Arizona Science Standards - High School Essential Standards

Physical Science Standards	
HS.P1U1.1	Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the Periodic Table and describe how these models are revised with new evidence.
HS.P1U1.2	Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
HS.P1U1.3	Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors.
HS.P1U3.4	Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.
HS.P2U1.5	Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).
HS.P3U1.6	Collect, analyze, and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws.
HS.P3U2.7	Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.
HS.P4U1.8	Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings.
HS.P4U3.9	Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.
HS.P4U1.10	Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.

Earth and Space Science Standards	
HS.E1U1.11	Analyze and interpret data to determine how energy from the Sun affects weather patterns and climate.
HS.E1U1.12	Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).
HS.E1U1.13	Evaluate explanations and theories about the role of energy and matter in geologic changes over time.
HS.E1U3.14	Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other.
HS.E2U1.15	Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.
HS.E2U1.16	Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings.
HS.E2U1.17	Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.

Life Science Standards	
HS.L2U3.18	Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.
HS.L2U1.19	Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.
HS.L1U1.20	Ask questions and/or make predictions based on observations and evidence to demonstrate how cellular organization, structure, and function allow organisms to maintain homeostasis.
HS.L2U1.21	Obtain, evaluate, and communicate data showing the relationship of photosynthesis and cellular respiration; flow of energy and cycling of matter.
HS.L1U1.22	Construct an explanation for how cellular division (mitosis) is the process by which organisms grow and maintain complex, interconnected systems.
HS.L1U3.23	Obtain, evaluate, and communicate the ethical, social, economic and/or political implications of the detection and treatment of abnormal cell function.
HS.L3U1.24	Construct an explanation of how the process of sexual reproduction contributes to genetic variation.
HS.L3U1.25	Obtain, evaluate, and communicate information about the causes and implications of DNA mutation.
HS.L3U3.26	Engage in argument from evidence regarding the ethical, social, economic, and/or political implications of a current genetic technology.
HS.L4U1.27	Obtain, evaluate, and communicate evidence that describes how changes in frequency of inherited traits in a population can lead to biological diversity.
HS.L4U1.28	Gather, evaluate, and communicate multiple lines of empirical evidence to explain the mechanisms of biological evolution.

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Arizona Science Standards - High School Physical Science Essential and Plus Standards

Physical Science Standards: Chemistry	
HS.P1U1.1	Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the Periodic Table and describe how these models are revised with new evidence.
HS+C.P1U1.1	Develop and use models to demonstrate how changes in the number of subatomic particles (protons, neutrons, electrons) affect the identity, stability, and properties of the element.
HS+C.P1U1.2	Obtain, evaluate, and communicate the qualitative evidence supporting claims about how atoms absorb and emit energy in the form of electromagnetic radiation.
HS+C.P1U1.3	Analyze and interpret data to develop and support an explanation for the relationships between kinetic molecular theory and gas laws.
HS.P1U1.2	Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.
HS.P1U1.3	Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors.
HS+C.P1U1.4	Develop and use models to predict and explain forces within and between molecules.
HS+C.P1U1.5	Plan and carry out investigations to test predictions of the outcomes of various reactions, based on patterns of physical and chemical properties.
HS+C.P1U1.6	Construct an explanation, design a solution, or refine the design of a chemical system in equilibrium to maximize production.
HS+C.P1U1.7	Use mathematics and computational thinking to determine stoichiometric relationships between reactants and products in chemical reactions.

Physical Science Standards: Chemistry	
HS.P1U3.4	Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.
HS+C.P1U3.8	Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of fission, fusion, and radioactive decay.
Physical Science Standards: Physics	
HS.P2U1.5	Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).
HS+Phy.P2U1.1	Plan and carry out investigations to design, build, and refine a device that works within given constraints to demonstrate that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
HS.P3U1.6	Collect, analyze, and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws.
HS+Phy.P3U1.2	Develop and use mathematical models of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic forces between objects.
HS+Phy.P3U1.3	Develop a mathematical model, using Newton's laws, to predict the motion of an object or system in two dimensions (projectile and circular motion).
HS+Phy.P3U1.4	Engage in argument from evidence regarding the claim that the total momentum of a system is conserved when there is no net force on the system.

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Physical Science Standards	
HS.P3U2.7	Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.
HS.P4U1.8	Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings.
HS.P4U3.9	Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.
HS+Phy.P4U1.6	Analyze and interpret data to quantitatively describe changes in energy within a system and/or energy flows in and out of a system.
HS+Phy.P4U2.7	Design, evaluate, and refine a device that works within given constraints to transfer energy within a system.
HS+Phy.P4U1.8	Use mathematics and computational thinking to explain the relationships between power, current, voltage, and resistance.
HS.P4U1.10	Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.

Essential standards are standards that will be assessed on the state exam and are intended for ALL students to have learned by the end of 3 credits of high school science courses.

Physical Science Plus (+) Standards HS+P are supporting standards designed to be used with the essential standards for students taking a high school physics (P) course. Standards HS+C are supporting standards designed to be used with the essential standards for students taking a high school chemistry (C) course.

Arizona Science Standards - High School Essential Standards and Elements

Physical Science Standards

HS.P1U1.1 Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the Periodic Table and describe how these models are revised with new evidence.

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- 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.

HS.P1U1.2 Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes.

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- The opposite electric charges of protons and electrons attract each other, keeping atoms together and accounting for the formation of some compounds.

HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors.

- 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, that are matched by changes in kinetic energy

HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.

- There are disadvantages as well as advantages to some technological products. Although the use of some artificial materials may mean less demand on scarce natural ones, many new materials do not degrade as do natural materials, presenting a waste disposal problem when discarded.

Physical Science Standards

HS.P2U1.5 Construct an explanation for a field's strength and influence on an object (electric, gravitational, magnetic).

- Gravity, electric and magnetic interactions can be described in terms of fields.
- 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.
- 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.

HS.P3U1.6 Collect, analyze, and interpret data regarding the change in motion of an object or system in one dimension, to construct an explanation using Newton's Laws.

- Newton's second law accurately predicts changes in the motion of macroscopic objects.
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.
- Within an isolated system of interacting objects, any change in momentum of one object is balanced by an equal and oppositely directed change in the total momentum of the other objects. Thus total momentum is a conserved quantity.
- 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.

Clarification Statement: 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, and object rolling down a ramp, or a moving object being pulled by a constant force. Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.

The elements are not to be used as a check-off list, but rather a useful tool to help educators identify the specific pieces of knowledge and skill that make up the practice, crosscutting concept, or core idea at that grade-band.

Physical Science Standards

HS.P3U2.7 Use mathematics and computational thinking to explain how Newton's laws are used in engineering and technologies to create products to serve human ends.

- Interactions between any two objects can cause changes in one or both of them. An understanding of the forces between objects is important for describing how their motions change, as well as for predicting stability or instability in systems at any scale.

HS.P4U1.8 Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings.

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.
- 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.
- Energy cannot be created or destroyed. When energy is transferred from one object to others the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain.

HS.P4U3.9 Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.

- The availability of energy limits what can occur in any system.
- Although energy cannot be destroyed, it can be converted to less useful forms - for example, to thermal energy in the surrounding environment.
- Across the world, the demand for energy increases as human populations grow and because modern lifestyles require more energy, particularly in the convenient form of electrical energy. Ways of generating electricity have to be sought, while reducing demand and improving the efficiency of the processes in which we use it.

HS.P4U1.10 Construct an explanation about the relationships among the frequency, wavelength, and speed of waves traveling in various media, and their applications to modern technology.

- 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.
- Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

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