Ninth Grade Science Indicators
Class Summary

Ninth Grade	Assessment	Type of Intervention
Earth and Space Standard		
Explain how evidence from stars and other celestial objects provide information about the processes that cause changes in the composition and scale of the physical universe.		
1. Describe that stars produce energy from nuclear reactions and that processes in stars have led to the formation of all elements beyond hydrogen and helium.		
2. Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago.		
Explain that many processes occur in patterns within the Earth's systems.		
4. Explain the relationships of the oceans to the lithosphere and atmosphere (e.g., transfer of energy, ocean currents and landforms).		
Explain the 4.5 billion-year history of Earth and the 4 billion-year-history of life on Earth based on observable scientific evidence in the geological record.		
3. Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the solar system.		
Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources.		

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	Assessment		**Type of Intervention**																									
Earth and Space Standard																												
Explain the processes that move and shape Earth's surface.																												
5. Explain how the slow movement of material within Earth results from:																												
a) thermal energy transfer (conduction and convention) from the deep interior:																												
b) the action of gravitational forces on regions of of different density.																												
6. Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding).																												
7. Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating).																												
Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences.																												
8. Use historical examples to explain how new ideas limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., heliocentric theory and plate tectonics theory).																												

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Life Standard																											
Explain that cells are the basic unit of structure and function of living organisms, that once life originated all cells come from pre-existing cells, and that there are a variety of cell types.																											
Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development.																											
Explain the genetic mechanisms and molecular basis of inheritance.																											
Explain the flow of energy and the cycling of matter through biological and ecological systems (cellular, organismal and ecological).																											
Explain how evolutionary relationships contribute to an understanding of the unity and diversity of life.																											
Explain the structure and function of ecosystems and relate how ecosystems change over time.																											
Describe how human activities can impact the status of natural systems.																											
Describe a foundation of biological evolution as the change in gene frequency of a population over time.																											
Explain the historical and current scientific developments, mechanisms and processes of biological evolution. Describe how scientists continue to investigate and critically analyze aspects of evolutionary theory. (The intent of this benchmark does not mandate the teachings or testing of intelligent design).																											

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Life Standard																												
Explain how natural selection and other evolutionary mechanisms account for the unity and diversity of past and present life forms.																												
Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of life sciences.																												
Physical Standard																												
Describe that matter is made of minute particles called atoms and comprised of even smaller components. Explain the structure and properties of atoms.																												
1. Recognize that all atoms of the same element contain the same number of protons, and elements have the same mass. Those with different masses (different numbers of neutrons) are called isotopes																												
2. Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral.																												
4. Show that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations.																												

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Physical Standard																											
Describe that matter is made of minute particles called atoms and comprised of even smaller components.																											
Explain the structure and properties of atoms.																											
5. Describe how ions are formed when an atom or a group of atoms acquire an unbalanced charge by gaining or losing one or more electrons.																											
Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.																											
6. Explain that the electric force between the nucleus and the electrons hold an atom together. Relate that on a larger scale, electric forces hold solid and liquid materials together (e.g., salt crystals and water).																											
7. Show how atoms may be bonded together by losing, gaining or sharing electrons and that in a chemical reaction, the number, type of atoms and total mass must be the same before and after the reaction (e.g., writing correct chemical formulas and writing balanced chemical equations).																											
8. Demonstrate that the pH scale (0-14) is used to measure acidity and classify substances or solutions as acidic, basic, or neutral.																											
Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.																											

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Ninth Grade	Assessment	Type of Intervention
Physical Standard		
Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance.		
9. Investigate the properties of pure substances and mixtures (e.g., density, conductivity, hardness, and properties of alloys, superconductors and semiconductors).		
10. Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity.		
Explain the movement of objects by applying Newton's three laws of motion.		
21. Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time.		
22. Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it.		
23. Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (Fnet =ma. Note that weight is the gravitational force on a mass.)		

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Ninth Grade	Assessment	Types of Intervention
Explain the movement of objects by applying Newton's three laws of motion.		
24. Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.		
25. Demonstrate the ways, in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, and an airplane in flight).		
Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored).		
12. Explain how an object's kinetic energy depends on its mass and its speed (KE=1/2mv 2).		
13. Demonstrate that near Earth's surface an object's gravitational potential energy depends upon its weight (mg where m is the object's mass and g is the acceleration due to gravity) and height (h) above a reference surface (PE=mgh).		
Explain how energy may change form or be redistributed but the total quantity of energy is conserved.		
3. Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high-energy wavelike radiation.		

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Physical Standard																												
Explain how energy may change form or be redistributed but the total quantity of energy is conserved.																												
11. Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion, and during changes of state the temperature remains constant.																												
14. Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.)																												
15. Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy.																												
16. Illustrate that chemical reactions are either endothermic or exothermic (e.g., cold packs hot packs and the burning of fossil fuels).																												
17. Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electro magnetic radiation).																												

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Physical Standard																												
Demonstrate that waves (e.g., sound, seismic, water, and light) have energy and waves can transfer energy when they interact with matter.																												
18. Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electro magnetic spectrum (e.g., radio waves, microwaves infrared, visible light, ultraviolet, X-rays, and gamma rays).																												
19. Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic waves can be propagated without a medium.																												
20. Describe how waves can superimpose on one another when propagated in the same medium. Analyze conditions in which waves can bend around corners, reflect off surfaces, are absorbed by materials they enter, and change direction and speed when entering a different material.																												
Trace the historical development of scientific theories and ideas, and describe emerging issues in the study of physical sciences.																												
26. Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establish ment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., atomic theory, quantum theory and Newtonian mechanics).																												

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Physical Standard																												
Trace the historical development of scientific theories and ideas, and describe emerging issues in the study of physical sciences.																												
27. Describe advances and issues in physical science that have important, long-lasting effects on science and society (e.g., atomic theory, quantum theory, Newtonian mechanics, nuclear energy, nano technology, plastics, ceramics and communication technology).																												
Science and Technology Standard																												
Explain the ways in which the processes of technological design respond to the needs of society.																												
2. Identify a problem or need, propose designs and choose among alternative solutions for the problem.																												
3. Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined.																												
Explain that science and technology is interdependent; each drives the other.																												
1. Describe means of comparing the benefits with the risks of technology and how science can inform public policy.																												

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Scientific Inquiry Standard																												
Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.																												
1. Distinguish between observations and inferences given a scientific situation.																												
2. Research and apply appropriate safety precautions when designing and conducting scientific investigations (e.g., OSHA, Material Safety Data Sheets [MSDS], eyewash, goggles and ventilation).																												
3. Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts.																												
4. Decide what degree of precision based on the data is adequate and round off the results of calculator operations to the proper number of significant figures to reasonably reflect those of the inputs.																												
5. Develop oral and written presentations using clear language, accurate data, appropriate graphs, tables, maps and available technology.																												
6. Draw logical conclusions based on scientific knowledge and evidence from investigations.																												

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Scientific Ways of Knowing Standard		
Explain that scientific knowledge must be based on evidence; be predictive, logical, subject to modification and limited to the natural world.		
1. Comprehend that many scientific investigations require the contributions of women and men from different disciplines in and out of science. These people study different topics, use different techniques and have different standards of evidence but share a common purpose - to better understand a portion of our universe.		
3. Demonstrate that reliable scientific evidence improves the ability of scientists to offer accurate predictions.		
Explain how scientific inquiry is guided by knowledge, observations, ideas and questions.		
5. Justify that scientific theories are explanations of large bodies of information and/or observations that withstand repeated testing.		
6. Explain that inquiry fuels observation and experimentation that produce data that are the foundation of scientific disciplines. Theories are explanations of these data.		
7. Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge.		

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Scientific Ways of Knowing Standard																												
Describe the ethical practices and guidelines in which science operates.																												
2. Illustrate that the methods and procedures used to obtain evidence must be clearly reported to enhance opportunities for further investigations.																												
4. Explain how support of ethical practices in science (e.g., individual observations and confirmations, accurate reporting, peer review and publication) are required to reduce bias.																												
Recognize that scientific literacy is part of being a knowledgeable citizen.																												
8. Illustrate that much can be learned about the internal workings of science and the nature of science from the study of scientists, their daily work and their efforts to advance scientific knowledge in their area of study.																												
9. Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue.																												