

## 2019 Minnesota Academic Standards in Science

9th Grade-12th Grade Physics		
Strand	Code	Benchmark
Exploring Phenomena or Engineering Problems	9P.1.1.1.1	Evaluate questions about the advantages and disadvantages of using digital transmission and storage of information.
	9P.1.2.1.1	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
	9P.1.2.1.2	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system.
Looking at data and empirical evidence to understand phenomena or solve problems	9P.2.1.1.1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
	9P.2.2.1.1	Apply mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
	9P.2.2.1.2	Apply mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
	9P.2.2.1.3	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in or out of the system are known.

Developing possible explanations of phenomena or designing solutions to engineering problems	9P.3.1.1.1	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	9P.3.1.1.2	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between two objects and the changes in energy of the two objects due to the interaction and describe how these forces are present in phenomena.
	9P.3.2.2.1	Develop a computer simulation to demonstrate the impact of a proposed solution that minimizes the force on a macroscopic object during a collision.
	9P.3.2.2.2	Evaluate a solution to a complex energy-related problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, aesthetics, and maintenance, as well as social, cultural, and environmental impacts.
Communicating reasons, arguments and ideas to others	9P.4.1.1.1	Evaluate the claims, evidence, and reasoning behind the argument that electromagnetic radiation can be described using either a wave model or a particle model, and that for some phenomena one model is more useful than the other.
	9P.4.2.1.1	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
	9P.4.2.1.2	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.