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ABSTRACT

This document outlines the content standards for science in the state of Colorado. The document is organized into six standards, each of which is subdivided into a set of guiding questions exemplifying the standard and a series of lists defining what is expected of students at each grade level within the standard. The standards are that students understand the process of scientific investigation; that they know and understand qualities of matter and energy; that they know and understand the characteristics and structures of living things; that they know and understand the processes and interactions of Earth's systems; that they know and understand interrelationships between science, technology, and human activity; and that they understand that science involves a particular way of knowing. A list of references is also included. (MM)

COLORADO MODEL CONTENT STANDARDS FOR SCIENCE

Suggested Grade Level Expectations*

(*Suggestions for improvement are always welcome)

06/21/01

Standard 1:

Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.

Guiding questions:

- How do scientists ask questions that help them learn about the world?
- How do scientists design and conduct investigations that answer their questions?
- How do scientists evaluate data derived from the investigation?
- How do scientists communicate their findings to others?

In grades K-4, what students know and are able to do includes:

Asking questions and stating predictions (hypotheses) that can be addressed through scientific inquiry.

Kindergarten and first grade students will:

- ask reasonable questions based on observation about objects, organisms, and events in their environment
- state simple hypotheses about cause and effect relationships in the environment
- predict the results of an observable cause and effect relationship in the environment
- ask "what if" questions and explore multiple possible explanations

Second grade students will:

- create and refine ideas and questions about events in their environment by asking for information and trying things out (e.g. identify a simple problem and test a possible solution)
- observe patterns and make predictions based on the observation
- develop solutions to unfamiliar problems through reasoning and inquiry that includes formulating a plan, gathering data and constructing a reasonable explanation
- use accurate tools to observe and measure objects during an inquiry
- measure length, temperature, and liquid volume with appropriate tools and express measurements

- compare and sort common objects based or two or more physical attributes (e.g. color and texture, size and shape)
- conduct inquiry into a topic of their interest and run repeat trials of a related simple experiment to compare results
- identify a sequence of events in a natural cycle(e.g. water cycle, life to death)
- distinguish between actual observations from ideas and speculation about what was observed
- describe the process used in solving the problem or investigation
- create communications that describe and compare things in terms of numbers, shape, texture, size, odor, sound, mass, and motion
- restate, illustrate, or summarize what others have said
- use a variety of media to search for information

Third grade students will:

- predict what is missing and what will come next in sequences of objects and events and test his/her predictions
- seek evidence to support ideas by asking, "How does it work?" "How do we know?" "Why?"
- predict the outcome of a simple investigation and compare the result to the prediction
- select and explore the use and accuracy of a variety of measuring devices
- demonstrate alternate ways to display data
- search for information from multiple sources
- explain and discuss various influences affecting observations and interpretations
- use numerical data in describing and comparing objects, events and measurements
- seek evidence to support opinions, statements, and conclusions

Fourth grade students will:

- plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations
- use the data from one investigation, generate a prediction for a new investigation
- conduct a systematic observation over time
- organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram)
- select and use mathematical tools to measure, count, sort, identify, describe, label, and communicate information from observations (e.g. whole numbers, simple fractions, geometric figures, representative charts such as pie and bar charts)
- analyze data found in graphs, charts, and articles in order to draw and evaluate conclusions
- develop and evaluate explanations based upon experimental evidence and the experience of others
- check explanations against scientific knowledge, experiences and observations of others
- use facts to support and evaluate the fairness of conclusions
- write instructions that others can follow
- describe and illustrate the steps taken in solving a problem including the resources used
- use appropriate units to add meaning to numbers
- use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps and stories to represent objects, events, and processes
- select and use simple devices to gather data related to an investigation (e.g. ruler, thermometers, watches, magnifying lens, microscopes, calculators, and computers)

In grades K-4, what students know and are able to do includes:

Selecting and using simple devices to gather data related to an investigation.

Kindergarten students will:

- organize (e.g. sort, classify, sequence) and explore how objects, organisms, and events are measured according to different characteristics
- perform simple measurements using appropriate tools and devices
- compare observable characteristics of common objects (e.g. size, color, texture) for similarities and differences
- compare objects according to their measurement (e.g. larger than, heavier than)
- observe and describe changes in a simple system (e.g. plant terrarium, ant farm,. aquarium)
- observe and describe simple patterns and cycles (e.g. seasons, day/night, geometric designs)

First grade students will:

- conduct simple inquiry based on his/her own questions
- make multiple observations of events and explorations using the five senses (or as many of the five senses as are appropriate)
- perform simple measurements using appropriate tools and devices (e.g. magnifiers, thermometers, rulers)
- manipulate a simple mechanical devise and verbally communicate how it works
- draw pictures that portray some features of a natural event they observe (e.g. fish in aquarium, weather change)
- record observations/data on a bar graph
- describe the relative position of objects using two references (e.g. above and next to, below and left of)

Second grade students will:

- create and refine ideas and questions about events in their environment by asking for information and trying things out (e.g. identify a simple problem and test a possible solution)
- observe patterns and make predictions based on the observation

- develop solutions to unfamiliar problems through reasoning and inquiry that includes formulating a plan, gathering data and constructing a reasonable explanation

- use accurate metric measuring tools to observe and measure objects

- measure length, mass, temperature and liquid volume with appropriate tools and express measurements

- compare and sort common objects based or two or more physical attributes (e.g. color and texture, size and shape)

- conduct inquiry into topic of their interest and run repeat trials of a related simple experiment to compare results

- identify a sequence of events in a natural cycle(e.g. water cycle, life to death)

- distinguish between actual observations from ideas and speculation about what was observed

- describe the process used in solving the problem or investigation

- describe and compare things in terms of numbers, shape, texture, size, odor, sound, mass, and motion

- write or draw descriptions of a sequence of steps, events, and observations

- restate, illustrate, or summarize what others have said

- use a variety of media to search for information

Third grade students will:

- predict what is missing and what will come next in sequences of objects and events and test his/her predictions

- seek evidence to support ideas by asking, "How does it work?" "How do we know?" "Why?"

- predict the outcome of a simple investigation and compare the result to the prediction

- select and explore the use of a variety of measuring devices

- select and explore the use and accuracy of a variety of measuring devices

- demonstrate alternate ways to display data
- search for information from multiple sources
- explain and discuss various influences affecting observations and interpretations
- use numerical data in describing and comparing objects, events and measurements
- seek evidence to support opinions, statements, and conclusions

Fourth grade students will:

- plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations
- use the data from one investigation, generate a prediction for a new investigation
- conduct a systematic observation over time
- organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram)
- select and use mathematical tools to measure, count, sort, identify, describe, label, and communicate information from observations (e.g. whole numbers, simple fractions, geometric figures, representative charts such as pie and bar charts
- analyze data found in graphs, charts, and articles in order to draw and evaluate conclusions
- develop and evaluate explanations based upon experimental evidence and the experience of others
- write instructions for a scientific or experimental procedure that others can follow
- describe and illustrate the steps taken in solving a problem including the resources used
- use appropriate units when presenting or using numerical data
- use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps and stories to represent objects, events, and processes

- select and using simple devices to gather data related to an investigation (e.g. ruler, thermometers, watches, magnifying lens, microscopes, calculators, and computers)

In grades K-4, what students know and are able to do includes:

Using data based on observations to construct a reasonable explanation.

Kindergarten students will:

- offer explanations of observed events and evidence of event

First grade students will:

- consider the ideas expressed by others about natural events and discuss whether these ideas can be supported by fact
- be able to reasonably explain what they observe in an inquiry on a science topic that interests them

Second grade students will:

- identify a simple problem and test a possible solution
- observe patterns and make predictions based on observations
- develop solutions to unfamiliar problems through reasoning and inquiry that includes formulating a plan, gathering data and constructing a reasonable explanation
- use accurate tools to observe and measure objects during an inquiry
- measure length, temperature and liquid volume with appropriate tools and express measurements in standard and non-standard units
- compare and sort common objects based or two or more physical attributes (e.g. color and texture, size and shape)
- conduct inquiry into topic of their interest and run repeat trials of a related simple experiment to compare results
- identify a sequence of events in a natural cycle(e.g. water cycle, life to death)
- distinguish between actual observations from ideas and speculation about what was observed

- describe the process used in solving the problem or investigation
- create communications that describe and compare things in terms of numbers, shape, texture, size, odor, sound, mass, and motion
- write or draw descriptions of a sequence of steps, events, and observations
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- use a variety of media to search for information

Third grade students will:

- predict what is missing and what will come next in sequences of objects and events and test his/her predictions
- seek evidence to support ideas by asking, "How does it work?" "How do we know?" "Why?"
- predict the outcome of a simple investigation and compare the result to the prediction
- select and explore the use and accuracy of a variety of measuring devices
- demonstrate alternate ways to display data
- search for information from multiple sources
- explain and discuss various influences affecting observations and interpretations
- use numerical data in describing and comparing objects, events and measurements
- seek evidence to support opinions, statements, and conclusions

Fourth grade students will:

- plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations
- using the data from one investigation, generate a prediction for a new investigation
- conduct a systematic observation over time

- organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram)

- select and use mathematical tools to measure, count, sort, identify, describe, label, and communicate information from observations (e.g. whole numbers, simple fractions, geometric figures, representative charts such as pie and bar charts

- analyze data found in graphs, charts, and articles in order to draw and evaluate conclusions

- develop and evaluate explanations based upon experimental evidence and the experience of others

- use knowledge and evidence obtained in experimentation, to support explanation

- check explanations against scientific knowledge, experiences and observations of others

- use facts to support and evaluate the fairness of conclusions

- write instructions for a scientific or experimental procedure that others can follow

- describe and illustrate the steps taken in solving a problem including the resources used

- use appropriate units when presenting or using numerical data

- describe and illustrate the steps taken in solving a problem including the resources used

- use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps and stories to represent objects, events, and processes

In grades K-4, what students know and are able to do includes:

Communicating about investigations and explanations.

Kindergarten students will:

- communicate observations and comparisons through various means such as pictographs, pictures, models, and words

- describe observations with pictures pictographs models and words

- describe similarities and differences of observations

First grade students will:

- describe the relative position of objects using two references (e.g. above and next to, below and left of)

Second grade students will:

- create and refine ideas and questions about events in their environment by asking for information and trying things out (e.g. identify a simple problem and test a possible solution)
- observe patterns and make predictions based on observations
- develop solutions to unfamiliar problems through reasoning and inquiry that includes formulating a plan, gathering data and constructing a reasonable explanation
- use accurate tools to observe and measure objects during an inquiry
- measure length, temperature and liquid volume with appropriate tools and express measurements in standard and non-standard units
- compare and sort common objects based or two or more physical attributes (e.g. color and texture, size and shape)
- conduct inquiry into topic of their interest and run repeat trials of a related simple experiment to compare results
- identify a sequence of events in a natural cycle(e.g. water cycle, life to death)
- distinguish between actual observations from ideas and speculation about what was observed
- describe the process used in solving the problem or investigation
- create communications that describe and compare things in terms of numbers, shape, texture, size, odor, sound, mass, and motion
- write or draw descriptions of a sequence of steps, events, and observations
- restate, illustrate, or summarize what others have said
- use a variety of media to search for information

Third grade students will:

- predict what is missing and what will come next in sequences of objects and events and test his/her predictions
- seek evidence to support ideas by asking, "How does it work?" "How do we know?" "Why?"
- predict the outcome of a simple investigation and compare the result to the prediction
- select and explore the use of a variety of measuring devices
- select and explore the use and accuracy of a variety of measuring devices
- demonstrate alternate ways to display data
- search for information from multiple sources
- observe events and phenomena of varying duration and report occurrences affecting observations and interpretations
- explain and discuss various influences affecting observations and interpretations
- use numerical data in describing and comparing objects, events and measurements
- seek evidence to support opinions, statements, and conclusions

Fourth grade students will:

- plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations
- using the data from one investigation, generate a prediction for a new investigation
- organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram)
- select and use mathematical tools to measure, count, sort, identify, describe, label, and communicate information from observations (e.g. whole numbers, simple fractions, geometric figures, representative charts such as pie and bar charts

- develop and evaluate explanations based upon experimental evidence and the experience of others
- use data from an experiment to support explanation
- check explanations against scientific knowledge, experiences and observations of others
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- write instructions that others can follow
- describe and illustrate the steps taken in solving a problem including the resources used
- use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps and stories to represent objects, events, and processes

In grades 5-8, what students know and are able to do includes:

Identifying and evaluating alternative explanations and procedures;

Using examples to demonstrate that scientific ideas are used to explain previous observations and to predict future events (e.g., plate tectonics and future earthquake activity);

Asking questions and stating hypotheses that lead to different types of scientific investigations (e.g., experimentation, collecting specimens, constructing models researching scientific literature);

Creating a written plan for an investigation;

Using appropriate tools, technologies, and measurement units to gather and organize data interpreting and evaluating data in order to formulate conclusions;

Communicating results of their investigations in appropriate ways (e.g., written reports, graphic displays, oral presentations);

Using metric units in measuring, calculating, and reporting results;

Explaining that scientific investigations sometimes result in unexpected findings that lead to new questions and more investigations; and

Giving examples of how collaboration can be useful in solving scientific problems and sharing findings.

Fifth grade students will:

- identify alternative explanations to natural phenomena and design procedures to test explanations
- differentiate between an explanation and a description
- predict an outcome based on a set of experimental data
- recognize that scientific investigations sometimes generate new methods or procedures for an investigation or develop new technologies to improve the collection of data
- differentiate between ideas based on scientific fact or understanding and those based on myths or misrepresented data
- differentiate between a question and a hypothesis
- develop a testable hypothesis
- refine hypotheses from a series of investigations
- demonstrate ability to identify and control variables
- design a model to illustrate an investigation
- select appropriate tools (e.g. thermometers, balances, beakers) and make quantitative observations
- organize and present data in an appropriate format (e.g. charts, graphs, labeled diagrams, tables)
- draw a conclusion based on a set of experimental data
- use metric units in measuring, calculating, and reporting results
- communicate the results of an investigation that includes the hypotheses tested, tests conducted or evidence examined, conclusions drawn, and explanations for any inconsistencies, limitations, and variability in recorded observations

Sixth grade students will:

- choose measurement methods and devices according to the level of precision demanded by the problem

- predict an outcome based on a set of experimental data
- recognize that scientific investigations sometimes lead to new methods or procedures for conducting an investigation or new technologies to improve the collection of data
- construct a model that illustrates a concept developed from an inquiry
- refine hypotheses from a previous investigation
- identify the variables in an investigation
- create a written plan to include the question to be investigated, an appropriate hypothesis, design of the experiment, identification of the variables, a developed scientific procedure to collect and record data; the design should also include a number of repeated trials, accurate measurements and record keeping and a comparison to a control
- organize and present the data in appropriate formats (e.g. histograms, circle graphs, flow charts) and make inferences based on that data
- identify, and interpret patterns, trends, relationships in collected data
- identify data that does not fit a pattern
- analyze the results of an experiment, draw conclusions about the question being investigated, and defend those conclusions
- use metric units in measuring, calculating, and reporting results

Seventh grade students will:

- propose and critique alternative explanations and procedures
- suggest alternative explanations for the same observations
- predict an outcome based on a set of experimental data
- recognize that scientific investigations sometimes generate new methods or procedures for an investigation or develop new technologies to improve the collection of data
- identify the assumptions that influence and guide their investigations

- propose and execute design changes to correct what might be wrong with an experimental design
- cite subject matter knowledge when making judgments
- refine hypotheses from a previous investigation
- construct a model that demonstrates change within a system
- construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge
- create a written plan to include the question to be investigated, an appropriate hypothesis, design of the experiment, identification of the control and variables, a developed scientific procedure to collect and record data; the design should also include a number of repeated trials, accurate measurements and record keeping and a comparison to a control
- organize and construct representation of data into appropriate formats (e.g. histograms, circle graphs, flow charts) and make inferences based on that data
- interpret patterns, trends, relationships in collected data
- decide what data to use and what data to ignore in forming conclusions
- form a logical argument about cause and effect relationships in conclusions
- use mathematics to structure convincing explanations
- use metric units in measuring, calculating, and reporting results
- construct appropriate graphs from data and develop qualitative statements about the relationships between the variables
- use analogies to understand how things work
- summarize the results of others' investigations to see if findings will result in new questions and more investigations
- share findings and offer explanations for inconsistencies, limitations, and variability in recorded observations
- acknowledge different ideas and explanations, be able to accept the skepticism of others, and consider alternative explanations

Eighth grade students will:

- create a written plan to include the question to be investigated, an appropriate hypothesis, design of the experiment, identification of the control and labeled variables, a developed scientific procedure to collect and record data; the design should also include a number of repeated trials, unbiased sampling, accurate measurements and record keeping and a comparison to a control
- apply scientific ideas, concepts, and relationships to the formation of scientific questions
- evaluate explanations by examining evidence, comparing evidence, identifying faulty reasoning, and pointing out statements that go beyond the evidence
- predict an outcome based on a set of experimental data
- recognize that scientific-investigations sometimes generate new methods or procedures for an investigation or develop new technologies to improve the collection of data
- refine hypotheses from a previous investigation
- construct a model to predict change (e.g. stream table, computer simulation)
- organize and construct representation of data into appropriate formats (e.g. histograms, circle graphs, flow charts) and make inferences based on that data
- interpret patterns, trends, relationships in collected data
- state relationships in terms of the relationship between two or more variables
- evaluate the accuracy and reproducibility of data
- analyze data and evaluate hypothesis
- identify areas for further investigation
- construct appropriate graphs from data and develop quantitative statements about the relationships between variables
- communicate the logical connection among hypothesis, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence
- distinguish between linear and non-linear relationships on a graph of data

- use metric units in measuring, calculating, and reporting results
- acknowledge that the scientific community accepts and uses explanations until those explanations are displaced by better scientific ones
- acknowledge different ideas and explanations, be able to accept the skepticism of others, and consider alternative explanations

In grades 9-12, what students know and are able to do includes:

Asking questions and stating hypotheses, using prior scientific knowledge to help guide their development;

Creating and defending a written plan of action for a scientific investigation;

Selecting and using appropriate technologies to gather, process, and analyze data and to report information related to an investigation;

Identifying major sources of error or uncertainty within an investigation (e.g., particular measuring devices and experimental procedures);

Constructing and revising scientific explanations and models, using evidence, logic, and experiments that include identifying and controlling variables;

Communicating and evaluating scientific thinking that leads to particular conclusions;

Recognizing and analyzing alternative explanations and models; and

Explaining the difference between a scientific theory and a scientific hypothesis.

For students continuing their science education beyond the standards, what they know and are able to do may include:

Designing and completing an advanced scientific investigation—either individually or as part of a student team—that extends over several days or weeks; and continuing to practice and apply inquiry skills as they extend their understanding of science content through further study.

Ninth through Twelfth grade students will:

- asking questions and stating hypotheses, using prior knowledge to help guide their development
- creating and defending a written plan of action for a scientific investigation

- selecting and using appropriate technologies to gather, process, and analyze data and to report information related to an investigation

- identifying major sources of error or uncertainty within an investigation (for example, particular measuring devices and experimental procedures)

- constructing and revising scientific explanations and models, using evidence, logic, and experiments that include identifying and controlling variables

- communicating and evaluating scientific thinking that leads to particular conclusions

- recognizing and analyzing alternative explanations and models

- explaining the difference between a scientific theory and a scientific hypothesis

Standard 2:

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

Guiding questions:

- How do we describe the physical world around us?
- What is the world around us made of and how do we know?
- What is energy?
- How do electricity, magnetism, sound, and light interact with matter?

Kindergarten students will:

- sort common objects (e.g. blocks, rocks, buttons) using specific properties such as shape, texture, color, patterns
- identify physical properties of objects that are detected by the senses (e.g. large or small, odor, rough or smooth, heavy or light, soft or hard)
- describe or demonstrate how matter can be mixed or put together (e.g. mix different liquids and describe the results
- predict whether an object can sink or float

First grade students will:

- examine, describe, and compare objects based on common physical properties (e.g. an ice cube melting)
- explore forms of energy (e.g. heat and moving objects; choose an object and observe how it moves on different surfaces)
- describe interactions that produce change in a system (e.g. making mobiles to understand balance and stability)
- understand that things near the earth fall to the ground unless something holds them up
- investigate which objects will sink or float

Second grade students will:

- examine, describe, and compare the properties of solids and liquids
- identify the properties of magnets

- separate mixtures according to their properties (e.g. sand and gravel, sand and iron filings)

- make observations and gather data on quantities associated with energy, movement, and change (e.g. time to melt an ice cube)

- compare quantities associated with energy movement and change by constructing simple diagrams and charts (e.g. chart of melting time)

- know that sound is caused by vibration (e.g. use a variety of items such as cymbals, hair combs, rulers to produce sounds and record the physical evidence of how things that make sound vibrate)

- recognize motion, light, heat, and sound as forms of energy (e.g. make a musical instrument to investigate sound; observe and describe what happens when a rolling object travels down an incline at different heights; investigate light by using mirrors)

Third grade students will:

- measure common physical properties of objects (e.g. length, mass, volume, temperature)

- investigate that heat can be produced in many ways (e.g. burning, rubbing, mixing one substance with another)

- identify and consider a variety of methods that produce heat by friction (e.g. rubbing hands together, rubbing pieces of metal together, shaking sand in a can)

- identify characteristics of conductive materials and of isolative materials

- predict which materials will reflect, which will absorb, and which will transmit light (e.g. glass, clear plastic, paper)

- identify simple machines (e.g. lever, pulley, incline plane, wedge, gears)

- predict the pitch of a sound compared to the size of the instrument

- investigate the properties of oil and water and why they do not mix (simple introduction to density)

Fourth grade students will:

- understand that materials can exist in different forms, (solid, liquid, gas) and can be changed from one form to another by heating or cooling

- describe the position and motion of an object by pushing and pulling and understanding the size of the change is related to the strength of the push or pull

- produce sound with vibrating objects and understand that the pitch of the sound can be varied by changing the rate of the vibration

- investigate the properties of light as it travels in a straight line until it strikes an object; reflected by a mirror, refracted by a lens, or absorbed by an object

- investigate how heat can move from one object to another by conduction

- apply knowledge of simple circuits to create a new circuit that involves more components (using batteries, wires, light or a buzzer, demonstrate the requirements for a complete circuit)

- predict whether objects will sink or float based on a qualitative understanding of the concepts of density and buoyancy

- describe how forces work in common simple machine {e. g. seesaws, crowbars slides)

- understand that matter changes in both physical and chemical ways

Fifth grade students will:

- know that materials made by chemically combining two or more substances may have properties that differ from the original properties (e.g. vinegar and baking soda)

- recognize that there are 92 known elements in nature many of which combine to form compounds

- use diffraction gratings and prisms to investigate light from different sources

- know that heat flows from warmer to cooler objects until both reach the same temperature

- recognize that forces of gravity, magnetism, and electricity operate simple machines

- recognize the forces necessary for an object to move or to be in equilibrium

Sixth grade students will:

- describe the difference between the student's own weight and mass

- construct models of several kinds of atoms and describes their general properties (nucleus, proton, neutron, electron)

- use laboratory investigations to demonstrate the formation of new compounds

- investigate changes in the state of water and use the particle model to explain these changes

- design a simple circuit that can do work and explain the energy transfer taking place in the system

- calculate the average speed of a toy or an animal moving in a straight or curved path by making appropriate measurements (motion of an object can be described by its position, direction of motion, and speed)

- measure the various net forces acting on an object and their effects (explain in terms of forces involved, why a satellite orbits the Earth)

- know that energy can be carried from one place to another by heat flow or by waves including water waves, light and sound, or by moving objects

Seventh grade students will:

- know the qualitative properties of waves (e.g. frequency, wavelength, crests, troughs)

- give examples of heat transfer

- measure the amount of energy required to melt a known mass of ice and compare it to the energy needed to boil water

- know that the states of matter (solid, liquid, gas) depend on molecular motion

- identify and describe the chemical changes in various materials by observing everyday events (e.g. nail left in water)

- recognize that substances are often placed in categories or groups if they react in similar ways (e.g. periodic table)

- classify matter in terms of elements, compounds, and mixtures

- use word equations to describe a chemical change

- examine, describe, compare, measure, and classify objects using common properties of matter including mass, volume, temperature, density, rating solutions by pH, and relative solubility in water

- separate mixtures based on their physical including solubility in water, particle size, density and magnetism

- know that all objects experience a buoyant force when immersed in a fluid (the buoyant force on an object in a fluid is equal to the weight of the fluid it has displaced)

Eighth grade students will:

- experiment with tuning forks, ripple tanks, "slinkys", and other objects to observe and analyze problems with waves

- classify waves as mechanical (sound, tidal, earthquake) or electromagnetic (radio, sunlight)

- draw an electromagnetic spectrum and identifies the forms of radiant energy in the visible part of the spectrum and the use of the non visible part of the spectrum (e.g. x-rays, microwaves, ultra violet light)

- know that white light is a mixture of many wavelengths and that retinal cells react differently with different wavelengths

- know that light interacts with matter by transmission (including refraction) absorption, or scattering (including reflection)

- know that the angle of reflection of a light beam is equal to the angle of incidence

- determine the potential and kinetic energy of a cart as it moves up and down an inclined lane

- interpret and explain the relationship among kinetic energy, potential energy, and mechanical advantage (e.g. demonstrate the types of energy, changes in motion, and mechanical advantage involved in shooting an arrow)

- interpret graphs of position versus time and speed versus time for motion in a single direction

- know that force has both direction and magnitude and when an object is subject to two or more forces at once, the effect is the cumulative effect of all the forces

- know that when forces on an object are balanced, the motion of the object does not change; when the forces are unbalanced the object will change its motion (e.g. speed up, slow down, or change direction)

- demonstrate that simple machines can be used to change the direction or size of a force (e.g. measure the effectiveness of a lever in moving objects with different masses)

- compare series and parallel circuits

- use various materials in a simple circuit, show the difference between conductors and insulators and compare the efficiency of electrical conductors

- understand that chemical reactions are processes in which atoms are rearranged into different combinations of molecules

- know that in chemical reactions, the number of atoms stays the same no matter how they are arranged so their total mass stays the same (conservation of matter)

- determine whether a solution is acidic, basic, or neutral

- understand that chemical energy is stored in chemical bonds between atoms in elements and compounds

Ninth through Twelfth grade students will:

- demonstrate how the Periodic Table can be used to predict the properties of elements and reflects trends in these properties as they relate to the physical world

- describe the molecular, atomic, and ionic makeup of a variety of substances, use appropriate formula to represent these substances and investigate common chemical reactions

- use bonding diagrams (ionic, covalent) to predict the outcome of a chemical reaction

- use word or symbol equations to predict chemical and physical interactions (neutralization, combustion, Newton's Second Law)

- analyze and discuss the effect of solute and solvent concentration on the rate of dissolving, acidity, and viscosity of a solution

- describe the components of the modern model of the atom and how they are related

- design an electrical circuit and apply Ohm's Law to evaluate the components of the circuit (voltage and resistance affect the flow of electrical current in a circuit)

- explain the Doppler effect and identify some of its applications (energy can be transferred as waves; the frequency and wavelengths of the waves are affected by the relative motion of the source and receiver)

- describe how energy is involved in chemical, physical and nuclear changes

- investigate the relationship between heat and work (e.g. how the interior of a refrigerator is cooled)

- investigate phase changes that are induced by adding/subtracting heat energy and explain using the particle model, how the interaction of atoms or molecules during a change of state affects the properties of the substance

- give an example of an object moving in a circular path and find and compare its speed, period, frequency, acceleration and centripetal force with other masses and report these findings

- collect and graph data and explain that acceleration is a change in velocity or direction of travel

- calculate and report the acceleration and motion of several different objects when released from the same position

- observe, interpret, and explain the behavior of a compass needle near a permanent magnet

- formulate a model of radioactive decay

- demonstrate that for every action there is an equal and opposite reaction (e.g. identifying places on a roller coaster ride where one feels lighter or heavier)

- observe, diagram, and label the parts of transverse waves having different frequencies and amplitudes

- use a wave model of light to predict optical phenomena

- observe and measure the effect of friction on moving objects

- know that the laws of conservation of energy and momentum provide a way to predict and describe the movement of objects

Standard 3:

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

Guiding questions:

- What are the characteristics of living things and how do they interact with their environment?
- What are the interrelationship of matter and energy in living systems?
- How does the human body function and how does this compare with other living things?
- In what ways are living things adapted to survive in their environment?
- How do species change over time in terms of biological evolution and genetics?

Kindergarten students will:

- identify and describe living and non living things
- use pictures to describe the growth of a plant
- describe some plants and animals that live in different places (e.g. polar bear) and how they are different

First grade students will:

- distinguish living from non living things
- describe the changes that take place as a previously living thing decays in the environment (e.g. plants; fruit with skin and without skin over time)
- explore life cycles of selected organisms (e.g. cat, mealworm, bees)
- discuss how living and nonliving things change over time (e.g. insects)
- discuss how each plant or animal has different structures that serve different functions in growth, and survival
- know that plants and animals have predictable life cycles

Second grade students will:

- identify parts of plants and animals (e.g. stem, root, seed, flower, leaf, bud, bulb)

- recognize that green plants need energy from sunlight and various raw materials to live

- identify variables that affect plant growth (e.g. water and light)

- recognize and compare the structural characteristics of plants and animals (e.g. plants and animals that live in the ocean with those that live on land)

- describe metamorphosis of insect (e.g. butterfly, beetle)

- recognize how environmental changes influence the life and death of plants and animals

- discuss how the behavior of animals and plants is dependent upon their environment

- identify and discuss the similarities and differences between parents and their offspring

Third grade students will:

- describe how plants and animals have life cycles (e.g. birth, growth, reproduction, and death)

- recognize that all organisms cause and respond to changes in their environment

- describe and draw food chains

- identify characteristics of plants and animals that allow them to live in specific environments

- recognize that the human body is made of systems with structures and functions that are related and serve different functions in growth and survival .

Fourth grade students will:

- recognize that some characteristics of organisms are inherited while others are environmentally influenced

- give examples of food chains/webs in Colorado ecosystems (e.g. mountains, plains, plateaus)

- describe animal and plant characteristics that allow them to survive and adapt in different life zones in the Rocky Mountains

- give examples of how organisms interact with each other and with other nonliving parts of environment

- conduct investigations to gather data, information, and ideas related to the energy and nutrients organisms need from their environment in order to survive

- explore a simple natural system (e.g. classroom aquarium or outdoor habitat and generate questions about the transfer of energy and use of nutrients)

- know that all organisms need energy and matter to live and grow

- know that many plants depend on animals for pollination and seed dispersal while animals depend on plants for food and shelter

Fifth grade students will:

- construct models that illustrate food chains and food webs (e.g. use terms such as carnivore, producer, consumer, and decomposer to describe the role of the organism in the food chain and food web)

- recognize that the human body is organized into systems

- understand that the human body systems depend on each other (e.g. nervous, circulatory,
  digestive, respiratory)

- construct a model of an ecosystem and explain the interaction and interdependence of living and nonliving components within the ecosystem

- explore the process of photosynthesis

- explore the process of cellular respiration

- describe the process of digestion in humans and now the human body gets energy from food

- describe basic food requirements for humans and classify food into basic food groups

- develop and use a classification key that can be used to place common organisms into proper kingdoms

- demonstrate an understanding that all living things are made up of one or more cells and that complex multi cellular living things have tissues, organs, and organ systems

Sixth grade students will:

- explain how adaptations affect a species survival
- explain interactions and interdependence of nonliving and living components within ecosystems with first order consumers, second order consumers, biotic factors and biotic factors
- explore bio-diversity in ecosystems
- know that energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism in food webs
- categorizes organisms according to their roles in food chains and food webs as carnivores, herbivores, omnivores, producers, consumers, or decomposers
- identify the difference between plant and animal cells
- identify parts of a cell explaining the structure and function of a cell
- describe the role of chromosomes and genes in heredity (e.g. a typical cell of any organism contains genetic instructions that specify its traits; these traits may be modified by environmental influences)
- understand that DNA is the genetic material of living organisms and is located in the chromosomes of each cell

Seventh grade students will:

- understand that plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism
- understand that organ systems function because of the contributions of individual organs, tissues, and cells; the failure of any part can affect the entire system (e.g. bones and muscles work together to provide a structural framework for movement
- identify the characteristics of plants and animals that enable them to survive
- create and interpret food chains and webs
- describe the bio-diversity of different ecosystems and understand that there is a relationship between the biotic and abiotic factors in an ecosystem
- investigate and describe the causes and effects of changes in populations (e.g. predator-prey, human, and carrying capacity)

- construct a simple branching diagram to classify living groups of organisms by shared derived characteristics, and expand the diagram to include fossil organisms (e.g. fossils provide evidence of how life and environmental conditions have changed)

- know that a typical cell of an organism contains genetic instructions that specify its traits and those traits may be modified by environmental influences

Eighth grade students will:

- explain the characteristics of plants and animals that enable them to survive

- compare, contrast, and explain the difference in biodiversity of different ecosystems

- explain the causes and effects of changes in populations (e.g. predator-prey, human, and carrying capacity)

- organize information into a model that demonstrates the interaction of systems of cells, tissues, organs, and organ networks in a complex multi cellular organism through chemical and physical processes

- use models to demonstrate how genetic material is transmitted and how gene traits are expressed in offspring (e.g. Punnett squares and pedigree charts to show how single gene traits are expressed in offspring)

- describe sexual reproduction patterns in flowering plants and a variety of animals

- observe, describe, and measure changes that occur in an organism as it develops from a seed or fertilized egg to an adult (e.g. bean plant, frog, chicken)

- research the evolutionary adaptation of a number of present day organisms and explain how these adaptations contributed to the survival of the organism (e.g. beak shape, protective coloration, flower color)

Ninth through Twelfth grade students will:

- understand that life processes of plants and animals depend on a variety of chemical reactions that are carried out in specialized areas of the organism's cells

- use and produce a variety of classification systems for organisms

- compare and contrast the purpose and process of cell division (mitosis) with the production of sex cells (meiosis)
- understand that a multi-organism develops from single zygote and its phenotype depends on its genotype, which is established at fertilization

- understand that genes are a set of instructions, encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism

- understand the role of DNA in resolving questions of relationship and evolutionary change

- understand that the genetic composition of cells can be altered by incorporation of exogenous DNA into the cells

- predict and describe the interactions of populations and ecosystems

- understand the concepts of mutation, natural selection, and reproductive isolation impacts
  on the planet's bio-diversity

- calculate the probability that an individual will inherit a particular single gene trait

- compare and contrast the processes of photosynthesis and respiration

- explain how large molecules are broken down into small molecules serving as an energy source or as basic building blocks in organisms

- explain how energy is used in the maintenance, repair, growth, and development of tissue

- describe the cycling of matter and the movement and change of energy through the ecosystem

Standard 4:

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

Guiding questions:

- What is the physical earth made of and how do we describe them?
- What processes and interactions change the earth over time?
- Where is water found on the earth, what are it's characteristics, and how does it move?
- What causes different kinds of weather and the seasons and how does it change overtime?
- What is the earth's place in the solar system, galaxy, and universe?

Kindergarten students will:

- identify that the Earth is a planet with many living and nonliving things
- identify major features of the Earth's surface (e.g. mountains, oceans, forests, deserts)
- know that soil and rock are materials of the earth; soil is used to grow plants we use as food; soils have properties of color and texture
- identify events that change the Earth's surface (hurricanes, tornadoes, earthquakes)
- describe how activities and clothing must be changed to agree with the weather
- name the four seasons and some characteristics of each
- know that rain and snow furnish water for rivers
- identify that water as important to all living things on Earth
- know that the sun can only be seen in the daytime whereas the moon can be seen mostly at night but sometimes during the day

First grade students will:

- know that Earth's materials are part of the Earth's surface
- know that fossils are evidence of plants and animals that lived on Earth long ago

- explore some processes that change the Earth's surface (e.g. erosion, weathering)

- draw pictures of the four seasons
- identify changes in weather and know that weather changes with the seasons in different regions of the United States

- know that water is needed to support the growth of plants in our food supply

- know that the sun provides light

Second grade students will:

- describe the components of soil (e.g. organize a rock collection)

- compare the ingredients in different soils

- describe how plants cycle water through their parts (e.g. soil, roots, stem, leaves, and atmosphere)

- explore that soils differ in their capacity to retain water

- know that the sun's movements can be observed and described

- know that the sun provides heat

- identify patterns and changes in the sun, moon, and stars

Third grade students will:

- recognize that the sun is a principle source of Earth's heat and light and is a major factor in weather systems

- describe natural processes that change Earth's surface (e.g. erosion, weathering)

- collect and record weather condition data (e.g. temperature, amount of cloud cover, rainfall)

- draw a picture illustrating how water cycles in nature

- identify and describe the states that water can be found on Earth (glaciers, oceans, clouds)

- know that every 24 hours, the Earth makes a full rotation on its axis which cause the day and night cycle

Fourth grade students will:

- identify the basic components of the solar system
- describe the motion of Earth in relation to the sun
- compare Earth to other planets (e.g. size, distance from sun and from each other, temperature, length of day)
- know that the Earth is one of nine planets that orbit the sun and that as the Earth orbits the sun, different patterns of stars can be seen in different seasons
- explore objects associated with the universe (comets, galaxies, asteroids)
- compare and contrast the physical features of Earth (e.g. land forms)
- identify the main landforms in Colorado (e.g. mountains, plains, plateaus)
- distinguish between weather and climate
- know that clouds have properties, locations, and movements that can be observed and described
- know that weather can be described in measurable quantities, temperature wind direction, and precipitation
- identify the water cycle (e.g. evaporation, condensation, transpiration, etc.)
- recognize the importance of water and its uses
- identify and describe the states (e.g. solid, liquid, gas) in which water can be found on Earth

Fifth grade students will:

- identify Earth's energy resources and characterize each as renewable or non-renewable (e.g. petroleum, coal, natural gas, propane, uranium)
- evaluate how revolution, rotation, and tilt of the Earth influences the amount of sunlight that reaches the surface
- know that the rotation of Earth on its axis every 24 hours causes the day and night and makes the sun, moon, planets, and stars appear to move across the sky from east to west each day

- explain lunar and solar eclipses and moon phases

- compare and contrast the environment of Colorado today to that of long ago through fossil evidence (e.g. Florissant Fossil Beds, Denver Basin Project)
- compare the similarities and differences between fossils and living organisms

- classify rocks and minerals according to their physical characteristics

- discover and evaluate patterns and relationships in information to predict and identify areas that store water

- compare weather patterns in different locations in the United States and discuss how these patterns influence plant growth and human activity in those states

- know that energy from the sun heats the Earth unevenly, causing air movements resulting in changing weather patterns

- use weather maps and weather forecasts to predict local weather and that predication depends on many changing variables

- conduct investigations to determine the effect of temperature or wind on evaporation and condensation

Sixth grade students will:

- know that soils are found in layers with each having a different composition and texture

- know that layers of sedimentary rocks confirm the long history of the earth and its changing life forms

- use characteristics to identify selected minerals and rocks

- explain the difference between rocks and minerals

- describe major differences in the physical properties of water as a solid, liquid, and gas

- describe the cycling of water in a closed system (e.g. bottle terrarium)

- know that the Solar System forms part of the Milky Way Galaxy which is one of many galaxies that comprise the Universe

- know that the nine planets, their respective moons, comets, many asteroids and meteorites orbit the sun which is the gravitational center of the Solar System

- know that the path of a planet around the sun is due to the gravitational attraction between the sun and the planet

- know that the sun, an average star, is the central and largest body in the solar system and is comprised primarily of hydrogen and helium

Seventh grade students will:

- identify and explain the components of the rock cycle

- understand how minerals form (e.g. evaporation, precipitation, crystallization)

- explain how fossils indicate that life has changed through geologic time

- explain the effects of the motions of the Earth and moon in space (e.g. tidal patterns and seasonal changes related to the motion of the moon and the tilt of the Earth in space)

- know that Earth rotates on a tilted axis and revolves around the sun; this combination causes changes in the amount of sunlight reaching the Earth's surface and makes our seasons

- know that the solid Earth is layered with cold, brittle lithosphere, hot convecting mantle and dense metallic core

- know that the surface of the Earth has changed as a result of dynamic forces originating with the mantle; the physical evidence (e.g. faulting, volcanoes, folding of rock, etc.) of these constructive and destructive forces is associated with plate movement

- identify areas of volcanic activity based upon understanding of plate tectonics

- demonstrate continental drift using models

- know that earthquakes are sudden motions along break in the crust called faults and volcanoes/fissures are locations where magma reaches the surface

Eighth grade students will:

- describe the gaseous composition of the atmosphere

- measure humidity, temperature, and pressure of the troposphere

- explain how atmospheric circulation is driven by solar heating which involves radiation, convention, and conduction

- know that the Earth has three distinct physical spheres (atmosphere, hydrosphere, and lithosphere) and each has different compositions yet interfaces with each other

- use graphs and charts to describe and compare the distribution of the world's water including rivers, oceans, ground water, and atmosphere

- use diagrams/models, show the direction of water circulation through Earth's system

- know that the yearly revolution of Earth in its orbit about the sun and the tilt on its axis cause the angle at which sunlight strikes the Earth to vary at different locations; this causes differences in the heating of Earth's surface which produce seasonal variations in weather and a variety of climates

Ninth through Twelfth grade students will:

- describe the composition and structure of the Earth's interior

- use the theory of plate tectonics to explain the relationships among earthquakes, volcanoes, mid ocean ridges, and deep sea trenches

- use evidence to investigate how the Earth has changed or remained constant over short and long periods of time

- evaluate the feasibility of predicting and controlling natural events

- analyze the costs, benefits, and consequences of natural resource exploration, development and consumption

- know that energy enters the Earth system primarily as solar radiation and eventually escapes as heat

- know that climate (in the long run) and weather (in the short run) involve the transfer of energy in and out of the atmosphere

- investigate factors that influence water quality

- explain the water cycle in terms of how water circulates through the biosphere, lithosphere, and atmosphere

- analyze the structure and evolution of the atmosphere and its significance to life

- describe the structure of-the solar system and forces within as well as beyond the system (e.g. gravity and centrifugal force)

- describe electromagnetic radiation produced by the sun and other stars
- know that stars differ in their life cycles, and visual, radio, and x-ray telescopes collect data that reveal these differences

Standard 5:

Students know and understand interrelationships among science, technology, and human activity and how they can affect the world.

Guiding questions:

- What impacts have advanced technologies had on the world?
- How do people use science and technology in their professional and personal lives?
- How do humans interact with the physical and biological earth?

Kindergarten students will:

- describe differences between natural objects and objects made by people
- recognize how people use observation and prediction in their jobs
- recognize some resources that come from the Earth and sun (e.g. soil from the Earth; light from the sun)
- use tools and simple construction materials

First grade students will:

- identify daily activities/devices used in everyday life that involve the use of technology
- design a simple plan for a new invention and report on it
- identify types of people that use science and technology in their jobs

Second grade students will:

- use a variety of materials (e.g. wood, plastic, fabric, clay) to make simple products and identify what can be recycled and what can not
- identify careers that use science and technology
- identify the use of technologies in their everyday life

Third grade students will:

- list some major inventions in the 19th century and compare them to the major inventions in the 20th century

- know that people have always invented new ways to solve problems and get work done; these new inventions affect all aspects of life
- invent a new device and communicate the problem, design, and solution

Fourth grade students will:

- identify some causes for recent increases in technological advances
- make a plan for building a device considering the limitations of the material and including multiple views
- describe and define the invention process (e.g. brainstorm, analyze, combine and create)

Fifth grade students will:

- compare present day technologies to those of the past (e.g. refrigerator to ice box; horse drawn carriage to automobile) and discuss the impact these differences have on the quality of life
- recognize that technologies consume and generate energy
- recognize that conservation is a method of preventing depletion of energy

Sixth grade students will:

- describe how people use science and technology in their profession
- describe ways in which innovations address human biological, physical, and psychological needs
- describe uses of renewable and non-renewable resources (e.g. forests and fossil fuels)

Seventh grade students will:

- describe advantages and disadvantages that might accompany the introduction of a new technology
- explain how the choice of materials depends upon their properties and characteristics and how they interact with other materials

Eighth grade students will:

- identify and analyze ways in which advances in science and technology have affected each other and society

- use the results of material tests (e.g. hardness, tensile strength, conductivity) to suggest appropriate uses for materials

- evaluate designs, devices, or solutions and develop measures of quality

Ninth through Twelfth grade students will:

- discuss the scientific, technological, and political aspects of major challenges to society

- analyze and evaluate how specific technological solutions may impact the environment in areas such as habitat loss, disruption of the food web, and temperature and chemical changes

- identify particular characteristics of material resources (e.g. synthetic, composite, and biological)

- explain how various energy sources and forms of information are also resources with specific characteristics

- analyze how the introduction of a new technology has affected or could affect human activity

- analyze benefits, limitations, costs and consequences involved in using technology or resources

Standard 6:

Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

Guiding questions:

- How do scientists decide what to believe?
- How is science related to other ways of knowing?
- How have people of diverse cultures contributed to and influenced developments in science?

Kindergarten, first and second grade students will:

- know that in order to learn, it is important to observe the same things often and compare them
- know that when experiments are repeated under the same conditions, similar results are usually obtained
- know that in doing science it is often helpful to work with a team and to share findings with others

Third grade students will:

- know that it is important to keep accurate records and descriptions to provide information and clues on causes of discrepancies in repeated experiments
- know that a model of something is different from the real thing, but can be used to learn something about the real thing

Fourth grade students will:

- recognize that when a science experiment is repeated with the same conditions, the experiment generally works the same way
- compare knowledge gained from direct experience to knowledge gained indirectly
- identify observable patterns and changes in their lives and predict future events based on those patterns
- describe and compare the components and interrelationships of a simple system
- compare a model with what it represents

Fifth and sixth grade students will:

- know that scientific knowledge is subject to modification as new information
- challenge prevailing theories and new theories lead to looking at old observations in a new way
- know that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects
- know that a change in one or more variables may alter the outcome of an investigation
- recognize the scientific contributions that are made by individuals of diverse backgrounds, interests, talents, and motivations
- know that when similar investigations give different results, the scientific challenge is to verify whether the differences are significant by further study
- recognize that patterns exist within and across systems

Seventh and eighth grade students will:

- explain why a controlled experiment must have comparable results when repeated
- give examples of how scientific knowledge changes as new knowledge is acquired and previous ideas are modified
- describe the contributions of science made by people in different cultures and at different time times in history
- identify, compare, and predict variables and conditions related to change
- identify and illustrate natural cycles within systems
- use models to predict change

Ninth through Twelfth grade students will:

- evaluate print and visual media for scientific evidence, bias, or opinion
- identify, discuss, and respond to information from credible sources (e.g. scientists making claims in their areas of expertise and from sources of questionable credibility)

- explain that the scientific way of knowing involves a critique and consensus process (e.g. peer review, openness to criticism, logical arguments)

- understand that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth

- know that from time to time, major shifts occur in the scientific view of how the world works but that more often, the changes take place in the body of scientific knowledge are small modifications of prior knowledge

- use graphs, equations, or other models to analyze systems involving change and constancy

- analyze and compare models of cyclic change as used within and among scientific disciplines

- identify and predict cause and effect relationships within a system

- identify and describe the dynamics of a natural system

- identify and test a model to analyze systems involving change and constancy

- explain an exponential model (e.g. pH, Richter scale)

- refine a hypothesis based on accumulation of data over time

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