NEXT GENERATION SCIENCE STANDARDS
For States, By States

Search Performance Expectations

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Search for performance expectations using the categories below. Click on a category name to expand the list, then select desired criteria.

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▼ Grade Band/Level

- ☐ **K-2**
- ☐ **K**
- ☐ **1**
- ☐ **2**
- ☐ **3-5**
- ☐ **3**
- ☐ **4**

▶ Practices

▶ Cross Cutting Concepts

▼ Disciplinary Core Ideas

- ☐ **Physical Sciences**
- ☑ **-PS1A: Structure and Properties of Matter**
- ☐ **-PS1B: Chemical Reactions**
- ☐ **-PS1C: Nuclear Processes**
- ☐ **-PS2A: Forces and Motion**
- ☐ **-PS2B: Types of Interactions**
- ☐ **-PS3A: Definitions of Energy**

[Apply]   [Reset criteria]

How to read the standards »

HS-PS1-1 Matter and its Interactions

Students who demonstrate understanding can:

HS-PS1-1. **Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** [Clarification Statement: 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.] [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Developing and Using Models	**PS1.A: Structure and Properties of Matter**	**Patterns**
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and	• 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	• 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.

systems and their components in the natural and
designed w orlds.
- Use a model to predict the relationships betw een
  systems or betw een components of a system.

- The periodic table orders elements horizontally by
  the number of protons in the atom's nucleus and
  places those w ith similar chemical properties in
  columns. The repeating patterns of this table
  reflect patterns of outer electron states.

phenomena.

Connections to other DCIs in this grade-band:
HS.LS1.C

Articulation of DCIs across grade-bands:
MS.PS1.A ; **MS.PS1.B**

Common Core State Standards Connections:
ELA/Literacy -

RST.9-10.7	Translate quantitative or technical information expressed in w ords in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into w ords. *(HS-PS1-1)*

How to read the standards »

HS-PS1-2 Matter and its Interactions

Students who demonstrate understanding can:

HS-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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]

The performance expectation above w as developed using the follow ing elements from the NRC document *A Framework for K-12 Science Education*:

Constructing Explanations and Designing Solutions	**PS1.A: Structure and Properties of Matter**	**Patterns**
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent w ith scientific ideas, principles, and theories. - Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' ow n investigations, models, theories, simulations, peer review) and the assumption that theories and law s that describe the natural w orld operate today as they did in the past and w ill continue to do so in the future.	- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those w ith similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. **PS1.B: Chemical Reactions** - The fact that atoms are conserved, together w ith know ledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	- Different patterns may be observed at each of the scales at w hich a system is studied and can provide evidence for causality in explanations of phenomena.

Connections to other DCIs in this grade-band:
HS.LS1.C ; **HS.ESS2.C**

Articulation of DCIs across grade-bands:

MS.PS1.A ; **MS.PS1.B**

Common Core State Standards Connections:
ELA/Literacy -

WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2)
WHST.9-12.5	Develop and strengthen w riting as needed by planning, revising, editing, rew riting, or trying a new approach, focusing on addressing w hat is most significant for a specific purpose and audience. (HS-PS1-2)

Mathematics -

HSN-Q.A.1	Use units as a w ay to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2)
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement w hen reporting quantities. *(HS-PS1-2)*

How to read the standards »

HS-PS1-3 Matter and its Interactions

Students who demonstrate understanding can:

HS-PS1-3. **Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** [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 networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [*Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.*]

The performance expectation above w as developed using the follow ing elements from the NRC document *A Framework for K-12 Science Education*:

Planning and Carrying Out Investigations	**PS1.A: Structure and Properties of Matter**	**Patterns**
Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed	- The structure and interactions of matter at the bulk scale are determined by electrical forces w ithin and betw een atoms.	- Different patterns may be observed at each of the scales at w hich a system is studied and can provide evidence for causality in explanations of phenomena.

to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.		

Connections to other DCIs in this grade-band:
HS.ESS2.C

Articulation of DCIs across grade-bands:
MS.PS1.A ; MS.PS2.B

Common Core State Standards Connections:
ELA/Literacy -

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3)
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3)
WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. *(HS-PS1-3)*

Mathematics -

HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-PS1-3)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS1-3)*

How to read the standards »

HS-PS1-4 Matter and its Interactions

Students who demonstrate understanding can:

HS-PS1-4. **Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.** [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.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Developing and Using Models	PS1.A: Structure and Properties of Matter	Energy and Matter
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	• 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. **PS1.B: Chemical Reactions** • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	• 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.

Connections to other DCIs in this grade-band:
HS.PS3.A ; HS.PS3.B ; HS.PS3.D ; HS.LS1.C

Articulation of DCIs across grade-bands:
MS.PS1.A ; MS.PS1.B ; MS.PS2.B ; MS.PS3.D ; MS.LS1.C

Common Core State Standards Connections:
ELA/Literacy -

SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-PS1-4)*

Mathematics -

MP.4	Model with mathematics. *(HS-PS1-4)*
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-PS1-4)*
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4)
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS1-4)*

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* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

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