

HS-PS1-7 Matter and its Interactions

California Science Test—Item Content Specifications

# HS-PS1-7 Matter and its Interactions

Students who demonstrate understanding can:

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

[Clarification Statement: Emphasis is on using mathematical ideas 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.] [*Assessment Boundary: Assessment does not include complex chemical reactions*.]

Continue to the next page for the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Using Mathematics and Computational Thinking  Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.  Use mathematical representations of phenomena to support claims. | PS1.B: Chemical Reactions   1. 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. | Energy and Matter  The total amount of energy and matter in closed systems is conserved.  Connections to Nature of Science  Scientific Knowledge Assumes an Order and Consistency in Natural Systems  Science assumes the universe is a vast single system in which basic laws are consistent. |

## 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.

5.1 Ability to develop mathematical and/or computational models (e.g., graphical representation in a simulation)

5.2 Ability to conduct mathematical and/or computational analyses

### 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.

5.1.1 Ability to generate mathematical representations to describe characteristics and patterns of a scientific phenomenon and/or a design solution

5.2.2 Ability to use the results of computational models to identify the mathematical and/or computational representations that support a scientific explanation or a design solution

5.2.3 Ability to use computational models (e.g., simulations) to make predictions for a scientific phenomenon

### Disciplinary Core Idea Assessment Targets

#### PS1.B.9

* Identify the components of a chemical reaction (i.e., reactants and products) represented in a chemical equation
* Calculate the molar masses of the components of a chemical reaction based on their chemical formulas
* Use the molar masses of the components of a chemical reaction to calculate their molar quantities
* Use Avogadro’s number to calculate the numbers of molecules and/or atoms in the components of a chemical reaction given their mole quantities or masses
* Describe the stoichiometric relationships represented by the coefficients in a balanced chemical equation on an atomic or molecular scale and a macroscopic scale
* Use stoichiometric relationships to calculate the mass of any component of a reaction given the mass of another component
* Use mathematical representations based on the stoichiometric relationships in a balanced chemical equation to show that atoms, and therefore mass, are conserved during a chemical reaction

### Crosscutting Concept Assessment Target(s)

CCC5 Identify that the total amount of energy and matter in closed systems is conserved

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a balanced chemical equation and the masses of the components of a reaction:

* Selects the mathematical relationships that best demonstrate that atoms are conserved in the chemical reaction (5.1.1, PS1.B.9, and CCC5)

Task provides data or graphical representations of the mass or the number of particles generated from a simulation of a reaction:

* Uses data and/or graphical representations of data to determine the mathematical relationship(s) between the reactant(s) and product(s) (5.2.1, PS1.B.9, and CCC5)

Task provides a balanced chemical equation, the mass of one of the components of the chemical reaction, and a prompt to predict the mass of another component:

* Selects the mathematical representation that predicts the mass of the other component (5.2.2, PS1.B.9, and CCC5)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Conservation of atoms and/or mass in simple acid-base, precipitation, and redox reactions
* Determination of the amount of reactant consumed or needed
* Use of proportional reasoning to determine the amount of product yielded
* Stoichiometry
  + Making caramel (hydrolysis of sucrose)
  + Making soap from fats and NaOH
  + Synthesis of compounds used for perfumes or responsible for aroma in food

## Common Misconceptions

Note that the list in this section is not exhaustive.

* In a reaction, atoms can be gained or lost depending on whether a reaction is exothermic or endothermic.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS1-7 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS1-7 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS1-7%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>

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