Accelerated Science Course Pathway

Physical Science - Integrated

2016

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Notes:

1. This is a companion document and instructors are to use the Arkansas K-12 Science Standards for Grades 5-8 document to guide curriculum development.
2. Student Performance Expectations (PEs) or standards may be taught in any sequence or grouping within a grade level. Several PEs are described as being "partially addressed in this course" because the same PE is revisited in a subsequent course during which that PE is fully addressed.
3. An asterisk (*) indicates an engineering connection to a practice, core idea, or crosscutting concept.
4. The clarification statements are examples and additional guidance for the instructor. AR indicates Arkansas-specific clarification statements.
5. The assessment boundaries delineate content that may be taught but not assessed in large-scale assessments. AR indicates Arkansas-specific assessment boundaries.
6. The examples given (e.g.,) are suggestions for the instructor.

Accelerated Science Course Pathway Overview

Arkansas Accelerated Science Course Pathway allows districts and schools an **option** to maximize opportunities for high-performing students to meet the Arkansas K-12 Science Standards as well as be prepared to pursue advanced level science courses earlier in middle and high school and at a more rapid pace. This accelerated science course pathway is not intended for all students, but for students who have demonstrated advanced academic proficiency in the prerequisite courses and who intend to pursue a specific college and career pathway beyond high school. Science is a quantitative discipline, so it is important for educators to ensure that students' science learning coheres well with their understanding of mathematics. To achieve this alignment, the Arkansas K-12 Science Committee made every effort to ensure that the mathematics standards do not outpace or misalign to the accelerated pathway courses. If this pathway is implemented, it is recommended that a unit of algebra I be earned concurrently with a unit of accelerated physical science-integrated, which requires a Grades 5-8 course approval for both the algebra I and the accelerated physical science-integrated course from the Arkansas Department of Education. Arkansas Accelerated Science Course Pathway details the following optional accelerated courses.

Accelerated Grade 6 Science	Course is an integration of 6th, 7th, and 8th Grade life science, Earth and space science, physical science, and engineering design standards.
Accelerated Grade 7 Science	Course is an integration of 6th, 7th, and 8th Grade life science, Earth and space science, physical science, and engineering design standards.
Accelerated Grade 8/Physical Science - Integrated	Course is an integration of the balance of 8th Grade physical science standards not mapped in the accelerated 6th and 7th Grade models and the high school physical science - integrated standards. *(5-8 course approval for physical science- integrated required)
Accelerated Biology - Integrated	Course is an integration of the biology - integrated standards with additional life science standards and clarification statements written by the Arkansas K-12 Science Committee.
Accelerated Chemistry - Integrated	Course is an integration of the chemistry - integrated course standards with additional chemistry standards and clarification statements written by the Arkansas K-12 Science Committee.

* A course approval for Grades 5-8 is necessary for a high school course to be taught at the middle school level. Teachers must hold the appropriate 7-12 licensure. Contact the ADE Curriculum Support Services unit for more details.

Key: Indicates from which course the standards was originally assigned.	
Physical Science - Integrated	(yellow)
Grade 8	(red)
Physical Science - Integrated Engineering Design	(white)

Accelerated Physical Science - Integrated

Topic 1: Elements, Matter, and Interactions
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Topic 5: Human Impacts
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PSI5-ETS1-3
APSI5-ETS1-4

Accelerated Physical Science - Integrated

Topic 1: Elements, Matter, and Interaction	
Students who demonstrate understanding can:	
APSI-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.** [AR Clarification Statement: This PE is partially addressed in this course. Examples of properties that could be predicted from patterns could include types of bonds (ionic & covalent) formed, numbers of bonds formed, and hydrogen bonds in water.] [Assessment Boundary: Assessment is limited to main group elements.]
APSI-PS1-2	**Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** [AR Clarification Statement: This PE is partially addressed in this course. Examples could include recognizing patterns to identify types of chemical reactions, such as, combustion, single replacement, double replacement, decomposition and synthesis.] [Assessment Boundary: Assessment does not include predicting chemical products.]
APSI-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.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on understanding of the strengths of forces between particles including hydrogen bonding in water. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [AR Assessment Boundary: Assessment limited to materials of same states of matter.]
APSI-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.** [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]
APSI-PS1-7	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on demonstrating conservation of atoms through balancing chemical equations and assessing students' use of mathematical thinking, not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include the mole concept or complex chemical reactions.]
APSI-ESS2-7	**Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on identifying and describing the evidence for simultaneous co-evolution and the causes, effects, and feedbacks between the biosphere and Earth's other systems. Geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Physical Science - Integrated.	

Accelerated Physical Science - Integrated

Topic 2: Forces and Motion	
Students who demonstrate understanding can:	
A8-PS2-1	**Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*** [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]
A8-PS2-2	**Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.][Assessment Boundary: Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]
A8-PS3-1	**Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.** [AR Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sized rocks downhill, or getting hit by a plastic ball versus a tennis ball.]
A8-PS3-2	**Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.** [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include changing the direction/orientation of a magnet, a balloon with static electrical charge being brought closer to a classmate's hair, and the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves. Examples of models could include representations, diagrams, pictures, or written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]
APSI-PS2-1	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis on qualitative analysis of data. Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [AR Assessment Boundary: Assessment is limited to qualitative analysis of one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]
APSI-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.*** [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]
APSI-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.** [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]
APSI-PS2-6	**Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific

	receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]
APSI2-ETS1-1	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** [AR Clarification Statement: Examples of global challenges could be energy distribution, protective sports equipment, and transportation safety designs (automobile safety and shipping/packing materials).]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards f or Grade 8 and Physical Science - Integrated.	

Topic 3: Energy
Students who demonstrate understanding can: **A8-PS2-3** **Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.** [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.] **A8-PS2-5** **Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.** [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.] **APSI-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.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on explaining the meaning of mathematical expressions used in the model.] [AR Assessment Boundary: Assessment is limited to basic algebraic expressions or computations. **APSI-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).** [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] [AR Assessment Boundary: Assessment is limited to mechanical energy.] **APSI-PS3-3** **Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*** [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.] **APSI-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).** [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.] **APSI-ESS1-5** **Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.** [AR Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal (continental and oceanic) rocks. Examples could include evidence of the ages of oceanic crust (lithosphere that includes crust and upper mantle and the asthenosphere) increasing with distance from mid-ocean ridges (a result of divergent boundaries/plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).] **APSI3-ETS1-3** **Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-**

	offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Examples could include building and evaluating wind turbines, solar cells, solar ovens, and generators.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8 and Physical Science - Integrated.	

Topic 4: Waves	
Students who demonstrate understanding can:	
A8-PS4-1	**Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.** [Clarification Statement: Emphasis is on describing waves applying both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]
A8-PS4-2	**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]
A8-PS4-3	**Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.** [Clarification Statement: Emphasis is on the basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in Wi-Fi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]
APSI-PS4-1	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [AR Clarification Statement: This PE is partially addressed in this course. Examples of data could include seismic waves and sound waves traveling through air and water.] [AR Assessment Boundary: Assessment is limited to describing relationships qualitatively.]
APSI-PS4-2	**Evaluate questions about the advantages of using a digital transmission and storage of information.** [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]
APSI4-ETS1-2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** [AR Clarification Statement: Examples of possible problems could be cell phone reception, emergency radio transmission, and earthquake notification.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8 and Physical Science - Integrated.	

Topic 5: Interactions of Humans and the Environment	
Students who demonstrate understanding can:	
APSI-LS2-7	**Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*** [AR Clarification Statement: This PE is partially addressed in this course. Examples of human activities could include urbanization, fracking, greenhouse gases and dams. [AR Assessment Boundary: Assessment is to include student choice from multiple scenarios.]
APSI-LS4-5	**Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on physical changes to the environment (temperature change and acidification).]
APSI-ESS2-1	**Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.** [AR Clarification Statement: Emphasis is on how the appearance of land features (mountains, valleys, and plateaus) and sea floor features (trenches, ridges, and seamounts) are a result of both constructive forces (volcanism, tectonic uplift, and orogeny) and destructive mechanisms (weathering, mass wasting, and coastal erosion).
APSI-ESS3-1	**Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on key natural resources. Examples could include access to fresh water (rivers, lakes, and groundwater), regions of fertile soils (river deltas) and high concentrations of minerals and fossil fuels. Examples of natural hazards could be from interior processes (volcanic eruptions), surface processes (tsunamis, mass wasting, and soil erosion), and severe weather (hurricanes, floods, and droughts). Examples of the results of changes in climate that could affect populations or drive mass migrations include changes to sea level and regional patterns of temperature and precipitation.]
APSI-ESS3-2	**Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on identifying possible problems to be solved (conservation, recycling, and on minimizing impacts).]
APSI5-ETS1-1	**Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** [AR Clarification Statement: Examples could include research and analysis of the spread of zebra mussels, decline of chestnut trees, and the impact of fracking.]
APSI5-ETS1-2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** [AR Clarification Statement: Examples of design challenges could include solving man-made erosion problems, reducing thermal/light pollution, and safe disposal of fracking waste fluids.]
APSI5-ETS1-3	**Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** [AR Clarification Statement: Examples could be the environmental effects of certain plastics (cost, safety, biodegradability, and recyclability) and evaluating the tradeoffs for each source of energy production.]
APSI5-ETS1-4	**Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification Statement: Examples of possible computer simulation resources could include PhET, ArcGIS, and InTeGrate-SERC.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Physical Science - Integrated.	