Minnesota Science Standards Covered in Physics

| Grade | Strand | Substrand | Standard | Content Area | Benchmark |
|---|---|---|---|---|---|
| 9-12 Physics | 1 Exploring phenomena or engineering problems | 1.2 Planning and carrying out investigations | 1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena. | Physics – PS: Motion and Stability: Forces and Interactions | 9P.1.2.1.1 Plan and conduct an investigation to provide evidence that an electric current can produce a magnet and that a changing magnetic field can produce an elec current. (P: 3, CC: 2, CI: PS2) Examples of contexts for investigations may include coils, motors, generators, an transformers. |
| 9-12 Physics | 1 Exploring phenomena or engineering problems | 1.2 Planning and carrying out investigations | 1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena. | Physics - PS: Energy | 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 w closed system results in a more uniform energy distribu among the components in the system. (P: 3, CC: 3, CI: P Emphasis is on analyzing data from student investigatio using mathematical thinking to describe the energy cha both quantitatively and conceptually. Examples may inc mixing liquids at different initial temperatures or addin objects at different temperatures to water. |
| 9-12 Physics | 2 Looking at data and empirical evidence to understand phenomena or solve problems | 2.1 Analyzing and interpreting data | 2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables. | Physics - PS: Motion and Stability: Forces and Interactions | 9P.2.1.1.1 Analyze data to support the claim that Newto second law of motion describes the mathematical relationship among the net force on a macroscopic obje mass, and its acceleration. (P: 4, CC: 2, CI: PS2) Example data (including data from student investigations) may in tables or graphs of position or velocity as a function of t for objects subject to a net unbalanced force, such as a object, an object sliding down a ramp, or a moving obje being pulled by a constant force. |
| 9-12 Physics | 2 Looking at data and empirical evidence to understand phenomena or solve problems | 2.2 Using mathematics and computational thinking | 2.2.1 Students will be able to use mathematics to represent physical variables and their relationships, compare mathematical expressions to the real world, and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds. | Physics – PS: Motion and Stability: Forces and Interactions | 9P.2.2.1.1 Apply mathematical representations to supp claim that the total momentum of a system of objects is conserved when there is no net force on the system. (P: CC: 4, CI: PS2) Emphasis is on the quantitative conservat momentum in interactions and the qualitative meaning this principle. Examples may include investigating chang momentum before and after collisions in closed system |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9-12 Physics | 2 Looking at data and empirical evidence to understand phenomena or solve problems | 2.2 Using mathematics and computational thinking | 2.2.1 Students will be able to use mathematics to represent physical variables and their relationships, compare mathematical expressions to the real world, and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds. | Physics – PS: Motion and Stability: Forces and Interactions | 9P.2.2.1.2 Apply mathematical representations of Newt Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces betwe objects. (P: 5, CC: 1, CI: PS2) Emphasis is on both quanti and conceptual descriptions of gravitational and electri and the forces on objects in the fields. | | |
| 9-12 Physics | 2 Looking at data and empirical evidence to understand phenomena or solve problems | 2.2 Using mathematics and computational thinking | 2.2.1 Students will be able to use mathematics to represent physical variables and their relationships, compare mathematical expressions to the real world, and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds. | Physics - PS: Energy | 9P.2.2.1.3 Create a computational model to calculate th change in the energy of one component in a system wh change in energy of the other component(s) and energy in or out of the system are known.** (P: 5, CC: 4, CI: PS3 Emphasis is on explaining the meaning of mathematical expressions used in the model for systems of two or thr components. Forms of energy may include thermal ene kinetic energy, and elastic potential energy. Computatio models may include the creation or use of a simulation analysis of a data set. | | |
| 9-12 Physics | 3 Developing possible explanations of phenomena or designing solutions to engineering problems | 3.1 Developing and using models | 3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others. | Physics - PS: Energy | 9P.3.1.1.1 Develop and use models to illustrate that ene the macroscopic scale can be accounted for as a combi of energy associated with the motions of particles (obje and energy associated with the relative positions of par (objects). (P: 2, CC: 5, CI: PS3) Examples of phenomena macroscopic scale may include the conversion of kineti energy to thermal energy, the energy stored due to pos of an object above Earth, and the energy stored betwe electrically charged plates. Examples of models may inc diagrams, drawings, descriptions, and computer simula | | |
| 9-12 Physics | 3 Developing possible explanations of phenomena or designing solutions to engineering problems | 3.1 Developing and using models | 3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others. | Physics - PS: Energy | 9P.3.1.1.2 Develop and use a model of two objects inte through electric or magnetic fields to illustrate the forc between the two objects and the changes in energy of t two objects due to the interaction and describe how th forces are present in phenomena. (P: 2, CC: 2, CI: PS3) Examples of models may include drawings, diagrams, a texts, such as drawings of what happens when two cha opposite polarity are near each other. Examples of phenomena may include motors, electromagnetic indu speakers, generators, wireless charging, and induction cooktops. | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9-12 Physics | 3 Developing possible explanations of phenomena or designing solutions to engineering problems | 3.2 Constructing explanations and designing solutions | 3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.* | Physics - PS: Motion and Stability: Forces and Interactions | 9P.3.2.2.1 Develop a computer simulation to de impact of a proposed solution that minimizes th macroscopic object during a collision.** (P: 6, C ETS1) Emphasis is on applying science and engin principles and analyzing the energy conversions a device may include a helmet, a parachute, an packaging for safe shipping. | | |
| 9-12 Physics | 3 Developing possible explanations of phenomena or designing solutions to engineering problems | 3.2 Constructing explanations and designing solutions | 3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.* | Physics - PS: Energy | 9P.3.2.2.2 Evaluate a solution to a complex ener problem based on prioritized criteria and tradeo account for a range of constraints, including cos reliability, aesthetics, and maintenance, as well cultural, and environmental impacts.* (P: 6, CC: ETS1) Examples of energy-related problems may from alternative energy, manufacturing, and tra systems. | | |
| 9-12 Physics | 4 Communicating reasons, arguments and ideas to others | 4.1 Engaging in argument from evidence | 4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments. | Physics – PS: Waves and Their Applications in Technologies for Information Transfer | 9P.4.1.1.1 Evaluate the claims, evidence, and rea behind the argument that electromagnetic radia described using either a wave model or a particl that for some phenomena one model is more us other. (P: 7, CC: 4, CI: PS4) Emphasis is on how t experimental evidence supports the claim and h is generally modified in light of new evidence. E phenomena may include resonance, interferenc and photoelectric effect. | | |
| 9-12 Physics | 4 Communicating reasons, arguments and ideas to others | 4.2 Obtaining, evaluating and communicating information | 4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats. | Physics – PS: Waves and Their Applications in Technologies for Information Transfer | 9P.4.2.1.1 Evaluate the validity and reliability of published materials of the effects that different of electromagnetic radiation have when absorb (P: 8, CC: 2, CI: PS4) Emphasis is on the idea that associated with different frequencies of light ha energies, and the damage to living tissue from electromagnetic radiation depends on the energ radiation. Examples may include medical imagin and communication devices. | | |
| 9-12 Physics | 4 Communicating reasons, arguments and ideas to others | 4.2 Obtaining, evaluating and communicating information | 4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats. | Physics – PS: Waves and Their Applications in Technologies for Information Transfer | 9P.4.2.1.2 Communicate technical information a some technological devices use the principles of behavior and wave interactions with matter to t capture information and energy.* (P: 8, CC: 2, C Examples of devices may include medical imagin technologies, cell phones, GPS, Doppler radar or that capture light and convert it to electricity. | | |

* indicates an engineering-related benchmark or standard
** indicates a computer science–related benchmark