

## Physics

Standards	<p style="text-align: center;"><b>Not Proficient</b></p> <p>Students who perform at this level have not demonstrated mastery in academic performance, thinking abilities, and application of understandings that reflect the knowledge and skills specified by the grade/course level content standards and are not prepared for the next level of study.</p>	<p style="text-align: center;"><b>Approaching Proficient</b></p> <p>Students who perform at this level demonstrate partial mastery in academic performance, thinking abilities, and application of understandings that reflect the knowledge and skills specified by the grade/course level content standards and are minimally prepared for the next level of study.</p>	<p style="text-align: center;"><b>* Proficient</b></p> <p>Students who perform at this level demonstrate mastery in academic performance, thinking abilities, and application of understandings that reflect the knowledge and skills specified by the grade/course level content standards and are well prepared for the next level of study.</p>	<p style="text-align: center;"><b>Advanced</b></p> <p>Students who perform at this level demonstrate superior mastery in academic performance, thinking abilities, and application of understandings that reflect the knowledge and skills specified by the grade/course level content standards and are significantly prepared for the next level of study.</p>
<b>Embedded Inquiry</b>	NOTE: embedded standards are taught and assessed as components that are integrated into the science content at each grade level or course.			
<b>Embedded Technology and Engineering</b>	NOTE: embedded standards are taught and assessed as components that are integrated into the science content at each grade level or course.			
<b>Embedded Mathematics</b>	NOTE: embedded standards are taught and assessed as components that are integrated into the science content at each grade level or course			

<p style="text-align: center;"><b>1.0 Mechanics</b></p>	<p>A student at this level has not demonstrated a basic understanding of the principles associated with the Physics topic of Mechanics.</p>	<p>A student at this level can identify which of Newton's laws of motion are represented in a particular situation. The student can identify the correct variables and apply given kinematics equations to solve for unknown quantities. He/she can design an experiment to determine distance/time and velocity/time relationships. The student can analyze vector diagrams. He/she applies the law of conservation of energy to describe conversions between different forms of energy.</p>	<p>A student at this level can explain why Newton's laws of motion are applicable in a particular situation. The student can identify the correct variables and select and apply the proper kinematics equations to solve for unknown quantities. He/she can interpret distance/time and velocity/time graphs, and understands the physical meaning of slope. The student resolves and determines resultant vectors. He/she applies the law of conservation of energy to calculate conversions between different forms of energy.</p>	<p>A student at this level can select and apply the appropriate law of motion to interpret a particular situation. The student can identify the correct variables and derive kinematics equations to solve for unknown quantities. He/she can prepare and interpret distance/time and velocity/time graphs, and understands the physical meaning of slope. He/she understands methods to approximate instantaneous values for non-linear data. The student uses trigonometric functions to resolve and determine resultant vectors. He/she can design an investigation that applies the law of conservation of energy to calculate conversions between various forms of energy.</p>

<p style="text-align: center;"><b>2.0 Thermodynamics</b></p>	<p>A student at this level has not demonstrated a basic understanding of the principles associated with the Physics topic of Thermodynamics.</p>	<p>A student at this level can describe the basic relationship between the laws of thermodynamics and conservation of energy. He/she uses tools and measurement scales to explore changes in heat content and associates resulting observations with kinetic energy and specific heat. He/she can graph complex data to draw conclusions. A student can apply given equations and analyze data for thermal expansion and contraction.</p>	<p>A student at this level can explain the relationship between the laws of thermodynamics and conservation of energy. He/she selects and uses appropriate tools and measurement scales to investigate changes in heat content and can associate the results with kinetic energy and specific heat. He/she can extrapolate between data points to make predictions. A student can identify the proper equations and analyze data for thermal expansion and contraction.</p>	<p>A student at this level can explain the complex connection between the laws of thermodynamics and conservation of energy. He/she can design an investigation to study changes in heat content and associate the results with kinetic energy and specific heat. He/she can interpolate and extrapolate between data points to make inferences and predictions. A student can select and apply appropriate equations and analyze complex data for thermal expansion and contraction.</p>

<b>3.0 Waves</b>	<p>A student at this level has not demonstrated a basic understanding of the principles associated with the Physics topic of waves.</p>	<p>A student at this level can identify examples of simple harmonic motion and calculate amplitude and period of oscillation. He/she understands the relationship between the velocity, frequency and wavelength of a sound wave. The student recognizes that wave characteristics vary with temperature, density, and elasticity of the medium. He/she can predict the change in apparent frequency for a stationary observer. He/she can measure the spring constant in a laboratory setting. The student can interpret a graphical representation of a transverse wave that illustrates wavelength, amplitude, and frequency.</p>	<p>A student at this level can describe simple harmonic motion and use laboratory equipment to determine amplitude and period of oscillation. He/she can explain how the velocity, frequency and wavelength of a sound wave are affected by the physical environment. The student can apply Doppler shift equations to calculate apparent frequency and velocity for a stationary observer. He/she can calculate the spring constant using Hooke's law. The student can prepare a graphical representation of a transverse wave that illustrates the correct wavelength, amplitude, and frequency.</p>	<p>A student at this level can design a method to determine the amplitude and period of oscillation of simple harmonic motion. He/she can predict how the velocity, frequency and wavelength of a sound wave will be affected by different physical environments. The student can apply complex Doppler shift equations to calculate apparent frequency or velocity for a stationary or moving observer. He/she can design an investigation to determine the spring constant. The student can design an investigation to study the properties of transverse waves.</p>

## 4.0 Optics

A student at this level has not demonstrated a basic understanding of the principles associated with the Physics topic of Optics.

A student at this level can distinguish among different forms of electromagnetic energy. The student can interpret an optical scenario to determine image distance, image height, and magnification. He/she can describe a formed image based on an object's location and type of lens or mirror. The student can name the major tenets of the ray, wave, and particle models of light. He/she can predict the type of refraction that occurs at the boundary between two different optical media. The student can use additive and subtractive processes to determine color combinations for light and pigments. He/she understands that optical media are used to store information and how this ability is used by the communication industry.

A student at this level can explain the difference among various forms of electromagnetic energy and determine their sources. The student can use algebraically manipulated versions of the lens maker's equation to solve for image distance, image height, and magnification. He/she can explain the relationships among a formed image, an object's location, and the type of lens or mirror. The student can compare and contrast the major tenets of the ray, wave, and particle models of light. He/she can apply Snell's law to determine the angle of refraction between different optical media. The student can design an investigation of additive and subtractive processes to determine color combinations for light and pigments. He/she can describe how optical media store information and why applications of optic principles have led to advancements in the communication industry.

A student at this level can rank order the different forms of electromagnetic energy in terms of wavelength and describe their different properties. The student can apply the lens maker's equation to solve for image distance, image height, and magnification. He/she can predict the nature of a formed image based on an object's location and the type of lens or mirror. The student can explain and apply the ray, wave and particle models of light. He/she can apply Snell's law to determine the angle of refraction and critical angle between different optical media. The student is able to apply the additive and subtractive processes to predict color combinations for light and pigments. He/she can explain how new optical tools and technologies are utilized by the communication industry.

**5.0 Electricity and Magnetism**

A student at this level has not demonstrated a basic understanding of the principles associated with the Physics topics of Electricity and Magnetism.

A student at this level can describe the force on a charge caused by other charges in an electric field and sketch the orientation of the electric field. He/she can apply given equations to solve for voltage, current, and resistance. The student draws and interprets diagrams of series and parallel circuits and calculates the equivalent resistance of the circuit. He/she can build simple series and parallel circuits in the laboratory. The student understands that a magnetic field can induce current.

A student at this level can apply Coulomb's law to predict the force on a charge due to other charges. He/she uses Ohm's law to solve for voltage, current, and resistance. The student interprets series and parallel circuit diagrams to determine voltage and current drops at various points in the circuit. The student can compare equivalent resistance for series and parallel circuits. He/she can build functional series and parallel circuits in the laboratory. The student can conduct an experiment to induce a current from a magnetic field and describe how this process occurs in a motor.

A student at this level can apply Coulomb's law to predict the net force on a charge, given a complex charge distribution. He/she designs an investigation that demonstrates how Ohm's law is applied to solve for voltage, current or resistance. The student can prepare series, parallel, and complex circuit diagrams that illustrate voltage and current drops at various points in the circuit. The student can determine equivalent resistance for series, parallel, and complex circuits. He/she selects appropriate components to build functional series, parallel, and complex circuits in the laboratory. The student can design an experiment to induce a current from a magnetic field and use this current in a practical circuit.

## 6.0 Nuclear Physics

A student at this level has not demonstrated a basic understanding of the principles associated with the Physics topic of Nuclear Physics.

A student at this level understands the structure and properties of the atom. The student recognizes that the nucleus of radioactive elements is dynamic and that it decays in predictable ways. The student can compare atomic models. He/she can quantify nuclear physics using nuclear equations and describe these phenomena. He/she can describe the fundamental difference between nuclear fission and fusion. He/she can discuss the impact of nuclear energy technology on social, political, and economic systems.

A student at this level can describe the structure and properties of the atom. The student can describe factors that make the nucleus of radioactive elements dynamic and explain why it decays in predictable ways. The student can compare and contrast the Bohr and quantum models of the atom. He/she can quantify nuclear physics using nuclear equations and apply quantum theory to interpret these phenomena. The student can compare and contrast nuclear fission and fusion. He/she can evaluate the pros and cons of current applications of nuclear technology.

A student at this level can associate specific properties of the atom with particular structures. The student understands why the nucleus of radioactive elements is dynamic and decays in predictable ways. He/she can quantify nuclear physics using complex nuclear equations and apply quantum theory to explain these phenomena. The student can compare and contrast particular examples of nuclear fission and fusion. He/she applies the engineering design process to develop ideas for safer and more efficient ways to utilize nuclear technology.