



ORGANIZING THEME/TOPIC

FOCUS STANDARDS & SKILLS

<p>UNIT 1: MOTION</p> <ul style="list-style-type: none">• Distance• Speed vs Velocity• Vectors	<p>HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Constructing Explanations and Designing Solutions: Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• ETS1.C: Optimizing the Design Solution: Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Cause and Effect: Systems can be designed to cause a desired effect.
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<p>UNIT 2: FORCE AND MOTION</p> <ul style="list-style-type: none">• Newton’s Laws of Motion• Balanced and Unbalanced Forces• Friction• Momentum• Acceleration	<p>HS-PS2-1. Analyze data to support the claim that Newton’s second law of motion describes the relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Analyzing and Interpreting Data: Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS2.A: Forces and Motion: Newton’s second law accurately predicts changes in the motion of macroscopic objects. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. <p>HS-PS2-2. Use 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.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Using Mathematics and Computational Thinking: Use mathematical representations of phenomena to describe explanations. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS2.A: Forces and Motion: Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.• PS2.A: Forces and Motion: If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Systems and System Models: When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.
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<p>UNIT 2: FORCE AND MOTION (continued)</p>	<p>HS-PS2-4. Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Using Mathematics and Computational Thinking: Use mathematical representations of phenomena to describe explanations. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS2.B: Types of Interactions: Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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<p>UNIT 3: WORK AND ENERGY</p> <ul style="list-style-type: none">• Kinetic and Potential Energy• Conservation of Energy• Energy Transfer• Simple Machines	<p>HS-PS3-1. 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 and out of the system are known.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Using Mathematics and Computational Thinking: Create a computational model or simulation of a phenomenon, designed device, process, or system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS3.A: Definitions of Energy: Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.• PS3.B: Conservation of Energy and Energy Transfer: Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.• PS3.B: Conservation of Energy and Energy Transfer: Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.• PS3.B: Conservation of Energy and Energy Transfer: Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.• PS3.B: Conservation of Energy and Energy Transfer: The availability of energy limits what can occur in any system. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Systems and System Models: Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
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<p>UNIT 3: WORK AND ENERGY (continued)</p>	<p>HS-PS3-2. 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 position of particles (objects).</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Developing and Using Models: Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS3.A: Definitions of Energy: These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Energy and Matter: Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. <p>HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Constructing Explanations and Designing Solutions: Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS3.A: Definitions of Energy: At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Energy and Matter: Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
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<p>UNIT 3: WORK AND ENERGY (continued)</p>	<p>HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Planning and Carrying Out Investigations: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS3.B: Conservation of Energy and Energy Transfer: Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Systems and System Models: When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
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<p>UNIT 4: ELECTRICITY & MAGNETISM</p> <ul style="list-style-type: none">• Electricity• Magnetism	<p>HS-PS2-5. 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.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Planning and Carrying Out Investigations: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS2.B: Types of Interactions: Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
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<p>UNIT 5: WAVES</p> <ul style="list-style-type: none"> • Wave Characteristics • Electromagnetic Radiation • Sound • Light 	<p>HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Using Mathematics and Computational Thinking: Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS4.A: Wave Properties: The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. <p>HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Engaging in Argument from Evidence: Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS4.B: Electromagnetic Radiation: Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Systems and System Models: Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
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<p>UNIT 5: WAVES (continued)</p>	<p>HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Obtaining, Evaluating, and Communicating Information: Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS4.B: Electromagnetic Radiation When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Cause and Effect: Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. <p>HS-PS4-5. 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.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Obtaining, Evaluating, and Communicating Information: Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS4.B: Electromagnetic Radiation Photoelectric materials emit electrons when they absorb light of a high-enough frequency. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Cause and Effect: Systems can be designed to cause a desired effect.
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<p>UNIT 6: ATOMS AND THE PERIODIC TABLE</p> <ul style="list-style-type: none">• Properties of Matter• States of Matter• Atomic Structure• Periodic Table• Isotopes• Electron Configuration	<p>HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Developing and Using Models: Use a model to predict the relationships between systems or between components of a system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS1.A: Structure and Properties of Matter: Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.• PS1.A: Structure and Properties of Matter: The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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<p>UNIT 7: FORMULAS AND BONDING</p> <ul style="list-style-type: none"> • Nature of Compounds • Types of Bonds • Naming and Writing Formulas for Ionic and Molecular Compounds 	<p>HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Developing and Using Models: Use a model to predict the relationships between systems or between components of a system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS1.A: Structure and Properties of Matter: Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • PS1.A: Structure and Properties of Matter: The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. <p>HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none"> • Planning and Carrying Out Investigations: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none"> • PS1.A: Structure and Properties of Matter: The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. <p>Crosscutting Concept(s):</p> <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none"> • Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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<p>UNIT 8: CHEMICAL REACTIONS</p> <ul style="list-style-type: none">• Nature of a Chemical Reaction• Energy in Chemical Reactions• Balancing Chemical Equations• Types of Chemical Reactions• Rates of Reactions• Introduction to Stoichiometry	<p>HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Developing and Using Models: Develop a model based on evidence to illustrate the relationships between systems or between components of a system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS1.B: Chemical Reactions: Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Energy and Matter: Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. <p>HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Constructing Explanations and Designing Solutions: Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS1.B: Chemical Reactions: Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
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UNIT 8: CHEMICAL REACTIONS
(continued)

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*

Science & Engineering Practice(s):

- **Constructing Explanations and Designing Solutions:** Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Disciplinary Core Idea(s):

- **PS1.B: Chemical Reactions:** In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

Crosscutting Concept(s):

- **Stability and Change:** Much of science deals with constructing explanations of how things change and how they remain stable.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Science & Engineering Practice(s):

- **Using Mathematics and Computational Thinking:** Use mathematical representations of phenomena to support claims.

Disciplinary Core Idea(s):

- **PS1.B: Chemical Reactions:** The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Crosscutting Concept(s):

- **Energy and Matter:** The total amount of energy and matter in closed systems is conserved.

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<p>UNIT 9: TYPES OF INTERACTIONS</p> <ul style="list-style-type: none">• Components of Solutions• Water• Polarity• Solubility• Factors Affecting Solubility• Molarity• Definition of acid and base• pH scale• Neutralization Reaction	<p>HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Developing and Using Models: Use a model to predict the relationships between systems or between components of a system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS2.B: Types of Interactions: Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. <p>HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Planning and Carrying Out Investigations: Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS2.B: Types of Interactions: Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Patterns: Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena
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UNIT 9: TYPES OF INTERACTIONS (continued)	HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. Science & Engineering Practice(s): <ul style="list-style-type: none">• Obtaining, Evaluating, and Communicating Information: Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). Disciplinary Core Idea(s): <ul style="list-style-type: none">• PS2.B: Types of Interactions: Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. Crosscutting Concept(s): <ul style="list-style-type: none">• Structure and Functions: Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
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<p>UNIT 10: NUCLEAR PROCESSES</p> <ul style="list-style-type: none">• Nuclear Decay• Fission and Fusion• Uses of Nuclear Energy	<p>HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.</p> <p>Science & Engineering Practice(s):</p> <ul style="list-style-type: none">• Developing and Using Models: Develop a model based on evidence to illustrate the relationships between systems or between components of a system. <p>Disciplinary Core Idea(s):</p> <ul style="list-style-type: none">• PS1.C Nuclear Processes: Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. <p>Crosscutting Concept(s):</p> <ul style="list-style-type: none">• Energy and Matter: In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
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