Colorado Measures of Academic Success

(Based on the 2020 Colorado Academic Standards)

Science Assessment Framework (starting in 2023) Middle School

Concepts and skills explicitly identified in the Colorado Academic Standards (CAS) are the basis for the Colorado Measures of Academic Success (CMAS) assessment. CMAS Science Frameworks list the percentage representation and number of score points for each reporting category and standards area that appears on the summative assessments. The relative weight across reporting categories is based on the number and depth of the Evidence Outcomes within the reporting category. The Frameworks also specify the Prepared Graduates, Grade Level Expectations, and Evidence Outcomes that are included on the state assessments. Each Prepared Graduate will be represented on the assessment each year.

Colorado's 2020 Science Standards support a three-dimensional model of science teaching and learning. Consistent with best practices for three-dimensional summative assessment, all items require integration of at least two dimensions, based on a grounding phenomenon for the item. Many items incorporate all three dimensions, as outlined by the 2020 CAS.

The Three Dimensions of Science Teaching and Learning – Middle School 2020 Colorado Academic Standards

Disciplinary Core Ideas

The Disciplinary Core Ideas (DCIs) form the basis for the content that students are expected to know by the end of the grade band and are present in every item.

All DCIs are included in the Middle School standards. They are listed below, with their numerical association as listed in the 2020 CAS Document.

Physical Science: Students know and understand common properties, forms, and changes in matter and energy.

PS1 Matter and Its Interactions

PS2 Motion and Stability: Forces and Interactions

PS3 Energy

PS4 Waves and Their Applications in Technologies for Information Transfer

Life Science: Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.

LS1 From Molecules to Organisms: Structures and Processes

LS2 Ecosystems: Interactions, Energy, and Dynamics

LS3 Heredity: Inheritance and Variation of Traits

LS4 Biological Evolution: Unity and Diversity

Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.

ESS1 Earth's Place in the Universe

ESS2 Earth's Systems

ESS3 Earth and Human Activity

Science and Engineering Practices

The Science and Engineering Practices (SEPs) in the CAS are interwoven within certain items, and all SEPs found in the Middle School standards are tested at grade level according to the SEP progressions.

All SEPs are included in the Middle School standards. They are listed below, with their numerical association as listed in the 2020 CAS Document.

1. Asking questions (for science) and defining problems (for engineering)

2. Developing and using models

3. Planning and carrying out investigations

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

6. Constructing explanations (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

Cross Cutting Concepts

Crosscutting concepts (CCCs) have applications across all domains of science. As such, they are a way of linking the different domains of science. The CCCs in the CAS are interwoven within certain items. Each CCC found in the Middle School standards is assessed according to the CCC progressions.

All CCCs are included in the Middle School standards. They are listed below, with their numerical association as listed in the 2020 CAS Document.

1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Scenarios for Items

Items are driven by high-quality scenarios that are grounded in phenomena or problems. All scenarios are puzzling and intriguing and are explainable using grade appropriate integration of the three dimensions of the 2020 CAS. Scenarios are presented in three different ways: simulations, clusters, and standalone items.

Simulations: Students are presented with an interactive simulation of a science model or experiment and asked to make sense of the phenomenon shown and answer multiple associated two or three dimensional questions using their knowledge of the 2020 CAS.

Clusters: Students are presented with background information, still images, graphs, tables, and additional media and asked to make sense of the phenomenon described and answer multiple associated two or three dimensional questions using their knowledge of the 2020 CAS.

Standalone Items: Students are presented with a unique phenomenon asked to make sense of that phenomenon based on the information in the stimulus and answer the two or three dimensional question using their knowledge of the 2020 CAS.

Simulation and cluster scenarios comprise the majority of the assessment, as students are asked to make sense of a larger phenomenon and answer more questions associated with those scenarios. Standalone items are included only to target a small number of 2020 CAS Evidence Outcomes not represented in simulation and cluster scenarios, and these Evidence Outcomes rotate on an annual basis.

Item Types

Items associated with grounding phenomena are presented in three different ways.

Selected Response (Multiple Choice, Multiple Response, and Fill in the Blank): For multiple choice and multiple response items, students utilize information from the stimulus to make sense of the phenomenon and select a correct answer out of provided

choices. For fill in the blank items, students utilize information from the stimulus to make sense of the phenomenon and type their answer in a blank box.

Technology-Enhanced (bar graph, drag and drop, inline choice, hot spot, and match table grid): Students utilize information from the stimulus to make sense of the phenomenon and show their answer using technology, such as by creating a bar graph. Drag and drop items require students to drag answer choices into correct answer bays. Inline choice items require students to select their answer from a drop-down menu to complete a sentence or sentences. Hot spot items require students to select the correct response from its' location in an image. Match table grid items require students to check checkboxes in cells to indicate a match between the column and row labels.

Constructed Response: Students utilize information from the stimulus to make sense of the phenomenon and construct an open-ended response.

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			Cluster (7 Points each)	Mini Cluster (6 points each)	Standalone (1-2 Points Each)
1	**Physical Science**	**34**	**7**	**6-12**	**2-8**
	Prepared Graduate 1. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding structure, properties and interactions of matter.				
	Grade Level Expectation: MS.1.1 The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter and phases changes. **Evidence Outcomes:** a. Develop models to describe the atomic composition of simple molecules and extended structures. (MS PS1-1) b. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. (MS-PS1-2) c. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. (MS-PS1-3) d. 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-PS1-4) **Grade Level Expectation: MS.1.2 Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.** **Evidence Outcomes:** a. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. (MS-PS1-2) b. 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 PS 1-5) c. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. (MS PS1-6)				

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	Prepared Graduate 2. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding interactions between objects and within systems of objects.				
	Grade Level Expectation: MS.1.3 Motion is described relative to a reference frame that must be shared with others and is determined by the sum of the forces acting on it. The greater the mass of the object, the greater the force needed to achieve the same change in motion. **Evidence Outcomes:** a. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. (MS-PS-2-1) b. Plan an investigation to provide evidence that the change in an objects motion depends on the sum of the forces on the object and the mass of the object. (MS-PS-2-2) **Grade Level Expectation: MS.1.4 Forces that act a distance (gravitational, electric, and magnetic) can be explained by force fields that extend through space and can be mapped by their effect on a test object.** **Evidence Outcomes:** a. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. (MS-PS2-3) b. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. (MS-PS2-4) c. 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-PS2-5)				

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	Prepared Graduate 3. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how energy is transferred and conserved.				
	Grade Level Expectation: MS.1.5 Kinetic energy can be distinguished from the various forms of potential energy. **Evidence Outcomes:** a. 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-PS3-1) b. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. (MS-PS-3-2) c. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (MS-PS3-3) d. 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. (MS-PS3-4) e. 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. (MS-PS3–5) **Grade Level Expectation: MS.1.6 Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states and amounts of matter.** **Evidence Outcomes:** a. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (MS PS3-3) b. 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. (MS-PS3-4) c. Construct, use, and present arguments to support the claim that when kinetic energy of an object changes, energy is transferred to or from the object. (MS-PS3-5)				

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	Grade Level Expectation: MS.1.7 When two objects interact, each one exerts a force on the other that can cause energy to be transferred to and from the object. **Evidence Outcomes:** a. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. (MS-PS3-2)				
	Prepared Graduate 4. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how waves are used to transfer energy and information.				
	Grade Level Expectation: MS.1.8 A simple wave model has a repeating pattern with specific wavelength, frequency, and amplitude and mechanical waves need a medium through which they are transmitted. This model can explain many phenomena which include light and sound. **Evidence Outcomes:** a. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in the wave. (MS PS4-1) b. Develop and use a model to describe that waves are reflected, absorbed or transmitted through various materials. (MS-PS4-2) **Grade Level Expectation: MS.1.9 A wave model of light is useful to explain how light interacts with objects through a variety of properties.** **Evidence Outcomes:** a. Develop and use a model to describe that waves are reflected, absorbed or transmitted through various materials. (MS-PS4-2) **Grade Level Expectation: MS.1.10 Designed technologies can transmit digital information as wave pulses.** **Evidence Outcomes:** a. 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. (MS-PS4-3)				

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2	**Life**	**36**	**7**	**6-12**	**3-9**
	Prepared Graduate 5. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how individual organisms are configured and how these structures function to support life, growth, behavior and reproduction.				
	Grade Level Expectation: MS.2.1 All living things are made up of cells, which is the smallest unit that can be said to be alive. **Evidence Outcomes:** a. 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-LS1-1) b. Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function. (MS LS1-2) c. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. (MS-LS1-3) **Grade level Expectation: MS.2.2 Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.** **Evidence Outcomes:** a. 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-LS1-4) b. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (MS-LS1-5) **Grade level Expectation: MS.2.3 Sustaining life requires substantial energy and matter inputs.** **Evidence Outcomes:** a. 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-LS1-6)				

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	b. 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. (MS-LS1-7) **Grade level Expectation: MS.2.4 Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain.** **Evidence Outcomes:** a. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. (MS-LS1-8)				
	Prepared Graduate 6. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how living systems interact with the biotic and abiotic environment.				
	Grade Level Expectation: MS.2.5 Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with nonliving. **Evidence Outcomes:** a. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. (MS-LS2-1) b. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. (MS-LS2-2) **Grade Level Expectation: MS.2.6. Ecosystems are sustained by the continuous flow of energy, originating primarily from the sun, and the recycling of matter and nutrients within the system.** **Evidence Outcomes:** a. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (MS-LS2-3)				

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	Grade Level Expectation: MS.2.7. Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem. **Evidence Outcomes:** a. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. (MS-LS2-4) b. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (MS-LS2-5)				
	Prepared Graduate 7. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how genetic and environmental factors influence variation of organisms across generations.				
	Prepared Graduate 8. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how natural selection drives biological evolution accounting for the unity and diversity of organisms.				
	Grade Level Expectation: MS.2.8. Heredity explains why offspring resemble, but are not identical to, their parents and is a unifying biological principle. Heredity refers to specific mechanisms by which characteristics or traits are passed from one generation to the next via genes. **Evidence Outcomes:** a. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. (MS-LS3-1) b. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. (MS-LS3-2)				

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	Grade Level Expectation: MS.2.9 Fossils are mineral replacements, preserved remains, or traces of organisms that lived in the past. **Evidence Outcomes:** a. 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-LS4-1) b. 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-LS4-2) c. 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. (MS-LS4-3) **Grade Level Expectation: MS.2.10 Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment.** **Evidence Outcomes:** a. 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. (MS-LS4-4) c. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. (MS-LS4-6) **Grade Level Expectation: MS.2.11. Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions.** **Evidence Outcomes:** a. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. (MS-LS4-6)				

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	Grade Level Expectation: MS.2.12. Biodiversity is the wide range of existing life forms that have adapted to the variety of conditions on Earth, from terrestrial to marine ecosystems. **Evidence Outcomes:** a. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (MS-LS2-5)				
3	**Earth and Space Science**	**30**	**7**	**6**	**5**
	Prepared Graduate 9. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding the universe and Earth's place in it.				
	Grade Level Expectation: MS.3.1 Motion is predictable in both solar systems and galaxies. **Evidence Outcomes:** a. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. (MS-ESS1-1) b. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. (MS-ESS1-2) **Grade Level Expectation: MS.3.2 The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons.** **Evidence Outcomes:** a. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. (MS-ESS1-2) b. Analyze and interpret data to determine scale properties of objects in the solar system. (MS-ESS1-3) c. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. (MS-ESS1-1)				

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	Prepared Graduate 10. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how and why Earth is constantly changing.				
	Prepared Graduate 11. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how human activities and the Earth's surface processes interact.				
	Grade Level Expectation: MS.3.3 Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history. **Evidence Outcomes:** a. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. (MS-ESS1-4) **Grade Level Expectation: MS.3.4 Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.** **Evidence Outcomes:** a. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. (MS-ESS2-1) b. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (MS-ESS2-2) **Grade Level Expectation: MS.3.5 Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history.** **Evidence Outcomes:** a. 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-ESS2-3)				

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	Grade Level Expectation: MS.3.6 Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features. **Evidence Outcomes:** a. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (MS-ESS2-2) b. 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-ESS2-4) c. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. (MS-ESS2-5) d. 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-ESS2-6) **Grade Level Expectation: MS.3.7 Complex interactions determine local weather patterns and influence climate, including the role of the ocean.** **Evidence Outcomes:** a. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. (MS-ESS2-5) b. 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-ESS2-6) **Grade Level Expectation: MS.3.8 Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.** **Evidence Outcomes:** a. 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-ESS3-1)				

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	Grade Level Expectation: MS.3.9 Mapping the history of natural hazards in a region and understanding related geological forces. **Evidence Outcomes:** a. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. (MS-ESS3-2) **Grade Level Expectation: MS.3.10 Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things.** **Evidence Outcomes:** a. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. (MS-ESS3-3) b. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. (MS-ESS3-4)				
4	**Science and Engineering Practices (SEP)**	**65-74**			
All Standards	**Item Types**				
	Selected Response and Technology Enhanced Items	**54**			
	Constructed Response Items	**46**			
Total		**100**	**21**	**24**	**16**

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