Bemidji Area Schools

Grades 9-12 Science Investigations II - Science Outcomes

Strand	Substrand	Standard "Understand that ...	Code	Benchmark
1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.	9.1.2.1.1	Understand that engineering designs and products are often continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved. *For example:* If the price of an essential raw material changes, the product design may need to be changed.
			9.1.2.1.2	Recognize that risk analysis is used to determine the potential positive and negative consequences of using a new technology or design, including the evaluation of causes and effects of failures. *For example:* Risks and benefits associated with using lithium batteries.
			9.1.2.1.3	Explain and give examples of how, in the design of a device, engineers consider how it is to be manufactured, operated, maintained, replaced and disposed of.
		2. Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.	9.1.2.2.1	Identify a problem and the associated constraints on possible design solutions. *For example:* Constraints can include time, money, scientific knowledge and available technology.
			9.1.2.2.2	Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications. *For example:* Develop a prototype to test the quality, efficiency and productivitiy of a product.
	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	1. Natural and designed systems are made up of components that act within a system and interact with other systems.	9.1.3.1.1	Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs. *For example:* A power plant or ecosystem.
			9.1.3.1.2	Identify properties of a system that are different from those of its parts but appear because of the interaction of those parts.
			9.1.3.1.3	Describe how positive and/or negative feedback occur in systems. *For example:* The greenhouse effect

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1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	3. Science and engineering operate in the context of society and both influence and are influenced by this context.	9.1.3.3.1	Describe how values and constraints affect science and engineering. *For example:* Economic, environmental, social, political, ethical, health, safety, and sustainability issues.
			9.1.3.3.2	Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.
		4. Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.	9.1.3.4.1	Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics, and new technologies.
			9.1.3.4.2	Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts. *For example:* Consideration of chemical and biological hazards in the lab.
			9.1.3.4.3	Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.
			9.1.3.4.4	Relate the reliability of data to consistency of results, identify sources of error, and suggest ways to improve the data collection and analysis. *For example:* Use statistical analysis or error analysis to make judgments about the validity of results
			9.1.3.4.5	Demonstrate how unit consistency and dimensional analysis can guide the calculation of quantitative solutions and verification of results.
			9.1.3.4.6	Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers.

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2. Physical Science	2. Motion	2. An object's mass and the forces on it affect the motion of an object.	9.2.2.2.1	Recognize that inertia is the property of an object that causes it to resist changes in motion.
			9.2.2.2.2	Explain and calculate the acceleration of an object subjected to a set of forces in one dimension (F=ma).
			9.2.2.2.3	Demonstrate that whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object.
			9.2.2.2.4	Use Newton's universal law of gravitation to describe and calculate the attraction between massive objects based on the distance between them. *For example:* Calculate the weight of a person on different planets using data of the mass and radius of the planets.
	3. Energy	2. Energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	9.2.3.2.1	Identify the energy forms and explain the transfers of energy involved in the operation of common devices. *For example:* Light bulbs, electric motors, automobiles or bicycles.
			9.2.3.2.2	Calculate and explain the energy, work and power involved in energy transfers in a mechanical system. *For example:* Compare walking and running up or down steps.
			9.2.3.2.3	Describe how energy is transferred through sound waves and how pitch and loudness are related to wave properties of frequency and amplitude.
			9.2.3.2.4	Explain and calculate current, voltage and resistance, and describe energy transfers in simple electric circuits.
			9.2.3.2.5	Describe how an electric current produces a magnetic force, and how this interaction is used in motors and electromagnets to produce mechanical energy.
			9.2.3.2.6	Compare fission and fusion in terms of the reactants, the products and the conversion from matter into energy. *For example:* The fusion of hydrogen produces energy in the sun. *Another example:* The use of chain reactions in nuclear reactors.
			9.2.3.2.7	Describe the properties and uses of forms of electromagnetic radiation from radio frequencies through gamma radiation. *For example:* Compare the energy of microwaves and X-rays.

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2. Physical Science	4. Human Interactions with Physical Systems	1. There are benefits, costs and risks to different means of generating and using energy.	9.2.4.1.1	Compare local and global environmental and economic advantages and disadvantages of generating electricity using various sources or energy. *For example:* Fossil fuels, nuclear fission, wind, sun or tidal energy.
			9.2.4.1.2	Describe the trade-offs involved when technological developments impact the way we use energy, natural resources, or synthetic materials. *For example:* Fluorescent light bulbs use less energy than incandescent lights, but contain toxic mercury.
3. Earth and Space Science	4. Human Interactions with the Earth Systems	1. People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.	9.3.4.1.1	Analyze the benefits, costs, risks and tradeoffs associated with natural hazards, including the selection of land use and engineering mitigation. *For example:* Determining land use in floodplains and areas prone to landslides.
			9.3.4.1.2	Explain how human activity and natural processes are altering the hydrosphere, biosphere, lithosphere and atmosphere, including pollution, topography and climate. *For example:* Active volcanoes and the burning of fossil fuels contribute to the greenhouse effect.