



## 2023 NATIONAL SCIENCE OLYMPIAD

### DIVISION B (MIDDLE SCHOOL; GRADES 6-9)

#### EVENT ALIGNMENT TO NATIONAL EDUCATIONAL STANDARDS

**AIR TRAJECTORY** – Prior to the competition, teams will design, construct, and calibrate a single device capable of launching projectiles onto a target and collect data regarding device parameters and performance.

#### **Middle School Physical Sciences**

*MS. Motion and Stability: Forces and Interactions*

*MS-PS 2-2.* – Plan an investigation to provide evidence that the change in an object’s motion depends on force.  
*MS. Energy*

*MS-PS 3-1.* Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

*MS-PS 3-5.* Construct, use, and present arguments to support the claim that when kinetic energy of an object changes, energy is transferred to or from an object.

#### **Middle School Engineering Design**

*MS. Engineering Design*

*MS-ETS 1-1.* - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

*MS-ETS 1-2.* - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

*MS-ETS 1-3.* - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

*MS-ETS 1-4.* - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**ANATOMY AND PHYSIOLOGY** – Participants will be assessed on their understanding of the anatomy and physiology for the human Cardiovascular, Lymphatic, and Excretory systems.

#### **Middle School Life Science**

*MS. Structure, Function, and Information Processing*

*MS-LS 1-3.* Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

**CAN'T JUDGE A POWDER** – Students will test and characterize one pure substance and then, based only on the data they collect, answer a series of questions about that substance. Students will not be asked to identify the substance. The emphasis of this event is on the quality of the data collected, answering questions about the substance and providing data to support their answers.

### **Middle School Physical Science**

#### *MS. Chemical Reactions*

*MS-PS 1-2.* - Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

#### *MS. Structures and Properties of Matter*

*MS-PS 1-3.* Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

**CODEBUSTERS** – Teams will cryptanalyze and decode encrypted messages using cryptanalysis techniques for historical and modern advance ciphers.

### **K-12 Computer Science Framework**

#### *6-8 Networks and the Internet*

*Cybersecurity* - Explain how physical and digital security measures protect electronic information.

*Cybersecurity* - Apply multiple methods of encryption to model the secure transmission of information.

**CRIME BUSTERS** – Given a scenario, a collection of evidence, and possible suspects, students will perform a series of tests. The test results along with other evidence will be used to solve a crime.

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#### *MS. Chemical Reactions*

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#### *MS. Structures and Properties of Matter*

*MS-PS 1-3.* Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

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*MS-ETS 1-2.* - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

*MS-ETS 1-3.* - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

**DISEASE DETECTIVES** – Participants will use their investigative skills in the scientific study of disease, injury, health, and disability in populations or groups of people.

## **Middle School Life Science**

*MS. Growth, Development, and Reproduction of Organisms*

*MS-LS 1-5.* Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

*MS. Interdependent Relationships in Ecosystems*

*MS-LS 2-2.* - Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

*MS. Matter and Energy in Organisms and Ecosystems*

*MS-LS 2-4.* - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

*MS. Natural Selection and Adaptations*

*MS-LS 4-4.* - Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

## **Middle School Earth and Space Sciences**

*MS. Human Impacts*

*MS-ESS 3-4.* - Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

## **Middle School Engineering Design**

*MS. Engineering Design*

*MS-ETS 1-1.* - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

*MS-ETS 1-2.* - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

*MS-ETS 1-3.* - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

**DYNAMIC PLANET** – Students will use process skills to complete tasks related to Earth’s fresh waters.

### **Middle School Earth and Space Sciences**

#### *MS. Earth’s Systems*

*MS-ESS 2-4.* - Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.

*MS-ESS 2-6.* - Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates..

#### *MS. Earth and Human Activity*

*MS-ESS 3-1.* – Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.

*MS-ESS 3-3.* - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

**ECOLOGY** – Students will answer questions involving content knowledge and process skills in the area of ecology and adaptations in featured North American biomes.

#### *Middle School Life Sciences*

#### *MS. Matter and Energy on Organisms and Ecosystems*

*MS-LS 2–1.* Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

*MS-LS 2–3.* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

*MS-LS 2–4.* Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

#### *MS. Interdependent Relationships in Ecosystems*

*MS-LS 2–2.* Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

*MS-LS 2–5.* Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

**EXPERIMENTAL DESIGN** – This event will determine the participant’s ability to design, conduct, and report the findings of an experiment conducted entirely on site.

**Note:** *The exact nature of the experiment conducted during the Experimental Design event changes depending upon the tournament site. Therefore, matching this event to exact standards can be problematic. The standards listed are ones that might be addressed at any given tournament.*

## **Middle School Physical Science**

### *MS. Chemical Reactions*

*MS-PS 1-2.* - Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

*MS-PS 1-5.* - Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

### *MS. Structures and Properties of Matter*

*MS-PS 1-4.* - Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

### *MS. Forces and Interactions*

*MS-PS 2-2.* - Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

*MS-PS 2-5.* Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

### *MS. Energy*

*MS-PS 3-1.* - Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

*MS-PS 3-4.* - Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

## **Middle School Life Science**

### *MS. Structure, Function, and Information Processing*

*MS-LS 1-1.* - Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

### *MS. Matter and Energy in Organisms and Ecosystems*

*MS-LS 1-6.* - Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

## **Middle School Earth and Space Sciences**

### *MS. Earth's Systems*

*MS-ESS 2-4.* - Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

*MS-ESS 2-6.* - Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates..

### *MS. Earth and Human Activity*

*MS-ESS 3-1.* – Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.

*MS-ESS 3-3.* - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

**FAST FACTS** – Teams will fill in a grid of terms that begin with a given letter to match given scientific categories.

**Note:** *The exact nature of the Fast Facts event changes depending upon the tournament site. Therefore, matching this event to exact standards can be problematic. The standards listed are ones that might be addressed at any given tournament.*

### **Middle School Physical Science**

#### *MS. Chemical Reactions*

*MS-PS 1-2.* - Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

*MS-PS 1-5.* - Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

#### *MS. Structures and Properties of Matter*

*MS-PS 1-4.* - Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

#### *MS. Forces and Interactions*

*MS-PS 2-2.* - Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.

*MS-PS 2-5.* Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

#### *MS. Energy*

*MS-PS 3-1.* - Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

*MS-PS 3-4.* - Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

### **Middle School Life Science**

#### *MS. Structure, Function, and Information Processing*

*MS-LS 1-1.* - Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

*MS. Matter and Energy in Organisms and Ecosystems*

*MS-LS 1–6.* - Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

*MS. Growth, Development, and Reproduction of Organisms*

*MS-LS 1-5.* Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

*MS. Matter and Energy in Organisms and Ecosystems*

*MS-LS 2-2.* - Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

*MS-LS 2-4.* - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

*MS. Natural Selection and Adaptations*

*MS-LS 4-4.* - Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

**FLIGHT** – Prior to the tournament teams design, construct, and test free flight rubber-powered aircraft to achieve maximum time aloft.

**Middle School Physical Science**

*MS. Forces and Interactions*

*MS-PS 2-1.* - Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

*MS. Energy*

*MS-PS 3-5.* - Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

**Middle School Engineering Design**

*MS. Engineering Design*

*MS-ETS 1-1.* - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

*MS-ETS 1-2.* - Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

*MS-ETS 1-3.* - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

*MS-ETS 1-4.* - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**FORESTRY** – Participants will be assessed on their knowledge of trees found in the United States that are on the 2024 Official Science Olympiad National Tree List.

### **Middle School Life Science**

*MS. Growth, Development, and Reproduction of Organisms*

*MS-LS 1-4.* - Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

*MS. Natural Selection and Adaptations*

*MS-LS 4-2.* - Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships

*MS-LS 4-3.* - Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

**FOSSILS** – Teams use fossils to date and correlate rock units as well as demonstrate their knowledge of ancient life by completing tasks related to fossil identification and classification.

### **Middle School Earth and Space Science**

*MS. Earth's Systems*

*MS-ESS 2-3.* - Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

### **Middle School Life Science**

*MS. Natural Selection and Adaptations*

*MS-LS 4-1.* - Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

*MS-LS 4-2.* - Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.



**METEOROLOGY** – Participants will use scientific process skills and quantitative analysis to demonstrate an understanding of the factors that influence Everyday Weather.

### **Middle School Earth and Space Sciences**

#### *MS. Earth's Systems*

*MS-ESS 2-5.* - Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

*MS-ESS 2-6.* - Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates

#### *MS. Earth and Human Activity*

*MS-ESS 3-2.* - Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

**MICROBE MISSION** – Teams will answer questions, solve problems, and analyze data about microbes.

### **Middle School Life Sciences**

#### *MS. Structure, Function, and Information Processing*

*MS-LS 1-1.* Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

#### *MS. Matter and Energy in Organisms and Ecosystems*

*MS-LS 1-6.* Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

*MS-LS 1-7.* Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

**OPTICS** – Teams will participate in an activity involving positioning mirrors to direct a laser beam towards a target and complete a written test on the principles of geometric and physical optics.

### **Middle School Physical Sciences**

#### *MS. Waves and Electromagnetic Radiation*

*MS-PS 4-1.* Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

*MS-PS 4-2.* Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

*MS-PS 4-3.* Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

**REACH FOR THE STARS** – Participants will demonstrate an understanding of the formation and early-stage evolution of stars and their observation across the electromagnetic spectrum.

### **Middle School Physical Sciences**

*MS. Waves and Electromagnetic Radiation*

*MS-PS 4–1.* Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

*MS-PS 4–2.* Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

### **High School Earth and Space Sciences**

*HS-ESS Earth’s Place in the Universe*

*HS-ESS 1–2.* Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.

*HS-ESS 1–3.* Communicate scientific ideas about the way stars, over their life cycle, produce elements..

**ROAD SCHOLAR** – Teams will answer interpretive questions that may use one or more state highway maps, USGS topographic maps, Internet-generated maps, a road atlas or satellite/aerial images.

### **Middle School Earth and Space Sciences**

*MS. History of Earth*

*MS-ESS 2-3.* – Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

*MS. Erath’s Systems*

*MS-ESS 3-1.* – Construct a scientific explanation based on evidence for how the uneven distribution of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.

**ROLLER COASTER** – Prior to the competition, teams design, build, and test a Roller Coaster track to guide a ball/sphere that uses gravitational potential energy as its sole means of propulsion to travel as close as possible to a Target Time.

### **Middle School Physical Science**

*MS. Forces and Interactions*

*MS-PS 2-1.* – Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.

*MS-PS 2-2.* – Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.

### *MS. Energy*

*MS-PS 3-1.* – Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and the speed of an object.

*MS-PS 3-5.* – Construct, use, and present arguments to support the claim that when the motion energy of an object changes, energy is transferred to or from the object.

## **Middle School Engineering Design**

### *MS. Engineering Design*

*MS-ETS 1-1.* - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

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*MS-ETS 1-4.* - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**TOWER** – Teams will design and build a Tower (Structure) meeting requirements specified in these rules to achieve the highest structural efficiency.

## **Middle School Engineering Design**

### *MS. Engineering Design*

*MS-ETS 1-1.* - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

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*MS-ETS 1-4.* - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**WHEELED VEHICLE** – Teams design, build, and test one Vehicle that uses non-metallic, elastic material as its sole means of propulsion to travel a distance as quickly and accurately as possible.

### **Middle School Physical Science**

#### *MS. Forces and Interactions*

*MS-PS 2-1.* - Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.

#### *MS. Energy*

*MS-PS 3-5.* - Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

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*MS-ETS 1-4.* - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**WIND POWER** – Teams construct a blade assembly device prior to the tournament that is designed to capture wind power and complete a written test on the principles of alternative energy.

### **Middle School Physical Science**

#### *MS. Motion and Stability: Forces and Interactions*

*MS-PS 2-3* – Ask questions about data to determine the factors that affect the strength and magnetic forces.

#### *MS. Energy*

*MS-PS 3-1* – Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

*MS-PS 3-5* – Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

## **Middle School Earth and Space Science**

### *MS. Earth and Human Activity*

*MS-ESS 3-4* – Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.

## **Middle School Engineering Design**

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*MS-ETS 1-3*. - Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

*MS-ETS 1-4*. - Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

**WRITE IT/DO IT** – One participant will write a description of an object and how to build it. The other participant will attempt to construct the object from this description.

## **Common Core English Language Arts Standard**

### *Writing*

*Writing. Grade 6.2* - Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

*Writing. Grade 7.2* - Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

*Writing. Grade 8.2* - Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

## **K-12 Computer Science Framework**

### *6-8 Algorithms and Programming*

*Algorithms* - Algorithms affect how people interact with computers and the way computers respond. People design algorithms that are generalizable to many situations. Algorithms that are readable are easier to follow, test, and debug.

*Program Development* - People design meaningful solutions for others by defining a problem’s criteria and constraints, carefully considering the diverse needs and wants of the community, and testing whether criteria and constraints were met.