Missouri Educator Gateway Assessments

FIELD 078: PHYSICS
TEST FRAMEWORK

June 2019

DRAFT

Content Domain		Range of Competencies	Approximate Percentage of Test Score
I.	Motion and Stability: Mechanical Forces and Interactions	0001–0004	27.5%
II.	Motion and Stability: Electromagnetic Forces and Interactions	0005–0007	20%
III.	Thermodynamics, Modern Physics, Waves, and Light	0008–0011	15%
IV.	Chemistry	0012	12.5%
V.	Biology	0013	12.5%
VI.	Earth Science	0014	12.5%

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A scientific calculator will be available to examinees taking the Physics test.

MOTION AND STABILITY: MECHANICAL FORCES AND INTERACTIONS

0001 Analyze linear and angular motion.

For example:

1.1 Use multiple representations (e.g., pictures, graphs, equations, motion maps) to analyze one-dimensional motion.

1.2 Solve problems involving constant acceleration in one dimension.

1.3 Solve problems involving angular motion with constant angular acceleration.

1.4 Apply properties of vectors to describe motion in two dimensions.

1.5 Model and solve problems involving projectile motion near the surface of Earth.

1.6 Apply knowledge of laboratory practices and techniques for data collection, analysis, and reporting (e.g., observation and measurement, quantitative and qualitative data, graphing methods) related to physical systems (i.e., kinematics).

1.7 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to motion in one and two dimensions (e.g., using a video to analyze the motion of an object, finding similarities between free-fall acceleration and acceleration on a ramp) and make connections between science, engineering, and daily life (e.g., building a prototype projectile launcher, using vector diagrams to visualize an airplane in a crosswind).

0002 Apply knowledge of forces as interactions and their effects on linear and angular motion and stability.

For example:

2.1 Identify implications of Newton's laws in a variety of situations.

2.2 Analyze free body diagrams.

2.3 Apply Newton's second law to solve problems involving forces and motion, including problems involving gravitational, frictional, and elastic forces (i.e., Hooke's law).

2.4 Interpret and solve a variety of problems involving moments of inertia and torques.

2.5 Apply knowledge of Newton's law of universal gravitation to describe and predict the gravitational forces between objects.

2.6 Analyze and solve problems involving uniform circular motion.

2.7 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to forces as interactions and their effects on motion and stability (e.g., designing an experiment to measure how force varies with distance in a spring, comparing Newton's law to other inverse square laws) and make connections between science, engineering, and daily life (e.g., relating air resistance to gas mileage in vehicles, analyzing how satellites are used in communication systems).

0003 Apply knowledge of energy and conservation of energy.

For example:

3.1 Use multiple representations (e.g., graphs, equations) to interpret factors that affect the translational and rotational kinetic and potential energies of an object (e.g., mass, speed, force, distance, relative position).

3.2 Apply principles of work, potential energy, and kinetic energy in situations involving conservative and nonconservative forces (e.g., determine the speed of a roller coaster at various heights, evaluate the effectiveness of various ramps).

3.3 Apply principles of power to solve problems involving energy changes.

3.4 Apply the principle of the conservation of energy to situations involving energy transfers in a system (e.g., recognize conditions in which total mechanical energy is conserved, analyze a device that converts chemical energy to mechanical energy).

3.5 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to energy and the conservation of energy (e.g., determining the energy needed to launch a projectile to a given height, calculating the power requirements for a device to perform a task) and make connections between science, engineering, and daily life (e.g., designing an amusement park ride, describing how to maximize energy available at varying RPM levels for a car engine).

0004 Apply knowledge of conservation of linear and angular momentum.

For example:

4.1 Apply the relationships between force, impulse, and momentum (e.g., analyze the design of a device that minimizes the force on an egg dropped from a height, explain how airbags can protect a passenger during a collision).

4.2 Analyze and solve problems involving the conservation of momentum for elastic and inelastic collisions in one dimension.

4.3 Apply principles of linear and angular momentum to verify that the momenta of a system are conserved when there is no net force or torque acting on the system.

4.4 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to the conservation of momentum (e.g., designing an experiment involving the conservation of momentum, predicting the outcome of an inelastic collision in one dimension) and make connections between science, engineering, and daily life (e.g., analyzing the dynamics of a device powered by an inflated balloon, evaluating engine type for a rocket based on force generated).

MOTION AND STABILITY: ELECTROMAGNETIC FORCES AND INTERACTIONS

0005 Apply knowledge of properties of electric fields.

For example:

5.1 Evaluate factors that affect the strength of an electric force (i.e., Coulomb's law) and an electric field.

5.2 Describe electric forces and electric fields for various simple charge distributions.

5.3 Describe the motion of a charged particle in a uniform electric field.

5.4 Demonstrate knowledge of electric potential energy, energy transfer, and potential difference.

5.5 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to properties of the electric field (e.g., analyzing the forces on a charged balloon, describing a system of point charges that would result in a region where the electric field is zero) and make connections between science, engineering, and daily life (e.g., relating concepts of the electric field to thunderstorms and lightning, explaining how a static charge of thousands of volts is not dangerous).

0006 Apply knowledge of properties of magnetic fields and electromagnetic induction.

For example:

6.1 Analyze the magnetic force on a moving charge in a uniform magnetic field.

6.2 Demonstrate knowledge of factors that affect the strength of a magnetic field (e.g., analyze how the number of turns of wire can affect the strength of an electromagnet).

6.3 Demonstrate knowledge of how an electric current can produce a magnetic field and how a changing magnetic field can produce an electric current.

6.4 Describe the operation of devices such as electric motors, generators, and transformers.

6.5 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to properties of the magnetic field and electromagnetic induction (e.g., designing an experiment to measure the field of an electromagnet, describing how an electric motor can be modified to act as a generator) and make connections between science, engineering, and daily life (e.g., building an electric motor out of common household objects, analyzing an electrical power generation system).

0007 Apply knowledge of properties of electric circuits.

For example:

7.1 Describe and classify energy sources, storage components, and transfers in electrical devices.

7.2 Describe characteristics of conductors, insulators, and common electrical components (e.g., capacitor, resistor).

7.3 Apply Ohm's law to solve problems.

7.4 Describe characteristics of parallel and series circuits involving resistors.

7.5 Analyze electric circuits and devices in terms of energy or power.

7.6 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to the properties of electric circuits (e.g., identifying applications of resistors, determining the type and power of an electricity source to operate various devices) and make connections between science, engineering, and daily life (e.g., interpreting a plan for the wiring of a residential dwelling, designing a simple circuit for a given purpose).

THERMODYNAMICS, MODERN PHYSICS, WAVES, AND LIGHT

0008 Apply knowledge of principles of thermodynamics.

For example:

8.1 Analyze an investigation or data to determine relationships between energy transferred, type of material, mass of material, and temperature change.

8.2 Solve problems involving thermal expansion, specific heat, and phase changes.

8.3 Demonstrate knowledge of the kinetic theory of matter, including concepts associated with the energy distribution among components of a system.

8.4 Demonstrate knowledge of thermal energy transfer (by conduction, convection, and radiation) and properties of conductors and insulators of thermal energy (e.g., analyze the design of a device that minimizes thermal energy transfer, predict conductance properties of materials similar to known examples).

8.5 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to the principles of thermodynamics (e.g., analyzing a heat engine in terms of efficiency, maximizing volume change of a device based on materials used) and make connections between science, engineering, and daily life (e.g., interpreting the operation of a refrigerator, explaining how a bimetal thermostat functions).

0009 Apply knowledge of fundamental principles of modern and nuclear physics.

For example:

9.1 Demonstrate knowledge of the fundamental concepts of quantum physics (e.g., wave-particle duality, uncertainty principle).

9.2 Demonstrate knowledge of the particle nature of light and the photoelectric effect.

9.3 Demonstrate knowledge of models of the atom and the nucleus.

9.4 Demonstrate knowledge of the fundamental concepts of special relativity (e.g., speed of light is constant, simultaneity, time dilation).

9.5 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to the fundamental principles of modern and nuclear physics (e.g., interpreting the operation of a nuclear power plant, describing red-shift in celestial objects) and make connections between science, engineering, and daily life (e.g., describing application of lasers in medicine, explaining how quantum physics is used in semiconductor technology).

0010 Apply knowledge of properties of waves.

For example:

10.1 Demonstrate knowledge of a simple model of a wave that includes how energy is related to amplitude and frequency.

10.2 Demonstrate knowledge of wave propagation, types of waves, and how waves transfer energy and momentum.

10.3 Solve problems involving wave speed, wave frequency, and wavelength.

10.4 Analyze the reflection, refraction, and constructive and destructive interference of waves.

10.5 Analyze characteristics of mechanical waves, including sound.

10.6 Demonstrate knowledge of how information is transmitted via wave motion.

10.7 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to the properties of waves (e.g., describing basic principles of amplitude modulation, predicting where nodes and antinodes will form in a standing wave system) and make connections between science, engineering, and daily life (e.g., exploring how waves can transmit binary information, analyzing the sound produced by a musical instrument).

0011 Apply knowledge of light and electromagnetic radiation.

For example:

11.1 Demonstrate knowledge of the electromagnetic spectrum and the production and transmission of electromagnetic waves.

11.2 Apply knowledge of light behavior and models (e.g., ray, wave) to describe optical phenomena (e.g., lenses, mirrors, prisms).

11.3 Interpret information related to factors affecting the energy of electromagnetic radiation and how the radiation interacts with matter.

11.4 Recognize applications of electromagnetic waves in information technology.

11.5 Apply knowledge of scientific practices, crosscutting concepts, and engineering practices to light and electromagnetic radiation (e.g., describing the role of electromagnetic radiation in photosynthesis, differentiating between the advantages of AM and FM radio transmitters) and make connections between science, engineering, and daily life (e.g., exploring how optics can be used to correct vision, describing medical applications of X-rays).

CHEMISTRY

0012 Apply knowledge of chemistry concepts.

For example:

12.1 Apply knowledge of predominant historical models of the atom; the experimental techniques used to refine and revise those models; and the properties of elements, including development of the periodic table and basic periodic trends in the elements.

12.2 Distinguish between various forms of matter (i.e., pure substances and mixtures).

12.3 Analyze the various types of chemical bonds (i.e., covalent, ionic, and metallic), predict what types of bonds specific elements will form, and apply general rules of nomenclature.

12.4 Analyze energy transfer during chemical reactions and identify exothermic and endothermic reactions.

12.5 Analyze and identify types of reactions in terms of conservation of mass, energy, and charge; and balance common chemical equations.

12.6 Apply the mole concept and solve basic stoichiometry problems.

12.7 Demonstrate knowledge of solutions, suspensions, and colloids; analyze the acid/base nature of solutions; and predict the extent of dissociation.

BIOLOGY

0013 Apply knowledge of biology concepts.

For example:

13.1 Apply knowledge of the structure of prokaryotic and eukaryotic cells; the function of membranes and organelles; and the processes of photosynthesis and cellular respiration.

13.2 Analyze how bacteria, plants, and animals obtain, store, and use energy, nutrients, and water to maintain homeostasis, including through the use of the levels of biological organization in multicellular organisms.

13.3 Demonstrate knowledge of cellular division and the cell cycle.

13.4 Apply knowledge of the synthesis, structure, and function of nucleic acids; factors controlling gene expression; the processes involved in protein synthesis; and basic methods and applications of genetic engineering (e.g., restriction enzymes, DNA sequencing, recombinant DNA).

13.5 Analyze the patterns and processes of inheritance, including asexual and sexual reproduction.

13.6 Demonstrate knowledge of population genetics and the primary mechanisms of evolution, natural selection, and speciation.

13.7 Analyze how biotic and abiotic factors affect carrying capacity and biodiversity of an ecosystem, population curves, the types of relationships that exist between organisms in communities, and factors that produce change in communities.

13.8 Analyze energy flow and biogeochemical cycling in ecosystems and the trophic roles of organisms in different ecosystems (e.g., food chain, food web).

EARTH SCIENCE

0014 Apply knowledge of Earth science concepts.

For example:

14.1 Demonstrate knowledge of the origin of the universe and the characteristics and life cycles of stars, galaxies, and other objects in the universe.

14.2 Apply knowledge of the characteristics and motions of objects within the solar system and the interactions of the Earth-moon-sun system.

14.3 Demonstrate knowledge of the geologic timescale and dating methods; the structure of Earth's interior and methods used to study it; the evidence for, and causes of, plate tectonics; the rock cycle; and the processes of weathering, erosion, and deposition.

14.4 Apply knowledge of the properties of water, movement of water through the hydrologic cycle, and characteristics of different water reservoirs.

14.5 Demonstrate knowledge of factors of the composition, evolution, and structure of the atmosphere; the processes of energy transfer in the atmosphere; factors that affect weather, climate, and climate change; and the use of weather models, maps, and weather-related technology.

14.6 Demonstrate knowledge of factors that influence the movement of matter through geochemical cycles; types, characteristics, distribution, and management of renewable and nonrenewable resources; and the advantages and disadvantages of different sources of energy.

14.7 Demonstrate knowledge of natural hazards and catastrophic events and their impacts on human populations, the effects of human activities on each of Earth's systems, and strategies for mitigating these effects.