Bemidji Area Schools

Grades 10-12 Aerospace Engineering Science Outcomes

Strand	Substrand	Standard "Understand that ...	Benchmark "The student will …	Activity
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.	General discussion of hypothesis, theory and law and how they do not lie on a continuum.
			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.	General discussion on the history of flight and how it evolved over time. History of flight presentation.
			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.	Discussion on NASA and the negative side of the race to space. History of flight presentation.
			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.	Discussion on the funding of NASA and how it changes with different Presidents.
			9.1.1.1.6 Describe how changes in scientific knowledge generally occur in incremental steps that include and build on earlier knowledge.	General discussion on the history of flight. History of flight presentations.
	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.	Discussion on engineering. Designing a glider with limited supplies project.
			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.	Study of how advanced technology can hinder a mission or make it a success.

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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.	9.1.2.1.3 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.	Airfoil design project.
		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.	Airfoil design project. Glider design project.
			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.	Airfoil design and wind tunnel testing.
	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.	9.1.3.2.2 Analyze possible careers in science and engineering in terms of education requirements, working practices and rewards.	General discussion on the careers in Aerospace Engineering and astrophysics and what education requirements each field requires.
		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.	Discussion on how politics and wars determined where funding is used for research and development.
			9.1.3.3.3 Describe how scientific investigations and engineering processes require multi-disciplinary contributions and efforts. *For example:* Nanotechnology, climate change, agriculture, or biotechnology.	Research project on the effects that space has on the human body and how experts from different disciplines have to work together for a successful mission.

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1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	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.	General discussion on the importance of correct calculations and measurements to insure the safety on the astronauts.
			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.	Lab safety procedure discussion. Demonstration of proper use of lab tools and safety equipment.
			9.1.3.4.3 Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.	Students will present their designs and experimental results using various methods including graphs and diagrams.
			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	The students will include error analysis with all of their experiments which will be used to determine validity of their results.
			9.1.3.4.5 Demonstrate how unit consistency and dimensional analysis can guide the calculation of quantitative solutions and verification of results.	Demonstration on unit conversions and students will carry units through out their calculations to verify their solutions.
			9.1.3.4.6 Analyze the strengths and limitations of physical, conceptual, mathematical and computer models used by scientists and engineers.	Students will keep a journal throughout the class which will include the advantages and limitations of all the programs, models and equipment used in the course.

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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.	Discussion and examples of Newton's 3 laws of 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).	Discussion and examples of Newton's 3 laws of motion. Model rocket design and engine testing.
			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.	Discussion and examples of Newton's 3 laws of motion. Model rocket design and engine testing. Glider design and launching.
			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.	Discussion and examples of Newton's Universal Law of Gravitation. Students will be able to calculate the gravitational pull of a planet and the escape velocity needed to leave a planet or moon.
		1. The periodic table illustrates how patterns in the physical and chemical properties of elements are related to atomic structure.	9C.2.1.1.2 Identify and compare trends on the periodic table, including reactivity and relative sizes of atoms and ions; use the trends to explain the properties of subgroups, including metals, non-metals, alkali metals, alkaline earth metals, halogens and noble gases.	
1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics, and Society	3. Developments in physics affect society and societal concerns affect the field of physics.	9P.1.3.3.1 Describe changes in society that have resulted from significant discoveries and advances in technology in physics. *For example:* Transistors, generators, radio/television, or microwave ovens.	Discussion on the history of science.
		4. Physical and mathematical models are used to describe physical systems.	9P.1.3.4.1 Use significant figures and an understanding of accuracy and precision in scientific measurements to determine and express the uncertainty of a result.	Discussion on error analysis measurement lab with error analysis.
2. Physical Science	2. Motion	1. Forces and inertia determine the motion of objects.	9P.2.2.1.1 Use vectors and free-body diagrams to describe force, position, velocity and acceleration of objects in two-dimensional space.	Discussion and examples on force diagrams understanding flight activity.

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		1. Forces and inertia determine the motion of objects.	9P.2.2.1.2 Apply Newton's three laws of motion to calculate and analyze the effect of forces and momentum on motion.	Discussion and examples on Newton's 3 laws and momentum rocket design and engine test. Understanding flight activity.
		1. Forces and inertia determine the motion of objects.	9P.2.2.1.3 Use gravitational force to explain the motion of objects near Earth and in the universe.	Discussion and examples on Newton's Law of Universal Gravitation.
		2. When objects change their motion or interact with other objects in the absence of frictional forces, the total amount of mechanical energy remains constant.	9P.2.2.2.2 Describe and calculate the change in velocity for objects when forces are applied perpendicular to the direction of motion. *For example:* Objects in orbit.	Discussion on centripetal acceleration and force wind tunnel testing.
		2. When objects change their motion or interact with other objects in the absence of frictional forces, the total amount of mechanical energy remains constant.	9P.2.2.2.3 Use conservation of momentum and conservation of energy to analyze an elastic collision of two solid objects in one-dimensional motion.	Discussion and examples on energy and collisions. Satellite collision video.