Louisiana Believes

# Crosswalk for Louisiana Student Standards for Science and NGSS: Chemistry

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 24, 2021

DEPARTMENT of EDUCATION
Louisiana Believes

| **MATTER AND ITS INTERACTIONS** | **HS-PS1-1** |
|---|---|
| **LSSS** | **NGSS** |
| 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. | |
| **Clarification Statement** | |
| Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, <u>atomic radius, atomic mass, or</u> reactions with oxygen. <u>Emphasis is on main group elements and qualitative understanding of the relative trends of ionization energy and electronegativity.</u> | 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. |
| **Science and Engineering Practice:** | Developing and using models |
| **Disciplinary Core Ideas:** | 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. (HS.PS1A.a)<br><br>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) | |
| | 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.(HS.PS2B.c) | |
| **Crosscutting Concepts:** | 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. | |

**Underlined sections denote* ***additional information*** *included in the Louisiana Student Standards for Science.*

| MATTER AND ITS INTERACTIONS | HS-PS1-2 |
|---|---|
| **LSSS** | **NGSS** |
| 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. | |
| **Clarification Statement** | |
| Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, or carbon and hydrogen. <u>Reaction classification aids in the prediction of products (e.g. synthesis, decomposition, single displacement, double displacement, and acid-base).</u> | 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. |
| **Science and Engineering Practice:** | Constructing explanations and designing solutions |
| **Disciplinary Core Ideas:** | 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. (HS.PS1A.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. (HS.PS1B.c) | |
| **Crosscutting Concepts:** | 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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| MATTER AND ITS INTERACTIONS | HS-PS1-3 |
|---|---|
| **LSSS** | **NGSS** |
| Plan and conduct an investigation to gather evidence to compare the structure of substances at the macroscale to infer the strength of electrical forces between particles. | 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. |
| **Clarification Statement** | |
| Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and network solids (such as graphite). Examples of macro-properties of substances could include the melting point and boiling point, vapor pressure, and surface tension. | Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and network materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension. |
| **Science and Engineering Practice:** | Planning and carrying out investigations |
| **Disciplinary Core Ideas:** | Structure and properties of matter |
| The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. (HS.PS1A.c) | The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. |
| | 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. (secondary) (HS.PS2B.c) | |
| **Crosscutting Concepts:** | 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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| MATTER AND ITS INTERACTIONS | HS-PS1-4 |
|---|---|
| **LSSS** | **NGSS** |
| 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. | |
| **Science and Engineering Practice:** | Developing and using models |
| **Disciplinary Core Ideas:** | Structure and properties of matter |
| A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS.PS1A.d) | |
| | 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. (HS.PS1B.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. | |

| MATTER AND ITS INTERACTIONS | HS-PS1-5 |
|---|---|
| **LSSS** | **NGSS** |
| 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. | |
| **Clarification Statement** | |
| Student reasoning should focus on the number and energy of collisions between molecules. Emphasis is on simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature. | |
| **Science and Engineering Practice:** | Constructing explanations and designing solutions |
| **Disciplinary Core Ideas:** | 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. (HS.PS1B.a) | |
| **Crosscutting Concepts:** | 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. | |

| MATTER AND ITS INTERACTIONS | HS-PS1-6 |
|---|---|
| **LSSS** | **NGSS** |
| Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. | |
| **Clarification Statement** | |
| Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products. | |
| **Science and Engineering Practice:** | Constructing explanations and designing solutions |
| **Disciplinary Core Ideas:** | 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. (HS.PS1B.b) | |
| | 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. (secondary) (HS.ETS1C.a) | |
| **Crosscutting Concepts:** | Stability and change |
| Much of science deals with constructing explanations of how things change and how they remain stable. | |

<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 colspan="2">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><th>Science and Engineering Practice:</th><td>Using mathematics and computational thinking</td></tr>
<tr><th>Disciplinary Core Ideas:</th><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><th>Crosscutting Concepts:</th><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>

| MATTER AND ITS INTERACTIONS | HS-PS1-8 |
|---|---|
| **LSSS** | **NGSS** |
| 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. | |
| **Clarification Statement** | |
| 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. Emphasis is on alpha, beta, and gamma radioactive decays. | 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. |
| **Science and Engineering Practice:** | Developing and using models |
| **Disciplinary Core Ideas:** | Nuclear processes |
| Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.<br>The total number of neutrons plus protons does not change in any nuclear process. (HS.PS1C.a) | |
| **Crosscutting Concepts:** | Energy and matter |
| In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. | |

**Underlined sections denote information that* ***does not appear*** *in the Louisiana Student Standards for Science.*

| MOTION AND STABILITY: FORCES AND INTERACTIONS | HS-PS2-6 |
|---|---|
| **LSSS** | **NGSS** |
| Communicate scientific and technical information about why the atomic-level, subatomic-level, and/or molecular level structure is important in the functioning of designed materials. | 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, fireworks and neon signs are made of certain elements, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors. | 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. |
| **Science and Engineering Practice:** | Obtaining, evaluating, and communicating information |
| **Disciplinary Core Ideas:** | Structure and properties of matter |
| The structure and interactions of matter at the macro scale are determined by electrical forces within and between atoms. (HS.PS1A.c) | NONE PROVIDED |
| | 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. (HS.PS2B.c) | |
| | Electromagnetic radiation |
| Photoelectric materials emit electrons when they absorb light of a high-enough frequency. (HS.PS4B.c) Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (HS.PS4B.d) | NONE PROVIDED |
| **Crosscutting Concepts:** | Structure and function |
| 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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<table>
<tr><th>ENERGY</th><th>HS-PS3-1</th></tr>
<tr><th>LSSS</th><th>NGSS</th></tr>
<tr><td colspan="2">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.</td></tr>
<tr><th colspan="2">Clarification Statement</th></tr>
<tr><td>Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations, systems of two or three components, and thermal energy.</td><td>Emphasis is on explaining the meaning of mathematical expressions used in the model. Focus is on basic algebraic expression or computations, systems of two or three components, and thermal energy, <u>kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.</u></td></tr>
<tr><td>Science and Engineering Practice:</td><td>Using mathematics and computational thinking</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. 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. (HS.PS3A.a)</td></tr>
<tr><td></td><td>Conservation of energy and energy transfer</td></tr>
<tr><td colspan="2">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. (HS.PS3B.a)<br>Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS.PC3B.b)</td></tr>
<tr><td>Mathematical expressions <u>allow the concept of conservation of energy to be used to predict and describe system behavior.</u> <u>These expressions</u> 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 <u>velocity</u>. (HS.PC3B.c)</td><td>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, <u>allow the concept of conservation of energy to be used to predict and describe system behavior.</u></td></tr>
<tr><td colspan="2">The availability of energy limits what can occur in any system. (HS.PC3B.d)</td></tr>
<tr><td>Crosscutting Concepts:</td><td>Systems and system models</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

**Underlined sections denote ***information*** that does not appear in both sets of standards.*

| ENERGY | HS-PS3-2 |
| --- | --- |
| HS-PS3-2 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | 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). |
| **Clarification Statement** | |
| HS-PS3-2 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | 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. |
| **Science and Engineering Practice:** | Developing and using models |
| **Disciplinary Core Ideas:** | Definitions of energy |
| HS-PS3-2 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | 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)<br>At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS.PS3A.b)<br>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) |
| **Crosscutting Concepts:** | Energy and matter |
| HS-PS3-2 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. |

| 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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<table>
<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 colspan="2">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></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></td><td>Energy in chemical processes and everyday life</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>
</table>

| ENERGY | HS-PS3-5 |
| --- | --- |
| **LSSS** | **NGSS** |
| HS-PS3-5 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | 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. |
| **Clarification Statement** | |
| HS-PS3-5 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | 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. |
| **Science and Engineering Practice:** | Developing and using models |
| **Disciplinary Core Ideas:** | Relationship between energy and forces |
| HS-PS3-5 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | When two objects interacting through a field change relative position, the energy stored in the field is changed. |
| **Crosscutting Concepts:** | Cause and effect |
| HS-PS3-5 DOES NOT APPEAR IN LOUISIANA CHEMISTRY STANDARDS - APPEARS IN PHYSICS AND PHYSICAL SCIENCE | 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. |

| **ENERGY** | *** HS-PS3-6** |
|---|---|
| ***Standard HS-PS3-6 appears in the Louisiana Student Standards for Science (LSSS) ONLY** | |
| Evaluate the validity and reliability of claims in published materials about the viability of nuclear power as a source of alternative energy relative to other forms of energy (e.g., fossil fuels, wind, solar, geothermal). | |
| **Clarification Statement** | |
| Emphasis is on the trade-offs existing between the amount of energy produced, the types and amounts of pollution produced, safety, and cost . Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias. | |
| **Science and Engineering Practice:** | Obtaining, evaluating, and communicating information |
| **Disciplinary Core Ideas:** | 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. (HS.PS1C.a) | |
| | Developing possible solutions |
| When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (HS.ETS1B.a) | |
| | Natural resources |
| All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS.ESS3A.b) | |
| **Crosscutting Concepts:** | Energy and matter |
| In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. | |