Semester 1/Quarter 1
6th Grade Earth and Space Science

Unit 1: Matter

Essential Question: How does an atoms structure determine the characteristics of matter?

Teaching time required: 6 weeks

Day(s)	Topic(s) Vocabulary	State Standard(s) and Practices	Objectives	Resources and Materials	Labs and Projects	Supporting Questions
2-4 days per obj. 1 month or so	atom elements molecules compound protons electrons neutrons periodic table	**MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures.	Students will: • Analyze various models of atom and construct a variety of models of atoms including protons, electrons, and neutrons. • Distinguish between an element and a compound through real life examples and purpose for each. • Recognize that molecules range from simple to complex by giving examples of each such as carbon dioxide to DNA. • Understand that substances are made from different types of atoms, which combine with one another in various ways. • Explain how and why the periodic table is organized in a certain way.	• Text: Ch 2, Sections 1-2 • Atoms Basics–Science Spot Online Resources: • Atom Resources • Atom/ Periodic Table Tutorial • NOVA–Hunting the Elements • Brain Pop • Atoms and related concepts	• PHET–Atom Building Simulation • PHET–Molecule building simulation	• What is purpose of creating and analyzing the structure of atoms? • What is the different between an atom and molecule/ compound? • How is the periodic table organized and why? • How does an atoms/elements number of protons, electrons, and neutrons determine the properties of that atom/ element? • Why do some atoms bond with other atoms much easier than other others?

2-4 days for each obj. 2 weeks or so	matter states phase change solid liquid gas kinetic energy thermal energy temperature chemical/ physical change	**MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures.	Students will: • Identify what is matter and what is not matter by giving examples of each. • Describe the four main states of matter and their properties. • Illustrate through various models how matter changes phases. • Recognize that as atoms gain/loss energy molecular motion increases/decreases resulting in phase change. • Define and give examples of chemical and physical changes.	• Text: Ch 2, Section 3 • States of Matter Resources • NASA States of Matter Lessons • Matter Resource	• NMSI– Changing States Activity • Vernier Probe ware–Graphing Phase Change (temperature probe) • PHET States of Matter-Basics • PHET States of Matter Simulation • PHET Energy Changing Forms	• What are the characteristics of matter in different phases? • Why/How does matter change from one phase to another? • Why do various substances change phases at different temperature?
2-4 days per obj.	density mass volume ratio buoyancy	**MS-PS1-1** Develop models to describe the atomic composition of simple molecules and extended structures.	Students will: • Distinguish between objects of low density to high density. • State examples of objects that float and sink. • Investigate the relationship between mass and volume. • Form conclusions about why warm fluids rise and cool fluids sinks.	• Text: Ch 2, Section 3 • Brain Pop Density Related • Density Video-Basics	• Density Foldable and Resources • PHET Simulations: Density • Buoyancy • Fluid Pressure and Flow	• Why do objects float or sink? • What are the differences between low density and high density objects? • What do warmer fluids rise and cooler fluids sink?

Semester 1/Quarters 1&2
6th Grade Earth and Space Science

Unit 2: Weather and Human Impacts

Essential Questions: How is weather impacted by changing temperatures, pressures, and humidity's? How do human activities affect Earth systems? How do we know our global climate is changing?

Teaching time required: 8 weeks

Day(s)	Topic(s) Vocabulary	State Standard(s) and Practices	Objectives	Resources and Materials	Labs and Projects	Supporting Questions
2-4 days for each obj. 2 weeks or so	water cycle evaporation condensation precipitation atmosphere	**MS-ES S2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy	Students will: • Interpret how weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living	• Text: Ch 15, Sections 1, 2, 3 • NOAA Fresh Water Education Resources	• NMSI-Evaporation and Condensation • NMSI-Are you current on Convection?	• What is the relationship between energy and the processes of evaporation and condensation?

	convection-currents	from the sun and the force of gravity.	things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. • Understand how water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Understand how global movements of water and its changes in form are propelled by sunlight and gravity.	• Search NASA Education Resources and Lesson Plans: Meteorology filter • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Water Cycle • Teaching Earth Science: Classroom Activities and Lesson Plans from Geology.com	• NMSI-Molecular Motion Convection • PHET Glaciers • Weather and Atmosphere Unit	• How environmental conditions (temperature and precipitation) impact glacial mass budget; identify where snow accumulates in a glacier and justify why? • How does water influence weather, circulate in the oceans?
2 weeks	weather climate air mass low/ high pressure front humidity isobar isotherm jet stream meteorology radar	**MS-ES S2-5.** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.	Students will: • Explain how the ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. • Infer that weather patterns are so complex, weather can only be predicted probabilistically. • Analyze the complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. • Investigate how to use multiple variables and provide evidence to support explanations or solutions.	• Text: Ch 16, Sections 1, 2, 3 • NOAA Resources for Educators: Weather and Atmosphere • Search NASA Education Resources and Lesson Plans: Weather • Teaching Earth Science: Classroom Activities and Lesson Plans from Geology.com	• NMSI-Reasons for the Seasons • NMSI-Relative Humidity	• How does energy from the sun cause weather to change? • Why is weather so hard to predict? • What are technologies to gather evidence of changing weather conditions?
2 weeks	climate atmosphere	**MS-ES S2-6.** Develop and use a model to describe	Students will: • Interpret how weather and climate are influenced by	• Text: Ch 17, Sections 1, 2, 3, Ch 18, Sections 2, 3	• NMSI-Blowing in the Wind:	• What is the role of the sun?

	ocean motion convection-currents latitude-longitude thermal-energy	how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.	interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. • Explain how the ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. • Analyze the complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.	• NOAA Resources for Educators: Climate • Search NASA Education Resources and Lesson Plans: Climate • Teaching Earth Science: Classroom Activities and Lesson Plans from Geology.com	Mapping Air Currents • NMSI-Acid Rain Keeps Falling on my Head • NMSI-Emission Possible • PHET Molecules and light • PHET The Greenhouse Effect	• How does moving air and water impact the air, land and ocean? • What impact does the ocean absorbing the sun's energy have on ocean currents? • How does the movement of water in the atmosphere determine? • weather patterns?
2 weeks	human impact erosional forces restoration contamination climate-change renewable/nonrenewable energy global warming	**MS-ES S3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	Students will: • Collect and analyze data relating to human's impact on their environment. • Develop and or identify systems that monitor how humans are impacting the environment negatively or positively. • Demonstrate how human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. • Understand that typically and human populations and per-	• Text: Ch 20, Sections 1, 2, 3, Ch 21, Sections 1, 2, 3 • Pop Pollution Brain • Satellites Brain Pop • NOAA Resources for Educators: Climate • Search NASA Education Resources and Lesson Plans • Teaching Earth Science: Classroom Activities and Lesson Plans from Geology.com	• NMSI-Are You Meeting the Kyoto Protocol? Carbon Footprint • NMSI-Greenhouse Effect • PHET The Greenhouse Effect • Dams Unit Plan	• What are the ways humans impact the environment? • How does human activity alter availability of natural resources? • How are various organisms negatively and positively impacted by human activity? • What are ways that humans can monitor human's impact on their environment? • How can humans lessen their impact on the environment? • What are good data sources to analyze relating to human

			capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involve are engineered otherwise. • Construct explanations and design solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Design solutions to real life issues/ problems facing the environment that are consistent with scientific principles.			impact on the environment?

Semester 1/Quarter 2
6th Grade Earth and Space Science

Unit 3: The Solar System

Essential Question:

Teaching time required: 3 weeks

Day(s)	Topic(s) Vocabulary	State Standard(s) and Practices	Objectives	Resources and Materials	Labs and Projects	Supporting Questions
2-3 days	Earth/ terrestrial lunar/moon orbit rotation cycle/ pattern tilt axis seasons intensity	**MS-ES S1-1.** 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 season.	Students will: • Recognize how Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. • Understand that seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.	• Text: Ch 23, Section 1 • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Magnetic	• Text: Ch. 23 Lab–Earth's Spin • Earth Magnetic Field: Teaching Engineering lesson - Magnetic Fields • Space Unit	• What are some characteristics of the earth? • How can the motion of the Earth, moon, and the sun explain how eclipses occur? • How does the tilting of the Earth cause the seasons to change?
2-3 days	moon solar system eclipse apparent-motion	**MS-ES S1-1.** Develop and use a model of the earth-sun-moon system to describe the cyclic patterns of	Students will: • Recognize how the patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed,	• Text: Ch 23, Sections 2, 3 • Search NASA Educational Resources and	• NMSI-Moon Watch: Lunar Phases Model • Sun lesson	• What causes the moon to look different? • How can a model be used to demonstrate

		lunar phases, eclipses of the sun and moon, and season.	described, predicted, and explained with models. • Understand how a model of the solar system explains eclipses of the sun and the moon.	Lesson Plans: Moon • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Moon		an eclipse of the moon or the sun?
3–4 days	solar system asteroid asteroid belt gas planets/rocky planets star/sun comet meteorite	**MS-ES S1-3.** Analyze and interpret data to determine scale properties of objects in the solar system.	Students will: • Explain that solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • Recognize how the patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. • Understand that the solar system appears to have formed from a disk of dust and gas, drawn together by gravity. • Develop, use, and revise models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena.	• Text: Ch 24, Sections 1, 2, 3 • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Solar System • Search NASA Education Resources and Lesson Plans: Solar System • NASA Solar System Exploration • Teaching Earth Science: Classroom Activities and Lesson Plans from Geology.com	• NMSI-Not So Lost In Space • PHET My solar system • Mission to Mars Unit • PHET My solar system	• What makes up our solar system? • What would a scale model of the solar system look like? • How did the solar system form?
2-3 days	Gravity and Orbits planets moons suns comet meteorite asteroid observations	**MS-ES S1-2.** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.	Students will: • Explain that solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • Recognize how the patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed,	• NASA Wavelength: Search NASA Resources Earth and Space Science Education: Orbits • Search NASA Education Resources and Lesson Plans: Orbits • NASA Solar System	• PHET Gravity and Orbits Simulation	• What causes the planets to spin around the sun? • What causes galaxies and other objects in space to move in a particular path?

			described, predicted, and explained with models. • Identify that the solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • Understand that the solar system appears to have formed from a disk of dust and gas, drawn together by gravity. • Develop a model to describe unobservable mechanisms.	Exploration: Gravity and Mechanics		

Semester 2/Quarter 3
6th Grade Earth and Space Science

Unit 4: Space and Space Technology

Essential Question:

Teaching time required: 3 weeks

Day(s)	Topic(s) Vocabulary	State Standard(s) and Practices	Objectives	Resources and Materials	Labs and Projects	Supporting Questions
2-3 days	Making Observations of the Sky telescope Milky Way galaxy universe	**MS-ES S1-2.** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.	Students will: • Describe that the Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • Recognize how the patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. • Analyze data to extend quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	• Text: Ch 22 Section 1 • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Telescope • Teaching Earth Science: Classroom Activities and Lesson Plans from Geology.com	• Making a Simple Astrolabe • The Astrolabe • Text: Ch 22 Internet Lab: Star Sightings–record your sightings of Polaris • NMSI-Stars at Night are Big and Bright	• How did ancient people make observations of the stars? • What are the different types of instruments used to make observations of the sky today?

2-3 days	Electro-magnetic Spectrum waves frequency amplitude Aurora-Borealis	**MS-ES S1-3.** Analyze and interpret data to determine scale properties of objects in the solar system.	Students will: • Describe that the Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • Develop, use, and revise models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena.	• Text: Ch 22 Section 1 • Discovery Ed. Lesson Plan Library: Electromagnetic Spectrum • Search NASA Education Resources and Lesson Plans: Electromagnetic Spectrum • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Electromagnetic Spectrum	• PBS NOVA: Tour Electromagnetic Spectrum • PHET Wave on a String Simulation • PHET Radio Waves & Electro-magnetic Fields • PHET Wave Interference • PHET Bending Light • Chandra X-Ray Observatory Classroom Ready Activities	• How do we know what we know about the stars? • How is the electromagnetic spectrum classified?
2-3 days	Space Exploration	**MS-ES S1-2.** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system	Students will: • Develop, use, and revise models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena.	• Text: Ch 22 Sections 2, 3 • NMSI-Beyond the Black Hole • Search NASA Education Resources and Lesson Plans: Space Science filter • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Astronomy filter		• What are the differences between natural satellites, artificial satellites and space probes? • What are the benefits of the space shuttle and space station? • What applications of space technology go we use in everyday life?
2-3 days	Stars and Galaxies	**MS-ES S1-2.** Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. **MS-ES S1-3.** Analyze and interpret data	Students will: • Describe that the Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • Analyze and interpret data to determine similarities and differences in findings.	• Text: Ch 25, Sections 1, 2, 3, 4 • Cosmic Times Lesson Plans from NASA • Earth and Space Lessons from NASA		• What is the structure of our sun compared to other suns? • How do we describe vast distances in the universe? • What is the sun's position in the Milky Way?

		to determine scale properties of objects in the solar system.	• Define light year and use the concept to understand the scale of the universe.	• Search NASA Education Resources and Lesson Plans: Space Science filter • NASA Wavelength: Search NASA Resources Earth and Space Science Education: Astronomy filter		

Semester 2/Quarters 3 & 4
6th Grade Earth and Space Science

Unit 5: Plate Tectonics

Essential Question: What are the forces that cause the surface of the Earth to change gradually?

Teaching time required: 7 weeks

Day(s)	Topic(s) Vocabulary	State Standard(s) and Practices	Objectives	Resources and Materials	Labs and Projects	Supporting Questions
1-3 days per obj. 2-3 weeks	Plate tectonics Plate boundaries Fossils Rock types Sea floor-spreading Continents trenches	**MS-ES S2-3.** Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	Students will: • Explain that tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. • Analyze various maps of ancient land and water patterns based on investigations of rocks and fossils. • Illustrate or diagram how Earth's plates have moved great distances, collided or spread apart. • Investigate causes of tectonic plate movement by analyzing various forms of data to	• Plate Tectonics Text: Pgs. 276-278 • Fossil Text: Pgs. 362-369 • Web Resources • Earth's Structure–Tutorial • USGS Plate Tectonic Resource • Fossil Records Database • Earth Processes Video–Overview • Plate Tectonics Powers the Rock Cycle • Fossil Game • Fossil/ Layers Game	• PHET simulation-Plate Tectonics • Model of sea floor spreading • Fault Modeling Lab • Fossil Lesson • Plate tectonics Lesson	• What evidence is there that plate tectonics is real? • How do fossil records give clues to how plate tectonics work? • When seafloor spreading occurs how can magnetic reversals of lava give clues to the past? • How do the shapes of the continents help us to understand how the Earth has changed through plate motion?

			determine correlations between phenomena. • Identify different plate boundaries and predict future plate movement. • Determine how rock formations are correlated with various fault boundaries.			• Why do tectonic plates move and at different rates? • What role do convection currents in the Earth's mantle and crust.
1-2 days per obj. 2 weeks	time scales plate motion uplift subduction zones weathering erosion deposition geoscience catastrophic -event	**MS-ES S2-2.** Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales	Students will: • Analyze various time and spatial scales, make observations about scales purpose. • Investigate geoscience processes that occur quickly like a landslide, or slowly like plate motion, while also investigating processes that generally behave gradually but build up to catastrophic events like volcanic eruptions, earthquakes, or meteor impacts. • Understand and recognize how geoscience systems interact over large to small scales from microscope to global and how these systems have shaped Earth's history. • Understand how water's movement-both on land and underground-cause weathering and erosion. • Determine localized examples of geoscience processes such as erosion that impact the community negatively, and develop solutions to those processes from damaging life or property.	• Text: Ch 8-9 • Time Scale Related Lessons • Erosional Forces Chapter Resources • Brain Pop Erosion Related Videos	• Time Scale Project • NOVA interactive timescale • Glaciation PHET Simulation	• What are examples of events or processes on Earth that occur quickly and slowly? • Why do some of Earth's processes occur quickly while some occur slowly? • How do Earth's processes change the Earth's surface in various ways? • What can humans do to protect life and property from Earth's changes?
1-3 days per obj. 2-3 weeks	natural hazards catastrophic -events	**MS-ES S3-2.** Analyze and interpret data on natural hazards to	Students will: • Investigate how certain natural hazards are more predictable such as weather, while others	• National Geo Graphic Video Resource	• Make a Concept Map–Brain Pop • Earthquake Lesson	• Why some natural hazards harder to predict than others?

total	quantitative phenomena magnitude frequency innovation	forecast future catastrophic events and inform the development of technologies to mitigate their effects.	such as Earthquakes are not as predictable. • Analyze the history of local natural disasters and make predictions for future events. • Give examples of natural events that occur below ground and natural events that occur above ground. • Identify various technologies that record and monitor various natural events. • Examine/ analyze local data on natural hazards and create a plan to respond to various local threats to life and property	• Natural Disaster Resource/Data • Predicting Natural Disasters Resource • Brain Pop-Natural Disasters • NOVA–Earthquake disasters and predictions video	• Hurricane Lesson	• How can past natural disasters help to predict future events? • What is the difference between events that occur above ground vs below ground? • How has technology improved human's ability to predict and monitor natural events? • What local data sources can be used to help plan for future natural disasters?

Semester 2/Quarter 4
6th Grade Earth and Space Science

Unit 6: Rocks and Minerals

Essential Question:

Teaching time required: 7 weeks

Day(s)	Topic(s) Vocabulary	State Standard(s) and Practices	Objectives	Resources and Materials	Labs and Projects	Supporting Questions
1-4 periods of each obj. 3-4 weeks	rock cycle sediments time scales rock strata fossils relative age eon era period epochs ages	**MS-ES S1-4.** Construct a scientific explanation based on evidence from rock strata for how the geologic times scale is used to organize Earth's 4.6 billion year-old history.	Students will: • Investigate the rock cycle and rock formation by creating and evaluating models. • Interpret rock strata and organize Earth's history into a time scale. • Analyze rock strata and fossil records to understand relative dates vs. absolute scale. • Construct explanations and design solutions supported by multiple sources of evidence.	• Text: Rock Strata Pgs. 370-375 • Rock Cycle Tutorial • Rock Cycle Links • Rock Cycle Brain Pop	• NMSI–Sands of Time (relative dating and geologic time) • Module 6 • Rock Cycle Project • Rock Strata Activity	• How and why do rocks change form? • What clues can be analyzing rock strata help understand Earth's past? • How do fossil records give clues to Earth's past? • How do geologic time scales help to understand Earth's past? • How can a time scale be constructed to

			• Generate a time scale of part or all of Earth's history.			provide clear understanding of Earth's history?
2-4 days per obj. 3-4 weeks total	resources distribution biosphere renewable non-renewable hydrothermal	**MS-ES S3-1.** 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	Students will: • Determine how and why various mineral and water resources are distributed. • Analyze localized data of resource distribution and make predictions of how those resources ended up there. • Evaluate how humans depend on the Earth's land, ocean, atmosphere, and biosphere for many different resources. • Differentiate how resources are distributed unevenly around the planet because of past geologic processes. • Conclude that minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetime.	• Text: Ch 5–Earth's Energy and Mineral Resources Pgs. 120-141 • Alaska Mapping Resources • Alaska Mineral Map • Mineral Map Resource	• NMSI–Mineral Masters (investigating the weathering of rocks) Module 11	• Why are mineral and water resources distributed unevenly? • How does local data about resource distribution give clues to the resource placement? • What impact does mining have on local/ state resources? • In what ways do humans depend on the land, oceans, the atmosphere, and biosphere? • How have past geologic processes distributed resources unevenly? • What resources are renewable and nonrenewable?

Appendix

Appendix A: Inquiry and Process Skills
(Applied in content Units 1-6)

- Apply safe laboratory techniques
- Apply the process skills of the scientific method: observing, questioning, researching, predicting, hypothesizing, measuring, classifying, generalizing, inferring, concluding, communicating
- Select and use the appropriate tools: rulers, balances, graduated cylinders, microscopes, probeware, calculators, computers
- Apply SI measurements (the metric system) in a lab setting
- Differentiate between scientific hypotheses, theories, and laws
- Develop and revise models to describe, test, and predict interactions and phenomena
- Differentiate between science and engineering approaches
- Evaluate multiple solutions based on scientifically obtained evidence
- Identify and evaluate the sources used to support scientific statements
- Recognize and investigate the contributions of diverse individuals in advancing science and technology
- Recognize that scientific knowledge is refined over time as new evidence emerges

Appendix B: Engineering and Technology Standards
(Applied in content Units 1-7)

MS-ETS1-1. Define the criteria and constraints of a design problem to ensure a successful solution, accounting for relevant impact on people and the natural environment (simplified for clarity). **MTS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of a problem. **MTS-ETS1-3.** 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. **MTS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process to achieve an optimal design.

Appendix C: Experimental Design Lab Outline *(adapted from Science Olympiad Experimental Design event)*

Title:

Experimental Question:

What effect does _____ (IV) have on _____ (DV)?

Hypothesis:

If _____ *(how is independent variable manipulated?)*
then _____ *(how will the dependent variable respond?)*
because _____ *(describe rationale for hypothesis.)*

Variables:

Independent variable (IV): _____
Dependent variable (DV): _____
Constants: _____

Experimental control (standard of comparison):

_____

Schematic Diagram:

Data Table:

Organized by IV (X axis) and DV (Y axis)
Include multiple trials

IV	DV

Graph:

("TAILS": Title, Axes, Increments, Labels, Scale)

Qualitative Observations:

Conclusion:

Re-state hypothesis.
Analysis of data for patterns
Evaluation of data: was hypothesis supported?
Practical application
Recommendations for continued future research

Teacher note: This outline provides a framework for students to investigate a cause and effect relationship between numerical (quantitative) variables. (Example question: What effect does light intensity have on a plant's growth?)
This outline does not fit well with yes/no questions and categorical investigations. (Example question: Does a plant grow better in the shade or in direct sun?)
Although such investigations have an important role in scientific inquiry, they should serve as a scaffold to the higher level of investigation described in this outline.