HS-PS1-1

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 *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models 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 world(s). • Use a model to predict the relationships between systems or between components of a system.	**PS1.A: Structure and Properties of Matter** • 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 the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.	**Patterns** • 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.

	Observable features of the student performance by the end of the course:	
1	Components of the model	
	a	From the given model, students identify and describe* the components of the model that are relevant for their predictions, including:
		i. Elements and their arrangement in the periodic table;
		ii. A positively-charged nucleus composed of both protons and neutrons, surrounded by negatively-charged electrons;
		iii. Electrons in the outermost energy level of atoms (i.e., valence electrons); and
		iv. The number of protons in each element.
2	Relationships	
	a	Students identify and describe* the following relationships between components in the given model, including:
		i. The arrangement of the main groups of the periodic table reflects the patterns of outermost electrons.
		ii. Elements in the periodic table are arranged by the numbers of protons in atoms.
3	Connections	
	a	Students use the periodic table to predict the patterns of behavior of the elements based on the attraction and repulsion between electrically charged particles and the patterns of outermost electrons that determine the typical reactivity of an atom.
	b	Students predict the following patterns of properties:
		i. The number and types of bonds formed (i.e. ionic, covalent, metallic) by an element and between elements;
		ii. The number and charges in stable ions that form from atoms in a group of the periodic table;

		iii.	The trend in reactivity and electronegativity of atoms down a group, and across a row in the periodic table, based on attractions of outermost (valence) electrons to the nucleus; and
		iv.	The relative sizes of atoms both across a row and down a group in the periodic table.