Bemidji Area Schools

Grades 9-12 Science Investigations I Science Outcomes

Strand	Substrand	Standard "Understand that ...	Code	Benchmark "The stdent will …
1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world and is characterized by emperical criteria, logical argument and skeptical review.	9.1.1.1.1	Explain the implications of the assumption that the rules of the universe are the same everywhere and these rules can be discovered by careful and systematic investigation.
			9.1.1.1.2	Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories.
			9.1.1.1.3	Explain how the traditions and norms of science define the bounds of professional scientific practice and reveal instances of scientific error or misconduct. *For example:* The use of peer review, publications and presentations.
			9.1.1.1.4	Explain how societal and scientific ethics impact research practices. *For example:* Research involving human subjects may be conducted only with the informed consent of the subjects.
			9.1.1.1.5	Identify sources of bias and explain how bias might influence the direction of research and the interpretation of data. *For example:* How funding of research can influence questions studied, procedures used, analysis of data, and communication of results.
			9.1.1.1.6	Describe how changes in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge.
			9.1.1.1.7	Explain how scientific and technological innovations-as well as new evidence-can challenge portions of, or entire accepted theories and models including, but not limited to: cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease, and the big bang theory.
		2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.	9.1.1.2.1	Formulate a testable hypothesis, design and conduct an experiment to test the hypothesis, analyze the data, consider alternative explanations, and draw conclusions supported by evidence from the investigation.
			9.1.1.2.2	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations.

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1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.	9.1.1.2.3	Identify the critical assumptions and logic used in a line of reasoning to judge the validity of a claim.
			9.1.1.2.4	Use primary sources or scientific writings to identify and explain how different types of questions and their associated methodologies are used by scientists for investigations in different disciplines..
	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.	9.1.3.2.1	Provide examples of how diverse cultures, including natives from all of the Americas, have contributed scientific and mathematical ideas and technological inventions. *For example:* Native American understanding of ecology; Lisa Meitner's contribution to understanding radioactivity; Tesla's ideas and inventions relating to electricity; Watson, Crick and Franklin's discovery of the structure of DNA; or how George Washington Carver's ideas changed land use.
			9.1.3.2.2	Analyze possible careers in science and engineering in terms of education requirements, working practices and rewards.
2. Physical Science	1. Matter	1. The structure of the atom determines chemical properties of elements.	9.2.1.1.1	Describe the relative charges, masses, and locations of the protons, neutrons, and electrons in an atom of an element.
			9.2.1.1.2	Describe how experimental evidence led Dalton, Rutherford, Thompson, Chadwick and Bohr to develop increasingly accurate models of the atom.
			9.2.1.1.3	Explain the arrangement of the elements on the Periodic Table, including the relationships among elements in a given column or row.
			9.2.1.1.4	Explain that isotopes of an element have different numbers of neutrons and that some are unstable and emit particles and/or radiation. *For example* : Some rock formations and building materials emit radioactive radon gas. *Another example:* The predictable rate of decay of radioactive isotopes makes it possible to estimate the age of some materials, and makes them useful in some medical procedures.

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2. Physical Science	1. Matter	2. Chemical reactions involve the rearrangement of atoms as chemical bonds are broken and formed through transferring or sharing of electrons and the absorption or release of energy.	9.2.1.2.1	Describe the role of valence electrons in the formation of chemical bonds.
			9.2.1.2.2	Explain how the rearrangement of atoms in a chemical reaction illustrates the law of conservation of mass.
			9.2.1.2.3	Describe a chemical reaction using words and symbolic equations. *For example:* The reaction of hydrogen gas with oxygen gas can be written: $2H_2 + O_2 \rightarrow 2H_2O$.
			9.2.1.2.4	Relate exothermic and endothermic chemical reactions to temperature and energy changes.
3. Earth and Space Science	1. Earth Structure and Processes	1. The relationships among earthquakes, mountains, volcanoes, fossil deposits, rock layers and ocean features provide evidence for the theory of plate tectonics.	9.3.1.1.1	Compare and contrast the interaction of tectonic plates at convergent and divergent boundaries. *For example:* Compare the kinds of magma that emerge at plate boundaries.
			9.3.1.1.2	Use modern earthquake data to explain how seismic activity is evidence for the process of subduction. *For example:* Correlate data on distribution, depth and magnitude of earthquakes with subduction zones.
			9.3.1.1.3	Describe how the pattern of magnetic reversals and rock ages on both sides of a mid-ocean ridge provides evidence of sea-floor spreading.
			9.3.1.1.4	Explain how the rock record provides evidence for plate movement. *For example:* Similarities found in fossils, certain types of rocks, or patterns of rock layers in various locations.
			9.3.1.1.5	Describe how experimental and observational evidence led to the theory of plate tectonics.
		3. By observing rock sequences and using fossils to correlate the sequences at various locations, geologic events can be inferred and geologic time can be estimated.	9.3.1.3.1	Use relative dating techniques to explain how the structures of the Earth and life on Earth have changed over short and long periods of time.

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3. Earth and Space Science	2. Interdepen-dence Within the Earth System	1. The Earth system has internal and external sources of energy, which produce heat and drive the motion of material in the oceans, atmosphere and solid earth.	9.3.2.1.1	Compare and contrast the energy sources of the Earth, including the sun, the decay of radioactive isotopes and gravitational energy.
			9.3.2.1.2	Explain how the outward transfer of Earth's internal heat drives the convection circulation in the mantle to move tectonic plates.
		2. Global climate is determined by distribution of energy from the sun at the Earth's surface.	9.3.2.2.2.	Explain how evidence from the geologic record, including ice core samples, indicates that climate changes have occurred at varying rates over geologic time and continue to occur today.
	3. The Universe	2. The solar system, sun, and Earth formed over billions of years.	9.3.3.2.1	Describe how the solar system formed from a nebular cloud of dust and gas 4.6 billion years ago.
			9.3.3.2.2.	Explain how the Earth evolved into its present habitable form through interactions among the solid earth, the oceans, the atmosphere and organisms.
			9.3.3.2.3.	Compare and contrast the environmental conditions that make life possible on Earth with conditions found on the other planets and moons of our solar system.
		3. The big bang theory states that the universe expanded from a hot, dense chaotic mass, after which chemical elements formed and clumped together to eventually form stars and galaxies.	9.3.3.3.1	Explain how evidence, including the Doppler shift of light from distant stars and cosmic background radiation, is used to understand the composition, early history and expansion of the universe.
			9.3.3.3.2	Explain how gravitational clumping leads to nuclear fusion, producing energy and the chemical elements of a star.