HS-PS1-7

Students who demonstrate understanding can:

HS-PS1-7. **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.*]

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

Science and Engineering Practices

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.

Disciplinary Core Ideas

PS1.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.

Crosscutting Concepts

Energy and Matter

- The total amount of energy and matter in closed systems is conserved.

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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.

Observable features of the student performance by the end of the course:			
1	Representation		
	a	Students identify and describe* the relevant components in the mathematical representations:	
		i.	Quantities of reactants and products of a chemical reaction in terms of atoms, moles, and mass;
		ii.	Molar mass of all components of the reaction;
		iii.	Use of balanced chemical equation(s); and
		iv.	Identification of the claim that atoms, and therefore mass, are conserved during a chemical reaction.
	b	The mathematical representations may include numerical calculations, graphs, or other pictorial depictions of quantitative information.	
	c	Students identify the claim to be supported: that atoms, and therefore mass, are conserved during a chemical reaction.	
2	Mathematical modeling		
	a	Students use the mole to convert between the atomic and macroscopic scale in the analysis.	
	b	Given a chemical reaction, students use the mathematical representations to	
		i.	Predict the relative number of atoms in the reactants versus the products at the atomic molecular scale; and
		ii.	Calculate the mass of any component of a reaction, given any other component.
3	Analysis		
	a	Students describe* how the mathematical representations (e.g., stoichiometric calculations to show that the number of atoms or number of moles is unchanged after a chemical reaction where a specific mass of reactant is converted to product) support the claim that atoms, and therefore	

		mass, are conserved during a chemical reaction.
	b	Students describe* how the mass of a substance can be used to determine the number of atoms, molecules, or ions using moles and mole relationships (e.g., macroscopic to atomic molecular scale conversion using the number of moles and Avogadro's number).