

Main Criteria: Forward Education
Secondary Criteria: Minnesota Academic Standards
Subjects: Mathematics, Science, Technology Education
Grades: 11, 12, Key Stage 4

Forward Education

Autonomous Electric Vehicles of the Future

**Minnesota Academic Standards
 Mathematics
 Grade 11 - Adopted: 2008**

CONTENT STANDARD / DOMAIN	MN.9.2.	Algebra
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.2.2.	Recognize linear, quadratic, exponential and other common functions in real world and mathematical situations; represent these functions with tables, verbal descriptions, symbols and graphs; solve problems involving these functions, and explain results in the original context.
INDICATORS OF PROGRESS / STRAND	9.2.2.1.	Represent and solve problems in various contexts using linear and quadratic functions.
INDICATORS OF PROGRESS / STRAND	9.2.2.3.	Sketch graphs of linear, quadratic and exponential functions, and translate between graphs, tables and symbolic representations. Know how to use graphing technology to graph these functions.

**Minnesota Academic Standards
 Mathematics
 Grade 12 - Adopted: 2008**

CONTENT STANDARD / DOMAIN	MN.9.2.	Algebra
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.2.2.	Recognize linear, quadratic, exponential and other common functions in real world and mathematical situations; represent these functions with tables, verbal descriptions, symbols and graphs; solve problems involving these functions, and explain results in the original context.
INDICATORS OF PROGRESS / STRAND	9.2.2.1.	Represent and solve problems in various contexts using linear and quadratic functions.
INDICATORS OF PROGRESS / STRAND	9.2.2.3.	Sketch graphs of linear, quadratic and exponential functions, and translate between graphs, tables and symbolic representations. Know how to use graphing technology to graph these functions.

**Minnesota Academic Standards
 Science
 Grade 11 - Adopted: 2009**

CONTENT STANDARD / DOMAIN	MN.9.1.	The Nature of Science and Engineering
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.1.2.	The Practice of Engineering
INDICATORS OF PROGRESS / STRAND	9.1.2.1.	The student will understand that engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.

INDICATORS OF PROGRESS	9.1.2.1.1.	Understand that engineering designs and products must be continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved.
INDICATORS OF PROGRESS	9.1.2.1.2.	Recognize that risk analysis is used to determine the potential positive and negative consequences of using a new technology or design, including the evaluation of causes and effects of failures.
INDICATORS OF PROGRESS	9.1.2.1.3.	Explain and give examples of how, in the design of a device or process, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of.

CONTENT STANDARD / DOMAIN	MN.9.1.	The Nature of Science and Engineering
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.1.2.	The Practice of Engineering
INDICATORS OF PROGRESS / STRAND	9.1.2.2.	The student will understand that engineering design is an analytical and creative process of devising a product or solution to meet a need or solve a specific problem.

INDICATORS OF PROGRESS	9.1.2.2.1.	Identify a problem and the associated constraints on possible design solutions.
INDICATORS OF PROGRESS	9.1.2.2.2.	Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications.

CONTENT STANDARD / DOMAIN	MN.9.1.	The Nature of Science and Engineering
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.1.3.	Interactions Among Science, Technology, Engineering, Mathematics, and Society
INDICATORS OF PROGRESS / STRAND	9.1.3.4.	The student will understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.

INDICATORS OF PROGRESS	9.1.3.4.1.	Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics and new technologies.
INDICATORS OF PROGRESS	9.1.3.4.2.	Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts.
INDICATORS OF PROGRESS	9.1.3.4.3.	Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.

CONTENT STANDARD / DOMAIN	MN.9.2.	Physical Science
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.2.3.	Energy

INDICATORS OF PROGRESS / STRAND	9.2.3.2.	The student will understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.
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INDICATORS OF PROGRESS 9.2.3.2.5. Describe how an electric current produces a magnetic force, and how this interaction is used in motors and electromagnets to produce mechanical energy.

CONTENT STANDARD / DOMAIN	MN.9C.	Chemistry
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PERFORMANCE INDICATOR / DOMAIN COMPONENT	9C.1.	The Nature of Science and Engineering
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INDICATORS OF PROGRESS / STRAND	9C.1.3.	Interactions Among Science, Technology, Engineering, Mathematics, and Society
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INDICATORS OF PROGRESS	9C.1.3.3.	The student will understand that developments in chemistry affect society and societal concerns affect the field of chemistry.
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INDICATOR 9C.1.3.3.1 Explain the political, societal, economic and environmental impact of chemical products and technologies.

CONTENT STANDARD / DOMAIN	MN.9P.	Physics
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PERFORMANCE INDICATOR / DOMAIN COMPONENT	9P.2.	Physical Science
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INDICATORS OF PROGRESS / STRAND	9P.2.3.	Energy
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INDICATORS OF PROGRESS	9P.2.3.2.	The student will understand that electrons respond to electric fields and voltages by moving through electrical circuits and this motion generates magnetic fields.
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INDICATOR 9P.2.3.2.4 Use the interplay of electric and magnetic forces to explain how motors, generators, and transformers work.

Grade 11 - Adopted: 2010

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
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PERFORMANCE INDICATOR / DOMAIN COMPONENT		Key Ideas and Details
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INDICATORS OF PROGRESS / STRAND 11.13.2.2. 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.

INDICATORS OF PROGRESS / STRAND 11.13.3.3. Follow precisely a complex multistep procedure when carrying out experiments, designing solutions, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Craft and Structure

INDICATORS OF PROGRESS / STRAND 11.13.4.4. Determine the meaning of symbols, equations, graphical representations, tabular representations, 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.

INDICATORS OF PROGRESS / STRAND 11.13.5.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

INDICATORS OF PROGRESS / STRAND 11.13.6.6. Analyze the author's purpose in describing phenomena, providing an explanation, describing a procedure, or discussing/reporting an experiment in a text, identifying important issues and questions that remain unresolved.

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Integration of Knowledge and Ideas

INDICATORS OF PROGRESS / STRAND 11.13.9.9. 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.

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Range of Reading and Level of Text Complexity

INDICATORS OF PROGRESS / STRAND 11.13.10.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11-12 text complexity band independently and proficiently.

CONTENT STANDARD / DOMAIN	MN.11.14	Writing Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Text Types and Purposes

INDICATORS OF PROGRESS / STRAND 11.14.2.2. Write informative/explanatory texts, as they apply to each discipline and reporting format, including the narration of historical events, of scientific procedures/ experiments, or description of technical processes.

INDICATORS OF PROGRESS 11.14.2.2.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.

CONTENT STANDARD / DOMAIN	MN.11.14	Writing Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Production and Distribution of Writing

INDICATORS OF PROGRESS / STRAND 11.14.4.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to discipline, task, purpose, and audience.

**Minnesota Academic Standards
Science
Grade 12 - Adopted: 2009**

CONTENT STANDARD / DOMAIN	MN.9.1.	The Nature of Science and Engineering
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.1.2.	The Practice of Engineering
INDICATORS OF PROGRESS / STRAND	9.1.2.1.	The student will understand that engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.

INDICATORS OF PROGRESS 9.1.2.1.1 Understand that engineering designs and products must be continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved.

INDICATORS OF PROGRESS 9.1.2.1.2 Recognize that risk analysis is used to determine the potential positive and negative consequences of using a new technology or design, including the evaluation of causes and effects of failures.

INDICATORS OF PROGRESS 9.1.2.1.3 Explain and give examples of how, in the design of a device or process, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of.

CONTENT STANDARD / DOMAIN	MN.9.1.	The Nature of Science and Engineering
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.1.2.	The Practice of Engineering
INDICATORS OF PROGRESS / STRAND	9.1.2.2.	The student will understand that engineering design is an analytical and creative process of devising a product or solution to meet a need or solve a specific problem.

INDICATORS OF PROGRESS 9.1.2.2.1 Identify a problem and the associated constraints on possible design solutions.

INDICATORS OF PROGRESS 9.1.2.2.2 Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications.

CONTENT STANDARD / DOMAIN	MN.9.1.	The Nature of Science and Engineering
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PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.1.3.	Interactions Among Science, Technology, Engineering, Mathematics, and Society
INDICATORS OF PROGRESS / STRAND	9.1.3.4.	The student will understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.

INDICATORS OF PROGRESS 9.1.3.4.1. Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics and new technologies.

INDICATORS OF PROGRESS 9.1.3.4.2. Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts.

INDICATORS OF PROGRESS 9.1.3.4.3. Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.

CONTENT STANDARD / DOMAIN	MN.9.2.	Physical Science
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9.2.3.	Energy
INDICATORS OF PROGRESS / STRAND	9.2.3.2.	The student will understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.

INDICATORS OF PROGRESS 9.2.3.2.5. Describe how an electric current produces a magnetic force, and how this interaction is used in motors and electromagnets to produce mechanical energy.

CONTENT STANDARD / DOMAIN	MN.9C.	Chemistry
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9C.1.	The Nature of Science and Engineering
INDICATORS OF PROGRESS / STRAND	9C.1.3.	Interactions Among Science, Technology, Engineering, Mathematics, and Society
INDICATORS OF PROGRESS	9C.1.3.3.	The student will understand that developments in chemistry affect society and societal concerns affect the field of chemistry.

INDICATOR 9C.1.3.3.1 Explain the political, societal, economic and environmental impact of chemical products and technologies.

CONTENT STANDARD / DOMAIN	MN.9P.	Physics
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9P.2.	Physical Science
INDICATORS OF PROGRESS / STRAND	9P.2.3.	Energy

INDICATORS OF PROGRESS	9P.2.3.2.	The student will understand that electrons respond to electric fields and voltages by moving through electrical circuits and this motion generates magnetic fields.
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INDICATOR 9P.2.3.2.4 Use the interplay of electric and magnetic forces to explain how motors, generators, and transformers work.

Grade 12 - Adopted: 2010

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Key Ideas and Details

INDICATORS OF PROGRESS / STRAND 11.13.2.2. 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.

INDICATORS OF PROGRESS / STRAND 11.13.3.3. Follow precisely a complex multistep procedure when carrying out experiments, designing solutions, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Craft and Structure

INDICATORS OF PROGRESS / STRAND 11.13.4.4. Determine the meaning of symbols, equations, graphical representations, tabular representations, 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.

INDICATORS OF PROGRESS / STRAND 11.13.5.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

INDICATORS OF PROGRESS / STRAND 11.13.6.6. Analyze the author's purpose in describing phenomena, providing an explanation, describing a procedure, or discussing/reporting an experiment in a text, identifying important issues and questions that remain unresolved.

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
PERFORMANCE INDICATOR / DOMAIN COMPONENT		Integration of Knowledge and Ideas

INDICATORS OF PROGRESS / STRAND 11.13.9.9. 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.

CONTENT STANDARD / DOMAIN	MN.11.13	Reading Benchmarks: Literacy in Science and Technical Subjects 6-12
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PERFORMANCE INDICATOR / DOMAIN COMPONENT		Range of Reading and Level of Text Complexity
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INDICATORS OF PROGRESS / STRAND 11.13.10.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11-12 text complexity band independently and proficiently.

CONTENT STANDARD / DOMAIN	MN.11.14.	Writing Benchmarks: Literacy in Science and Technical Subjects 6-12
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PERFORMANCE INDICATOR / DOMAIN COMPONENT		Text Types and Purposes
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INDICATORS OF PROGRESS / STRAND	11.14.2.2.	Write informative/explanatory texts, as they apply to each discipline and reporting format, including the narration of historical events, of scientific procedures/ experiments, or description of technical processes.
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INDICATORS OF PROGRESS d. 11.14.2.2. 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.

CONTENT STANDARD / DOMAIN	MN.11.14.	Writing Benchmarks: Literacy in Science and Technical Subjects 6-12
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PERFORMANCE INDICATOR / DOMAIN COMPONENT		Production and Distribution of Writing
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INDICATORS OF PROGRESS / STRAND 11.14.4.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to discipline, task, purpose, and audience.

**Minnesota Academic Standards
Technology Education
Grade 11 - Adopted: 2009**

CONTENT STANDARD / DOMAIN	MN.IT.L.9-12.	Information and Technology Literacy Standards (Refresh 2009)
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PERFORMANCE INDICATOR / DOMAIN COMPONENT	9-12.3.	Technology Use and Concepts: Students will explore multiple technologies, evaluate their suitability for the desired educational or personal task, and apply the tools needed.
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INDICATORS OF PROGRESS / STRAND	9-12.3.1.	Use of Technology
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INDICATORS OF PROGRESS	9-12.3.I.D.	Strategically solve information and technology issues.
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INDICATOR 9-12.3.I.D.1. Independently troubleshoot technology issues, following organizational policies.

INDICATOR 9-12.3.I.D.2. Locate assistance independently and ask appropriate expert when necessary.

Technology Education
Grade 12 - Adopted: 2009

CONTENT STANDARD / DOMAIN	MN.IT.L.9-12.	Information and Technology Literacy Standards (Refresh 2009)
PERFORMANCE INDICATOR / DOMAIN COMPONENT	9-12.3.	Technology Use and Concepts: Students will explore multiple technologies, evaluate their suitability for the desired educational or personal task, and apply the tools needed.
INDICATORS OF PROGRESS / STRAND	9-12.3.1.	Use of Technology
INDICATORS OF PROGRESS	9-12.3.I.D.	Strategically solve information and technology issues.

INDICATOR	9-12.3.I.D.1.	Independently troubleshoot technology issues, following organizational policies.
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INDICATOR	9-12.3.I.D.2.	Locate assistance independently and ask appropriate expert when necessary.
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