Bemidji Area Schools

Grades 11-12 College Physics 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. Density Lab.
			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 science. Density Lab. Archimedes Principle Lab.
			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 Newton's Laws and the invention of calculus.
			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 science and how new ideas and technology change the way we practice science. Density Lab. Archimedes Principle Lab.
		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 data analysis and uncertainty. Examined on every lab.
	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.	Class discussion on engineering. Armageddon 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.	9.1.3.2.1 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 the background of all topics in the class.
			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 Physics, Chemistry, Medicine 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.	9.1.3.3.3 Describe how scientific investigations and engineering processes require multi-disciplinary contributions and efforts. *For example:* Nanotechnology, climate change, agriculture, or biotechnology.	Discussion on why many disciplines require a physics background and the importance of taking physics.
		4. Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.	9.1.3.4.5 Demonstrate how unit consistency and dimensional analysis can guide the calculation of quantitative solutions and verification of results.	Simple Harmonic Motion Lab. Acceleration Lab. Density Lab.
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. Discussion and examples of Newton's 3 Laws of Motion. Newton's 2nd Law Lab.

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2. Physical Science	2. Motion	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 and examples of Newton's 3 Laws of Motion. Newton's 2nd Law Lab.
		2. An object's mass and the forces on it affect the motion of an object.	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. Rocket Project.
			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. Acceleration Due to Gravity Lab.
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. Significant Figure Activity. Density Lab.
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. Vector Lab.
			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 2nd examples on Newton's 3 Laws and Momentum. Newton's 2nd Law Lab. Rocket Project. Ballistic Pendulum Lab
			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 Acceleration Lab.

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2. Physical Science	2. Motion	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.2.2.2.1 Explain and calculate the work, power, potential energy and kinetic energy involved in objects moving under the influence of gravity and other mechanical forces.	Discussion and examples on energy and collisions. Ballistic Pendulum Lab. Harmonic Motion Lab.
		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. Centripetal Force Demo. Roller Coaster video.
		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. Ballistic Pendulum Lab.
	3. Energy	1. Sound waves are generated from mechanical oscillations of objects and travel through a medium.	9P.2.3.1.1 Analyze the frequency, period and amplitude of an oscillatory system. *For example:* An ideal pendulum, a vibrating string, or a vibrating spring-and-mass system.	Discussion and examples on harmonic motion. Harmonic Motion Lab. Computer simulation.
		1. Sound waves are generated from mechanical oscillations of objects and travel through a medium.	9P.2.3.1.2 Describe how vibration of physical objects sets up transverse and/or longitudinal waves in gases, liquids and solid materials.	Discussion and examples on harmonic motion and wave computer simulation. Harmonic Motion Lab. Wave Demonstration.
		1. Sound waves are generated from mechanical oscillations of objects and travel through a medium.	9P.2.3.1.3 Explain how interference, resonance, refraction and reflection affect sound waves.	Discussion on the properties of waves. Diffraction Lab. Computer simulation. Demonstration on refraction and diffraction.
		1. Sound waves are generated from mechanical oscillations of objects and travel through a medium.	9P.2.3.1.4 Describe the Doppler effect changes that occur in an observed sound as a result of the motion of a source of the sound relative to a receiver.	Discussion and examples of the Doppler Effect.
		3. Magnetic and electric fields interact to produce electromagnetic waves.	9P.2.3.3.4 Use properties of light, including reflection, refraction, interference, Doppler effect and the photoelectric effect, to explain phenomena and describe applications.	Discussion and examples on the properties of light. Computer simulation on interference and refraction.

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2. Physical Science	3. Energy	4. Heat energy is transferred between objects or regions that are at different temperatures by the processes of convection, conduction and radiation.	9P.2.3.4.1 Describe and calculate the quantity of heat transferred between solids and/or liquids, using specific heat, mass and change in temperature.	Discussion on heat transfer and radiation. Specific Heat Lab. Heat of Fusion Lab.
		4. Heat energy is transferred between objects or regions that are at different temperatures by the processes of convection, conduction and radiation.	9P.2.3.4.2 Explain the role of gravity, pressure and density in the convection of heat by a fluid.	Discussion on Bernoulli's and Archimedes Principles. Archimedes Lab.
		4. Heat energy is transferred between objects or regions that are at different temperatures by the processes of convection, conduction and radiation.	9P.2.3.4.3 Compare the rate at which objects at different temperatures will transfer thermal energy by electromagnetic radiation.	Discussion on heat transfer and radiation. Specific Heat Lab. Heat of Fusion Lab.