

# Chemistry Pacing Guide

## CC: Cross-Cutting Concepts

- CC#1: Patterns  
 CC#2: Cause & Effect  
 CC#3: Scale, Proportion, Quantity  
 CC#4: Systems/System Models  
 CC#5: Energy & Matter: Flows, Cycles, Conservation  
 CC#6: Structure & Function  
 CC#7: Stability and Change

## HOP: Habits of Practice

- Practice 1: Asking Questions/Defining Problems  
 Practice 2: Developing and Using Models  
 Practice 3: Planning/Carrying Out Investigations  
 Practice 4: Analyzing/Interpreting Data  
 Practice 5: Using Math & Computational Thinking  
 Practice 6: Constructing Explanations/Designing Solutions  
 Practice 7: Engaging in Argument from Evidence  
 Practice 8: Obtaining/Evaluating/Communicating Info  
 Practice 9: Metacognition-Think about My Thinking

## NGSS Chemistry Core Topics

- HS-PS1-1 Periodic Table: trends, reactivity, bonding  
 HS-PS1-2 Chemical Reactions  
 HS-PS1-3 Kinetic Molecular Theory  
 HS-PS1-4 Thermochemistry  
 HS-PS1-5 Rate of Reactions  
 HS-PS1-6 Le Chatelier's Principle  
 HS-PS1-7 Relationships between moles and masses  
 HS-PS1-8 Nuclear reactions

| Standard                         | Blocks | SPI                                    | Chapter-Topic  | Concept (SPI)  | Labs/Activities   | NGSS Connections                     |
|----------------------------------|--------|--|--|--|---|--------------------------------------|
| STEM                             | 3      | SPI<br>3221.Inq.3<br>SPI<br>3221.T/E.1 | 1.1-What is chemistry?<br>1.3-Lab Safety<br>(scientific method embedded)<br>Engineering design cycle | <ul style="list-style-type: none"> <li>Determine appropriate tools to gather precise and accurate data.</li> <li>Distinguish among tools and procedures best suited to conduct a specific inquiry.</li> </ul>  | <ul style="list-style-type: none"> <li>See Chapter 1 Resources in Supplemental Materials</li> </ul> | CC: 6<br>HOP:1,8<br>NGSS:NA          |
| Standard 1:<br>Atomic Energy and | 3      | SPI<br>3221.1.1<br>SPI<br>3221.1.2     | 4.1-Defining the atom<br>4.2-The Nuclear atom<br>4.3-Isotopes and atomic mass                        | <ul style="list-style-type: none"> <li>Compare and contrast the major models of the atom (i.e., Bohr, and the quantum mechanical model).</li> <li>Interpret the periodic table to describe an element's atomic makeup.</li> </ul>  | <ul style="list-style-type: none"> <li>See Chapter 4 Resources in Supplemental Materials</li> </ul> | CC:4,6<br>HOP:2,6,7<br>NGSS:HS-PS1-8 |
| Standard 1:<br>Atomic Structure  | 4      | SPI<br>3221.1.4<br>SPI<br>3221.1.5     | 5.1-Models of the atom<br>5.2-Electrons in atoms<br>5.3-Quantum mechanical model                     | <ul style="list-style-type: none"> <li>Determine the Lewis electron dot structure or number of valence electrons for an atom of any main-group element from its atomic number or position in the periodic table.</li> <li>Represent an electron's location in the quantum mechanical model of</li> </ul> | <ul style="list-style-type: none"> <li>See Chapter 5 Resources in Supplemental Materials</li> </ul> | CC:4,6<br>HOP:2,6,7<br>NGSS:HS-PS1-8 |

|                                  |   |                                    |   |   |  |  |
|----------------------------------|---|------------------------------------|---|---|--|--|
|                                  |   |                                    |   | an atom in terms of the shape of electron clouds (s and p orbitals in particular), relative energies of orbitals, and the number of electrons possible in the s, p, d and f orbitals.   |  |  |
| Standard 1:<br>Atomic Structure  | 3 | SPI<br>3221.1.2<br>SPI<br>3221.1.3 | 6.1-Organizing elements and periodic labels<br>6.2-Classifying elements and electron configurations<br>Appendix A-Element Handbook<br>6.3-Periodic trends | <ul style="list-style-type: none"> <li>Interpret the periodic table to describe an element's atomic makeup.</li> <li>Describe the trends found in the periodic table with respect to atomic size, ionization energy, or electronegativity.</li> </ul>                                       | <ul style="list-style-type: none"> <li>See Chapter 6 Resources in Supplemental Materials</li> </ul>  | CC:1,6,7<br>HOP:2,4<br>NGSS:HS-PS1-1         |
| <b>End Q 1</b>                   |   |                                    |   | <b>End of Quarter 1 (AB Schedule)</b>   |  |  |
| Standard 2:<br>Matter and Energy | 3 | SPI<br>3221.2.1<br>SPI<br>3221.2.4 | 2.1-2.4-Properties of Matter, mixtures, elements, compounds and chemical changes  | <ul style="list-style-type: none"> <li>Distinguish among elements, compounds, and mixtures.</li> <li>Classify a property of change in matter as physical or chemical.</li> </ul>  | <ul style="list-style-type: none"> <li>See Chapter 2 Resources in Supplemental Materials</li> </ul>  | CC: 6<br>HOP:2,5<br>NGSS:HS-PS1-2            |
| Standard 2:<br>Matter and Energy | 4 | SPI<br>3221.2.6<br>SPI<br>3221.2.7 | 13.1-State of matter: nature of gases<br>13.2-Nature of liquids<br>13.3-Nature of solids<br>13.4-Changes of states  | <ul style="list-style-type: none"> <li>Investigate similarities and differences among solids, liquids and gases in terms of energy and particle spacing.</li> <li>Predict how changes in volume, temperature, and pressure affect the behavior of a gas.</li> </ul>                         | <ul style="list-style-type: none"> <li>See Chapter 13 Resources in Supplemental Materials</li> </ul> | CC: 1, 2<br>HOP: 2, 6<br>NGSS: HS-PS1-3      |
| Standard 2:<br>Matter and Energy | 5 | SPI<br>3221.2.4<br>SPI<br>3221.2.5 | 17.1-Flow of heat and energy-heat and work<br>17.2-Enthalpy changes<br>17.3-Heat in changes of state<br>17.4-Heats of reaction                            | <ul style="list-style-type: none"> <li>Classify a property of change in matter as physical or chemical.</li> <li>Compare and contrast heat and temperature changes (endothermic /exothermic) in chemical (e.g., combustion) or physical (e.g., phase transformations) processes.</li> </ul> | <ul style="list-style-type: none"> <li>See Chapter 17 Resources in Supplemental Materials</li> </ul> | CC:2,4,5<br>HOP:2,5<br>NGSS:HS-PS4, HS-PS1-3 |

| End Q 2  |   |                                    |  | End of Quarter 2 (AB schedule)<br>End of Quarter 1 for Block   |   |                                      |
|--|---|------------------------------------|--|--|---|--------------------------------------|
| Standard 1:<br>Atomic Structure<br>And<br>Standard 3:<br>Interactions<br>of Matter | 3 | SPI<br>3221.1.4<br>SPI<br>3221.3.1 | 7.1-Ions<br>7.2-Ionic bonds and<br>compounds   | <ul style="list-style-type: none"> <li>Determine the Lewis electron dot structure or number of valence electrons for an atom of any main-group element from its atomic number or position in the periodic table.</li> <li>Analyze ionic and covalent compounds in terms of their formation (electron transfer versus sharing), names, chemical formulas, percent composition, and molar masses.</li> </ul> | <ul style="list-style-type: none"> <li>See Chapter 7 Resources in Supplemental Materials</li> </ul> | CC:1,6,7<br>HOP:2,8<br>NGSS:HS-PS1-1 |
| Standard 1:<br>Atomic Structure<br>And<br>Standard 3:<br>Interactions<br>of Matter | 3 | SPI<br>3221.1.4<br>SPI<br>3221.3.1 | 8.1-Molecular compounds<br>8.2, 8.3-Covalent bonding and<br>the octet rule   | <ul style="list-style-type: none"> <li>Determine the Lewis electron dot structure or number of valence electrons for an atom of any main-group element from its atomic number or position in the periodic table.</li> <li>Analyze ionic and covalent compounds in terms of their formation (electron transfer versus sharing), names, chemical formulas, percent composition, and molar masses.</li> </ul> | <ul style="list-style-type: none"> <li>See Chapter 8 Resources in Supplemental Materials</li> </ul> | CC:1,6,7<br>HOP:2,8<br>NGSS:HS-PS1-1 |
| Standard 3:<br>Interactions<br>of Matter   | 5 | SPI<br>3221.3.1<br>SPI<br>3221.3.7 | 9.1-Naming ions<br>9.2-Names and formulas for<br>ionic compounds<br>9.3-Names formulas for<br>molecular compounds<br>9.4-Acids and bases names and<br>formulas | <ul style="list-style-type: none"> <li>Analyze ionic and covalent compounds in terms of their formation (electron transfer versus sharing), names, chemical formulas, percent composition, and molar masses.</li> <li>Classify substances as acids or bases based on their formulas and how they react with litmus and</li> </ul>  | <ul style="list-style-type: none"> <li>See Chapter 9 Resources in Supplemental Materials</li> </ul> | CC:1,6<br>HOP:2,6<br>NGSS:HS-PS1-1   |

|  |    |   |  |  |  |  |
|--|----|---|--|--|--|--|
|  |    |   |  | phenolphthalein.   |  |  |
| Standard 3:<br>Interactions<br>of Matter | 5  | SPI<br>3221.3.2<br>SPI<br>3221.3.3<br>SPI<br>3221.3.4 | 11.1-Describing chemical reactions<br>11.2-Types of chemical reaction<br>11.3-Predicting products of composition/decomposition | <ul style="list-style-type: none"> <li>Identify the reactants, products, and types of different chemical reactions: composition, decomposition, double replacement, single replacement, combustion.</li> <li>Predict the products of a chemical reaction (e.g., composition and decomposition of binary compounds).</li> <li>Balance a chemical equation to determine molar ratios.</li> </ul> | <ul style="list-style-type: none"> <li>See Chapter 11 Resources in Supplemental Materials</li> </ul> | CC:1,5,7<br>HOP:2,4,6<br>NGSS:HS-PS1-2 |
| <b>End Q 3</b>                           |    |   |  | <b>End of Quarter 3 (AB Schedule)</b>  |  |  |
| Standard 3:<br>Interactions<br>of Matter | 5  | SPI<br>3221.3.1<br>SPI<br>3221.3.5                    | 10.1-The mole<br>10.2-Mole-mass and mole-volume<br>10.3-Percentage composition and chemical formulas                           | <ul style="list-style-type: none"> <li>Analyze ionic and covalent compounds in terms of their formation (electron transfer versus sharing), names, chemical formulas, percent composition, and molar masses.</li> <li>Convert among the following quantities of a substance: mass, number of moles, number of particles, molar volume at STP.</li> </ul>                                       | <ul style="list-style-type: none"> <li>See Chapter 10 Resources in Supplemental Materials</li> </ul> | CC:3,4<br>HOP:1,2,4,5<br>NGSS:HS-PS1-7 |
| Standard 3:<br>Interactions<br>of Matter | 11 | SPI<br>3221.3.4<br>SPI<br>3221.3.6                    | 12.1-Stoichiometry<br>12.2-Chemical calculations   | <ul style="list-style-type: none"> <li>Balance a chemical equation to determine molar ratios.</li> <li>Identify and solve stoichiometry problems which interconvert volume of gases at STP, moles, and mass.</li> </ul>  | <ul style="list-style-type: none"> <li>See Chapter 12 Resources in Supplemental Materials</li> </ul> | CC:1,3<br>HOP:4,5,8<br>NGSS:HS-PS1-2   |
| Standard 2:<br>Matter and<br>Energy      | 5  | SPI<br>3221.2.2<br>SPI<br>3221.2.3                    | 16.1-Properties of solutions<br>16.2-Concentrations of solutions<br>16.3-Colligative properties of                             | <ul style="list-style-type: none"> <li>Identify properties of an aqueous solution, including: colligative properties, procedure to make or determine the concentration of a</li> </ul>   | <ul style="list-style-type: none"> <li>See Chapter 16 Resources in Supplemental Materials</li> </ul> | CC:4,7<br>HOP:2,3,4,5<br>NGSS:HS-PS1-7 |

|                                    |   |                              |   |   |  |                                      |
|------------------------------------|---|------------------------------|---|---|--|--------------------------------------|
|                                    |   |                              | solutions   | <p>solution in molarity and molality.</p> <ul style="list-style-type: none"> <li>Classify a solution as saturated, unsaturated, or supersaturated based on its composition and temperature and a solubility graph.</li> </ul>   |  |                                      |
| Standard 2: Matter and Energy      | 4 | SPI 3221.2.3<br>SPI 3221.2.4 | 14.1-Properties of gases<br>14.2-The gas laws<br>14.3-Ideal gases                 | <ul style="list-style-type: none"> <li>Correlate kinetic molecular theory with the motion of particles within a substance</li> <li>Explain the effect of heat on temperature in terms of the motion of the particles within the substance.</li> <li>Explain how the motion of gas molecules affects the pressure.</li> <li>Explain the effects of pressure changes on the volume of a gas.</li> <li>Solve complex combined and ideal gas law problems to quantitatively explain the behavior of gases.</li> </ul> | <ul style="list-style-type: none"> <li>See Chapter 14 Resources in Supplemental Materials</li> </ul> |                                      |
| Standard 3: Interactions of Matter | 3 | SPI 3221.3.8                 | 25.1-Radioactivity and types of radiation<br>25.2-Radioactive decay and half-life | <ul style="list-style-type: none"> <li>Describe radioactivity through a balanced nuclear equation and through an analysis of the half-life concept.</li> </ul>  | <ul style="list-style-type: none"> <li>See Chapter 25 Resources in Supplemental Materials</li> </ul> | CC:4,6<br>HOP:2,6,7<br>NGSS:HS-PS1-8 |
| End Q 4                            |   |                              |   | <p><b>End of Quarter 4 (AB Schedule)</b><br/><b>End of Quarter 2 for Block Schedule</b></p>   |  |                                      |

How are the inquiry and technology/engineering SPIs covered?

Because these are overarching standards, they are taught and embedded throughout in lab work and follow-up questions to labs.

Consider adding these questions to your lab activities to address these SPIs:

- Based on what you learned in this lab, what follow-up experiment could you design to learn more about this topic?
- Based on your lab results, draw a conclusion and support it with specific data examples.
- Look at your results. How accurate are they? How do you know? How precise are they? How do you know?
- Examine the possible sources of error in this lab. Whether you made these errors or not, discuss the impact of at least three possible errors on your lab results.
- In this lab you had to make *qualitative observations*. Discuss why qualitative observations are more subject to bias than quantitative observations.
- Look at the tools we used in this lab. If money were no object, what additional tools would have increased the accuracy of this lab?

Another way to address the inquiry and technology/engineering SPIs is by using current articles and assigning reading questions that require students to apply engineering design cycle principles such as cost-benefit analysis, “quality of life” improvements, intended audience, etc.

## Additional Chemistry Resources

### Articles

These articles are found on the resources disc under Chemistry Resources.

Articles Recommended for Quarter 1 from the Chemistry Resources Document:

- Chemistry Article Designing Painkillers So That They Are Not Abused
- Chemistry Article Cost Benefit analysis of the use of chlorine
- Chemistry Article Ban Chlorine

Articles Recommended for Quarter 2 from the Chemistry Resources Document:

- Chemistry Article Concerning Pure Water
- Chemistry Article Hydrogen Economy
- Chemistry Article Methyl Alcohol as a fuel

Articles Recommended for Quarter 3 from the Chemistry Resources Document

- Chemistry Article Designing a Pain Killer
- Chemistry Article Hollywood Special Effects
- Chemistry Article The New Alchemy

Articles Recommended for Quarter 4 from the Chemistry Resources Document

- Chemistry Article Salting the Roads
- Chemistry Article Quantum Jump
- Chemistry Article Nuclear Chemistry article

### Formative Assessments

- Resource: Science Formative Assessment by Page Keeley
- A resource folder containing samples of formative assessment for chemistry is included on the resource disc.

### Teaching through Discrepant Events

- Resource: Invitations to Science Inquiry by Tik Liem
- A resource folder containing samples of Chemistry demonstrations for discrepant events is included on the resource disc.