Bemidji Area Schools

Grades 10-12 Astronomy 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. Application of terms in activities such as investigations of parallax, angular size, etc.
			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 astronomy and how the discipline evolved over time. Timeline of Astronomers activity.
			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 the setbacks of astronomy due to inaccurate teaching by influential people. Timeline of Astronomer activity.
			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 history of NASA and how the funding for government agencies work. Research of NASA missions project.
			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 t he history of astronomy and how the discipline evolved over time. Timeline of Astronomers activity. Researching the models of the development of the universe and how they are constantly changing.
			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.	In depth look at the history of the solar system models. Planetary research project.

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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.	9.1.1.2.1 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.	General discussion on the history of astronomy and how the discipline evolved over time. Timeline of Astronomers activity.
		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. Video on the development of rockets. NASA mission research 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 positive and negative consequences of NASA. Spinoff activity.
			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.	Class discussion on the history of the Apollo Missions.
	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.	Discussion on how Native Americans used ancient tools to keep track of seasons and astronomical events. Timeline of Astronomy project.

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1. The Nature of Science and Engineering	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 astronomy 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 determines the budget for NASA and the effects on the program. History of NASA project.
			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.	Discussion on how chemistry, math, physics, and biology play a crucial role in a space mission.
		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.	History of space flight project and how new designs are developed based on existing problems.
			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.	Modeling the moon phases. Modeling the seasons due to the tilt of the Earth and its position relative to the sun.
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).	
			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.	

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2. Physical Science	3. Energy	2. Energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.	9.2.3.2.6 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.	Discussion and examples of Newton's Universal Law of Gravitation. Planet project. Star project.
			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.	Discussions and activities related to fusion and spectral signatures coming from stars.
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.	Discussion on how plate tectonics help shape the Earth's landscape and the landscape of other planets.
	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.	Discussion on the origins of the universe and how it evolved. Video *Origins of the Universe.*
			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.	Discussion on the requirements for life and how life has evolved on Earth to survive different conditions.
		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.	Discussion on the Doppler Shift and how it supports the Big Bang Theory.
			9.3.3.3.2 Explain how gravitational clumping leads to nuclear fusion, producing energy and the chemical elements of a star.	Newton's Universal Law of Gravity discussion and applying that knowledge to how the stars and planets formed. Star project. Planet project.