
3. Practical considerations, such as time, motivation, materials, and support, are constraints when selecting a problem to solve.	• Identify and discuss constraints associated with their potential research project. (Activity 2.1.3)
4. Writing a well-defined and accurate problem statement guides research and helps determine if the solution has solved the problem.	• Write a problem statement for their research project. (Project 2.1.4)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
2. Apply appropriate academic and technical skills.
• CRP.02.01: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
6. Demonstrate creativity and innovation.
• CRP.06.01: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.
7. Employ valid and reliable research strategies.
• CRP.07.01: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.
• CRP.07.02: Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community.

Next Generation Science Standards Alignment

Science and Engineering Practices	
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. • Ask questions that arise from careful observation of phenomena, or unexpected results ▪ to clarify and/or seek additional information. ▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. • Evaluate a question to determine if it is testable and relevant.

	• Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.
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 the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. • Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. • Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Understandings about the Nature of Science	
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. • Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Scientists often use hypotheses to develop and test theories and explanations.
Science is a Way of Knowing	• 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.
Science is a Human Endeavor	• Scientific knowledge is a result of human endeavor, imagination, and creativity. • Individuals and teams from many nations and cultures have contributed to science and to advances in engineering. • Science and engineering are influenced by society and society is influenced by science and engineering.
Science Addresses Questions About the Natural and Material World.	• Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. • **RST.11-12.2 –** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
Craft and Structure	• **RST.11-12.4 –** 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.
Integration of Knowledge and Ideas	• **RST.11-12.9 –** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Text Types and Purposes	**WHST.11-12.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • **WHST.11-12.2.A –** Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge	• **WHST.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. • **WHST.11-12.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. • **WHST.11-12.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. Why do problems exist?
2. How are problems defined?
3. How is brainstorming used to identify and solve a problem?
4. How are constraints mitigated in research?
5. Why is a formal problem statement written in research?
6. How do annotated references contribute to research?
7. How are proposals evaluated for usefulness?
8. What is the difference between a problem statement and a literature review?
9. How do researchers decide on a direction for research?
10. Why must demand or marketing be considered when evaluating research direction?

Lesson 2.2 Proposing Solutions

Concepts	**Performance Objectives**
Students will know and understand	*Students will learn concepts by doing*
1. Finding solutions to a problem are impacted by social, legal, financial, and environmental considerations.	• Consider impacts of research and development surrounding a specific issue. (Activity 2.2.1) • Develop a list of potential solutions and use a decision matrix to determine the best solution to research. (Activity 2.2.2)

2. A feasibility study may be used to determine the viability of new ideas and innovations. 3. A proposed solution must be written to be testable or solvable. 4. Partnering with professionals in the field can validate and guide research when solving a problem.	• Complete a feasibility study and evaluate a proposed research project. (Project 2.2.3) • Write a solution proposal to submit for approval. (Project 2.2.4) • Identify potential professional resources and develop a professional network. (Activity 2.2.5)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
1. Act as a responsible and contributing citizen and employee.
• CRP.01.01: Model personal responsibility in the workplace and community.
• CRP.01.02: Evaluate and consider the near-term and long-term impacts of personal and professional decisions on employers and community before taking action.
2. Apply appropriate academic and technical skills.
• CRP.02.01: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
• CRP.02.02: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
5. Consider the environmental, social and economic impacts of decisions.
• CRP.05.01: Assess, identify and synthesize the information and resources needed to make decisions that positively impact the workplace and community.
• CRP.05.02: Make, defend and evaluate decisions at work and in the community using information about the potential environmental, social and economic impacts.
6. Demonstrate creativity and innovation.
• CRP.06.01: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.
• CRP.06.02: Assess a variety of workplace and community situations to identify ways to add value and improve the efficiency of processes and procedures.
• CRP.06.03: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.
7. Employ valid and reliable research strategies.
• CRP.07.01: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
• CRP.08.01: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.
• CRP.08.02: Investigate, prioritize and select solutions to solve problems in the workplace and community.
• CRP.08.03: Establish plans to solve workplace and community problems and execute them with resiliency.
9. Model integrity, ethical leadership and effective management.
• CRP.09.01: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).
• CRP.09.02: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).
11. Use technology to enhance productivity.
• CRP.11.01: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

Agriculture, Food, and Natural Resources Career Cluster
1. Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster.
• AG 1.1: Explain how regulations and major laws impact management of AFNR activities.
• AG 1.5: Explain the impact of sustainability on ARNR activities and practices.
3. Examine and summarize importance of health, safety, and environmental management systems in AFNR organizations.
• AG 3.1: Examine health risks associated with a particular skill to better form personnel safety guidelines.
• AG 3.3: Identify hazards and acquire first aid skills to promote environmental safety.
• AG 3.4: Examine required regulations to maintain/improve safety, health and environmental management systems and sustainable business practices.
4. Demonstrate stewardship of natural resources in AFNR activities.
• AG.4.2: Explain the environmental considerations of decision making in AFNR management.

Next Generation Science Standards Alignment

Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
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. • 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.
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. • 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.
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.

Science and Engineering Practices	
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. • Ask questions that arise from careful observation of phenomena, or unexpected results ▪ to clarify and/or seek additional information. • Evaluate a question to determine if it is testable and relevant. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. • Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences 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 world(s). • Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

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 an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. • Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. • Select appropriate tools to collect, record, analyze, and evaluate data. • Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated.
Constructing Explanations and Designing Solutions	Constructing explanations and designing solutions in 9–12 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. • 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.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Crosscutting Concepts	
Understandings about the Nature of Science	
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. • New technologies advance scientific knowledge. • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. • The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use. • Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Scientific Knowledge is Based on Empirical Evidence	• Science knowledge is based on empirical evidence. • Science disciplines share common rules of evidence used to evaluate explanations about natural systems. • Science includes the process of coordinating patterns of evidence with current theory. • Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
Science is a Way of Knowing	• 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. • Science is a unique way of knowing and there are other ways of knowing. • Science distinguishes itself from other ways of knowing through use of empirical standards, logical arguments, and skeptical review. • Science knowledge has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time.
Science is a Human Endeavor	• Scientific knowledge is a result of human endeavor, imagination, and creativity. • Technological advances have influenced the progress of science and science has influenced advances in technology. • Science and engineering are influenced by society and society is influenced by science and engineering.
Science Addresses Questions About the Natural and Material World.	• Not all questions can be answered by science. • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. • 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. • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Text Types and Purposes	**WHST.11-12.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • **WHST.11-12.2.A –** Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • **WHST.11-12.2.B –** Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • **WHST.11-12.2.C –** Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • **WHST.11-12.2.D –** Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • **WHST.11-12.2.E –** Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.5 –** 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. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge	• **WHST.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. • **WHST.11-12.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. • **WHST.11-12.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How do researchers narrow their focus to identify testable and solvable problems and solutions?
2. How do social, legal, financial, and environmental considerations affect a problem and solution?
3. How is the feasibility of a solution evaluated?
4. How does feedback help researchers develop and test solutions?
5. What are the benefits of professional collaboration?
6. How are professional networks developed?
7. How do professional networks contribute to career success?

Lesson 3.1 Planning Ahead

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Carefully planned step-by-step instructions guide the problem solving process.	• Practice writing and following step-by-step instructions for simple daily activities. (Activity 3.1.1) • Write a draft of step-by-step instructions for the research and development project. (Activity 3.1.1)
2. Project scope is dependent upon the resources available.	• Research and identify uses, safety practices, and limitations for proposed tools, materials, and equipment. (Activity 3.1.2)
3. Researchers use a literature review to curate a collection of information on a topic.	• Summarize research and information pertinent to the research project into a literature review. (Project 3.1.3)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
2. Apply appropriate academic and technical skills.
• CRP.02.01: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
• CRP.02.02: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
6. Demonstrate creativity and innovation.
• CRP.06.01: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.
• CRP.06.03: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.
7. Employ valid and reliable research strategies.
• CRP.07.01: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.
• CRP.07.02: Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
• CRP.08.02: Investigate, prioritize and select solutions to solve problems in the workplace and community.
• CRP.08.03: Establish plans to solve workplace and community problems and execute them with resiliency.
9. Model integrity, ethical leadership and effective management.
• CRP.09.01: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).
• CRP.09.02: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).
11. Use technology to enhance productivity.
• CRP.11.01: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

Agriculture, Food, and Natural Resources Career Cluster
3. Examine and summarize importance of health, safety, and environmental management systems in AFNR organizations.
• AG 3.1: Examine health risks associated with a particular skill to better form personnel safety guidelines.
• AG 3.5: Enact procedures that demonstrate the importance of safety, health, and environmental responsibilities in the workplace.
• AG 3.6: Demonstrate methods to correct common hazards.
• AG.3.7: Demonstrate application of personal and group health and safety practices.

Next Generation Science Standards Alignment

Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
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. • 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.
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. • 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.
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.

Science and Engineering Practices	
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. • Ask questions that arise from careful observation of phenomena, or unexpected results ▪ to clarify and/or seek additional information. ▪ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. ▪ to determine relationships, including quantitative relationships, between independent and dependent variables. ▪ to clarify and refine a model, an explanation, or an engineering problem. • Evaluate a question to determine if it is testable and relevant. • Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. • Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. • Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences 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 world(s). • Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. • Design a test of a model to ascertain its reliability. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

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 an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. • 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. • Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.

Understandings about the Nature of Science	
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. • New technologies advance scientific knowledge. • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. • Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. • Scientists often use hypotheses to develop and test theories and explanations.
Science is a Human Endeavor	• Scientific knowledge is a result of human endeavor, imagination, and creativity.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. • **RST.11-12.2 –** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
Craft and Structure	• **RST.11-12.6 –** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Integration of Knowledge and Ideas	• **RST.11-12.7 –** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. • **RST.11-12.8 –** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. • **RST.11-12.9 –** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Text Types and Purposes	**WHST.11-12.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • **WHST.11-12.2.A –** Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • **WHST.11-12.2.B –** Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • **WHST.11-12.2.C –** Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • **WHST.11-12.2.D –** Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • **WHST.11-12.2.E –** Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.5 –** 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. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge	• **WHST.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. • **WHST.11-12.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. • **WHST.11-12.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. Why is planning critical for research and development?
2. What processes are necessary to plan research and development processes?
3. How does resource availability affect research and development?
4. How is the cost of a research project or product development determined?
5. Why should research and development be assigned a financial value?
6. How are financial measures predicted for the future of a research project or product development?
7. Why are detailed instructions or procedures critical in research?
8. How are step-by-step procedures written?
9. How are opportunity costs calculated?
10. What is the difference between a literature review and a problem statement?

Lesson 3.2 Data Collection

Concepts	Performance Objectives
Students will know and understand 1. The problem dictates the type of data needed for valid results. 2. Selection of appropriate data collection instruments is necessary for valid data. 3. Standards are necessary when collecting data. 4. An ongoing evaluation process monitors the validity of the solution.	*Students will learn concepts by doing* • Compare commonly used data collection instruments. (Activity 3.2.1) • Develop protocol for data collection in a research and development project. (Project 3.2.2) • Identify standards to use for collected data from a research and development project. (Project 3.2.2) • Plan how to evaluate a research and development project. (Project 3.2.3) • Conduct research according to protocols and plans developed. (Project 3.2.4)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
2. Apply appropriate academic and technical skills.
• CRP.02.01: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
• CRP.02.02: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
6. Demonstrate creativity and innovation.
• CRP.06.01: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.
• CRP.06.03: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.
7. Employ valid and reliable research strategies.
• CRP.07.01: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
• CRP.08.01: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.
• CRP.08.02: Investigate, prioritize and select solutions to solve problems in the workplace and community.
• CRP.08.03: Establish plans to solve workplace and community problems and execute them with resiliency.
9. Model integrity, ethical leadership and effective management.
• CRP.09.01: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).
• CRP.09.02: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).
11. Use technology to enhance productivity.
• CRP.11.01: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

12. Work productively in teams while using cultural/global competence.
• CRP.12.01: Contribute to team-oriented projects and builds consensus to accomplish results using cultural global competence in the workplace and community.
• CRP.12.02: Create and implement strategies to engage team members to work toward team and organizational goals in a variety of workplace and community situations (e.g., meetings, presentations, etc.).
Agriculture, Food, and Natural Resources Career Cluster
3. Examine and summarize importance of health, safety, and environmental management systems in AFNR organizations.
• AG.3.7: Demonstrate application of personal and group health and safety practices.

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
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. • 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.
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. • 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.
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.

Science and Engineering Practices	
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. • Ask questions that arise from careful observation of phenomena, or unexpected results ▪ to clarify and/or seek additional information. ▪ to determine relationships, including quantitative relationships, between independent and dependent variables. ▪ to clarify and refine a model, an explanation, or an engineering problem. • Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.
Developing and Using Models	Modeling in 9–12 builds on K–8 experiences 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 world(s). • Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. • Design a test of a model to ascertain its reliability. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
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 an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.

	• 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. • Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts. • Select appropriate tools to collect, record, analyze, and evaluate data. • Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. • Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.

Crosscutting Concepts	
Cause and Effect: Mechanism and Prediction	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
	• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects.
Systems and System Models	A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
	• Systems can be designed to do specific tasks. • 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.

Understandings about the Nature of Science	
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. • New technologies advance scientific knowledge. • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. • The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use. • Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Scientific Knowledge is Open to Revision in Light of New Evidence	• Scientific explanations can be probabilistic. • Most scientific knowledge is quite durable but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. • Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	• Theories and laws provide explanations in science, but theories do not with time become laws or facts. • A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Scientists often use hypotheses to develop and test theories and explanations.
Science is a Way of Knowing	• 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. • Science is a unique way of knowing and there are other ways of knowing. • Science distinguishes itself from other ways of knowing through use of empirical standards, logical arguments, and skeptical review. • Science knowledge has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time.
Science is a Human Endeavor	• Scientific knowledge is a result of human endeavor, imagination, and creativity. • Individuals and teams from many nations and cultures have contributed to science and to advances in engineering. • Scientists' backgrounds, theoretical commitments, and fields of endeavor influence the nature of their findings.

	• Technological advances have influenced the progress of science and science has influenced advances in technology. • Science and engineering are influenced by society and society is influenced by science and engineering.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. • **RST.11-12.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Integration of Knowledge and Ideas	• **RST.11-12.7 –** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. • **RST.11-12.8 –** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.5 –** 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. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge	• **WHST.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. • **WHST.11-12.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. • **WHST.11-12.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How do data collection instruments aid researchers?
2. How do researchers choose data collection instruments?
3. What are standards for data collection?
4. Why are standards necessary for data?
5. How is research evaluated?
6. How do researchers know if they achieve their goals?

Lesson 4.1 Results and Conclusions

Concepts	Performance Objectives
Students will know and understand 1. Researchers use graphs and charts to interpret, analyze, and organize data. 2. Researchers collect and analyze data to solve a problem. 3. Conclusions of research are derived from data. 4. Project reflection encourages expansion and continuation.	*Students will learn concepts by doing* • Complete an online statistics tutorial. (Activity 4.1.1) • Apply statistical analysis to sample data. (Activity 4.1.2) • Organize, interpret, and analyze data collected through the research and development process. (Project 4.1.3) • Formulate a conclusion statement for the research and development process. (Project 4.1.4) • Write a reflection on the completed research project. (Project 4.1.5)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
2. Apply appropriate academic and technical skills.
• CRP.02.01: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.
• CRP.02.02: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
6. Demonstrate creativity and innovation.
• CRP.06.01: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.
7. Employ valid and reliable research strategies.
• CRP.07.01: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
• CRP.08.01: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.
• CRP.08.02: Investigate, prioritize and select solutions to solve problems in the workplace and community.
• CRP.08.03: Establish plans to solve workplace and community problems and execute them with resiliency.
9. Model integrity, ethical leadership and effective management.
• CRP.09.03: Demonstrate behaviors that contribute to a positive morale and culture in the workplace and community (e.g., positively influencing others, effectively communicating, etc.).

Next Generation Science Standards Alignment

Disciplinary Core Ideas	
Engineering, Technology, and the Application of Science	
ETS1: Engineering Design	
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.

	• 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.
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. • 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.
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.

Science and Engineering Practices	
Analyzing and Interpreting Data	Analyzing data in 9–12 builds on K–8 experiences 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. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. • Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. • Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. • Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
Using Mathematics and Computational Thinking	Mathematical and computational thinking in 9-12 builds on K-8 and experiences 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, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. • Apply techniques of algebra and functions to represent and solve scientific and engineering problems. • Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model “makes sense” by comparing the outcomes with what is known about the real world. • Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3, acre-feet, etc.).
Constructing Explanations and Designing Solutions	Constructing explanations and designing solutions in 9–12 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. • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. • Construct and revise 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. • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. • Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. • 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.
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 the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

	• Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Crosscutting Concepts	
Patterns	Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.
	• 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. • Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.
Cause and Effect: Mechanism and Prediction	Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.
	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects.

Understandings about the Nature of Science	
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. • New technologies advance scientific knowledge. • Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. • The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use. • Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Scientific Knowledge is Based on Empirical Evidence	• Science knowledge is based on empirical evidence. • Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
Scientific Knowledge is Open to Revision in Light of New Evidence	• Scientific explanations can be probabilistic.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. • Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. • Scientists often use hypotheses to develop and test theories and explanations.
Science is a Human Endeavor	• Scientific knowledge is a result of human endeavor, imagination, and creativity. • Science and engineering are influenced by society and society is influenced by science and engineering.

Common Core State Standards for High School Mathematics

Modeling standards are indicated by the star symbol (*) throughout other conceptual categories.

CCSS: Conceptual Category – Number and Quantity	
Quantities	• *Reason quantitatively and use units to solve problems.

CCSS: Conceptual Category – Statistics and Probability	
Interpreting Categorical and Quantitative Data	• *Summarize, represent, and interpret data on a single count or measurement variable. • *Interpret linear models.
Making Inferences and Justifying Conclusions	• *Understand and evaluate random processes underlying statistical experiments. • *Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. • **RST.11-12.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Craft and Structure	• **.RST.11-12.4 –** 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.
Integration of Knowledge and Ideas	• **RST.11-12.8 –** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Text Types and Purposes	**WHST.11-12.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • **WHST.11-12.2.D –** Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • **WHST.11-12.2.E –** Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.5 –** 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. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge	• **WHST.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.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How is data organized?
2. How is data analyzed?

3. Why is data necessary to make conclusions?
4. How are graphs and charts used effectively?
5. How can graphs and charts be misleading?
6. What is statistical analysis?
7. How do researchers reflect on their experiences?
8. How can a research project be expanded upon?
9. Why do researchers continue projects that are not their own?
10. How do new research solutions impact society?
11. Why is reflection a valuable step of the research process?

Lesson 5.1 Communicating Results

Concepts	Performance Objectives
Students will know and understand	*Students will learn concepts by doing*
1. Communicating results to a target audience disseminates the body of research for further use.	• Identify the target audience for research results. (Activity 5.1.1) • Review articles for professional communication techniques. (Activity 5.1.1) • Write a scientific abstract for a research paper. (Activity 5.1.1.)
2. Sharing a professional body of work promotes ongoing research.	• Submit a formal research paper to peers and a professional research committee for review prior to publishing. (Project 5.1.2)
3. Researchers use various media to communicate results professionally.	• Select and develop an alternative dissemination method for research results. (Project 5.1.3)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
• CRP.08.03: Establish plans to solve workplace and community problems and execute them with resiliency.
9. Model integrity, ethical leadership and effective management.
• CRP.09.02: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).

Next Generation Science Standards Alignment

Science and Engineering Practices	
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 the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

	• Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. • Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions. • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.
Obtaining, Evaluating, and Communicating Information	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. • Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. • Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Key Ideas and Details	• **RST.11-12.1 –** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. • **RST.11-12.3 –** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Integration of Knowledge and Ideas	• **RST.11-12.7 –** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. • **RST.11-12.8 –** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. • **RST.11-12.9 –** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Range of Reading and Level of Text Complexity	• **.RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Text Types and Purposes	**WHST.11-12.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • **WHST.11-12.2.A –** Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • **WHST.11-12.2.B –** Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • **WHST.11-12.2.C –** Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • **WHST.11-12.2.D –** Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • **WHST.11-12.2.E –** Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.5 –** 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. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge	• **WHST.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. • **WHST.11-12.8 –** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. • **WHST.11-12.9 –** Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How does a research project build on current technologies and research?
2. How does a research and development project engage others?
3. Why is the communication of research and development critical for the broader scientific community?
4. How is a portfolio used by a researcher?
5. How are research and development results communicated in a professional manner?
6. How are research and development projects continued and expanded?

Lesson 5.2 Going Forward

Concepts	Performance Objectives
Students will know and understand 1. Society is impacted by new solutions to problems. 2. A portfolio of work communicates all aspects of research.	*Students will learn concepts by doing* • Increase public awareness of the research problem, solution, and product. (Problem 5.2.1) • Complete a self-evaluation of performance, skill acquisition, and contributions to agriscience. (Project 5.2.2) • Compile a professional portfolio with the body of work completed in this course and other works of significance. (Project 5.2.3)

National AFNR Common Career Technical Core Standards Alignment

Career Ready Practices
1. Act as a responsible and contributing citizen and employee.
• CRP.01.03: Identify and act upon opportunities for professional and civic service at work and in the community.
4. Communicate clearly, effectively and with reason.
• CRP.04.02: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.

9. Model integrity, ethical leadership and effective management.
• CRP.09.01: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).

Common Core State Standards for English Language Arts

CCSS: English Language Arts Standards » Science & Technical Subjects » Grade 11-12	
Range of Reading and Level of Text Complexity	• **RST.11-12.10 –** By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

CCSS: English Language Arts Standards » Writing » Grade 11-12	
Text Types and Purposes	**WHST.11-12.2 –** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. • **WHST.11-12.2.A –** Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • **WHST.11-12.2.B –** Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • **WHST.11-12.2.C –** Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • **WHST.11-12.2.D –** Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • **WHST.11-12.2.E –** Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
Production and Distribution of Writing	• **WHST.11-12.4 –** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • **WHST.11-12.5 –** 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. • **WHST.11-12.6 –** Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Range of Writing	• **WHST.11-12.10 –** 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.

Essential Questions

1. How can researchers harness the power of social activism to educate society about agriscience problems?
2. What is the value of sharing research results and conclusion with the public?
3. Why should researchers and scientists engage in dialogue with the public?
4. How is research compiled for use in professional settings?
5. What do employers look for in reflective employees?
6. How do you complete professional reflection?
7. How are strengths intentionally developed?