

High School MCAS Introductory Physics Performance Level Descriptors

Student results on the MCAS tests are reported according to four performance levels: *Advanced*, *Proficient*, *Needs Improvement*, and *Warning/Failing*. The descriptors in this document illustrate the kinds of knowledge and skills students demonstrate on MCAS at each level.

Knowledge and skills are cumulative at each level. No descriptors are provided for the *Warning/Failing* performance level because student work at this level, by definition, falls below the criteria of the *Needs Improvement* level.

Motion and Forces		
Needs Improvement	Proficient	Advanced
Identifies examples of some vector and scalar quantities	Describes most vector and scalar quantities	Explains why quantities are scalar or vector in any context
Solves simple motion problems and interprets graphs of position vs. time and distance vs. time	Solves most motion problems where the formula is solved for the unknown, and analyzes and produces speed/velocity vs. time graphs and displacement graphs	Solves complex motion problems and interprets and produces complex motion graphs
Identifies Newton's laws of motion	Describes Newton's laws of motion for given examples	Explains and applies Newton's laws of motion in various contexts
Determines net force from a free-body diagram with two colinear forces	Determines net force from a diagram with unbalanced colinear forces and balanced perpendicular colinear forces; creates a simple net force diagram with two colinear forces	Creates and explains various colinear net force diagrams
Recognizes a situation in which static friction is greater than kinetic friction	Describes a typical situation where static friction is greater than kinetic friction	Explains the factors that affect kinetic friction and static friction
Identifies either mass or distance as a determinant of gravitational attraction	Describes how mass and distance are both involved in gravitational attraction	Explains the quantitative relationships of mass and distance as related to gravitational attraction
Identifies the force in a simple circular motion example	Describes that the force in circular motion is directed inward toward the center of the circle	Describes and represents centripetal force as always acting perpendicular to the direction of motion of the body

Conservation of Energy and Momentum

Needs Improvement	Proficient	Advanced
<p>Identifies examples where energy is transferred and recognizes that energy cannot be created or destroyed</p> <p>Defines work and power and solves simple problems given force, distance, and/or time</p> <p>Identifies velocity and mass (inertia) as the two factors that affect momentum and calculates momentum for a single object</p>	<p>Describes transfers between potential energy and kinetic energy and solves problems with kinetic and potential energy</p> <p>Differentiates between work and power and solves problems involving both</p> <p>Solves problems for momentum involving two objects and recognizes that momentum is always conserved in a closed system</p>	<p>Explains transfers of energy and solves complex problems involving kinetic energy, potential energy, and work</p> <p>Provides examples of both work and power and explains how they are related</p> <p>Solves problems for velocity or mass where momentum is given and applies conservation of momentum to these problems</p> <p>Explains how the conservation of momentum relates to Newton's laws of motion; recognizes that force is equal to the rate of change of momentum</p>

Heat and Heat Transfer

Needs Improvement	Proficient	Advanced
<p>Identifies examples of convection, conduction, and radiation and describes how heat energy moves from higher to lower temperatures</p> <p>Describes temperature in terms of average molecular motion and identifies substances changing phases; identifies simple examples of evaporation, condensation, cooling, and warming</p> <p>Recognizes that materials differ in the heat required to effect a given temperature change</p>	<p>Describes heat transfer in various examples and describes how equilibrium of heat energy can be reached in a system</p> <p>Describes how energy is transferred in phase changes and describes evaporation, condensation, cooling, and warming in terms of average molecular kinetic energy</p> <p>Solves problems related to specific heat</p>	<p>Provides examples of heat transfer and explains the transfer of energy in these examples</p> <p>Explains conduction, convection, and radiation in terms of molecular kinetic energy</p> <p>Explains the relationships among evaporation, condensation, cooling, and warming in terms of average molecular kinetic energy</p> <p>Explains the relationships among temperature, heat transfer, mass, and specific heat in problems</p>

Waves		
Needs Improvement	Proficient	Advanced
<p>Solves simple problems involving properties of waves</p> <p>Identifies examples of simple harmonic motion</p> <p>Recognizes that mechanical waves require a medium and identifies examples of mechanical (transverse, longitudinal) and electromagnetic waves</p> <p>Identifies situations in which waves are reflected or refracted</p> <p>Recognizes that sound waves move faster through a solid than through a liquid and faster through a liquid than through a gas</p> <p>Identifies simple examples of the Doppler effect</p>	<p>Describes properties of waves and solves various problems involving these properties; provides examples of simple harmonic motion</p> <p>Compares mechanical and electromagnetic waves</p> <p>Describes the motion of media for transverse and longitudinal waves</p> <p>Describes situations in which waves are reflected and situations in which waves are refracted</p> <p>Recognizes that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas</p> <p>Describes the Doppler effect in a given example</p>	<p>Explains the relationships among properties of waves and solves complex problems involving these properties</p> <p>Provides examples of mechanical (transverse, longitudinal) and electromagnetic waves and describes differences between these examples</p> <p>Explains the path of reflected and refracted waves</p> <p>Recognizes that light of different frequencies is refracted at different angles in the same medium</p>

Electromagnetic Radiation		
Needs Improvement	Proficient	Advanced
<p>Recognizes that electromagnetic waves do not need a medium to travel through</p> <p>Identifies the locations of some electromagnetic waves on the spectrum</p>	<p>Recognizes that electromagnetic waves are transverse waves and travel at the same speed in a vacuum</p> <p>Identifies the locations of electromagnetic waves on the spectrum and explains that increasing frequency is associated with decreasing wavelength on the spectrum</p>	<p>Recognizes that electromagnetic waves travel at different speeds through various media</p>

Electromagnetism

Needs Improvement	Proficient	Advanced
<p>Identifies situations involving attraction and repulsion of charged object, and identifies examples of conductors and insulators</p> <p>Solves simple Ohm's law problems and problems involving power</p> <p>Describes a closed circuit and identifies symbols for common circuit elements. Identifies series and parallel circuits</p> <p>Identifies common applications involving both electricity and magnetism</p>	<p>Describes transfer of charge between objects and the resulting forces, and provides examples of insulators and conductors</p> <p>Describes current, voltage, power, and resistance, and solves problems involving Ohm's law and power</p> <p>Describes differences between series and parallel circuits and produces simple examples of each</p> <p>Describes the relationship between electricity and magnetic force</p>	<p>Explains in detail the behavior of electrons and protons as charges on insulators and conductors, and explains how energy can produce a separation of charges</p> <p>Analyzes and produces series and parallel circuits consisting of common circuit elements in terms of voltage, current, power, and resistance</p> <p>Describes advantages and disadvantages of series and parallel circuits in given examples</p> <p>Interprets the relationship between current, voltage, and power in various representations (e.g., graphs, etc.)</p> <p>Describes how electric motors and generators work in terms of electricity and magnetic force</p>