Unit Title: Atomic Structure	**Content Area:** Chemistry	**Grade Level:** High School

Unit Summary: The number of electrons protons and neutrons as well as their organization determines the properties and behaviors of all elements. This basic understanding of elements will drive the rest of the year's studies because this determines how compounds are formed and how chemical reactions proceed. Topics included in this unit are mass numbers, atomic numbers, ions, isotopes, electron configurations, orbital diagrams, Bohr models, quantum numbers, average atomic mass, families, periods, metals, nonmetals, and metalloids.

Engineering Practices:
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
5. Using mathematics and computational thinking

Cross-cutting concepts:
1. Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions 7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Unit Essential Questions:	**Unit Enduring Understandings:**
• How does the organization of protons, neutrons and electrons lead to the properties and function of an element? • What information was used to organize and develop the periodic table?	• Protons and neutrons are located in the nucleus. The electrons are contained in orbitals of varying size and energy that surround the nucleus. The shape, energy and contents of these orbitals determine various properties of elements. • The periodic table was built in such a way that elements are organized by numbers of atomic particles and chemical properties.

Possible Student Misconceptions: Students often confuse formulas for calculating electrons, protons and neutrons - especially when asked to do this for an ion. This is a topic that will probably require skill drilling for most students. Additionally, students will confuse mass numbers with average atomic mass numbers listed on the periodic table. Another shortcoming is that students do not understand that the identity of an element is determined by the protons in the nucleus, hence the atomic numbers. Ions and isotopes are still the same element even after neutrons or electrons have changed. Students also do not remember family names or the difference between families, periods and groups. This can be corrected by spiraling this material into subsequent units throughout the year.

NJCCCS: 5.2.12 A1 and 5.2.12 A3-4 5.2.12.B.1 http://www.state.nj.us/education/cccs/standards/5/5-2-A.htm

NGSS Performance Expectations: *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.
- HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Primary CCSS ELA/Literacy Connections: RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)	**Primary CCSS Mathematics Connections:** MP.4 Model with mathematics. (HS-PS1-8)

Lesson Pace & Sequence

Lesson Title/Number: Lesson 1:Protons, Neutrons and Isotopes	**Learning Objective(s):**SWBAT Calculate Protons, neutrons and electrons SWBAT Identify isotopes	**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now Activity: Students draw the modern model of the atom with labels (taught in first unit)			Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)	
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct instruction: Teacher must teach mass numbers, atomic numbers and isotopes. Engagement ideas: Hold up two models of different elements and ask students to spot the difference between them. (Different elements have different protons, neutrons and electrons) This can also be done to teach isotopes. Analogy: Hold up two cards with different colors of green - both green but they must have different components to get different shades of green		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)	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. (HS-PS1-1),(HS-PS1-3)

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Option1: Have students create a table for at least three elements with the headings atomic symbol, atomic number, mass number, protons, electrons and neutrons. Give students data for some columns and then fill in the rest. Option 2: Game: "Here comes the BOOM" - A bag of cards is given to students in groups of 3 or more. A few cards say "Boom". For every question card that students answer correctly they earn one point, incorrectly they earn a negative point and a BOOM card means you go back to zero.	• Holt Pg. 86 Fill in Table Activity	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) 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. (HS-PS1-1)	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. (HS-PS1-1),(HS-PS1-3)
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can work backwards: instead of giving mass number and atomic number, give them the number of protons, neutrons or electrons and have them work backwards to mass numbers. You could even have students create different combinations of numbers and try to stump their classmates to find the missing information.	• Holt Pg. 87 Students create problems and trade cards	Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1)	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. (HS-PS1-1),(HS-PS1-3)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Example Problems Pg. 89 • Holt Chemistry TE Section 2 Review or Quiz			
Extend: How will students deepen their conceptual understanding through use in new context?	Isotopes are used often in medicine. Connect today's lesson on isotopes to a medical application				
Lesson Title/Number: Lesson 2 Ions		**Learning Objective(s):** SWBAT calculate protons, electrons and neutrons in an ion			**Lesson Duration:** 80 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Students should complete problems similar to the day before as review. These can be chosen based off exit ticket answers from the previous lesson. Whichever level of question the teacher finds the most breakdown is where they should target this bell ringer. It will reinforce skills for students that know it and give a brief re-teach time for students who did not catch it in the previous lesson.			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. (HS-PS1-1)	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Optional Direct Instruction - if this lesson is not taught as an inquiry based lesson using the outline in the explore section - the teacher will need to present this information by direct instruction.		Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)		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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Students can use bingo chips to represent electrons, protons and neutrons for a given element on a place mat with two circles - one for the atom and one for the nucleus. After students build a neutral atom they will be asked to take away or add electrons to create ions. They will be asked to discover the relationship between the charge given and the changes to the electrons. The whole goal of this activity is for students to understand that adding electrons results in a negative charge and taking away electrons results in a positive charge. This is often a point of confusion for students. Note: The place mat will not have rings for electron orbitals as students will not learn this until later in the unit.	• This is another idea for simulating building an atom. It is an online simulation and accompanying packet. The online simulator lets students build an atom with any combination of protons, neutrons or electrons. It will tell the student the element, charge and if it is stable each time. The packet is an inquiry activity to get students to understand the differences between neutral elements, ions and isotopes. • Inquiry Activity Packet: http://phet.colorado.edu/en/contributions/view/3756 • Simulator only: http://phet.colorado.edu/en/simulation/build-an-atom	Planning and Carrying Out Investigations Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)	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. (HS-PS1-1)	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. (HS-PS1-1),(HS-PS1-3)
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Have students work backwards: instead of giving mass number and atomic number, give them the number of protons, neutrons or electrons and have them work backwards to mass numbers. You could even have students create different combinations of numbers and try to stump their classmates to find the missing information. These problems should include both ions and neutral elements so that students can answer these problems when mixed together.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)	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. (HS-PS1-1)	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students will be asked to identify pairs of ions, isotopes or completely different elements. They will be asked to label the pairs with correct labels. This will ensure that students truly understand the definitions and differences between these terms.	• Holt Pg. 87 Students create problems and trade cards	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)	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. (HS-PS1-1)	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Pg. 165 Holt Chemistry TE Quiz or Pg. 165 • Holt Chemistry TE Section Review #11 - change question from electron configuration to calculate the protons, neutrons and electrons.			
Extend: How will students deepen their conceptual understanding through use in new context?	1) Article/worksheet on Water Quality Manager - test ions in water 2) Online game where students are given the number of protons, neutrons and electrons and then asked to determine if it is neutral, positive or negative before deciding what element it is.	• Holt Planner CD-ROM Real World Connection Worksheet 6 • Online game link http://www.learner.org/interactives/periodic/basics_interactive.html			
Lesson Title/Number: Lesson 3 Average Atomic Mass		**Learning Objective(s):** SWBAT write and electron configuration SWBAT write and orbital diagram			**Lesson Duration:** 40 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	OPTION 1: Class wide Discussion: Ask students what the decimal number on under the elements on the periodic table may represent. After they discuss/provide a few ideas present them with an example set of isotopes and then have them compare it to the average atomic mass on the periodic table. See if they can determine that it is an average. OPTION 2: Give students a series of test scores and ask them to write a formula to find the average score of the class. They can then relate this formula to calculating average atomic mass later.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		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. (HS-PS1-1),(HS-PS1-3)
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students should be able recognize if their answers are correct when they calculate averages. Show them an average of test scores where the average is outside the range of given scores. Some students will instantly pick up that the average must be incorrect. Have them then talk about how this can help them test their own work.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)	ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	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. (HS-PS1-1),(HS-PS1-3)

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Direction Instruction: Provide formula for average atomic mass, reinforce definition of isotope and complete practice problems calculating average atomic mass.	• Online Simulation: This simulation allows students to create mixtures of various isotopes to see how the average atomic mass will change. It also allows students to visually see 'nature's mix' of isotopes and the resulting average atomic mass. This is a very visual representation of the abundance of various isotopes. It is suggested that the simulation be presented on the board after the formula has already been introduced and sample problems solved. • Website: http://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Have students rearrange equations to find missing information: Instead of providing students with multiple isotopes and having them calculate average atomic mass, provide students with average atomic mass and some isotopes and have them rearrange the equation to find it.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		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. (HS-PS1-1),(HS-PS1-3)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Pg. 236 Holt Chemistry TE Practice Problems Pg. 233 • Holt Chemistry TE Sample Problem E and additional practice Pg. 240 • Holt Chemistry TE Section 2 Review			
Lesson Title/Number: Lesson 4Quantum Numbers		**Learning Objective(s):** SWBAT write and electron configuration SWBAT write and orbital diagram			**Lesson Duration:** 40 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Review Structure of atom. Have each student draw picture in pencil of what they think Calcium looks like. Save for end of class.		Developing and Using Models Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)		
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Teacher led class discussion: Addresses require multiple pieces of information to be accurate. Electrons also have multiple ways to describe their locations.			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. (HS-PS1-1) 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Direct Instruction: The teacher must introduce each quantum number, its meaning, possible values and most likely a graphical representation of its		Obtaining, Evaluating, and Communicating Information Communicate scientific and	PS1.A: Structure and Properties of Matter Each atom has a charged substructure consisting of a	Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

	shape. Students will probably need a graphic organizer or guided notes to accompany this lesson. In addition to labeling electrons with quantum numbers and defining each number/symbol, students can also draw each orbital or color code the different quantum numbers.		technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)	
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	1) Give students a set of quantum numbers and have them explain why it's invalid. 2) Give students a set of quantum numbers and have students analyze which possible elements it could describe.		Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1) 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	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. (HS-PS1-1),(HS-PS1-3)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Electron Configurations and Periodic Table Multiple Choice Questions: https://njctl.org/courses/science/chemistry/electron-configurations-and-the-periodic-table/electron-configurations-and-the-periodic-table-multiple-choice/#			
Extend: How will students	Take out the drawing from the	• Online game link:	Obtaining, Evaluating, and	ETS1.C: Optimizing the Design	Stability and Change

deepen their conceptual understanding through use in new context?	beginning of class. Have students modify it into a Bohr model with rings containing the correct number of electrons/ring based on the electron configuration. An extension of this is an online game where students place elements in the correct location on the periodic table based on how many electrons are located in each ring.	http://vitalnj.pbslearningmedia.org/asset/phy03_int_ptable/	Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)Developing and Using Models Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)	Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Lesson Title/Number: Day 5 Electron Configuration and Orbital Diagram		**Learning Objective(s):** SWBAT write and electron configuration SWBAT write an orbital diagram			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Place a partially filled in table of quantum numbers/definitions on the board. You can have students complete this at their seat before coming to the board or cold call students to complete it. Also have students recall that quantum numbers are like an address of a single electron. Electron configurations are a way to list the locations of many electrons at once - all the			ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	

	electrons in an element.				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct instruction: Teacher must lead lesson on electron configurations and orbital diagrams. This lesson must include orbital filling rules and example problems. For orbital diagrams relate the arrow drawing rules to real life experiences. For example, Hund's Rule can be explained as the "Empty Bus Seat" Rule. When you take a public bus you fill empty seats before doubling up anywhere. Aufbau Principle is the "Lazy Tenant Rule" - Tenants fill lower apartments before upper apartments because they are too lazy to walk up all the stairs.	• This website has a slide show that may be helpful for this lesson https://njctl.org/courses/science/chemistry/electron-configurations-and-the-periodic-table/# • This website has an electron configuration tutorial with various visual representations of the topic. http://www.chemtutor.com/struct.htm#con	Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1) 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Training wheel activity - students are given problems that are partially solved to begin and then slowly are given problems with less and less solved for them. Eventually they will complete the problem all by their own. This can be used for electron configurations and orbital diagrams.	• Alternate Idea: Online activity where students visually build an orbital diagram and the atom itself. It is an excellent re-enforcement of quantum numbers/connection of quantum numbers to orbital diagrams. Online activity: http://www.learner.org/interactives/periodic/elementary_interactive.html	Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1) 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

				ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Students can label periodic tables with the letters and numbers of electron configuration. For example "2s". This can also be color coded for more visual students.		Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1) 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	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. (HS-PS1-1),(HS-PS1-3)
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	1) Provide students with an electron configuration and have them determine which element it is. 2) Give students an electron configuration with a mistake and have them explain why it's wrong.	• Pg. 99 Holt Chemistry TE Section 3 Review #4 and 8	Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1) The periodic table orders elements horizontally by the number of protons in the atom's	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they

				nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	remain stable. (HS-PS1-6)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Pg. 99 Holt Chemistry TE Section 3 Review and additional practice			
Extend: How will students deepen their conceptual understanding through use in new context?	1) Have students answer a short answer question on the homework explaining why quantum numbers aren't needed to describe the locations of protons. 2) Online activity where students visually build an orbital diagram and the atom itself. It is an excellent re-enforcement of quantum numbers/connection of quantum numbers to orbital diagrams.	• Online activity: http://www.learner.org/interactives/periodic/elementary_interactive.html		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. (HS-PS1-1)	
Lesson Title/Number: Lesson 6 Exceptions and shorthand		**Learning Objective(s):** SWBAT write an electron configuration for an element with an exception and SWBAT write the shorthand/noble gas configuration for an element			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Before assigning the Do Now, look at the previous day's exit tickets. Determine what level of questioning students had the biggest break down in understanding and assign a similar question as the Do Now.				

Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct instruction: How many people like shortcuts?!!! Strike a bargain with the students. You'll teach them a shortcut to save how much writing/drawing they must do, but in exchange you need to teach them about a few elements that don't follow the rules. After students are on board then teach them noble gas/shorthand configurations as well as exceptions to the rule. Be sure to include practice problems using both skills.	• This website has a slide show that may be helpful for this lesson : https://njctl.org/courses/science/chemistry/electron-configurations-and-the-periodic-table/#			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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Students will complete a "Climb the Ladder" Activity with practice problems. Students work independently solving #1 posted on the wall. If they get it correct they move onto #2. If they get it incorrect they sit at table #1 and complete remedial problems similar to the one they couldn't complete on the wall. If they complete the remedial work they then move onto #2 on the wall. Students must correctly complete all problems through #5 or #6 (depending on how many steps are added). For these objectives steps could be as follows 1 - simple electron configuration 2- longer configuration perhaps with d or f orbitals #3 short orbital diagram #4 longer orbital diagram perhaps with d or f orbitals. #5 shorthand configuration #6 shorthand configuration with exception. Students that quickly complete through #6 without mistakes can then be re-assigned to students at lower levels to help them learn the material. This activity sorts students into differentiated groups as well as shows the teacher which students are in most need of remediation.			ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	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. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can be provided with incorrectly completed shorthand or exception problems. They must find the mistake and explain in a short answer/essay why it is incorrect.		Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and		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

			the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)		phenomena. (HS-PS1-1), (HS-PS1-3) Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment				
Lesson Title/Number: Lesson 7Periodic Table Labeling		**Learning Objective(s):** SWBAT identify metals, nonmetals, metalloids, families, periods on the Periodic table			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Give students three minutes to write down everything they know about the periodic table and how it's organized. They students can make a class list on the board.		Developing and Using Models Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4)		
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction: Teacher leads lesson on the organization of the periodic table including families, periods, rows, diatomic elements, metals, nonmetals, and metalliods.	• This website has a slide show that may be helpful for this lesson https://njctl.org/courses/science/chemistry/electron-configurations-and-the-periodic-table/#		PS1.A: Structure and Properties of Matter 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	

Explore: What hands-on/minds-on common experience(s) will you provide for students?	1) Students can use crayons/markers to color code the periodic table with all the information presented on family names, metals, nonmetals, metalloids, diatomic elements and groups/periods. 2) Online game: What doesn't belong - reinforces idea that elements from the same family have similar properties. Low rigor activity perhaps best for lower level students or intro activity.	• Pg. 124-131 in Holt Chemistry book is an excellent reading section for families and groups of the periodic table. Students can color code a blank periodic table as mentioned left, they can fill in a periodic table with notes on families or they could read this section with guided notes where they fill in important information. This section of the book can be well used with any form of graphic organizer. • Online game http://www.learner.org/interactives/periodic/box_interactive.html	Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	PS1.A: Structure and Properties of Matter 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.) ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	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. (HS-PS1-1),(HS-PS1-3)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Pg. 122 Holt Chemistry TE Quiz or Section Review #8-14			

Extend: How will students deepen their conceptual understanding through use in new context?	Students can be provided with samples of elements from each family to hold and touch while completing the exploration of the periodic table activity.	• Element activity: Holt Chemistry Pg. 119 Teacher's edition • Article on which elements are in the human body: http://www.sciencelearn.org.nz/Contexts/Just-Elemental/Science-Ideas-and-Concepts/The-essential-elements There is a similar "consumer focus" article on essential elements on Pg. 123 of the Holt textbook. • Article on properties of metals and metal alloys : http://www.sciencelearn.org.nz/Contexts/Just-Elemental/Science-Ideas-and-Concepts/Metals-alloys-and-metal-compounds • Interactive Periodic Table: http://www.sciencelearn.org.nz/Contexts/Just-Elemental/Science-Ideas-and-Concepts/The-essential-elements		PS1.A: Structure and Properties of Matter 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	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. (HS-PS1-1),(HS-PS1-3)
Lesson Title/Number: Lesson 8 Review		Online Quiz for Review: http://www.learner.org/interactives/periodic/testskills.html			**Lesson Duration:** 40 minutes
Lesson Title/Number: Lesson 9 Test		**Learning Objective(s):**			**Lesson Duration:** 40 minutes
Lesson Title/Number: Lesson 10Flame Test Lab		**Learning Objective(s):**SWBAT draw a Bohr model of an element SWBAT identify an element based on its flame color			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***

Elicit: How will you access students' prior knowledge?	Do Now: Assign students one of three metals to draw a Bohr Model. After they complete it they can share it with two students of other metals and check each other for mistakes.		Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	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. (HS-PS1-1)	
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction or pre-reading material on fireworks. This will connect today's lesson to how fireworks are created.	• Show introductory video of how fireworks gain their coloring: http://vitalnj.pbslearningmedia.org/resource/phy03.sci.phys.matter.fireworkcol/fireworks-making-color/		PS1.A: Structure and Properties of Matter 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Flame Test Lab - students are given different chloride chemicals which they can test in a flame. If limited supplies this can be done with Q-tips and candles. List of Flame test chemicals LiCl, SrCl2, BaCl2, CaCl2, NaCl, CuCl2, and KCl. If these are not available the Holt Chemistry Textbook version completes the experiment with sulfates as well.	• Pg. 772 Holt Chemistry TE	Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)	PS1.A: Structure and Properties of Matter 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	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. (HS-PS1-1),(HS-PS1-3)
Explain: How will you help students connect their	Students will use observations on colors of known elements to		Planning and Carrying Out Investigations Plan and conduct	PS1.A: Structure and Properties of Matter	Patterns

exploration to the concept/topic under investigation?	identify an unknown element.		an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)	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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.) ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	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. (HS-PS1-1),(HS-PS1-3)
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Extension/Review of Pre-reading and Direct Instruction. Students will be presented with how electrons can jump orbitals when put in a flame before dropping back down producing a flash of colored light.			PS1.A: Structure and Properties of Matter 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. (HS-PS1-1) (Note: This Disciplinary Core Idea is also addressed by HS-PS1-1.)	Stability and Change Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Students will write a lab report of their findings including an introduction, hypothesis, procedure, data section and conclusion. This lab report should be graded with a rubric or even a checklist that details all the information students should include and in what order. Because it is still early in the		Obtaining, Evaluating, and Communicating Information Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats	ETS1.C: Optimizing the Design Solution Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (secondary to HS-PS1-6)	

	year students can be given a fill in the blank type handout for the lab report instead of being expected to write a report from scratch. This project can be tailored to the student's academic level or experience with lab reports. Another approach to teaching lab report writing is to focus on one section per report for the beginning of the year. Teach a lesson on introductions and have students focus their efforts on writing a strong introduction. Then focus on procedure, analysis and so on.		(including orally, graphically, textually, and mathematically). (HS-PS2-6)		
Extend: How will students deepen their conceptual understanding through use in new context?	This lab focuses on elements that provide color to fireworks, but the resource to the right discusses all elements used in fireworks and to what purpose.	• Online Periodic table of elements most used in fireworks and for which purpose: http://www.pbs.org/wgbh/nova/assets/swf/1/periodic-table/periodic-table.html			