# Physical Sciences—High School

# Alternate Item Content Specifications

**Prepared for the California Department of Education by Educational Testing Service**



**Presented August 1, 2020**

 

Table of Contents

HS-PS1-1 Matter and Its Interactions 3

HS-PS1-4 Matter and Its Interactions 5

HS-PS1-8 Matter and Its Interactions 7

HS-PS2-1 Motion and Stability: Forces and Interactions 9

HS-PS2-3 Motion and Stability: Forces and Interactions 11

HS-PS2-6 Motion and Stability: Forces and Interactions 12

HS-PS3-4 Energy 15

HS-PS3-5 Energy 17

HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer 19

HS-PS4-5 Waves and Their Applications in Technologies for Information Transfer 21

## HS-PS1-1 Matter and Its Interactions

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Organize different materials based on properties of elements. | 1. Recognize that types of materials (e.g., elements) can be grouped together.
 | Recognize that materials have different properties. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.]*

### Mastery Statements

Students will be able to:

* Recognize that materials have different properties
* Identify basic properties of materials
* Group objects together based on shared properties

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Familiar household materials, e.g., a fuzzy robe and a stuffed animal (soft), a spoon and a metal jar lid (hard metal), a rubber band and a spring (flexible)
* Familiar classroom materials can be used for hands-on items, e.g., a chair and a bookcase (hard), a playground ball and a golf ball (round) or a pencil and wooden ruler (inflexible)

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS1-1

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps1-1.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS1-4 Matter and Its Interactions

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Using a model, determine whether energy is released or absorbed in a chemical reaction system. | 1. Ability to use a model containing data in a graph or table to determine whether energy is released or absorbed in a chemical reaction system.
 | Determine whether energy is released or absorbed in a chemical reaction system. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.]*

### Mastery Statements

Students will be able to:

* Recognize a temperature increase or decrease when two products are combined
* Recognize a chemical reaction that releases energy
* Recognize a chemical reaction that absorbs energy
* Identify that a chemical reaction occurred based on a change in temperature
* Identify that a chemical reaction occurred based on the release of light
* Evaluate data in a graph or table to identify whether energy was absorbed or released in a chemical reaction

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Pictures of flame
* Data tables or graphs showing beginning and ending temperatures of combined substances
* Before and after pictures of thermometers in substances that have been combined

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS1-4

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps1-4.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS1-8 Matter and Its Interactions

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Identify changes in the composition of the center of an atom during a reaction. | 1. Ability to identify the center of an atom.
2. Ability to identify the changes to the center of an atom that occur during a reaction.
 | Identify that there are reactions that produce more energy than basic chemical reactions. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.] *[Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]*

### Mastery Statements

Students will be able to:

* Identify the center of an atom
* Identify that nuclear reactions produce more energy than chemical reactions
* Identify a nuclear reaction can give off tiny particles
* Recognize the center of an atom is made of tiny particles
* Recognize energy is released when the nucleus of an atom reacts

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Simple diagrams that show the basic structure of the atom, with electron orbitals and the nucleus
* Simple diagrams that show the nuclei of two atoms colliding to form one atom with a single nucleus
* Simple diagrams that show nuclear and chemical reactions

### Additional Assessment Boundaries

* Only fusion reactions are included.

### Additional References

California Science Test Item Specification for HS-PS1-8

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps1-8.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS2-1 Motion and Stability: Forces and Interactions

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Recognize the relationship between an object’s acceleration and the force. | 1. Identify that a decrease in acceleration is caused by a change in the net force.
 | Identify that increasing the force exerted on an object increases the acceleration of the object. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.] *[Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]*

### Mastery Statements

Students will be able to:

* Recognize that the speed of an object is dependent on the force exerted on it
* Recognize when an object is moving at a constant speed, a push or pull in the opposite direction will make the object slow down

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Scenarios showing a toy being pushed or pulled
* Scenarios showing a heavy object being pushed or pulled
* Scenarios showing children manipulating a cart or wagon to make it speed up or slow down

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS2-1

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps2-1.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS2-3 Motion and Stability: Forces and Interactions

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Evaluate a device designed to minimize force by comparing data (e.g., momentum, mass, velocity, force, time). | 1. Ability to evaluate a device designed to minimize force by comparing data.
 | Identify cause and effect relationships between force and the outcome of a collision. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.]*

### Mastery Statements

Students will be able to:

* Recognize the faster an object is going, the greater the effect of a collision
* Recognize common objects used in daily life to minimize the effect of a collision
* Use data to evaluate which device will minimize the effect of an impact

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Seatbelts, bumpers, airbags
* Packaging containers
* Helmets, hardhats
* Baseball mitts
* Gym mats, safety nets, climbing ropes

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS2-3

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps2-3.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

##

## HS-PS2-6 Motion and Stability: Forces and Interactions

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Recognize that different materials have different molecular structures and properties which determine different functioning (e.g., flexible, but durable) of the material. | 1. Ability to recognize that different materials have different properties that determine different functioning (e.g., flexible, but durable) of the material.
 | Identify that different materials have different properties. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.]*

### Mastery Statements

Students will be able to:

* Recognize properties of materials
* Recognize that different materials have different properties
* Identify a material with properties different than other materials in a group
* Recognize that materials with common properties can be used to perform the same function
* Recognize that materials with different properties would not be used to perform the same function
* Recognize how the property of a material supports its purpose

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Classroom objects made of paper, wood, plastic, or other easily identifiable materials that share a common property
* Toys with easily observable properties including softness or flexibility
* Common household materials, such as materials that keep things warm

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS2-6

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps2-6.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS3-4 Energy

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Identify that the temperature of two different components, when combined, show uniform energy distribution. | 1. Recognize that the mixture of two different components shows uniform energy distribution.
 | Recognize components change their temperature when combined. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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.]*

### Mastery Statements

Students will be able to:

* Recognize the temperature of a warmer substance will decrease when a cooler substance is added
* Recognize the temperature of a cooler substance will increase when a warmer substance is added
* Recognize the combination of two substances with different temperatures will result in a final temperature between that of the two substances
* Recognize the combination of two substances with different energy levels will result in a uniform final energy distribution because one substance loses heat energy and the other gains heat energy

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Combining warm and cold water in fish tanks, kitchen sinks, bathtubs, etc.
* Adding a cold liquid food to a warm liquid food
* Adding ice to a beverage

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS3-4

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps3-4.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS3-5 Energy

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Identify a model (e.g., drawing, diagram) that shows the cause and effect relationships between forces produced by electric or magnetic fields. | 1. Identify a model (e.g., drawing, diagram) that shows the cause and effect relationships between forces produced by electric fields.
2. Identify a model (e.g., drawing, diagram) that shows the cause and effect relationships between forces produced by magnetic fields.
 | Identify electric and magnetic forces that attract or repulse. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**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: 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.] *[Assessment Boundary: Assessment is limited to systems containing two objects.]*

### Mastery Statements

Students will be able to:

* Recognize that opposite magnetic poles attract
* Recognize that similar magnetic poles repel
* Recognize that opposite electrical charges attract
* Recognize that similar electrical charges repel
* Identify an effect produced by an electrical field
* Identify an effect produced by a magnetic field
* Recognize why an object will be attracted or repelled

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Two magnets with the same or opposite poles near one another
* Two magnets interacting, one in a fixed position and one that can move
* A magnetic object (nail or washer) moves past a magnet
* Two charged objects near one another, such as a balloon and hair
* Two charged objects, one in a fixed position and one that can move
* Two charged objects, both of which can move, such as two balloons hanging from strings

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS3-5

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps3-5.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Recognize that electromagnetic radiation (e.g., a radio, microwave, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. | 1. Ability to recognize that electromagnetic radiation (e.g., a radio, microwave, light) can be modeled as particles called photons.
 | Electromagnetic radiation (e.g., radio, microwave, light) can be modeled as a wave. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] *[Assessment Boundary: Assessment does not include using quantum theory.]*

### Mastery Statements

Students will be able to:

* Identify that electromagnetic radiation travels in waves
* Compare the movement of electromagnetic radiation waves to the movement of other objects or materials
* Identify that electromagnetic radiation is a form of energy
* Identify that electromagnetic radiation is in photons, which are like tiny particles

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Light from the Sun
* Microwave ovens
* Cell phone transmittal
* Television or radio tower transmission

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS4-3

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps4-3.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

## HS-PS4-5 Waves and Their Applications in Technologies for Information Transfer

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Describe how a device operates using the principles of wave behavior by identifying steps in a model that show how a device uses waves to transmit and capture information and transmit energy. | 1. Ability to describe how a device operates using the principles of wave behavior by identifying steps in a model that show how a system uses waves to transmit and receive information.
2. Ability to describe how a device operates using the principles of wave behavior by identifying steps in a model that show how a system uses waves to transmit and receive energy.
 | Identify common devices that use light or sound waves to transmit information. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] *[Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]*

### Mastery Statements

Students will be able to:

* Identify devices which use light or sound waves to transmit information
* Identify steps in models in which devices use waves to transmit or capture information
* Identify steps in models in which devices use waves to transmit energy
* Recognize that light, sound, and energy are transmitted in waves

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Students using cell phones to send and receive messages
* Students watching television or listening to the radio
* Students talking on the phone
* Students using a computer

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-PS4-5

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ps4-5.docx>

Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade Twelve

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts

<https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

*Posted by the California Department of Education, August 2020*