GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING*

Big Questions	Formative/ Summative Assessments Formative and summative assessments created by teachers/teams
1. What are the basic tools of science and engineering? 2. How does a scientist use experimental evidence to develop and refine a theory? 3. How does a scientist communicate results so others can review, test and build upon those results? 4. How do Engineers use science and technology to develop new products or processes to design a solution to a problem? 5. How do societal values, problems and needs influence scientific inquiry and engineering design?	Options may include but are not limited to: – Measurement Lab – Penny Mass Lab – Scientist research project – Engineering research project – Experiment design lab – Engineering design project

Substrand/Standard	Curriculum Benchmark	MCA III Test Item Specifications	Standards of Proficiency Description of what students must show to demonstrate proficiency (created by teachers/teams)	Resources
Substrand: The Practice of Science Standard: Understand that science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	Explain the implications of the assumption that the rules of the universe are the same everywhere and these rules can be discovered by careful and systematic investigation. *(Standard NSE: 9.1.1.1.1)*	• Rules of the universe are things and events in the universe that "occur in consistent patterns that are comprehensible through careful systematic study"; scientific theories and natural laws are the result of that systematic study (Project 2061, Atlas of Science Literacy, Volume 2, [American Association for the Advancement of Science, 2007], 5). • A theory is defined as "a well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences and tested hypotheses" (National Academy of Sciences, Teaching and the Nature of Science, [National Academy Press, 1998], 5). • A law is defined as "a descriptive generalization about how some aspect of the natural world behaves under stated circumstances" and that carries the weight of scientific evidence (National Academy of Sciences, Teaching About Evolution and the Nature of Science, [National Academy Press, 1998], 5). • Items may require students to apply their knowledge of scientific theories and natural laws to a context. • Items will NOT require students to define scientific theory or natural law.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) http://einstein.stanford.edu https://perimeterinstitute.ca/en/Outreach/General/Teachers/

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: The Practice of Science Standard: Understand that science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories. *(Standard NSE: 9.1.1.1.2)*	None.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)
Substrand: The Practice of Science Standard: Understand that science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	Explain how the traditions and norms of science define the bounds of professional scientific practice and reveal instances of scientific error or misconduct. (For example: The use of peer review, publications and presentations.) *(Standard NSE: 9.1.1.1.3)*	• Items will NOT require students to make ethical decisions.		
Substrand: The Practice of Science Standard: Understand that science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	Identify sources of bias and explain how bias might influence the direction of research and the interpretation of data. (For example: How funding of research can influence questions studied, procedures used, analysis of data, and communication of results.) *(Standard NSE: 9.1.1.1.5)*	• Items will NOT require students to make ethical decisions. • Sources of bias may include gender bias, misconception, cultural bias, funding bias, procedural bias, individual bias based on prior experience with the subject and political bias.		
Substrand: The Practice of Science Standard: Understand that science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	Describe how changes in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge. *(Standard NSE: 9.1.1.1.6)*	• Items may require students to show how one scientific understanding leads to another (e.g., show how new evidence or analysis led to further development of the theory of evolution, germ theory or theory of inheritance). • Items assessing this benchmark may also assess benchmarks 9.1.3.2.1 and 9.4.4.1.3.		

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: The Practice of Science Standard: Understand that science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	Explain how scientific and technological innovations-as well as new evidence-can challenge portions of, or entire accepted theories and models including, but not limited to: cell theory, atomic theory, theory of evolution, plate tectonic theory, term theory of disease, and the big bang theory. *(Standard NSE: 9.1.1.1.7)*	• Items will address theories, models and the validity of scientific knowledge in the context of life science. • Technological innovations may include microscopy, global positioning system (GPS), genetic engineering and molecular engineering.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) http://education.usgs.gov/ http://einstein.stanford.edu/ http://www.fnal.gov/
Substrand: Earth Structure and Processes Standard: Understand that the relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence for the theory of plate tectonics.	Describe how experimental and observational evidence led to the theory of plate tectonics. *(Standard ESS: 9.3.1.1.5)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) (22.4, 22.5, 23.6) For example: Fossil records 23.6; Rock record 23.6; Ocean survey p 730
Substrand: Earth Structure and Processes Standard: Understand that the relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence for the theory of plate tectonics.	Compare and contrast the interaction of tectonic plates at convergent and divergent boundaries. (For example: Compare the kinds of magma that emerge at plate boundaries.) *(Standard ESS: 9.3.1.1.1)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - p 682 - p 639
Substrand: Earth Structure and Processes Standard: Understand that the relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence for the theory of plate tectonics.	Explain how the rock record provides evidence for plate movement. (For example: Similarities found in fossils, certain types of rocks, or patterns of rock layers in various locations) *(Standard ESS: 9.3.1.1.4)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 22.4 p 677 - 23.6 p 733

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: The Universe Standard: Understand that the solar system, sun, and Earth formed over billions of years.	Describe how the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago. *(Standard ESS: 9.3.3.2.1)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 26.5 p 852
Substrand: The Universe Standard: Understand that the big bang theory states that the universe expanded from a hot, dense chaotic mass, after which chemical elements formed and clumped together to eventually form stars and galaxies.	Explain how the gravitational clumping leads to nuclear fusion, producing energy and the chemical elements of a star. *(Standard ESS: 9.3.3.3.2)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 26.5
Substrand: The Practice of Science Standard: Understand that scientific inquiry uses multiple interrelated processes to investigate and explain the natural world.	Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation. *(Standard NSE: 9.1.1.2.1)*	• Context of items should demonstrate all appropriate safety considerations. • Items may address part or all of the benchmark. • Hypothesis is defined as "a testable statement about the natural world that can be used to build more complex inferences and explanations" (National Academy of Sciences, Teaching About Evolution and the Nature of Science, [National Academy Press, 1988], 5). • Items will NOT require students to define the term hypothesis. • Items may require students to evaluate or draw an accurate conclusion based on presented evidence. • Items may require students to identify which variables were changed, kept the same and measured in a given experiment. • Items will NOT use the terms independent variable, dependent variable, manipulated variable or responding variables.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: The Practice of Science Standard: Understand that scientific inquiry uses multiple interrelated processes to investigate and explain the natural world.	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations. *(Standard NSE: 9.1.1.2.2)*	• Items may require students to evaluate a set of data to formulate possible conclusions.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)
Substrand: The Practice of Science Standard: Understand that scientific inquiry uses multiple interrelated processes to investigate and explain the natural world.	Identify the critical assumptions and logic used in a line of reasoning to judge the validity of a claim. *(Standard NSE: 9.1.1.2.3)*	• Items may include product claims, pseudoscience and unsupported conclusions.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) For example: Perpetual motion machine http://www.lhup.edu/~dsimanek/museum/unwork.htm
Substrand: The Practice of Science Standard: Understand that scientific inquiry uses multiple interrelated processes to investigate and explain the natural world.	Use primary sources or scientific writings to identify and explain how different types of questions and their associated methodologies are used by scientists for investigations in different disciplines. *(Standard NSE: 9.1.1.2.4)*	• Disciplines are limited to zoology, botany, microbiology, evolutionary biology, ecology, genetics, cell biology, anatomy and physiology. • Methodologies may include observation, gathering data, organizing information, analysis, experimentation and computer modeling.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)
Substrand: The Practice of Engineering Standard: 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.	Understand that engineering designs and products are often continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved. (For example: If the price of an essential raw material changes, the product design may need to be changed.) *(Standard NSE: 9.1.2.1.1)*	• Items will NOT require students to know details of specific technologies. • Items will be placed in contexts that give sufficient background information. • Items are limited to environmental effects on ecosystems and their physical and biological components.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 20.2 p 608

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: The Practice of Engineering Standard: 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.	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. (For example: Risks and benefits associated with using lithium batteries.) *(Standard NSE: 9.1.2.1.2)*	• Items will NOT require students to know details of specific technologies. • Items will be placed in contexts that give sufficient background information. • Items are limited to environmental effects on ecosystems and their physical and biological components. • Items may require students to identify risks and benefits of a new technology or design.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 20.2 p 608
Substrand: The Practice of Engineering Standard: 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.	Explain and give examples of how, in the design of a device, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of. *(Standard NSE: 9.1.2.1.3)*	• Items will NOT require students to know details of specific technologies. • Items will be placed in contexts that provide sufficient background information. • Items are limited to environmental effects on ecosystems and their physical and biological components.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 20.2 p 608
Substrand: The Practice of Engineering Standard: Understand that engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.	Identify a problem and the associated constraints on possible design solutions. (For example: Constraints can include time, money, scientific knowledge and available technology.) *(Standard NSE: 9.1.2.2.1)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 20.2 p 608 For example: Solar Vehicle Hybrid Vehicle

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: The Practice of Engineering Standard: Understand that engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.	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. (For example: Develop a prototype to test the quality, efficiency and productivity of a product.) *(Standard NSE: 9.1.2.2.2)*	• Items may require students to evaluate conceptual, physical or mathematical prototypes to identify solutions to an engineering problem.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) Rube Goldberg Device For example: Water bottle activity
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that natural and designed systems are made up of components that act within a system and interact with other systems.	Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs. (For example: A power plant or ecosystem) *(Standard NSE: 9.1.3.1.1)*	• Items may use either natural or designed systems. • Items will be placed in contexts that give sufficient background information.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) – Unit 2: Energy Resources – Unit 4: Electricity and Magnetism
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	Provide examples of how diverse cultures, including natives from all of the Americas, have contributed scientific mathematical ideas and technological inventions. (For example: Native American understanding of ecology; Lisa Meitner's contribution to understanding radioactivity; Tesla's ideas and inventions relating to electricity; Watson, Crick and Franklin's discovery of the structure of DNA; or how George Washington Carver's ideas changed land use.) *(Standard NSE: 9.1.3.2.1)*	• Items assessing this benchmark may also assess benchmarks 9.1.1.1.6 and 9.4.4.1.3. • Items will be placed in contexts that give sufficient background information. • Items will NOT require students to match an individual to a specific idea or invention. • Items may require students to recognize how an idea or invention has contributed to the field of science.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) Scientific Biographies For example: http://www.perimeterinstitute.ca/en/Outreach/Students/Meet_a_Scientist/ http://wdrs.fnal.gov/employ/videos.html

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	Analyze possible careers in science and engineering in terms of educational requirements, working practices and rewards. *(Standard NSE: 9.1.3.2.2)*	• Not assessed on the MCA-III.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 1.1 p 4 http://www.aps.org/careers/index.cfm
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science and engineering operate in the context of society and both influence and are influenced by this context.	Describe how values and constraints affect science and engineering. (For example: Economic, environmental, social, political, ethnical, health, safety, and sustainability issues.). *(Standard NSE: 9.1.3.3.1)*	• Not assessed on the MCA-III.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 20.2 p 608
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science and engineering operate in the context of society and both influence and are influenced by this context.	Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means. *(Standard NSE: 9.1.3.3.2)*	• Items may require students to justify or defend procedures and results based on data, observations, or other evidence. • Items may require students to interpret or create a graphic in order to communicate procedures and results. • Items may require students to analyze or produce quantitative information in order to communicate procedures and results.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 1.4 p 25

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science and engineering operate in the context of society and both influence and are influenced by this context.	Describe how scientific investigations and engineering processes require multi-disciplinary contributions and efforts. (For example: Nanotechnology, climate change, agriculture, or biotechnology.) *(Standard NSE: 9.1.3.3.3)*	• Examples of disciplines are limited to zoology, botany, microbiology, evolutionary biology, ecology, genetics, cell biology, anatomy and physiology. • Items will provide context with sufficient background information.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.	Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics, and new technologies. *(Standard NSE: 9.1.3.4.1)*	• Not assessed on the MCA-III.		
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.	Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts. (For example: Consideration of chemical and biological hazards in the lab.) *(Standard NSE: 9.1.3.4.2)*	• All measurements will use the International System of Units (SI).		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 1.3 p 16
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.	Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results. *(Standard NSE: 9.1.3.4.3)*	• All measurements will use the SI system of measurement. • Items may require students to place appropriate variables on graph axes. • Items may require students to determine appropriate increments on graphs.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) – 1.3 – 1.4

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

THE NATURE AND METHODS OF SCIENCE AND ENGINEERING* (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.	Relate the reliability of data to consistency of results, identify sources of error, and suggest ways to improve the data collection and analysis. (For example: Use statistical analysis or error analysis to make judgments about the validity of results.) *(Standard NSE: 9.1.3.4.4)*	• Examples of error include uncontrolled variables, operator error and measurement error. • Mathematics will be limited to grade 8 mathematics or below, per the Minnesota Academic Standards in Mathematics, and can include the concepts of percent, mean, median, mode and line of best fit. • Items will NOT require students to do mathematics without using the results to evaluate data. • All measurements will use the SI system of measurement. • Items that require students to do calculations will provide a calculator tool.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 1.3 p 19
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.	Demonstrate how unit consistency and dimensional analysis can guide the calculation of quantitative solutions and verification of results. *(Standard NSE: 9.1.3.4.5)*	• Mathematics will be limited to grade 8 mathematics or below, per the Minnesota Academic Standards in Mathematics. • All measurements will use the SI system of measurement. • Items that require students to do calculations will provide a scientific calculator tool.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 1.3 p 16
Substrand: Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard: Understand that science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.	Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers. *(Standard NSE: 9.1.3.4.6)*	• Examples of models include population growth, bacterial growth and probability in genetics.		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

UNIT 1: MOTION AND FORCES

Big Questions	Formative/ Summative Assessments Formative and summative assessments created by teachers/teams
1. What is the difference between a scalar quantity and a vector quantity? 2. What is the relationship between Position, Speed/Velocity and Acceleration? 3. What are the Laws of Motion? 4. What are the fundamental Forces? 5. What is the relationship between mass and weight?	Options may include but are not limited to: - Speed Lab - Acceleration Lab - Unit exam

Substrand/Standard	Curriculum Benchmark	MCA III Test Item Specifications	Standards of Proficiency Description of what students must show to demonstrate proficiency (created by teachers/teams)	Resources
Substrand: Motion Standard: Understand that an object's mass and the forces on it affect the motion of an object.	Recognize that inertia is the property of an object that causes it to resist changes in motion. *(Standard PS: 9.2.2.2.1)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 12.2 p 364
Substrand: Motion Standard: Understand that an object's mass and the forces on it affect the motion of an object.	Explain and calculate the acceleration of an object subjected to a set of forces in one dimension (F = ma). *(Standard PS: 9.2.2.2.2)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 12.2 p 365
Substrand: Motion Standard: Understand that an object's mass and the forces on it affect the motion of an object.	Demonstrate that whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object. *(Standard PS: 9.2.2.2.3)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 12.3 p 373
Substrand: Motion Standard: Understand that forces and object mass determine the motion of an object.	Use Newton's universal law of gravitation to describe and calculate the attraction between massive objects based on the distance between them. (For example: Calculate the weight of a person on different planets in the solar system.) *(Standard PS: 9.2.2.2.4)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 12.2 p 368

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

UNIT 2: ENERGY

Big Questions	Formative/ Summative Assessments Formative and summative assessments created by teachers/teams
1. What is the relationship between Force, Work, Energy and Power? 2. What are the different forms of Energy? 3. What role does Conservation of Energy play in energy transformations? 4. What are the advantages and disadvantages of various Energy resources? 5. How does the addition or removal of heat energy affect a system? 6. What are the methods of heat transfer?	Options may include but are not limited to: - Work and Power Lab - Energy Resources project/report - Heat Transfer Lab - Unit exam

Substrand/Standard	Curriculum Benchmark	MCA III Test Item Specifications	Standards of Proficiency Description of what students must show to demonstrate proficiency (created by teachers/teams)	Resources
Substrand: Energy Standard: Understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	Identify the energy forms and explain the transfers of energy involved in the operation of common devices. (For example: Light bulbs, electric motors, automobiles or bicycles) *(Standard PS: 9.2.3.2.1)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 14 p 436
Substrand: Energy Standard: Understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	Calculate and explain the energy, work and power involved in energy transfers in a mechanical system. (For example: Compare walking and running up or down steps.) *(Standard PS: 9.2.3.2.2)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 14.1
Substrand: Human Interaction with Physical Systems Standard: Understand that there are benefits, costs and risks to different means of generating and using energy.	Compare local and global environmental and economic advantages and disadvantages of generating electricity using various sources or energy. (For example: Fossil fuels, nuclear fission, wind, sun or tidal energy) *(Standard PS: 9.2.4.1.1)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 15
Substrand: Interdependence Within the Earth System Standard: Understand that the Earth system has internal and external sources of energy, which produce heat and drive the motion of material in the oceans, atmosphere and solid earth.	Explain how the outward transfer of Earth's internal heat drives the convection circulation in the mantle to move tectonic plates. *(Standard ESS: 9.3.2.1.2)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 16 p 481 - 22.4 p 679, 680 - 22.6 p 694

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

UNIT 2: ENERGY (continued)				
Substrand/Standard	**Curriculum Benchmark**	**MCA III Test Item Specifications**	**Standards of Proficiency** Description of what students must show to demonstrate proficiency (created by teachers/teams)	**Resources**
Substrand: Interdependence Within the Earth System Standard: The Earth system has internal and external sources of energy, which produce heat and drive the motion of material in the oceans, atmosphere and solid earth.	Compare and contrast the energy sources of the Earth, including the sun, the decay of radioactive isotopes and gravitational energy. *(Standard ESS: 9.3.2.1.1)*	None		Textbook: Conceptual Physics (Third Edition) (Prentice Hall)

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GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

UNIT 3: WAVES AND OPTICS

Big Questions	Formative/ Summative Assessments Formative and summative assessments created by teachers/teams
1. What are the different types of waves? 2. What are the characteristics and properties of waves? 3. How do waves transport energy from one location to another? 4. How do the conditions of the system affect the properties of waves? 5. What are the principles of reflection and refraction of waves?	Options may include but are not limited to: – Standing waves lab – Mirrors lab – Refraction/Lenses lab – Unit exam

Substrand/Standard	Curriculum Benchmark	MCA III Test Item Specifications	Standards of Proficiency Description of what students must show to demonstrate proficiency (created by teachers/teams)	Resources
Substrand: Energy Standard: Understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	Describe how energy is transferred through sound waves and how pitch and loudness are related to wave properties of frequency and amplitude. *(Standard PS: 9.2.3.2.3)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 17.2 p 507
Substrand: Energy Standard: Understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	Describe the properties and uses of forms of electromagnetic radiation from radio frequencies through gamma radiation. (For example: Compare the energy of microwaves and X-rays.) *(Standard PS: 9.2.3.2.7)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 18.2
Substrand: Earth Structure and Processes Standard: Understand that the relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence for the theory of plate tectonics.	Use modern earthquake data to explain how seismic activity is evidence for the process of subduction. (For example: Correlate data on distribution, depth and magnitude of earthquakes with subduction zones.) (Standard ESS: 9.3.1.1.2)	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 22.6 p 697
Substrand: The Universe Standard: Understand that the big bang theory states that the universe expanded from a hot, dense chaotic mass, after which chemical elements formed and clumped together to eventually form stars and galaxies.	Explain how evidence, including the Doppler shift of light from distant stars and cosmic background radiation, is used to understand the composition, early history and expansion of the universe. (Standard ESS: 9.3.3.3.1)	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 17.4 p 516 - 26.5 p 852 - 26.5 p 854

* The Nature and Methods of Science and Engineering benchmarks are embedded through the course.

GRADE 9: PHYSICS CURRICULUM FRAMEWORKS

UNIT 4: ELECTRICITY AND MAGNETISM

Big Questions	Formative/ Summative Assessments Formative and summative assessments created by teachers/teams
1. What is the relationship between: Voltage, Resistance and Current? 2. What is the relationship between: Electrical Energy and Electrical Power? 3. What are the effects of the Earth's magnetic field? 4. How does a motor work? 5. How does a generator work? 6. How is Electrical Energy generated and transmitted?	Options may include but are not limited to: - Simple Circuits lab - Light bulb lab - Unit exam

Substrand/Standard	Curriculum Benchmark	MCA III Test Item Specifications	Standards of Proficiency Description of what students must show to demonstrate proficiency (created by teachers/teams)	Resources
Substrand: Energy Standard: Understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	Explain and calculate current, voltage and resistance, and describe energy transfers in simple electric circuits. *(Standard PS: 9.2.3.2.4)*	. None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall)
Substrand: Energy Standard: Understand that energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	Describe how an electric current produces a magnetic force, and how this interaction is used in motors and electromagnets to produce mechanical energy. *(Standard PS: 9.2.3.2.5)*	None		
Substrand: Human Interaction with Physical Systems Standard: Understand that there are benefits, costs and risks to different means of generating and using energy.	Describe the trade-offs involved when technological developments impact the way we use energy, natural resources or synthetic materials. (For example: Fluorescent light bulbs use less energy than incandescent lights, but contain toxic mercury.) *(Standard PS: 9.2.4.1.2)*	None		
Substrand: Earth Structure and Processes Standard: Understand that the relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence for the theory of plate tectonics.	Describe how the pattern of magnetic reversals and rock ages on both sides of a mid-ocean ridge provides evidence of sea-floor spreading. *(Standard ESS: 9.3.1.1.3)*	None		Textbook: Physical Science – Concepts in Action with Earth and Space Science (Prentice Hall) - 22.4 p 679

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