

HS-PS1-8 Matter and its Interactions

California Science Test—Item Content Specifications

# HS-PS1-8 Matter and its Interactions

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.*]

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Developing and Using ModelsModeling 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 worldsDevelop a model based on evidence to illustrate the relationships between systems or between components of a system. | PS1.C: Nuclear Processes1. 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.
 | Energy and MatterIn nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

2.1 Ability to develop models

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

2.1.1 Ability to determine components of a scientific event, system, or design solution

2.1.2 Ability to determine the relationships among multiple components of a scientific event, system, or design solution

2.1.3 Ability to determine scope, scale, and grain size of models, as appropriate for their intended use

2.1.4 Ability to represent mechanisms, relationships, and connections to illustrate, explain, or predict a scientific event

### Disciplinary Core Idea Assessment Targets

#### PS1.C.2

* Identify an element based on the number of protons in an atom of the element
* Determine the number of neutrons in an element based on the atomic number (number of protons) and mass number (total number of protons and neutrons)
* Explain that the total number of neutrons plus protons does not change during nuclear processes (the law of conservation of nucleon number)
* Apply the law of conservation of nucleon number to identify the components of a nuclear process
* Recognize that the relative scale of energy change in nuclear processes is greater than in other types of reactions
* Differentiate between fission and fusion and the characteristic features of each process
* Differentiate between the three major radioactive decay processes, including the characteristics of the emitted particles

### Crosscutting Concept Assessment Target(s)

CCC5 Identify that, in nuclear processes, atoms are not conserved, but rather the total number of protons plus neutrons is conserved

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a complete model of a nuclear process:

* Labels the components by applying the scientific principle of nucleon conservation (2.1.1, PS1.C.2, and CCC5)

Task provides an incomplete model of a nuclear process and a list of relevant and irrelevant components:

* Selects the relevant components to complete the model by applying the scientific principle of nucleon conservation (2.1.1, PS1.C.2, and CCC5)

Task provides a description or representation of a nuclear process and a choice of models:

* Identifies the model that best illustrates the process, including the scale of energy change associated with the process (2.1.2, PS1.C.2, and CCC5)
* Identifies the model that illustrates the process at the subatomic scale (e.g., a neutron decaying to a proton and electron in beta decay) (2.1.3, PS1.C.2, and CCC5)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Fusion of hydrogen in the Sun and other stars
* Fission of uranium (i.e., U-238) in nature and in nuclear reactors
* Radioactive decay of isotopes used for dating (e.g., C-14, K-40, Rb-87, U-238)
* Emission during radioactive decay (e.g., alpha decay of U-235, beta decay of C-14, gamma emission from various radioisotopes)

## Common Misconceptions

Note that the list in this section is not exhaustive.

* The conservation of atoms and mass is not the same as the conservation of nucleons (protons and neutrons).
* The atomic number of an atom is determined by the number of neutrons in the atom.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS1-8 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS1-8 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS1-8%20Evidence%20Statements%20June%202015%20asterisks.pdf)

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Posted by the California Department of Education, March 2021 (updated February 2024)