Unit Title: Mole Calculations	**Content Area:** Chemistry	**Grade Level:** 9-12

Unit Summary: This unit teaches introductory calculation skills needed for the remainder of calculations done throughout this course. Molar mass and beginning stoichiometry skills are needed for all calculations involving chemical reactions or predictions of products. Without these foundation skills students will not be able to progress with the mathematical portion of this course.
Additionally, this unit will build on students' current understanding of compounds with the topic of % composition. This knowledge is a continuation of previous knowledge as well as gives
students a direct application of chemistry to their daily lives – especially in the realm of nutrition which we discuss at the conclusion of this unit. This unit covers the topics of molar mass, molar volume, Avogadro's number, one step conversions between moles, grams and liters, empirical/molecular formulas and percent composition.

Cross Cutting Concepts:
3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Science and Engineering Practices
5. Using mathematics and computational thinking

NOTE: Depending on the sequencing of units or personal choice, molar volume may be omitted from this unit. It may have been included in gas laws instead.

Unit Essential Questions:

- How does dimensional analysis permit us to change units when baking, completing experiments or taking household measurements?
- What is a mole of a substance?
- If you have 100 grams of water, how many moles, particles and liters are present?

Unit Enduring Understandings:

- Dimensional analysis is a method of calculations and conversions that is based on units of measurement.
- A mole is a unit of measurement. A mole of any substance contains 6.02*10^23 atoms of that substance. The mass of a mole is dependent on the molar mass of that substance.
- Dimensional analysis and a few key conversion factors can be used to convert between atoms, liters, grams and moles. The conversion factors are:
  1 mole = 6.02*10^23 atoms
  1 mole = the molar mass of the element or compound
  1mole = 22.L liters of a gas at STP

Possible Student Misconceptions: Students often confuse empirical and molecular formulas. They also will forget the steps to calculating and empirical formula. Significant figures will become an issue in this unit if they have not been taught earlier in the year or in a previous unit. If student knowledge is lacking on this subject it is suggested that the teacher does some pre-work on this topic. Additionally, students should have a basis of knowledge in scientific notation. Again, if student knowledge is lacking the teacher may want to pre-teach or review this information. For most students this will be their first experience with dimensional analysis unless they have used it in math, physics or other science course previously. This process will need to be broken down into steps and constantly re-enforced throughout the unit. Students should always be reminded that units must cancel each other. It will most likely be necessary to do many differentiated activities throughout this unit as some students will pick this up very quickly and others will be intimidated by it. Some such activities are included in this guide but please add other ideas for differentiated class activities.

NJCCCS: 5.2.12.B.3 The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept.

NGSS Performance Expectations: *Students who demonstrate understanding can…*

- **HS-PS1-6.** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
- **HS-PS1-7.** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Primary CCSS ELA/Literacy Connections: WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Primary CCSS Mathematics Connections: MP.2 Reason abstractly and quantitatively. HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.3Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Lesson Pace & Sequence

Lesson Title/Number: Lesson 1 Moles and Atoms	**Learning Objective(s):**	**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?	Do Now: Have students list as many counting terms as they can, for example dozen, ream, deck, etc. Have students then share answers on the board of the term they chose and how many that term represents.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7) Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (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)	Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction: Introduce conversion problems using terms that students know - for example dozens or weeks/days. Start off with simple problems such as this "Desiree needs to practice her trumpet every day for 44 consecutive days in order to be ready for her band audition. How many weeks is this?" After the initial steps of dimensional analysis have been completed introduce these steps in the context of a word problem: "Sally works in her aunt's bakery. Her cake recipe calls for 3 eggs per cake. If she has 13 dozen eggs, how many cakes could she make?" Additionally, you will need to provide students with context of how big a mole is. You can do this with many YouTube videos out there (links not included) or with simple	• Dimensional Analysis Intro Video: http://chemcollective.org/activities/tutorials/stoich/dimensionalanalysis	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

	examples students can relate to. Ex.1 One mole of marbles would cover the entire earth (oceans included) for a depth of two miles. Ex. 2 A mole of paper stacked on top of itself would reach to the moon and back about 80 billion times. Ex. 3 If you could count at the rate of 1 million numbers a second it would take about 20 billion years to count one mole. Students need to not memorize these facts, but realize that atoms are so tiny that we need a whole new unit to talk about them. Hence, the mole				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Students should complete practice problems. As mentioned above, differentiated activities work well for dimensional analysis with moles. Here is an example of an activity that can be used: Training wheels/leveled worksheets - Students choose from three levels of worksheets Red, Yellow or Green. Red is "stop I need help", yellow is "I'm ok I just need to work a little slow and ask questions" and Green is "I'm ready to solve these problems because this material makes sense to me." Each of these worksheets has the same questions on them - but the lower levels have hand written hints from the teacher or partially solved problems. Each student chooses which level they feel comfortable with, but students can ask anyone in the room for help or to work together because all the problems are the same.	• Video introducing the mole and practice problems: http://chemcollective.org/activities/tutorials/stoich/the_mole	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)	Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

	Additionally, if the assignment is graded each student completed the same amount of work - some just had additional help.				
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Students should practice these calculations more, but in context. After students can complete simple problems with moles and atoms, word problems can be introduced. Be sure that students are comfortable solving problems from moles to atoms and also atoms to moles. They must be comfortable with both directions.	• This website has a long list of resources for teaching mole calculations: http://www.scilinks.org/MyScilinks/SearchByCode.aspx?Enc=1&Scilink=YETfY9r6WvOA=&EntPt=YP+w8/+elL/sgdfvkltszSg==	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?	Students can be provided with solved problems and asked to find the mistake, or they can write problems for classmates to solve.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment	• Holt Chemistry Pg. 229 Practice 1-5			
Extend: How will students deepen their conceptual understanding through use in new context?	Ask students to create problems using conversion units and food packing terms. Resource at right.	• Holt Chemistry TE Pg227	Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Lesson Title/Number: Lesson 2 Molar Volume		**Learning Objective(s):** SWBAT convert between moles and liters for a given element			**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	Have students recall what they				

students' prior knowledge?	learned about the properties gases in the second unit of the year. This can be done with them creating an open ended list, or it can be done as a fill in the blank chart/paragraph.				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction: The teacher will introduce molar volume and complete practice problems. Moles can be used to measure atoms, they will be used later to measure mass and they can also be used to measure volume - but only in the case of gases. Molar volume = 22.4L .		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Students complete practice problems. After performing a sample problem for the class have small groups each solve a problem converting between moles and liters for a different gas. As they share answers stress that 22.4L can be used for any gas at STP. Be sure that students are comfortable solving these problems in both directions, moles to liters and liters to moles. Again, a differentiated activity can be used here. Assign the whole class three short questions and then have them score their work. Based on scores you can sort them into groups or pairs. Students can be matched with other students of the same level, or you can match high/low with one another so they can help each other.		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)	Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Students can complete more practice problems, but of a higher level. After students can complete simple problems with moles and atoms, word problems	• This website has a long list of resources for teaching mole calculations: http://www.scilinks.org/MyScilinks/SearchByCode.aspx	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated		

	can be introduced. Students need an opportunity to answer these types of problems in context.	?Enc=1&Scilink=YETfY9r6WvOA=&EntPt=YP+w8/+elL/sgdfvkltszSg==	sources of evidence, prioritized criteria, and tradeoff considerations. (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 solved problems and asked to find the mistake, or they can write problems for classmates to solve.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment.	• Mole Calculations Practice Problems: https://njctl.org/courses/science/chemistry/mole-calculations/mole-calculations-practice-problems/#			
Lesson Title/Number: Lesson 3 Molar Mass and combined calculations		**Learning Objective(s):** SWBAT calculate molar mass for a given element, compound or hydrate SWBAT convert between moles and grams for a given element, compound or hydrate SWBAT complete combined mole calculations involving molar mass, volume and atoms			**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?	Review problems from the previous lessons - specifically make sure students remember conversion factors for atoms, and liters as well as the steps to make sure units cancel.				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students can measure molar mass for a given set of elements using a balance - completed in groups or as a class to make it more time appropriate	• Quick hands on lab: Page 225 of Holt Chemistry TE			

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Direct Instruction: The teacher must present a mini lesson on molar mass, mass/mol conversions and three step conversions. When presenting three step problems it is suggested to provide students with a flow chart or have the class create on Students will complete a "Climb the Ladder" Activity. 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 - molar mass of an element 2- molar mass of a compound #3 moles to grams of element #4 grams to moles of compound #5 three step starting with liters and ending with grams of a compound #6 three step starting with grams of compound and ending with atoms 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.	• Video on how to calculate molecular weight http://chemcollective.org/activities/tutorials/stoich/calculating_molecular_weight • Flow Chart/road map for combined mole calculations with grams, liters, atoms and moles http://chemtutor.com/mols.htm#road	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)	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 complete additional practice. After students can complete simple problems with moles and atoms, word problems can be introduced. Students need an opportunity to answer these types of problems in context.	• Stoichiometry Tutorials – Using Molecular Weights: http://chemcollective.org/activities/tutorials/stoich/using_mw	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?	Students complete additional practice by being provided with solved problems and asked to find the mistake, or they can write problems for classmates to solve.	• This website has a long list of resources for teaching mole calculations: http://www.scilinks.org/MyScilinks/SearchByCode.aspx?Enc=1&Scilink=YETfY9r6WvOA=&EntPt=YP+w8/+elL/sgdfvkltszSg==	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment.	• Holt Chemistry Pg. 233 Section 1 review #9-13			
Lesson Title/Number: Lesson 4 % Composition		**Learning Objective(s):SWBAT calculate % composition for a given compound or hydrate**		**Lesson Duration: 40 min**	
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?	Have students calculate percentages - perhaps they calculate them on a recent quiz or test. Give them an example out of one hundred and then an example of an odd number. As a group ask them for a generic % equation. Example: What you want/total *100. This generic equation can also be used for today's lesson.		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)	Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction: Teacher must define % composition, provide the formula and put it into real world contexts. % composition can be related to food labels - how much of a particular food is fat, how much of your daily value have you already consumed, etc. Or it can be related to other aspects of consumerism - how much of a material is recycled plastic or how much of an item is made from metal (perhaps someone has metal allergies). There can also be a discussion of car emissions and how they must meet certain percentage requirements to be legal in some states.	• Website with sample percent composition lesson: http://www.ausetute.com.au/percentc.html	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Students complete one of many % composition activities with candy. Students must learn to count how many of each candy and incorporate the mass of each type of candy into their calculations. This is an excellent segue into percent composition of compounds. Many labs/activities like this are found online, but one example is cited to the right.	• Percent Composition of M&M's Lab: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CC0QFjAC&url=http%3A%2F%2Frrhs.roundrockisd.org%2FUserFiles%2FServers%2FServer_9304%2FFile%2FEmery%2F8%2FPercent%2520M%26M%2520PAP.doc&ei=Q6LfU9TnCpDksASw8YKICA&usg=AFQjCNFlUhAfgkZl_LkbWbDQdBmBCXoRDg&sig2=oVxmnyq5ib0WHwo4TnKA0Q&bvm=bv.72197243,d.aWw	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (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)	Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students can work backwards for the mass of a compound/element if given the % or the molecular mass of the compound. Additionally, students can be asked to analyze their calculations. "Which compound has a higher percentage of oxygen?" "Which compound has a higher % of nonmetals?" Etc.		Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment.	• This website has tons of mole calculations questions to pull from https://njctl.org/courses/science/chemistry/mole-calculations/mole-calculations-practice-problems/#			

Extend: How will students deepen their conceptual understanding through use in new context?	Introduce the students to carbon monoxide poisoning and detectors. After reading some information from the website at the right or another source, give students take home problems on various levels of carbon monoxide. Have them determine which combinations of gas are dangerous and which are not.	• http://www.carbon-monoxide-survivor.com/carbon-monoxide-levels-in-the-air.html	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)
Lesson Title/Number: Lesson 5 % Composition Lab		**Learning Objective(s):** SWBAT calculate the % composition of sugar in bubble gum OR SWBAT calculate the % water in a hydrate (this experiment is not described here but referenced in the first resource box			**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?	Students can review % composition calculations from homework or by sharing the formula on the board. This should be quick so there is enough time for the experiment, specifically if it is the hydrate experiment.	• ALTERNATE EXPERIMENT: % composition of hydrates Holt Chemistry TE Pg. 780-785			
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction: Quick Mini Lesson/Application by the teacher: Relate % composition to food labels - specifically contents of sugar in various foods. You can even provide students with various foods to pass around so they can analyze labels. Additionally, they should be given some pre-reading on the materials inside gum. What		Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)

	happens when it is chewed? Why does it change shape/mass?				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Lab Activity: % composition of sugar in bubble gum. Students will hypothesize what % of sugar is contained in a piece of bubble gum. Different groups can have different flavors to compare data afterwards, but each student should measure and chew their own gum (unless they have braces or medical restrictions). They will measure the gum before chewing and after chewing. Five min is recommended for double bubble brand to keep all data accurate to a time frame. However, timing can be changed for different gums, or you can have different groups chew different amounts of time to add more variables and an opportunity to graph sugar loss. If students assume that all mass lost was sugar and the mass of saliva on the gum is negligible, they can divide the two masses to get % sugar. These assumptions will introduce plenty of error to the experiment so students can also do a % error calculation using the amount of sugar listed on the wrapper. This is an excellent lab to lead some in depth discussions of error. ALTERNATE IDEA/DEMO: Find the amount of water in un-popped popcorn. See reference to the right	• Bubble Gum – Calculating Percent Sugar: http://www.westminster.edu/acad/sim/pdf/sbubblegumcalculatingpercentsugar.pdf. The lab activity linked above isn't incredibly detailed on procedure and does not include the error analysis piece, but it does provide excellent background reading on bubble gum. • ALTERNATE LAB/DEMO: Holt TE Page 241 Demonstration	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Elaborate: How will students apply their learning and develop a more sophisticated	Students complete analysis and calculations. The lab can be combined with review questions		Using Mathematics and Computational Thinking Use mathematical		Science assumes the universe is a vast single system in which basic laws are consistent. (HS-

understanding of the concept/topic?	on % composition of hydrogen, oxygen and carbon in a sugar molecule itself. Students could even be given questions on comparing straight sugar to high fructose corn syrup seeing as how concern over this appears in the news quite often.		representations of phenomena to support claims. (HS-PS1-7)		PS1-7) The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Students should write a lab report for this experiment. This should be graded with rubric or a checklist not only to keep grading consistent but to give students a template to follow on part of a report. For lower level students or classes with less prior experience, lab report writing can be done on a more fill in the blank template. By the end of the chemistry course hopefully all students would be able to write without the fill in the blank - but by using a rubric or checklist. Additionally, if students are unfamiliar with lab report writing, the year can be broken down into areas of focus. One lab report can focus on procedure, one on introduction, another on data/calculations and another on conclusions. Give mini lessons on the section of the lab report that is being graded most carefully. Hopefully by the end of the year students can combine these mini lessons to create one complete lab report.		Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (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)	Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)
Lesson Title/Number: Lesson 6 Empirical and Molecular Formulas		**Learning Objective(s):** SWBAT distinguish between empirical and molecular formulas SWBAT calculate empirical and molecular formulas if given percent composition			**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?	Give the students the following scenario: "You work in a medicine producing laboratory. You have found that Medicine X works well to cure a new disease that is spreading throughout the US. Unfortunately the scientist who created Medicine X has passed away in a fire and his notes on the medicine have all burned. Before you begin to produce this life saving medicine, what must you discover about it first?" After the students discuss in small groups or respond to the prompt individually in writing, share with the class. Students must realize that the first step is finding out what elements are inside the medicine and in what ratios.	• Idea from Holt TE Pg. 242	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Direct Instruction: The teacher must teach the definition of empirical and molecular formulas as well as the steps to calculate both. Sample problems should be done with the whole class before students attempt them on their own.	• Video introducing empirical formulas: http://chemcollective.org/activities/tutorials/stoich/empiricalformula	Using Mathematics and Computational Thinking Use mathematical representations of phenomena to support claims. (HS-PS1-7)		

Explain: How will you help students connect their exploration to the concept/topic under investigation?	When calculating empirical formulas, here is a rhyme that may help: 1) % to mass, 2) mass to mole 3) divide by small 4) multiple til whole. As for differentiating, it may be best to give lower level math students a problem that results in whole number ratios without multiplying - but then you have to ensure that the rhyme does not confuse them.	• This slideshow has some problems already solved. Students can look at a solved problem and label with the pieces of the rhyme. https://njctl.org/courses/science/chemistry/mole-calculations/#	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)	Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Students will learn this topic best with repetition of steps. Plenty of practice problems should be provided. Videos are linked to the right as well as practice problems in the Chemistry textbook. The textbook also provides many real-world applications or word problems for this topic.	• Videos on how to calculate both empirical and molecular formulas 1)http://chemcollective.org/activities/tutorials/stoich/ef_molecular 2) http://chemcollective.org/activities/tutorials/stoich/ef_analysis Holt TE Pg. 241-248	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Administer an exit ticket, quiz or other assessment.	• Pg. 28 Holt Chemistry Section 3 Review			
Extend: How will students deepen their conceptual understanding through use in new context?	Have students read about serotonin in the brain and then calculate the empirical and molecular formulas.	• Pg. 246 Holt TE	Constructing Explanations and Designing Solutions Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)		Structure and Function Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)

Lesson Title/Number: Lesson 7 Test	**Learning Objective(s):**	**Lesson Duration:** 40 minutes