Guidelines for Developing Science Curriculum

A Measurable Continuum of Performance Standards and Developmental Indicators

Early Childhood – Eighth Grade

Ralph Waldo Emerson: "Great men are they who see that the spiritual is stronger than any material force; that thoughts rule the world." There can be no greater goal for Catholic science education than to incorporate the spiritual with the material in pursuit of excellence.

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Introduction

The performance standards and developmental indicators included in this guide constitute a core of student learning in science. However, it does not incorporate all the learning students will accomplish and opportunities for student learning will continue to vary, change, and increase. Thus, refining and updating the science curriculum must be ongoing. It is the responsibility of individual schools, administrators, and teachers to build upon this continuum, enrich classroom experiences, and incorporate new knowledge and skills.

THE CASE FOR LEARNING STANDARDS

A Changing World

Technological breakthroughs, an explosion of information and global economies are just a few of the conditions that have changed dramatically in the past decade. To be successful in a world characterized by change, students will need to learn the basics, but the basics of 2011 go far beyond the basics of the past century to include knowledge and skills students will need to acquire new ways to learn that will serve them throughout their lives.

Sharing What Works

Shared standards have the potential to draw teachers, parents, schools and communities together to share their best ideas and practices and help each other adapt them for the conditions affecting their students. From lesson plans to test items, from scheduling methods to technology plans, the standards can provide an organizer for shared efforts to improve education. To paraphrase a famous saying, all teaching and learning is local, but the capacity for innovative ideas is infinite within those localities. The standards can be the vehicle for sharing and supporting many ways to help students learn.

High Expectations as a Component of Fairness

Research shows that students learn best when they are clear about what they are expected to know and do. Part of being fair to students is letting them know the standards for achievement.
Another part of being fair is to maintain the same high standards for all students, wherever they may live. Unfairness occurs when students may meet or even excel at local standards, but then move to a new community or leave home to attend college, only to find that other students have been held to higher expectations. Setting state standards is part of meeting the school's obligation to provide fair and equitable educational opportunities for all students.

Measuring Progress

To know if students are meeting the standards, their progress must be measured over time. Most of this measuring will occur in the classroom where teachers see students on a daily basis. There, teachers can check progress in many ways—by observing, questioning, reviewing work assignments, testing or judging projects and performances. Some of this measuring will occur through a variety of national and international tests taken by students' individual choice such as Advanced Placement (AP) exams or by voluntary participation of their schools in tests such as the National Assessment of Educational Progress (NAEP).

Each level of measurement in and of itself cannot provide a complete picture of student achievement. Taken together, however, a learning profile can emerge, allowing students, parents and educators to know how well students are doing and where improvements are needed. By extension, progress data can inform education commissions, communities and education agencies about where to make changes and improvements in programs, resources and support.
The standards and learning benchmarks in this document provide a "road map" for local measures of progress.

Being Accountable

Being accountable for results requires that everyone involved understand what results are desired. The goals, standards and benchmarks form the basis for this shared understanding.
From students to teachers to parents, from school administrators to education commissions, from employers to college admissions officers—all have some level of accountability for the results of education.
The adoption of the Learning Standards provides an opportunity for greater accountability. The standards define the desired results, with further definition supplied through classroom and standardized tests and shared examples of student work that meets high expectations. All responsible parties will have to define their own roles in producing the results and determine how they will convey that they have met their responsibilities.

Improving the Education System

Standards alone do not improve education. However, they provide the focus, the foundation, upon which other reforms must be anchored. For example, technology planning, because technology is woven throughout the Learning Standards, can and must be built around creating new learning opportunities for students. The analysis of student achievement data in relation to the Learning Standards will drive the improvement of teaching and learning

Understanding the Standards Framework

The Criteria for Standards

From the outset, the following set of criteria guided the writing of the goals, standards and benchmarks:

- The standards and benchmarks must be clear and meaningful to students, parents, educators, business representatives and the community at large.
- The standards and benchmarks should include an appropriate combination of knowledge and skills, not just facts alone or skills alone.
- The standards and benchmarks should build upon and go beyond the basics within each of the academic disciplines.
- The standards and benchmarks should be specific enough to convey what students should learn, but broad enough to allow for a variety of approaches to teaching, curriculum, course design and assessment.
- The standards and benchmarks should be specific enough to be used in assessing progress and improving students' learning.

The Philosophy Behind the Standards

In addition to the criteria used to write and edit the standards, the following statements summarize other important concepts that guided their development :

- The standards reflect what is generally agree upon as constituting a core of student learning. However, the standards cannot possibly incorporate all the learning students will accomplish. If schools and their communities believe that important content has been omitted, it is their responsibility to develop school-based standards to fill the void.
- Conditions affecting student learning continue to change. Thus, refinement and updating of the standards must be a continuous process.
- Workplace preparation is an important purpose of schooling. The standards incorporate knowledge and skills that will help enable students to be successful in the workplace of their choice, as well as in their roles as citizens, family members and participants in our society. The standards also create opportunities to integrate the academic and workplace knowledge and skills and learning opportunities to enhance students' ability to see connections between what is learned and practical applications of that learning.
- The standards must reflect the impact of technology on our world. It is important to recognize the increasing roles of visual and media literacy in communication. Thus, the standards include verbs such as "research", "develop", "share", and "compare" in addition to "read" and "observe", empowering students to communicate through visual images, animation and video in addition to text and classroom experiences.
- Students cannot be held accountable for achieving the standards if they do not have adequate and sufficient opportunities to acquire the identified knowledge and skills. Administrators and teachers must identify the nature and extent of such problems and develop solutions which will ensure that students have the necessary learning opportunities. That may require thinking about schooling in different ways and looking for new structures and approaches for educating students.

Early Childhood – Three and Four Year Olds Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principals and processes of scientific inquiry.

Benchmarks and Descriptors

11.A.ECa Uses senses to explore and observe materials and natural phenomena.

Three Year Olds

Use senses to observe and explore classroom materials and natural phenomena.
- observe classroom pets and plants
- look at natural objects and point out details
- wonder where bubbles come from when water is shaken in a plastic jar
- listen to an audio tape of familiar sounds and guess what the sounds are
- guess the identity of objects from their smell

Four Year Olds

Ask questions and use senses to observe and explore materials and natural phenomena.
- explore at the sand and water table
- observe ice cubes and snow at room temperature to see what happens
- listen to sounds from outside and identify the source
- take apart a flashlight or toy to see what is inside

11.A.ECb Collect, describe and record information.

Three year Olds

Begin to use simple tools and equipment for investigation

- look at a variety of objects through a large magnifying glass in a tripod and hand lenses
- use a baster or eye dropper to drop water into a container
- pump water out of a liquid soap container
- use water to make a water wheel spin around at the water table

Four Year Olds

Use simple tools and equipment for investigation

- use hand lenses to observe insects, rocks, shells, and a variety of objects
- use a simple microscope
- use binoculars to get a better look at an animal at a distance

Three Year Olds

Make comparisons among objects and comment on what they see

- examine rocks and shells
- look at pictures of bugs in books and make observations
- float and sink objects at the water table
- tell which rhythm instrument is making a sound

Four Year Olds

Make comparisons and begin to draw conclusions form observations

- collect leaves and describe the differences in color, shape, size, etc.
- compare and describe a variety of materials and fabrics at the collage table
- compare handprints with those of their classmates
- compare the properties of objects that float in water with objects that sink
- note the difference in speed of trucks and cars when rolled on different surfaces

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

11.B.ECa Use scientific tools such as thermometers, balance scales and magnifying glasses for investigation.

Three Year Olds

- see 11.A.ECb above
- use a balance scale to experiment with blocks and other small toys

Four Year Olds

- **see 11.A.ECb above**
- use a thermometer to observe the change in temperature when an ice cube or snow is added to a container of water
- make a prediction of which object is heavier and test the prediction using a balance scale

11.B.ECb Become familiar with the use of devices incorporating technology.

GOAL 12:
Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important:
This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A: Know and apply concepts that explain how living things function, adapt and change.

Benchmarks

12.A.ECa Investigate and categorize living things in the environment.

12.A.ECb Show an awareness of changes that occur in themselves and their environment.

Learning Standard

B: Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmark

12.B.EC Describe and compare basic needs of living things.

Learning Standard

C: Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmark and Descriptors

12.C.EC Make comparisons among objects that have been observed.

Three Year Olds

- see **11.B.ECa**

Four Year Olds

- see **11.B.ECa**

Learning Standard

D: Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

12.D.EC Describe the effects of forces in nature (e.g. wind, gravity and magnetism).

Learning Standard

E: Know and apply the concepts that describe the features and processes of the earth and its resources.

Benchmarks and Descriptors

12.E.ECa Use common weather-related vocabulary (e.g. rainy, snowy, sunny, windy).
12.E.ECb Participate in recycling in their environment.

Learning Standard

F: Know and apply concepts that explain the composition and structure of the universe and the Earth's place in it.

Benchmark and Descriptors

12.F.EC Identify basic concepts associated with night/day and seasons.

Learning Standard

D: Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

12.D.EC Describe the effects of forces in nature (e.g. wind, gravity and magnetism).

Learning Standard

E: Know and apply the concepts that describe the features and processes of the earth and its resources.

Benchmarks and Descriptors

12.E.ECa Use common weather-related vocabulary (e.g. rainy, snowy, sunny, windy).
12.E.ECb Participate in recycling in their environment.

Learning Standard

12.F: Know and apply concepts that explain the composition and structure of the universe and the earth's place in it.

Benchmark and Descriptors

12.F.EC Identify basic concepts associated with night/day and seasons.

GOAL 13

Understand the relationships among science, technology and society in historical and contemporary contexts.

Learning Standard

A: Know and apply the accepted practices of science.

Benchmark

13.A.EC Begin to understand basic safety practices.

Learning Standard

B: Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

13.B.ECa Express wonder and ask questions about their world.
13.B.ECb Begin to be aware of technology and how it affects their lives.

Kindergarten
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

11.A.Ka Use senses to explore and observe materials.

- note the different ways that insects move (crawling, hopping, flying)
- smell flowers and commenting on their scents
- describe and record the day's weather on a chart
- take apart a flashlight to see what is inside.

11.A.Kb Begin to develop questions on scientific topics, such as natural phenomena.

- investigate phenomena observed, such as plants growing, the effect of pollination or change in the seasons

11.A.Kc Seek information through observation, exploration, and investigations.

- inspect an object and comment on its features (e.g., a bird's nest, a chrysalis, and a plant)
- explore absorption of a variety of different materials (paper towels, cotton cloth, netting, waxed paper) to see which absorbs more water
- create ramps and run various sizes of cars down the ramps to see if some cars go faster than others
- figure out ways, with teacher help, to investigate phenomena they have observed

11.A.Kd Collect, describe, compare and record information.

- .become more accurate and precise when recording observations (e.g., counting the number of ridges on a shell or trying to use all of the senses when observing).

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

11.B.Ka Use simple tools and equipment to enhance observation and gather data.

- collect information using a variety of tools: ruler, balance scale, hand lens, thermometer, etc.

11.B.Kb Become familiar with the use of devices incorporating technology.

- use technology to problem solve.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

12.A.Ka Observe, categorize, and describe characteristics, basic needs, and life cycles.

- sort a collection into two categories: living things and non-living things

12.A.Kb Show an awareness of changes that occur in themselves and their environment.

- describe changes in nature throughout the year,

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

12.B.K Describe and compare basic needs of living things.

- compare the needs of a variety of living things.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

12.C.K Identify, describe, and compare properties of objects (e.g., size, shape, and color).

- describe similarities and differences among objects.

Learning Standard

D. **Know and apply concepts that describe force and motion and the principles that explain them.**

Benchmarks and Descriptors

12.D.K Describe the effects of forces in nature.

- explore simple forces around us (e.g., wind, gravity, and magnetism.)

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

13.A.Ka Begin to understand and use basic safety practices.

- practice appropriate safety procedures.

13.A.Kb Use observation skills to learn to document changes in science.

- Observe various processes and hypothesize answers to "why" and "what" questions.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society

Benchmarks and Descriptors

13.B.Ka Express curiosity and ask questions about their world.

- formulate questions about the environment.

13.B.Kb Recognize common scientific instruments.

- use scientific instruments to explore the environment (e.g., thermometer, balance, and computer).

13.B.Kc Form explanations and communicate scientific information.

- record scientific changes.

13.B.Kd Begin to be aware of technology and how it affects their lives.

- identify technology (e.g., remote control, computer, and microwave).

13.B.Ke Begin to understand ways to reduce, reuse, and recycle materials.

- participate in separating paper and cans for trash collection.

First Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.1a Describe an observed event.

Stage A
Describe an observed science concept,

- using appropriate senses, or
- making applicable estimations and measurements, or
- predicting steps or sequences, or
- describing changes in terms of starting and ending conditions using words, diagrams or graphs.

Stage B
Describe observed science event,

- sequencing processes or steps, or
- choosing/proposing causes or effects based on observations, or
- using measurable and descriptive attributes and units.

11.A.1b Develop questions on scientific topics.

Stage A
Begin guided inquiry
- asking questions using prior knowledge and observations, or
- inferring from observations to generate new questions, or
- developing strategies to investigate questions.

Stage B
Begin guided inquiry investigations about objects, events, and/or organisms that can be tested,
- asking pertinent questions, or
- predicting conditions that can influence change, or
- determining simple steps to follow to investigate selected question(s).

11.A.1c Collect data for investigations using measuring instruments and technologies.

Stage A
Conduct guided inquiry,
- following appropriate procedural steps and safety precautions as directed by teacher.

Stage B
Conduct guided inquiry,
- assembling proper materials and equipment, or
- following appropriate procedural steps and safety precautions.

11.A.1d Record and store data using available technologies.

Stage A
Record and store data,
- assembling pictures to illustrate data, or
- organizing data on charts and pictographs, tables, journals or computers.

Stage B
Collect data for investigations,
- choosing and using appropriate instruments and units, or
- recording data on classroom charts, tables, journals or on computers, or
- sorting or modifying pictures or drawings that illustrate data.

11.A.1e Arrange data into logical patterns and describe the patterns.

Stage A
Analyze and display results,
- recognizing and describing patterns, or
- noting similarities and differences in patterns, or
- predicting trends.

Stage B
Analyze results investigation
- organizing data on graphs or charts, or
- constructing reasonable and accurate explanations from data, or
- applying qualitative and quantitative terminology that describes observed data patterns.

11.A.1f Compare observations of individuals and groups.

Stage A
Communicate individual and group results,
- identifying similar data from others, or
- generalizing data, or
- drawing simple conclusions, or
- suggesting more questions to consider.

Stage B
Communicate results of individual and group investigation
- matching similar data from other data sources, or
- identifying reasons for differences or discrepancies in the data, or
- selecting data that can be used to predict future events or data trends, or
- generating questions for possible future inquiry investigations.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.1a Given a simple design problem, formulate possible solutions.

Stage A
Propose ideas for solutions to technological design questions,
- asking questions about concept (e.g., how to demonstrate that sound is produced by vibrating objects), or
- identifying criteria for measuring success of design, or
- prioritizing possible solutions from given list.

Stage B
Propose ideas for solutions to technological design problem,
- asking questions about causes and effects of concept to model or test (e.g., how to test 'if-then' effects of magnets, batteries, sound, buoyancy), or
- identifying criteria for measuring success of design, or
- prioritizing possible solutions from given list.

11.B.1b. Design a device that will be useful in solving problems.

Stage A
Select a possible solution which addresses the design question,
- choosing materials from teacher-generated options, or
- determining the order of assembly steps, or
- identifying the variables for testing criteria factors, or
- proposing procedural steps to test design, or
- sketching the projected final design.

Stage B
Begin a design solution,
- choosing procedural steps for construction and testing from teacher-generated options, or
- suggesting the variables for testing criteria factors, or
- sketching the projected final design.

11.B.1c. Build the device using the materials and tools provided.

Stage A
Construct the selected technological solution,
- using the materials and tools provided, or
- recording observational data for design process.

Stage B
Construct the selected technological design,
- using the materials and tools provided, or
- recording anecdotal data from design process, or
- evaluating construction success.

11.B.1d. Test the device and record results using given instruments, techniques, and measurement methods.

Stage A and B
Test for design success based on teacher-generated criteria,
- conducting multiple trials, or
- collecting data from tests using appropriate measurement methods.

11.B.1e. Report the design of the device, the test process, and the results in solving a given problem .

Stage A
Communicate results of design tests,
- comparing data from student trials to evaluate design success, or
- reporting the procedures followed, or
- evaluating best design to solve technological design question, or
- proposing modifications for design solution in additional trials.

Stage B

Communicate results of design tests,

- presenting group results which include data from student trials to evaluate design success in testing scientific principle, procedures followed, suggestions for second round of design, or
- evaluating best design to solve technological problem.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

12.A.1a. Identify and describe the component parts of living things (eg., birds have feathers; people have bones, blood, hair, skin) and their major functions.

Stage A
Apply scientific inquiries or technological designs to introduce basic needs, characteristics and component parts of living things,

- comparing living and non-living things, or
- describing basic needs and characteristics of living things, or
- sorting the common key structures and functions for animal and plant groupings, or
- classifying common animals by size, color, family units, and shape, and explaining the rationale for the grouping, or
- distinguishing common physical characteristics or structures for groupings of animals or plants with regard to seasonal, age changes and parent characteristics.

Stage B
Apply scientific inquiries or technological designs to explore common and diverse structures and functions of living things,

- describing how plants and animals obtain energy, or
- categorizing animals by structures for food-getting and movement, or
- comparing how plants and animals live and reproduce, or
- associating common plant products with plant structures and functions, or
- comparing common and distinctive plants' or animals' growth cycles, structures and functions.

12.A.1b. Categorize living organisms using a variety of observable features (e.g., size, color, shape, backbone).

Stage A

Apply scientific inquiries or technological designs to introduce basic needs, characteristics and component parts of living things,

- classifying common animals by size, color, family units, and shape, and explaining the rationale for the grouping, or
- distinguishing common physical characteristics or structures for groupings of animals or plants with regard to seasonal, age changes and parent characteristics.

Stage B

Apply scientific inquiries or technological designs to explore common and diverse structures and functions of living things,

- describing how plants and animals obtain energy, or
- categorizing animals by structures for food-getting and movement, or
- comparing how plants and animals live and reproduce, or
- associating common plant products with plant structures and functions, or
- comparing common and distinctive plants' or animals' growth cycles, structures and functions.

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

12.B.1a. Describe and compare characteristics of living things in relationship to their environments.

Stage A

Apply scientific inquiries or technological designs to explore the relationships of living things to their environment,

- identifying the common characteristics of habitats, or
- matching the needs of organisms in local and global habitats.

Apply scientific inquiries or technological designs to explore how living things are dependent on one another for survival,

- identifying the survival needs of plants and animals, or
- matching groupings of animals (e.g., lion's pride, gaggle of geese, herds, packs), or
- predicting what would happen to organisms when their environmental resources are changed (i.e., seasonally or climatically), or
- explaining how humans adapt to their environments.

Stage B

Apply scientific inquiries or technological designs to explore the impact of plants and animals in their changing environments,

- identifying factors that affect animal and plant growth and reproduction, or
- matching plant and animal adaptations to changing seasons or climatic changes.

Apply scientific inquiries or technological designs to examine how plants and animals (including humans) survive together in their ecosystems,

- describing the food chains or webs in various ecosystems, or
- identifying local habitats, or
- identifying predator/prey and parasite/host relationships.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

12.C.1a. Identify and compare sources of energy (e.g. batteries, the sun).

Stage A

Apply scientific inquiries or technological designs to examine forms of energy,

- exploring sources and types of energy in familiar situations, or
- experimenting with sounds by vibrating different materials, or
- exploring ways that heat, light and sound are produced naturally and artificially.

Stage B

Apply scientific inquiries or technological designs to demonstrate energy sources,

- constructing and testing simple electrical circuits with batteries, or
- demonstrating how sound is produced by vibrating objects, or
- analyzing which energy sources power different objects.

12.C.1b. Compare large-scale physical properties of matter (e.g. size, shape, color, texture, odor).

Stage A

Apply scientific inquiries or technological designs to explore the states and properties of matter,

- comparing solids, liquids and gases and how they change states, or
- sorting objects by similar large-scale physical properties.

Stage B
Apply scientific inquiries or technological designs to compare qualitative and quantitative properties of matter,
- identifying component materials in objects, or
- classifying objects or materials according to variable masses, volumes, temperatures, and states, or constants such as texture, odor, magnetism and buoyancy.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.1a. Identify examples of motion (e.g., moving in a straight line, vibrating, rotating).

Stage A
Apply scientific inquiries or technological designs to explore simple forces around us,
- describing how push or pull may affect the motion of objects, or
- classifying materials by their magnetic attraction or repulsion, or
- sorting examples of simple machines.

Stage B
Apply scientific inquiries or technological designs to compare and contrast common forces around us,
- dramatizing the ways that forces cause action and reaction behaviors of common objects, or
- distinguishing the work of simple machines, or
- describing the attraction and repulsion of magnetic and electrical fields, or
- sorting examples of natural or man-made forces.

12.D.1b. Identify observable forces in nature (e.g., pushes, pulls, gravity, magnetism).

Stage A
Apply scientific inquiries or technological designs to explore the simple concepts of motion,
- changing the position and motion of objects, or
- showing simple inertia and momentum in real-world applications.

Stage B
Apply scientific inquiries or technological designs to make connections between the basic concepts of motion to real world applications,
- describing how gravity affects motion, or
- demonstrating the rate, time and distance factors and units for speed, or
- describing examples of inertia and momentum in the classroom, playground and at home.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.1a. Identify components and describe diverse features of the Earth's land, water, and atmospheric systems.

Stage A
Apply scientific inquiries or technological designs to introduce the Earth's land, water and atmospheric components,

- sorting pictures of different land features, or
- identifying the basic features of globes or maps, or
- classifying major sources or uses of water, or
- sketching atmospheric features seen in the sky over time.

Stage B
Apply scientific inquiries or technological designs to demonstrate the properties of Earth's basic materials,

- describing different types and uses of Earth's rocks, soils and minerals, or
- identifying major sources/locations of water on the planet, or
- identifying major Earth and atmospheric features from photographs including those from satellites.

12.E.1b. Identify and describe patterns of weather and seasonal change.

Stage A
Apply scientific inquiries or technological designs to introduce weather and seasonal changes,

- collecting daily weather data, or
- predicting local weather conditions based on collected data, or
- associating seasonal variations of weather data, or
- creating pictographs or other graphic displays of local weather patterns.

Stage B
Apply scientific inquiries or technological designs to examine the natural processes that change Earth's surface,

- modeling erosion processes in various soil compositions, or
- comparing different water flow models for weathering impact, or
- identifying water cycle in local weather conditions and features.

12.E.1c. Identify renewable and non renewable natural resources.

Stage A
Apply scientific inquiries or technological designs to classify renewable and non-renewable natural resources,

- sorting different examples of simple natural resources, or
- identifying the origin of these examples with their recyclable possibilities, or
- setting and working toward a possible recycling or reusing goal for classroom application effort.

Stage B
Apply scientific inquiries or technological designs to examine various renewable or non-renewable resources,

- comparing different paper, glass or plastic composition examples, or
- collecting data about paper, glass or plastic consumption at school over time, or
- predicting futuristic resource uses and availabilities.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.1a. Identify and describe characteristics of the sun, Earth, and moon as familiar objects in the solar system.

Stage A
Apply scientific inquiries or technological designs to explore the familiar objects of the solar system,

- identifying the easily visible components, or
- exploring their relative sizes using scale models, or
- recording daily and/or nightly moon sightings, or
- introducing space mission studies.

Stage B
Apply scientific inquiries or technological designs to describe the main bodies in the solar system,

- identifying the sizes, distances, and relationships of them, or
- relating Earth's dependence on the Sun for heat and light, or
- modeling the phases of the Moon, or
- suggesting how and why people have studied and explained the solar system through time.

12.F.1b. Identify daily, seasonal, and annual patterns related to the Earth's rotation and revolution.

Stage A
Apply scientific inquiries or technological designs to explore the explanations of the daily and annual patterns of the Earth's motion,
- recording observations of the daily path of the sun over time, or
- comparing shadows during a day, or
- observing the daily and seasonal differences of the day and night sky.

Stage B
Apply scientific inquiries or technological designs to explain the seasonal and annual motions of the Earth and other planets in relation to the Sun,
- modeling the Earth's motion in relation to the Sun during the day, night, year, or
- introducing the comparative orbits of planets in the solar system, or
- relating the moon's orbit to its observed phases, or
- using constellation models to explain apparent changes in the night sky.

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.1a. Use basic safety practices (e.g. not tasting materials without permission, "stop/drop/roll").

Stage A
Apply the appropriate principles of safety,
- using established classroom safety, order and cleanliness rules during science inquiry or design investigations, or
- applying general science rules in home and playground settings, or
- role-playing what should be done in case of fire, or
- explaining when and why electricity can be harmful and helpful, or

● reinforcing decision-making skills related to the promotion and protection of individual health.

Stage B
Apply the appropriate principles of safety,
● explaining the dangers of electricity to applicable classroom and home situations, or
● refraining from tasting unknown substances, or
● mapping pathways to leave classroom or home in case of fire or severe weather situations, or
● identifying safety hazards associated with classroom science inquiry or design investigations.

13.A.1b. Explain why similar results are expected when procedures are done the same way.

13.A.1c. Explain how knowledge can be gained by careful observation.

Stage A
Apply scientific habits of mind,
● valuing the importance of recording scientific data accurately and honestly in inquiry and design investigations, or
● comparing observations by different students observing the same activity, or
● proposing reasons for differences in observations, or
● reporting data from repeated observations across timed intervals.

Stage B
Apply scientific habits of mind,
● proposing ways to test student-generated predictions for science-conceptual relationships, or
● practicing how scientists generate questions for possible studies, or
● relating knowledge that was gained through careful, repeated observations by classmates, or
● distinguishing hypotheses from guesses.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.1a. Explain the uses of common scientific instruments (e.g., ruler, thermometer, balance, probe, computer).

13.B,1b. Explain how using measuring tools improves the accuracy of estimates.

Stage A
Apply the use of appropriate scientific tools in inquiry or design investigations,
- using instruments for measuring length and temperature, or
- recording values with accuracy.

Stage B
Apply the use of appropriate scientific technologies in inquiry and design investigations,
- selecting appropriate technologies for measuring and recording data, or
- comparing accuracy of estimations and precise measurements, or
- sequencing appropriate steps for instructed use of equipment, or
- investigating the technology of measuring time in history

13.B.1c. Describe contributions men and women have made to science and technology.

Stage A
Explore the contributions of men and women in the life, environmental, physical, earth and space sciences,
- identifying individuals and their discoveries or inventions, or
- explaining how scientists have advanced our knowledge in real life.

Stage B
Correlate careers and avocations in life, environmental, physical, earth and space sciences to important historical events and ordinary daily life,
- studying applicable personal interest stories, or
- reporting on specific examples of how scientists or technologists have affected society.

13.B.1d. Identify and describe ways that science and technology affect people's everyday lives (e.g., transportation, medicine, agriculture, sanitation, communication, occupations).

Stage A
Describe ways that science and technology are found in real-world situations,
- identifying familiar jobs and careers from science fields, or
- inferring the impact of science and technologies in their lives, or
- identifying how technologies make work easier, faster or more efficient, or
- describing ways that scientists are working to solve problems.

Stage B
Describe the science connections to the fields of transportation, medicine, agriculture, sanitation, communication,
- associating these fields to pertinent life, environmental, physical, earth and space science concepts, or
- describing ways sciences and technology have affected societal problems in the past, present and projected future, or
- identifying types and causes of pollutions, or
- applying the practices of reducing, reusing, or recycling renewable resources.

13.B.1e. Demonstrate ways to reduce, reuse, and recycle materials.

Stage A

Demonstrate an understanding of conservation and the need to protect natural resources,

- identifying types and causes of pollution, or
- listing materials that can be recycled, or
- suggesting ideas for reducing, reusing, or recycling renewable resources.

Stage B

Describe ways sciences and technology have affected societal problems in the past, present and projected future,

- identifying types and causes of pollutions, or
- applying the practices of reducing, reusing, or
- recycling renewable resources.

Second Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.1a Describe an observed event.

Stage A
Describe an observed science concept,
- using appropriate senses, or
- making applicable estimations and measurements, or
- predicting steps or sequences, or
- describing changes in terms of starting and ending conditions using words, diagrams or graphs.

Stage B
Describe observed science event,
- sequencing processes or steps, or
- choosing/proposing causes or effects based on observations, or
- using measurable and descriptive attributes and units.

Stage C
Describe an observed (cause and effect) science experience or situation,
- using the appropriate attributes, units and tools, or
- classifying observations into characteristic, sequential or cause-and-effect categories, or
- describing phenomenon in terms of starting and ending conditions, types of changes.

11.A.1b Develop questions on scientific topics.

Stage A
Begin guided inquiry
- asking questions using prior knowledge and observations, or
- inferring from observations to generate new questions, or
- developing strategies to investigate questions.

Stage B
Begin guided inquiry investigations about objects, events, and/or organisms that can be tested,
- asking pertinent questions, or
- predicting conditions that can influence change, or
- determining simple steps to follow to investigate selected question(s).

Stage C
Devise inquiry investigation,
- brainstorming possible questions for investigation consideration, or
- prioritizing questions for inquiry, or
- wording questions into appropriate hypotheses, or
- choosing the procedural steps, or
- creating data collection format to address selected hypothesis.

11.A.1c Collect data for investigations using measuring instruments and technologies.

Stage A
Conduct guided inquiry,
- following appropriate procedural steps and safety precautions as directed by teacher.

Stage B
Conduct guided inquiry,
- assembling proper materials and equipment, or
- following appropriate procedural steps and safety precautions.

Stage C
Collect data from inquiry investigations,
- selecting and using the appropriate data-gathering instruments, or measurable unit.

11.A.1d Record and store data using available technologies.

Stage A
Record and store data,
- assembling pictures to illustrate data, or
- organizing data on charts and pictographs, tables, journals or computers.

Stage B
Collect data for investigations,
- choosing and using appropriate instruments and units, or
- recording data on classroom charts, tables, journals or on computers, or
- sorting or modifying pictures or drawings that illustrate data.

Stage C
Collect data from inquiry investigations,
- reading and recording data into student-created tables, charts, or journals.

11.A.1e Arrange data into logical patterns and describe the patterns.

Stage A
Analyze and display results,
- recognizing and describing patterns, or
- noting similarities and differences in patterns, or
- predicting trends.

Stage B
Analyze results investigation
- organizing data on graphs or charts, or
- constructing reasonable and accurate explanations from data, or
- applying qualitative and quantitative terminology that describes observed data patterns.

Stage C
Analyze results or data pattern,
- noting similarities and differences, or
- summarizing for cause or effect, or
- constructing reasonable and accurate explanations of data, or
- identifying reasons why similar investigations may not always have the same results.

11.A.1f Compare observations of individuals and groups.

Stage A
Communicate individual and group results,
- identifying similar data from others, or
- generalizing data, or
- drawing simple conclusions, or
- suggesting more questions to consider.

Stage B
Communicate results of individual and group investigation
- matching similar data from other data sources, or
- identifying reasons for differences or discrepancies in the data, or
- selecting data that can be used to predict future events or data trends, or
- generating questions for possible future inquiry investigations.

Stage C
Communicate conclusions from individual and group results,

- displaying appropriate data analysis tables and charts, or
- describing patterns from personal and group data, or
- proposing causes or effects from data comparisons, or
- suggesting additional questions from analyzed procedures, similarities, discrepancies, or conclusions.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.1a Given a simple design problem, formulate possible solutions.

Stage A
Propose ideas for solutions to technological design questions,

- asking questions about concept (e.g., how to demonstrate that sound is produced by vibrating objects), or
- identifying criteria for measuring success of design, or
- prioritizing possible solutions from given list.

Stage B
Propose ideas for solutions to technological design problem,

- asking questions about causes and effects of concept to model or test (e.g., how to test 'if-then' effects of magnets, batteries, sound, buoyancy), or
- identifying criteria for measuring success of design, or
- prioritizing possible solutions from given list.

Stage C
Describe an observed cause and effect technological design dilemma,

- generating critical and creative questions associated with design dilemma (e.g., how to test the effect of friction, or how light is reflected, or how toy cars accelerate), or
- recording observations into sequential or cause and effect categories, or
- describing dilemma in terms of starting conditions, types of changes and ending conditions.

11.B.1b. Design a device that will be useful in solving problems.

Stage A
Select a possible solution which addresses the design question,

- choosing materials from teacher-generated options, or

- determining the order of assembly steps, or
- identifying the variables for testing criteria factors, or
- proposing procedural steps to test design, or
- sketching the projected final design.

Stage B
Begin a design solution,
- choosing procedural steps for construction and testing from teacher-generated options, or
- suggesting the variables for testing criteria factors, or
- sketching the projected final design.

Stage C
Begin design investigation of cause and effect dilemma,
- describing design conditions of the phenomenon that can be influenced by change, or
- brainstorming possible questions related to causes and effects of phenomenon, or
- prioritizing design options for design investigation, or
- generating success criteria, or
- choosing the procedural steps to address selected design plan.

11.B.1c. Build the device using the materials and tools provided.

Stage A
Construct the selected technological solution,
- using the materials and tools provided, or
- recording observational data for design process.

Stage B
Construct the selected technological design,
- using the materials and tools provided, or
- recording anecdotal data from design process, or
- evaluating construction success.

Stage C
Construct design prototype,
- selecting the appropriate materials, or
- designing necessary data tables for addressing success criteria, or
- using materials and tools provided.

11.B.1d. Test the device and record results using given instruments, techniques, and measurement methods.

Stage A and B
Test for design success based on teacher-generated criteria,
- conducting multiple trials, or
- collecting data from tests using appropriate measurement methods.

Stage C

Collect data from prototype testing,

- recording multiple incremental data sets and procedural observations, or
- keeping accurate procedural journals and drawings.

Display and analyze results,

- summarizing individual data patterns, or
- constructing reasonable and accurate explanations of data, or
- identifying reasons why different designs can accomplish the same effect differently.

11.B.1e. Report the design of the device, the test process, and the results in solving a given problem .

Stage A

Communicate results of design tests,

- comparing data from student trials to evaluate design success, or
- reporting the procedures followed, or
- evaluating best design to solve technological design question, or
- proposing modifications for design solution in additional trials.

Stage B

Communicate results of design tests,

- presenting group results which include data from student trials to evaluate design success in testing scientific principle, procedures followed, suggestions for second round of design, or
- evaluating best design to solve technological problem.

Stage C

Communicate design conclusions from individual and group results,

- describing patterns from data tables, or
- evaluating designs according to design success criteria, or
- generating design modifications from analyzed procedures, similarities, discrepancies, or conclusions.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

12.A.1a. Identify and describe the component parts of living things (eg., birds have feathers; people have bones, blood, hair, skin) and their major functions.

Stage A
Apply scientific inquiries or technological designs to introduce basic needs, characteristics and component parts of living things,

- comparing living and non-living things, or
- describing basic needs and characteristics of living things, or
- sorting the common key structures and functions for animal and plant groupings, or
- classifying common animals by size, color, family units, and shape, and explaining the rationale for the grouping, or
- distinguishing common physical characteristics or structures for groupings of animals or plants with regard to seasonal, age changes and parent characteristics.

Stage B
Apply scientific inquiries or technological designs to explore common and diverse structures and functions of living things,

- describing how plants and animals obtain energy, or
- categorizing animals by structures for food-getting and movement, or
- comparing how plants and animals live and reproduce, or
- associating common plant products with plant structures and functions, or
- comparing common and distinctive plants' or animals' growth cycles, structures and functions.

Stage C

Apply scientific inquiries or technological designs to explore past and present life forms and their adaptations,

- classifying plant and animal groupings according to simple taxonomy guides or characteristics (e.g., locomotion, color, habitat, reproduction), or
- categorizing body structures of living organisms to those from fossil studies, or
- suggesting why changes over time for individuals and groupings of plants and animals happened, or
- matching the basic organs and functions of major human body systems.

12.A.1b. Categorize living organisms using a variety of observable features (e.g., size, color, shape, backbone).

Stage A

Apply scientific inquiries or technological designs to introduce basic needs, characteristics and component parts of living things,

- classifying common animals by size, color, family units, and shape, and explaining the rationale for the grouping, or
- distinguishing common physical characteristics or structures for groupings of animals or plants with regard to seasonal, age changes and parent characteristics.

Stage B

Apply scientific inquiries or technological designs to explore common and diverse structures and functions of living things,

- describing how plants and animals obtain energy, or
- categorizing animals by structures for food-getting and movement, or
- comparing how plants and animals live and reproduce, or
- associating common plant products with plant structures and functions, or
- comparing common and distinctive plants' or animals' growth cycles, structures and functions.

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

12.B.1a. Describe and compare characteristics of living things in relationship to their environments.

Stage A

Apply scientific inquiries or technological designs to explore the relationships of living things to their environment,

- identifying the common characteristics of habitats, or
- matching the needs of organisms in local and global habitats.
-

Apply scientific inquiries or technological designs to explore how living things are dependent on one another for survival,

- identifying the survival needs of plants and animals, or
- matching groupings of animals (e.g., lion's pride, gaggle of geese, herds, packs), or
- predicting what would happen to organisms when their environmental resources are changed (i.e., seasonally or climatically), or
- explaining how humans adapt to their environments.

Stage B

Apply scientific inquiries or technological designs to explore the impact of plants and animals in their changing environments,

- identifying factors that affect animal and plant growth and reproduction, or
- matching plant and animal adaptations to changing seasons or climatic changes.
-

Apply scientific inquiries or technological designs to examine how plants and animals (including humans) survive together in their ecosystems,

- describing the food chains or webs in various ecosystems, or
- identifying local habitats, or
- identifying predator/prey and parasite/host relationships.

Stage C

Apply scientific inquiries or technological designs to explore past and current ecosystems,

- matching fossils of extinct organisms to their probable past ecosystems, or
- comparing extinct organisms and their past ecosystems to plants and animals that live in current comparable ecosystems.

Apply scientific inquiries or technological designs to examine the interdependence of organisms in ecosystems,

- identifying adaptations that help animals survive in specific or multiple environments, or
- describing the interaction between living and non-living factors in an ecosystem, or
- predicting what can happen to organisms if they lose different environmental resources or ecologically related groups of organisms.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

12.C.1a. Identify and compare sources of energy (e.g. batteries, the sun).

Stage A
Apply scientific inquiries or technological designs to examine forms of energy,
- exploring sources and types of energy in familiar situations, or
- experimenting with sounds by vibrating different materials, or
- exploring ways that heat, light and sound are produced naturally and artificially.

Stage B
Apply scientific inquiries or technological designs to demonstrate energy sources,
- constructing and testing simple electrical circuits with batteries, or
- demonstrating how sound is produced by vibrating objects, or
- analyzing which energy sources power different objects.

Stage C
Apply scientific inquiries or technological designs to examine the flow of energy,
- measuring variations of heat absorption or reflection in objects, or
- comparing qualitative data about friction, or
- contrasting the transmission of sound through different materials, or
- describing how energy in different forms affects common objects in common events, or
- experimenting with the reflection of light, or
- analyzing simple wave studies.

12.C.1b. Compare large-scale physical properties of matter (e.g. size, shape, color, texture, odor).

Stage A
Apply scientific inquiries or technological designs to explore the states and properties of matter,
- comparing solids, liquids and gases and how they change states, or
- sorting objects by similar large-scale physical properties.

Stage B
Apply scientific inquiries or technological designs to compare qualitative and quantitative properties of matter,
- identifying component materials in objects, or
- classifying objects or materials according to variable masses, volumes, temperatures, and states, or constants such as texture, odor, magnetism and buoyancy.

Stage C
Apply scientific inquiries or technological designs to analyze simple properties and changes,

- matching examples of physical and chemical properties to common substances (e.g., mixtures, solutions, solids, liquids, gases), or
- categorizing common changes according to physical and chemical groupings, or
- explaining common examples of changes in terms of their physical or chemical nature.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.1a. Identify examples of motion (e.g., moving in a straight line, vibrating, rotating).

Stage A
Apply scientific inquiries or technological designs to explore simple forces around us,

- describing how push or pull may affect the motion of objects, or
- classifying materials by their magnetic attraction or repulsion, or
- sorting examples of simple machines.

Stage B
Apply scientific inquiries or technological designs to compare and contrast common forces around us

- dramatizing the ways that forces cause action and reaction behaviors of common objects, or
- distinguishing the work of simple machines, or
- describing the attraction and repulsion of magnetic and electrical fields, or
- sorting examples of natural or man-made forces.

Stage C
Apply scientific inquiries or technological designs to explain the concepts of motion,

- dramatizing rate, time and distance factors for objects in constant motion, or accelerating.

12.D.1b. Identify observable forces in nature (e.g., pusjes, pulls, gravity, magnetism).

Stage A
Apply scientific inquiries or technological designs to explore the simple concepts of motion,

- changing the position and motion of objects, or
- showing simple inertia and momentum in real-world applications.

Stage B

Apply scientific inquiries or technological designs to make connections between the basic concepts of motion to real world applications,

- describing how gravity affects motion, or
- demonstrating the rate, time and distance factors and units for speed, or
- describing examples of inertia and momentum in the classroom, playground and at home.

Stage C

Apply scientific inquiries or technological designs to explain the characteristics of forces,

- comparing examples of gravitational pull on earth, or
- introducing the concepts associated with weightlessness (or more exactly, in continuous free fall) in space flight, or
- diagramming the directions of forces affecting motion in common examples, or
- exploring how simple machines work.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.1a. Identify components and describe diverse features of the Earth's land, water, and atmospheric systems.

Stage A

Apply scientific inquiries or technological designs to introduce the Earth's land, water and atmospheric components,

- sorting pictures of different land features, or
- identifying the basic features of globes or maps, or
- classifying major sources or uses of water, or
- sketching atmospheric features seen in the sky over time.

Stage B

Apply scientific inquiries or technological designs to demonstrate the properties of Earth's basic materials,

- describing different types and uses of Earth's rocks, soils and minerals, or
- identifying major sources/locations of water on the planet, or
- identifying major Earth and atmospheric features from photographs including those from satellites.

Stage C
Apply scientific inquiries or technological designs to analyze Earth's land, water and atmosphere as systems,

- classifying samples of the major rock families, or
- sorting soil types based on their formation and composition, or
- illustrating nature's oxygen and water cycles, or
- identifying the major components of air.

12.E.1b. Identify and describe patterns of weather and seasonal change.

Stage A
Apply scientific inquiries or technological designs to introduce weather and seasonal changes,

- collecting daily weather data, or
- predicting local weather conditions based on collected data, or
- associating seasonal variations of weather data, or
- creating pictographs or other graphic displays of local weather patterns.

Stage B
Apply scientific inquiries or technological designs to examine the natural processes that change Earth's surface,

- modeling erosion processes in various soil compositions, or
- comparing different water flow models for weathering impact, or
- identifying water cycle in local weather conditions and features.

Stage C
Apply scientific inquiries or technological designs to examine weather patterns,

- observing local, state, regional or national weather patterns, or
- identifying topographic features which affect weather patterns, or
- comparing simple models of Earth tilt and revolution to major seasonal changes, or
- predicting future weather conditions.

12.E.1c. Identify renewable and non renewable natural resources.

Stage A
Apply scientific inquiries or technological designs to classify renewable and non-renewable natural resources,

- sorting different examples of simple natural resources, or
- identifying the origin of these examples with their recyclable possibilities, or
- setting and working toward a possible recycling or reusing goal for classroom application effort.

Stage B
Apply scientific inquiries or technological designs to examine various renewable or non-renewable resources,

- comparing different paper, glass or plastic composition examples, or
- collecting data about paper, glass or plastic consumption at school over time, or
- predicting futuristic resource uses and availabilities.

Stage C
Apply scientific inquiries or technological designs to compare natural resource availability,

- creating tests for decomposition of paper, glass or plastic samples, or
- mapping natural resources from around the world (Mideast oil, Illinois coal, US pine lumber, etc.), or
- evaluating impact of reducing, recycling or reusing projects at home and at school.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.1a. Identify and describe characteristics of the sun, Earth, and moon as familiar objects in the solar system.

Stage A
Apply scientific inquiries or technological designs to explore the familiar objects of the solar system,

- identifying the easily visible components, or
- exploring their relative sizes using scale models, or
- recording daily and/or nightly moon sightings, or
- introducing space mission studies.

Stage B
Apply scientific inquiries or technological designs to describe the main bodies in the solar system,

- identifying the sizes, distances, and relationships of them, or
- relating Earth's dependence on the Sun for heat and light, or
- modeling the phases of the Moon, or
- suggesting how and why people have studied and explained the solar system through time.

Stage C

Apply scientific inquiries or technological designs to compare the main bodies of the solar system,

- describing the surface conditions and composition of the planets, or
- modeling the impact of meteorites on solar system bodies, or
- introducing gravitational force of bodies, or
- researching how 21st century scientists study the solar system.

12.F.1b. Identify daily, seasonal, and annual patterns related to the Earth's rotation and revolution.

Stage A

Apply scientific inquiries or technological designs to explore the explanations of the daily and annual patterns of the Earth's motion,

- recording observations of the daily path of the sun over time, or
- comparing shadows during a day, or
- observing the daily and seasonal differences of the day and night sky.

Stage B

Apply scientific inquiries or technological designs to explain the seasonal and annual motions of the Earth and other planets in relation to the Sun,

- modeling the Earth's motion in relation to the Sun during the day, night, year, or
- introducing the comparative orbits of planets in the solar system, or
- relating the moon's orbit to its observed phases, or
- using constellation models to explain apparent changes in the night sky.

Stage C

Apply scientific inquiries or technological designs to examine the Earth's motions in space,

- modeling the three-dimensional rotation and revolution of Earth in its orbit, including its axial tilt to introduce the explanation of seasons and solar/lunar eclipses, or
- addressing historical misconceptions of the Earth's place in the universe.

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.1a. Use basic safety practices (e.g. not tasting materials without permission, "stop/drop/roll").

Stage A
Apply the appropriate principles of safety,

- using established classroom safety, order and cleanliness rules during science inquiry or design investigations, or
- applying general science rules in home and playground settings, or
- role-playing what should be done in case of fire, or
- explaining when and why electricity can be harmful and helpful, or
- reinforcing decision-making skills related to the promotion and protection of individual health.

Stage B
Apply the appropriate principles of safety,

- explaining the dangers of electricity to applicable classroom and home situations, or
- refraining from tasting unknown substances, or
- mapping pathways to leave classroom or home in case of fire or severe weather situations, or
- identifying safety hazards associated with classroom science inquiry or design investigations.

Stage C
Apply the appropriate principles of safety,

- identifying materials, equipment, and safety rules that apply in inquiry and design investigations, or

- identifying proper storage locations for some dangerous chemicals that can be found at home or school, or
- following established procedures for simple investigations, including following appropriate equipment and clean-up requirements.

13.A.1b. Explain why similar results are expected when procedures are done the same way.

13.A.1c. Explain how knowledge can be gained by careful observation.

Stage A
Apply scientific habits of mind,
- valuing the importance of recording scientific data accurately and honestly in inquiry and design investigations, or
- comparing observations by different students observing the same activity, or
- proposing reasons for differences in observations, or
- reporting data from repeated observations across timed intervals.

Stage B
Apply scientific habits of mind,
- proposing ways to test student-generated predictions for science-conceptual relationships, or
- practicing how scientists generate questions for possible studies, or
- relating knowledge that was gained through careful, repeated observations by classmates, or
- distinguishing hypotheses from guesses.

Stage C
Apply scientific habits of mind,
- comparing data sets from classroom observations and timed intervals, or
- summarizing knowledge that was gained through careful observations, or
- generating questions and strategies to test science concepts using critical and creative thinking, or
- defining and identifying hypotheses, predictions, laws and theories.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.1a. Explain the uses of common scientific instruments (e.g., ruler, thermometer, balance, probe, computer).

13.B,1b. Explain how using measuring tools improves the accuracy of estimates.

Stage A

Apply the use of appropriate scientific tools in inquiry or design investigations,

- using instruments for measuring length and temperature, or
- recording values with accuracy.

Stage B

Apply the use of appropriate scientific technologies in inquiry and design investigations,

- selecting appropriate technologies for measuring and recording data, or
- comparing accuracy of estimations and precise measurements, or
- sequencing appropriate steps for instructed use of equipment, or
- investigating the technology of measuring time in history

Stage C

Apply uses of scientific technologies in scientific investigations and innovations,

- comparing tools for measuring, or
- collecting and recording data for accuracy and precision, or
- examining how to care for animals in these investigations, or
- researching how advances in technologies have altered how scientists measure, collect and record data.

13.B.1c. Describe contributions men and women have made to science and technology.

Stage A

Explore the contributions of men and women in the life, environmental, physical, earth and space sciences,

- identifying individuals and their discoveries or inventions, or
- explaining how scientists have advanced our knowledge in real life.

Stage B

Correlate careers and avocations in life, environmental, physical, earth and space sciences to important historical events and ordinary daily life,

- studying applicable personal interest stories, or
- reporting on specific examples of how scientists or technologists have affected society.

Stage C

Researching global examples of life, environmental, physical, earth and space scientific and technologic advances,

- exploring historic and current discoveries and innovations, or
- investigating impact of different scientific discoveries, and/or technologic advances on world population and environmental conditions.

13.B.1d. Identify and describe ways that science and technology affect people's everyday lives (e.g., transportation, medicine, agriculture, sanitation, communication, occupations).

Stage A

Describe ways that science and technology are found in real-world situations,

- identifying familiar jobs and careers from science fields, or
- inferring the impact of science and technologies in their lives, or
- identifying how technologies make work easier, faster or more efficient, or
- describing ways that scientists are working to solve problems.

Stage B

Describe the science connections to the fields of transportation, medicine, agriculture, sanitation, communication,

- associating these fields to pertinent life, environmental, physical, earth and space science concepts, or
- describing ways sciences and technology have affected societal problems in the past, present and projected future, or

Stage C

Explore the basic occupational categories for direct connections to science and technology,

- identifying science processes, skills and concepts that apply in the career interest areas (e.g., agriculture and natural resources, business and administrative services, arts and communication, family and human services, industrial and scientific technology and health care), or
- researching past, present and projected future influences of science and technology in job skills, hobbies and home application.

13.B.1e. Demonstrate ways to reduce, reuse, and recycle materials.

Stage A

Demonstrate an understanding of conservation and the need to protect natural resources,

- identifying types and causes of pollution, or
- listing materials that can be recycled, or
- suggesting ideas for reducing, reusing, or recycling renewable resources.

Stage B

Describe ways sciences and technology have affected societal problems in the past, present and projected future,

- identifying types and causes of pollutions, or
- applying the practices of reducing, reusing, or
- recycling renewable resources.

Stage C

Associate linkages between conservation and natural resource availabilities to historic and current technological changes,

- identifying causes of pollution in various global and local cases, their effects on plant and animal life, or
- projecting ways to prevent or reduce pollution.

Third Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.1a Describe an observed event.

Stage B
Describe observed science event,
- sequencing processes or steps, or
- choosing/proposing causes or effects based on observations, or
- using measurable and descriptive attributes and units.

Stage C
Describe an observed (cause and effect) science experience or situation,
- using the appropriate attributes, units and tools, or
- classifying observations into characteristic, sequential or cause-and-effect categories, or
- describing phenomenon in terms of starting and ending conditions, types of changes.

Stage D
Formulate contextual inquiry questions,
- brainstorming questions, or
- converting questions into hypothesis statements, or
- researching associated scientific knowledge and skills, or
- identifying simple independent and dependent variables to be investigated.

11.A.1b Develop questions on scientific topics.

Stage B
Begin guided inquiry investigations about objects, events, and/or organisms that can be tested,

- asking pertinent questions, or
- predicting conditions that can influence change, or
- determining simple steps to follow to investigate selected question(s).

Stage C
Devise inquiry investigation,

- brainstorming possible questions for investigation consideration, or
- prioritizing questions for inquiry, or
- wording questions into appropriate hypotheses, or
- choosing the procedural steps, or
- creating data collection format to address selected hypothesis.

Stage D
Formulate contextual inquiry questions,

- brainstorming questions, or
- converting questions into hypothesis statements, or
- researching associated scientific knowledge and skills, or
- identifying simple independent and dependent variables to be investigated.

11.A.1c Collect data for investigations using measuring instruments and technologies.

Stage B
Conduct guided inquiry,

- assembling proper materials and equipment, or
- following appropriate procedural steps and safety precautions.

Stage C
Collect data from inquiry investigations,

- selecting and using the appropriate data-gathering instruments, or measurable unit.

Stage D
Conduct inquiry investigation,

- collecting quantitative and qualitative data from trials, or
- using applicable metric units, or
- observing appropriate and necessary safety precautions, or
- validating data for accuracy.

11.A.1d Record and store data using available technologies.

Stage B
Collect data for investigations,

- choosing and using appropriate instruments and units, or
- recording data on classroom charts, tables, journals or on computers, or

- sorting or modifying pictures or drawings that illustrate data.

Stage C
Collect data from inquiry investigations,
- reading and recording data into student-created tables, charts, or journals.

Stage D
Construct charts and visualizations to display data,
- choosing appropriate display media for data analysis, or
- incorporating available/appropriate technology.

11.A.1e Arrange data into logical patterns and describe the patterns.

Stage B
Analyze results investigation
- organizing data on graphs or charts, or
- constructing reasonable and accurate explanations from data, or
- applying qualitative and quantitative terminology that describes observed data patterns.

Stage C
Analyze results or data pattern,
- noting similarities and differences, or
- summarizing for cause or effect, or
- constructing reasonable and accurate explanations of data, or
- identifying reasons why similar investigations may not always have the same results.

Stage D
Analyze data trends,
- summarizing inferences, or
- explaining data points including outliers and discrepancies, or
- synthesizing collected data as evidence for explanations.

11.A.1f Compare observations of individuals and groups.

Stage B
Communicate results of individual and group investigation
- matching similar data from other data sources, or
- identifying reasons for differences or discrepancies in the data, or
- selecting data that can be used to predict future events or data trends, or
- generating questions for possible future inquiry investigations.

Stage C
Communicate conclusions from individual and group results,
- displaying appropriate data analysis tables and charts, or
- describing patterns from personal and group data, or
- proposing causes or effects from data comparisons, or

- suggesting additional questions from analyzed procedures, similarities, discrepancies, or conclusions.

Stage D
Communicate investigation hypothesis, procedure, and explanations,
- presenting the results of observations and explanations orally and in written format, or
- generating further questions for investigation to verify or refute hypothesis or explanation.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.1a Given a simple design problem, formulate possible solutions.

Stage B
Propose ideas for solutions to technological design problem,
- asking questions about causes and effects of concept to model or test (e.g., how to test 'if-then' effects of magnets, batteries, sound, buoyancy), or
- identifying criteria for measuring success of design, or
- prioritizing possible solutions from given list.

Stage C
Describe an observed cause and effect technological design dilemma,
- generating critical and creative questions associated with design dilemma (e.g., how to test the effect of friction, or how light is reflected, or how toy cars accelerate), or
- recording observations into sequential or cause and effect categories, or
- describing dilemma in terms of starting conditions, types of changes and ending conditions.

Stage D
Identify a contextual technological design dilemma,
- brainstorming design questions for consideration (e.g., how pendulums work, how heat is transmitted), or
- researching associated knowledge and skills, or
- identifying independent and dependent variables.

Begin investigations into technological design,
- identifying design parameters, or
- brainstorming design options and necessary materials, or
- sketching design plans, or

- determining logical sequence for design procedures, or
- generating success criteria indicators, ranges and graphic display options, or
- identifying appropriate safety measures to follow.

11.B.1b. Design a device that will be useful in solving problems.

Stage B
Begin a design solution,
- choosing procedural steps for construction and testing from teacher-generated options, or
- suggesting the variables for testing criteria factors, or
- sketching the projected final design.

Stage C
Begin design investigation of cause and effect dilemma,
- describing design conditions of the phenomenon that can be influenced by change, or
- brainstorming possible questions related to causes and effects of phenomenon, or
- prioritizing design options for design investigation, or
- generating success criteria, or
- choosing the procedural steps to address selected design plan.

Stage D
Construct design prototype,
- selecting necessary materials and equipment, or
- following procedural steps and necessary safety measures.

11.B.1c. Build the device using the materials and tools provided.

Stage B
Construct the selected technological design,
- using the materials and tools provided, or
- recording anecdotal data from design process, or
- evaluating construction success.

Stage C
Construct design prototype,
- selecting the appropriate materials, or
- designing necessary data tables for addressing success criteria, or
- using materials and tools provided.

Stage D
Construct design prototype,
- selecting necessary materials and equipment, or
- following procedural steps and necessary safety measures.

11.B.1d. Test the device and record results using given instruments, techniques, and measurement methods.

Stage B

Test for design success based on teacher-generated criteria,

- conducting multiple trials, or
- collecting data from tests using appropriate measurement methods.

Stage C

Collect data from prototype testing,

- recording multiple incremental data sets and procedural observations, or
- keeping accurate procedural journals and drawings.

Display and analyze results,

- summarizing individual data patterns, or
- constructing reasonable and accurate explanations of data, or
- identifying reasons why different designs can accomplish the same effect differently.

Stage D

Construct charts and visualizations to display data,

- selecting appropriate graphic display of data, or
- recording appropriate quantitative and qualitative data from multiple trials, or
- incorporating technology.

Analyze data to evaluate design selection or adaptability,

- synthesizing collected data, or
- comparing designs, processes, sources of error and success criteria.

11.B.1e. Report the design of the device, the test process, and the results in solving a given problem .

Stage B

Communicate results of design tests,

- presenting group results which include data from student trials to evaluate design success in testing scientific principle, procedures followed, suggestions for second round of design, or
- evaluating best design to solve technological problem.

Stage C

Communicate design conclusions from individual and group results,

- describing patterns from data tables, or
- evaluating designs according to design success criteria, or
- generating design modifications from analyzed procedures, similarities, discrepancies, or conclusions.

Stage D

Communicate design solution, procedure, and explanations,

- preparing graphs and charts to report the results, or
- generating future design modifications, or
- suggesting alternative applications for design.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

12.A.1a. Identify and describe the component parts of living things (eg., birds have feathers; people have bones, blood, hair, skin) and their major functions.

Stage B
Apply scientific inquiries or technological designs to explore common and diverse structures and functions of living things,

- describing how plants and animals obtain energy, or
- categorizing animals by structures for food-getting and movement, or
- comparing how plants and animals live and reproduce, or
- associating common plant products with plant structures and functions, or
- comparing common and distinctive plants' or animals' growth cycles, structures and functions.

Stage C
Apply scientific inquiries or technological designs to explore past and present life forms and their adaptations,

- classifying plant and animal groupings according to simple taxonomy guides or characteristics (e.g., locomotion, color, habitat, reproduction), or
- categorizing body structures of living organisms to those from fossil studies, or
- suggesting why changes over time for individuals and groupings of plants and animals happened, or
- matching the basic organs and functions of major human body systems.

Stage D

Apply scientific inquiries or technological designs to explore the patterns of change in life cycles of plants and animals,

- comparing the stages within simple life cycles, or
- examining and comparing microscopic and macroscopic life forms and their structures, or
- making generalizations of observed patterns.

Apply scientific inquiries or technological designs to explore the similarities and differences of generations of offspring,

- comparing and contrasting specific characteristics of offspring with their parents from immaturity to maturity (e.g., teeth, coloration, metamorphosis variations), or
- linking characteristics (e.g., habit of walking, kind of teeth, use of appendages) among animals to changes over time.

12.A.1b. Categorize living organisms using a variety of observable features (e.g., size, color, shape, backbone).

Stage B

Apply scientific inquiries or technological designs to explore common and diverse structures and functions of living things,

- describing how plants and animals obtain energy, or
- categorizing animals by structures for food-getting and movement, or
- comparing how plants and animals live and reproduce, or
- associating common plant products with plant structures and functions, or
- comparing common and distinctive plants' or animals' growth cycles, structures and functions.

Stage D

Apply scientific inquiries or technological designs to examine the nature of inheritance in structural and functional features of plants and animals,

- applying general rules of probability to predict characteristics of offspring from selected parents, or
- comparing body structures (or functions) from animal fossils that are no longer evident in contemporary animals.

Apply scientific inquiries or technological designs to examine the nature of learned behavior in animals,

- distinguishing specific characteristics as learned or inherited in various examples, or
- conducting simple surveys relating to learned behaviors or attitudes of classmates.

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

12.B.1a. Describe and compare characteristics of living things in relationship to their environments.

Stage B

Apply scientific inquiries or technological designs to explore the impact of plants and animals in their changing environments,

- identifying factors that affect animal and plant growth and reproduction, or
- matching plant and animal adaptations to changing seasons or climatic changes.

Apply scientific inquiries or technological designs to examine how plants and animals (including humans) survive together in their ecosystems,

- describing the food chains or webs in various ecosystems, or
- identifying local habitats, or
- identifying predator/prey and parasite/host relationships.

Stage C

Apply scientific inquiries or technological designs to explore past and current ecosystems,

- matching fossils of extinct organisms to their probable past ecosystems, or
- comparing extinct organisms and their past ecosystems to plants and animals that live in current comparable ecosystems.

Apply scientific inquiries or technological designs to examine the interdependence of organisms in ecosystems,

- identifying adaptations that help animals survive in specific or multiple environments, or
- describing the interaction between living and non-living factors in an ecosystem, or
- predicting what can happen to organisms if they lose different environmental resources or ecologically related groups of organisms.

Stage D

Apply scientific inquiries or technological designs to examine relationships among organisms in their environment,

- diagramming a simple relationship between plants and/or animals (i.e., predator/prey, parasite/host, consumer/producer) commonly found in local habitats, or
- describing simple food chains and webs in various habitats, or
- considering habitat changes due to changes in moisture, temperature, or seasons, or
- contrasting the behavioral patterns and adaptations of organisms from different ecosystems.

Apply scientific inquiries or technological designs to compare the adaptations of physical features of organisms to their environments,

- identifying the physical features that help plants or animals survive in their environments, or

- reporting on a specific plant or animal which has adapted to different environments over time.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

12.C.1a. Identify and compare sources of energy (e.g. batteries, the sun).

Stage B
Apply scientific inquiries or technological designs to demonstrate energy sources,

- constructing and testing simple electrical circuits with batteries, or
- demonstrating how sound is produced by vibrating objects, or
- analyzing which energy sources power different objects.

Stage C
Apply scientific inquiries or technological designs to examine the flow of energy,

- measuring variations of heat absorption or reflection in objects, or
- comparing qualitative data about friction, or
- contrasting the transmission of sound through different materials, or
- describing how energy in different forms affects common objects in common events, or
- experimenting with the reflection of light, or
- analyzing simple wave studies.

Stage D
Apply scientific inquiries or technological designs to compare the properties of various kinds of energy,

- demonstrating how light travels in a straight line and can be reflected, refracted, or absorbed, or
- experimenting with a variety of ways that heat can be produced, transmitted or absorbed, or
- examining how sound can be detected in animals, or
- exploring how sound is transmitted in different objects, or
- identifying various sources of power in community resources, or
- exploring heat distribution in the classroom or building, or
- explaining the interrelationships among light, heat, sound, chemical, electrical and mechanical energy.

12.C.1b. Compare large-scale physical properties of matter (e.g. size, shape, color, texture, odor).

Stage B

Apply scientific inquiries or technological designs to compare qualitative and quantitative properties of matter,

- identifying component materials in objects, or
- classifying objects or materials according to variable masses, volumes, temperatures, and states, or constants such as texture, odor, magnetism and buoyancy.

Stage C

Apply scientific inquiries or technological designs to analyze simple properties and changes,

- matching examples of physical and chemical properties to common substances (e.g., mixtures, solutions, solids, liquids, gases), or
- categorizing common changes according to physical and chemical groupings, or
- explaining common examples of changes in terms of their physical or chemical nature.

Stage D

Apply scientific inquiries or technological designs to associate the properties of common elements, common compounds, and simple mixtures,

- categorizing heterogeneous and homogeneous samples, or
- analyzing the physical and chemical properties of these samples, or
- distinguishing the energy requirements to separate physical and chemical combinations.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.1a. Identify examples of motion (e.g., moving in a straight line, vibrating, rotating).

Stage B

Apply scientific inquiries or technological designs to compare and contrast common forces around us

- dramatizing the ways that forces cause action and reaction behaviors of common objects, or
- distinguishing the work of simple machines, or
- describing the attraction and repulsion of magnetic and electrical fields, or
- sorting examples of natural or man-made forces.

Stage C

Apply scientific inquiries or technological designs to explain the concepts of motion,

- dramatizing rate, time and distance factors for objects in constant motion, or accelerating.

Stage D
Apply scientific inquiries or technological designs to introduce constant, variable and periodic motion,

- describing examples of motions in everyday situations, or
- exploring pendulum variations of length, mass and initial energy inputs, or
- creating student-action models to demonstrate motions in classroom or playground activities, such as walking and running in straight lines and in circular paths.

12.D.1b. Identify observable forces in nature (e.g., pushes, pulls, gravity, magnetism).

Stage B
Apply scientific inquiries or technological designs to make connections between the basic concepts of motion to real world applications,

- describing how gravity affects motion, or
- demonstrating the rate, time and distance factors and units for speed, or
- describing examples of inertia and momentum in the classroom, playground and at home.

Stage C
Apply scientific inquiries or technological designs to explain the characteristics of forces,

- comparing examples of gravitational pull on earth, or
- introducing the concepts associated with weightlessness (or more exactly, in continuous free fall) in space flight, or
- diagramming the directions of forces affecting motion in common examples, or
- exploring how simple machines work.

Stage D
Apply scientific inquiries or technological designs to analyze forces,

- collecting and graphing mathematical data on mechanical advantage using simple machines, or
- comparing the relationships of weight and mass on Earth, the moon or other planets, or
- exploring the effect of friction in common examples.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.1a. Identify components and describe diverse features of the Earth's land, water, and atmospheric systems.

Stage B

Apply scientific inquiries or technological designs to demonstrate the properties of Earth's basic materials,

- describing different types and uses of Earth's rocks, soils and minerals, or
- identifying major sources/locations of water on the planet, or
- identifying major Earth and atmospheric features from photographs including those from satellites.

Stage C

Apply scientific inquiries or technological designs to analyze Earth's land, water and atmosphere as systems,

- classifying samples of the major rock families, or
- sorting soil types based on their formation and composition, or
- illustrating nature's oxygen and water cycles, or
- identifying the major components of air.

Stage D

Apply scientific inquiries or technological designs to examine the Earth's land, water and atmospheric conditions,

- describing erosion/weathering in terms of impact on features on Earth, or
- diagramming the water cycle to explain changes that occur in the atmosphere during different weather conditions, or
- predicting atmospheric conditions from cloud, barometric, and other observations.

12.E.1b. Identify and describe patterns of weather and seasonal change.

Stage B

Apply scientific inquiries or technological designs to examine the natural processes that change Earth's surface,

- modeling erosion processes in various soil compositions, or
- comparing different water flow models for weathering impact, or
- identifying water cycle in local weather conditions and features.

Stage C

Apply scientific inquiries or technological designs to examine weather patterns,

- observing local, state, regional or national weather patterns, or
- identifying topographic features which affect weather patterns, or
- comparing simple models of Earth tilt and revolution to major seasonal changes, or
- predicting future weather conditions.

Stage D

Apply scientific inquiries or technological designs to analyze the natural weather patterns,

- describing short- to long-term changes in Earth's climate, or
- suggesting possible causes of climatic changes and effects on biotic communities, or
- evaluating evidence that human activities have long-term effects on global climate.

12.E.1c. Identify renewable and non renewable natural resources.

Stage B
Apply scientific inquiries or technological designs to examine various renewable or non-renewable resources,
- comparing different paper, glass or plastic composition examples, or
- collecting data about paper, glass or plastic consumption at school over time, or
- predicting futuristic resource uses and availabilities.

Stage C
Apply scientific inquiries or technological designs to compare natural resource availability,
- creating tests for decomposition of paper, glass or plastic samples, or
- mapping natural resources from around the world (Mideast oil, Illinois coal, US pine lumber, etc.), or
- evaluating impact of reducing, recycling or reusing projects at home and at school.

Stage D
Apply scientific inquiries or technological designs to evaluate natural resource supplies,
- mapping availabilities of these resources, or
- examining the human causes of diminished supplies of resources.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.1a. Identify and describe characteristics of the sun, Earth, and moon as familiar objects in the solar system.

Stage B
Apply scientific inquiries or technological designs to describe the main bodies in the solar system,
- identifying the sizes, distances, and relationships of them, or
- relating Earth's dependence on the Sun for heat and light, or
- modeling the phases of the Moon, or
- suggesting how and why people have studied and explained the solar system through time.

Stage C
Apply scientific inquiries or technological designs to compare the main bodies of the solar system,

- describing the surface conditions and composition of the planets, or
- modeling the impact of meteorites on solar system bodies, or
- introducing gravitational force of bodies, or
- researching how 21st century scientists study the solar system.

Stage D

Apply scientific inquiries or technological designs to study celestial objects in space,

- comparing planetary objects' composition and distances, or
- introducing the categories of stars and their characteristics, or
- explaining how planets change their position in the sky relative to the stars, or
- outlining the kinds of space research advances, risks and benefits.

12.F.1b. Identify daily, seasonal, and annual patterns related to the Earth's rotation and revolution.

Stage B

Apply scientific inquiries or technological designs to explain the seasonal and annual motions of the Earth and other planets in relation to the Sun,

- modeling the Earth's motion in relation to the Sun during the day, night, year, or
- introducing the comparative orbits of planets in the solar system, or
- relating the moon's orbit to its observed phases, or
- using constellation models to explain apparent changes in the night sky.

Stage C

Apply scientific inquiries or technological designs to examine the Earth's motions in space,

- modeling the three-dimensional rotation and revolution of Earth in its orbit, including its axial tilt to introduce the explanation of seasons and solar/lunar eclipses, or
- addressing historical misconceptions of the Earth's place in the universe.

Stage D

Apply scientific inquiries or technological designs to document the natural cycles and patterns in the solar system,

- using models of planetary orbits to predict the planets' changing positions, the Moon's changing phases, Earth's changing seasons, the visible constellations' paths, or
- introducing the relationship of solar system cycles to planning for space flights.

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.1a. Use basic safety practices (e.g. not tasting materials without permission, "stop/drop/roll").

Stage B
Apply the appropriate principles of safety,

- explaining the dangers of electricity to applicable classroom and home situations, or
- refraining from tasting unknown substances, or
- mapping pathways to leave classroom or home in case of fire or severe weather situations, or
- identifying safety hazards associated with classroom science inquiry or design investigations.

Stage C
Apply the appropriate principles of safety,

- identifying materials, equipment, and safety rules that apply in inquiry and design investigations, or
- identifying proper storage locations for some dangerous chemicals that can be found at home or school, or
- following established procedures for simple investigations, including following appropriate equipment and clean-up requirements.

Stage D
Apply the appropriate principles of safety,

- identifying tools and proper steps for use of scientific equipment, or
- using equipment and materials in a safe and proper manner when conducting inquiry or design investigations, or
- caring for classroom animal collections properly, or

- identifying ways and places that chemicals can be properly stored, or
- stating general rules to follow in case dangerous chemicals are ingested or inhaled, or
- predicting potential causes of accidents at school, home, and in the community, or
- following classroom rules for preparation, procedures and clean-up.

13.A.1b. Explain why similar results are expected when procedures are done the same way.

13.A.1c. Explain how knowledge can be gained by careful observation.

Stage B
Apply scientific habits of mind,
- proposing ways to test student-generated predictions for science-conceptual relationships, or
- practicing how scientists generate questions for possible studies, or
- relating knowledge that was gained through careful, repeated observations by classmates, or
- distinguishing hypotheses from guesses.

Stage C
Apply scientific habits of mind,
- comparing data sets from classroom observations and timed intervals, or
- summarizing knowledge that was gained through careful observations, or
- generating questions and strategies to test science concepts using critical and creative thinking, or
- defining and identifying hypotheses, predictions, laws and theories.

Stage D
Apply scientific habits of mind,
- recognizing the necessity of controlled variables in inquiry and design investigations, or
- identifying faulty procedural steps which could cause different results, or

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.1a. Explain the uses of common scientific instruments (e.g., ruler, thermometer, balance, probe, computer).

13.B,1b. Explain how using measuring tools improves the accuracy of estimates.

Stage B

Apply the use of appropriate scientific technologies in inquiry and design investigations,

- selecting appropriate technologies for measuring and recording data, or
- comparing accuracy of estimations and precise measurements, or
- sequencing appropriate steps for instructed use of equipment, or
- investigating the technology of measuring time in history

Stage C

Apply uses of scientific technologies in scientific investigations and innovations,

- comparing tools for measuring, or
- collecting and recording data for accuracy and precision, or
- examining how to care for animals in these investigations, or
- researching how advances in technologies have altered how scientists measure, collect and record data.

Stage D

Apply scientific habits of mind,

- recording observations accurately and honestly, or
- generating questions and strategies to test science concepts using critical and creative thinking, or
- contrasting hypotheses, predictions, laws, theories and assumptions

13.B.1c. Describe contributions men and women have made to science and technology.

Stage B

Correlate careers and avocations in life, environmental, physical, earth and space sciences to important historical events and ordinary daily life,

- studying applicable personal interest stories, or
- reporting on specific examples of how scientists or technologists have affected society.

Stage C

Researching global examples of life, environmental, physical, earth and space scientific and technologic advances,

- exploring historic and current discoveries and innovations, or
- investigating impact of different scientific discoveries, and/or technologic advances on world population and environmental conditions.

13.B.1d. Identify and describe ways that science and technology affect people's everyday lives (e.g., transportation, medicine, agriculture, sanitation, communication, occupations).

Stage B

Describe the science connections to the fields of transportation, medicine, agriculture, sanitation, communication,

- associating these fields to pertinent life, environmental, physical, earth and space science concepts, or

- describing ways sciences and technology have affected societal problems in the past, present and projected future, or

Stage C

Explore the basic occupational categories for direct connections to science and technology,

- identifying science processes, skills and concepts that apply in the career interest areas (e.g., agriculture and natural resources, business and administrative services, arts and communication, family and human services, industrial and scientific technology and health care), or
- researching past, present and projected future influences of science and technology in job skills, hobbies and home application.

Stage D

Associate the interactions of technology in science and societal situations,

- comparing and contrasting its impact, risks and benefits in historical and current physical environmental settings, or
- evaluating available data models of this impact, or
- displaying graphically the influences of these interactions in the lives and careers of people, or
- investigating ways that technology has changed local, national or global environments.

13.B.1e. Demonstrate ways to reduce, reuse, and recycle materials.

Stage B

Describe ways sciences and technology have affected societal problems in the past, present and projected future,

- identifying types and causes of pollutions, or
- applying the practices of reducing, reusing, or
- recycling renewable resources.

Stage C

Associate linkages between conservation and natural resource availabilities to historic and current technological changes,

- identifying causes of pollution in various global and local cases, their effects on plant and animal life, or
- projecting ways to prevent or reduce pollution.

Stage D

Associate the interactions of societal decisions in science and technology innovations and discoveries,

- comparing how personal or community choices affect local, regional and global environments in historic, current or projected future settings, or
- explaining the changes in society brought about by the space program, or
- role-playing public or personal informed decision-making about energy choices, resource availability, conservation, etc.

Fourth Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.2a Formulate questions on a specific science topic and choose the steps needed to answer the questions.

Stage C
Describe an observed (cause and effect) science experience or situation,
- using the appropriate attributes, units and tools, or
- classifying observations into characteristic, sequential or cause-and-effect categories, or
- describing phenomenon in terms of starting and ending conditions, types of changes.

Stage D
Formulate contextual inquiry questions,
- brainstorming questions, or
- converting questions into hypothesis statements, or
- researching associated scientific knowledge and skills, or
- identifying simple independent and dependent variables to be investigated.

Stage E
Construct an inquiry hypothesis that can be investigated,
- researching pertinent context, or
- proposing the logical sequence of steps, or

- securing the appropriate materials and equipment, or
- determining data-collection strategies and format for approved investigation.

11.A.2b Collect data for investigations using scientific process skills including observing, estimating and measuring.

Stage C
Devise inquiry investigation,
- brainstorming possible questions for investigation consideration, or
- prioritizing questions for inquiry,
- wording questions into appropriate hypotheses,
- choosing the procedural steps, or
- creating data collection format to address selected hypothesis.

Stage D
Formulate contextual inquiry questions,
- brainstorming questions, or
- converting questions into hypothesis statements, or
- researching associated scientific knowledge and skills, or
- identifying simple independent and dependent variables to be investigated.

Stage E
Conduct scientific inquiry investigation,
- observing safety precautions and following procedural steps accurately over multiple trials.

Collect qualitative and quantitative data from investigation,
- using available technologies, or
- determining the necessary required precision, or validating data for accuracy

11.A.2c Construct charts and visualizations to display data.

Stage C
Collect data from inquiry investigations,
- selecting and using the appropriate data-gathering instruments, or measurable unit.

Stage D
Propose procedural steps to investigate inquiry hypothesis,
- applying logical sequence for investigatory process, or
- constructing applicable data tables, or
- selecting necessary materials and equipment, or
- identifying appropriate safety measures to follow

Conduct inquiry investigation,
- collecting quantitative and qualitative data from trials, or
- using applicable metric units, or

- observing appropriate and necessary safety precautions, or
- validating data for accuracy.

Stage E
Organize and display data,
- determining most appropriate visualization strategies for collected data, or
- using graphs (i.e., double bar, double line, stem and leaf plots) and technologies.

11.A.2d Use data to produce reasonable explanations.

Stage C
Collect data from inquiry investigations,
- reading and recording data into student-created tables, charts, or journals.

Stage D
Construct charts and visualizations to display data,
- choosing appropriate display media for data analysis, or
- incorporating available/appropriate technology.

Stage E
Analyze data to produce reasonable explanations,
- comparing and summarizing data from multiple trials,
- interpreting trends, or
- evaluating conflicting data, or
- determining sources of error.

11.A.2e Report and display the results of individual and group investigations.

Stage C
Analyze results or data pattern,
- noting similarities and differences, or
- summarizing for cause or effect, or
- constructing reasonable and accurate explanations of data, or
- identifying reasons why similar investigations may not always have the same results.

Stage D
Analyze data trends,
- summarizing inferences, or
- explaining data points including outliers and discrepancies, or
- synthesizing collected data as evidence for explanations.

Stage E
Communicate analysis and conclusions from investigation,
- interpreting graphs and charts, or

- preparing oral, and/or written conclusions for peer review, or
- generating additional questions that can be tested.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.2b Develop a plan, design and procedure to address the problem identifying constraints (e.g., time, materials, technology).

Stage C
Describe an observed cause and effect technological design dilemma,
- generating critical and creative questions associated with design dilemma (e.g., how to test the effect of friction, or how light is reflected, or how toy cars accelerate), or
- recording observations into sequential or cause and effect categories, or
- describing dilemma in terms of starting conditions, types of changes and ending conditions.

Stage D
Identify a contextual technological design dilemma,
- brainstorming design questions for consideration (e.g., how pendulums work, how heat is transmitted), or
- researching associated knowledge and skills, or
- identifying independent and dependent variables.

Stage E
Identify an innovative technological design from ordinary surroundings or circumstances,
- brainstorming common design questions (e.g., how to squeeze toothpaste better, how to fly a better paper airplane), or
- researching background information, or
- suggesting the appropriate materials, equipment, data-collection strategies and success factors for approved investigation.

11.B.2c Build a prototype of the design using available tools and materials.

Stage C
Begin design investigation of cause and effect dilemma,
- describing design conditions of the phenomenon that can be influenced by change, or
- brainstorming possible questions related to causes and effects of phenomenon, or
- prioritizing design options for design investigation, or

- generating success criteria, or
- choosing the procedural steps to address selected design plan.

Construct design prototype,
- selecting the appropriate materials, or
- designing necessary data tables for addressing success criteria, or
- using materials and tools provided.

Stage D

Identify a contextual technological design dilemma,
- brainstorming design questions for consideration (e.g., how pendulums work, how heat is transmitted), or
- researching associated knowledge and skills, or
- identifying independent and dependent variables.

Begin investigations into technological design,
- identifying design parameters, or
- brainstorming design options and necessary materials, or
- sketching design plans, or
- determining logical sequence for design procedures, or
- generating success criteria indicators, ranges and graphic display options, or
- identifying appropriate safety measures to follow.

Stage E

Construct selected technological innovation,
- sketching design, or
- proposing the logical sequence of steps for construction, or
- collecting appropriate materials, supplies, and safety equipment, or
- completing assembly of innovation.

11.B.2d Test the prototype using suitable instruments, techniques and quantitative measurements to record data.

Stage C

Collect data from prototype testing,
- recording multiple incremental data sets and procedural observations, or
- keeping accurate procedural journals and drawings.

Display and analyze results,
- summarizing individual data patterns, or
- constructing reasonable and accurate explanations of data, or
- identifying reasons why different designs can accomplish the same effect differently.

Stage D

Construct charts and visualizations to display data,
- selecting appropriate graphic display of data, or
- recording appropriate quantitative and qualitative data from multiple trials, or

- incorporating technology.

Analyze data to evaluate design selection or adaptability,

- synthesizing collected data, or
- comparing designs, processes, sources of error and success criteria.

Stage E

Test prototype,

- conducting multiple trials, or
- collecting reliable and precise data, or
- recording observations.

11.B.2e Assess test results and the effectiveness of the design using given criteria and noting possible sources of error.

Stage C

Communicate design conclusions from individual and group results,

- describing patterns from data tables, or
- evaluating designs according to design success criteria, or
- generating design modifications from analyzed procedures, similarities, discrepancies, or conclusions.

Stage D

Communicate design solution, procedure, and explanations,

- preparing graphs and charts to report the results, or
- generating future design modifications, or
- suggesting alternative applications for design.

Stage E

Analyze data,

- comparing and summarizing data, or
- interpreting trends, or
- evaluating conflicting data, or
- determining sources of error.

11.B.2f Report test design, test process and test results.

Stage C

Communicate conclusions from individual and group results,

- displaying appropriate data analysis tables and charts, or
- describing patterns from personal and group data, or
- proposing causes or effects from data comparisons, or
- suggesting additional questions from analyzed procedures, similarities, discrepancies, or conclusions.

Stage D

Communicate investigation hypothesis, procedure, and explanations,

- presenting the results of observations and explanations orally and in written format, or
- generating further questions for investigation to verify or refute hypothesis or explanation.

Stage E

Communicate analysis and conclusions from investigation,

- interpreting graphs and charts, or
- preparing oral, and/or written conclusions for peer review, or
- generating additional questions that can be tested.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

12.A.2a Describe simple life cycles of plants and animals and the similarities and differences in their offspring.

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

Stage C

Apply scientific inquiries or technological designs to explore past and present life forms and their adaptations,

- classifying plant and animal groupings according to simple taxonomy guides or characteristics (e.g., locomotion, color, habitat, reproduction), or
- categorizing body structures of living organisms to those from fossil studies, or
- suggesting why changes over time for individuals and groupings of plants and animals happened, or
- matching the basic organs and functions of major human body systems.

Stage D

Apply scientific inquiries or technological designs to explore the patterns of change in life cycles of plants and animals,

- comparing the stages within simple life cycles, or
- examining and comparing microscopic and macroscopic life forms and their structures, or
- making generalizations of observed patterns.

Apply scientific inquiries or technological designs to explore the similarities and differences of generations of offspring,

- comparing and contrasting specific characteristics of offspring with their parents from immaturity to maturity (e.g., teeth, coloration, metamorphosis variations), or
- linking characteristics (e.g., habit of walking, kind of teeth, use of appendages) among animals to changes over time.

Stage E
Apply scientific inquiries or technological designs to explore the patterns of change and stability at the micro- and macroscopic levels of organisms (including humans),

- comparing the stages of simple life cycles and energy requirements, or
- identifying structures and their functions in cells, tissues, organs, systems and organisms (including humans).

12.A.2b Categorize features as either inherited or learned (e.g., flower color or eye color is inherited; language is learned).

Stage D
Apply scientific inquiries or technological designs to examine the nature of inheritance in structural and functional features of plants and animals,

- applying general rules of probability to predict characteristics of offspring from selected parents, or
- comparing body structures (or functions) from animal fossils that are no longer evident in contemporary animals.

Apply scientific inquiries or technological designs to examine the nature of learned behavior in animals,

- distinguishing specific characteristics as learned or inherited in various examples, or
- conducting simple surveys relating to learned behaviors or attitudes of classmates.

Stage E
Apply scientific inquiries or technological designs to examine the nature of inheritance in structural and functional features of organisms (including humans),

- describing genetic and environmental influences on the features of organisms, or
- distinguishing between inherited and acquired characteristics, or
- explaining how cells respond to genetic and environmental influences.
-

Apply scientific inquiries or technological designs to examine the nature of learned behavior or responses in all organisms (including humans),

- distinguishing characteristics as learned or inherited, or
- conducting simple surveys relating to learned behaviors of classmates, and/or family members.

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

12.B.2a Describe relationships among various organisms in their environments (e.g., predator/prey, parasite/host, food chains and food webs)..

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

Stage C

Apply scientific inquiries or technological designs to explore past and current ecosystems,

- matching fossils of extinct organisms to their probable past ecosystems, or
- comparing extinct organisms and their past ecosystems to plants and animals that live in current comparable ecosystems.

Apply scientific inquiries or technological designs to examine the interdependence of organisms in ecosystems,

- identifying adaptations that help animals survive in specific or multiple environments, or
- describing the interaction between living and non-living factors in an ecosystem, or
- predicting what can happen to organisms if they lose different environmental resources or ecologically related groups of organisms.

Stage D

Apply scientific inquiries or technological designs to examine relationships among organisms in their environment,

- diagramming a simple relationship between plants and/or animals (i.e., predator/prey, parasite/host, consumer/producer) commonly found in local habitats, or
- describing simple food chains and webs in various habitats, or
- considering habitat changes due to changes in moisture, temperature, or seasons, or
- contrasting the behavioral patterns and adaptations of organisms from different ecosystems.

Stage E

Apply scientific inquiries or technological designs to categorize organisms (including humans) by their energy relationships in their environments,

- classifying organisms by their position in a food web, or
- grouping organisms according to their adaptive internal and/or external features, or
- contrasting food webs within and among different biomes, or
- identifying the biotic and abiotic factors associated with specific habitats, or
- making simple inferences to the closed systems of other planets.

12.B.2b Identify physical features of plants and animals that help them live in different environments (e.g., specialized teeth for eating certain foods, thorns for protection, insulation for cold temperature).

Stage C

Apply scientific inquiries or technological designs to examine the interdependence of organisms in ecosystems,

- identifying adaptations that help animals survive in specific or multiple environments, or
- describing the interaction between living and non-living factors in an ecosystem, or
- predicting what can happen to organisms if they lose different environmental resources or ecologically related groups of organisms.

Stage D

Apply scientific inquiries or technological designs to compare the adaptations of physical features of organisms to their environments,

- identifying the physical features that help plants or animals survive in their environments, or
- reporting on a specific plant or animal which has adapted to different environments over time.

Stage E

Apply scientific inquiries or technological designs to explain competitive, adaptive and survival potential of species in different local or global ecosystems,

- identifying survival characteristics of organisms, or
- explaining abiotic or biotic factors which threaten health or survival of populations or species (including humans), or
- identifying theories explaining mass extinctions.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

12.C.2a Describe and compare types of energy including light, heat, sound, electrical and mechanical.

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

Stage C

Apply scientific inquiries or technological designs to examine forms of energy,

- exploring sources and types of energy in familiar situations, or
- experimenting with sounds by vibrating different materials, or
- exploring ways that heat, light and sound are produced naturally and artificially.

Stage D

Apply scientific inquiries or technological designs to compare the properties of various kinds of energy,

- demonstrating how light travels in a straight line and can be reflected, refracted, or absorbed, or
- experimenting with a variety of ways that heat can be produced, transmitted or absorbed, or
- examining how sound can be detected in animals, or
- exploring how sound is transmitted in different objects, or
- identifying various sources of power in community resources, or
- exploring heat distribution in the classroom or building, or

- explaining the interrelationships among light, heat, sound, chemical, electrical and mechanical energy.

Stage E

Apply scientific inquiries or technological designs to explore energy,

- demonstrating how mirrors, prisms, diffraction gratings and filters direct light patterns, or
- diagramming how electricity can be produced from different sources of energy, or
- explaining how electrical energy can be converted to light, heat, sound, and magnetic energy, or
- analyzing common examples of potential and kinetic energy, or
- comparing insulation, conduction, convection, and radiation of heat.

12.C.2b Describe and explain the properties of solids, liquids and gases.

Stage C

Apply scientific inquiries or technological designs to explore the states and properties of matter,

- comparing solids, liquids and gases and how they change states, or
- sorting objects by similar large-scale physical properties.

Stage D

Apply scientific inquiries or technological designs to associate the properties of common elements, common compounds, and simple mixtures,

- categorizing heterogeneous and homogeneous samples, or
- analyzing the physical and chemical properties of these samples, or
- distinguishing the energy requirements to separate physical and chemical combinations.

Stage E

Apply scientific inquiries or technological designs to distinguish the properties of matter,

- separating components of mixtures by solubility, magnetic properties and densities, or
- analyzing compound samples by quantitative methods, or
- graphing the temperature variations associated with phase changes of simple substances, or
- categorizing the properties of common elements into a graphic format.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.2a Explain constant, variable and periodic motions.

Stage C
Apply scientific inquiries or technological designs to explain the concepts of motion,
- dramatizing rate, time and distance factors for objects in constant motion, or accelerating in a straight line (on flat or inclined surfaces) and/or in circular paths.

Stage D
Apply scientific inquiries or technological designs to introduce constant, variable and periodic motion,
- describing examples of motions in everyday situations, or
- exploring pendulum variations of length, mass and initial energy inputs, or
- creating student-action models to demonstrate motions in classroom or playground activities, such as walking and running in straight lines and in circular paths.

Stage E
Apply scientific inquiries or technological designs to explore constant, variable and periodic motion,
- tracing and measuring motion of vehicles (e.g., cars, bicycles, skates) in terms of position, direction, acceleration and speed in straight line, circular and inclined paths, or
- introducing the concepts of harmonic and oscillating motion in everyday examples, or
- applying the concepts of natural frequency.

12.D.2b Demonstrate and explain ways that forces cause actions and reactions (e.g., magnets attracting and repelling; objects falling, rolling and bouncing).

Stage C
Apply scientific inquiries or technological designs to explain the characteristics of forces,
- comparing examples of gravitational pull on earth, or
- introducing the concepts associated with weightlessness (or more exactly, in continuous free fall) in space flight, or
- diagramming the directions of forces affecting motion in common examples, or
- exploring how simple machines work.

Stage D
Apply scientific inquiries or technological designs to analyze forces,
- collecting and graphing mathematical data on mechanical advantage using simple machines, or
- comparing the relationships of weight and mass on Earth, the moon or other planets, or
- exploring the effect of friction in common examples.

Stage E
Apply scientific inquiries or technological designs to analyze actions and reactions,
- examining initial and final forces, or
- manipulating simple direct and inverse proportions to forces, or

- explaining thrust, weight, lift and drag in flight, or
- analyzing gears and gear ratios to do work, or
- demonstrating Newton's Laws of Motion in terms of space flight.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.2a Identify and explain natural cycles of the Earth's land, water and atmospheric systems (e.g., rock cycle, water cycle, weather patterns).

Stage C
Apply scientific inquiries or technological designs to analyze Earth's land, water and atmosphere as systems,
- classifying samples of the major rock families, or
- sorting soil types based on their formation and composition, or
- illustrating nature's oxygen and water cycles, or
- identifying the major components of air.

Stage D
Apply scientific inquiries or technological designs to examine the Earth's land, water and atmospheric conditions,
- describing erosion/weathering in terms of impact on features on Earth, or
- diagramming the water cycle to explain changes that occur in the atmosphere during different weather conditions, or
- predicting atmospheric conditions from cloud, barometric, and other observations.

Stage E
Apply scientific inquiries or technological designs to analyze global topographic features
- modeling the effect of glaciation on a surface with applications to Illinois topography, or
- using satellite pictures, various topographic and thematic maps to indicate demographic, economic and weather patterns, and/or their interrelationships to each other.

12.E.2b Describe and explain short-term and long-term interactions of the Earth's components (e.g., earthquakes, types of erosion).

Stage C
Apply scientific inquiries or technological designs to examine weather patterns,
- observing local, state, regional or national weather patterns, or
- identifying topographic features which affect weather patterns, or

- comparing simple models of Earth tilt and revolution to major seasonal changes, or
- predicting future weather conditions.

Stage D
Apply scientific inquiries or technological designs to analyze the natural weather patterns,
- describing short- to long-term changes in Earth's climate, or
- suggesting possible causes of climatic changes and effects on biotic communities, or
- evaluating evidence that human activities have long-term effects on global climate.

Stage E
Apply scientific inquiries or technological designs to analyze weather and climatic conditions,
- comparing historic and current precipitation, barometric, and temperature records, and trends, or
- projecting future trends based on past and current records, or
- making inferences about cloud formations and weather conditions

12.E.2c Identify and classify recyclable materials.

Stage C
Apply scientific inquiries or technological designs to compare natural resource availability,
- creating tests for decomposition of paper, glass or plastic samples, or
- mapping natural resources from around the world (Mideast oil, Illinois coal, US pine lumber, etc.), or
- evaluating impact of reducing, recycling or reusing projects at home and at school.

Stage D
Apply scientific inquiries or technological designs to evaluate natural resource supplies,
- mapping availabilities of these resources, or
- examining the human causes of diminished supplies of resources.

Stage E
Apply scientific inquiries or technological designs to examine long-term global, national and local renewable and nonrenewable resource supplies,
- explaining how historic economic choices have affected resource supplies, or
- focusing on comparative historic and projected water supplies and demands such as those for the local community, Illinois, the nation, and/or the world.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.2a Identify and explain natural cycles and patterns in the solar system (e.g., order of the planets; moon phases; seasons as related to Earth's tilt, one's latitude, and where Earth is in its yearly orbit around the sun).

Stage C
Apply scientific inquiries or technological designs to compare the main bodies of the solar system,

- describing the surface conditions and composition of the planets, or
- modeling the impact of meteorites on solar system bodies, or
- introducing gravitational force of bodies, or
- researching how 21st century scientists study the solar system.

Stage D
Apply scientific inquiries or technological designs to study celestial objects in space,

- comparing planetary objects' composition and distances, or
- introducing the categories of stars and their characteristics, or
- explaining how planets change their position in the sky relative to the stars, or
- outlining the kinds of space research advances, risks and benefits.

Stage E
Apply scientific inquiries or technological designs to introduce concepts that explain planetary, interplanetary and stellar characteristics and cycles,

- generalizing the composition and features of the inner and outer planets, asteroids, comets, and different star types, or
- applying orbital concepts for seasonal positions of constellations, or
- applying apparent motions in the sky to use the sky as a clock, compass or calendar, or
- explaining how the planets change their position in the sky relative to the stars over time using varying astronomic images.

12.F.2b Explain the apparent motion of the sun and stars.

Stage C
Apply scientific inquiries or technological designs to examine the Earth's motions in space,

- modeling the three-dimensional rotation and revolution of Earth in its orbit, including its axial tilt to introduce the explanation of seasons and solar/lunar eclipses, or
- addressing historical misconceptions of the Earth's place in the universe.

Stage D
Apply scientific inquiries or technological designs to document the natural cycles and patterns in the solar system,

- using models of planetary orbits to predict the planets' changing positions, the Moon's changing phases, Earth's changing seasons, the visible constellations' paths, or
- introducing the relationship of solar system cycles to planning for space flights.

Stage E

Apply scientific inquiries or technological designs to introduce the concepts of gravitation in the solar system and beyond,

- identifying the general applications of gravitational forces on Earth and in near and far space examples, or
- explaining continuous free fall in space flight, or
- applying solar system cycles to trajectories in space flight and research.

12.F.2c Identify easily recognizable star patterns (e.g., the Big Dipper, constellations).

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.2a Demonstrate ways to avoid injury when conducting science activities (e.g., wearing goggles, fire extinguisher use).

Stage C
Apply the appropriate principles of safety,

- identifying materials, equipment, and safety rules that apply in inquiry and design investigations, or
- identifying proper storage locations for some dangerous chemicals that can be found at home or school, or
- following established procedures for simple investigations, including following appropriate equipment and clean-up requirements.

Stage D
Apply the appropriate principles of safety,

- identifying tools and proper steps for use of scientific equipment, or
- using equipment and materials in a safe and proper manner when conducting inquiry or design investigations, or
- caring for classroom animal collections properly, or
- identifying ways and places that chemicals can be properly stored, or
- stating general rules to follow in case dangerous chemicals are ingested or inhaled, or
- predicting potential causes of accidents at school, home, and in the community, or
- following classroom rules for preparation, procedures and clean-up.

Stage E
Apply appropriate principles of safety,

- wearing appropriate safety gear during inquiry or design investigations, or

- demonstrating how to use a fire extinguisher, or
- identifying safety procedures for preparation, process and conclusion of science investigations to minimize safety hazards, or
- recognizing potential poisonous plants or substances in classroom, outdoor or home settings, or
- role-playing safe reactions to safety crisis situations.

13.A.2b Explain why similar investigations may not produce similar results.

13.A.2c Explain why keeping accurate and detailed records is important.

Stage C
Apply scientific habits of mind,
- comparing data sets from classroom observations and timed intervals, or
- summarizing knowledge that was gained through careful observations, or
- generating questions and strategies to test science concepts using critical and creative thinking, or
- defining and identifying hypotheses, predictions, laws and theories.

Stage D
Apply scientific habits of mind,
- recognizing the necessity of controlled variables in inquiry and design investigations, or
- identifying faulty procedural steps which could cause different results, or
- recording observations accurately and honestly, or
- generating questions and strategies to test science concepts using critical and creative thinking, or
- contrasting hypotheses, predictions, laws, theories and assumptions.

Stage E
Apply scientific habits of mind,
- explaining why similar investigations should but may not produce similar results, or
- identifying circumstances which distort how variables interact, or
- labeling accurate observations fully and carefully, or
- generating questions and strategies to test science concepts using critical and creative thinking.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.2a Explain how technology is used in science for a variety of purposes (e.g., sample collection, storage and treatment; measurement; data collection, storage and retrieval; communication of

Stage C
Apply uses of scientific technologies in scientific investigations and innovations,

- comparing tools for measuring, or
- collecting and recording data for accuracy and precision, or
- examining how to care for animals in these investigations, or
- researching how advances in technologies have altered how scientists measure, collect and record data.

Stage D
Apply scientific technologies,

- incorporating appropriate data collection, storage, retrieval and communication capabilities in classroom investigations, or
- describing how these technologies have enabled scientists to observe phenomenon beyond the capabilities of unaided human senses (radar, microscopy, etc.).

Stage E
Apply scientific technologies,

- collecting, storing, retrieving, and communicating data in classroom research and investigations, or
- researching the progression of technological advances in pure and applied scientific investigations and innovations.

13.B.2b Describe the effects on society of scientific and technological innovations (e.g., antibiotics, steam engine, digital computer).

13.B.2c Identify and explain ways that science and technology influence the lives and careers of people.

13.B.2d Compare the relative effectiveness of reducing, reusing and recycling in actual situations.

13.B.2e Identify and explain ways that technology changes ecosystems (e.g., dams, highways, buildings, communication networks, power plants).

Stage C
Researching global examples of life, environmental, physical, earth and space scientific and technologic advances,

- exploring historic and current discoveries and innovations, or investigating impact of different scientific discoveries, and/or technologic advances on world population and environmental conditions.

Explore the basic occupational categories for direct connections to science and technology,

- identifying science processes, skills and concepts that apply in the career interest areas (e.g., agriculture and natural resources, business and administrative services, arts and communication, family and human services, industrial and scientific technology and health care), or
- researching past, present and projected future influences of science and technology in job skills, hobbies and home application.

Stage D

Associate the interactions of technology in science and societal situations,

- comparing and contrasting its impact, risks and benefits in historical and current physical environmental settings, or
- evaluating available data models of this impact, or
- displaying graphically the influences of these interactions in the lives and careers of people, or
- investigating ways that technology has changed local, national or global environments.

Stage E

Investigate the interactions of technology in science and societal situations,

- displaying graphically the improvements and their impact in local and global agriculture, transportation, health, sanitation, engineering, and manufacturing settings over time, or
- explaining different perceptions about discoveries, innovations, and trends in places, events, and regions.

13.B.2f Analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems (e.g., lawn and garden care, mass transit).

Stage C

Associate linkages between conservation and natural resource availabilities to historic and current technological changes,

- identifying causes of pollution in various global and local cases, their effects on plant and animal life, or
- projecting ways to prevent or reduce pollution.

Stage D

Associate the interactions of societal decisions in science and technology innovations and discoveries,

- comparing how personal or community choices affect local, regional and global environments in historic, current or projected future settings, or
- explaining the changes in society brought about by the space program, or
- role-playing public or personal informed decision-making about energy choices, resource availability, conservation, etc.

Stage E

Investigate the interactions of societal decisions in science and technology innovations and discoveries, exploring the family, local, national, or global impact of them, or

- examining conceptual, mathematical and policy implications of energy conservation programs for classrooms, schools, homes and communities, or
- describing the changes in tools, careers, resource use and productivity over the centuries.

Fifth Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.2a Formulate questions on a specific science topic and choose the steps needed to answer the questions.

Stage D
Formulate contextual inquiry questions,
- brainstorming questions, or
- converting questions into hypothesis statements, or
- researching associated scientific knowledge and skills, or
- identifying simple independent and dependent variables to be investigated.

Stage E
Construct an inquiry hypothesis that can be investigated,
- researching pertinent context, or
- proposing the logical sequence of steps, or
- securing the appropriate materials and equipment, or
- determining data-collection strategies and format for approved investigation.

Stage F
Formulate hypotheses,
- generating if-then, cause-effect statements and predictions, or

- choosing and explaining selection of the controlled variables.

Design and conduct scientific investigation,
- incorporating appropriate safety precautions, available technology and equipment, or
- researching historic and current foundations for similar studies, or
- replicating all processes in multiple trials.

11.A.2b Collect data for investigations using scientific process skills including observing, estimating and measuring.

Stage D
Formulate contextual inquiry questions,
- brainstorming questions, or
- converting questions into hypothesis statements, or
- researching associated scientific knowledge and skills, or
- identifying simple independent and dependent variables to be investigated.

Stage E
Conduct scientific inquiry investigation,
- observing safety precautions and following procedural steps accurately over multiple trials.

Collect qualitative and quantitative data from investigation,
- using available technologies, or
- determining the necessary required precision, or validating data for accuracy

Stage F
Collect data accurately,
- using consistent measuring and recording techniques with necessary precision, or
- using appropriate metric units.
-

11.A.2c Construct charts and visualizations to display data.

Stage D
Propose procedural steps to investigate inquiry hypothesis,
- applying logical sequence for investigatory process, or
- constructing applicable data tables, or
- selecting necessary materials and equipment, or
- identifying appropriate safety measures to follow

Conduct inquiry investigation,
- collecting quantitative and qualitative data from trials, or
- using applicable metric units, or
- observing appropriate and necessary safety precautions, or
- validating data for accuracy.

Stage E
Organize and display data,
- determining most appropriate visualization strategies for collected data, or
- using graphs (i.e., double bar, double line, stem and leaf plots) and technologies.

Stage F

Organize data accurately,
- documenting data accurately from collecting instruments, or
- graphing data appropriately.

11.A.2d Use data to produce reasonable explanations.

Stage D
Construct charts and visualizations to display data,
- choosing appropriate display media for data analysis, or
- incorporating available/appropriate technology.

Stage E
Analyze data to produce reasonable explanations,
- comparing and summarizing data from multiple trials,
- interpreting trends, or
- evaluating conflicting data, or
- determining sources of error.

Stage F
Interpret and represent results of analysis to produce findings,
- differentiating observations that support or refute a hypothesis, or
- identifying the unexpected data within the data set, or
- proposing explanations for discrepancies in

11.A.2e Report and display the results of individual and group investigations.

Stage D
Analyze data trends,
- summarizing inferences, or
- explaining data points including outliers and discrepancies, or
- synthesizing collected data as evidence for explanations.

Stage E
Communicate analysis and conclusions from investigation,
- interpreting graphs and charts, or
- preparing oral, and/or written conclusions for peer review, or
- generating additional questions that can be tested.

Stage F
Report the process and results of an investigation,

- using available technologies for presentations, or
- distinguishing observations that support the original hypothesis, or
- analyzing a logical proof or explanation of findings, or
- generating additional questions which address procedures, similarities, discrepancies or conclusions for further investigations.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.2b Develop a plan, design and procedure to address the problem identifying constraints (e.g., time, materials, technology).

Stage D
Identify a contextual technological design dilemma,

- brainstorming design questions for consideration (e.g., how pendulums work, how heat is transmitted), or
- researching associated knowledge and skills, or
- identifying independent and dependent variables.

Stage E
Identify an innovative technological design from ordinary surroundings or circumstances,

- brainstorming common design questions (e.g., how to squeeze toothpaste better, how to fly a better paper airplane), or
- researching background information, or
- suggesting the appropriate materials, equipment, data-collection strategies and success factors for approved investigation.

Stage F
Formulate proposals for technological designs which model or test scientific principles,

- generating investigation ideas to apply curricular science principles (e.g., how to test phase changes of substances or acceleration in free fall, or effect of ice/glaciers on rocks), or
- brainstorming pertinent variables, or
- researching historic designs, or
- conducting peer review and choice for design and criteria selection.

11.B.2c Build a prototype of the design using available tools and materials.

Stage D

Identify a contextual technological design dilemma,

- brainstorming design questions for consideration (e.g., how pendulums work, how heat is transmitted), or
- researching associated knowledge and skills, or
- identifying independent and dependent variables.

Begin investigations into technological design,

- identifying design parameters, or
- brainstorming design options and necessary materials, or
- sketching design plans, or
- determining logical sequence for design procedures, or
- generating success criteria indicators, ranges and graphic display options, or
- identifying appropriate safety measures to follow.

Stage E

Construct selected technological innovation,

- sketching design, or
- proposing the logical sequence of steps for construction, or
- collecting appropriate materials, supplies, and safety equipment, or
- completing assembly of innovation.

Stage F

Plan and construct technological design,

- incorporating the safety and procedural guidelines into the construction plan, or
- maximizing resource capabilities.

11.B.2d Test the prototype using suitable instruments, techniques and quantitative measurements to record data.

Stage D

Construct charts and visualizations to display data,

- selecting appropriate graphic display of data, or
- recording appropriate quantitative and qualitative data from multiple trials, or
- incorporating technology.

Analyze data to evaluate design selection or adaptability,

- synthesizing collected data, or
- comparing designs, processes, sources of error and success criteria.

Stage E

Test prototype,

- conducting multiple trials, or
- collecting reliable and precise data, or
- recording observations.

Stage F
Collect and record data accurately,

- using consistent (metric) measuring and recording techniques with necessary precision, or
- documenting data from collecting instruments accurately in selected format.

11.B.2e Assess test results and the effectiveness of the design using given criteria and noting possible sources of error.

Stage D
Communicate design solution, procedure, and explanations,

- preparing graphs and charts to report the results, or
- generating future design modifications, or
- suggesting alternative applications for design.

Stage E
Analyze data,

- comparing and summarizing data, or
- interpreting trends, or
- evaluating conflicting data, or
- determining sources of error.

Stage F
Interpret and represent results of analysis to produce findings,

- comparing data sets for supporting or refuting scientific principle, or
- evaluating multiple criteria for overall design success, or
- proposing explanations for sources of error in the data set for process or product design flaws.

11.B.2f Report test design, test process and test results.

Stage D
Communicate investigation hypothesis, procedure, and explanations,

- presenting the results of observations and explanations orally and in written format, or
- generating further questions for investigation to verify or refute hypothesis or explanation.

Stage E
Communicate analysis and conclusions from investigation,

- interpreting graphs and charts, or
- preparing oral, and/or written conclusions for peer review, or
- generating additional questions that can be tested.

Stage F

Communicate the results of design investigation,

- presenting an oral and/or written report, or
- explaining the test of the scientific principle, or
- using available technologies, or
- relating anecdotal and quantitative observations, or
- generating additional design modifications which can be tested later.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

12.A.2a Describe simple life cycles of plants and animals and the similarities and differences in their offspring.

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

Stage D

Apply scientific inquiries or technological designs to explore the patterns of change in life cycles of plants and animals,

- comparing the stages within simple life cycles, or
- examining and comparing microscopic and macroscopic life forms and their structures, or
- making generalizations of observed patterns.

Apply scientific inquiries or technological designs to explore the similarities and differences of generations of offspring,

- comparing and contrasting specific characteristics of offspring with their parents from immaturity to maturity (e.g., teeth, coloration, metamorphosis variations), or
- linking characteristics (e.g., habit of walking, kind of teeth, use of appendages) among animals to changes over time.

Stage E

Apply scientific inquiries or technological designs to explore the patterns of change and stability at the micro- and macroscopic levels of organisms (including humans),

- comparing the stages of simple life cycles and energy requirements, or
- identifying structures and their functions in cells, tissues, organs, systems and organisms (including humans).

Stage F

Apply scientific inquiries or technological designs to examine the cellular unit,

- recognizing how cells function independently to keep the organism alive at the single cell level and dependently at specialized levels, or
- comparing the metabolic and reproductive processes, structures and functions of single and multi-cellular organisms.

12.A.2b Categorize features as either inherited or learned (e.g., flower color or eye color is inherited; language is learned).

Stage D

Apply scientific inquiries or technological designs to examine the nature of inheritance in structural and functional features of plants and animals,

- applying general rules of probability to predict characteristics of offspring from selected parents, or
- comparing body structures (or functions) from animal fossils that are no longer evident in contemporary animals.

Apply scientific inquiries or technological designs to examine the nature of learned behavior in animals,

- distinguishing specific characteristics as learned or inherited in various examples, or
- conducting simple surveys relating to learned behaviors or attitudes of classmates.

Stage E

Apply scientific inquiries or technological designs to examine the nature of inheritance in structural and functional features of organisms (including humans),

- describing genetic and environmental influences on the features of organisms, or
- distinguishing between inherited and acquired characteristics, or
- explaining how cells respond to genetic and environmental influences.

Apply scientific inquiries or technological designs to examine the nature of learned behavior or responses in all organisms (including humans),

- distinguishing characteristics as learned or inherited, or
- conducting simple surveys relating to learned behaviors of classmates, and/or family members.

Stage E

Apply scientific inquiries or technological designs to examine the patterns of change and stability over time,

- investigating the development of organisms and their environmental adaptations over broad time periods, or
- comparing the physical characteristics of two to three generations of familial characteristics.

Apply scientific inquiries or technological designs to explore the basic roles of genes and chromosomes in transmitting traits over generations,

- describing how physical traits are transmitted through sexual or asexual reproductive processes, or
- charting 'pedigree' probabilities for transmissions, or
- identifying examples of selective breeding for particular traits, or
- analyzing how familiar human diseases are related to genetic mutations.

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

12.B.2a Describe relationships among various organisms in their environments (e.g., predator/prey, parasite/host, food chains and food webs)..

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

Stage D

Apply scientific inquiries or technological designs to examine relationships among organisms in their environment,

- diagramming a simple relationship between plants and/or animals (i.e., predator/prey, parasite/host, consumer/producer) commonly found in local habitats, or
- describing simple food chains and webs in various habitats, or
- considering habitat changes due to changes in moisture, temperature, or seasons, or
- contrasting the behavioral patterns and adaptations of organisms from different ecosystems.

Stage E

Apply scientific inquiries or technological designs to categorize organisms (including humans) by their energy relationships in their environments,

- classifying organisms by their position in a food web, or
- grouping organisms according to their adaptive internal and/or external features, or
- contrasting food webs within and among different biomes, or
- identifying the biotic and abiotic factors associated with specific habitats, or
- making simple inferences to the closed systems of other planets.

Stage F

Apply scientific inquiries or technological designs to study the impact of multiple factors that affect organisms in a habitat,

- describing how behaviors are influenced by internal and external factors, or

- sketching the interrelationships among/between the land, water and air components to life in the system, or
- predicting the consequences of the disruption of a food pyramid, or
- identifying the interrelationships and variables that affect population sizes and behaviors, or
- identifying different niches and relationships found among organisms in an Illinois habitat.

12.B.2b Identify physical features of plants and animals that help them live in different environments (e.g., specialized teeth for eating certain foods, thorns for protection, insulation for cold temperature).

Stage D

Apply scientific inquiries or technological designs to compare the adaptations of physical features of organisms to their environments,

- identifying the physical features that help plants or animals survive in their environments, or
- reporting on a specific plant or animal which has adapted to different environments over time.

Stage E

Apply scientific inquiries or technological designs to explain competitive, adaptive and survival potential of species in different local or global ecosystems,

- identifying survival characteristics of organisms, or
- explaining abiotic or biotic factors which threaten health or survival of populations or species (including humans), or
- identifying theories explaining mass extinctions.

Stage F

Apply scientific inquiries or technological designs to apply the competitive, adaptive and survival potential of organisms,

- describing how fossils are used to determine patterns of evolution, or
- observing how plant and animal characteristics help organisms survive in their environments, or
- analyzing how environmental factors threaten or enhance the survival potential of populations.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

12.C.2a Describe and compare types of energy including light, heat, sound, electrical and mechanical.

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

Stage D

Apply scientific inquiries or technological designs to compare the properties of various kinds of energy,

- demonstrating how light travels in a straight line and can be reflected, refracted, or absorbed, or
- experimenting with a variety of ways that heat can be produced, transmitted or absorbed, or
- examining how sound can be detected in animals, or
- exploring how sound is transmitted in different objects, or
- identifying various sources of power in community resources, or
- exploring heat distribution in the classroom or building, or
- explaining the interrelationships among light, heat, sound, chemical, electrical and mechanical energy.

Stage E

Apply scientific inquiries or technological designs to explore energy,

- demonstrating how mirrors, prisms, diffraction gratings and filters direct light patterns, or
- diagramming how electricity can be produced from different sources of energy, or
- explaining how electrical energy can be converted to light, heat, sound, and magnetic energy, or
- analyzing common examples of potential and kinetic energy, or
- comparing insulation, conduction, convection, and radiation of heat.

Stage F

Apply scientific inquiries or technological designs to demonstrate the interactions of energy forms,

- explaining how interactions of matter and energy affect the changes of state, or
- tracing electrical current in simple direct and alternating circuits, or
- diagramming how sound, heat and light energy forms are detected by humans and other organisms.

12.C.2b Describe and explain the properties of solids, liquids and gases.

Stage D

Apply scientific inquiries or technological designs to associate the properties of common elements, common compounds, and simple mixtures,

- categorizing heterogeneous and homogeneous samples, or
- analyzing the physical and chemical properties of these samples, or
- distinguishing the energy requirements to separate physical and chemical combinations.

Stage E

Apply scientific inquiries or technological designs to distinguish the properties of matter,

- separating components of mixtures by solubility, magnetic properties and densities, or
- analyzing compound samples by quantitative methods, or
- graphing the temperature variations associated with phase changes of simple substances, or
- categorizing the properties of common elements into a graphic format.

Stage F

Apply scientific inquiries or technological designs to explore the basic structure of matter

- illustrating the structure of elements and simple compounds, or
- measuring the masses of chemical reactants and products to show that the sum equals the parts, or
- investigating the compressibility and expansion of gases at colder and hotter temperatures, or
- analyzing the electrical nature of charges, attraction, and repulsion.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.2a Explain constant, variable and periodic motions.

Stage D

Apply scientific inquiries or technological designs to introduce constant, variable and periodic motion,

- describing examples of motions in everyday situations, or
- exploring pendulum variations of length, mass and initial energy inputs, or
- creating student-action models to demonstrate motions in classroom or playground activities, such as walking and running in straight lines and in circular paths.

Stage E

Apply scientific inquiries or technological designs to explore constant, variable and periodic motion,

- tracing and measuring motion of vehicles (e.g., cars, bicycles, skates) in terms of position, direction, acceleration and speed in straight line, circular and inclined paths, or
- introducing the concepts of harmonic and oscillating motion in everyday examples, or
- applying the concepts of natural frequency.

Stage F
Apply scientific inquiries or technological designs to examine gravitational forces,

- correlating how an object's mass and distances affect weight in Earth and planetary examples, or
- identifying the effects of the Sun's gravitational force in the solar system, or
- predicting direct and inverse proportional trends from data of gravitational attraction.

12.D.2b Demonstrate and explain ways that forces cause actions and reactions (e.g., magnets attracting and repelling; objects falling, rolling and bouncing).

Stage D
Apply scientific inquiries or technological designs to analyze forces,

- collecting and graphing mathematical data on mechanical advantage using simple machines, or
- comparing the relationships of weight and mass on Earth, the moon or other planets, or
- exploring the effect of friction in common examples.

Stage E
Apply scientific inquiries or technological designs to analyze actions and reactions,

- examining initial and final forces, or
- manipulating simple direct and inverse proportions to forces, or
- explaining thrust, weight, lift and drag in flight, or
- analyzing gears and gear ratios to do work, or
- demonstrating Newton's Laws of Motion in terms of space flight.

Stage F
Apply scientific inquiries or technological designs to incorporate the impact of force on motion,

- associating Newton's three laws of motion to mass, distance and acceleration, or
- making metric mathematical calculations of average speed, velocity and acceleration, or
- comparing resistance and friction factors in electrical, magnetic, fluid and physical systems.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.
12.E.2a Identify and explain natural cycles of the Earth's land, water and atmospheric systems (e.g., rock cycle, water cycle, weather patterns).

Stage D

Apply scientific inquiries or technological designs to examine the Earth's land, water and atmospheric conditions,

- describing erosion/weathering in terms of impact on features on Earth, or
- diagramming the water cycle to explain changes that occur in the atmosphere during different weather conditions, or
- predicting atmospheric conditions from cloud, barometric, and other observations.

Stage E

Apply scientific inquiries or technological designs to analyze global topographic features

- modeling the effect of glaciation on a surface with applications to Illinois topography, or
- using satellite pictures, various topographic and thematic maps to indicate demographic, economic and weather patterns, and/or their interrelationships to each other.

Stage F

Apply scientific inquiries or technological designs to examine the large-scale dynamic forces events and processes that affect Earth's land and populations,

- demonstrating tectonic movements related to earthquakes, tsunamies and volcanoes, or
- researching past, current and projected Earth system phenomena that affect populations.

12.E.2b Describe and explain short-term and long-term interactions of the Earth's components (e.g., earthquakes, types of erosion).

Stage D

Apply scientific inquiries or technological designs to analyze the natural weather patterns,

- describing short- to long-term changes in Earth's climate, or
- suggesting possible causes of climatic changes and effects on biotic communities, or
- evaluating evidence that human activities have long-term effects on global climate.

Stage E

Apply scientific inquiries or technological designs to analyze weather and climatic conditions,

- comparing historic and current precipitation, barometric, and temperature records, and trends, or
- projecting future trends based on past and current records, or
- making inferences about cloud formations and weather conditions

Stage F

Apply scientific inquiries or technological designs to examine the large-scale dynamic forces, events and processes that affect Earth's water/atmospheric systems and populations,

- researching hurricane paths, global temperature trends, ocean temperatures and their effects on populations, or
- researching past, current and projected Earth system phenomena that affect populations, or

- exploring the concepts associated with the 'greenhouse effect' on Earth.

12.E.2c Identify and classify recyclable materials.

Stage D
Apply scientific inquiries or technological designs to evaluate natural resource supplies,
- mapping availabilities of these resources, or
- examining the human causes of diminished supplies of resources.

Stage E
Apply scientific inquiries or technological designs to examine long-term global, national and local renewable and nonrenewable resource supplies,
- explaining how historic economic choices have affected resource supplies, or
- focusing on comparative historic and projected water supplies and demands such as those for the local community, Illinois, the nation, and/or the world.

Stage F
Apply scientific inquiries or technological designs to relate various pollution and resource relationships,
- examining community and national policies for regulating recycling, pollution, and production of resources, or
- evaluating biodegradability of natural and synthetic materials according to composition and risk/benefits.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.2a Identify and explain natural cycles and patterns in the solar system (e.g., order of the planets; moon phases; seasons as related to Earth's tilt, one's latitude, and where Earth is in its yearly orbit around the sun).

Stage D
Apply scientific inquiries or technological designs to study celestial objects in space,
- comparing planetary objects' composition and distances, or
- introducing the categories of stars and their characteristics, or
- explaining how planets change their position in the sky relative to the stars, or
- outlining the kinds of space research advances, risks and benefits.

Stage E

Apply scientific inquiries or technological designs to introduce concepts that explain planetary, interplanetary and stellar characteristics and cycles,

- generalizing the composition and features of the inner and outer planets, asteroids, comets, and different star types, or
- applying orbital concepts for seasonal positions of constellations, or
- applying apparent motions in the sky to use the sky as a clock, compass or calendar, or
- explaining how the planets change their position in the sky relative to the stars over time using varying astronomic images.

Stage F

Apply scientific inquiries or technological designs to analyze the solar system and planetary characteristics,

- comparing gravitational, atmospheric, and compositional energy factors necessary for planetary habitation, or
- describing evidence for presence of water beyond Earth, or
- predicting factors and materials necessary for interplanetary travel and study.

12.F.2b Explain the apparent motion of the sun and stars.

Stage D

Apply scientific inquiries or technological designs to document the natural cycles and patterns in the solar system,

- using models of planetary orbits to predict the planets' changing positions, the Moon's changing phases, Earth's changing seasons, the visible constellations' paths, or
- introducing the relationship of solar system cycles to planning for space flights.

Stage E

Apply scientific inquiries or technological designs to introduce the concepts of gravitation in the solar system and beyond,

- identifying the general applications of gravitational forces on Earth and in near and far space examples, or
- explaining continuous free fall in space flight, or
- applying solar system cycles to trajectories in space flight and research.

Stage F

Apply scientific inquiries or technological designs to examine the features of the universe,

- introducing the calculations associated with the scale of the universe in terms of the speed of light, or
- describing the star groupings according to masses, color, apparent color, distances and brightness, or
- identifying these characteristics about our star and its layers, or
- comparing the capabilities of different kinds of telescopes and imaging technologies.

12.F.2c Identify easily recognizable star patterns (e.g., the Big Dipper, constellations).

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.2a Demonstrate ways to avoid injury when conducting science activities (e.g., wearing goggles, fire extinguisher use).

Stage D
Apply the appropriate principles of safety,

- identifying tools and proper steps for use of scientific equipment, or
- using equipment and materials in a safe and proper manner when conducting inquiry or design investigations, or
- caring for classroom animal collections properly, or
- identifying ways and places that chemicals can be properly stored, or
- stating general rules to follow in case dangerous chemicals are ingested or inhaled, or
- predicting potential causes of accidents at school, home, and in the community, or
- following classroom rules for preparation, procedures and clean-up.

Stage E
Apply appropriate principles of safety,

- wearing appropriate safety gear during inquiry or design investigations, or
- demonstrating how to use a fire extinguisher, or
- identifying safety procedures for preparation, process and conclusion of science investigations to minimize safety hazards, or
- recognizing potential poisonous plants or substances in classroom, outdoor or home settings, or
- role-playing safe reactions to safety crisis situations.

Stage F
Apply appropriate principles of safety,

- outlining safety precautions, clean-up and disposal procedures, as well as specimen care and handling for inquiry or design investigations, or
- role-playing responses for individual or group reactions in threatening weather, hazardous chemical contamination, or other unsafe situations, or
- conducting safety tests or surveys about potential safety hazards in the classroom, school building, or home.

13.A.2b Explain why similar investigations may not produce similar results.

13.A.2c Explain why keeping accurate and detailed records is important.

Stage D
Apply scientific habits of mind,

- recognizing the necessity of controlled variables in inquiry and design investigations, or
- identifying faulty procedural steps which could cause different results, or
- recording observations accurately and honestly, or
- generating questions and strategies to test science concepts using critical and creative thinking, or
- contrasting hypotheses, predictions, laws, theories and assumptions.

Stage E
Apply scientific habits of mind,

- explaining why similar investigations should but may not produce similar results, or
- identifying circumstances which distort how variables interact, or
- labeling accurate observations fully and carefully, or
- generating questions and strategies to test science concepts using critical and creative thinking.

Stage F
Apply scientific habits of mind,

- generating questions and strategies to test science concepts using critical and creative thinking, or
- researching historic examples of valid and faulty hypothesis generation and investigations, or
- contrasting the scientific methods of observational and experimental investigations, or
- proposing how and why more than one possible conclusion should be considered and can be drawn from scientific investigations.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.2a Explain how technology is used in science for a variety of purposes (e.g., sample collection, storage and treatment; measurement; data collection, storage and retrieval; communication of

Stage D
Apply scientific technologies,
- incorporating appropriate data collection, storage, retrieval and communication capabilities in classroom investigations, or
- describing how these technologies have enabled scientists to observe phenomenon beyond the capabilities of unaided human senses (radar, microscopy, etc.).

Stage E
Apply scientific technologies,
- collecting, storing, retrieving, and communicating data in classroom research and investigations, or
- researching the progression of technological advances in pure and applied scientific investigations and innovations.

Stage F
Apply scientific technologies,
- incorporating technology and probe ware into classroom research, investigations, and
- contextual studies, or
- projecting possible technological advances in the near and long-term future.

13.B.2b Describe the effects on society of scientific and technological innovations (e.g., antibiotics, steam engine, digital computer).

13.B.2c Identify and explain ways that science and technology influence the lives and careers of people.

13.B.2d Compare the relative effectiveness of reducing, reusing and recycling in actual situations.

13.B.2e Identify and explain ways that technology changes ecosystems (e.g., dams, highways, buildings, communication networks, power plants).

Stage D
Associate the interactions of technology in science and societal situations,
- comparing and contrasting its impact, risks and benefits in historical and current physical environmental settings, or
- evaluating available data models of this impact, or

- displaying graphically the influences of these interactions in the lives and careers of people, or
- investigating ways that technology has changed local, national or global environments.

Stage E
Investigate the interactions of technology in science and societal situations,
- displaying graphically the improvements and their impact in local and global agriculture, transportation, health, sanitation, engineering, and manufacturing settings over time, or
- explaining different perceptions about discoveries, innovations, and trends in places, events, and regions.

Stage F
Research the interactions of technology in science and societal situations,
- explaining ways that ecosystems have been changed as results of technological innovations, or
- inferring technological impact in published medical, economic, and population statistic (e.g., birth/death rates, disease transmission), or
- explaining how changes in transportation, communication, production, and other technologies affect the location of economic activities

Analyze cases of scientific studies,
- studying historic examples of valid inquiry investigations associated with the life, environmental, physical, earth, and space sciences, or
- contrasting faulty studies with deviations from established scientific methods, or
- contrasting the scientific methods between observational, remote and experimental investigations, or
- suggesting how societal influences have affected scientific inquiry positively and negatively.

13.B.2f Analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems (e.g., lawn and garden care, mass transit).

Stage D
Associate the interactions of societal decisions in science and technology innovations and discoveries,
- comparing how personal or community choices affect local, regional and global environments in historic, current or projected future settings, or
- explaining the changes in society brought about by the space program, or
- role-playing public or personal informed decision-making about energy choices, resource availability, conservation, etc.

Stage E
Investigate the interactions of societal decisions in science and technology innovations and discoveries,
- exploring the family, local, national, or global impact of them, or

- examining conceptual, mathematical and policy implications of energy conservation programs for classrooms, schools, homes and communities, or
- describing the changes in tools, careers, resource use and productivity over the centuries.

Stage F

Analyze the societal interactions resulting from scientific discoveries and technological innovations,

- researching the scientific milestones that have revolutionized thinking over time, or
- grouping technological innovations to historic time periods and changes in communities and countries, or
- comparing public perceptions about the costs and impact of pure science research and applied science solutions.

Sixth Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.2a Formulate questions on a specific science topic and choose the steps needed to answer the questions.

Stage E
Construct an inquiry hypothesis that can be investigated,

- researching pertinent context, or
- proposing the logical sequence of steps, or
- securing the appropriate materials and equipment, or
- determining data-collection strategies and format for approved investigation.

Stage F
Formulate hypotheses,

- generating if-then, cause-effect statements and predictions, or
- choosing and explaining selection of the controlled variables.

Stage G
Formulate contextual hypotheses,

- generating an if-then, cause- effect premise, or
- differentiating qualitative and quantitative data and their applicability, or

- using conceptual/mathematical/ physical models, or
- previewing existing research as primary reading sources.

11.A.2b Collect data for investigations using scientific process skills including observing, estimating and measuring.

Stage E
Conduct scientific inquiry investigation,
- observing safety precautions and following procedural steps accurately over multiple trials.

Collect qualitative and quantitative data from investigation,
- using available technologies, or
- determining the necessary required precision, or validating data for accuracy

Stage F
Design and conduct scientific investigation,
- incorporating appropriate safety precautions, available technology and equipment, or
- researching historic and current foundations for similar studies, or
- replicating all processes in multiple trials.

Collect and organize data accurately,
- using consistent measuring and recording techniques with necessary precision, or
- using appropriate metric units, or
- documenting data accurately from collecting instruments, or
- graphing data appropriately.

Stage G
Design inquiry investigation which addresses proposed hypothesis,
- Determining choice of variables, or
- preparing data-collecting format, or
- incorporating all procedural and safety precautions, materials and equipment handling directions.

Conduct inquiry investigation
- choosing applicable metric units of measurement with estimated scale and range of results for student-generated data tables, or
- using direct, indirect, or remote technologies for observing and measuring, or
- conducting sufficient multiple trials, or
- recording all necessary data and observations objectively.

11.A.2c Construct charts and visualizations to display data.

Stage E
Organize and display data,
- determining most appropriate visualization strategies for collected data, or
- using graphs (i.e., double bar, double line, stem and leaf plots) and technologies.

Stage F
Interpret and represent results of analysis to produce findings,

- differentiating observations that support or refute a hypothesis, or
- identifying the unexpected data within the data set, or
- proposing explanations for discrepancies in the data set.

Stage G
Organize data accurately,

- documenting data accurately from collecting instruments, or
- graphing data appropriately.

11.A.2d Use data to produce reasonable explanations.

Stage E
Analyze data to produce reasonable explanations,

- comparing and summarizing data from multiple trials,
- interpreting trends, or
- evaluating conflicting data, or
- determining sources of error.

Stage F
Interpret and represent results of analysis to produce findings,

- differentiating observations that support or refute a hypothesis, or
- identifying the unexpected data within the data set, or
- proposing explanations for discrepancies in

Stage G
Interpret and represent analysis of results to produce findings,

- observing trends within data sets, or
- evaluating data sets to explore explanations of outliers or sources of error, or
- analyzing observations and data which may support or refute inquiry hypothesis,

11.A.2e Report and display the results of individual and group investigations.

Stage E
Communicate analysis and conclusions from investigation,

- interpreting graphs and charts, or
- preparing oral, and/or written conclusions for peer review, or
- generating additional questions that can be tested.

Stage F
Report the process and results of an investigation,

- using available technologies for presentations, or
- distinguishing observations that support the original hypothesis, or

- analyzing a logical proof or explanation of findings, or
- generating additional questions which address procedures, similarities, discrepancies or conclusions for further investigations.

Stage G
Report and display the process and findings of inquiry investigation,

- presenting oral or written final report for peer review, or
- generating further questions for alternative investigations or procedural refinements, or
- evaluating other investigations for consolidation/refinement of procedures or data explanation.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.2b Develop a plan, design and procedure to address the problem identifying constraints (e.g., time, materials, technology).

Stage E
Identify an innovative technological design from ordinary surroundings or circumstances,

- brainstorming common design questions (e.g., how to squeeze toothpaste better, how to fly a better paper airplane), or
- researching background information, or
- suggesting the appropriate materials, equipment, data-collection strategies and success factors for approved investigation.

Stage F
Formulate proposals for technological designs which model or test scientific principles,

- generating investigation ideas to apply curricular science principles (e.g., how to test phase changes of substances or acceleration in free fall, or effect of ice/glaciers on rocks), or
- brainstorming pertinent variables, or
- researching historic designs, or
- conducting peer review and choice for design and criteria selection.

Stage G
Identify an important historic innovation or model of a technological design,

- examining inventions or entrepreneurial events driven by science or engineering principles, or

- searching pertinent historical foundation, or
- determining the success criteria, design constraints, and testing logistics that were encountered.

11.B.2c Build a prototype of the design using available tools and materials.

Stage E
Construct selected technological innovation,
- sketching design, or
- proposing the logical sequence of steps for construction, or
- collecting appropriate materials, supplies, and safety equipment, or
- completing assembly of innovation.

Stage F
Plan and construct technological design,
- incorporating the safety and procedural guidelines into the construction plan, or
- maximizing resource capabilities.

Stage G
Construct selected technological innovation model,
- sketching a progression of design stages and prototypes, or
- proposing the logical sequence of steps in design construction, or
- identifying original and comparable simulation materials for construction, or
- predicting proportional scale for actual parameters and materials, or
- completing assembly of innovation model.

11.B.2d Test the prototype using suitable instruments, techniques and quantitative measurements to record data.

Stage E
Test prototype,
- conducting multiple trials, or
- collecting reliable and precise data, or
- recording observations.

Stage F
Collect and record data accurately,
- using consistent (metric) measuring and recording techniques with necessary precision, or
- documenting data from collecting instruments accurately in selected format.

Stage G
Test prototype,
- predicting proportional scale for actual parameters and materials, or

- conducting multiple trials according to success criteria, scale, and design constraints, or
- recording reliable and precise data and anecdotal observations.

11.B.2e Assess test results and the effectiveness of the design using given criteria and noting possible sources of error.

Stage E
Analyze data,
- comparing and summarizing data, or
- interpreting trends, or
- evaluating conflicting data, or
- determining sources of error.

Stage F
Interpret and represent results of analysis to produce findings,
- comparing data sets for supporting or refuting scientific principle, or
- evaluating multiple criteria for overall design success, or
- proposing explanations for sources of error in the data set for process or product design flaws.

Stage G
Analyze data to evaluate design,
- comparing and summarizing data from multiple model trials, or
- correlating historic conditions and data to model testing.

11.B.2f Report test design, test process and test results.

Stage E
Communicate analysis and conclusions from investigation,
- interpreting graphs and charts, or
- preparing oral, and/or written conclusions for peer review, or
- generating additional questions that can be tested.

Stage F
Communicate the results of design investigation,
- presenting an oral and/or written report, or
- explaining the test of the scientific principle, or
- using available technologies, or
- relating anecdotal and quantitative observations, or
- generating additional design modifications which can be tested later.

Stage G
Communicate design evaluation report,

- presenting oral and written report on historical significance of selected technological design and tested model, its original constraints and conditions, or
- generating possible alternative designs which could have been considered historically.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

12.A.2a Describe simple life cycles of plants and animals and the similarities and differences in their offspring.

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

Stage E

Apply scientific inquiries or technological designs to explore the patterns of change and stability at the micro- and macroscopic levels of organisms (including humans),

- comparing the stages of simple life cycles and energy requirements, or
- identifying structures and their functions in cells, tissues, organs, systems and organisms (including humans).

Stage F

Apply scientific inquiries or technological designs to examine the cellular unit,

- recognizing how cells function independently to keep the organism alive at the single cell level and dependently at specialized levels, or
- comparing the metabolic and reproductive processes, structures and functions of single and multi-cellular organisms.

Stage G

Apply scientific inquiries or technological designs to examine the cellular-to-organism interrelationships,

- comparing the increasingly complex structure and function of cells, tissues, organs and organ systems, or
- demonstrating the processes for biological classification, or

- analyzing normal and abnormal growth and health in organisms (with a focus on humans), or

- describing how physiological systems carry out vital functions (e.g., respiration, digestion, reproduction, photosynthesis, excretion, and temperature regulation).

12.A.2b Categorize features as either inherited or learned (e.g., flower color or eye color is inherited; language is learned).

Stage E

Apply scientific inquiries or technological designs to examine the nature of inheritance in structural and functional features of organisms (including humans),

- describing genetic and environmental influences on the features of organisms, or
- distinguishing between inherited and acquired characteristics, or
- explaining how cells respond to genetic and environmental influences.

Apply scientific inquiries or technological designs to examine the nature of learned behavior or responses in all organisms (including humans),

- distinguishing characteristics as learned or inherited, or
- conducting simple surveys relating to learned behaviors of classmates, and/or family members.

Stage F

Apply scientific inquiries or technological designs to examine the patterns of change and stability over time,

- investigating the development of organisms and their environmental adaptations over broad time periods, or
- comparing the physical characteristics of two to three generations of familial characteristics.

Apply scientific inquiries or technological designs to explore the basic roles of genes and chromosomes in transmitting traits over generations,

- describing how physical traits are transmitted through sexual or asexual reproductive processes, or
- charting 'pedigree' probabilities for transmissions, or
- identifying examples of selective breeding for particular traits, or
- analyzing how familiar human diseases are related to genetic mutations.

Stage G

Apply scientific inquiries or technological designs to examine macro- and micro-evolution in organisms,

- comparing and assessing changes in the features or forms of organisms over broad time periods to their adaptive functions and competitive advantages, or
- describing how natural selection accounts for diversity of species over many generations

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

12.B.2a Describe relationships among various organisms in their environments (e.g., predator/prey, parasite/host, food chains and food webs)..

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

Stage E

Apply scientific inquiries or technological designs to categorize organisms (including humans) by their energy relationships in their environments,

- classifying organisms by their position in a food web, or
- grouping organisms according to their adaptive internal and/or external features, or
- contrasting food webs within and among different biomes, or
- identifying the biotic and abiotic factors associated with specific habitats, or
- making simple inferences to the closed systems of other planets.

Stage F

Apply scientific inquiries or technological designs to study the impact of multiple factors that affect organisms in a habitat,

- describing how behaviors are influenced by internal and external factors, or
- sketching the interrelationships among/between the land, water and air components to life in the system, or
- predicting the consequences of the disruption of a food pyramid, or
- identifying the interrelationships and variables that affect population sizes and behaviors, or
- identifying different niches and relationships found among organisms in an Illinois habitat.

Stage G

Apply scientific inquiries or technological design to examine the energy requirements of ecosystems,

- tracing the roles and population ratios of producers, consumers, and decomposers in food chains and webs, or
- identifying the biomass relationship with the transfer of energy from the sun to final consumers.

Apply scientific inquiries or technological to relate the chemical cycles in ecosystems,

- modeling the water, carbon, and nitrogen cycles with local references, or
- researching groundwater resources and potential sources of contamination with local examples.

12.B.2b Identify physical features of plants and animals that help them live in different environments (e.g., specialized teeth for eating certain foods, thorns for protection, insulation for cold temperature).

Stage E

Apply scientific inquiries or technological designs to explain competitive, adaptive and survival potential of species in different local or global ecosystems,

- identifying survival characteristics of organisms, or
- explaining abiotic or biotic factors which threaten health or survival of populations or species (including humans), or
- identifying theories explaining mass extinctions.

Stage F

Apply scientific inquiries or technological designs to apply the competitive, adaptive and survival potential of organisms,

- describing how fossils are used to determine patterns of evolution, or
- observing how plant and animal characteristics help organisms survive in their environments, or
- analyzing how environmental factors threaten or enhance the survival potential of populations.

Stage G

Apply scientific inquiries or technological to explore the interactions between an ecosystem's organisms,

- examining types of interactive relationships (e.g., mutualism, predation, parasitism) with specific examples, or
- explaining interrelationship of adaptations and ecosystem survival.

Apply scientific inquiries or technological designs to introduce population dynamics in ecosystems,

- exploring models of population growth rates, or
- determining factors that limit population growth, or
- researching specific instances of population explosions over time.

Apply scientific inquiries or technological designs to model global biomes,

- identifying the general climate, soil, and inhabitant of the six major land-base biomes, or
- mapping the global biomes, or
- comparing the graphical meteorological data (temperature, precipitation) of biomes/ecosystems.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

12.C.2a Describe and compare types of energy including light, heat, sound, electrical and mechanical.

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

Stage E
Apply scientific inquiries or technological designs to explore energy,

- demonstrating how mirrors, prisms, diffraction gratings and filters direct light patterns, or
- diagramming how electricity can be produced from different sources of energy, or
- explaining how electrical energy can be converted to light, heat, sound, and magnetic energy, or
- analyzing common examples of potential and kinetic energy, or
- comparing insulation, conduction, convection, and radiation of heat.

Stage F
Apply scientific inquiries or technological designs to demonstrate the interaction of energy forms,

- explaining how interactions of matter and energy affect the changes of state, or
- tracing electrical current in simple direct and alternating circuits, or
- diagramming how sound, heat and light energy forms are detected by humans and other organisms.

Stage G
Apply scientific inquiries or technological designs to compare heat, light, and sound energies,

- distinguishing heat and temperature, their measurements, and the relationship to mass, or
- recording temperatures of simple substances collected during melting/freezing or boiling/condensing to trace phase changes, or
- identifying ways of production and travel for heat, light, and sound in various media, or
- relating sound reflection, loudness, frequency, and pitch in common examples.

Apply scientific inquiries or technological designs to explore the nature of energy conversions and conservation,

- describing energy and its different forms with common examples, or
- categorizing energy into kinetic and potential states, or
- explaining energy conversion and conservation possibilities, or
- introducing the connections to concepts of force, momentum, power, and motion.

12.C.2b Describe and explain the properties of solids, liquids and gases.

Stage E
Apply scientific inquiries or technological designs to distinguish the properties of matter,

- separating components of mixtures by solubility, magnetic properties and densities, or

- analyzing compound samples by quantitative methods, or
- graphing the temperature variations associated with phase changes of simple substances, or
- categorizing the properties of common elements into a graphic format.

Stage F
Apply scientific inquiries or technological designs to explore the basic structure of matter

- illustrating the structure of elements and simple compounds, or
- measuring the masses of chemical reactants and products to show that the sum equals the parts, or
- investigating the compressibility and expansion of gases at colder and hotter temperatures, or
- analyzing the electrical nature of charges, attraction, and repulsion.

Stage G
Apply scientific inquiries or technological designs to explore the basic structure of matter,

- measuring mass and volumes of common solids (regular and irregular) and liquids to introduce density ratios, or
- comparing ratios of different masses and different volumes of the same kinds of samples, or
- relating how historic models of elemental matter from ancient Greeks to medieval alchemists evolved to current representations and explanations, or
- classifying comparable properties of representative elements or similar compounds (mixtures, acids, bases, salts, metals, non-metals), or
- constructing simple chemical structure models to explain chemical combinations, states, and properties.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.2a Explain constant, variable and periodic motions.
Stage E
Apply scientific inquiries or technological designs to explore constant, variable and periodic motion,

- tracing and measuring motion of vehicles (e.g., cars, bicycles, skates) in terms of position, direction, acceleration and speed in straight line, circular and inclined paths, or
- introducing the concepts of harmonic and oscillating motion in everyday examples, or

- applying the concepts of natural frequency.

Stage F

Apply scientific inquiries or technological designs to examine gravitational forces,

- correlating how an object's mass and distances affect weight in Earth and planetary examples, or
- identifying the effects of the Sun's gravitational force in the solar system, or
- predicting direct and inverse proportional trends from data of gravitational attraction.

Stage G

Apply scientific inquiries or technological designs to explore frames of reference for measuring motion,

- visualizing the possible reference frames in multiple motion examples, or
- comparing scope of motion (straight line, projectile, inclined, free fall, circular) of various objects.

Apply scientific inquiries or technological designs to explore frames of reference for measuring motion,

- explaining the dimensions of speed/time with directional units, or
- comparing speed, average speed, velocity, acceleration, and momentum with common examples, or
- using simple machines to demonstrate the principles of mechanics, or
- analyzing components of motion graphically.

12.D.2b Demonstrate and explain ways that forces cause actions and reactions (e.g., magnets attracting and repelling; objects falling, rolling and bouncing).

Stage E

Apply scientific inquiries or technological designs to analyze actions and reactions,

- examining initial and final forces, or
- manipulating simple direct and inverse proportions to forces, or
- explaining thrust, weight, lift and drag in flight, or
- analyzing gears and gear ratios to do work, or
- demonstrating Newton's Laws of Motion in terms of space flight.

Stage F

Apply scientific inquiries or technological designs to incorporate the impact of force on motion,

- associating Newton's three laws of motion to mass, distance and acceleration, or
- making metric mathematical calculations of average speed, velocity and acceleration, or
- comparing resistance and friction factors in electrical, magnetic, fluid and physical systems.

Stage G

Apply scientific inquiries or technological designs to measure force,

- explaining the dimensions of force graphically, or
- comparing common examples of balanced or unbalanced forces in everyday use, or
- examining frictional forces in common examples.

Apply scientific inquiries or technological designs to explore laws and theories associated with motion,

- comparing common situations to each of Newton's three laws of motion, or
- using the appropriate units, or
- introducing applications to Newton's Law of Universal Gravitation, or
- incorporating the variant of air resistance.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.2a Identify and explain natural cycles of the Earth's land, water and atmospheric systems (e.g., rock cycle, water cycle, weather patterns).

Stage E

Apply scientific inquiries or technological designs to analyze global topographic features

- modeling the effect of glaciation on a surface with applications to Illinois topography, or
- using satellite pictures, various topographic and thematic maps to indicate demographic,
  economic and weather patterns, and/or their interrelationships to each other.

Stage F

Apply scientific inquiries or technological designs to examine the large-scale dynamic forces, events and processes that affect Earth's land and populations,

- demonstrating tectonic movements related to earthquakes, tsunamies and volcanoes, or
- researching past, current and projected Earth system phenomena that affect populations.

Stage G

Apply scientific inquiries and technological designs to investigate large-scale dynamic forces that change geologic features,

- diagramming single global features over time as affected by continental drift, or
- identifying properties and origins of rocks and minerals, or

- explaining impact of weathering, erosion, and deposition.

12.E.2b Describe and explain short-term and long-term interactions of the Earth's components (e.g., earthquakes, types of erosion).

Stage E

Apply scientific inquiries or technological designs to analyze weather and climatic conditions,

- comparing historic and current precipitation, barometric, and temperature records, and trends, or
- projecting future trends based on past and current records, or
- making inferences about cloud formations and weather conditions

Stage F

Apply scientific inquiries or technological designs to examine the large-scale dynamic forces, events and processes that affect Earth's water/atmospheric systems and populations,

- researching hurricane paths, global temperature trends, ocean temperatures and their effects on populations, or
- researching past, current and projected Earth system phenomena that affect populations, or
- exploring the concepts associated with the 'greenhouse effect' on Earth.

Stage G

Apply scientific inquiries or technological designs to investigate large-scale meteorological forces.

- distinguishing weather from climate, or
- examining global weather data over broad periods of time, or
- explaining how atmospheric circulation is driven by solar heating.

Apply scientific inquiries or technological designs to investigate large-scale to investigate large-scale oceanographic forces,

- mapping ocean motions and life zones,
- identifying the quantitative proportions of ocean and fresh water.

12.E.2c Identify and classify recyclable materials.

Stage E

Apply scientific inquiries or technological designs to examine long-term global, national and local renewable and nonrenewable resource supplies,

- explaining how historic economic choices have affected resource supplies, or
- focusing on comparative historic and projected water supplies and demands such as those for the local community, Illinois, the nation, and/or the world.

Stage F

Apply scientific inquiries or technological designs to relate various pollution and resource relationships,

- examining community and national policies for regulating recycling, pollution, and

production of resources, or
- evaluating biodegradability of natural and synthetic materials according to composition and risk/benefits.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.2a Identify and explain natural cycles and patterns in the solar system (e.g., order of the planets; moon phases; seasons as related to Earth's tilt, one's latitude, and where Earth is in its yearly orbit around the sun).

Stage E
Apply scientific inquiries or technological designs to introduce concepts that explain planetary, interplanetary and stellar characteristics and cycles,
- generalizing the composition and features of the inner and outer planets, asteroids, comets, and different star types, or
- applying orbital concepts for seasonal positions of constellations, or
- applying apparent motions in the sky to use the sky as a clock, compass or calendar, or
- explaining how the planets change their position in the sky relative to the stars over time using varying astronomic images.

Stage F
Apply scientific inquiries or technological designs to analyze the solar system and planetary characteristics,
- comparing gravitational, atmospheric, and compositional energy factors necessary for planetary habitation, or
- describing evidence for presence of water beyond Earth, or
- predicting factors and materials necessary for interplanetary travel and study.

Stage G
Apply scientific inquiries or technological designs to explore the earth in space with its moon,
- plotting how the relative motions and positions of the sun, earth, and moon influence eclipses, moon phases, and tides, comparing the composition and surface features of the earth and moon, or
- using imaging, magnifications and displays to model the moon's surface features, or
- calculating earth and moon rise and set over time.

12.F.2b Explain the apparent motion of the sun and stars.

Stage E

Apply scientific inquiries or technological designs to introduce the concepts of gravitation in the solar system and beyond,

- identifying the general applications of gravitational forces on Earth and in near and far space examples, or
- explaining continuous free fall in space flight, or
- applying solar system cycles to trajectories in space flight and research.

Stage F

Apply scientific inquiries or technological designs to examine the features of the universe,

- introducing the calculations associated with the scale of the universe in terms of the speed of light, or
- describing the star groupings according to masses, color, apparent color, distances and brightness, or
- identifying these characteristics about our star and its layers, or
- comparing the capabilities of different kinds of telescopes and imaging technologies.

Stage G

Apply scientific inquiries or technological designs to study the galaxies,

- describing the relationship of galactic components (e.g., age, composition, properties), or
- explaining imaging displays of views of galactic objects.

Apply scientific inquiries or technological designs to study space exploration,

- creating a timeline which denotes the important events associated with the global space programs, or
- identifying the kinds of technologies which are currently used for studying the solar system and universe, or
- reporting on applicable historic studies which have provided discoveries, tools or explanations associated with space exploration.

12.F.2c Identify easily recognizable star patterns (e.g., the Big Dipper, constellations).

Stage G

Apply scientific designs to explore the solar system,

- comparing the major features of the solar system including the nine planets, their moons orbital shapes, surface and atmospheric conditions, orientation and periods of rotation and revolution, or
- charting orbital factors of comets, asteroids, meteors, etc., or
- explaining imaging displays of different kinds of solar system objects.

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.2a Demonstrate ways to avoid injury when conducting science activities (e.g., wearing goggles, fire extinguisher use).

Stage E
Apply appropriate principles of safety,

- wearing appropriate safety gear during inquiry or design investigations, or
- demonstrating how to use a fire extinguisher, or
- identifying safety procedures for preparation, process and conclusion of science investigations to minimize safety hazards, or
- recognizing potential poisonous plants or substances in classroom, outdoor or home settings, or
- role-playing safe reactions to safety crisis situations.

Stage F
Apply appropriate principles of safety,

- outlining safety precautions, clean-up and disposal procedures, as well as specimen care and handling for inquiry or design investigations, or
- role-playing responses for individual or group reactions in threatening weather, hazardous chemical contamination, or other unsafe situations, or
- conducting safety tests or surveys about potential safety hazards in the classroom, school building, or home.

Stage G
Apply appropriate principles of safety,

- identifying potentially hazardous chemical combinations in the home or classroom, or

- suggesting responses and reactions in home and classroom settings in case of threatening chemical scenarios, or
- following all necessary safety precautions, cleaning and disposal procedures for scientific investigations, or
- demonstrating safe transport, precise use, and appropriate storage for scientific equipment, or
- providing safe and ethical care for all classroom organism collections.

13.A.2b Explain why similar investigations may not produce similar results.
13.A.2c Explain why keeping accurate and detailed records is important.

Stage E
Apply scientific habits of mind,

- explaining why similar investigations should but may not produce similar results, or
- identifying circumstances which distort how variables interact, or
- labeling accurate observations fully and carefully, or
- generating questions and strategies to test science concepts using critical and creative thinking.

Stage F
Apply scientific habits of mind,

- generating questions and strategies to test science concepts using critical and creative thinking, or
- researching historic examples of valid and faulty hypothesis generation and investigations, or
- contrasting the scientific methods of observational and experimental investigations, or
- proposing how and why more than one possible conclusion should be considered and can be drawn from scientific investigations.

Stage G
Apply scientific habits of mind,

- generating questions and strategies to test science concepts using critical and creative thinking, or
- identifying instances of how scientific reasoning, insight, skill, creativity, intellectual honesty, tolerance of ambiguity, skepticism, persistence, and openness to new ideas have been integral to scientific discoveries and technological improvements, or
- comparing scientist's work and habits of mind to work in other careers.

Analyze cases of scientific studies,

- studying historic examples of valid investigations from curricular life, environmental, physical, earth, and space sciences, or
- finding examples of faulty or biased scientific reasoning which distorted scientific understanding, or
- citing experimental and observational strategies in direct, indirect, and remote investigations

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.2a Explain how technology is used in science for a variety of purposes (e.g., sample collection, storage and treatment; measurement; data collection, storage and retrieval; communication of

Stage E
Apply scientific technologies,

- collecting, storing, retrieving, and communicating data in classroom research and investigations, or
- researching the progression of technological advances in pure and applied scientific investigations and innovations.

Stage F
Apply scientific technologies,

- incorporating technology and probe ware into classroom research, investigations, and
- contextual studies, or
- projecting possible technological advances in the near and long-term future.

Stage G
Explore scientific technologies in life, environmental, physical, earth, and space sciences,

- identifying advances in the past century, or
- describing technologies used by scientists to forecast, explain, or test major events in each of the sciences, or
- diagramming processes and products from applicable technologies.

13.B.2b Describe the effects on society of scientific and technological innovations (e.g., antibiotics, steam engine, digital computer).
13.B.2c Identify and explain ways that science and technology influence the lives and careers of people.
13.B.2d Compare the relative effectiveness of reducing, reusing and recycling in actual situations.
13.B.2e Identify and explain ways that technology changes ecosystems (e.g., dams, highways, buildings, communication networks, power plants).

Stage E

Investigate the interactions of technology in science and societal situations,

- displaying graphically the improvements and their impact in local and global agriculture, transportation, health, sanitation, engineering, and manufacturing settings over time, or
- explaining different perceptions about discoveries, innovations, and trends in places, events, and regions.

Stage F

Research the interactions of technology in science and societal situations,

- explaining ways that ecosystems have been changed as results of technological innovations, or
- inferring technological impact in published medical, economic, and population statistics (e.g., birth/death rates, disease transmission), or
- explaining how changes in transportation, communication, production, and other technologies affect the location of economic activities

Analyze cases of scientific studies,

- studying historic examples of valid inquiry investigations associated with the life, environmental, physical, earth, and space sciences, or
- contrasting faulty studies with deviations from established scientific methods, or
- contrasting the scientific methods between observational, remote and experimental investigations, or
- suggesting how societal influences have affected scientific inquiry positively and negatively.

Stage G

Explore the interactions of science and technology in multicultural, societal, and economic settings,

- analyzing how the introduction of a new technology has affected human activities worldwide, or
- associating personal biographic information about science leaders from around the world.

Analyze the societal interactions resulting from scientific discoveries and technological innovations,

- researching the scientific milestones that have revolutionized thinking over time, or
- grouping technological innovations to historic time periods and changes in communities and countries, or
- comparing public perceptions about the costs and impact of pure science research and applied science solutions.

Explore historic, multicultural societal influences on scientific discoveries and technological innovations,

- comparing the knowledge, skills, and methods of early and modern scientists in the sciences, or
- finding examples of rejection of scientific or technological advances by cultures based on belief systems.

Explore scientific concepts in career and technical knowledge and skills in everyday settings,

- interviewing adults to identify specific applications of scientific concepts or technological innovations, or
- researching job market trends for anticipated changes in the next ten-year period based on projected technology interventions, resource depletion or access, or economic interactions, or
- demonstrating relationships between improving technology, all science fields, and educational/training requirements for such careers.

13.B.2f Analyze how specific personal and societal choices that humans make affect local, regional and global ecosystems (e.g., lawn and garden care, mass transit).

Stage E

Investigate the interactions of societal decisions in science and technology innovations and discoveries,

- exploring the family, local, national, or global impact of them, or
- examining conceptual, mathematical and policy implications of energy conservation programs for classrooms, schools, homes and communities, or
- describing the changes in tools, careers, resource use and productivity over the centuries.

Seventh Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard

A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.3a Formulate hypotheses that can be tested by collecting data.

Stage F
Formulate hypotheses,
- generating if-then, cause-effect statements and predictions, or
- choosing and explaining selection of the controlled variables.

Stage G
Formulate contextual hypotheses,
- generating an if-then, cause- effect premise, or
- differentiating qualitative and quantitative data and their applicability, or
- using conceptual/mathematical/ physical models, or
- previewing existing research as primary reading sources.

Stage H
Formulate issue-specific hypothesis,
- generating inquiry questions for an issue investigational premise, or
- differentiating qualitative and quantitative data and their applicability, or
- using conceptual/mathematical/ physical models, or
- previewing associated research.

11.A.3b Conduct scientific experiments that control all but one variable.

Stage F
Design and conduct scientific investigation,
- incorporating appropriate safety precautions, available technology and equipment, or
- researching historic and current foundations for similar studies, or
- replicating all processes in multiple trials.

Collect and organize data accurately,
- using consistent measuring and recording techniques with necessary precision, or
- using appropriate metric units, or
- documenting data accurately from collecting instruments, or
- graphing data appropriately.

Stage G
Design inquiry investigation which addresses proposed hypothesis,
- Determining choice of variables, or
- preparing data-collecting format, or
- incorporating all procedural and safety precautions, materials and equipment handling directions.

Stage H
Design specific issue investigation which addresses proposed hypothesis(es),
- proposing applicable survey instruments, or
- selecting associated research, analysis, and communication components.

Conduct issue investigation,
- using technologies for data collection and assimilation, or
- following established formats for random sampling, or
- following all procedural and safety precautions, materials and equipment handling directions.

11.A.3c Collect and record data accurately using consistent measuring and recording techniques and media.

11.A.3d Explain the existence of unexpected results in a data set.

11.A.3e Use data manipulation tools and quantitative (e.g., mean, mode, simple equations) and representational methods (e.g., simulations, image processing) to analyze measurements.

Stage F
Collect and organize data accurately,
- using consistent measuring and recording techniques with necessary precision, or
- using appropriate metric units, or
- documenting data accurately from collecting instruments, or

- graphing data appropriately.

Stage G
Conduct inquiry investigation,
- choosing applicable metric units of measurement with estimated scale and range of results for student-generated data tables, or
- using direct, indirect, or remote technologies for observing and measuring, or
- conducting sufficient multiple trials, or
- recording all necessary data and observations objectively.

Stage H
Conduct issue investigation,
- using technologies for data collection and assimilation, or
- following established formats for random sampling, or
- following all procedural and safety precautions, materials and equipment handling directions.

11.A.3f Interpret and represent results of analysis to produce findings.

Stage F
Interpret and represent results of analysis to produce findings,
- differentiating observations that support or refute a hypothesis, or
- identifying the unexpected data within the data set, or
- proposing explanations for discrepancies in the data set.

Stage G
Interpret and represent analysis of results to produce findings,
- observing trends within data sets, or
- evaluating data sets to explore explanations of outliers or sources of error, or
- analyzing observations and data which may support or refute inquiry hypothesis.

Stage H
Interpret and represent analysis of results,
- evaluating data sets to explore explanations of unexpected responses and data concurrence, or
- evaluating survey validity and reliability, or
- analyzing research and data for supporting or refuting the hypothesis.

11.A.3g Report and display the process and results of a scientific investigation.

Stage F
Report the process and results of an investigation,
- using available technologies for presentations, or
- distinguishing observations that support the original hypothesis, or
- analyzing a logical proof or explanation of findings, or

- generating additional questions which address procedures, similarities, discrepancies or conclusions for further investigations.
- presenting oral or written final report for peer review, or
- generating further questions for alternative investigations or procedural refinements, or
- evaluating other investigations for consolidation/refinement of procedures or data explanation.

Stage H
Report, display and defend the process and findings of issue investigation,
- presenting oral or written final report for action response options for peer review, or
- generating further questions or issues for consideration, or
- evaluating other resolutions or responses for action for applicable correlations, consolidation or explanations.

Learning Standard

B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.3a Identify an actual design problem and establish criteria for determining the success of a solution,

Stage F
Formulate proposals for technological designs which model or test scientific principles,
- generating investigation ideas to apply curricular science principles (e.g., how to test phase changes of substances or acceleration in free fall, or effect of ice/glaciers on rocks), or
- brainstorming pertinent variables, or
- researching historic designs, or
- conducting peer review and choice for design and criteria selection.

Stage G
Identify an important historic innovation or model of a technological design,
- examining inventions or entrepreneurial events driven by science or engineering principles, or
- searching pertinent historical foundation, or
- determining the success criteria, design constraints, and testing logistics that were encountered.

Stage H
Formulate proposals for design investigation,

- generating strategies to test or model a scientific concept, or
- suggesting appropriate supplies, materials, resources, and equipment to test concepts.

11.B.3b Sketch, propose and compare design solutions to the problem considering available materials, tools, cost effectiveness and safety.

11.B.3c Select the most appropriate design and build a prototype or simulation.

Stage F
Plan and construct technological design,
- incorporating the safety and procedural guidelines into the construction plan, or
- maximizing resource capabilities.

Stage G
Construct selected technological innovation model,
- sketching a progression of design stages and prototypes, or
- proposing the logical sequence of steps in design construction, or
- identifying original and comparable simulation materials for construction, or
- predicting proportional scale for actual parameters and materials, or
- completing assembly of innovation model.

Stage H
Create and conduct technological design testing objectively,
- sketching schematic of design or predictions, or
- incorporating the appropriate safety, available technology and equipment capabilities into construction and testing of design.

11.B.3d Test the prototype using available materials, instruments and technology and record the data.

Stage F
Collect and record data accurately,
- using consistent (metric) measuring and recording techniques with necessary precision, or
- documenting data from collecting instruments accurately in selected format.

Stage G
Test prototype,
- predicting proportional scale for actual parameters and materials, or
- conducting multiple trials according to success criteria, scale, and design constraints, or
- recording reliable and precise data and anecdotal observations.

Stage H
Collect and record data accurately,
- using consistent metric measuring and recording techniques with necessary precision, or

- recording data accurately in appropriate format, or
- graphing data appropriately according to the tested variables.

11.B.3e Evaluate the test results based on established criteria, note sources of error and recommend improvements.

Stage F
Interpret and represent results of analysis to produce findings,
- comparing data sets for supporting or refuting scientific principle, or
- evaluating multiple criteria for overall design success, or
- proposing explanations for sources of error in the data set for process or product design flaws.

Stage G
Analyze data to evaluate design,
- comparing and summarizing data from multiple model trials, or
- correlating historic conditions and data to model testing.

Stage H
Represent results of analysis to produce findings,
- comparing data sets according to the design criteria, or
- evaluating multiple prototype solutions to the overall design success criteria, or
- proposing explanations for sources of error in the data set with regards to product design flaws, or model limitations.

11.B.3f Using available technology, report the relative success of the design based on the test results and criteria.

Stage F
Communicate the results of design investigation,
- presenting an oral and/or written report, or
- explaining the test of the scientific principle, or
- using available technologies, or
- relating anecdotal and quantitative observations, or
- generating additional design modifications which can be tested later.

Stage G
Communicate design evaluation report,
- presenting oral and written report on historical significance of selected technological design and tested model, its original constraints and conditions, or
- generating possible alternative designs which could have been considered historically.

Stage H
Report the process and results of a design investigation,
- selecting graphs and charts that effectively report the design data, or

- making oral and/or written presentations, or
- proposing logical explanations of success or errors, or
- generating additional design modifications which can be tested later.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard

A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

12.A.3a Explain how cells function as "building blocks" of organisms and describe the requirements for cells to live.

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

Stage F
Apply scientific inquiries or technological designs to examine the cellular unit,

- recognizing how cells function independently to keep the organism alive at the single cell level and dependently at specialized levels, or
- comparing the metabolic and reproductive processes, structures and functions of single and multi-cellular organisms.

Apply scientific inquiries or technological designs to examine the patterns of change and stability over time,

- investigating the development of organisms and their environmental adaptations over broad time periods, or
- comparing the physical characteristics of two to three generations of familial characteristics.

Stage G
Apply scientific inquiries or technological designs to examine the cellular-to-organism interrelationships,

- comparing the increasingly complex structure and function of cells, tissues, organs and organ systems, or
- demonstrating the processes for biological classification, or
- analyzing normal and abnormal growth and health in organisms (with a focus on humans), or

- describing how physiological systems carry out vital functions (e.g., respiration, digestion, reproduction, photosynthesis, excretion, and temperature regulation).

Apply scientific inquiries or technological designs to examine macro- and micro-evolution in organisms,

- comparing and assessing changes in the features or forms of organisms over broad time periods to their adaptive functions and competitive advantages, or
- describing how natural selection accounts for diversity of species over many generations.

Stage H

Apply scientific inquiries or technological designs to explain the chemical nature of biological processes,

- describing photosynthesis in terms of basic requirements and products, or
- correlating respiration, or
- diagramming the nitrogen, water, oxygen, and carbon cycles with reference to ecosystem-to-molecular levels.

12.A.3b Compare characteristics of organisms produced from a single parent with those of organisms produced by two parents.

Stage F

Apply scientific inquiries or technological designs to explore the basic roles of genes and chromosomes in transmitting traits over generations,

- describing how physical traits are transmitted through sexual or asexual reproductive processes, or
- charting 'pedigree' probabilities for transmissions, or
- identifying examples of selective breeding for particular traits, or
- analyzing how familiar human diseases are related to genetic mutations.

Stage G

Apply scientific inquiries or technological designs to explore the science of genetics,

- tracing the history of genetics, or
- correlating the principles of genetics to mitotic cell division and simple mathematical probabilities, or
- researching applied genetics in plant and animal breeding, or
- associating genetic factors for inheritance in humans, including genetic disorders.

Stage H

Apply scientific inquiries or technological designs to correlate the basis of cellular and organism reproductive processes,

- correlating possible genetic combinations to the type of reproductive process, or
- diagramming and comparing mitotic and meiotic cell division, or
- distinguishing asexual and sexual (egg, sperm and zygote formation) reproduction with examples.

12.A.3c Compare and contrast how different forms and structures reflect different functions (e.g., similarities and differences among animals that fly, walk or swim; structures of plant cells and animal cells).

Stage F
Apply scientific inquiries or technological designs to examine stimulus-response reactions in organisms,

- comparing growth responses in plants, or
- comparing simple locomotive or metabolic responses in simple or complex life forms.

Stage G
Apply scientific inquiries or technological designs to examine macro- and micro-evolution in organisms,

- comparing and assessing changes in the features or forms of organisms over broad time periods to their adaptive functions and competitive advantages, or describing how natural selection accounts for diversity of species over many generations

Apply scientific inquiries or technological designs to examine the cellular coordination of responses,

- describing how the nervous system communicates between cells within the whole organism, or
- tracing stimulus-response paths in various nervous systems, or
- analyzing the effect of substances (e.g., oxygen, food, blood, hormones, drugs) circulating through the body.

Stage H
Apply scientific inquiries or technological designs to compare evolutionary trend between kingdoms and phyla,

- exploring natural and applied hybridization, or
- explaining the increasing sophistication of body systems correlating embryological, structural, and functional development, or
- exploring the impact of environmental factors on these trends.

Apply scientific inquiries or technological designs to explore social and environmental responses of organisms,

- describing learned and inherited behaviors and responses across kingdoms and between/among phyla, or
- explaining cyclic behaviors and responses in various species, or
- examining social behaviors of insects and vertebrates.

Learning Standard

B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

12.B.3a Identify and classify biotic and abiotic factors in an environment that affect population density, habitat and placement of organisms in an energy pyramid.

Stage F
Apply scientific inquiries or technological designs to study the impact of multiple factors that affect organisms in a habitat,

- describing how behaviors are influenced by internal and external factors, or
- sketching the interrelationships among/between the land, water and air components to life in the system, or
- predicting the consequences of the disruption of a food pyramid, or
- identifying the interrelationships and variables that affect population sizes and behaviors, or
- identifying different niches and relationships found among organisms in an llinois habitat.

Stage G
Apply scientific inquiries or technological design to examine the energy requirements of ecosystems,

- tracing the roles and population ratios of producers, consumers, and decomposers in food chains and webs, or
- identifying the biomass relationship with the transfer of energy from the sun to final consumers.

Apply scientific inquiries or technological to relate the chemical cycles in ecosystems,

- modeling the water, carbon, and nitrogen cycles with local references, or
- researching groundwater resources and potential sources of contamination with local examples.

Stage H
Apply scientific inquiries or technological design to explore the implications of change and stability in ecosystems,

- identifying evolutionary adaptations brought on by environmental changes, or
- analyzing factors that influence the size and stability of populations (e.g., temperature, climate, soil conditions, predation, habitat), or
- contrasting energy use by organisms.

Apply scientific inquiries or technological design to examine species' demise or success within ecosystems,

- identifying problems for species conservation and extinction, or

- projecting population changes when habitats are altered or destroyed (deforestation, desertification, wetlands destruction, introduction of exotic species),or
- researching economic and scientific value implications for changes to genetic diversity.

12.B.3b Compare and assess features of organisms for their adaptive, competitive and survival potential (e.g., appendages, reproductive rates, camouflage, defensive structures).

Stage F

Apply scientific inquiries or technological designs to apply the competitive, adaptive and survival potential of organisms,

- describing how fossils are used to determine patterns of evolution, or
- observing how plant and animal characteristics help organisms survive in their environments, or
- analyzing how environmental factors threaten or enhance the survival potential of populations.

Stage G

Apply scientific inquiries or technological to explore the interactions between an ecosystem's organisms,

- examining types of interactive relationships (e.g., mutualism, predation, parasitism) with specific examples, or
- explaining interrelationship of adaptations and ecosystem survival.

Apply scientific inquiries or technological designs to introduce population dynamics in ecosystems,

- exploring models of population growth rates, or
- determining factors that limit population growth, or
- researching specific instances of population explosions over time.

Apply scientific inquiries or technological designs to model global biomes,

- identifying the general climate, soil, and inhabitant of the six major land-base biomes, or
- mapping the global biomes, or
- comparing the graphical meteorological data (temperature, precipitation) of biomes/ecosystems.

Stage H

Apply scientific inquiries or technological designs to study biogeography,

- researching global biomes, or
- locating hemispheric, continental, and regional examples of each biome, or
- graphing associated mathematical comparison factors.

Apply scientific inquiries or technological designs to analyze Illinois-specific ecosystems and biomes,

- modeling topographic features, population data, plant diversity and distributionfrom historic records, or
- collecting scientific seasonal/annual local ecosystem data for direct connection to change and stability factors, or
- projecting scenarios of changes to local ecosystem for near- and long-term future contingencies.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

12.C.3a Explain interactions of energy with matter including changes of state and conservation of mass and energy.

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

Stage F

Apply scientific inquiries or technological designs to demonstrate the interaction of energy forms,

- explaining how interactions of matter and energy affect the changes of state, or
- tracing electrical current in simple direct and alternating circuits, or
- diagramming how sound, heat and light energy forms are detected by humans and other organisms.

Stage G

Apply scientific inquiries or technological designs to compare heat, light, and sound energies,

- distinguishing heat and temperature, their measurements, and the relationship to mass, or
- recording temperatures of simple substances collected during melting/freezing or boiling/condensing to trace phase changes, or
- identifying ways of production and travel for heat, light, and sound in various media, or
- relating sound reflection, loudness, frequency, and pitch in common examples.
-

Apply scientific inquiries or technological designs to explore the nature of energy conversions and conservation,

- describing energy and its different forms with common examples, or

- categorizing energy into kinetic and potential states, or
- explaining energy conversion and conservation possibilities, or
- introducing the connections to concepts of force, momentum, power, and motion.

Stage H

Apply scientific inquiries or technological designs to examine patterns of interactions of energy with matter,

- describing and measuring how the interactions effect changes of state or properties, or
- using quantitative data from investigations and simple chemical formulas and equations to support the concept of conservation of mass, or
- comparing positions, movements, and relationships of atoms in different states, or
- predicting chemical reactivity from information in the Periodic Table.

Apply scientific inquiries or technological designs to explore electric and magnetic energy fields,

- describing natural forces of static electricity and kinds of conductors and insulators, or
- sketching the magnetic lines of force and basic polar attraction and repulsion, or creating electric, magnetic, and electromagnetic.

Apply scientific inquiries or technological designs to examine the conservation of matter and energy,

- quantifying conservation of mass, or
- diagramming conservation of energy in common examples, or
- relating the concepts of force, momentum, power, motion, and work to the concepts of mass, distance, and velocity and their applicable constants, laws, and equations.

12.C.3b Model and describe the chemical and physical characteristics of matter (e.g., atoms, molecules, elements, compounds, mixtures).

Stage F

Apply scientific inquiries or technological designs to explore the basic structure of matter

- illustrating the structure of elements and simple compounds, or
- measuring the masses of chemical reactants and products to show that the sum equals the parts, or
- investigating the compressibility and expansion of gases at colder and hotter temperatures, or
- analyzing the electrical nature of charges, attraction, and repulsion.

Stage G

Apply scientific inquiries or technological designs to explore the basic structure of matter,

- measuring mass and volumes of common solids (regular and irregular) and liquids to introduce density ratios, or
- comparing ratios of different masses and different volumes of the same kinds of samples, or

- relating how historic models of elemental matter from ancient Greeks to medieval alchemists evolved to current representations and explanations, or
- classifying comparable properties of representative elements or similar compounds (mixtures, acids, bases, salts, metals, non-metals), or
- constructing simple chemical structure models to explain chemical combinations, states, and properties.

Stage H

Apply scientific inquiries or technological designs to examine the chemical and physical characteristics of matter,

- constructing and discussing models and charts that explain these properties, or
- investigating the relationships among atoms, molecules, elements, and compounds, or
- classifying objects and mixtures based on these properties, or
- explaining the organization of elements in the Periodic Table, or
- investigating the properties of gases at varying temperatures and pressures.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.3a Explain and demonstrate how forces affect motion (e.g., action/reaction, equilibrium conditions, free-falling objects).

Stage F
Apply scientific inquiries or technological designs to examine gravitational forces,

- correlating how an object's mass and distances affect weight in Earth and planetary examples, or
- identifying the effects of the Sun's gravitational force in the solar system, or
- predicting direct and inverse proportional trends from data of gravitational attraction.

Stage G
Apply scientific inquiries or technological designs to explore frames of reference for measuring motion,

- visualizing the possible reference frames in multiple motion examples, or
- comparing scope of motion (straight line, projectile, inclined, free fall, circular) of various objects.

Apply scientific inquiries or technological designs to explore frames of reference for measuring motion,

- explaining the dimensions of speed/time with directional units, or
- comparing speed, average speed, velocity, acceleration, and momentum with common examples, or
- using simple machines to demonstrate the principles of mechanics, or
- analyzing components of motion graphically.

Stage H

Apply scientific inquiries or technological designs to examine patterns of interactions of energy with matter,

- describing and measuring how the interactions effect changes of state or properties, or
- using quantitative data from investigations and simple chemical formulas and equations to support the concept of conservation of mass, or
- comparing positions, movements, and relationships of atoms in different states, or
- predicting chemical reactivity from information in the Periodic Table.

12.D.3b Explain the factors that affect the gravitational forces on objects (e.g., changes in mass, distance).

Stage F

Apply scientific inquiries or technological designs to incorporate the impact of force on motion,

- associating Newton's three laws of motion to mass, distance and acceleration, or
- making metric mathematical calculations of average speed, velocity and acceleration, or
- comparing resistance and friction factors in electrical, magnetic, fluid and physical systems.

Stage G

Apply scientific inquiries or technological designs to measure force,

- explaining the dimensions of force graphically, or
- comparing common examples of balanced or unbalanced forces in everyday use, or
- examining frictional forces in common examples.

Apply scientific inquiries or technological designs to explore laws and theories associated with motion,

- comparing common situations to each of Newton's three laws of motion, or
- using the appropriate units, or
- introducing applications to Newton's Law of Universal Gravitation, or
- incorporating the variant of air resistance.

Stage H

Apply scientific inquiries or technological designs to investigate gravitational forces:

- explaining the comparisons of weight and mass with variations of 'g' forces and different locations, or
- calculating descent and free fall trajectories of objects in various settings.

Apply scientific inquiries or technological designs to explore the applications of scientific work,

- constructing variations of simple and compound machines to measure work, power, and force with varying frictional factors, or
- calculating work efficiency of common and complex machines, or
- converting forces of mature (such as weather, tornadoes, wind) into Newtonian factors.

Learning Standard

E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.3a Analyze and explain large-scale dynamic forces, events and processes that affect the Earth's land, water and atmospheric systems (e.g., jetstream, hurricanes, plate tectonics).

Stage F
Apply scientific inquiries or technological designs to examine the large-scale dynamic forces, events and processes that affect Earth's land and populations,

- demonstrating tectonic movements related to earthquakes, tsunamies and volcanoes, or
- researching past, current and projected Earth system phenomena that affect populations.

Stage G
Apply scientific inquiries and technological designs to investigate large-scale dynamic forces that change geologic features,

- diagramming single global features over time as affected by continental drift, or
- identifying properties and origins of rocks and minerals, or
- explaining impact of weathering, erosion, and deposition.

Stage H
Apply scientific inquiries and technological designs to investigate the explanations of the geologic features and structures,

diagramming the established geologic eras, periods, and epochs, or

- describing the geological events that led to the formation of the Great Lakes and Illinois, or
- relating physical and chemical properties of minerals.

12.E.3b Describe interactions between solid earth, oceans, atmosphere and organisms that have resulted in ongoing changes of Earth (e.g., erosion, El Nino).

Stage F

Apply scientific inquiries or technological designs to examine the large-scale dynamic forces, events and processes that affect Earth's water/atmospheric systems and populations,

- researching hurricane paths, global temperature trends, ocean temperatures and their effects on populations, or
- researching past, current and projected Earth system phenomena that affect populations, or
- exploring the concepts associated with the 'greenhouse effect' on Earth.

Stage G

Apply scientific inquiries or technological designs to investigate large-scale meteorological forces.

- distinguishing weather from climate, or
- examining global weather data over broad periods of time, or
- explaining how atmospheric circulation is driven by solar heating.

Apply scientific inquiries or technological designs to investigate large-scale to investigate large-scale oceanographic forces,

- mapping ocean motions and life zones,
- identifying the quantitative proportions of ocean and fresh water.

Stage H

Apply scientific inquiries or technological designs to examine meteorological phenomena,

- describing large-scale and local weather systems, or
- interpreting weather maps, or
- describing the composition, properties, range of temperatures, and/or pressures in various layers of the atmosphere.
- describing relationships between the sun and the earth's climate, seasons and weather.

12.E.3c Evaluate the biodegradability of renewable and nonrenewable natural resources.

Stage F

Apply scientific inquiries or technological designs to relate various pollution and resource relationships,

- examining community and national policies for regulating recycling, pollution, and
- production of resources, or
- evaluating biodegradability of natural and synthetic materials according to
- composition and risk/benefits.

Stage H

Apply scientific inquiries or technological designs to examine Earth's resources quantitatively,

- demonstrating biodegradation of various substances, or
- explaining specific examples of mining, or
- comparing renewability or availability of earth resources, including freshwater
- reserves.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.3a Simulate, analyze and explain the effects of gravitational force in the solar system (e.g., orbital shape and speed, tides, spherical shape of the planets and moons).

Stage F
Apply scientific inquiries or technological designs to analyze the solar system and planetary characteristics,

- comparing gravitational, atmospheric, and compositional energy factors necessary for planetary habitation, or
- describing evidence for presence of water beyond Earth, or
- predicting factors and materials necessary for interplanetary travel and study.

Stage G
Apply scientific inquiries or technological designs to explore the earth in space with its moon,

- plotting how the relative motions and positions of the sun, earth, and moon influence eclipses, moon phases, and tides, comparing the composition and surface features of
- the earth and moon, or
- using imaging, magnifications and displays to model the moon's surface features, or
- calculating earth and moon rise and set over time.

Stage H
Apply scientific inquiries or technological designs to compare the view from Earth to the solar system,

- relating gravitational force between planetary bodies in the solar system, or
- introducing theories of origin of the solar system components, or
- explaining photographic or historic records and mathematical calculations of comets and their orbits.

Apply scientific inquiries or technological designs to compare the view from Earth to the galaxies,

- calculating exponential scale of distances within and beyond the Milky Way galaxy, or

- explaining the possible distortions of these views from Earth's surface, or
- classifying galaxies, etc. by size, composition, distances, established shapes, etc.

12.F.3b Describe the organization and physical characteristics of the solar system (e.g., sun, planets, satellites, asteroids, comets).

Stage F
Apply scientific inquiries or technological designs to examine the features of the universe,
- introducing the calculations associated with the scale of the universe in terms of the speed of light, or
- describing the star groupings according to masses, color, apparent color, distances and brightness, or
- identifying these characteristics about our star and its layers, or
- comparing the capabilities of different kinds of telescopes and imaging technologies.

Stage G
Apply scientific inquiries or technological designs to study the galaxies,
- describing the relationship of galactic components (e.g., age, composition, properties), or
- explaining imaging displays of views of galactic objects.

Apply scientific inquiries or technological designs to study space exploration,
- creating a timeline which denotes the important events associated with the global
- space programs, or
- identifying the kinds of technologies which are currently used for studying the solar
- system and universe, or
- reporting on applicable historic studies which have provided discoveries, tools or
- explanations associated with space exploration.

Stage H
Apply scientific inquiries or technological designs to compare the view from Earth to the solar system,
- relating gravitational force between planetary bodies in the solar system, or
- introducing theories of origin of the solar system components, or
- explaining photographic or historic records and mathematical calculations of comets and their orbits.

12.F.3c Compare and contrast the sun as a star with other objects in the Milky Way Galaxy (e.g., nebulae, dust clouds, stars, black holes).

Stage G
Apply scientific designs to explore the solar system,

- comparing the major features of the solar system including the nine planets, their moons, orbital shapes, surface and atmospheric conditions, orientation and periods of rotation and revolution, or
- charting orbital factors of comets, asteroids, meteors, etc., or
- explaining imaging displays of different kinds of solar system objects.

Stage H

Apply scientific inquiries or technological designs to compare the view from Earth to the galaxies,

- calculating exponential scale of distances within and beyond the Milky Way galaxy, or
- explaining the possible distortions of these views from Earth's surface, or
- classifying galaxies, etc. by size, composition, distances, established shapes, etc.

Apply scientific inquiries or technological designs to compare the history of astronomy through the ages,

- modeling major constellations, or
- explaining the roles that constellations played in the multi-cultural development of navigation and agriculture, or
- explaining theories, past and present, for the origin and evolution of the universe, or
- comparing astrological beliefs to astronomical laws and theories.

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.3a Identify and reduce potential hazards in science activities (e.g., ventilation, handling chemicals).

Stage F
Apply appropriate principles of safety,

- outlining safety precautions, clean-up and disposal procedures, as well as specimen care and handling for inquiry or design investigations, or
- role-playing responses for individual or group reactions in threatening weather, hazardous chemical contamination, or other unsafe situations, or
- conducting safety tests or surveys about potential safety hazards in the classroom, school building, or home.

Stage G
Apply appropriate principles of safety,

- identifying potentially hazardous chemical combinations in the home or classroom, or
- suggesting responses and reactions in home and classroom settings in case of threatening chemical scenarios, or
- following all necessary safety precautions, cleaning and disposal procedures for scientific investigations, or
- demonstrating safe transport, precise use, and appropriate storage for scientific equipment, or
- providing safe and ethical care for all classroom organism collections.

Stage H
Apply appropriate principles of safety within and beyond the science classroom,

- communicating and following clear instructions, or

- mapping classrooms for safe egress and distances/times to access safety treatment features, or
- demonstrating safety practices and emergency procedures pertaining to laboratory and field work, or
- explaining the basis of safety practices and procedures.

13.A.3b Analyze historical and contemporary cases in which the work of science has been affected by both valid and biased scientific practices.

13.A.3c Explain what is similar and different about observational and experimental investigations.

Stage F

Apply scientific habits of mind,

- generating questions and strategies to test science concepts using critical and creative thinking, or
- researching historic examples of valid and faulty hypothesis generation and investigations, or
- contrasting the scientific methods of observational and experimental investigations, or
- proposing how and why more than one possible conclusion should be considered and can be drawn from scientific investigations.

Stage G

Apply scientific habits of mind,

- generating questions and strategies to test science concepts using critical and creative thinking, or
- identifying instances of how scientific reasoning, insight, skill, creativity, intellectual honesty, tolerance of ambiguity, skepticism, persistence, and openness to new ideas have been integral to scientific discoveries and technological improvements, or
- comparing scientist's work and habits of mind to work in other careers.

Analyze cases of scientific studies,

- studying historic examples of valid investigations from curricular life, environmental, physical, earth, and space sciences, or
- finding examples of faulty or biased scientific reasoning which distorted scientific understanding, or
- citing experimental and observational strategies in direct, indirect, and remote investigations

Stage H

Apply scientific habits of mind to curricular investigations in life, environmental, physical, earth, and space sciences,

- evaluating evidence, or
- inferring statements based on data, or
- questioning sources of information, or

- explaining necessity of manipulating only one variable at a time, or
- retrieving mathematical data accurately for scientific analysis.

Analyze scientific studies referenced in curricular investigations in life, environmental, physical, earth, and space sciences,

- reviewing experimental procedures or explanations for possible faulty reasoning or unproven statements (e.g., power line magnetic fields, abiogenesis models), or
- distinguishing relationships of scientific theories, models, hypotheses, experiments, and methodologies, or
- distinguishing fact from opinion and science from pseudoscience.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.2a Explain how technology is used in science for a variety of purposes (e.g., sample collection, storage and treatment; measurement; data collection, storage and retrieval; communication of

Stage F
Apply scientific technologies,

- incorporating technology and probe ware into classroom research, investigations, and contextual studies, or
- projecting possible technological advances in the near and long-term future.

Stage G
Explore scientific technologies in life, environmental, physical, earth, and space sciences,

- identifying advances in the past century, or
- describing technologies used by scientists to forecast, explain, or test major events in each of the sciences, or
- diagramming processes and products from applicable technologies.

Stage H
Explore interaction of resource acquisition, technological development, and ecosystem impact,

- documenting actual local, regional, national, or global examples, or
- proposing alternative solutions to interaction impact, or
- estimating costs of such interactions.

13.B.2b Describe the effects on society of scientific and technological innovations (e.g., antibiotics, steam engine, digital computer).

13.B.2c Identify and explain ways that science and technology influence the lives and careers of people.

13.B.2d Compare the relative effectiveness of reducing, reusing and recycling in actual situations.

13.B.2e Identify and explain ways that technology changes ecosystems (e.g., dams, highways, buildings, communication networks, power plants).

Stage F

Research the interactions of technology in science and societal situations,

- explaining ways that ecosystems have been changed as results of technological innovations, or
- inferring technological impact in published medical, economic, and population statistic
- (e.g., birth/death rates, disease transmission), or
- explaining how changes in transportation, communication, production, and other technologies affect the location of economic activities

Analyze cases of scientific studies,

- studying historic examples of valid inquiry investigations associated with the life, environmental, physical, earth, and space sciences, or
- contrasting faulty studies with deviations from established scientific methods, or
- contrasting the scientific methods between observational, remote and experimental investigations, or
- suggesting how societal influences have affected scientific inquiry positively and negatively.

Stage G

Explore the interactions of science and technology in multicultural, societal, and economic settings,

- analyzing how the introduction of a new technology has affected human activities worldwide, or
- associating personal biographic information about science leaders from around the world.

Analyze the societal interactions resulting from scientific discoveries and technological innovations,

- researching the scientific milestones that have revolutionized thinking over time, or
- grouping technological innovations to historic time periods and changes in communities and countries, or
- comparing public perceptions about the costs and impact of pure science research and applied science solutions.

Explore historic, multicultural societal influences on scientific discoveries and technological innovations,

- comparing the knowledge, skills, and methods of early and modern scientists in the sciences, or
- finding examples of rejection of scientific or technological advances by cultures based on belief systems.

Explore scientific concepts in career and technical knowledge and skills in everyday settings,

- interviewing adults to identify specific applications of scientific concepts or technological innovations, or
- researching job market trends for anticipated changes in the next ten-year period based on projected technology interventions, resource depletion or access, or economic interactions, or
- demonstrating relationships between improving technology, all science fields, and educational/training requirements for such careers.

Stage H

Explore natural resource conservation and management programs,

- calculating home/school electric or water usage, etc., to propose plans for increased efficiency, or
- evaluating their effect on natural resources and the local economy, or
- researching the past, current, and future local landfill plans, or
- examining state wildlife programs for controlled breeding or population maintenance.

Explore policies which affect local science or technology issues,

- researching applicable issue of local concern (e.g., subdivision development, groundwater contamination), or
- developing classroom criteria to measure effectiveness of policies, or
- developing survey instruments to assess depths of informed opinions on issues, or
- collecting pertinent data from expert local sources, or
- analyzing data and policy correlation.

Eighth Grade
Science Goals, Standards, Benchmarks and Descriptors

GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

Learning Standard
A. Know and apply the concepts, principles and processes of scientific inquiry.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of scientific inquiry.

11.A.3a Formulate hypotheses that can be tested by collecting data.

Stage G
Formulate contextual hypotheses,
- generating an if-then, cause- effect premise, or
- differentiating qualitative and quantitative data and their applicability, or
- using conceptual/mathematical/ physical models, or
- previewing existing research as primary reading sources.

Stage H
Formulate issue-specific hypothesis,
- generating inquiry questions for an issue investigational premise, or
- differentiating qualitative and quantitative data and their applicability, or
- using conceptual/mathematical/ physical models, or
- previewing associated research.

Stage I
Formulate independent content-specific hypothesis,
- referencing pertinent reliable prior research, or
- proposing options for appropriate questions, procedural steps, and necessary resources.

11.A.3b Conduct scientific experiments that control all but one variable.

Stage G
Design inquiry investigation which addresses proposed hypothesis,
- determining choice of variables, or
- preparing data-collecting format, or
- incorporating all procedural and safety precautions, materials and equipment handling directions.

Stage H
Design specific issue investigation which addresses proposed hypothesis(es),
- proposing applicable survey instruments, or
- selecting associated research, analysis, and communication components.

Stage I
Design an inquiry investigation which addresses proposed hypothesis,
- determining variables and control groups, or
- incorporating all procedural and safety precautions, materials and equipment handling directions and data-collection formatting preparations, or
- securing approval for all procedures, equipment use and safety concerns.

11.A.3c Collect and record data accurately using consistent measuring and recording techniques and media.

11.A.3d Explain the existence of unexpected results in a data set.

11.A.3e Use data manipulation tools and quantitative (e.g., mean, mode, simple equations) and representational methods (e.g., simulations, image processing) to analyze measurements.

Stage G
Conduct inquiry investigation,
- choosing applicable metric units of measurement with estimated scale and range of results for
- student-generated data tables, or
- using direct, indirect, or remote technologies for observing and measuring, or
- conducting sufficient multiple trials, or
- recording all necessary data and observations objectively.

Stage H
Conduct issue investigation,
- using technologies for data collection and assimilation, or
- following established formats for random sampling, or
- following all procedural and safety precautions, materials and equipment handling directions.

Stage I
Conduct inquiry investigation,

- using technologies for observing and measuring directly, indirectly, or remotely, or
- completing multiple, statistically-valid trials, or
- accurately and precisely recording all data.

11.A.3f Interpret and represent results of analysis to produce findings.

Stage G
Interpret and represent analysis of results to produce findings,

- observing trends within data sets, or
- evaluating data sets to explore explanations of outliers or sources of error, or
- analyzing observations and data which may support or refute inquiry hypothesis.

Stage H
Interpret and represent analysis of results,

- evaluating data sets to explore explanations of unexpected responses and data concurrence, or
- evaluating survey validity and reliability, or
- analyzing research and data for supporting or refuting the hypothesis.

Stage I
Interpret and represent analysis of results to produce findings that support or refute inquiry hypothesis,

- evaluating data sets to explore explanations of outliers or sources of error and trends, or
- applying statistical methods to compare mode, mean, percent error and frequency functions.

11.A.3g Report and display the process and results of a scientific investigation.

Stage G
Report and display the process and findings of inquiry investigation,

- presenting oral or written final report for peer review, or
- generating further questions for alternative investigations or procedural refinements, or
- evaluating other investigations for consolidation/refinement of procedures or data explanation.

Stage H
Report, display and defend the process and findings of issue investigation,

- presenting oral or written final report for action response options for peer review, or
- generating further questions or issues for consideration, or
- evaluating other resolutions or responses for action for applicable correlations, consolidation or explanations.

Stage I
Present and defend process and findings in open forum,

- generating further questions, or
- explaining impact of possible sources of error, or
- reflecting on and evaluating peer critiques and comparable inquiry investigations for
- consolidation or refinement of procedures.

Learning Standard
B. Know and apply the concepts, principles and processes of technological design.

Benchmarks and Descriptors

Students who meet the standard know and apply the concepts, principles, and processes of technological design.

11.B.3a Identify an actual design problem and establish criteria for determining the success of a solution,

Stage G
Identify an important historic innovation or model of a technological design,

- examining inventions or entrepreneurial events driven by science or engineering principles, or
- searching pertinent historical foundation, or determining the success criteria, design constraints, and testing logistics that were encountered.

Stage H
Formulate proposals for design investigation,

- generating strategies to test or model a scientific concept, or
- suggesting appropriate supplies, materials, resources, and equipment to test concepts.

Stage I
Formulate independent content-specific hypothesis,

- referencing pertinent reliable prior research, or
- proposing options for appropriate questions, procedural steps, and necessary resources.

11.B.3b Sketch, propose and compare design solutions to the problem considering available materials, tools, cost effectiveness and safety.

11.B.3c Select the most appropriate design and build a prototype or simulation.

Stage G
Construct selected technological innovation model,

- sketching a progression of design stages and prototypes, or
- proposing the logical sequence of steps in design construction, or
- identifying original and comparable simulation materials for construction, or

- predicting proportional scale for actual parameters and materials, or
- completing assembly of innovation model.

Stage H
Create and conduct technological design testing objectively,
- sketching schematic of design or predictions, or
- incorporating the appropriate safety, available technology and equipment capabilities into construction and testing of design.

Stage I
Design an inquiry investigation which addresses proposed hypothesis,
- determining variables and control groups, or
- incorporating all procedural and safety precautions, materials and equipment handling directions and data-collection formatting preparations, or
- securing approval for all procedures, equipment use and safety concerns.

11.B.3d Test the prototype using available materials, instruments and technology and record the data.

Stage G
Test prototype,
- predicting proportional scale for actual parameters and materials, or
- conducting multiple trials according to success criteria, scale, and design constraints, or
- recording reliable and precise data and anecdotal observations.

Stage H
Collect and record data accurately,
- using consistent metric measuring and recording techniques with necessary precision, or
- recording data accurately in appropriate format, or
- graphing data appropriately according to the tested variables.

Stage I
Conduct inquiry investigation,
- using technologies for observing and measuring directly, indirectly, or remotely, or
- completing multiple, statistically-valid trials, or
- accurately and precisely recording all data.

11.B.3e Evaluate the test results based on established criteria, note sources of error and recommend improvements.

Stage G
Analyze data to evaluate design,
- comparing and summarizing data from multiple model trials, or
- correlating historic conditions and data to model testing.

Stage H

Represent results of analysis to produce findings,

- comparing data sets according to the design criteria, or
- evaluating multiple prototype solutions to the overall design success criteria, or
- proposing explanations for sources of error in the data set with regards to product design flaws, or model limitations.

Stage I

Interpret and represent analysis of results to produce findings that support or refute inquiry hypothesis,

- evaluating data sets to explore explanations of outliers or sources of error and trends, or
- applying statistical methods to compare mode, mean, percent error and frequency functions.

11.B.3f Using available technology, report the relative success of the design based on the test results and criteria.

Stage G

Communicate design evaluation report,

- presenting oral and written report on historical significance of selected technological
- design and tested model, its original constraints and conditions, or
- generating possible alternative designs which could have been considered historically.

Stage H

Report the process and results of a design investigation,

- selecting graphs and charts that effectively report the design data, or
- making oral and/or written presentations, or
- proposing logical explanations of success or errors, or
- generating additional design modifications which can be tested later.

Stage I

Present and defend process and findings in open forum,

- generating further questions, or
- explaining impact of possible sources of error, or
- reflecting on and evaluating peer critiques and comparable inquiry investigations for
- consolidation or refinement of procedures.

GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

Learning Standard
A. Know and apply concepts that explain how living things function, adapt and change.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain how living things function, adapt, and change.

12.A.3a Explain how cells function as "building blocks" of organisms and describe the requirements for cells to live.

Stage G
Apply scientific inquiries or technological designs to examine the cellular-to-organism interrelationships,

- comparing the increasingly complex structure and function of cells, tissues, organs and organ systems, or
- demonstrating the processes for biological classification, or
- analyzing normal and abnormal growth and health in organisms (with a focus on humans), or
- describing how physiological systems carry out vital functions (e.g., respiration,
- digestion, reproduction, photosynthesis, excretion, and temperature regulation).

Apply scientific inquiries or technological designs to examine macro- and micro-evolution in organisms,

- comparing and assessing changes in the features or forms of organisms over broad time periods to their adaptive functions and competitive advantages, or
- describing how natural selection accounts for diversity of species over many generations.

Stage H
Apply scientific inquiries or technological designs to explain the chemical nature of biological processes,

- describing photosynthesis in terms of basic requirements and products, or
- correlating respiration, or
- diagramming the nitrogen, water, oxygen, and carbon cycles with reference to ecosystem-to-molecular levels.

Stage I

Apply scientific inquiries or technological designs to explain metabolic processes within cells and between organisms and their environment,

- explaining gas exchange, food processing, transport, excretion, locomotion, body regulation, and nervous control, or
- investigating enzyme actions in various reactions, or
- describing the applications of the polar nature of water and the pH index in biochemical reactions.

Apply scientific inquiries or technological designs to analyze the cellular organelles and functions,

- using different microscopic techniques, or
- explaining functional processes chemically and structurally (e.g., osmotic, active and facilitated transport, enzyme action and protein/lipid/carbohydrate metabolism).

12.A.3b Compare characteristics of organisms produced from a single parent with those of organisms produced by two parents.

Stage G

Apply scientific inquiries or technological designs to

- explore the science of genetics, tracing the history of genetics, or
- correlating the principles of genetics to mitotic cell division and simple mathematical probabilities, or
- researching applied genetics in plant and animal breeding, or
- associating genetic factors for inheritance in humans, including genetic disorders.

Stage H

Apply scientific inquiries or technological designs to correlate the basis of cellular and organism reproductive processes,

- correlating possible genetic combinations to the type of reproductive process, or
- diagramming and comparing mitotic and meiotic cell division, or
- distinguishing asexual and sexual (egg, sperm and zygote formation) reproduction with examples.

Stage I

Apply scientific inquiries or technological designs to explain the molecular nature of the genetic code,

- explaining the function, chemical reactions, and schematic diagrams of the molecular components of DNA, RNA and simple proteins, or
- exploring the processes of recombinant DNA research, or
- describing the role of chromosomes in the normal and aberrant display of hereditary traits, mutations and disease.

12.A.3c Compare and contrast how different forms and structures reflect different functions (e.g., similarities and differences among animals that fly, walk or swim; structures of plant cells and animal cells).

Stage G

Apply scientific inquiries or technological designs to examine macro- and micro-evolution in organisms,

- comparing and assessing changes in the features or forms of organisms over broad time periods to their adaptive functions and competitive advantages, or
- describing how natural selection accounts for diversity of species over many generations

Apply scientific inquiries or technological designs to examine the cellular coordination of responses,

- describing how the nervous system communicates between cells within the whole organism, or
- tracing stimulus-response paths in various nervous systems, or
- analyzing the effect of substances (e.g., oxygen, food, blood, hormones, drugs) circulating through the body.

Stage H

Apply scientific inquiries or technological designs to compare evolutionary trend between kingdoms and phyla,

- exploring natural and applied hybridization, or
- explaining the increasing sophistication of body systems correlating embryological, structural, and functional development, or
- exploring the impact of environmental factors on these trends.

Apply scientific inquiries or technological designs to explore social and environmental responses of organisms,

- describing learned and inherited behaviors and responses across kingdoms and between/among phyla, or
- explaining cyclic behaviors and responses in various species, or
- examining social behaviors of insects and vertebrates.

Stage I

Apply scientific inquiries or technological designs to compare taxonomic criteria among organisms,

- examining unicellular, colonial, and multi-cellular organisms for common and differing characteristics.

Apply scientific inquiries or technological designs to explain tests of evolutionary evidence, analyzing acceptance of geologic and fossil records,

- researching comparative anatomy, embryology, biochemistry and cytology studies of analogous and homologous structures.

Learning Standard
B. Know and apply concepts that describe how living things interact with each other and with their environment.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe how living things interact with each other and with their environment.

12.B.3a Identify and classify biotic and abiotic factors in an environment that affect population density, habitat and placement of organisms in an energy pyramid.

Stage G
Apply scientific inquiries or technological design to

- examine the energy requirements of ecosystems, tracing the roles and population ratios of producers, consumers, and decomposers in food chains and webs, or
- identifying the biomass relationship with the transfer of energy from the sun to final consumers.

Apply scientific inquiries or technological to

- relate the chemical cycles in ecosystems, modeling the water, carbon, and nitrogen cycles with local references, or
- researching groundwater resources and potential sources of contamination with local examples.

Stage H
Apply scientific inquiries or technological designs to explore social and environmental responses of organisms,

- describing learned and inherited behaviors and responses across kingdoms and between/among phyla, or
- explaining cyclic behaviors and responses in various species, or
- examining social behaviors of insects and vertebrates.

Apply scientific inquiries or technological design to explore the implications of change and stability in ecosystems,

- identifying evolutionary adaptations brought on by environmental changes, or
- analyzing factors that influence the size and stability of populations (e.g., temperature, climate, soil conditions, predation, habitat), or
- contrasting energy use by organisms.
-

Apply scientific inquiries or technological design to examine species' demise or success within ecosystems,

- identifying problems for species conservation and extinction, or
- projecting population changes when habitats are altered or destroyed (deforestation, desertification, wetlands destruction, introduction of exotic species),or
- researching economic and scientific value implications for changes to genetic diversity.

Stage I

Apply scientific inquiries or technological design change and to explain population growth, density factors in ecosystem change and stability and biodiversity:

- researching population model studies to determine limiting factors and mathematical patterns of population growth in real-world situations, or
- investigating biotic and abiotic factors of ecosystems, or
- identifying the roles and relationships of organisms in their community in terms of impact on populations and the ecosystem.

Apply scientific inquiries or technological design change and to explain the environment-energy interactions,

- comparing the biomass involved in energy transfer by organisms at different tropic levels, or
- relating biome productivity to carbon-fixing and energy storage by producers, or
- correlating major chemical cycles (nitrogen, carbon dioxide, water) to other chemical cycles in nature (e.g., phosphorus, sulfur, strontium), or
- relating the laws of thermodynamics to environmental-energy transfer efficiency.

12.B.3b Compare and assess features of organisms for their adaptive, competitive and survival potential (e.g., appendages, reproductive rates, camouflage, defensive structures).

Stage G

Apply scientific inquiries or technological to explore the interactions between an ecosystem's organisms,

- examining types of interactive relationships (e.g., mutualism, predation, parasitism) with specific examples, or
- explaining interrelationship of adaptations and ecosystem survival.

Apply scientific inquiries or technological designs to introduce population dynamics in ecosystems,

- exploring models of population growth rates, or
- determining factors that limit population growth, or
- researching specific instances of population explosions over time.
-

Apply scientific inquiries or technological designs to model global biomes,

- identifying the general climate, soil, and inhabitant of the six major land-base biomes, or
- mapping the global biomes, or
- comparing the graphical meteorological data (temperature, precipitation) of biomes/ecosystems.

Stage H

Apply scientific inquiries or technological designs to study biogeography,

- researching global biomes, or

- locating hemispheric, continental, and regional examples of each biome, or
- graphing associated mathematical comparison factors.

Apply scientific inquiries or technological designs to analyze Illinois-specific ecosystems and biomes,

- modeling topographic features, population data, plant diversity and distribution from historic records, or
- collecting scientific seasonal/annual local ecosystem data for direct connection to
- change and stability factors, or
- projecting scenarios of changes to local ecosystem for near- and long-term future contingencies.

Stage I

Apply scientific inquiries or technological designs to research global biomes,

- identifying the latitude, altitude, soil, temperature and precipitation ranges, and inhabitants of the six major land-based biomes, or
- comparing the salinity, light penetration, nutrients, and inhabitants of aquatic biomes, identifying feeding relationships within biomes, or
- comparing climatographs of biomes or carbon-fixing/storage productivity estimations.

Learning Standard

C. Know and apply concepts that describe properties of matter and energy and the interactions between them.

Benchmarks and Descriptors

12.C.3a Explain interactions of energy with matter including changes of state and conservation of mass and energy.

Students who meet the standard know and apply concepts that describe properties of matter and energy and the interactions between them.

Stage G

Apply scientific inquiries or technological designs to compare heat, light, and sound energies,

- distinguishing heat and temperature, their measurements, and the relationship to mass, or
- recording temperatures of simple substances collected during melting/freezing or
- boiling/condensing to trace phase changes, or
- identifying ways of production and travel for heat, light, and sound in various media, or
- relating sound reflection, loudness, frequency, and pitch in common examples.

Apply scientific inquiries or technological designs to explore the nature of energy conversions and conservation,

- describing energy and its different forms with common examples, or

- categorizing energy into kinetic and potential states, or
- explaining energy conversion and conservation possibilities, or
- introducing the connections to concepts of force, momentum, power, and motion.

Stage H

Apply scientific inquiries or technological designs to examine patterns of interactions of energy with matter,

- describing and measuring how the interactions effect changes of state or properties, or
- using quantitative data from investigations and simple chemical formulas and equations to support the concept of conservation of mass, or
- comparing positions, movements, and relationships of atoms in different states, or
- predicting chemical reactivity from information in the Periodic Table.

Apply scientific inquiries or technological designs to explore electric and magnetic energy fields,

- describing natural forces of static electricity and kinds of conductors and insulators, or
- sketching the magnetic lines of force and basic polar attraction and repulsion, or
- creating electric, magnetic, and electromagnetic.

Apply scientific inquiries or technological designs to examine the conservation of matter and energy,

- quantifying conservation of mass, or
- diagramming conservation of energy in common examples, or
- relating the concepts of force, momentum, power, motion, and work to the concepts of mass, distance, and velocity and their applicable constants, laws, and equations.

Stage I

Apply scientific inquiries or technological designs to investigate the energies of the electromagnetic spectrum,

- describing the nature/ characteristics/types/speed/ interactions of waves, or
- contrasting the spectral bands of energy, their detection and applications, or
- modeling rays, reflection, refraction, diffraction and polarization of waves.
-

Apply scientific inquiries or technological designs to investigate heat and sound energy mechanics,

- contrasting the production and conversions of heat and sound from the atomic to industrial levels, or
- diagramming and modeling the processes or systems associated with large- and small-scale production, transmission and uses of heat and sound (e.g., heat engines, cooling systems, musical instruments).

12.C.3b Model and describe the chemical and physical characteristics of matter (e.g., atoms, molecules, elements, compounds, mixtures).

Stage G

Apply scientific inquiries or technological designs to explore the basic structure of matter,

- measuring mass and volumes of common solids (regular and irregular) and liquids to introduce density ratios, or
- comparing ratios of different masses and different volumes of the same kinds of samples, or
- relating how historic models of elemental matter from ancient Greeks to medieval
- alchemists evolved to current representations and explanations, or
- classifying comparable properties of representative elements or similar compounds (mixtures, acids, bases, salts, metals, non-metals), or
- constructing simple chemical structure models to explain chemical combinations, states, and properties.

Stage H

Apply scientific inquiries or technological designs to examine the chemical and physical characteristics of matter,

- constructing and discussing models and charts that explain these properties, or
- investigating the relationships among atoms, molecules, elements, and compounds, or
- classifying objects and mixtures based on these properties, or
- explaining the organization of elements in the Periodic Table, or
- investigating the properties of gases at varying temperatures and pressures.

Stage I

Apply scientific inquiries or technological designs to investigate the atomic and nuclear structure of matter,

- examining historical atomic theories and quantum theory, or
- modeling nuclear and electron configurations and their reactions, or
- predicting bonding and molecular structure.

Apply scientific inquiries or technological designs to explain how physical and chemical structures of matter affect its properties,

- relating bonding types and shapes of molecules to organic and inorganic compounds, or
- examining the colligative properties of solutes on the properties of solutions/mixtures.

Apply scientific inquiries or technological designs to investigate kinetic theory and laws of thermodynamics,

- describing the ideal gases, or
- analyzing the gas laws, or
- explaining entropy/ enthalpy, exothermic/endothermic reactions, and/or Hess's law.

Learning Standard

D. Know and apply concepts that describe force and motion and the principles that explain them.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe force and motion and the principles that explain them.

12.D.3a Explain and demonstrate how forces affect motion (e.g., action/reaction, equilibrium conditions, free-falling objects).

Stage G

Apply scientific inquiries or technological designs to explore frames of reference for measuring motion,

- visualizing the possible reference frames in multiple motion examples, or
- comparing scope of motion (straight line, projectile, inclined, free fall, circular) of various objects.

Apply scientific inquiries or technological designs to explore frames of reference for measuring motion,

- explaining the dimensions of speed/time with directional units, or
- comparing speed, average speed, velocity, acceleration, and momentum with common examples, or
- using simple machines to demonstrate the principles of mechanics, or
- analyzing components of motion graphically.

Stage H

Apply scientific inquiries or technological designs to examine patterns of interactions of energy with matter,

- describing and measuring how the interactions effect changes of state or properties, or
- using quantitative data from investigations and simple chemical formulas and equations to support the concept of conservation of mass, or
- comparing positions, movements, and relationships of atoms in different states, or
- predicting chemical reactivity from information in the Periodic Table.

Stage I

Apply scientific inquiries or technological designs to investigate motion relationships in natural and forced settings,

- calculating the kinematics of rectilinear, free fall, projectile, rotational, and circular motion in commonly experienced problem settings, or
- explaining torque and center of mass in relation to the conditions of equilibrium, or
- explaining the Doppler effect, or
- calculating forces in elastic and inelastic collisions.

12.D.3b Explain the factors that affect the gravitational forces on objects (e.g., changes in mass, distance).

Stage G

Apply scientific inquiries or technological designs to measure force,

- explaining the dimensions of force graphically, or
- comparing common examples of balanced or unbalanced forces in everyday use, or
- examining frictional forces in common examples.

Apply scientific inquiries or technological designs to explore laws and theories associated with motion,

- comparing common situations to each of Newton's three laws of motion, or
- using the appropriate units, or
- introducing applications to Newton's Law of Universal Gravitation, or
- incorporating the variant of air resistance.

Stage H

Apply scientific inquiries or technological designs to investigate gravitational forces:

- explaining the comparisons of weight and mass with variations of 'g' forces and different locations, or
- calculating descent and free fall trajectories of objects in various settings.

Apply scientific inquiries or technological designs to explore the applications of scientific work,

- constructing variations of simple and compound machines to measure work, power, and force with varying frictional factors, or
- calculating work efficiency of common and complex machines, or
- converting forces of mature (such as weather, tornadoes, wind) into Newtonian factors.

Stage I

Apply scientific inquiries or technological designs to investigate motion and pressure common examples in nature,

- defining the factors of pressure and its equilibrium, or
- identifying how particles in a fluid can exert pressure as related to altitude and depth, or
- explaining buoyancy and hydraulics in terms of comparative densities, or
- addressing Bernoulli's principles to flight, or
- relating pressure and gravity to common engineering settings.

Apply scientific inquiries or technological designs to explore atomic and nuclear physical systems,

- describing historic, current, and proposed research to explain purposes and impact of discoveries, or
- explaining radioactivity in terms of atomic decay, nuclear reactions, and emissions.

Apply scientific inquiries or technological designs to explain harmonic motion,

- describing the scope of vibrational motion, or
- calculating harmonic periods variations, or

- constructing variations to linear and angular simple harmonic motion and elastic constants, or
- exploring historic studies which established applicable constants, laws and theories.

Apply scientific inquiries or technological designs to investigate electricity and magnetism,
- comparing, flow, units, and charges in magnetic and electric fields and circuits, or
- measuring electromagnetic conversions and induction, or
- examining applicable historic discoveries, explanations and laws, or
- explaining static electricity, or
- explaining the schematic designs and flow models for electromagnetic devices.

Learning Standard
E. Know and apply concepts that describe the features and processes of the Earth and its resources.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the features and processes of Earth and its resources.

12.E.3a Analyze and explain large-scale dynamic forces, events and processes that affect the Earth's land, water and atmospheric systems (e.g., jetstream, hurricanes, plate tectonics).

Stage G
Apply scientific inquiries and technological designs to investigate large-scale dynamic forces that change geologic features,
- diagramming single global features over time as affected by continental drift, or
- identifying properties and origins of rocks and minerals, or
- explaining impact of weathering, erosion, and deposition.

Stage H
Apply scientific inquiries and technological designs to investigate the explanations of the geologic features and structures,
- diagramming the established geologic eras, periods, and epochs, or
- describing the geological events that led to the formation of the Great Lakes and Illinois, or
- relating physical and chemical properties of minerals.

Stage I
Apply scientific inquiries and technological designs to examine Earth's atmosphere and its changes,
- observing local weather factors over time, or
- comparing current and past climate, or
- analyzing weather conditions in terms of Earth's inclination and solar fluctuations.

Apply scientific inquiries and technological designs to examine Earth's hydrosphere and its changes,

- documenting impact of large-scale weather systems from short- and long-term weather reports, or
- predicting climatic conditions for geographic settings.

Apply scientific inquiries and technological designs to examine Earth's lithosphere and its changes,

- using earth rock cycle remnants, soil formation, and tectonic movements, and fossil records, or
- constructing models of tectonic plates and their impact on large-scale structures, or
- constructing local topographic maps.

Apply scientific inquiries and technological designs to examine earth's interior and its changes,

- explaining the distribution and causes of natural events such as earthquakes and volcanoes, or
- explaining the indirect methods to determine the Earth's inner structure and its effects on the surface features.

12.E.3b Describe interactions between solid earth, oceans, atmosphere and organisms that have resulted in ongoing changes of Earth (e.g., erosion, El Nino).

Stage G

Apply scientific inquiries or technological designs to investigate large-scale meteorological forces.

- distinguishing weather from climate, or
- examining global weather data over broad periods of time, or
- explaining how atmospheric circulation is driven by solar heating.

Apply scientific inquiries or technological designs to investigate large-scale oceanographic forces,

- mapping ocean motions and life zones, or
- identifying the quantitative proportions of ocean and fresh water.

Stage H

Apply scientific inquiries or technological designs to examine meteorological phenomena,

- describing large-scale and local weather systems, or
- interpreting weather maps, or
- describing the composition, properties, range of temperatures, and/or pressures in various layers of the atmosphere, or
- describing relationships between the sun and the earth's climate, seasons and weather.

Stage I

Apply scientific inquiries and technological designs to examine Earth's hydrosphere and its changes,

- documenting impact of large-scale weather systems from short- and long-term weather reports, or
- predicting climatic conditions for geographic settings.

Apply scientific inquiries and technological designs to examine Earth's lithosphere and its changes,

- using earth rock cycle remnants, soil formation, and tectonic movements, and fossil records, or
- constructing models of tectonic plates and their impact on large-scale structures, or
- constructing local topographic maps.

Apply scientific inquiries and technological designs to examine earth's interior and its changes,

- explaining the distribution and causes of natural events such as earthquakes and volcanoes, or
- explaining the indirect methods to determine the Earth's inner structure and its effects on the surface features.

Apply scientific inquiries and technological designs to examine the changing perspective of the Earth in space,

- documenting the changes in public perception of the Earth since the space program began, or
- researching the technologies which have broadened the information known about the earth and its resources.

12.E.3c Evaluate the biodegradability of renewable and nonrenewable natural resources.

Stage H

Apply scientific inquiries or technological designs to examine Earth's resources quantitatively,

- demonstrating biodegradation of various substances, or
- explaining specific examples of mining, or
- comparing renewability or availability of earth resources, including freshwater reserves.

Stage I

Apply scientific inquiries and technological designs to examine earth's interior and its changes,

- using earth rock cycle remnants, soil formation, and tectonic movements, and fossil records, or
- constructing models of tectonic plates and their impact on large-scale structures, or
- constructing local topographic maps.

Apply scientific inquiries and technological designs to examine earth's interior and its changes,

- explaining the distribution and causes of natural events such as earthquakes and volcanoes, or
- explaining the indirect methods to determine the Earth's inner structure and its effects on the surface features.

Apply scientific inquiries and technological designs to examine the changing perspective of the Earth in space,

- documenting the changes in public perception of the Earth since the space program began, or
- researching the technologies which have broadened the information known about the earth and its resources.

Learning Standard

F. Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

12.F.3a Simulate, analyze and explain the effects of gravitational force in the solar system (e.g., orbital shape and speed, tides, spherical shape of the planets and moons).

Stage G

Apply scientific inquiries or technological designs to explore the earth in space with its moon,

- plotting how the relative motions and positions of the sun, earth, and moon influence eclipses, moon phases, and tides, comparing the composition and surface features of the earth and moon, or
- using imaging, magnifications and displays to model the moon's surface features, or
- calculating earth and moon rise and set over time.

Stage H

Apply scientific inquiries or technological designs to compare the view from Earth to the solar system,

- relating gravitational force between planetary bodies in the solar system, or
- introducing theories of origin of the solar system components, or
- explaining photographic or historic records and mathematical calculations of comets and their orbits.

Apply scientific inquiries or technological designs to compare the view from Earth to the galaxies,

- calculating exponential scale of distances within and beyond the Milky Way galaxy, or

- explaining the possible distortions of these views from Earth's surface, or
- classifying galaxies, etc. by size, composition, distances, established shapes, etc.

Stage I
Apply scientific inquiries or technological designs to examine Earth's place in the solar system,
- calculating distances between planetary bodies, orbital paths, trajectories and collision potential with asteroids, etc., or
- explaining lunar and solar eclipses, or
- graphing meteor impact craters to geologic time periods and mass extinctions.

12.F.3b Describe the organization and physical characteristics of the solar system (e.g., sun, planets, satellites, asteroids, comets).

Stage G
Apply scientific inquiries or technological designs to study the galaxies,
- describing the relationship of galactic components (e.g., age, composition, properties), or
- explaining imaging displays of views of galactic objects.

Apply scientific inquiries or technological designs to study space exploration,
- creating a timeline which denotes the important events associated with the global space programs, or
- identifying the kinds of technologies which are currently used for studying the solar system and universe, or
- reporting on applicable historic studies which have provided discoveries, tools or
- explanations associated with space exploration.

Stage H
Apply scientific inquiries or technological designs to compare the view from Earth to the solar system,
- relating gravitational force between planetary bodies in the solar system, or
- introducing theories of origin of the solar system components, or
- explaining photographic or historic records and mathematical calculations of comets and their orbits.

Stage I
Apply scientific inquiries or technological designs to examine the Sun's place in the solar system,
- explaining the energy of the sun in relation to the full electromagnetic spectrum, or
- correlating sunspot activity and cycles to earth events and phenomena, or
- describing the solar atmosphere, inner layers, nuclear reactions, and temperatures.

12.F.3c Compare and contrast the sun as a star with other objects in the Milky Way Galaxy (e.g., nebulae, dust clouds, stars, black holes).

Stage G

Apply scientific designs to explore the solar system,

- comparing the major features of the solar system including the nine planets, their moons, orbital shapes, surface and atmospheric conditions, orientation and periods of rotation and revolution, or
- charting orbital factors of comets, asteroids, meteors, etc., or
- explaining imaging displays of different kinds of solar system objects.

Stage H

Apply scientific inquiries or technological designs to compare the view from Earth to the galaxies,

- calculating exponential scale of distances within and beyond the Milky Way galaxy, or
- explaining the possible distortions of these views from Earth's surface, or
- classifying galaxies, etc. by size, composition, distances, established shapes, etc.

Apply scientific inquiries or technological designs to compare the history of astronomy through the ages,

- modeling major constellations, or
- explaining the roles that constellations played in the multi-cultural development of
- navigation and agriculture, or
- explaining theories, past and present, for the origin and evolution of the universe, or
- comparing astrological beliefs to astronomical laws and theories.

Stage I

Apply scientific inquiries or technological designs to examine the Sun's place in the solar system,

- explaining the energy of the sun in relation to the full electromagnetic spectrum, or
- correlating sunspot activity and cycles to earth events and phenomena, or
- describing the solar atmosphere, inner layers, nuclear reactions, and temperatures.

Apply scientific inquiries or technological designs to examine the solar system's place in the universe,

- analyzing the life cycles of stars of different masses, or
- explaining the flow of energy within stars to the formation of the chemical elements, or
- relating nebulae, dust clouds, stars, pulsars, black holes, etc.

Apply scientific inquiries or technological designs to examine the similarities found throughout the universe,

- comparing bright line spectra of different elements in different stars, or
- using proportional relationships of reference stars to estimate magnitude of unknown stars, or
- demonstrating models of the expanding universe concepts.

GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important: Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

Learning Standard

A. Know and apply the accepted practices of science.

Benchmarks and Descriptors

Students who meet the standard know and apply accepted practices of science.

13.A.3a Identify and reduce potential hazards in science activities (e.g., ventilation, handling chemicals).

Stage G
Apply appropriate principles of safety,

- identifying potentially hazardous chemical combinations in the home or classroom, or
- suggesting responses and reactions in home and classroom settings in case of threatening chemical scenarios, or
- following all necessary safety precautions, cleaning and disposal procedures for scientific investigations, or
- demonstrating safe transport, precise use, and appropriate storage for scientific equipment, or
- providing safe and ethical care for all classroom organism collections.

Stage H
Apply appropriate principles of safety within and beyond the science classroom,

- communicating and following clear instructions, or
- mapping classrooms for safe egress and distances/times to access safety treatment features, or
- demonstrating safety practices and emergency procedures pertaining to laboratory and field work, or
- explaining the basis of safety practices and procedures.

Stage I
Apply appropriate principles of safety,

- following established procedures to maintain both personal & environmental safety when handling & disposing of chemicals, or

- estimating risks/benefits to alternative procedures, or
- mapping classroom laboratory facilities for safe egress & distances/times to access safety treatment features, or
- manipulating, reading and troubleshooting scientific equipment safely, or
- communicating school science storage and disposal policies for classroom investigations, or
- demonstrating safety practices and emergency procedures pertaining to laboratory and field work, or
- researching community disposal procedures (e.g., mercury thermometers or lead batteries), or
- participating in household waste and hazardous waste pickup programs in Illinois.

13.A.3b Analyze historical and contemporary cases in which the work of science has been affected by both valid and biased scientific practices.

13.A.3c Explain what is similar and different about observational and experimental investigations.

Stage G
Apply scientific habits of mind,
- generating questions and strategies to test science concepts using critical and creative thinking, or
- identifying instances of how scientific reasoning, insight, skill, creativity, intellectual honesty, tolerance of ambiguity, skepticism, persistence, and openness to new ideas have been integral to scientific discoveries and technological improvements, or comparing scientist's work and habits of mind to work in other careers.

Analyze cases of scientific studies,
- studying historic examples of valid investigations from curricular life, environmental, physical, earth, and space sciences, or
- finding examples of faulty or biased scientific reasoning which distorted scientific understanding, or
- citing experimental and observational strategies in direct, indirect, and remote investigations

Stage H
Apply scientific habits of mind to curricular investigations in life, environmental, physical, earth, and space sciences,
- evaluating evidence, or
- inferring statements based on data, or
- questioning sources of information, or
- explaining necessity of manipulating only one variable at a time, or
- retrieving mathematical data accurately for scientific analysis.

Analyze scientific studies referenced in curricular investigations in life, environmental, physical, earth, and space sciences,

- reviewing experimental procedures or explanations for possible faulty reasoning or unproven statements (e.g., power line magnetic fields, abiogenesis models), or
- distinguishing relationships of scientific theories, models, hypotheses, experiments, and methodologies, or
- distinguishing fact from opinion and science from pseudoscience.

Stage I

Apply scientific habits of mind to curricular investigations in life, environmental, physical, earth, and space sciences,

- identifying instances of how scientific reasoning, insight, creativity, skill, intellectual honesty, tolerance of ambiguity, skepticism, persistence, openness to new ideas, and sheer luck have been integral to discoveries, or
- identifying specific studies which demonstrate how scientific conclusions are open to modification as new data are collected, or
- researching classroom and real-world standards for peer review.

Learning Standard

B. Know and apply concepts that describe the interaction between science, technology and society.

Benchmarks and Descriptors

Students who meet the standard know and apply concepts that describe the interaction between science, technology, and society.

13.B.2a Explain how technology is used in science for a variety of purposes (e.g., sample collection, storage and treatment; measurement; data collection, storage and retrieval; communication of information.

Stage G

Explore scientific technologies in life, environmental, physical, earth, and space sciences,

- identifying advances in the past century, or
- describing technologies used by scientists to forecast, explain, or test major events in each of the sciences, or
- diagramming processes and products from applicable technologies.

Stage H

Explore interaction of resource acquisition, technological development, and ecosystem impact,

- documenting actual local, regional, national, or global examples, or
- proposing alternative solutions to interaction impact, or
- estimating costs of such interactions.

Stage I

Analyze the pure and applied research nature of science,

- evaluating public perceptions of value of scientific research, or
- assessing short- and long-term risks/benefits of specific pure research which directly led, or may lead, to direct applications.

Analyze career and occupational decisions that are affected by a knowledge of science,

- associating scientific concepts considered in career-specific decisions (e.g., use of pesticides by farmers, choosing ink for printing), or
- explaining chemical/physical interactions in occupational settings (e.g., insect abatement programs, waste water treatment).

Analyze how resource management and technologies accommodate population trends,

- explaining factors needed to sustain and enhance the quality of Earth's water, or
- quantifying benefits, costs, limitations and consequences involved in using scientific technologies or resources, or
- assessing global consequences of ecosystem modifications (Link to 11A-B, 12A-F, 16, 17, 22B.)

Analyze claims used in advertising and marketing strategies for scientific validity,

- collecting statements of purported scientific studies to evaluate mathematical validity, or
- researching scientific foundations use (or manipulation) in marketing and advertising strategies for target populations.

13.B.2b Describe the effects on society of scientific and technological innovations (e.g., antibiotics, steam engine, digital computer).

13.B.2c Identify and explain ways that science and technology influence the lives and careers of people.

13.B.2d Compare the relative effectiveness of reducing, reusing and recycling in actual situations.

13.B.2e Identify and explain ways that technology changes ecosystems (e.g., dams, highways,

Stage H

Explore the interactions of science and technology in multicultural, societal, and economic settings,

- analyzing how the introduction of a new technology has affected human activities worldwide, or
- associating personal biographic information about science leaders from around the world.

Analyze the societal interactions resulting from scientific discoveries and technological innovations,

- researching the scientific milestones that have revolutionized thinking over time, or

- grouping technological innovations to historic time periods and changes in communities and countries, or
- comparing public perceptions about the costs and impact of pure science research and applied science solutions.

Explore historic, multicultural societal influences on scientific discoveries and technological innovations,

- comparing the knowledge, skills, and methods of early and modern scientists in the sciences, or
- finding examples of rejection of scientific or technological advances by cultures based on belief systems.

Explore scientific concepts in career and technical knowledge and skills in everyday settings,

- interviewing adults to identify specific applications of scientific concepts or technological innovations, or
- researching job market trends for anticipated changes in the next ten-year period based on projected technology interventions, resource depletion or access, or economic interactions, or
- demonstrating relationships between improving technology, all science fields, and
- educational/training requirements for such careers.

Stage H

Explore natural resource conservation and management programs,

- calculating home/school electric or water usage, etc., to propose plans for increased efficiency, or
- evaluating their effect on natural resources and the local economy, or
- researching the past, current, and future local landfill plans, or
- examining state wildlife programs for controlled breeding or population maintenance.

Explore policies which affect local science or technology issues,

- researching applicable issue of local concern (e.g., subdivision development, groundwater contamination), or
- developing classroom criteria to measure effectiveness of policies, or
- developing survey instruments to assess depths of informed opinions on issues, or
- collecting pertinent data from expert local sources, or
- analyzing data and policy correlation.

Stage I

Analyze the pure and applied research nature of science,

- evaluating public perceptions of value of scientific research, or assessing short- and long-term risks/benefits of specific pure research which directly led, or may lead, to direct applications.

Analyze career and occupational decisions that are affected by a knowledge of science,

- associating scientific concepts considered in career-specific decisions (e.g., use of pesticides by farmers, choosing ink for printing), or

- explaining chemical/physical interactions in occupational settings (e.g., insect abatement programs, waste water treatment).

Analyze how resource management and technologies accommodate population trends,

- explaining factors needed to sustain and enhance the quality of Earth's water, or
- quantifying benefits, costs, limitations and consequences involved in using scientific technologies or resources, or
- assessing global consequences of ecosystem modifications

Analyze claims used in advertising and marketing strategies for scientific validity,

- collecting statements of purported scientific studies to evaluate mathematical validity, or
- researching scientific foundations use (or manipulation) in marketing and advertising strategies for target populations.