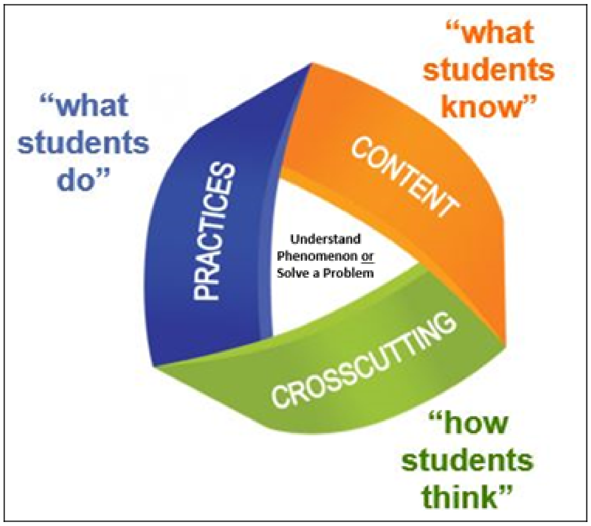
Science: Quick Reference Guide for Planning Rigorous Instruction



Three Dimensions of Science NRC: "combine to form each NGSS"	
Dimension	Categories/Classifications
8 Practices	Asking Questions and Defining Problems Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Using Mathematics, Information and Computer Technology, and Computational Thinking Constructing Explanations and Designing Solutions Engaging in Argument From Evidence Obtaining, Evaluating, and Communicating Information
7 Cross-Cutting Concepts	Concepts relating to Patterns, Similarity, and Diversity Concepts relating to Cause and Effect Concepts relating to Scale, Proportion and Quantity Concepts relating to Systems and System Models Concepts relating to Energy and Matter Concepts relating to Structure and Function Concepts relating to Stability and Change
4 Disciplinary Core Ideas "Content"	Physical Sciences Domain Life Sciences Domain Earth and Space Sciences Domain Engineering, Technology, & Applications of Science Domain

The cycle of science instruction revolves around understanding a phenomena or solving a problem that is congruent to the NGSS performance expectation(s). All aspects of instruction (i.e. learning targets, discussions, questions, formative assessment, learning experiences) must incorporate all three dimensions (Disciplinary Core Ideas, Cross-Cutting Concepts, and Science & Engineering Practices).

To plan rigorous science instruction, you will need access to the following:

NGSS evidence statements
https://www.nextgenscience.org/evidence-statements

DCI Progressions
https://www.nextgenscience.org/sites/default/files/resource/files/AppendixE-ProgressionswithinNGSS-061617.pdf

SEP Progressions
https://www.nextgenscience.org/sites/default/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf

CCC Progressions
http://www.nextgenscience.org/sites/default/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf

Please use the annotated samples (attached) to help you understand how to use this guide.

I. Locate the standard in the NGSS evidence statements document.

II. Box A contains three parts that help you form an initial understanding of the standard.
   1. Performance expectation (in black) - tells you what a student should be able to do at the end of a sequence of instruction on this standard. This performance expectation could be converted into an "I can" statement since it represents the intended learning.
   2. Clarification statement (in red) - provides specific examples and points of emphasis that give you an idea of where to focus your instruction around this standard.
   3. Assessment boundary (in red) - sets the outer limits of rigor. (i.e. - tells you 'how far your instruction should go)

III. Box B shows the three dimensions that make up the performance expectation**
   1. **Science and Engineering Practice (**blue) - Read the SEP. Look back to the performance expectation in Box A. Find the language in the performance expectation that corresponds to the SEP.
   2. **Disciplinary Core Idea** (orange) - Read the DCI. Find the language in the performance expectation that corresponds to the DCI. Locate the DCI in the progressions document. Note the level of rigor for your grade band. Look back to the previous grade band to see what prior knowledge students should already have, and to get ideas for developing a pre-assessment. Look ahead to the next grade band to establish where your instruction should be preparing students to go in the future.
   3. **Crosscutting Concept** (green) - Read the CCC. Find the language in the performance expectation that corresponds to the CCC.

IV. Box C contains the **observable features of student performance**. This chart tells you what students should know and be able to do as a result of instruction. In order to plan Instruction and assessment that meets the full rigor of the standards, learning tasks and Assessment items should match the observable features found in this chart.

**Note that all three dimensions are inherent in each performance expectation. The dimensions should be thought of as integrated, rather than as independent parts. (i.e. - you don't teach the content in one lesson, the science and engineering practice in another, and the crosscutting concept in another. All three dimensions should be explored and developed together).

NEXT GENERATION SCIENCE STANDARDS For States, By States

HS-PS1-1

Students who demonstrate understanding can:

A → **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*:

B →

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.

C →

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;

Physical Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
PS1.A Structure of matter (includes PS1.C Nuclear processes)	Matter exists as different substances that have observable different properties. Different properties are suited to different purposes. Objects can be built up from smaller parts.	Matter exists as particles that are too small to see, and so matter is always conserved even if it seems to disappear. Measurements of a variety of observable properties can be used to identify particular materials.	The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.	The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy to take the molecule apart.
PS1.B Chemical reactions	Heating and cooling substances cause changes that are sometimes reversible and sometimes not.	Chemical reactions that occur when substances are mixed can be identified by the emergence of substances with different properties; the total mass remains the same.	Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.	Chemical processes are understood in terms of collisions of molecules, rearrangement of atoms, and changes in energy as determined by properties of elements involved.
PS2.A Forces and motion	Pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it.	The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion. Some forces act through contact, some forces act even when the objects are not in contact. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	The role of the mass of an object must be qualitatively accounted for in any change of motion due to the application of a force.	Newton's 2^{nd} law (F=ma) and the conservation of momentum can be used to predict changes in the motion of macroscopic objects.
PS2.B Types of interactions			Forces that act at a distance involve fields that can be mapped by their relative strength and effect on an object.	Forces at a distance are explained by fields that can transfer energy and can be described in terms of the arrangement and properties of the interacting objects and the distance between them. These forces can be used to describe the relationship between electrical and magnetic fields.
PS2.C Stability & instability in physical systems	N/A	N/A	N/A	N/A
PS3.A Definitions of energy	N/A	Moving objects contain energy. The faster the object moves, the more energy it has. Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects). -- Systems move toward stable states.
PS3.B Conservation of energy and energy transfer	[Content found in PS3.D]			