Louisiana Believes

Crosswalk for Louisiana Student Standards for Science and NGSS: Physical Science

This document provides guidance to assist teachers, schools, and systems with determining alignment to Louisiana Student Standards for Science for resources designed for the Next Generation Science Standards. This guidance document is considered a "living" document, as we believe that teachers and other educators will find ways to improve the document as they use it. Please send feedback to STEM@la.gov so that we may use your input when updating this guide.

Updated August 25, 2021

DEPARTMENT of EDUCATION
Louisiana Believes

<table>
<tr><th>MATTER AND ITS INTERACTIONS</th><th>HS-PS1-1</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">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 and the composition of the nucleus of atoms.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Examples of properties that could be predicted from patterns could include metals, nonmetals, metalloids, number of valence electrons, types of bonds formed, or atomic mass. Emphasis is on main group elements.</td><td>Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen. Limited to main group elements. Does not include quantitative understanding of ionization energy beyond relative trends.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Developing and using models</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Structure and properties of matter</td></tr>
<tr><td colspan="2">Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS.PS1A.a)
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.PS1A.b)</td></tr>
<tr><td></td><td>Types of interactions</td></tr>
<tr><td colspan="2">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.(HS.PS2B.c)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Patterns</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

Underlined sections denote* ***information that does not appear* *in the LSSS for Physical Science.*

<table>
<tr><th>MATTER AND ITS INTERACTIONS</th><th>HS-PS1-2</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="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.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis, decomposition, single displacement, double displacement, and acid-base).</td><td>Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen. Limited to chemical reactions involving main group elements and combustion reactions.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Constructing explanations and designing solutions</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Structure and properties of matter</td></tr>
<tr><td colspan="2">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.PS1A.b)</td></tr>
<tr><td></td><td>Chemical Reactions</td></tr>
<tr><td colspan="2">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. (HS.PS1B.c)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Patterns</td></tr>
<tr><td colspan="2">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.</td></tr>
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<table>
<tr><th>MATTER AND ITS INTERACTIONS</th><th>HS-PS1-7</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Emphasis is on using mathematical ideas to communicate the relationship between masses of reactants and products as well as balancing chemical equations.</td><td>Emphasis is on using mathematical ideas as they relate to stoichiometry to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students’ use of mathematical thinking and not on memorization and rote application of problem-solving techniques.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Using mathematics and computational thinking</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Chemical reactions</td></tr>
<tr><td colspan="2">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. (HS.PS1B.c)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Energy and matter</td></tr>
<tr><td colspan="2">The total amount of energy and matter in closed systems is conserved.</td></tr>
</table>

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<table>
<tr><th colspan="2">MATTER AND ITS INTERACTIONS HS-PS1-8</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">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.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Emphasis is only on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations. Radioactive decay focus is on its relationship to half-life.</td><td>Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations. Does not include quantitative calculation of energy released. Emphasis is on alpha, beta, and gamma radioactive decays.</td></tr>
<tr><td colspan="2">Science and Engineering Practice: Developing and using models</td></tr>
<tr><td colspan="2">Disciplinary Core Ideas: Nuclear processes</td></tr>
<tr><td colspan="2">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. (HS.PS1C.a)</td></tr>
<tr><td colspan="2">Crosscutting Concepts: Energy and matter</td></tr>
<tr><td colspan="2">In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.</td></tr>
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MOTION AND STABILITY: FORCES AND INTERACTIONS **HS-PS2-1**

LSSS	**NGSS**

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.

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, an object rolling down a ramp, or a moving object being pulled by a constant force. Emphasis is on one-dimensional motion to macroscopic objects moving at non-relativistic speeds.

Science and Engineering Practice: Analyzing and interpreting data

Disciplinary Core Ideas: Forces and motion

Newton’s second law accurately predicts changes in the motion of macroscopic objects. (HS.PS2.A.a)

Crosscutting Concepts: Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

<table>
<tr><th>MOTION AND STABILITY: FORCES AND INTERACTIONS</th><th>HS-PS2-2</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="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.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Emphasis is on calculating momentum and the qualitative meaning of conservation of momentum.</td><td>Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle. Limited to systems of two macroscopic bodies moving in one dimension.</td></tr>
<tr><td>**Science and Engineering Practice:**</td><td>Using mathematics and computation thinking</td></tr>
<tr><td>**Disciplinary Core Ideas:**</td><td>Forces and motion</td></tr>
<tr><td>Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved. (HS.PS2A.b)</td><td>Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.</td></tr>
<tr><td colspan="2">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. (HS.PS2A.c)</td></tr>
<tr><td>**Crosscutting Concepts:**</td><td>Systems and system models</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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<table>
<tr><th>MOTION AND STABILITY: FORCES AND INTERACTIONS</th><th>HS-PS2-3</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Examples of evaluation and refinement could include determining the success of a device at protecting an object from damage such as, but not limited to, impact resistant packaging and modifying the design to improve it. Emphasis is on qualitative evaluations.</td><td>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. Limited to qualitative evaluations and/or algebraic manipulations.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Constructing explanations and designing solutions</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Forces and motion</td></tr>
<tr><td colspan="2">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. (HS.PS2A.c)</td></tr>
<tr><td></td><td>Defining and delimiting engineering problems</td></tr>
<tr><td colspan="2">Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS.ETS1A.a)
Screen reader support enabled.</td></tr>
<tr><td></td><td>Optimizing the design solution</td></tr>
<tr><td colspan="2">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. (HS.ETS1C.a)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Cause and Effect</td></tr>
<tr><td colspan="2">Systems can be designed to cause a desired effect.</td></tr>
</table>

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MOTION AND STABILITY: FORCES AND INTERACTIONS	**HS-PS2-5**
LSSS	**NGSS**
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.	
Clarification Statement	
Emphasis is on designing and conducting investigations including evaluating simple series and parallel circuits. Qualitative evidence is used to explain the relationship between a current-carrying wire and a magnetic compass. Screen reader support enabled.	Limited to designing and conducting investigations with provided materials and tools.
Science and Engineering Practice:	Planning and carrying out investigations
Disciplinary Core Ideas:	Types of interactions
Forces that act over 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.PS2B.b)	
	Definitions of energy
“Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. (HS.PS3A.d)	
Crosscutting Concepts:	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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<table>
<tr><th>ENERGY</th><th>HS-PS3-2</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="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 motion of particles (objects) and energy associated with the relative positions of particles (objects).</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Examples of phenomena at the macroscopic scale could include the conversion of potential energy to kinetic and thermal energy. Examples of models could include diagrams, drawings, descriptions, and computer simulations.</td><td>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.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Developing and using models</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Definitions of energy</td></tr>
<tr><td colspan="2">Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. There is a single quantity called energy. 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. (HS.PS3A.a)
At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b)
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. (HS.PS3A.c)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Energy and matter</td></tr>
<tr><td colspan="2">Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.</td></tr>
</table>

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ENERGY	**HS-PS3-3**
LSSS	**NGSS**
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 qualitative evaluations of devices. Constraints could include use of renewable energy forms and efficiency. Emphasis is on devices constructed with teacher approved materials. Examples of devices can be drawn from chemistry or physics clarification statements below.	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. Limited to devices constructed with materials provided to students.
Science and Engineering Practice:	Constructing explanations and designing solutions
Disciplinary Core Ideas:	Definitions of energy
At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b)	
	Energy in chemical processes
Although energy cannot be destroyed, it can be converted to other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)	
	Defining and delimiting engineering problems
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS.ETS1A.a)	
Crosscutting Concepts:	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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<tr><th>ENERGY</th><th>HS-PS3-4</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td colspan="2">Clarification Statement</td></tr>
<tr><td>Emphasis is on analyzing data from student investigations and using mathematical thinking appropriate to the subject to describe the energy changes quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.</td><td>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.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Planning and carrying out Investigations</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Conservation of energy and energy transfer</td></tr>
<tr><td colspan="2">Energy cannot be created or destroyed, but it can be transported from one place to another, transformed into other forms, and transferred between systems. (HS.PS3B.b) 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). (HS.PS3B.e)</td></tr>
<tr><td>Energy in chemical processes and everyday life</td><td>Energy in chemical processes</td></tr>
<tr><td colspan="2">Although energy cannot be destroyed, it can be converted to less useful other forms—for example, to thermal energy in the surrounding environment. (HS.PS3D.a)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Systems and models</td></tr>
<tr><td colspan="2">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.</td></tr>
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<tr><td>**ENERGY**</td><td>**HS-PS3-5**</td></tr>
<tr><td>**LSSS**</td><td>**NGSS**</td></tr>
<tr><td colspan="2">Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</td></tr>
<tr><td colspan="2">**Clarification Statement**</td></tr>
<tr><td>Examples of models could include drawings, diagrams, simulations and texts, such as what happens when two charged objects or two magnetic poles are near each other.</td><td>Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.</td></tr>
<tr><td>**Science and Engineering Practice:**</td><td>Developing and using models</td></tr>
<tr><td>**Disciplinary Core Ideas:**</td><td>Relationship between energy and forces</td></tr>
<tr><td colspan="2">When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS.PS3C.a)</td></tr>
<tr><td>**Crosscutting Concepts:**</td><td>Cause and Effect</td></tr>
<tr><td colspan="2">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.</td></tr>
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<table>
<tr><th colspan="2">WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER — HS-PS4-1</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Emphasis is on describing waves both qualitatively and quantitatively. Qualitative focus includes standard repeating waves and transmission/absorption of electromagnetic waves/radiation.</td><td>Examples of data could include electromagnetic radiation traveling through a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth. Emphasis is on algebraic relationships and describing those relationships qualitatively.</td></tr>
<tr><td>Science and Engineering Practice:</td><td>Using mathematical and computational thinking</td></tr>
<tr><td>Disciplinary Core Ideas:</td><td>Wave properties</td></tr>
<tr><td colspan="2">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. (HS.PS4A.a)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Cause and effect</td></tr>
<tr><td colspan="2">Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td></tr>
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<tr><th>WAVES AND THEIR APPLICATIONS IN TECHNOLOGIES FOR INFORMATION TRANSFER</th><th>HS-PS4-4</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias. Emphasis is on qualitative descriptions.</td><td>Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.</td></tr>
<tr><th>Science and Engineering Practice:</th><td>Obtaining, evaluating, and communicating information</td></tr>
<tr><th>Disciplinary Core Ideas:</th><td>Nuclear processes</td></tr>
<tr><td colspan="2">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. (HS.PS4B.b)</td></tr>
<tr><th>Crosscutting Concepts:</th><td>Energy and matter</td></tr>
<tr><td colspan="2">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.</td></tr>
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